NATIONAL GEOGRAPHIC

RESOURCE LIBRARY | LESSON

It's All About the Resources

Students brainstorm what they know and need to learn about endangered species, in order to best answer the driving question for the unit. Students then engage with a variety of sources about the Sumatran rhino to learn about conservation concepts, including causes of extinction, food webs, and ecosystem services. This lesson is part of the *Extinction Stinks!* unit.

GRADES

6, 7, 8

SUBJECTS

Biology, Ecology, Conservation

CONTENTS

4 Activities

In collaboration with

educurious
learning that connects

ACTIVITY 1: SOS—SAVING OUR SPECIES | 50 MINS

DIRECTIONS

This activity is part of the Extinction Stinks! unit.

1. Introduce the *Extinction Stinks!* unit with a video and interactive activity on personal thresholds for conservation.

- Show students the *Survival of the Fittest* video, ending at minute 2:25, after "We don't really know when we are going to cross thresholds."
    - The video claims that catastrophe doesn't come with losing a single species, but it can happen once we cross a threshold.
- Ask: *What is a threshold*?
    - Guide students to the idea from the video that a threshold is an amount of species lost that leads to disruptive, irreversible change in that ecosystem.
- Have students imagine that they are in one of their favorite ecosystems (e.g., a rainforest, the ocean, or a local park).
- Ask them to raise their hand if they think that losing one percent of species there would lead to disruptive change.
    - Continue prompting students with higher percentages (e.g., 10 percent of species lost, 25 percent of species lost).
    - Keep increasing the percentage until all students have raised their hand to indicate their personal threshold for species loss that would lead to disruptive change in that ecosystem.
    - Point out that different students' thresholds were at different levels, indicating differences in opinion on how much species loss is too much.
- Explain that every species that is lost is one step closer to that threshold where an ecosystem experiences irreversible disruption. This unit is about understanding extinction and its many impacts on local ecosystems and humans, and considering options for preventing extinction from occurring.

2. Define different levels of conservation status using an infographic.

- Display the *Endangered Species Categories and Criteria* chart on the board or distribute paper copies to small groups of students.
- As a class, create a working definition for the key vocabulary for the activity: threatened, endangered, extinction, species, and ecosystem.
    - These definitions could be recorded in student notebooks or in a common glossary available to students.

3. Introduce students to the Sumatran rhinoceros and the goals for the unit using an introduction video and a *Know & Need to Know* chart.

- Introduce students to the unit's driving question and final project:
    - Driving question: "How can we prevent a species from going extinct while also meeting the needs of humans and other local species?"
    - Final project: Students will work together as a class to study the Sumatran rhino, a species at high risk of extinction. This supports their subsequent work in small groups to address issues specific to a different target species. Students' final products will provide recommendations about how best to protect their target species from going extinct. They will give a pitch to try to secure funding for their conservation project.
- Create a class *Know & Need to Know* chart based on students' understanding and questions about the unit and its driving question.
    - Use the process below to elicit and record students' ideas and questions related to the unit, which can be revisited over time.
    - Show the *Saving the Sumatran Rhino* video.
        - Before playing the video, locate Sumatra and Indonesia on a map or globe to give context for where the species lives.
    - Using the video as a springboard to discuss issues pertaining to endangered species in general, prompt students to discuss the following questions with a partner, and then share their responses with the class:
    - *What do we already know about conservation solutions to help prevent endangered species' extinction, while balancing the needs of other local species and humans?*
    - Examples may include:
        - Endangered species need habitat to live in.
        - Endangered species need food and water.
        - Humans may have competing needs with endangered species, such as using habitat for industries or providing food or fuel.
    - *What do we need to know to develop solutions for how to best protect endangered species and the needs of other local species and humans?*
    - Examples may include:

    - Why a particular endangered species is vulnerable
    - How to balance human use with species' use
    - How species are identified as endangered

- Tell students that they will revisit the class *Know & Need to Know* chart over the course of the unit as they learn more to see what they can move from the "Need to Know" to "Know" category.

4. Have students respond to an exit ticket prompt to elicit their initial ideas about strategies to help protect the Sumatran rhino from extinction.

