



Endangered Relationships

Lesson Overview

GRADE LEVEL: 5-8

TOPIC/SUBJECT MATTER: Life Science/Environmental Science

TIME ALLOTMENT: 1-2 45-minute class periods

OVERVIEW:

This lesson uses video segments from the NATURE film "Crash: A Tale of Two Species" to explore the interrelationship between the horseshoe crab and a small migratory bird called the red knot. Both species are in decline, and the red knot's future, in particular, depends on the horseshoe crab making a comeback in the waters of the Delaware Bay.

Students will first be introduced to the horseshoe crab via a video segment, learning that the species' longevity (350 million years) makes the horseshoe crab a "living fossil," an anomaly in terms of the Earth's species. They will view several other video segments to explore the interconnectedness between the horseshoe crab and the red knot, following the videos with a discussion of the reasons for the decline of each species. Students will fill out an exit ticket to assess their comprehension of these concepts. An optional additional video segment can be used to explore how humans have come to depend on horseshoe crabs as well (their blood, which evolved to have primitive antibacterial properties, is used to test intravenous drugs for contamination).

As a culminating activity, students will use an interactive online map to research endangered species in the region of the United States where they live. They will discuss the environmental changes that have led to the species' decline (often of human origin) and will discuss the strategies being employed to prevent their extinction.



Media Resources

Video

NATURE: Crash: A Tale of Two Species (selected segments):

Clip 1: "The Living Fossil"

The horseshoe crab has survived for 350 million years.

Clip 2: "Horseshoe Crabs and Red Knots"

Horseshoe crabs are an essential source of nutrition for migrating birds.

Clip 3: "Protecting the Horseshoe Crab"

Measures have been undertaken to protect the horseshoe crab.

Clip 4: "Horseshoe Crabs and Humans"

The horseshoe crab has immense value to humans for its uses in medical technology.

Access the streaming and downloadable video segments for this lesson at the Video Segments Page.

Web sites

Sierra Club Endangered Species Map

<http://www.sierraclub.org/wildlife/species/map/>

This interactive map provides information on key endangered species, including efforts currently being undertaken to protect them, in different regions of the United States.

Standards:

National Science Education Standards

http://www.nap.edu/openbook.php?record_id=4962



LIFE SCIENCE: Content Standard C

As a result of their activities in grades 5-8, all students should develop understanding of

- **Diversity and adaptations of organisms**
 - Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

○ Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

As a result of their activities in grades 9-12, all students should develop understanding of:

- **The Interdependence of Organisms**
 - Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
 - Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
 - Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.



SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: Content Standard F

As a result of activities in grades 5-8, all students should develop understanding of

- **Populations, Resources, and Environments**
- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion vary from region to region and from country to country.

Materials

For each student:

- Endangered Relationships Exit Ticket

For each group of 3-4 students:

- One computer with broadband internet access

For the class:

- One computer for the teacher with a digital projection system

Objectives

Students will be able to:

- Describe characteristics of the horseshoe crab;
- Specify how "living fossils" like the horseshoe crab differ from most other species;
- Understand that over 99% of all species that have ever existed on earth are extinct;
- Name specific factors that can lead to species endangerment and extinction;
- List several strategies that can be undertaken by humans to protect endangered species;
- Provide at least one example of species interconnectedness: how the population decline of one species adversely affects another species.

Prep for Teachers

Prior to teaching this lesson, you will need to:



Learn more at www.pbs.org/nature.



Preview all of the video segments and Web sites used in the lesson.

Download the video clips used in the lesson to your classroom computer, or prepare to watch them using your classroom's Internet connection.

Bookmark the Web sites used in the lesson on each computer in your classroom. Using a social bookmarking tool such as del.icio.us or diigo.com (or an online bookmarking utility such as portaportal.com) will allow you to organize all the links in a central location.

Print and cut out a copy of the "Endangered Relationships Exit Ticket" for each student.

INTRODUCTORY ACTIVITY:

1) **FRAME** the first video clip for your students by telling them that they will be introduced to the horseshoe crab. As a **FOCUS**, ask your students to make a list of the facts they learn about horseshoe crabs by watching this video segment. For example, ask them to pay attention to the following information (you may want to make a list of the following on the board):

- o How old is the horseshoe crab species?
- o Where do most horseshoe crabs live?
- o What are their predators?
- o What are their closest relatives?
- o How many eyes do they have?
- o What color is their blood?

2) **PLAY** Clip 1, "The Living Fossil," for the class. Follow up by holding a discussion about the facts the students learned about horseshoe crabs, including the information you asked before:

- o *The horseshoe crab species is 350 million years old.*
- o *Most horseshoe crabs live on the ocean floor of the U.S.' Eastern seaboard.*
- o *Predators include sharks and sea turtles.*
- o *Their closest relatives are spiders and scorpions.*



- o *Horseshoe crabs have ten eyes.*
 - o *Horseshoe crab blood is blue.*
- 3) Ask if the students noticed that the horseshoe crab was referred to in the video as a "living fossil." Discuss the meaning of this term with the students (*a typical species may inhabit the earth between 1 and 10 million years before going extinct - and the human species, homo sapiens, has only been around for approximately 200,000 years. Plants and animals that buck this trend and have survived through multiple mass extinctions are named "living fossils" for their close resemblance to their ancient relatives in the fossil record.*)
- 4) Poll your class on the following question: Of all the species that have ever inhabited our earth, what percentage of species has gone extinct? (*Scientists generally agree that 99.9% off all species that have ever existed are extinct*). The fact that the horseshoe crab species has been on the earth for 350 million years makes it very special in this regard.

