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Teacher's Guide

Human Biology Ecology Teacher's Guide

The Program in Human Biology,
Stanford University, (HumBio)

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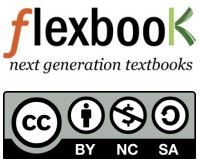
Printed: February 27, 2012



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CHAPTER 1 Introduction to Ecology - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

1.1 Overview

Human Biology: An inquiry-based guide for the middle school student.

Developed by the Program in Human Biology at Stanford University and

EVERYDAY LEARNING®

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Permission

[Enrichment 3-1 Resource 1/Food Web Game]

Adapted from Maumov, N. P., *The Ecology of Animals*, Copyright 1972 by the Board of Trustees of the University of Illinois.

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Bird, R.D. “Biotic communities of the aspen parkland of central Canada.” *Ecology* 11 (1930):356-442, and Cohen, J. *Food Webs and Niche Space*. Princeton, N.J.: Princeton University Press, 1978.

[Enrichment 3-1 Resource 2/Food Web Game]

Niering, W. A. “Caroline Islands.” *Ecological Monographs* 33 (1963): 131-160.

Adapted from Teal, J.M. “Energy flow in the salt marsh ecosystem of Georgia.” *Ecology* 43 (1962:) 614-624.

[Enrichment 11-1 Resource 1/Expedition to the Kalimantan Rain Forest]

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ISBN 1-57039-676-0

Stanford University’s Middle Grades Life Science Curriculum Project was supported by grants from the National Science Foundation, Carnegie Corporation of New York, and The David and Lucile Packard Foundation. The content of the Human Biology curriculum is the sole responsibility of Stanford University’s Middle Grades Life Science Curriculum Project and does not necessarily reflect the views or opinions of the National Science Foundation, Carnegie Corporation of New York, or The David and Lucile Packard Foundation.

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Dedication

The faculty, staff, and teachers of Stanford University's Human Biology Middle Grades Life Science Curriculum Project dedicate the publication of the HumBio Curriculum in memory of our colleagues and friends, Mrs. Donna Harrison and Dr. Mary Budd Rowe. Donna was the lead science teacher at Dozier Middle School, the project test site school in Newport News, Virginia. She was an outstanding teacher, a community leader, a devoted wife and mother, and a wonderful human being. Her involvement in the HumBio Project enriched the curriculum materials and brought great joy to our lives. Although her life ended suddenly and tragically, the inspiration she gave to all who knew her will live on in what we do to improve the education of children and youth. Mary Budd Rowe was our most distinguished science education colleague and our dear friend. She guided the early organizational stages of the project as a group of university scientists attempted to address issues of middle level science education. Her unbridled enthusiasm for the education of children always reminded us of the important purpose of our work. Mary continued her unwavering support of the HumBio curriculum until her passing in June of 1996.

1.3 Preface

Stanford University's Middle Grades Life Science Project began in 1986 with the vision of David A. Hamburg, M.D., then President of Carnegie Corporation of New York. A new wave of science education reform was gathering momentum following the release of *A Nation at Risk* by the United States Department of Education and *Educating Americans for the Twenty-First Century* by the National Science Board. Dr. Hamburg brought together the concerns of scientists and science educators over the watered down, vocabulary-laden life science curricula that were typical of middle level science courses at that time with broader public concern over large and increasing numbers of adolescents who engaged in high-risk behaviors leading to school failure, teen pregnancy, and other health problems. Because of his leadership in developing Stanford's undergraduate Program in Human Biology and his interests as a physician and scientist in the major physiological and behavioral transitions in the lives of children, Dr. Hamburg believed that a rigorous middle grades life science curriculum focused on human biology, and where possible on the adolescent, not only would greatly improve the science taught at this level, but through its relevance would capture the interest of this age group.

Initial work on the Human Biology (HumBio) Middle Grades Life Science Curriculum brought together faculty, staff, and students from Stanford's Program in Human Biology and its School of Education with local middle and high school teachers. The curriculum development team was enriched in 1991 by twelve interdisciplinary teams of middle level teachers from diverse test site schools across the country. These teams became our most valued collaborators. The teachers attended annual two week summer institutes at Stanford between 1991 and 1994 and used the draft curriculum units in their classes between 1991 and 1995. The teachers and their students provided extensive formative evaluation data on the field-test materials, which has shaped the final student and teacher versions of the units that comprise the HumBio Curriculum. Using HumBio units as a starting point, many teams also created their own innovative, interdisciplinary materials, which they taught across the middle level curricula in their schools.

The Project's Advisory Board provided insightful advice on the development of the curriculum from the unique perspectives of the professional associations, the institutions, and the fields its members represented. We are grateful to all of those who served for periods of time during the past seven years. We also would like to express our appreciation to the education consultants from universities, the National Middle School Association, and the California State Department of Education who made presentations and worked with the teacher teams during the summer institutes at Stanford. C. Stuart Brewster served with great distinction as our advisor on publication. We are indebted to him for his keen insights and good advice.

The Project faculty, the staff, and the teachers contributed more to the development of the HumBio Curriculum than anyone could have imagined before this work began. Their expertise, determination, and dedication to improving the education of young adolescents were inspirational. Supporting the curriculum development team and the test-site teachers were wonderful groups of Stanford undergraduates from the Program in Human Biology. They helped to ensure a productive and pleasurable working environment, which was an essential part of the success of the summer institutes.

To be sure, none of this work would have been possible without funding from Carnegie Corporation of New York, the National Science Foundation, and most recently The David and Lucile Packard Foundation. On behalf of the entire Project team we would like to thank these foundations and the Program Officers who have worked with us over the years for their support. As always, the final content of this curriculum is the sole responsibility of the Stanford University Middle Grades Life Science Project and does not necessarily reflect the views of Carnegie Corporation of New York, the National Science Foundation, or The David and Lucile Packard Foundation.

H. Craig Heller, *Principal Investigator*

Mary L. Kiely, *Project Director*

January, 1998. Stanford, California

1.4 Letter to the Teacher

Dear Teacher:

Greetings! I am glad that you have selected this curriculum.

I am particularly enthusiastic about the field of ecology because it provides the basis for understanding how the environment functions. And a successfully functioning environment is becoming everyone's concern more and more every day. Your students will be involved in forming public policy on the environment as they become voting citizens. Even now, young people are making daily decisions that affect the environment-what to buy, how to conserve resources, what to discard, and how to discard it. Consequently, a solid understanding of ecology will serve them throughout their lives.

We were confronted by two main challenges in developing the ecology unit. First, how can the broad field of ecology be effectively related to the life of a middle school student? Second, how can the many different subfields of ecology be comprehensively linked and investigated as a cohesive whole? We decided to address both of these challenges by building the unit around the important and basic concept of energy. Energy is the unifying theme throughout this ecology unit. The students investigate energy in the environment, from the tiny amounts of energy that they use twitching their muscles to the massive amounts of fossil-fuel energy that power our industrial-based economy.

This unit was written with the students always in mind. The text and activities were researched and developed to empower students as critical thinkers and effective problem solvers. Of course this curriculum will provide students with important knowledge about their natural world. But, more importantly, what they do as they actively investigate their environment will provide them with the tools they will need to investigate more, seek solutions to problems, and make good decisions about the environment long after they've completed the last activity.

This program is activity-based. And it is in the activities that the students use and perfect scientific and problem-solving tools that will make them good decision makers. So I want to thank Heidi Ballard, Susan Schultz, Geri Horsma, and Marjorie Gray for developing the activities from whatever slender threads of ideas I had.

I hope you enjoy using the text and its activities. Our research and field tests heighten my confidence that your students will enjoy and benefit from this curriculum.

Sincerely,

Robert B. Blair

Assistant Professor, Department of Zoology

Miami University of Oxford, Ohio

1.5 Unit Planning

Content Overview

How do we fit into the ecological system?

The major emphasis of this unit is for students to become aware of some basic ecological concepts.

Students

- consider how they fit into the ecological system.
- consider and analyze how they affect their local or global environment.
- realize that their actions or decisions affect others.

The unit provides an introduction to ecology for middle school students. The unit begins with topics that are likely to be relevant to a typical student, such as energy in the human body. Increasingly broader topics are then introduced. These topics range from the way natural communities function to the ways that humans affect the global environment. The last section introduces the field of conservation biology, which includes ways to prevent the loss of biodiversity.

You can use this unit in many different ways. Some teachers who participated in its field testing used the unit to kick off the school year. Some field-test teachers used it to finish the year. Others incorporated parts of the unit into their science curriculum throughout the year. Like the other units in HumBio, the Ecology unit is designed as a dynamic, interactive learning tool for both the teacher and the students. You can follow this Teacher's Guide as it is organized. Or you can take apart the Teacher's Guide; select the activities, projects, and discussion opportunities you feel are right for your class; and blend them with your current middle school science curriculum.

Students have the opportunity to participate in a hands-on, activity-centered curriculum. The curriculum offers the students a wide range of learning experiences. In addition to the hands-on activities, the learning experiences in which they are immersed include discussions, laboratory investigations, role-playing exercises, writing opportunities, and dramatic and creative art projects. All of the activity-based experiences are designed to increase student knowledge of science content, reinforce the concepts being presented, and enhance student problem-solving and decision-making abilities.

Section 1: You and the Environment introduces students to their environment, which is defined as everything outside the body that affects us or that we affect, and begins their exploration of the environment and the study of ecology.

Section 2: Food Chains: How Energy Gets to You explores the movement of energy throughout the environment. Students investigate the importance of the sun since almost all energy on Earth originates with our sun. They then explore the movement of energy as it is passed from organism to organism along a food chain.

Section 3: Energy Flow in a Community continues to explore the flow of energy in a community, a flow that can take many interrelated paths. In their investigations, students learn that the amount of useful energy decreases at each step in a food chain.

Section 4: Cycling introduces cycling and the concept that all resources (except energy, which tends to diffuse) are cycled in undisturbed ecosystems.

Section 5: Cycling in Biological Communities examines the differences between undisturbed and disturbed ecosys-

tems. Students investigate the concept that resources cycle in undisturbed ecosystems but may be lost in disturbed ones.

Section 6: Recycling in Human Communities explores the benefits of recycling and the concept that recycling is an attempt by humans to cycle their resources in much the same way that resources cycle in undisturbed ecosystems.

Section 7: Resources, Niches, and Habitats explores the needs of organisms for specific resources in specific amounts in order to survive and reproduce.

Section 8: Species Interactions examines the effects species of living organisms, including humans, have on one another. Students investigate how species, including humans, affect other species in both positive and negative ways.

Section 9: Human Population Growth introduces the impact humans have on the environment. Students investigate how humans alter the environment greatly and how the impact is proportional both to the number of humans and to how they use their resources.

Section 10: Global Change explores global changes and their effects. Students investigate how humans alter the environment on continental and worldwide scales.

Section 11: Defining Biological Diversity introduces the concept of biological diversity. Students explore biological diversity as the variety of living organisms that occurs at all levels of life, including the levels of genes, species, and habitats.

Section 12: Conserving Biological Diversity examines various ways that humans can prevent the loss of biological diversity.

Section 13: Conclusion: You and the Environment brings students full cycle to where they began the unit. They investigate the ways they can make a difference by "Thinking Globally-Acting Locally."

Why teach this unit?

This unit addresses two different but related topics: ecology and the environment. The unit explores how these topics are related. For example, the unit provides basic information about energy flow and the cycling of resources, which is a traditional area of study in ecology. Then the unit goes deeper to show that programs such as garbage recycling are human attempts to conserve energy and other resources, which are the traditional concerns of environmentalists.

Environmental issues are becoming increasingly complex. For this reason it is important for every student to have a solid background in ecology so that he or she may evaluate environmental issues independently. As citizens, students will be involved in making decisions about more difficult environmental issues than cleaning up dirty water or smoggy air. Some problems, such as lead contamination along highways or the extinction of a single species, may be less visible or without immediate consequences. Other environmental issues will involve long-term problems such as the depletion of aquifers in 50 to 100 years.

Summary Questions for the Unit

It is important that students, and everyone for that matter, focus on what they want to learn in order to stay on track with specific goals in mind. For that reason, it may be helpful to pose these broad questions to the students and ask them to keep the questions in their minds and even in their notebooks or their journals as they investigate the world around them. You might want to write these questions on poster board and post them in the front of the room while the class works with this unit.

What is your environment and how do you affect it?

Your environment is everything that is outside your body that affects you or that you affect. This idea is the basis of this unit and emphasizes that everyone's relationship to the environment is a two-way interaction.

What factors affect the distribution and abundance of organisms?

This question is the ultin1ate question of ecology. Ecologists study where organisms are found, why they are found there, how many there are, and what factors bring this about.