- Ask students to respond individually to the following exit ticket prompt: *At the end of the video, the speaker said that the primary goal is to make "one effort to boost the number of rhino births every year." Based on what you have learned so far, does this seem like a good strategy to save the Sumatran rhino from extinction? Why or why not?*
- Possible responses include:

    - Reproduction is important to increase population numbers.
    - Reproduction alone is not enough. For example, habitat protection must also be in place.
    - Restoring land to currently unprotected rainforests is also important.
    - Understanding the full scope of the Sumatran rhino's life history matters for protection of the species.

Tip

Step 1: Although the video is correct in saying that individual species loss does not always lead to major ecosystem disruption, "keystone species" are critical to an entire ecosystem's normal functioning. It would be very hard to recover from losing an ecosystem's keystone species, such as wolves in the Yellowstone ecosystem.

Tip

Step 1: You may choose to distinguish between human-driven extinction and the natural rate of extinction. Without human influence, extinction would still be occurring at a rate 100-1,000 times slower than what scientists currently observe. The goal of this unit is to focus on preventing human-driven extinction.

Tip

Step 2: In the classification chart, the differences between "endangered" and "critically endangered" are listed. Though it is not required for the purpose of this unit, you may want to discuss the differences between those two classifications so that students understand the different levels of urgency that each designation represents. The Sumatran rhino, the class focal species, is critically endangered.

Tip

Step 3: A *Know & Need to Know* chart is an excellent way to draw out student thinking and create a desire to uncover more information. Read more about this tool in Opening Paths.

Tip

Step 3: You might choose to play the *Saving the Sumatran Rhino* video twice: once for understanding, and the second time for students to take notes on what they know or need to know to answer the driving question for this focal species.

Informal Assessment

Use students' responses to the videos and creating the class *Know & Need to Know* chart to evaluate their prior knowledge and initial thinking about endangered species and extinction. This information can be used to leverage and build on students' ideas in subsequent activities.

Extending the Learning

Explore a local species using the U.S. Fish and Wildlife Service's Endangered Species Finder. You could choose to learn more about these species as one or more of the target species in Lesson 2, *Eliminating Extinction—It's Complicated,* if you can find grade-appropriate resources.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology
- Conservation

Learning Objectives

Students will:

- Understand the differences between major categories that describe species' conservation status, including vulnerable, endangered, and extinct.
- Identify the Sumatran rhino as a species at risk of extinction.
- Share what they already know and what they need to know to protect endangered species without compromising the needs of other species, including humans.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Visual instruction

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

- 21st Century Themes
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Obtaining, evaluating, and communicating information

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.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and Effect
• **Disciplinary Core Ideas LS2.A: Interdependent Relationships in Ecosystems:**
• **MS-LS2: Ecosystems: Interactions, Energy, and Dynamics:**
MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem
• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

Background Information

Scientists estimate that the rate of species extinction today is tens to hundreds of times higher than before humans lived on the planet. In addition to habitat protection and restoration and minimizing exploitation, humans can use technology and creative problem-solving to protect threatened species. Humans are working to understand how best to conserve many species, including the Sumatran rhino, through studying their ecological and reproductive needs and minimizing pressures on their ecosystems.

Prior Knowledge

["Students should be familiar with the basic definitions of an ecosystem and a species, although these will be reviewed during the activity."]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
ecosystem	*noun*	community and interactions of living and nonliving things in an area.
endangered species	*noun*	organism threatened with extinction.
extinction	*noun*	process of complete disappearance of a species from Earth.
species	*noun*	group of similar organisms that can reproduce with each other.
threatened species	*noun*	organism that may soon become endangered.
threshold	*noun*	point in a process that must be met to start a new stage in the process.

DIRECTIONS

This activity is part of the Extinction Stinks! unit.

1. Lead a brainstorm discussion to elicit students' ideas about why species become endangered or extinct.

- Ask: *What are some reasons that cause species to become endangered or extinct?*
    - Use a think-pair-share strategy to have students brainstorm and share their ideas.
    - Possible responses include:
        - Overharvesting
        - Habitat loss
        - Poaching and illegal hunting
        - Climate change
        - Pollution
    - Record students' responses on a whiteboard or a piece of butcher paper at the front of the room. Collect all of their responses for now, regardless of whether or not they may be a major cause of extinction.
- Ask students to predict which of these factors are most important to the Sumatran rhino becoming endangered. Ask them to support their claim using what they learned from *SOS —Saving our Species*.

