

Introduced Species
The environment influences the lifestyles and living standards of people just as people influence the environment. Introducing organisms to areas where they weren't found previously is one way that people and the environment interact. Planned and unplanned introductions may have both intended and unintended consequences. Scientists must consider trade-offs when planning to introduce a new species to an area.

**Lesson 1/72:
The Miracle Fish?**
Focus Question: What are the trade-offs of introducing a species into a new environment?

Students read the story of the introduction of Nile perch into Lake Victoria, Africa and discuss whether this fish should have been introduced into the lake.

**Lesson 2/73:
Introduced Species**
Focus Question: What effect can an introduced species have on an environment? What, if anything, should be done to control introduced species?

Students read about eight species introduced into the United States. They prepare a presentation on one of these species to learn more about the species, the consequences of its introduction, and its potential future impact.

AAAS Atlas:
Systems (p. 133)

1.3 Changes in Systems: Interdependence of Life
3.2 Science, Technology and Society: Environmental and Resource Issues

Blackworm Observations
In order to better understand the relationship between organisms and the physical environment, scientists observe and carry out experiments on organisms in the lab and in the field. This important work helps in making informed decisions about how we manage our delicate ecosystems.

**Lesson 3/74:
Observing Organisms**
Focus Question: How can a lab investigation help you learn more about the ecology of a species?

Students investigate the behavior of black worms in the laboratory.

AAAS Atlas:
Scientific Inquiry: Evidence and Reasoning in Inquiry (p. 17);
1.2 Investigating Systems: Questioning, Planning and Conducting Investigations, (p. 19); Avoiding Bias in Science (p. 23)

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Classification Systems
As scientists study organisms, they have developed classification systems as a strategy for organizing their observations. Using these classification systems, they can better understand the similarities and differences of organisms as well as the evolutionary relationships. There are many different ways to classify organisms and scientists do not always agree on a "right" way. Using well-accepted systems supports a common language and understanding of individuals, their relationships to other organisms, and the biodiversity found on earth.

**Lesson 4/75:
Classifying Animals**
Focus Question: What are some similarities and differences among animals?

Students arrange "Animal Cards" into groups and then adjust their groupings as they learn how scientists classify animals into phyla.

**Lesson 5/76:
People, Birds, and Bats**
Focus Question: What kinds of evidence can you use to classify vertebrates?

Students apply the defined characteristics of five major vertebrate classes to classify mystery organisms.

AAAS Atlas:
Scientific Inquiry: Evidence and Reasoning in Inquiry (p. 17)
Evolution of Life: Biological Evolution

1.1 Properties of Systems: Characteristics of Living Things
1.3 Changes in Systems: Biological Evolution

DOL - 10

Populations
The study and classification of organisms includes a careful look at how an organism interacts within its environment. Changes in the population of an organism can inform scientists about interactions of the population with other organisms and resources in the environment. Population studies also help scientists predict future trends and impacts on human populations.

**Lesson 6/77:
Ups and Downs**
Focus Question: How do scientists study the size of a population and predict future population changes?

Students graph and interpret population data and propose possible explanations for population fluctuations.

AAAS Atlas:
Systems (p. 133)

1.3 Changes in Systems: Interdependence of Life

DOL - 10

Flow of Energy and Matter in Ecosystems

Populations and interactions of organisms within an ecosystem can fluctuate and be influenced by many factors but one thing is certain: the matter that makes up living things cycles through the environment and is transformed when it passes from one organism to another and between organisms and their physical environment. Plant and animal life is driven by energy from the sun. Plants, known as producers, convert the sun's energy to chemical energy through a series of reactions called photosynthesis. In this process, plants use carbon obtained from carbon dioxide to store energy and build cells and tissues. Chloroplasts contain a pigment, chlorophyll, where the transformation of energy and matter begins. Animals, called primary consumers, eat plants and break down the material to obtain energy and matter for their cells and body functions. Other animals consume animals to obtain energy and matter thereby continuing the transfer of energy from the sun throughout a food web. The transfer of energy and matter continues after an organism has died. Decomposers consume the dead tissue, using energy and storing energy and matter. As energy and matter are transferred from one individual to another, some of the energy is dissipated to the environment in the form of heat energy and some of the matter is returned to the environment in a non-organic form.

HBS - 2
PE - 6
DOL - 2, 3, 4

Lesson 7/78: Coughing Up Clues

Focus Question: What can an owl pellet tell you about an owl's diet? How can you use this information to develop part of a food web?

Students extract bones from an owl pellet, sort them, and then try to reconstruct an animal skeleton(s).

Lesson 8/79: Eating for Energy

Focus Question: How are the energy relationships among organisms in an ecosystem affected by the introduction of a new species?

Students read about the introduced zebra mussel in the Great Lakes and identify producers and consumers within an ecosystem.

Lesson 9/80: Nature's Recyclers

Focus Question: Where can you find some decomposers? What do these decomposers look like?

Students isolate nematodes, use microscopes to observe them, and discuss the role of decomposers in all ecosystems.

Lesson 10/81: A Producer's Source of Energy

Focus Question: How do scientists study the role of light in photosynthesis?

Students collect evidence for photosynthesis by observing the uptake of carbon dioxide by *Elodea*.

Lesson 11/82: The Cells of Producers

Focus Question: How are the cells of producers different from the cells of consumers? How do plant cell structures relate to their function as producers?

Students make microscope slides of different plant parts and compare photosynthetic and non-photosynthetic plant cells.