TABLE 1.1: Unit Activities and Key Ideas

Section	Key Ideas	Activity
1. You and the Environment What is your environment and how is it related to ecology?	• Your environment is everything outside your body that effects you or that you affect.	**Activity 1-1:** Map your Environment
2. Food Chains: How Energy Gets to You Where do you get the energy to live?	• Almost all energy originates with the sun. • Energy is passed from organism to organism along a food chain.	**Activity 2-1:** Draw a Food Chain **Mini Activity:** Photosynthesis and Respiration Play **Enrichment 2-1:** What Do Owls Eat?
3. Energy Flow in a Community How does energy flow through the biological community?	• The flow of energy in a community can take many interrelated paths. • The amount of useful energy decreases at each step.	**Activity 3-1:** Classifying the Players in a Willow Forest **Mini Activity:** Draw Your Community **Mini Activity:** Draw the Community of a Largemouth Bass **Mini Activity:** What Can You Add to the Web? **Enrichment 3-1:** Food Web Game **Enrichment 3-2:** The Energy Game
4. Cycling Why don't natural systems run out of the materials they need?	• All resources (except energy, which tends to diffuse) are cycled in undisturbed ecosystems.	**Activity 4-1:** A Day in the Life of A Water **Enrichment 4-1:** What Goes Up Must Come **Enrichment 4-2:** Water Underground **Mini Activity:** A Day in the Life of a Carbon Atom **Mini Activity:** Create a Cycle Poster
5. Cycling in Biological Communities How do resources cycle in a forested watershed?	• Resources cycle in undisturbed ecosystems but may be lost in disturbed ones.	**Activity 5-1:** Go with the Flow: Hubbard Brook Watershed **Mini Activity:** How Do Scientists Know?
6. Recycling in Human Communities How can humans cycle their resources?	• Recycling is an attempt by humans to cycle their resources in much the same way that resources cycle in undisturbed ecosystems.	**Activity 6-1:** What's in Your Garbage and Where Does It Go? **Mini Activity:** Draw a Paper Cycle **Mini Activity:** Overpackaging

TABLE 1.1: (continued)

Section	Key Ideas	Activity
7. Resources, Niches and Habitats What are the things you, or any organisms, need to survive?	• Organisms need specific resources in specific amounts in order to survive and reproduce.	**Activity 7-1:** Too Many Bobcats **Enrichment 7-1:** What's in a Niche? **Mini Activity:** Define the Niche of an Animal
8. Species Interactions How do different species affect one another?	• Species, including humans, affect other species in both positive and negative ways.	**Activity 8-1:** Once Upon on Oak Tree **Enrichment 8-1:** Predator/Prey Relationships **Mini Activity:** How Do I Interact with Other Species?
9. Human Population Growth How do humans affect other species?	• Humans alter the environment greatly. • Human impact is proportional to both the number of humans and how they use their resources.	**Activity 9-1:** Brush Rabbit Boom
10. Global Change How do the activities of humans affect the environment on continental and worldwide scales?	• Humans alter the environment on continental and worldwide scales.	**Activity 10-1:** Feeling the Heat: The Greenhouse Effect
11. Defining Biological Diversity What is biological diversity?	• Biological diversity is the variety of living organisms that occurs at all levels of life, including the levels of genes, species, and habitats.	**Activity 11-1:** Expedition to the Kalimantan Rain Forest **Mini Activity:** Count Your Habitats **Mini Activity:** Local Species **Enrichment 11-1:** Measuring Species Diversity **Enrichment 11-2:** Extinction Crisis **Enrichment 11-3:** How Do You Value Biodiversity?
12. Conserving Biological Diversity How do species become extinct and what can humans do to prevent this loss of biodiversity?	• Humans can prevent the loss of biological diversity.	**Activity 12-1:** Design a Nature Reserve **Enrichment 12-1:** Endangered Species-Do or Die **Mini Activity:** Create a Wildlife Refuge

TABLE 1.1: (continued)

Section	Key Ideas	Activity
13. Conclusion: You and the Environment What is your environment and how is it related to ecology?	• You make a difference (think globally, act locally).	**Activity 13-1:** Map Your Environment, Revisited

Teacher's Guide Overview

This *Ecology* unit is built around a variety of student activities. Text material can be used to introduce, reinforce, and extend the concepts developed in the activities. The activities are the foundation of this unit, so the unit's success depends on students' involvement in the activities. Embedded activities are interrelated, since the concepts developed in one may be applied in another.

Section Planning

For each section, you'll find extensive advance planning for the student activities and the section topic. Key ideas, section objectives, background information, suggestions for introducing activities, and the materials needed for each activity are listed on the Section Planning page. Review this information ahead of time to ensure that materials for each activity are available when you need them.

Support for Embedded Activities

Embedded activities are those activities contained or "embedded" in the student edition. Procedures for each embedded activity are contained in the student edition. In the Teacher's Guide, you'll find activity planning information, activity assessment, and student reproducible pages for each embedded activity.

Enrichment Activities

Enrichment activities are activities found in the Teacher's Guide. These activities are designed to extend and enrich students' learning experiences. Complete Enrichment activities, including Teacher Activity Notes and the student procedures and reproducible pages, are located at the end of each appropriate section of the Teacher's Guide.

GroupWork Activities

Learning science is a process that is both individual and social. Students in science classrooms often need to interact with their peers to develop a knowledge of scientific concepts and ideas, just as researchers, engineers, mathematicians, and physicians who are working in teams do to answer questions and to solve problems. The Group Work activities of the HumBio Curriculum for Middle Grades have been developed to foster a collaborative environment for groups of students. Students plan experiments, collect and review data, ask questions and offer solutions, use data to explain and justify their arguments, discuss ideas and negotiate conflicting interpretations, summarize and present findings, and explore the societal implications of the scientific enterprise. In short, Group Work activities provide an environment in which students are "doing science" as a team.

For more information, refer to "Using GroupWork Activities" on TE. The specific GroupWork activities for this unit can be found beginning on TE.

Projects

The research and action projects in HumBio are varied and provide students with time to explore a particular topic in depth. With Projects, students have the opportunity to take a position based on knowledge gained through research, debate an issue, and devise a plan of action. In this way, students can apply what they are learning to larger issues in the world around them.

Projects for this unit include

- Research Questions and Action Projects
- Population Boom or Bust
- Species Diversity of Birds

Assessment Overview

Within each section of the unit there are suggestions for assessment that can be used individually or in combination to develop a complete assessment package. The list below describes the variety of assessment tools provided.

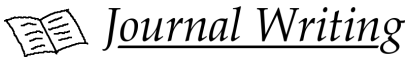
Apply Your Knowledge Questions appear throughout each section. They can be used as homework assignments and as ways to initiate a class discussion. These Questions are designed to assess

- communication skills
- depth of thought and preparation
- problem-solving skills
- ability to apply concepts to related or big ideas
- how well students relate their new knowledge to different problems

What Do You Think?

These Questions appear in each section. They provide students with opportunities to think and write about the concepts they are learning in a larger context. You can use these Questions to assess

- writing skills
- problem-solving abilities
- creativity and depth of thought
- the ability to analyze and summarize



Journal Writing prompts are suggested throughout the unit. These prompts provide opportunities for students to write critically and creatively about concepts and issues. The writing products can be used to assess

- writing skills
- depth of thought
- and the ability to explain and expand concepts

Review Questions

Review Questions are located at the end of each section. These Questions can be used for written responses or as the basis for class discussion. These Questions are designed to assess content knowledge and whether students can explain the concepts explored in the section.

Activity-Based Assessment

Inquiry-based student-centered activities are the foundation of the *Human Biology* Program. The unit is rich with relevant exciting activities that introduce, support, or reinforce concepts students are exploring. Within the Teacher's Guide, you'll find extensive teacher information, including assessment strategies, for each type of activity:

- Embedded Activities
- Enrichment Activities
- Mini Activities
- GroupWork
- Projects

You can use students' products to assess their progress. These products include models, simultaneous, observations and reports of laboratory investigations, role plays, written responses to questions and written observations, student-designed explorations and procedures, poster presentations and classroom presentations.

PORTFOLIO ASSESSMENT

You may want to have your students develop a portfolio for the unit. Portfolio assessment is an excellent way to assess the whole student as he or she progresses throughout the unit. Although there are many opportunities to select a variety of the student's products, the following list shows one possible assessment portfolio for this unit:

- Written responses to three *What Do You Think*? questions
- An analysis of their two favorite Activities and how those activities helped then understand an important concept
- Two examples of creative writing from the following:

  Activity 4-1: A Day in the Life of a Water Molecule; Enrichment 12-1: Endangered Species-Do or Die

- A videotape of the *Mini Activity: Photosynthesis/Respiration Play*
- A report from three laboratory investigations, such as Enrichment 2-1, Enrichment 4-1, and Enrichment 11-1
- One example of an artistic creation such as *Mini Activity: Cycle Posters*
- An analysis or interpretation of three graphs from various activities

Getting Started

Keep Students Interested. Encourage the students to read the text. Every effort was made to make the text interesting to students and appropriate to their reading level.

This unit is built around a set of student activities. Text material can be used to introduce, reinforce, and/or extend the concepts addressed in the activities. The success of this unit depends on completion of the activities. Some activities are related since the data obtained in one may be used in another.

Plan Ahead. The entire unit is activity based. You can select the activities that best fit your class. The activities are listed in the Unit Matrix. Some activities called Mini Activities are short and can be done individually with minimal teacher input. The Mini Activities are located in the margin of the student edition. The embedded activities in the student text are longer activities or laboratory investigations that require some planning or setup time. Other laboratory investigations called Enrichment Activities are located at the end of each section in the Teacher's Guide. These Enrichment Activities greatly enhance student knowledge of the concept explored in the section.

A variety of projects were designed to accompany the unit. These include ongoing class projects, school projects, and/or community projects. These projects are found at the end of the Teacher's Guide.

Customize the Unit. Teaching timelines are provided on TE pages xxii-xxv. The first timeline on TE page xxii demonstrates how to complete this unit within a six-week schedule. The timeline on TE page xxiv demonstrates how to complete this unit within an eight-week schedule. These timelines highlight the essential activities you may want to use if class time is limited. If your class has time to study ecology over a- longer period of time or throughout the school year, many additional activities are available.

Allow Time for Projects. Consider having students start projects at the beginning of the unit and then prepare those projects for presentation as a culminating event. When possible, encourage students to use computers and the Internet as resources for simulation and interactive programs and as sources that enhance the presentation of their projects.

Connect with Other Disciplines. The Interdisciplinary Web on the following page is provided to assist in your planning if your school uses an interdisciplinary, team approach. The web classifies the unit's activities and projects by related disciplines-language arts, math, social studies, physical education, health/nutrition, and visual/performing arts, and of course, science.

For interdisciplinary planning, schedule meetings with your team early. You are encouraged to tap the talents and interests of your team members as well as of your unique school and community resources in developing other suitable activities for this unit.

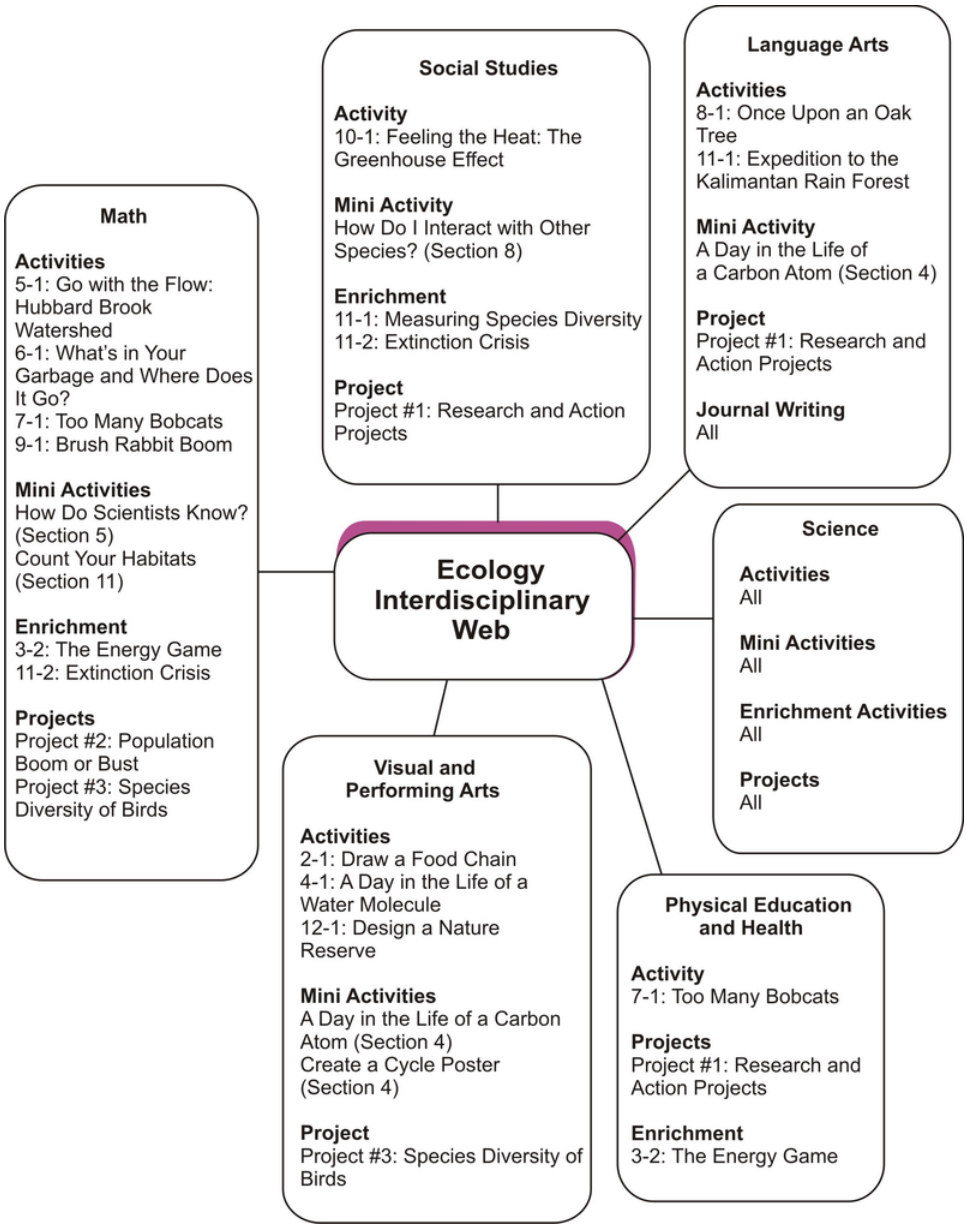
Use Current Events. You might want to ask the students to bring in newspaper clippings that relate to what they are investigating each week in the Ecology unit. Relating the unit content to current events helps the students see that what they are doing in class is, in fact, relevant to their lives. Students can use current events to make group scrapbooks, bulletin boards, and posters or to develop class presentations.