2. Use a map to orient students to the Sumatran rhino's current challenges.

- Display or distribute the *Vanishing Populations Map* to students. Prompt students to explore the map, then ask them to identify the major pieces of information they can gather from the map. Record their responses on the board. These might include:
    - Sumatran rhino populations decreased 70 percent in the last 20 years.
    - Poaching is the major cause of the species' decline.
    - Populations are small in number (5-50) and spread out across several islands in small, isolated fragments.

3. Show a video to solidify new information about the Sumatran rhino's conservation needs.

- Show the *Saving the Sumatran Rhino* (5:26 minutes), prompting students to focus on what specific factors led to the Sumatran rhino becoming endangered.
- After playing the video, direct students to revisit their brainstorm list and claim about the Sumatran rhino from Step 1.

    - They may want to add new reasons why animals become endangered now that they have more information specific to the Sumatran rhino.
    - Ask students if their original prediction for what most threatens the Sumatran Rhino was correct or incorrect.
    - Emphasize the factors discussed in the video and map: geographic isolation, habitat destruction, poaching, and a slow gestation rate.

4. Ask students to write initial claims, evidence, and reasoning about three factors that contribute to the Sumatran rhinos' path to extinction.

- Distribute the *Understanding Extinction* handout to students. Explain that they will complete Part I by writing about the cause and effect of three factors that have led the Sumatran rhino closer to extinction.
- Have students work individually or with a partner to develop their scientific argument about why the three factors threaten the Sumatran rhino, using a Claim-Evidence-Reasoning (C-E-R) format.

    - Students may want to watch the *Saving the Sumatran Rhino* video one more time, once they have identified their claims to provide the evidence they need for their arguments.
    - Although only words are required, images may also be helpful in supporting students' C-E-R statements.

- Have students complete the reflection question at the end of Part I on the *Understanding Extinction* handout and share their ideas.

    - Possible responses include:

        - Promote captive breeding programs and reintroductions.
        - Protect land from deforestation and restoring habitat.
        - Monitor protected areas and enforcing regulations to reduce poaching.

    - This question prompts students to consider possible conservation solutions for dealing with issues, which is important preparation for the final product of the

Extinction Stinks! unit.

Modification

Step 3: Try this introduction lesson from the Lawrence Hall of Science to orient students to the relationships between claims, evidence, and reasoning.

Tip

Step 3: Working with students on supporting a claim using evidence connected through reasoning is an important skill emphasized in the Next Generation Science Standards (NGSS). Read more about claims, evidence, and reasoning in this article from Ambitious Science Teaching.

Informal Assessment

Read students' *Understanding Extinction* handouts to evaluate their thinking about the causes of the rhino's endangered status. Look carefully for any evidence that was not present in the video, or reasoning that does not clearly tie the evidence to students' claims.

Extending the Learning

Learn more about genetic bottlenecking, a phenomenon in which small numbers of individuals that are geographically isolated end up with low genetic diversity. This leads to vulnerability to diseases and other challenges, as individuals that are closely related will be more likely to have similar reactions to change and, therefore, an entire population could be wiped out if their genetic makeup makes them susceptible to that change.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology
- Conservation

Learning Objectives

Students will:

- Utilize different sources to determine some of the major causes of extinction.
- Draw from different sources to identify some of the challenges faced by the Sumatran rhino, a species at risk of extinction.
- Apply an understanding of conservation issues specific to the Sumatran rhino.
- Practice developing scientific claims supported by evidence and reasoning.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
    - Media Literacy
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
  - Analyzing Geographic Information

- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Engaging in argument from evidence
  - Obtaining, evaluating, and communicating information

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.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 1:**
Patterns
• **Crosscutting Concept 2:**
Cause and effect: Mechanism and prediction
• **Disciplinary Core Ideas LS2.A: Interdependent Relationships in Ecosystems:**
• **MS. Ecosystems: Interactions, Energy, and Dynamics:**
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 7:**
Engaging in argument from evidence
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

BACKGROUND & VOCABULARY

Background Information

Many factors, including habitat loss, overexploitation, invasive species, climate change, and toxic pollution driven by human activities, may cause a species to become endangered. Habitat loss, overharvesting, and invasive species can all lead to a decrease in population size and, therefore, genetic diversity. Genetic diversity is essential to having a thriving species that can withstand challenges like climate change and disease. Of the more than 100,000 species assessed by the International Union for Conservation of Nature (IUCN), more than one fourth are categorized on the Red List as threatened to some extent.

