

Context

An ecosystem is a higher level of organization that encompasses a community plus its physical environment. Ecosystems include both the biological and physical components affecting the community and its members. This lesson plan examines ecosystems from a structural view of population distribution, resource availability, and patterns of interaction and from a functional view of energy flow and other processes.

Essential Questions

- What fundamental concepts are related to interactions, energy, and the dynamics of ecosystems?
- How are the components of an ecosystem interdependent?
- What are the processes within ecosystems?
- How does human activity affect ecosystems? What local and global issues result from human activity in ecosystems?

Enduring Understandings

- Ecosystems are communities of living (biotic) and nonliving (abiotic) organisms in particular places and the chemical and physical factors that influence them.
- Ecosystems consist of life forms existing in symbiotic relationships with their environments.
- An ecosystem is alive and dynamic. There are four fundamental processes that go on in all ecosystems. Different species carry out the processes in each ecosystem.
- Human populations have a greater impact on ecosystems than populations of most other living things. Human activities can change ecosystems so much that the balance of the ecosystem is often threatened or harmed.

Time

These activities can be completed in 1–2 class periods of approximately 50 minutes.

Grade Level

Grades 6–12. Activities can easily be adapted to fit grade and ability levels.

Differentiation

These inquiry activities can be completed as a class guided by the teacher, in groups, pairs, or individually based on students' abilities.

Materials

- Rosen Digital's [Core Concepts: Biology](#) database
- Computers
- Smart Board, iPad, or other computer projection presentation device (optional if Teacher/Librarian wants to demonstrate worksheets and/or have one group worksheet)
- Appropriate Assistive Technology for students with special needs (if applicable)
- [Plan-It Earth: Cause & Effect](#) activity
- Supplement 1 - Earth's Biomes
- Supplement 2 - Earth's Biomes Worksheet
- Supplement 3 - Eco Buddies: Friend or Foe? Worksheet
- Supplement 4 - Earth's Cycles

Dynamic Ecosystems

- Supplement 5 - Multimedia Presentation Rubric
- Research materials (access to books and the Internet)
- Paper/pencils
- Plastic zip-seal sandwich bags
- Permanent markers
- Water
- Tape

Student Learning Objectives

- Students will be able to define and describe a community as the set of all populations that inhabit a specific area.
- Students will be able to recognize and explain patterns and processes of species in communities.
- Students will describe and discuss energy flow and energy transfer in ecosystems defining relevant vocabulary.
- Students will investigate the impact of human activity on the biodiversity in ecosystems, focusing on the use of natural resources and demonstrating cause and effect relationships.

Next Generation Science Standards Addressed

MS-ESS2-4.	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]
MS-ESS3-4.	Construct an argument supported by evidence for how increases in human population and per-capital consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]
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. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-2.	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]
MS-LS2-3.	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]
MS-LS2-4.	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]
MS-LS2-5.	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]
HS-LS2-2.	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]
HS-LS2-3.	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

HS-LS2-4.	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]
HS-LS2-5.	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]
HS-LS2-6.	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]
HS-LS2-7.	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]
HS-LS2-8.	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

NGSS Science and Engineering Practices Addressed

- Develop and use a model to describe phenomena
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence

NGSS Crosscutting Concepts Addressed

- Patterns. Patterns can be used to identify cause and effect relationships.
- Stability and change. Small changes in one part of a system might cause large changes in another part.
- Cause and effect. Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

- Scale, proportion, and quantity. The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
- Systems and system models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Energy and matter. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems.
- Stability and change. Much of science deals with constructing explanations of how things change and how they remain stable.

Common Core ELA Standards

[CCSS.ELA-Literacy.RST.6-8.1](#), [9-10.1](#), [11-12.1](#)

Cite specific textual evidence to support analysis of science and technical texts.

[CCSS.ELA-Literacy.RST.6-8.2](#), [9-10.2](#), [11-12.2](#)

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

[CCSS.ELA-Literacy.RST.6-8.4](#), [9-10.4](#), [11-12.4](#)

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8, grades 9–10 texts and topics.