You may want to make a "question box" available to the students. Ask students to think of questions they have about what they are investigating. They can write down their questions and put them in the box. Then, when the time is right, pull out the questions and read them to the class. These questions generate good discussion. They also can be used to initiate class research projects.

Use a Variety of Resources. For the duration of the unit, we encourage you and your students to use a wide variety of sources for information. The activities provide rich opportunities for students to explore a variety of concepts; and the more they can incorporate information from sources outside the classroom, the richer their experiences will be. Use computer services for student and teacher information, networking (student pen pals, other schools, and communities), and connecting with experts in the field. An extensive list of resources can be found of this Teacher's Guide.

Have Students Keep Ecology Journals. We strongly recommend that each student keep an ecology journal. Encourage students to use their journals as they explore the environment around them. Encourage them to use their journals in the following ways or in any way that enhances their learning:

- to express their feelings and thoughts about their environment and what they are learning
- as a place to write down questions that come up as they progress through the unit
- as a place to write goals, predictions, hypotheses, and plans
- in any way that will help them make studying ecology a positive learning experience.



Teaching Timelines

You can use these timelines as a place to start in designing your own timelines, or you can use them as they are laid out. If you're planning your own timeline, consider the inclusion of the Embedded activities first. The embedded activities are included in the student edition. The Enrichment activities, GroupWork activities, and projects can then be included, depending on your time restrictions. The timelines are guides that can vary if some activities are done at home or in other classes in addition to science class.

We realize it may not be possible to do all the activities shown on these timelines. If you need to remove activities, be careful not to remove any activities critical to the content of the unit. You may want to divide the activities among interdisciplinary members of your teaching team.

Page references in these charts refer to the student edition, except when Enrichments are suggested. The page references for Enrichments refer to this Teacher's Guide.

TABLE 1.2: Option 1: Six Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Read Section 1 **Activity 1-1:** Map Your Environment	Read Section 2	Review Section 2 **Activity 2-1:** Draw a Food Chain	Read Section 3 **Mini Activity:** Draw Your Community	Review Section 3 **Mini Activity:** Draw the Community of a Largemouth Bass
Week 2	**Activity 3-1:** Classifying the Players in a Willow Forest	Review of Sections 1, 2, 3 Assessment Sections 1, 2, 3	Read Section 4 **Activity 4-1:** A Day in the Life of a Water Molecule	Read Section 4 **Mini Activity:** A Day in the Life of a Carbon Atom OR **Mini Activity:** Create of Cycle Poster	Read Section 5. **Activity 5-1:** Go with the Flow: Hubbard Brook Watershed
Week 3	Continue **Activity 5-1:** Go with the Flow: Hubbard Brook Watershed	Read Section 6 **Activity 6-1:** What's in Your Garbage and Where Does It Go?	Read Section 6 **Mini Activity:** Overpackaging	Review of Sections 4, 5, 6 Assessment Section 4, 5, 6	Read Section 7 **Activity 7-1:** Too Many Bobcats
Week 4	Read Section 7 **Mini Activity:** Define the Niche of an Animal	Read Section 8	**Activity 8-1:** Once Upon an Oak Tree	Read Section 9	**Activity 9-1:** Brush Rabbit Boom
Week 5	Review of Sections 7, 8, 9 Assessment Sections 7, 8, 9	Read Section 10	**Activity 10-1:** Feeling the Heat: The Greenhouse Effect	Read Section 11 **Activity 11-1:** Expedition to the Kalimantan Rain Forest	Read Section 11 **Enrichment 11-1:** Measuring Species Diversity
Week 6	Continue **Enrichment 11-1:** Measuring Species Diversity	Read Section 12 **Activity 12-1:** Design a Nature Reserve	Continue **Activity 12-1:** Design a Nature Reserve	Read Section 13 **Activity 13-1:** Map Your Environment Revisited	Assessment Sections 10, 11, 12, 13 Or Unit Exam

TABLE 1.3: Option 2: Eight-Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Read Section 1 **Activity 1-1:** Map Your Environment	Read Section 2	Review Section 2 **Mini Activity:** Photosynthesis/Respiration Play	**Activity 2-1:** Draw a Food Chain	**Enrichment 2-1:** What Do Owls Eat?

TABLE 1.3: (continued)

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 2	Continue **Enrichment 2-1:** What Do Owls Eat?	Read Section 3 **Mini Activity:** Draw Your Community	Review Section 3 **Mini Activity:** Draw the Community of a Largemouth Bass	**Enrichment 3-1:** Food Web Game	Continue **Enrichment 3-1** Food Web Game
Week 3	**Activity 3-1:** Classifying the Players in a Willow Forest	Review of Sections 1,2,3 Assessment Sections 1,2,3	Read Section 4 **Activity 4-1:** A Day in the Life of a Water Molecule	**Enrichment 4-1:** What Goes Up, Must Come Down-Water-Cycle Simulation OR **Enrichment 4-2:** Water Underground	Review Section 4 **Mini Activity:** A Day in the Life of a Carbon Atom OR **Mini Activity**: Create a Cycle Poster
Week 4	Read Section 5 **Mini Activity:** How Do Scientists know	**Activity 5-1:** Go with the Flow: Hubbard Brook Watershed	Continue **Activity 5-1:** Go with the Flow: Hubbard Brook Watershed	Read Section 6 **Mini Activity:** Draw a Paper Cycle	**Activity 6-1:** What's in Your Garbage and Where Does It Go?
Week 5	Read Section 6 **Mini Activity:** Overpackaging	Review of Sections 4,5,6 Assessment Sections 4,5,6	Read Section 7 **Activity 7-1:** Too Many Bobcats	**Enrichment 7-1:** What's in a Niche?	Read Section 8
Week 6	**Activity 8-1:** Once Upon an Oak Tree	Read Section 9	**Activity 9-1:** Brush Rabbit Boom	Review of Sections 7,8,9 Assessment Sections 7,8,9	Read Section 10
Week 7	Review Section 10 **Activity 10-1:** Feeling the Heat: The Greenhouse Effect	Read Section 11 **Mini Activity:** Count Your Habitats OR **Mini Activity:** Local Species	Review Section 11 **Activity 11-1:** Expedition to the Kalimantan Rain Forest	**Enrichment 11-1:** Measuring Species Diversity	Continue **Enrichment 11-1:** Measuring Species Diversity
Week 8	**Enrichment 11-2:** Extinction Crisis	Read Section 12 **Activity 12-1:** Design a Nature Reserve	Continue **Activity 12-1:** Design a Nature Reserve	Read Section 13 **Activity 13-1:** Map Your Environment Revisited	Assessment Sections 10,11,12,13 OR Unit Exam

Safety for Teachers

- Always perform an experiment or demonstration on your own before allowing students to perform the activity. Look for possible hazards. Alert students to possible dangers. Safety instructions should be given each time an experiment is begun.
- Wear glasses and not contact lenses. Make sure you and your students wear safety goggles in the lab when performing any experiments.
- Do not tolerate horseplay or practical jokes of any kind.
- Do not allow students to perform any unauthorized experiments.
- Never use mouth suction in filling pipettes with chemical reagents.
- Never "force" glass tubing into rubber stoppers.
- Use equipment that is heat resistant.
- Set good safety examples when conducting demonstrations and experiments.
- Turn off all hot plates and open burners when they are not in use and when leaving the lab.
- When students are working with open flames, remind them to tie back long hair and to be aware of loose clothing in order to avoid contact with flames.
- Make sure you and your students know the location of and how to use fire extinguishers, eyewash fountains, safety showers, fire blankets, and first-aid kits.
- Students and student aides should be fully aware of potential hazards and know how to deal with accidents. Establish and educate students on first-aid procedures.
- Teach students the safety precautions regarding the use of electricity in everyday situations. Make sure students understand that the human body is a conductor of electricity. Never handle electrical equipment with wet hands or when standing in damp areas. Never overload electrical circuits. Use 3-prong service outlets.
- Make sure that electrical equipment is properly grounded. A ground-fault circuit breaker is desirable for all laboratory AC circuits. A master switch to cut off electricity to all stations is desirable for all laboratory AC circuits.
- Make sure you and your students are familiar with how to leave the lab safely in an emergency. Be sure you know a safe exit route in the event of a fire or an explosion.

For Student Safety

Safety in the Classroom

- Wear safety goggles in the lab when performing any experiments. Tie back long hair and tuck in loose clothing while performing experiments, especially when working near or with an open flame.
- Never eat or drink anything while working in the science classroom. Only lab manuals, notebooks, and writing instruments should be in the work area.
- Do not taste any chemicals for any reason, including identification.
- Carefully dispose of waste materials as instructed by your teacher. Wash your hands thoroughly.
- Do not use cracked, chipped, or deeply scratched glassware, and never handle broken glass with your bare hands.
- Lubricate glass tubing and thermometers with water or glycerin before inserting them into a rubber stopper. Do not apply force when inserting or removing a stopper from glassware while using a twisting motion.
- Allow hot glass to cool before touching it. Hot glass shows no visible signs of its temperature and can cause painful burns. Do not allow the open end of a heated test tube to be pointed toward another person.
- Do not use reflected sunlight for illuminating microscopes. Reflected sunlight can damage your eyes.
- Tell your teacher if you have any medical problems that may affect your safety in doing lab work. These problems may include allergies, asthma, sensitivity to certain chemicals, epilepsy, or any heart condition.
- Report all accidents and problems to your teacher immediately.

HANDLING DISSECTING INSTRUMENTS and PRESERVED SPECIMENS

- Preserved specimens showing signs of decay should not be used for lab observation or dissection. Alert your teacher to any problem with the specimen.
- Dissecting instruments, such as scissors and scalpels, are sharp. Use a cutting motion directed away from yourself and your lab partner.
- Be sure the specimen is pinned down firmly in a dissecting tray before starting a dissection.
- In most cases very little force is necessary for making incisions. Excess force can damage delicate, preserved tissues.
- Do not touch your eyes while handling preserved specimens. First wash your hands thoroughly with warm water and soap. Also wash your hands thoroughly with warm water and soap when you are finished with the dissection.

CHAPTER 2 You and the Environment - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

2.1 Planning

Key Idea

- Your environment is everything outside your body that affects you or that you affect.

Overview

This section provides a rationale for studying ecology. Students learn how much they depend on the biotic and abiotic factors within the environment by creating a map that illustrates the relationships between themselves and these factors. The introductory activity may be used to assess how your students picture the roles they play in the environment.

Objectives

Students:

✓ identify and explain the major biotic and abiotic resources in their environment.

✓ demonstrate their connection to other factors in the environment.

Vocabulary

abiotic, biotic, ecologist, environment, organism

Student Materials

Activity 1-1: Map Your Environment!

Per student

- Activity Report
- 1 piece of butcher paper or other large piece of paper
- Colored marking pens, pencils, or crayons

Teacher Materials

Activity 1-1: Map Your Environment

- Activity Report Answer Key

Advance Preparation

See Activity 1-1 in the Student Edition

Interdisciplinary Connections

Social Studies Students can investigate the career opportunities available related to ecology and environmental science.

Visual and Performing Arts Students can make drawings or use pictures to illustrate their map of the environment.

Enrichment Activities

None

2.2 Using You and the Environment – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "What is your environment and how is it related to ecology?" Answering this question will help set the context for the study of ecology and environmental issues.

Distinguish between the terms *biotic* and *abiotic*. Continue to use these terms throughout the unit.

Assign the *What Do You Think?* on page 2 as a writing prompt. This prompt will give the students an opportunity to express their preconceptions about the study of ecology as a career. Save their responses to compare to their answers after students complete this unit.

You can use *Activity 1-1: Map Your Environment* either as a pre-test for this unit in class or as a homework assignment for this section.