1.2 **Structure of Systems:** Structure and Organization of Living Systems
1.3 **Changes in Systems:** Interdependence of Life; Life Processes and the Flow of Matter and Energy

AAAS Atlas:
Flow of Matter and Energy: Flow of Matter in Ecosystems (p. 77);
Flow of Energy in Ecosystems (p. 79)

DOL - 8, 9
PE

Limiting Factors

Natural populations do not grow exponentially and many factors can limit population size. Organisms have habitat requirements and competition for needed resources plays a big role in limiting population size. Scientists observe individuals in a laboratory setting where competition is not a factor to understand more about behavioral adaptations, such as habitat and food preferences. In natural settings, individuals must compete with other species as well as their own species for limited habitat and food resources. The term *carrying capacity* refers to the population size an ecosystem can support at a given time under certain conditions.

Lesson 12/83: A Suitable Habitat

Focus Question: What are some of the important non-living characteristics of a habitat?

Students investigate the responses of blackworms to various substrata to determine characteristics of a good blackworm habitat.

Lesson 13/84: Clam Catch

Focus Question: How might the introduction of a competing species, such as zebra mussels, affect a population of native clams?

Students role-play plankton, clams, and mussels and record the size of the clam population over time to build an understanding of population fluctuations and factors that affect it.

Lesson 14/85: Is There Room for One More?

Focus Question: What is carrying capacity?

Students do an interactive reading to learn about carrying capacity and then critique a hypothetical experiment that attempts to explain a change in carrying capacity.

Field Ecology

Field ecologists conduct research within the ecosystem they are interested to learn more about the relationships between living organisms and the physical environment.

Lesson 15/86: Taking A Look Outside

Focus Question: What can you observe when you conduct a field study?

Students act as ecologists as they do a field study in the environment around the school or at a nearby park.

1.3 **Changes in Systems:**
Interdependence of Life

AAAS Atlas:
Scientific Inquiry: Scientific Investigations (p. 19)

Ecological Management

Ecosystems are complex systems with many different parts. Consequently, it is difficult to predict outcomes resulting from some type of ecological change. This is especially true when weighing options for managing an introduced species. Multiple management options exist and each option has its trade-offs.

Lesson 16/87: Too Many Mussels?

Focus Question: What are the trade-offs of trying to control an introduced species?

Students read about the various options for addressing issues concerning the introduction of zebra mussels in the U.S.

1.2. **Structure of Systems:** Structure and Organization of Living Systems

1.3 **Changes in Systems:**
Interdependence of Life

Lesson 17/88: Presenting the Facts

Focus Question: What, if anything, should be done about the introduction of a new species into an ecosystem?

Student groups conduct class discussions of what can and should be done about the population of the introduced species they have researched throughout the unit.

AAAS Atlas:
Systems (p. 133)

Extinction
The possible extinction of endangered species demands serious consideration of trade-offs involving different management options.

Lesson 1/89: Here Today, Gone Tomorrow?
Focus Question: What are the trade-offs in deciding whether to save an endangered species or to recreate an extinct one?
Students discuss the plight of the Asian elephant in the context of elephant evolution and extinction.

1.3 Changes in Systems: History and Evolution of Earth

Evidence of Change Over Time
Understanding the earth's history is necessary for understanding evolution. Fossils provide evidence of organisms that lived in the past and may or may not continue to exist today. The relative position of rock layers and fossils within these layers provides clues about the relative ages of fossils and history of life on earth. From this scientists have written a geologic time scale of the history of the earth.

Lesson 2/90: Figuring Out Fossils
Focus Question: What can fossils tell you about organisms that lived in the past?
Students handle and describe eight different fossils from various localities and geologic ages.

Lesson 3/91: Fossilized Footprints
Focus Question: How can fossil footprints be used to study the behavior of animals that were alive millions of years ago?
Students interpret fossilized footprint evidence to develop skills at distinguishing observations from inferences.

Lesson 4/92: Time For Change
Focus Question: How long have organisms been living on Earth?
Students develop a geologic-style personal time scale and then construct a geologic time scale.

Lesson 5/93: Reading the Rocks
Focus Question: How can you determine which fossils are older, which are younger, and which are likely to be from extinct species?
Students examine 4 drill cores and use evidence to create a stratigraphic column for each locality.

1.3 Changes in Systems: History and Evolution of Earth.

AAAS Atlas:
Evolution of Life: Biological Evolution (p. 81)

Natural Selection
Charles Darwin's theory of evolution by natural selection has become the foundation for understanding how life forms have changed over millions of years and continue to change. Fundamental to the understanding of natural selection is the idea that populations have the capacity to grow exponentially, yet are limited by the carrying capacity of the environment, predation and other factors. Consequently, not all individuals survive to reproduce. Because variation occurs naturally within populations, individuals possessing heritable traits that are better suited for survival under current conditions, survive to reproduce and pass on the beneficial traits to their offspring. Mutations in DNA are one source of the heritable variations.

Lesson 6/94: A Meeting of Minds
Focus Question: How does evolution happen?
Students role-play an imaginary meeting between Charles Darwin, Jean-Baptiste Lamarck, a modern-day science reporter, and a middle school student. Darwin and Lamarck compare their theories on how evolution occurs.

Lesson 7/95: Hiding in the Background
Focus Question: How do factors such as the environment and the presence of predators affect the process of natural selection?
Students simulate the effect of prey coloration on predation rates by birds using toothpicks of two colors.

Lesson 8/96: Battling Beaks
Focus Question: What role does variation play in the process of natural selection?
Students simulate the effect of natural selection on an imaginary forklbird species. Variation in the population, differential survival and reproduction changes the composition of the population over time.

Lesson 9/97: Origins of Species
Focus Question: What role do mutations play in natural selection?
Students read about how mutations provide genetic variation upon which natural selection acts.

1.2 Structure of Systems: Molecular Basis of Heredity
1.3 Changes in Systems: Biological Evolution

AAAS Atlas:
Evolution of Life: Biological Evolution (p. 81); Natural Selection (p. 83)

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PE