[CCSS.ELA-Literacy.RST.6-8.7](#), [9-10.7](#), [11-12.7](#)

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Activity 1: Earth's Biomes

Introduction

Any community in its environment can be called an ecosystem if it looks after itself. A small pond is an ecosystem because all the animals and plants in it get almost everything they need without leaving the water. The plants make the oxygen and food that the animals need, and in turn the animals make the nutrients and carbon dioxide that the plants need. A forest could also be seen as an ecosystem. In some parts of the world forests cover vast areas. So do grasslands, oceans, and deserts. A large geographical region that has its own distinctive climate, plants, and animals is called a biome and is generally made of several types of ecosystems. All the deserts on Earth form one biome; all the tropical forests make another.

Teacher Tip!

Introduce students to the concepts of interdependent ecosystems by playing [Plan-It Earth: Cause & Effect](#). The scenarios can be explored as a class (projected on the white board), in small groups, or individually. If time allows, encourage students to replay the activity to produce different outcomes.

Materials

- [Plan-It Earth: Cause & Effect](#) activity
- Supplement 1 - Earth's Biomes
- Supplement 2 - Earth's Biomes Worksheet
- Paper/pencils

Procedure

1. Project Supplement 1 (Earth's Biomes) on a whiteboard or overhead projector. Distribute Supplement 2 (Earth's Biomes Worksheet) so students may document information as you tour Earth's biomes. At each stop on the tour, students should record three key facts about the ecosystem such as location, climate, types of plants and animals. (Reference the [Understanding Ecosystems](#) article as needed.)
2. After touring the ecosystems and completing the Earth's Biomes Worksheet, ask students to identify similarities and differences between the terrestrial (land) and aquatic (water) ecosystems. Make a list of student responses. Ask students to identify reasons for the similarities and differences they noted. Add the responses to the list. Now have students think about factors that impact organisms that inhabit a given area. List the factors identified (such as temperature ranges, moisture and nutrient availability, light, human activity) and add responses to the list.
3. Keep the list of student responses to refer to during Activity 2.

Activity 2: Relationships in Ecosystems**Introduction**

Ask the students to describe a relationship. Explain that relationships in ecosystems are called symbiotic. Define "symbiosis." (Symbiosis is a relationship between different organisms.) Explain there are three main types of symbiosis:

1. Mutualism - A symbiotic relationship that benefits both species, represented in this activity by (+, +).
2. Commensalism - A relationship that benefits one species while the other species is not affected, represented by (+, 0).
3. Parasitism - A symbiotic relationship that benefits one species and harms the other, represented by (+, -). (Reference the [Associations Among Animals](#) article for more information.)

Materials

- Supplement 3 - Eco Buddies: Friend or Foe? Worksheet
- Research materials (access to books and the Internet)
- Paper/pencils

Procedure

1. Students may work individually or in pairs to research ecological relationships between various species from ecosystems they learned about in Activity 1. They will use Supplement 3 (Eco Buddies: Friend or Foe? Worksheet) to record and document sources for their findings. Divide students up to study one of six symbiotic relationships. Examples of symbiotic relationships include: clown fish and sea anemone, barnacles and blue whales, goby fish and shrimp, protozoan and termites, cattle egrets and cattle, tapeworms and humans.
2. When the research is complete, divide the class into six expert groups (one group for each ecosystem relationship researched.) Each team will compare the information found about the symbiotic relationship studied, confirming and consolidating information to create one cohesive research document (Supplement 3, page 2).
3. Encourage research teams to question each other's individual findings if they vary and to further research areas of dissent. While teams are working provide assistance as needed.

- After teams have completed the consolidate research document, give each expert group 3–4 minutes to present their information to the class, sharing their findings and research sources. Following the presentation provide the audience a few minutes to prepare one question based on the presentation. This question should be recorded on the Eco Buddies: Friend or Foe? Worksheet.

Activity 3: Processes in Ecosystems

Introduction

Ecosystems are self-contained units made up of living things and their nonliving environment. All living organisms need energy to grow and reproduce. Nearly all of this energy comes from the sun. The energy is absorbed by plants, which use some of it to make energy-storing foods, such as starch, in a process called photosynthesis.

Herbivorous (plant-eating) animals, such as rabbits, eat plants and use the stored energy to power their own activities. They also store some of the energy in their own bodies. If the rabbits are eaten by carnivores (meat eaters), such as foxes, the stored energy is passed on again. When plants die, bacteria and microorganisms break them down and release the important element nitrogen into the soil. Nitrogen-rich soil means that the dead plants help provide the nutrients for new plant life to flourish.