Use *What Do You Think?* on page 3 as a starting point in the discussion of the global context of environmental issues. Ask students to think of other cultures besides those given that would include very different biotic and abiotic factors from those of their own culture.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Name something that was once alive but has now been dead for thousands (or even millions) of years. Explain why you think it would be considered a biotic factor or an abiotic factor now? Explain.

What Do You Think?

Would you consider a career studying the environment? Why or why not? Find out about some of these careers and imagine yourself in ten years with one of those careers.

Journal Writing

You are an ecologist. Write about a typical day in your life as you study plants, animals, and their interactions with their environment and each other.

Journal Writing

Why should we study ecology?

2.3 Activities and Answer Keys

Activity 1-1: Map Your Environment

PLAN

Summary Students learn how they depend on various biotic and abiotic factors for survival and comfort by drawing themselves and the factors on a sheet of paper. Then students connect these components with lines to delineate relationships between themselves and the biotic and abiotic factors.

Objectives

Students:

✓ identify and explain the major biotic and abiotic resources in their environment.

✓ demonstrate their connection to other factors in the environment.

Student Materials

Per student

- Activity Report
- 1 Piece of butcher paper or other large piece of paper
- Colored marking pens, pencils, or crayons

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Prepare copies of the Activity Report.

Estimated Time 10-30 minutes, depending on discussion time

Interdisciplinary Connections

Social Studies As the students map their environment they are also identifying interactions of people, places, jobs, etc., that relate to the social as well as the ecological environments around them.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 1-1 by reviewing with students the difference between *biotic* and *abiotic* using Section 1 of the text for guidance. Debates may develop when students are asked to decide whether petrified wood or fossil fuels are biotic or abiotic. You may wish to develop a class definition of these two words. You may also wish to delve into the differences between organic and inorganic.

Helpful Hints

For an example of a map of an organism's environment show the students the map dog's environment in Figure 1.1 in the student book.

Steps 1-4 Have students follow the instructions for Activity 1-1 in the text. Supply them with paper and colored pens or pencils. During the activity, make sure students label each factor and its importance to them.

Steps 5-6 After students complete the activity, you may wish to assign the questions from Steps 5 and 6 of the Procedure as written class work or homework.

Extend Activity 1-1 by having students create a group or class map to illustrate their intersecting environments. The map should show how they could consider themselves part of a biological community. For example, many students probably put food, school, and each other on the maps of their environment. Consequently, these items would have lines drawn to more than one student on a group map. This would begin to demonstrate the concept of a web, which leads into the next section on energy flow and food webs.

ASSESS

Use the product, student's map of the environment, to assess if students can

✓ explain the difference between biotic and abiotic factors.

✓ explain the connections between various resources within their environment.

This activity can be considered a pre-test for the unit. The activity will demonstrate the students' previous knowledge about the relationships between themselves and the environment. Misconceptions or inaccurate information will be evident and should provide a starting point for exploring the ecology unit.

Activity 1-1: Map Your Environment – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Which of these factors is the most important to you?
2. Which factors, if any, could you live without?
3. What factors in your environment do you have in common with your classmates?
4. How are your environmental factors similar to those of your classmates? How are they different?

What Do You Think?

Consider the factors you found to be important in your environment. How do you think these factors differ from those of a student who lives in a village in the Brazilian rain forest, in a Japanese city, and near the Sahara Desert?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is your environment?

2. What is the difference between a biotic and an abiotic factor? Give three examples of each that are not mentioned in this book.
3. What are ecologists and what do they do?

Activity 1-1 Report: Map Your Environment

1. Which of these factors is the most important to you?
2. Which factors, if any, could you live without?
3. What factors in your environment do you have in common with your classmates?
4. How are your environmental factors similar to those of your classmates? How are they different?

CHAPTER 3 Food Chains: How Energy Gets to You - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

3.1 Planning

Key Ideas

- Almost all energy originates with the sun.
- Energy is passed from organism to organism along a food chain.

Overview

The previous section provided students with a starting point for studying ecology by distinguishing between biotic and abiotic factors. This section introduces the concept that energy flows through food chains. Students trace the flow of energy from their own breakfast food back to the sun. Students are introduced to topics such as cellular respiration, digestion, predation, and photosynthesis.

Objectives

Students:

✓ explain how energy flows through a food chain.

✓ select a specific food and trace the food chain back to its original energy source.

✓ explain that almost all energy used by plants and animals originates with the sun.

Vocabulary

aerobic respiration, food chain, photosynthesis

Student Materials

Activity 2-1: Draw a Food Chain

Per student

- Activity Report
- Paper

Per class

- 6 sets of marking pens, pencils, or crayons

Teacher Materials

Activity 2-1: Draw a Food Chain

- Activity Report Answer Key

Advance Preparation

See Activity 2-1 in the Student Edition.

Prepare copies of the Activity Report.

If you decide to use *Enrichment 2-1: What Do Owls Eat?*, you will need to order owl pellets. See the Advance Preparation for ordering owl pellets on TE.

Interdisciplinary Connections

Language Arts Students can write a story describing the relationships within the food chain that they have examined.

Visual and Performing Arts Students can make drawings or use pictures to illustrate their food chain. These can be displayed as mobiles. In addition, the Mini Activity introduces opportunities for students to create and perform a play.

Enrichment Activity

Enrichment 2-1: What Do Owls Eat?

Students learn basic lab dissection skills and analyze the components of an owl's diet by dissecting an owl pellet.

Background Information

How Muscles Contract: How muscles contract is not discussed in detail here. However, a short discussion of muscle contraction may help the students understand the need for energy. The muscles that are in your finger are typical of muscles found in animals. Each is made up of many muscle fibers. Each of these fibers is made up of many threads called fibrils. Each of these fibrils is made up of two types of filaments-actin filaments and myosin filaments. Each myosin filament has a hook called a head, which can reach out and grab onto a neighboring actin filament and pull along it.

When all of the myosin heads in a fibril pull on their neighboring actin filaments, the fibril shortens. When all of the fibrils in a muscle fiber contract, the fiber shortens. When all of the fibers in a muscle contract, the muscle shortens and, finally, your finger twitches.

Respiration: For the sake of simplicity this section explains only aerobic respiration because it provides the bulk of the ATP that fuels muscle movement.

Chlorophylls in Photosynthesis: The explanation concerning chlorophyll used in photosynthesis is a simplification. Several types of chlorophyll photosynthesize. But, only a couple of types are found in "higher" plants. Some algae and bacteria rely on other pigments including those that are blue, red, brown, and even gold!

3.2 Using Food Chains: How Energy Gets to You – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "Where do you get the energy to live?" Students may not yet have considered that eating food is how animals get energy from the sun. Emphasize that energy is stored in food, so our bodies must be able to release this energy to function.

Carefully analyze the figures with the students to trace the flow of energy backward from the movement of muscles in a finger to the sun by tracing where their breakfast came from.

The reversible nature of the reactions is the key to learning how energy is transferred from the sun to storage molecules in plants (photosynthesis) and then released from these molecules in plants and animals (respiration). Emphasize that green plants perform both photosynthesis and respiration. Green plants have to store the energy from the sun and then release it as they need it.

Activity 2-1: Draw a Food Chain will illustrate that the source of energy is almost always the sun no matter what organism you study in a food chain.

Journal Writing

Think about the last time you were exercising so hard that you were panting and gasping for breath. Describe what it felt like in your mouth, your throat, your chest and lungs. Now describe what you imagine is happening to the oxygen and carbon dioxide as it moves in and out of your body.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

If oxygen and sugar are the only things required to provide energy to move our muscles, why do we bother to eat other foods? Why do you think we eat other foods, such as potatoes, pasta, meat, ice cream, pizza, and spinach?

What Do You Think?

You might say that you have the energy to wiggle your finger because the sun shines. Read the quote from Steve Van Matre again.

"Each living thing is a spark of sunlight energy, a crystal bead in the net of life."

-Steve Van Matre

The Earth Speaks

What do you think the author meant when he wrote that sentence?

Mini-Activity

Photosynthesis/Respiration Play

Students learn about the process of photosynthesis and respiration by creating and performing a skit. Encourage the students to be creative. The following is a sample play written by a group of students at Egan Middle School.

Cast of Characters: Narrator 1, Narrator 2, Sun, Water, Carbon Dioxide, Oxygen, and Sugar

Setting: A cell is represented by a sheet spread over four stools. Arrange the sheet so that the front is totally covered and there is a space for people to hide in the back. All characters except oxygen, sugar, and the sun are standing in the "wings." Oxygen and sugar are hiding behind the sheet. The sun is crouching a few feet away from the cell.

Narrator 1: *(Reads the cast of characters)* The sun rose on a new day. *(The sun stands and opens its arms)* The young plant cell was preparing for photosynthesis. Deep inside the cell's chloroplasts, chlorophyll was absorbing energy from the sun. *(The sun pours rays over the cell.)* The plant was also absorbing water from the soil. *(Water jumps behind cell.)* Carbon dioxide entered the plant through tiny openings in its leaves called stomates. *(Carbon dioxide floats behind cell).*

Narrator 2: During the day, the cell was hard at work performing photosynthesis. *(Water and carbon dioxide run around behind the cell.)* Finally, the cell was finished and the products of this process were sugar and oxygen. *(Sugar and oxygen stand up. Water and carbon dioxide sit down.)* The sugar was stored for later use. *(Sugar sits.)* The oxygen was released into the air for other plants and animals to use in respiration.

The End

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

- **During what parts of the day does respiration occur in a plant cell? Explain your reasoning.**
- **Can plants photosynthesize in the dark? Explain your answer.**
- **Give an example of energy used by a living organism that cannot be traced back to the sun.**

3.3 Activities and Answer Keys

Activity 2-1: Draw a Food Chain

PLAN

Summary Students learn about relationships in a food chain by drawing two different food chains. One food chain is based on what they ate for breakfast. The other food chain is based on the food of a bird of prey.

Objectives

Students:

✓ trace a food chain based on an item from their breakfast.

✓ explain the relationships between the organisms in a food chain.

✓ explain that almost all energy used by plants and animals originates with the sun.

Student Materials

Per student

- Activity Report
- Paper

Per class

- 6 sets of marking pens, pencils, or crayons

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Prepare copies of Activity Report.

Estimated Time

20 minutes, depending on discussion time

Interdisciplinary Connections

Visual/Performing Arts In Activity 2-1 students will draw food chains. The students can build a mobile from the food chains they draw.

Language Arts Students write a story describing the relationships in their mobile. They write about how each organism depends on the others.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 2-1 by reviewing the concept of a food chain and emphasize that all our energy can be traced back to the sun.

Steps 1-4 Have students follow the instructions for Activity 2-1 in the text. Supply them with paper and colored pens or pencils. During the activity remind students to use a food derived from an animal that they ate for breakfast. This will allow for a longer food chain.

Step 5 After students have completed their food chains, you may want to hang them up around the room and compare breakfasts.

Extend Activity 2-1 by having students join their food chains together to make a food web. This will provide a transition into the concept of an interdependent food web rather than a linear food chain.

Students can choose one of the two food chains they've drawn and make it into a mobile. They can use pictures of animals and plants, construction paper, and their own drawings to make the parts of the mobile. Next, they can connect these parts with yarn according to the lines on their sketch. Each animal and plant should be connected only to the organisms that eat it or that it eats. Finally, you can hang the mobiles around your classroom.

Have students write a story describing the relationships displayed in their mobile. Encourage them to write about how each organism depends on the others.

ASSESS

Use the final product, a drawing of a food chain, to assess if students can

✓ explain that the energy for the food chain originates with the sun.

✓ draw and explain the correct arrangement of the organisms in the food chain.

Activity 2-1: Draw a Food Chain – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. List all the things you ate for breakfast this morning or that you have eaten recently.
2. List the foods your chosen bird of prey might eat.
3. List the foods each of the prey you listed above might eat.
4. How many steps are in each of your food chains? Which food chain that you drew has the most steps?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Long ago, when the land was beginning to be inhabited by living organisms, which do you think came first-animals or plants? Explain your answer.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Where do cells get their energy?
2. What process do plants use to capture the sun's energy?
3. How are respiration and photosynthesis related?
4. Where do plants get their energy? Where do animals get theirs?
5. What is the original source of almost all energy used by living things?
6. What is a food chain?

Activity 2-1 Report: Draw a Food Chain (Student Reproducible)

1. List all the things you ate for breakfast this morning or that you have eaten recently.
2. List the foods your chosen bird of prey might eat.
3. List the foods each of the prey you listed above might eat.
4. How many steps are in each of your food chains? Which food chain that you drew has the most steps?

3.4 Enrichment

Teacher Activity Notes

What Do Owls Eat?

PLAN

Summary

Students learn basic lab dissection skills and analyze the components of an owl's diet by dissecting an owl pellet.

Objectives

Students:

✓ demonstrate lab skills using dissection tools.

✓ explain how owl pellets are formed, what they consist of, and how owls obtain energy.

Student Materials

- Activity Guide
- Resource 1
- Resource 2
- Activity Report
- 1 owl pellet; 1 sheet of white paper; 1 set of Tweezers; 1 dissecting needle or probe; 1 ruler; 1 copy of drawings of rodent and bird bones; 1 sheet of construction paper; 2 petri dishes; 2 rubber gloves (optional)

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Prepare copies of Resources 1 and 2 and Activity Report.