Prior Knowledge

["Students should be somewhat familiar with the differences between a claim, evidence, and reasoning before completing the C-E-R activity in Step 4. See the “Tips” section for an external lesson that can help introduce these concepts."]

Recommended Prior Activities

- SOS—Saving Our Species

Vocabulary

Term	Part of Speech	Definition
endangered species	*noun*	organism threatened with extinction.
extinction	*noun*	process of complete disappearance of a species from Earth.
gestation	*noun*	pregnancy, or the period from conception until birth.
isolation	*noun*	separation from other people, habitats, or communities.
species range	*noun*	native, geographic area in which an organism can be found. Range also refers to the geographic distribution of a particular species.

ACTIVITY 3: NO SPECIES LIVES IN ISOLATION | 50 MINS

DIRECTIONS

This activity is part of the Extinction Stinks! unit.

1. Introduce the concept of biodiversity by showing a video about the penguins of Patagonia.

- Ask students what they think the term "biodiversity" means.
    - Break down the word into its two parts: "bio," meaning life, and "diversity," meaning variety and difference.
    - Define biodiversity for students: "all the different kinds of living organisms within a certain area."
- Show the *Penguins of Patagonia* video (4:31) as an example of biodiversity in coastal Argentina.
    - In the video, Explorer Pablo Borboroglu defines biodiversity and uses it as one measurement of ecosystem resilience—how well the ecosystem can persist through disturbances. Have students listen for specific benefits of biodiversity that are identified in the video.
    - After watching the video, lead a discussion with students about the benefits of biodiversity they heard. List them on the board for future reference.

2. Use a model food web to demonstrate the importance of biodiversity in ecosystems.

- Review the definition of the term ecosystem from the *SOS—Saving Our Species* activity.
- Explain that within an ecosystem, organisms are categorized based on how they gain the energy they need.
    - Producers create their own food, often using energy from the sun. All plants, as well as some microorganisms like cyanobacteria, are producers.
    - Consumers eat producers or other consumers. Consumers are usually categorized by their typical diet: herbivores eat primarily plants, carnivores eat primarily meat, and omnivores eat a combination of plants, meat, and fungi.
    - Decomposers gain their energy from dead and decaying organisms.
- Display the *Who's in My Backyard?* food web infographic.
    - Ask students to predict what they think the arrows in the diagram represent.
    - Explain that arrows show how energy moves between species—the arrow points in the direction of energy flow from one organism to another.

- Explain to students that they will model a food web using organisms that live in the Sumatran rhino's ecosystem. Each student will receive a role for the activity of one organism or other factor that is a part of the food web.
- Display the *Vanishing Populations Map* used in *The Roots of Extinction* activity. Point out Way Kambas National Park, the ecosystem that is home to the organisms used in this model ecosystem. This is also the place where the Sumatran Rhino Rescue site is located.
- Distribute the *Way Kambas Food Web Cards* (one card to each student) with an organism typically found in Way Kambas National Park.

    - Have students organize themselves in a few ways to have some fun and get oriented with who is in the ecosystem. Some ideas include:

        - Line up by size (have them make their best guess!).
        - Organize into groups by producers, consumers, decomposers, and anything else.
        - Organize so every organism is standing next to another organism that it has a direct energy relationship with—either giving or receiving energy to each other.

- Then prompt students to follow the steps below to build a model of the relationships between species.

    - Distribute the pieces of yarn so that each student has at least three or four pieces.
    - Have students stand in a circle with their cards facing outwards.
    - Students should take several pieces of yarn and use them to connect to others in the circle from whom they receive energy. For some, this will be just one source and for others this can be many different sources.

        - Producers will all connect to the sun.
        - Consumers will connect to several examples of the organisms they eat as food.
        - Decomposers should connect to several organisms they might eat.

    - Once everyone has connected to the species they are related to, point out to students that there are many relationships within the ecosystem that overlap with each other.

3. Direct students to create food web models in pairs using a subset of species in the previous step, in order to reflect on food webs and biodiversity.

- Distribute the *Way Kambas Food Web Model* handout to students.

- Prompt students to complete Part A by creating a food web model using a subset of the organisms from Way Kambas National Park.