The three fundamental ecological processes of ecosystems are the water cycle, carbon cycle, and the nitrogen cycle. Ecosystems also have processes of energy flow and community dynamics, which is the change in composition and structure of an ecosystem following a disturbance.

As a class, look back at the information learned in activities 1 and 2. Identify where and how each of these processes takes place in the ecosystems from the Plan-It Earth: Cause & Effect activity.

Materials

- Plan-It Earth: Cause & Effect activity
- Supplement 4 - Earth's Cycles
- Plastic zip-seal sandwich bags
- Permanent markers
- Water
- Tape
- Paper/pencils

Teacher Tip!

For more information on the diagrams, see [Water Cycle](#), [Carbon Cycle](#), [Nitrogen Cycle](#).

Procedure

- Project Supplement 4 (Earth's Cycles) on a white board and distribute handouts to students. Explain the water cycle. Give each student a plastic zip-seal sandwich bag. Break students into small groups. Have each group draw a simple diagram of the water cycle on the bag labeling the basic steps; evaporation, condensation, precipitation and run-off. Fill bags about ¼ full of water, seal, and tape to a window in the classroom. Have groups observe the bag as condensation forms, causing precipitation and run off.
- Use the carbon cycle diagram to explain the carbon cycle. Have students label the carbon cycle diagram. Explain that

the carbon cycle two key events: respiration and photosynthesis. Carbon is an important element that forms a blanket around the Earth. It traps the heat of the sun within the atmosphere and prevents the Earth from freezing. There is a constant exchange of carbon between the living and nonliving world, forming the carbon cycle. This cycle plays an important role in maintaining proper levels of carbon in the Earth's atmosphere.

3. Use the nitrogen cycle diagram to explain the nutrient cycle. Have students label the nitrogen cycle diagram. Nitrogen is used by life forms to carry out many of the functions of life. This element is especially important to plant life. Yet, nitrogen in its gaseous form is almost entirely unusable to life forms. It must first be converted or “fixed” into a more usable form. The process of converting nitrogen is called fixation.

Activity 4: Keeping the Balance: Understanding Human Impact

Introduction

The Earth's ecosystems are complex ecological environments which have developed over billions of years. If the intricate components of an ecosystem are altered, the changes can affect its survival. Humans harm the environment leading to issues like climate change, habitat destruction, acid deposition, and ocean acidification. Each type of human interference with ecosystems demonstrates the conflict between humans and their surrounding species, altering the balance needed for survival.

Materials

- o Plan-It Earth: Cause & Effect activity
- o Supplement 3 - Eco Buddies: Friend or Foe? Worksheet
- o Supplement 4 - Earth's Cycles
- o Supplement 5 - Multimedia Presentation Rubric
- o Research materials (access to books and the Internet)
- o Paper/pencils

Procedure

1. Divide students into six groups and assign each group a different ecosystem from Activity 1. Each student should have their completed work from activities 1, 2, and 3. If students have not already explored Plan-It Earth: Cause & Effect, have them do so as a group and discuss their decisions and outcomes.
2. Have students work in teams to answer the following questions and complete the following tasks:
 - a. What human activities are harming the ecosystem?
 - b. Describe each activity and its specific harmful impact.
 - c. What symbiotic relationships exist in the ecosystem? How are the relationships being affected by human activity?
 - d. What ecological processes exist in the ecosystem? How are they affected by human activity?
 - e. What are the current and long-term implications of the human activities in the ecosystem?
 - f. What has been or is being done to restore the ecosystem and/or prevent further damage?
 - g. What changes do you recommend to prevent further damage to the ecosystem?
3. Have each team present their findings to the class. If time permits, distribute Supplement 5 (Multimedia Presentation Rubric) and ask students to create presentations using images, videos, and maps to present their ecosystem.

Teacher Tip!

Students can use the [Create a Multimedia Presentation](#) interactive activity when planning their presentations.

Assessment Evidence**Ongoing Assessment**

- Plan-It Earth: Cause & Effect Activity written responses
- Supplement 1 - Earth's Biomes
- Supplement 2 - Earth's Biomes Worksheet

Summative Assessment

- Individual Research (Activity 2, Supplement 3)
- Expert Group Report (Activity 2, Supplement 3)
- Cycle diagrams (Activity 3, Supplement 4)
- Human Impact answers and presentation (Activity 4, Supplement 5)