You can order owl pellets from a scientific supply company. Some possible sources are

Pellets, Inc., 3004 Pinewood, Bellingham, WA. Phone number: (206) 733-3012. Fax number: (206) 738-3402.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Phone: 1-800-227-1150.

Genesis Inc., P.O. Box 2242, Mount Vernon, WA 98273. Phone: (206) 422-6764, FAX: (206) 422-6765. For Owl Pellet Kits, call 1-800-4PELLET.

These companies have the pellets as well as charts and drawings of bones, rodents, and birds. They also have excellent illustrations of food webs. The charts and drawings help students figure out exactly which animals are represented in their pellet. This helps them be more precise in their investigation instead of simply piling up unknown bones. If you know of an owl roost (check abandoned barns), you will be able to find a pile of owl pellets below the owls' favorite resting spots.

Estimated Time

Two or three 50-minute periods

Interdisciplinary Connections

Language Arts Have students research what type of plants rodents eat to write about a more complete food chain of an owl.

Prerequisites and Background Information

An owl is a nocturnal hunter. Like other birds of prey it is a raptor and swallows its prey whole. An owl cannot break up the bones and fur by chewing. Therefore it cannot digest anything larger than the openings in its intestine. The owl regurgitates the bones, fur, and feathers of its prey in the form of a compact pellet covered with mucus. The pellets dry quickly and accumulate under the owl's roost. Typically an owl will regurgitate two pellets a day. The rodents that are most often found in these pellets are voles, shrews, and mice. However, you can also find small birds and the cocoons of large insects. Since no bones are digested, students can find almost complete skeletons inside the pellet. Sometimes even the skull and lower jawbones are intact because fur has matted around them.

IMPLEMENT

Introduce Enrichment 2-1 by giving students some background as to how owl pellets are formed and what owls usually eat. Explain to students that the pellets are safe to handle. Point out that the pellets do not have any flesh in them because the owl digested it all. Likewise, reassure students that the pellets do not have any maggots or other decomposers inside.

Steps 1-3 Divide the class into pairs, and distribute all other materials before you hand out the pellets. Warn students to be very gentle with the pellets, scraping the top of the pellet with their probe or scalpel. Otherwise, they'll break the bones inside. Ask students to read through all the steps before they begin.

As they begin the activity, tell students they'll need to keep bones and fur separate as they dissect since the activity lasts more than one day. Each group will need one petri dish in which to put the fur they are still analyzing and one petri dish in which to put the bones that they've found. As students find bones, they'll want to know which animals the bones came from. Refer them to Resources 1 and 2.

> ***Extend Enrichment 2-1*** by having students draw a food chain of an owl, as in *Activity 2-1: Draw a Food Chain.* In order to complete the food chain, students will have to research what plants each rodent eats.
>
> **Helpful Hints**
>
> Remains of birds and insect cocoons are rare in most batches of owl pellets. Therefore, draw attention to any such remains that are found. Encourage the students to share their findings with each other.

Step 4 On the second and third days students will be finishing their dissecting and can begin sorting, gluing, and labeling the bones on construction paper. The charts and drawings of bones are important at this point. Encourage students to be creative in their organization of the bones: they can try to reconstruct a skeleton, or group the bones by type (femur, tibia, scapula, etc.) or by the animal they came from.

You may wish to assign the Activity Report as written class work or homework.

ASSESS

Use the final product, an organized poster of all the bones found in an owl pellet, and responses to the Activity Report to assess if students can

✓ demonstrate careful and thorough lab skills required to complete a dissection.

✓ identify the contents of an owl pellet.

✓ explain the difference between carnivore and omnivore.

Enrichment 2-1: What Do Owls Eat? – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Before dissection: Length of owl pellet: Width of owl pellet: Diameter: Observations of outside of pellet:
2. Are owls carnivores or omnivores? (Can you find evidence that owls eat plants?) Explain why you think so.
3. Use the hand lens to examine your findings. Sketch any two items found in your owl pellet. Label your sketch.
4. Where do you think would be the best place to find owl pellets?

Enrichment 2-1 Activity Guide: What Do Owls Eat? (Student Reproducible)

Introduction

How can ecologists find out what an animal eats without watching it eat? One way is to analyze the leftovers after an animal has eaten. To find out what owls eat we can analyze the pellets of bones and fur that they cough up after eating. Owls swallow their prey whole. They digest all of the soft tissue-the skin, muscle, and fat. But the owl can't digest the bones, fur, or feathers. These leftovers form a compact pellet that the owl regurgitates from their stomachs. The pellets include entire skeletons of whatever the owl ate. In this activity you will discover what an owl eats by dissecting one of these pellets.

Materials

- Resource 1 - Tweezers
- Resource 2 - Dissecting needle or probe
- Activity Report - Construction paper
- Owl pellet - Ruler
- White paper - 2 petri dishes

Procedure

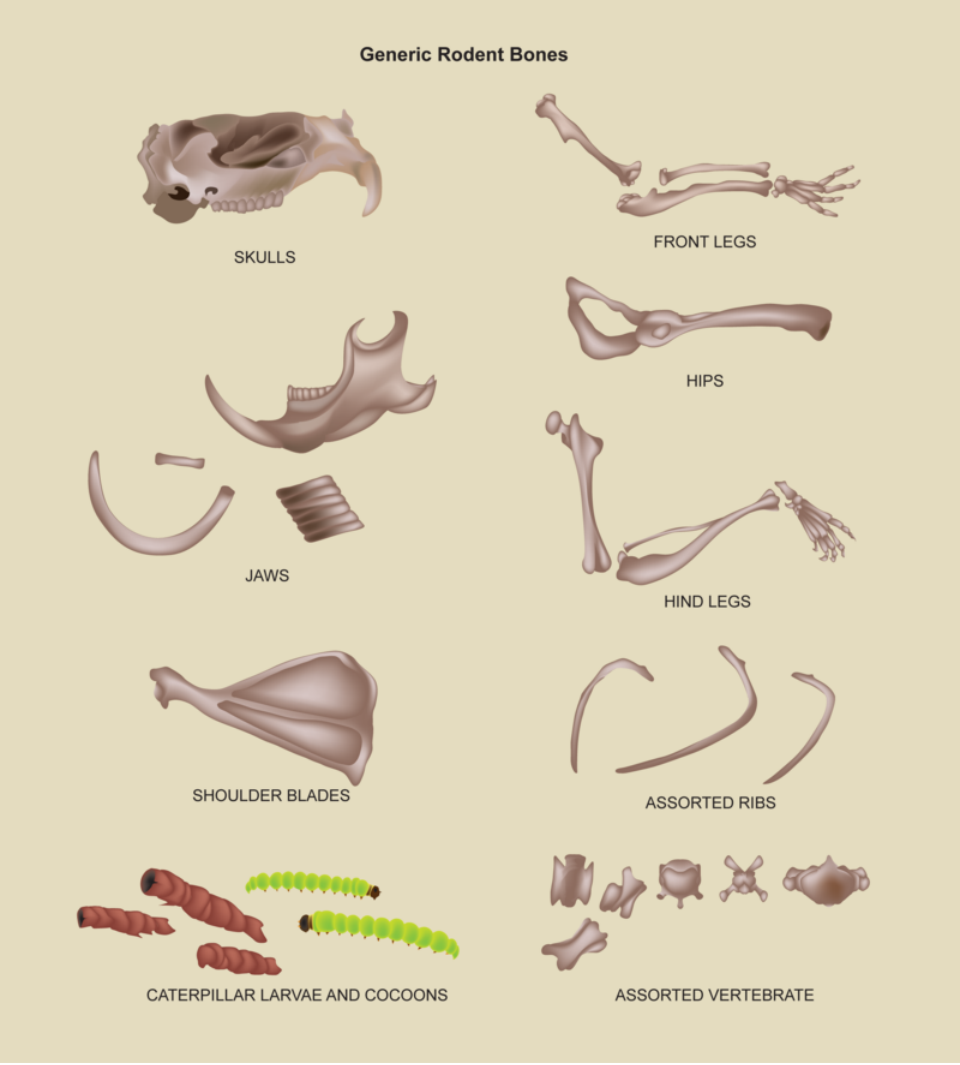
Step 1 Place the pellet on the white paper so you can see it better. Before you begin dissecting, make a sketch of your owl pellet, showing its actual size. Then label its length and width in centimeters. Record your observations of the outside of the pellet.

Step 2 Use the tweezers and probe to gently scrape away the fur from the outside of the pellet. Do not try to break the pellet in half or pry into the middle of it. You'll break the bones inside. Separate the bones from the fur or feathers, making sure that you thoroughly clean any debris from the bones. The drawings on Resources 1 and 2 are for comparison of the shape of the bones you will find in the owl pellet. The drawings are much larger than the actual bones.

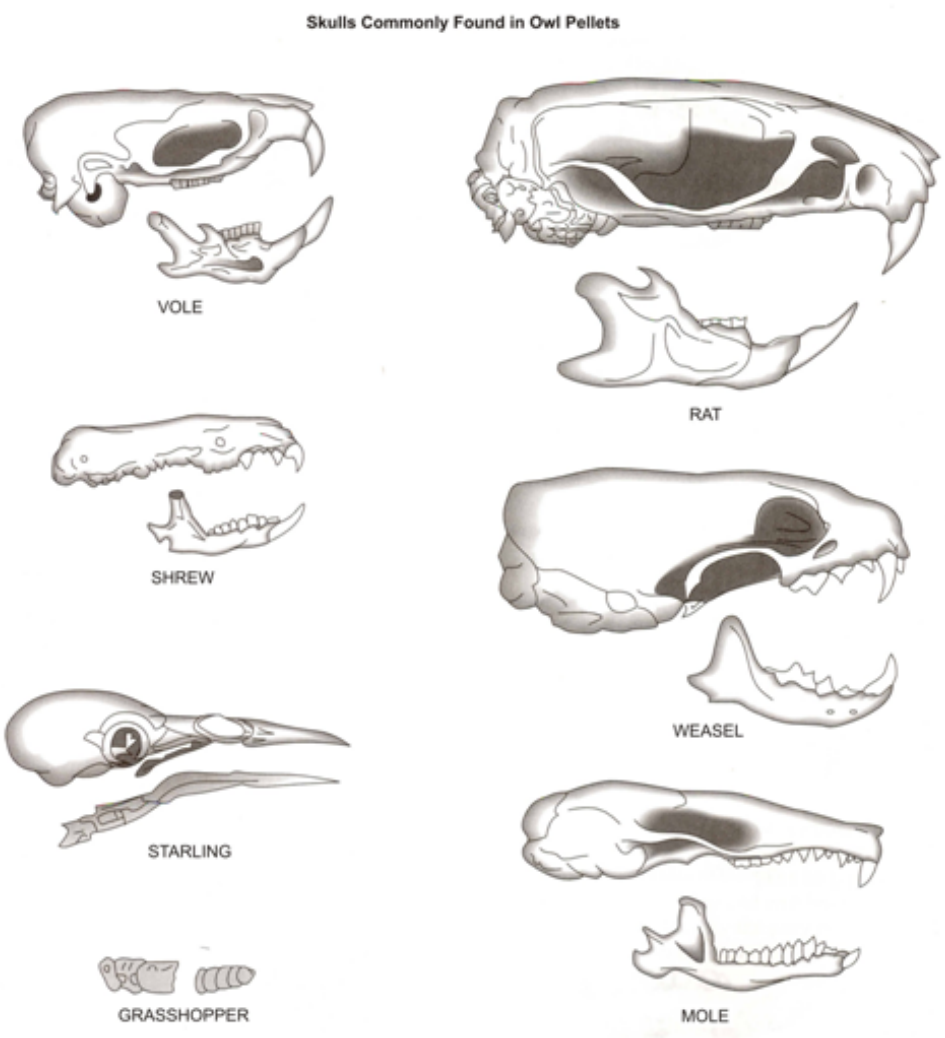
Step 3 After you have completely extracted all of the bones from the pellet (even the tiny ones), categorize the bones. You can categorize them by putting them in piles by type such as skulls, ribs, hipbones, vertebrae, leg and arm bones. Or make up your own category. Identify the prey of the owl by matching the skulls to the drawings on Resource 1 or Resource 2.

Step 4 Once you have organized the bones, glue them onto the piece of construction paper. Make sure you label each set of bones and what animals you think are included in your owl pellet.

Enrichment 2-1 Resource 1: What Do Owls Eat? (Student Reproducible)



Enrichment 2-1 Resource 2: What Do Owls Eat? (Student Reproducible)



Enrichment 2-1 Activity Report: What Do Owls Eat? (Student Reproducible)

1. Before dissection:

Length of owl pellet: _____

Width of owl pellet: _____

Diameter: _____

Observations of outside of pellet:

2. Are owls carnivores or omnivores? (Can you find evidence that owls eat plants?) Explain why you think so.

3. Use the hand lens to examine your findings. Sketch any two items found in your owl pellet. Label your sketch.

4. Where do you think would be the best place to find owl pellets?

CHAPTER 4 Energy Flow in a Community - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

4.1 Planning

Key Ideas

- The flow of energy in a community can take many interrelated paths.
- The amount of useful energy decreases at each step.