4. Model disruptions in an ecosystem using the physical model of species interactions.

- Have students retake their positions in the yarn-based model of the relationships between species, then use each of the *Way Kambas Food Web Disruption Cards* to introduce four different scenarios to the ecosystem. When each disruption happens, pause and prompt students to reflect on how that change would affect different species within the ecosystem using the questions printed on the card.
    - After disruptions #1 and #2, reset the food web before continuing with the next scenario.
    - After disruption #3, do not reset the ecosystem. Ask students to predict how an additional disruption might affect the ecosystem differently after already experiencing the impacts of this challenge. Then, complete disruption #4 with a reduced population of organisms in the ecosystem.
- After the disruptions are over, ask students to complete Part B of the *Way Kambas Food Web Model* handout and then consider how biodiversity affects the survival of the Sumatran rhino. Their ideas may include:
    - More species in an ecosystem allow for different sources of energy.
    - When species' numbers are depleted, the lower number of ecological relationships decreases an ecosystem's resilience after a disruptive event.
    - Biodiversity allows increased numbers of relationships between species, strengthening the resilience of the ecosystem.

5. Return to the class *Know & Need to Know* chart and add detail about students' knowledge of the value of biodiversity.

- Distribute the class *Know & Need to Know* chart from the *Saving Our Species—SOS* activity.
- Direct students to add new information they have learned about biodiversity through this activity. Examples may include:
    - Biodiversity is one measure of the health of an ecosystem supporting an endangered species.
    - Decreases in biodiversity might increase the risk of a species going endangered or extinct.

    - Species in an ecosystem affect each other even when they are not directly connected through an energy transfer.

- Students can also add new questions or ideas they have related to conserving endangered species while also protecting the needs of humans and other species.

Tip

Step 2: Please note that it is common practice in science to draw food webs with arrows pointing from organisms that provide energy toward the organisms that consume them.

Tip

Step 2: The *Way Kambas Food Web Cards* are organized to accommodate different sizes of student groups. The first 16 cards are intended to be the minimum for use, with up to 32 cards available, as needed.

Tip

Step 3: If you choose to have students draw their food web model in small groups, give each student a different colored marker. Tell students that all the colors being used should be equally visible in both words and diagrams to promote sharing work equitably.

Modification

Step 3: Students could use a web browser to find pictures of species for their food webs or type their responses to questions to reduce anxiety about or address challenges around creating their own visuals.

Informal Assessment

Use students' responses to the synthesis questions on the *Way Kambas Food Web Model* handout to assess their thinking about food webs and how ecosystem resilience can change with shifts in biodiversity.

Extending the Learning

Explore biodiversity in your schoolyard by holding a *BioBlitz* at your school. This activity engages learners in identifying as many species of living things that they can in your local ecosystem. BioBlitzes are a form of citizen science, where everyday people can collect data used by scientists to ask and answer questions on a large scale. Cataloguing what is present is engaging and helps scientists better understand the distribution and abundance of a variety of organisms in your local area, including species that may be threatened or endangered.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

- Conservation

Learning Objectives

Students will:

- Define biodiversity and its value to ecosystems.
- Explore relationships between species in several ecosystems using a food web.
- Use a physical model to represent ecological connections between species.
- Apply systems thinking to the relationships between the Sumatran rhino and other species in its habitat.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
    - Media Literacy
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Developing and using models
  - Engaging in argument from evidence
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
• **CCSS.ELA-Literacy.WHST.6-8.1:**
Write arguments focused on discipline-specific content.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 5:**

Energy and matter: Flows, cycles, and conservation

• **Disciplinary Core Ideas LS2.A: Interdependent Relationships in Ecosystems:**

• **LS2.C: Ecosystem Dynamics, Functioning, and Resilience:**

When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)

• **MS. Ecosystems: Interactions, Energy, and Dynamics:**

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

• **MS-LS2: Ecosystems: Interactions, Energy, and Dynamics:**

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem

• **Science and Engineering Practice 2:**

Developing and using models

• **Science and Engineering Practice 6:**

Constructing explanations and designing solutions

• **Science and Engineering Practice 7:**

Engaging in argument from evidence

• **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information

Preparation

BACKGROUND & VOCABULARY

Background Information

Species interact in a variety of ways with the other species in their ecosystems. Biodiversity, the variety of living things in an area, tends to lead to healthy and resilient ecosystems, and losing one species can have cascading effects for many other species. Understanding the complex relationships between species and how they impact each other is an important part of knowing how to support a species' survival.