LEARNING ACTIVITY 1:

- 1) FRAME video segment 2: explain that over time, other species have come to depend on the horseshoe crab. One species that relies on the horseshoe crab is a small bird called the red knot. This migratory shorebird makes one of the longest migrations of any bird, traveling from Chile, in South America, to the Arctic every year.
- 2) Ask the students for their predictions: in what way do they think that red knots might depend on horseshoe crabs? (You may want to make a list of predictions). FOCUS the students by asking them to test their predictions as they watch the video clip.
- 3) PLAY Clip 2, "Horseshoe Crabs and Red Knots."
- 4) FOLLOW UP with students by asking how the red knots depend on horseshoe crabs. (*Horseshoe crab eggs in the Delaware Bay provide essential nutrition to the migrating red knots. When the birds arrive on the Bay, they are emaciated and must pack on muscle and fat before trekking to the Arctic. Without horseshoe crab eggs, they wouldn't make it to their breeding ground to reproduce.*)
- 5) FRAME the next clip: as the students have seen, scientists are very concerned about declining red knot populations. There is fear that the bird will go extinct, largely because there are not enough horseshoe crab eggs making it to the beaches along the Delaware Bay to sustain the migrating birds. As a FOCUS, ask the students to determine a) the



cause of the decline in horseshoe crabs along the Bay, and b) the strategies that are in place to try to protect the horseshoe crab population.

6) PLAY Clip 3, "Protecting the Horseshoe Crab."

7) FOLLOW UP with a discussion about the role of overharvesting by humans in the dramatic decline in horseshoe crabs (and hence, in red knots). Also discuss the moratorium (temporary ban) that is protecting the horseshoe crab population while it recovers.

8) Lastly, discuss why all the efforts being made to help horseshoe crabs thrive may still not be enough to save the red knot (*the horseshoe crab is not sexually mature until it is 9 or 10 years old. The protective measures might not allow enough time for the horseshoe crab population to recover in time to save the red knot from extinction*).

LEARNING ACTIVITY 2 (optional):

1) FRAME video segment 4: Interestingly, a very different species that has come to depend on the horseshoe crab is the human. Ask the students for their predictions: how do humans rely on horseshoe crabs? (You may want to make a list of predictions on the board or to have students jot them down). As a FOCUS, ask the students to test their predictions as they watch the video segment.

2) PLAY Video Segment 4, "Horseshoe Crabs and Humans."

3) FOLLOW UP with a discussion about how humans rely on horseshoe crabs (*every hospitalized American has probably benefited from the horseshoe crab, because every IV drug that comes to market in the US has been tested using an extract from horseshoe crab blood*). Explore this medical phenomenon with questions such as:

- Why is horseshoe blood blue? (*It contains copper as its oxygen-carrying agent, rather than iron-based hemoglobin*)
- How does the blue blood help the horseshoe crab fight disease? (*It is a primitive antibiotic that kills bacterial cells*)
- How has this evolutionary adaptation proven useful to human medicine? (*There are proteins in the blood that clot around bacteria - an extract from the blood is used to test every IV drug that comes to market for contamination, per FDA regulations*)
- How much is a quart of horseshoe crab blood worth? (*\$15,000*)
- How has the practice of horseshoe crab harvesting changed as a result of the medical value of the blood? (*Fishermen used to harvest the crabs for bait - but now fishermen with special licenses "borrow" the horseshoe crabs so medical*)



- *laboratories can bleed them. The horseshoe crabs are then returned to the waterways).*

4) Discuss the interdependent relationships that have been explored thus far in the lesson (horseshoe crab/human; horseshoe crab/red knot). Make sure that students understand that interrelationships between species are the norm in every ecosystem - so if one link in the chain is disturbed, it affects many other species. If there were no more horseshoe crabs, what would happen to the red knot? (*It would go extinct*). What would happen to humans? (*While we won't go extinct, we would have to revert to testing drugs on rabbits or invent another means of ensuring the safety of our pharmaceuticals*).

CULMINATING ACTIVITY:

- 1) Direct the students (in groups if desired) to visit the Sierra Club Endangered Species Map (<http://www.sierraclub.org/wildlife/species/map/>).
- 2) This interactive map provides information on endangered species in different regions of the United States. Remind the students that these animals and plants are highly threatened; some are on the verge of extinction. If any of these animals and/or plants were to go extinct, would there be an impact on other species? (*Almost definitely yes - as the students have learned in the case of the horseshoe crab and the red knot, the extinction or reduction in population of one species almost always affects other interdependent species. In some cases, we may not even know the species that will be impacted, yet.*)
- 3) Provide a focus for the students, telling them to use the online map to make a list or summary of the endangered species in the area of the country where you live. For each species, they should include information on what has caused the population decline (if provided) and the efforts being undertaken to try to help them.
- 4) Once students have had some time to gather their information, have them report back to the class. Remind students that extinctions occur because an environmental change occurs that exceeds the adaptive capacity of the species. In our times, these environmental changes often have direct or indirect human causes.
- 5) Use the students' research as a jumping-off point to discuss some of the main strategies that can be undertaken to protect threatened and endangered species, such as:
 - a. Captive breeding programs



- b. Predator control
- c. Restricting human access (e.g. closing beaches and roads)
- d. Limits or prohibitions on hunting and harvesting
- e. Habitat protections, like establishment of a wildlife refuge
- f. Endangered Species Act (Note - the Endangered Species Act is rather complicated, but students can be told that it is the highest level of protection that can be bestowed on a species by the federal government, and ensures that a coordinated plan is made to help the species survive. The specific plan depends on the species being protected.)



Endangered Relationships: EXIT TICKET

1. What human activities have caused the horseshoe crab population to decline?
2. If the horseshoe crab population declines further, what will happen to the red knot, and why?
3. How have humans taken action to prevent the horseshoe crab from becoming extinct?

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