Overview

In the previous section students learned about the flow of energy within a simple food chain. This section expands on the concept of a simple food chain by exploring how food chains interconnect to form complex food webs. In this section, students explore how energy flows through a food web by classifying the role of each organism in the web. They will learn about the interdependence of organisms in a food web by analyzing diagrams and playing the part of an organism in a simulation.

Objectives

Students:

✓ explain how organisms are interdependent within a food web.

✓ identify the roles of producers, consumers, and decomposers.

✓ identify what happens in a food web if an organism is removed.

✓ explain how the energy from the sun flows between organisms in a food web.

✓ explain how an energy pyramid demonstrates the loss of energy as it is transferred up from one level to the next higher level.

Vocabulary

biological community, calorie, carnivore, consumer, decomposer, ecological pyramid, food web, herbivore, human community, omnivore, producer

Student Materials

Activity 3-1: Classifying the Players in a Willow Forest

Per student

- Activity Report
- Resource

Per class

- 6 sets of colored marking pens, pencils, or crayons

Teacher Materials

Activity 3-1: Classifying the Players in a Willow Forest

- Activity Report Answer Key

Advance Preparation

See Activity 3-1 in the Student Edition.

Activity 3-1: Classifying Players in a Willow Forest

- Prepare copies of Resource and Activity Report for the class.

Interdisciplinary Connections

Social Studies Examine the roles and players in social community and compare them to the roles and players in a biological community.

Enrichment Activities

Enrichment 3-1: Food Web Game

Students learn about the interdependent relationships in a food web by researching and drawing a food web focused on one organism and playing the part of that organism in the class' model of a food web. See four actual food web communities in the Background Information section.

Enrichment 3-2: The Energy Game

Students learn about the transfer and loss of energy along a food chain by playing a tag-like game whose object is to gather energy in order to survive and reproduce.

- Obtain 400 white, 90 blue, and 10 red poker chips for a class of 30 students.
- Select an outdoor area for the "habitat" in which to conduct the activity.

Background Information

The following references are excellent sources for examples of some different food webs used in Enrichment 3-1 Resources:

Niering, W A. 1963. Caroline Islands, Ecology Monographs. *33: 131-160.*

Naumov, N. P. 1972. The Ecology of Animals. *Norman Levine, ed. University of Illinois Press, Champaign, Illinois, p. 549*.

Bird, R. D. 1930. "Biotic communities of the aspen parkland of central Canada." Ecology *11: 356-442.*

Teal, J. M. 1962. "Energy flow in the salt marsh ecosystem of Georgia." Ecology *43: 614-624.*

4.2 Using Energy Flow in a community – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How does energy flow through a biological community?" This emphasizes the multifaceted flow of energy as opposed to the linear food chain concept. Distinguish between a food web and a food chain. One way to do this is by asking students to identify when two simple food chains interact to form a food web.

Assign *Mini Activities: Draw Your Community* and *Draw the Community of a Large mouth Bass* to reinforce the concept of biological communities. Then have students compare their own community to that of the bass.

Illustrate energy pyramids and how energy is always lost by assigning *Enrichment 3-2: The Energy Game*.

Assign *Activity 3-1: Classifying the Players in a Willow Forest* as a culminating activity to assess whether students can classify the major players in a food web and their sources of energy.

Mini-Activity

- **Draw Your Community**

  Students identify ten members of their community and discuss how these people interact with one another.

- **Draw the Community of a Largemouth Bass**

  Students draw and show the interactions between organisms in an aquatic habitat.

- **What Can You Add to the Web?**

  Students analyze a food web and add appropriate organisms.

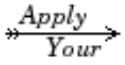
Journal Writing

Imagine you are an organism that lives in the pond. You can be the largemouth bass, the algae on the surface of the pond, the crawfish, or any organism you decide to be. When you decide which organism you want to be, write a story or poem about a day in your life in the community. Would you ever consider being a vegetarian or a vegan?

What Do You think?

If you had your choice, would you rather be a producer, consumer, or decomposer? Why?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**



KNOWLEDGE

List 5 foods that might be included in a vegetarian diet that would not be included in a vegan diet.

Apply Your KNOWLEDGE

What do you think is meant by the phrase "eating low on the food chain"? Could you feed more or fewer people from the same amount of land if everyone was a herbivore or if everyone was a carnivore?

Apply Your KNOWLEDGE

Look at the energy pyramid in Figure 3.5. Suppose a trout eats a smelt and then a human eats the trout. Now, about how many of the original 1000 calories contained in the algae reach the human? How does this compare to the situation in which the human ate the smelt directly?

4.3 Activities and Answer Keys

Activity 3-1: Classifying the Players in a Willow Forest

PLAN

Summary Students learn the basic ecological roles within a food web and their connection to each other by classifying the organisms in a willow forest food web. They classify the organisms in the willow forest food web as herbivore, carnivore, or omnivore.

Objectives

Students:

✓ identify the roles of producers, consumers, herbivores, carnivores, and omnivores in a food web.

✓ explain how organisms are interdependent within the food web.

✓ analyze a food web to find out what would happen if an organism or entire role was removed.

Student Materials

Per student

- Resource
- Activity Report
- Colored marking pens, pencils, or crayons

Per class

- 6 sets of colored marking pens,pencils,or crayons.

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Copy enough Resource Sheets and Activity Reports for the class.

Estimated Time

Approximately 20 minutes

Prerequisites and Background Information

Students should know the meaning of the terms *producer, consumer, herbivore, carnivore*, and *omnivore*. You might want to take a few minutes to review with students what these different types of organisms are.

Extend Activity 3-1 by having students use field guides of local flora and fauna to construct a possible food web. Then students can classify the organisms. Guide students in analyzing what each creature eats and labeling each organism as a producer, herbivore, carnivore, or omnivore.

Helpful Hints

A good way to make sure students understand a system or process is to ask them what would happen if a part of the system were removed. In the case of the willow forest food web the removal of the frog would have dramatic effects. According to the willow forest diagram the frog is the only predator for snails. So if the frog were removed, the snail population would increase dramatically. The frog is also the only food source for the snake. So the snake population would migrate or die out. If one kind of willow tree were removed, the changes to the willow forest food web would be subtler. Every organism that eats the willow tree, *Salix petiolaris*, has other food sources available. But with their food source options reduced these insects have less chance of surviving the winter, blight, or other natural disasters. You can use this example to discuss direct and indirect consequences of the many human activities that remove parts of a food web.

IMPLEMENT

Introduce Activity 3-1 by reviewing with students the terms *producer, consumer, herbivore, carnivore*, and *omnivore*.

Steps 1-3 Have students follow the instructions for Activity 3-1 as they explore the food web on Activity 3-1 Resource that illustrates a willow forest food web.

Steps 4-5 Once students have classified all the organisms in the food web, conduct small group or whole class discussions about the questions in Steps 4 and 5 of the Procedure.

Extend Activity 3-1 by having students use field guides of local flora and fauna to construct a possible food web. Then students can classify the organisms, analyzing and labeling each as a producer, consumer, carnivore, or omnivore.

ASSESS

Use the lists of the "players" in the willow forest produced by students and responses to the Activity Report to assess if students can

✓ differentiate between and among producers and consumers, herbivores, carnivores, and omnivores.

✓ explain the interrelationships between the organisms in the food web.

✓ demonstrate and describe the consequences of removing a major and/or minor "player" in the willow forest system.

Activity 3-1: Classifying the Players in a Willow Forest – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

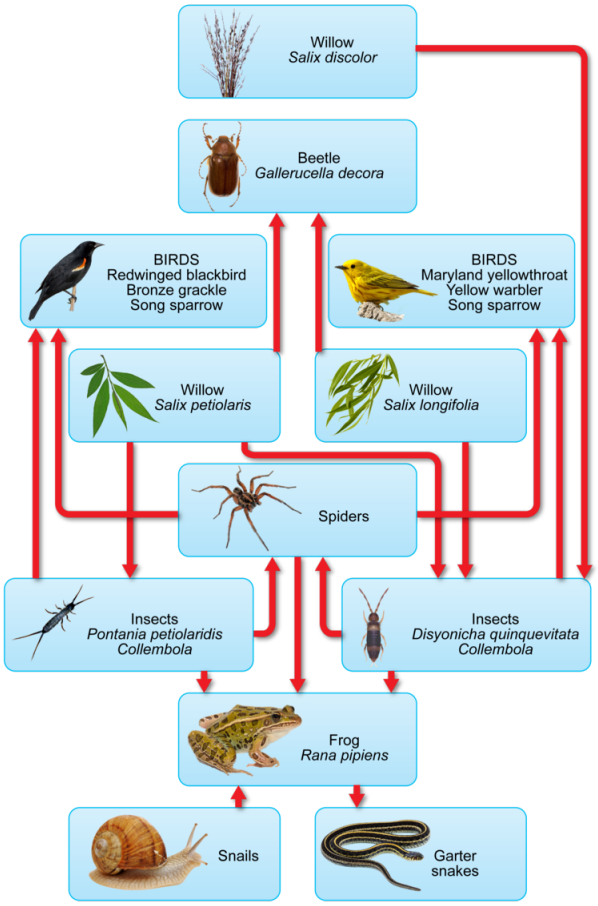
1. Describe what would happen to the members of the willow forest food web if all the frogs left or died out.
2. Describe what would happen to the willow forest food web if one type of willow tree was cut down and removed from the forest.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is a producer?
2. What is a consumer?
3. What happens to useful energy when it is transformed from one form to another?
4. What happens to the energy in an organism when that organism is eaten by another organism?
5. Draw an ecological pyramid using producers, herbivores, and carnivores.

Activity 3-1 Resource: Classifying the Players in a Willow Forest (Student Reproducible)



Activity 3-1 Report: Classifying the Players in a Willow Forest (Student Reproducible)

1. Describe what would happen to the members of the willow forest food web if all the frogs left or died out.

2. Describe what would happen to the willow forest food web if one type of willow tree was cut down and removed from the forest.

4.4 Enrichment

Enrichment 3-1: Teacher Activity Notes

Food Web Game

PLAN

Summary

Students learn about the interdependent relationships in a food web by researching and drawing a food web focused on one organism and playing the part of that organism in the class' model of a food web.

Objectives

Students:

✓ identify the parts that organisms may play in a food web: producer,consumer, herbivore, carnivore, omnivore, and decomposer.

✓ illustrate the flow of energy in the correct direction in the food web community-from the sun to the top carnivore.

✓ predict the effects of changes on the organisms in the food web community.

Student Materials

Per pair

- Activity Guide
- Resource 1
- Resource 2
- Activity Report
- 3 pieces of paper ($8\frac{1}{2}$ by 11 inches); 1 large piece of butcher paper or construction paper; Colored pens or crayons

Per class

- Approximately 50 pieces of yarn/string 3 meters long (number of pieces depends on number of students participating, anticipate about 4 pieces of yarn per student)

Teacher Materials

- Activity Report Answer Key
- Books, posters, and magazines about the organisms in the community selected for the activity. A great reference book for the salt marsh food web is *Life and Death of a Salt Marsh*, by J. M. and Mildred Teal, published by Little, Brown, 1969.

Advance Preparation

Select a natural community for the class to model. You might want to choose one of the communities shown in the food web diagrams on Resources 1 and 2. Do not show the food web diagram of the community you have selected to the students right away. It can be used as an answer key when evaluating the food web posters.

Make a list on the chalkboard or overhead projector of about 20 organisms from the community you have selected.

Gather books, posters, and magazines about the organisms in the natural community you have selected.

Provide a resource area where students can obtain the necessary research materials, paper, pens, and precut yarn pieces on their own.

Estimated Time

Part A: Two to three 50-minute periods

Part B: One to two 50-minute periods

Interdisciplinary Connection

Visual/Performing Arts Students can make masks and costumes for the organisms they represent using paper plates, straws, paper towel rolls, and other craft supplies.

Prerequisites and Background Information

Students should have a thorough understanding of the terms *producer, consumer, herbivore, carnivore*, and *omnivore*.

IMPLEMENT

Part A

Introduce Enrichment 3-1 by reviewing the Introduction and Procedure for Part A with the whole class. Clarify any misconceptions about food webs and the roles the various organisms play in the food web (producer, herbivore, carnivore, and omnivore). Emphasize that an organism usually interacts with and depends on many other organisms rather than on just one or two. This will prepare students for drawing all the possible connections in their web.

> **Helpful Hints**
>
> To help students draw neat circles around their organisms in Step 7 of Part A, give them rolls of masking tape to trace around. You may want to use different colored pieces of yarn corresponding to the colors of the circles around the organism providing the energy. For example, the string between the producer and the herbivore would be green, corresponding to the color of the producer.
>
> When moving from pairs to two large groups in Step 2 of Part B, give each student in the pair a number: one (1) or two (2). Tell all the "ones" to go to one side of the room and all the "twos" to go to the other side of the room.

Steps 1-3 Group students into pairs and have each pair choose a different organism from the list on the overhead projector or chalkboard.

Steps 4-7 Have students show you their rough drafts before they begin their final poster. The following are some suggestions for guiding students as they work through Steps 4-7.