Prior Knowledge

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Recommended Prior Activities

- SOS—Saving Our Species
- The Roots of Extinction

Vocabulary

Term	Part of Speech	Definition
biodiversity	*noun*	all the different kinds of living organisms within a given area.
carnivore	*noun*	organism that eats meat.
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 web	*noun*	all related food chains in an ecosystem. Also called a food cycle.
herbivore	*noun*	organism that eats mainly plants and other producers.
omnivore	*noun*	organism that eats a variety of organisms, including plants, animals, and fungi.
producer	*noun*	organism on the food chain that can produce its own energy and nutrients. Also called an autotroph.

ACTIVITY 4: ECOSYSTEMS HELP EVERYONE—EVEN HUMANS! | 1 HR 15 MINS

DIRECTIONS

This activity is part of the Extinction Stinks! unit.

1. Introduce the concept of ecosystem services through a reading and discussion.

- Have students read through the first section of the National Wildlife Federation's *Ecosystem Services* article. Then have a few volunteer to read about the different types of services listed out loud for the class.
- Ask: *How would you explain "ecosystem services" to a younger child?*
    - Guide students to produce specific explanations or metaphors so that you can assess students' understanding of the concept.

- Ask: *What are some examples of ecosystem services provided by the area around our school? Into which category of ecosystem service does each example fall?*

    - Examples may include: regulating services such as trees providing shade on a hot day or vegetation filtering and regulating water flow in the schoolyard, or cultural services such as improved student mental health from nature on the school grounds.

- Ask: *Do you think the ecosystem services provided by some ecosystems are more important than others? Why or why not?*

    - Students may say that ecosystem services that provide essential life-sustaining resources for humans or wildlife, such as water purification and life-saving medicine, are more important, while others may argue that they are all equally important.
    - Point out that these will be important considerations when writing their final grant proposals for the Extinction Stinks! unit project.

2. Guide students as they engage in a card sort to check their understanding of the types of ecosystem services.

- Remind students of the Sumatran rhino's ecosystem. Have students predict some of the ecosystem services the forest habitat likely provides. These may include:

    - Water filtration
    - Species that could be used for medicine
    - Tourism
    - Storing resources like water or carbon

- Organize students into small groups and give each group one set of the *Way Kambas Ecosystem Services Cards*.

    - Each card has a specific ecosystem service provided by rainforest ecosystems like that of Way Kambas National Park. Direct students to organize them into the category of ecosystem service that it provides: regulating, provisioning, cultural, or supporting.

- Circulate and elicit students' thinking by asking why cards are in particular categories.
- After all groups have sorted their cards, ask students to share a few of their categories. If students disagree, discuss why each group made their choice and see if students can reach a consensus.

3. Connect ecosystem services to biodiversity using the claims students made in *The Roots of Extinction* activity.

- Hand back students' *Understanding Extinction* handouts from the end of *The Roots of Extinction* activity.
- In Part II of the handout, have students connect the factors they identified as threats to the Sumatran rhino to the ecosystem services provided by and biodiversity of the rainforest ecosystem.
    - Using your own example, model how to fill out a row of the table. For instance, cutting down trees from the rainforest increases the provisioning services accessed by the local human community, but decreases Sumatran rhino habitat. It also decreases overall biodiversity because vegetation has decreased.
- Direct students to answer the guiding questions in Part II and then prompt a few volunteers to share out their responses with the class. Emphasize that there are many ways that the Sumatran rhino's survival relates to ecosystem services and local biodiversity, all of which need to be taken into account when designing possible conservation solutions to support its survival.

4. Return to the class *Know & Need to Know* charts to track changes in students' thinking.

- Retrieve the class *Know & Need to Know* chart created in the *SOS—Saving Our Species* activity.
- Lead a class discussion to update the chart to reflect students' current understanding. Some responses might include:
    - The ecosystems endangered species live in may provide essential ecosystem services that are in conflict with conservation of the species.
    - Ecosystem services may also only be maintained when endangered species are conserved, adding to the argument for species conservation projects.

5. Assess students' learning by prompting them to write scientific arguments related to the cascading impacts of a fire in Way Kambas National Park.

- Remind students that the essential question for the unit is "*How can we prevent a species from going extinct while also meeting the needs of humans and other local species?*"
- Distribute the *Lesson 1 Assessment* handout. Students must make a claim supported by evidence and reasoning about how these four groups of organisms will be affected by a significant loss of vegetation:

    - Sumatran rhinos
    - Other herbivores
    - Carnivores
    - Humans/ecosystem services

- Use the *Lesson 1 Assessment Rubric* to evaluate students' arguments.