- Give students some hints for looking through reference materials.
- Students often have trouble drawing arrows in the right direction. **Emphasize that arrows follow the flow of energy**. The arrows should all be one color.
- Once students have 4 to 6 organisms that are directly connected to theirs they need to go find "secondary" organisms to expand the web to 15 organisms. Often they will have very few plants. Therefore encourage them to find plants that fit in their web so they can include the sun.
- When students are deciding whether animals are herbivores, carnivores, or omnivores, don't let them guess. Encourage them to use the resource materials, consult with other students, or discuss their decisions with you.

Part B

Introduce Part B by hanging the food web posters on the wall so students can refer to them when constructing the web model. Label two desks with a sign with "sun" written on it to serve as the centers of the food web models.

Steps 1-2 Have students make a simple sign for themselves with the name of their organism on it so others can identify what they represent. Make sure they obtain the correct number of pieces of yarn for their organism. Guide the students as they form two large circles, with one student from each pair in each circle.

Step 3 Have one student in each group read Part B, Step 3 out loud. Then one at a time, have students walk across the circle and give the ends of their yarn to the organisms they eat.

Students will probably not find all of the organisms in their drawing represented by people in the circle since our food web examples don't include all the connections. Tell them to give yarn to as many organisms as they find represented.

Step 4 The scenarios in Step 4 of Part B are the key to illustrating the interdependence of the food web. You may choose to guide students through each scenario. Or you may let them read each one aloud and conduct the activity themselves.

When organisms are removed from the food web in the scenarios, the students representing those organisms should drop the yarn they are holding.

At the end of the activity, have students write their answers to the questions on the Activity Report.

Extend Enrichment 3-1

- Students may draw their group's food web for each of the scenarios in Step 4 of Part B on the back of their Activity Report. Reconvene the whole class to compare what each group predicted. Discuss the idea that although each group was given the same variables and scenarios there are several possible outcomes and effects just as in a natural ecosystem.

- The students can make masks and costumes for the organisms they represent using paper plates, straws, paper towel rolls, and other craft supplies.

ASSESS

Use the final product of Part A, a complex poster of the food web based on a single organism, and responses to the Activity Report to assess if students can

✓ demonstrate the connections of all organisms to the energy of the sun and to each other.

✓ explain the interdependence of all organisms in a food web.

✓ explain the concept that an organism is dependent on many other organisms in a natural community.

✓ demonstrate the skills necessary to research a single organism.

✓ demonstrate and explain the consequences of removing a part of the food web and the effects of this on the other organisms.

Enrichment 3-1 Activity Guide: Food Web Game (Student Reproducible)

Introduction

Would you survive if you ate only one kind of food? Like most animals humans need a variety of nutrients. We need to eat different organisms to get those nutrients. And the more food options we have, the more likely we are

to survive if something happens to one of our food sources. For each organism we eat we become a part of many different food chains. All of these linked food chains make up the food web of our community. In this activity you and your classmates will draw the food web of one particular natural community. You will take on the part of one organism in that community and form a food web made of all the organisms in the whole class.

Materials

Per student pair

- Resource 1
- Resource 2
- Activity Report
- 3 pieces of paper ($8\frac{1}{2}$ by 11 inches)
- 1 large piece of butcher paper or construction paper Colored pens or crayons

Per class

- Approximately 50 pieces of yarn/string 3 meters long (number of pieces depends on number of students participating, anticipate about 2 pieces of yarn per student)
- Books, posters, and magazines about the organisms in the community selected for the activity.

Procedure

Part A

Step 1 With your partner select one of the organisms in the natural community that the class has chosen to research.

Step 2 Use the books and other resources provided by your teacher to make two lists about your organism. Include in your list

- What your organism eats. Where does the organism get its energy?
- What your organism is eaten by. What animals get energy from your organism?

When you are finished, you should have roughly 4 to 6 organisms directly connected to your organism. You will have many organisms that aren't listed by your teacher.

Step 3 Remember the following four rules:

- You must have at least 15 organisms in your food web.
- You must include the sun in your food web.
- You must connect the organisms with arrows that show the direction of the energy flow. In other words, make sure the arrows point from the source of energy toward the organism getting the energy.
- You must show all the connections between organisms in your food web even if they aren't connected to the main organism.

Step 4 use the lists you developed in Step 3 to draw a rough draft of your food web. Start by writing the name of your organism in the middle of the paper. Label whether it is a producer, herbivore, carnivore, or omnivore.

Step 5 Choose several organisms from your two lists. Research to find out what they eat and what they are eaten by. Add these organisms to your web. Remember you need to connect 15 different organisms within the web.

Step 6 Finish your rough draft of your food web. Then identify the part played by each plant and animal in the food web. Do this by putting a circle around each organism with colored pens or crayons. Use the following colors:

Producers - Green circle

Herbivores - Blue circle

Carnivores - Red circle

Omnivores - Orange circle

Step 7 Check to make sure you have at least 15 organisms. Then check to make sure you classified them correctly. Now you can draw your food web on a large piece of paper. For this final version draw a picture of the organism inside a circle about 6 cm across. Make sure the circles are the appropriate color. (See Step 6.)

Part B

Step 1 Use your drawing to figure out the number of organisms your organism will eat. Obtain that number of pieces of yarn.

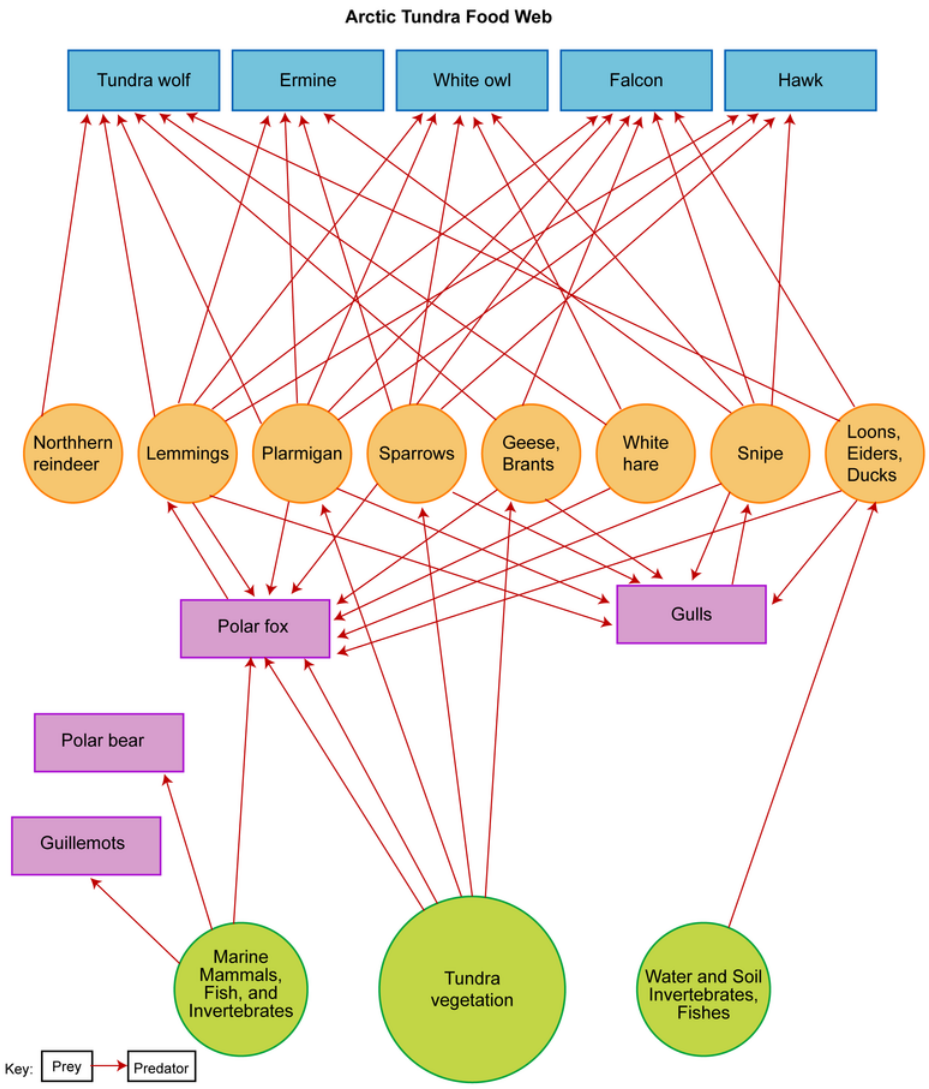
Step 2 You and your partner will split up and join one half of the class in two different large groups. Each of you is an expert on your organism. So you will represent that organism in your group's model of a food web.

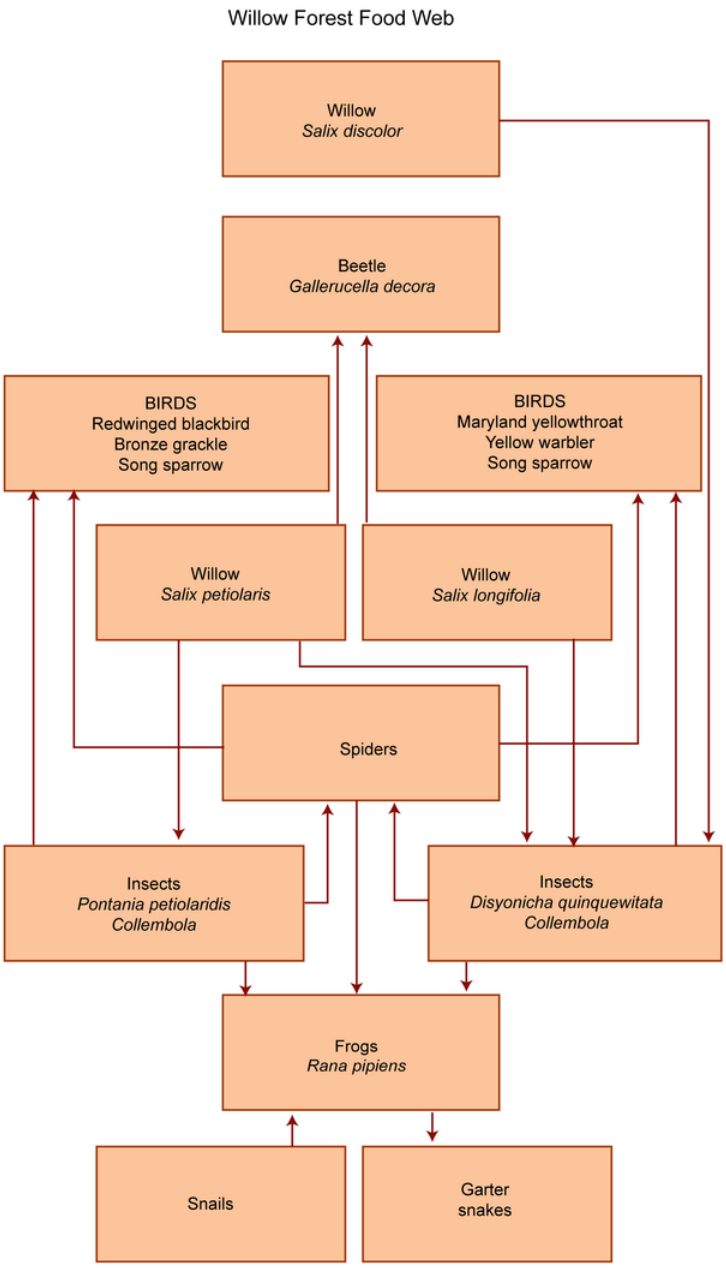
Step 3 In your large group, form a circle around one of the desks in the middle of the room labeled "Sun." One at a time each person must find the people who represent the organisms from which they get energy. Hold onto one end of each of your pieces of yarn and give the other end to your energy source. If you are a plant attach your yarn to the sun. You will also receive the end of a piece of yarn from any organism that eats you. When everyone is done you have a model of a food web!

Step 4 Try the following experiments while your group is in your food web model. Think about how each experiment affects your particular organism. Also think about how each experiment will affect the whole community over time.