6. Have students rank their species preferences for the unit's final project.

- Introduce the six potential target species that students can study during the species-specific part of the unit project:

    - Monarch butterfly *(Danaus plexippus)*
    - Sierra Nevada yellow-legged frog *(Rana sierrae)*
    - Mekong giant catfish *(Pangasianodon gigas)*
    - Transient killer whales *(Orcinus orca)*
    - Cheetah *(Acinonyx jubatus)*
    - Northern spotted Owl *(Strix occidentalis caurina)*

- Have students rank their preferences.

    - You could choose to have students write their top three preferences on a piece of paper, use an online form, or assign species groups randomly.
    - Students will receive their species assignment in the next activity of the unit: *Challenges Faced by Endangered Species*.

Tip

Step 6: If you need more time to assign students to their project groups, incorporate this step into an earlier activity.

Rubric

Use students' updated *Understanding Extinction* handout to assess their current understanding of the relationships between species' survival, biodiversity, and ecosystem services. The guiding questions create a strong foundation for thinking about the complex relationships in the ecosystems of students' target species. Additionally, the revisiting of the

Know & Need to Know chart is an opportunity to see the change in students' understanding and identify any gaps in their thinking. This will allow you to respond to students' curiosity and tie it into the unit's objectives, sparking authentic connection to the work of the unit.

At the end of this activity, use the *Lesson 1 Assessment Rubric* to assess students' understanding through their final claim-evidence-reasoning statements.

Extending the Learning

Consider the ecosystem services in your local schoolyard. What are the provisioning services at your school? What about the regulating services? Is there grass that drains and filters rainwater, or unique species that live there that might not be present elsewhere? What animals use the school's local environment to survive? Using some of the ideas listed here, consider what steps you might take to enhance the ecosystem services provided by the land your school sits on. For example, you might consider planting more native plants, installing a rain garden, or setting up bird feeders to support local wildlife.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

- Conservation

Learning Objectives

Students will:

- Define ecosystem services and categorize them according to general function.
- Categorize ecosystem services into different categories provided by the rainforest habitat of the Sumatran rhino.
- Use cause and effect to explain how ecosystem services would be altered with a biological or physical change to the local ecosystem of the Sumatran rhino.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Discussions
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Evaluating
  - Remembering
  - Understanding
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Engaging in argument from evidence
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
• **CCSS.ELA-LITERACY.WHST.6-8.1.A:**

Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

• **CCSS.ELA-LITERACY.WHST.6-8.1.B:**

Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**

Cause and Effect

• **Disciplinary Core Ideas LS2.A: Interdependent Relationships in Ecosystems:**

• **LS4.D: Biodiversity and Humans:**

Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

• **MS. Ecosystems: Interactions, Energy, and Dynamics:**

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

• **MS. Interdependent Relationships in Ecosystems:**

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

• **Science and Engineering Practice 7:**

Engaging in argument from evidence

• **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information

Preparation

BACKGROUND & VOCABULARY

Background Information

Ecosystems provide many essential services for the local, regional, and global community of living organisms, including humans. These services are broadly described in four categories: provisioning, regulating, cultural, and supporting services. Accessing or overexploiting provisioning ecosystem services can be seen as being at odds with preserving endangered species. Provisioning services like agriculture, hunting, or lumber extraction—all of which provide economic, food, and shelter benefits to people—can also threaten species' survival.

Prior Knowledge

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Recommended Prior Activities

- No Species Lives in Isolation
- SOS—Saving Our Species
- The Roots of Extinction

Vocabulary

Term	Part of Speech	Definition
cultural services	*noun*	non-material benefits that humans obtain from ecosystems, e.g., sense of home, mental and physical health, tourism, spiritual experience, etc.
provisioning services	*noun*	material benefits humans obtain from ecosystems, e.g., food, water, lumber, fiber, etc.
regulating services	*noun*	ways in which ecosystems regulate fluctuating factors in the environment, such as disease, climate, water cycles, nutrient cycles, etc.
supporting services	*noun*	benefits provided by ecosystems that are indirectly supportive of other types of ecosystem services, e.g., providing habitat, nutrient cycling, maintaining genetic diversity, etc.