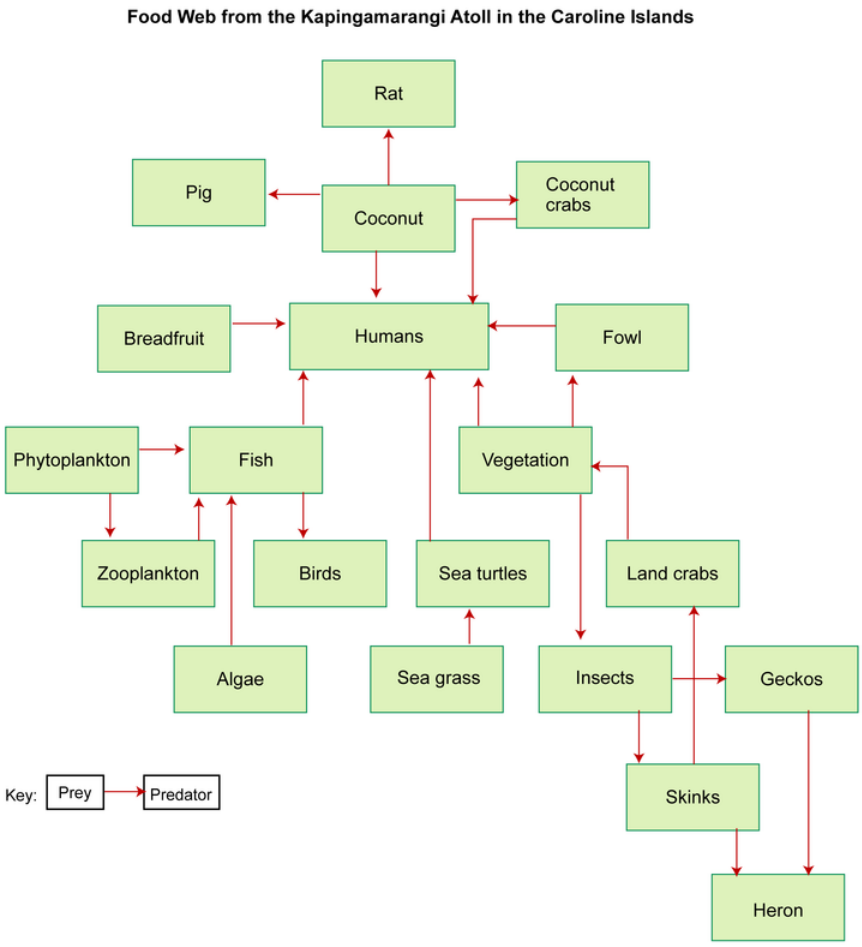
- A drought occurs and one species of producer can't survive. What happens to the organisms linked to it?
- A developer bulldozes half the land on which your community lives and wipes out one species of herbivore. What happens to the organisms linked to it?
- Farmers and ranchers decide that one of the carnivores in your ecosystem is killing their livestock. So they poison all the carnivores in the area. What happens to the organisms linked to the carnivores?

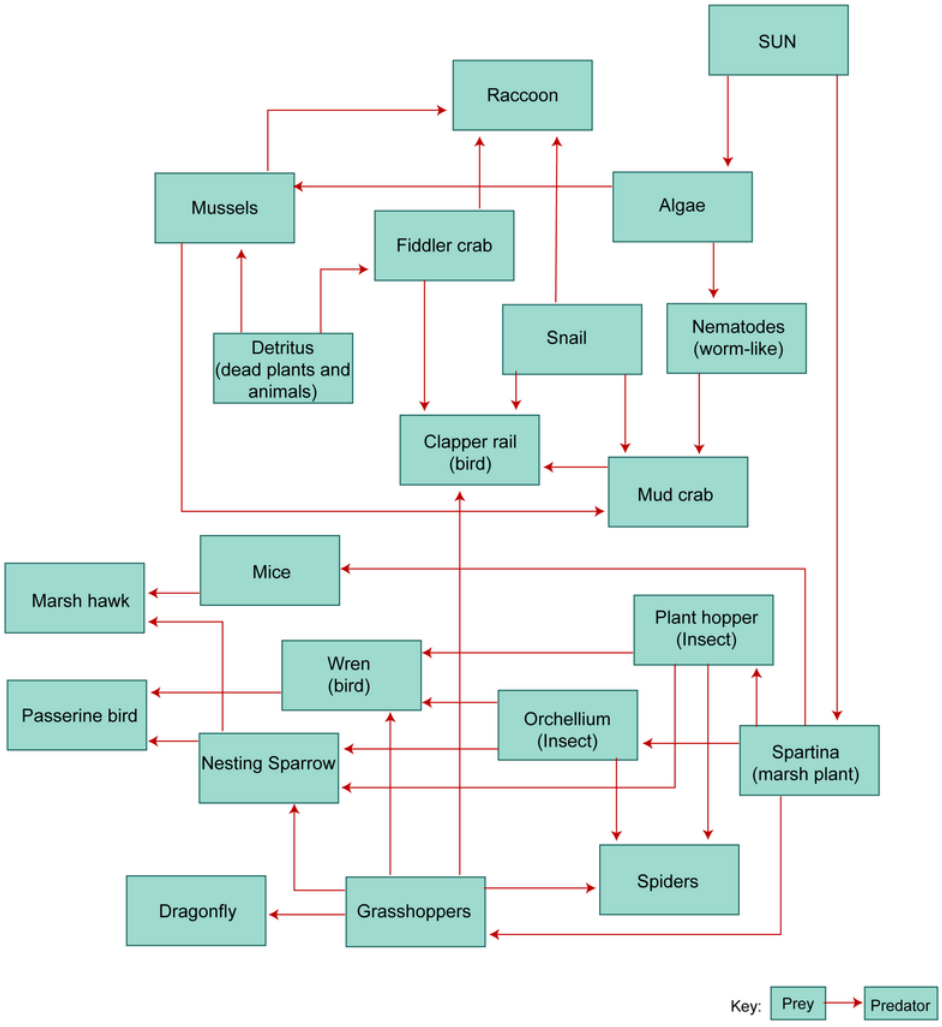
Enrichment 3-1 Resource 1: Food Web Game (Student Reproducible)




Willow Forest Food Web
Willow
Salix discolor
Beetle
Gallerucella decora
BIRDS
Redwinged blackbird
Bronze grackle
Song sparrow
BIRDS
Maryland yellowthroat
Yellow warbler
Song sparrow
Willow
Salix petiolaris
Willow
Salix longifolia
Spiders
Insects
Pontania petiolaridis
Collembola
Insects
Disyonicha quinquewitata
Collembola
Frogs
Rana pipiens
Snails
Garter
snakes

Enrichment 3-1 Resource 2: Food Web Game (Student Reproducible)





Enrichment 3-1 Activity Report: Food Web Game (Student Reproducible)

1. When there was a drought and one species of producer couldn't survive ...

a. What was the effect on the whole community? (Explain what happened in your model and what it represents in a natural community.)

b. What was the effect on your particular organism? (Explain what happened in your model and what it represents for a real organism.)

2. When a developer bulldozed half the land in the natural community and wiped out one species of herbivore . . .

a. What was the effect on the whole community? (Explain what happened in your model and what it represents in a natural community.)

b. What was the effect on your particular organism? (Explain what happened in your model and what it represents for a real organism.)

3. When farmers and ranchers decided that one of the carnivores in your natural community was killing their livestock and poisoned all the carnivores . . .

a. What was the effect on the whole community? (Explain what happened in your model and what it represents in a natural community.)

b. What was the effect on your particular organism? (Explain what happened in your model and what it represents for a real organism.)

Enrichment 3-2: Teacher Activity Notes

The Energy Game

PLAN

Summary

Students learn about the transfer and loss of energy along a food chain by playing a game similar to tag. In this game the goal is to gather enough energy in order to survive and continue the population of organisms.

Objectives

Students:

✓ describe how energy travels through an ecosystem.

✓ identify the resources necessary for an organism to survive and reproduce.

Student Materials

Per student

- Activity Guide
- Resource 1
- Activity Report
- plastic bag
- calculator
- Lamb cards (from Resource 2)
- White poker chips (enough for 15 per student)
- Blue poker chips (enough for 3 for every student)
- 10 red poker chips

Teacher Materials

- Data Report
- Activity Report Answer Key
- 3 containers to keep track of the chips; Clipboard; Pen or pencil; Watch or stopwatch; Whistle

Advance Preparation

Choose an outdoor area for the "habitat." Make sure that the "habitat" is large enough for the students to run around chasing each other. (If possible, a grassy area is a good choice to illustrate the idea of grass storing the energy made from the sun.)

Determine the number of white energy chips that will be the base of your energy pyramid in the following way. Multiply the total number of students playing the game by 10. Then, add 100 chips. For example, the number

needed for a class of 30 students is 400 white chips. You'll need about three blue chips per student for sheep and lambs and about 10 red chips to represent the few mountain lions.

Make 20 Lamb Cards from the master provided on TE. You will notice that Resource 2: Lamb Cards is marked "Reproducible" while Resource 1 is marked "Student Reproducible." Any page or pages intended to be copied for the students is marked "Student Reproducible." Any page or pages intended for your use during an activity is marked "Reproducible."

Estimated Time

Two 50-minute periods divided in the following way.

- Half of one period for explaining the game
- One period to play the game and collect data
- Half of one period to analyze game and data

Interdisciplinary Connection

Math The graphing and graph interpretation part of this activity could be done in math class with an emphasis on exploring the best way to represent a body of data in the form of a graph.

Prerequisites and Background Information

Review the concept of ecological pyramids with the students. Review graphing skills.

IMPLEMENT

Introduce Enrichment 3-2 by discussing the path that energy takes through a food chain. Begin with the sun and end with the top carnivore. You may want to give students some background or pictures of the bighorn sheep and mountain lions to provide a context for the game.

Before going outside, carefully review the rules of the game and the boundaries of the playing area. Describe how the data collected for each round of the game will be recorded on the Data Sheet. You may want to explain the game verbally instead of distributing the written instructions on the student activity pages.

Steps 1-6 Take the following things outside with you.

- Copy of the activity instructions
- 3 containers to keep track of the three colors of poker chips
- Box of plastic bags (one per student)
- 20 Lamb Cards
- Data Report on a clipboard
- 5 copies of Resource 1
- Pen
- Watch

Once at the playing field or "habitat" area outline the boundaries and describe the purpose of the game again. Scatter the 350 or more white chips evenly around the area. Give each student a blue chip to represent the available energy for the season.

Start the round. Call the end of the round after 30 seconds. Use the Rules Chart to determine who lives and dies for each round.

Steps 5-6 At the end of each round count the number of surviving plants, sheep, and mountain lions. Record this data on the Data Sheet or ask a student to do the recording.

Before starting the next round, scatter another 100 white chips that represent plants around the field. Explain that the number of plants added is the same every season because the amount of energy that comes into the system from

the sun remains constant. You may want to point out that the assumption is being made that the habitat is not being degraded from season to season.

Step 7 After the third round, ask for the student with the most lambs to come forward. This person is now a mountain lion and will be chasing everyone else in order to tag them. Becoming a mountain lion means the student gives you all his or her blue and white chips and Lamb Cards. You give him or her one red chip. Remind the new mountain lion that he or she needs to tag 10 sheep in order to survive the season.

Step 8 At the end of every round from now on add a mountain lion by converting the person with the most lambs as in Step 7 above.

Play the game for 6 or 7 rounds depending on how much time you have. Then, return to the classroom to analyze the data.

Step 9 Have students graph and analyze the data in groups or as a class. Use a line graph. The x-axis should indicate the "Season Number." The y-axis should indicate the "Population Number"-plants, sheep, or mountain lions. Students could prepare separate line graphs for each set of population data-plants, sheep, and mountain lions. Alternatively students could graph the population data for plants, sheep, and mountain lions all on the same set of axes. If they graph all three on one line graph, use different colors for the line representing each data set. Students should be able to use the graphs to see how the population sizes fluctuate and mirror each other. The changes in population size reflect how energy flows through the community.

After students have drawn their graphs, emphasize that they can analyze the information on the graphs to answer the questions on the Activity Report. As part of a class discussion of the Activity Report questions you may want to raise the following questions about the authenticity of the Energy Game.

- Did everything truly represent the parts of an energy pyramid?
- What was realistic and unrealistic about the game?
- What other food chains would this game be an example of?

Extend Enrichment 3-2 by doing the graphing and graph interpretation part of this activity in math class with an emphasis on exploring the best way to represent a body of data in the form of a graph.

ASSESS

Use the students' graphs, discussion, and responses to the Activity Report to assess if students can

✓ trace the flow of energy through a food chain and the structure of an energy pyramid.

✓ construct and interpret graphs.

Enrichment Activity 3-2: The Energy Game – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Draw the food chain that represents what happened in the Energy Game.
2. Describe what happened to the population of sheep during the first three seasons.
3. How many sheep could your habitat area support over several seasons?
4. Describe what happened to the population of bighorn sheep in the fourth season after the mountain lion appeared.
5. Consider the mountain lion population data. How many mountain lions could your habitat area support over several seasons?

6. What would happen if there were a drought and half of the plants died? How would this affect the sheep population over time?

Enrichment 3-2 Activity Guide: The Energy Game (Student Reproducible)

Introduction

Imagine that you and your classmates have suddenly become bighorn sheep. You receive energy from the plants that you eat. The plants you eat receive their energy from the sun. As a bighorn sheep you may be eaten by mountain lions. Some energy is used up and lost in these processes. The goal of this energy game is to obtain as much energy as possible in order to survive and keep your population growing. If you don't get enough energy, you and your offspring die. If you get more energy than you need, you can become a mountain lion. But, as a mountain lion you will need even more energy to survive.

Materials

- Resource 1
- Plastic bag
- Energy chips (white, blue, and red poker chips)
- Lamb Cards
- Data Report
- Calculators
- Graph paper (optional)
- Activity Report

Procedure

This is what each "energy" chip represents.

- White energy chip = Energy stored in plants.
- Blue energy chip = 10 white energy chips = energy needed by 1 bighorn sheep.
- Red energy chip = 10 blue energy chips = 100 white energy chips = energy needed by one mountain lion.

Step 1 The game begins when the "sun" (portrayed by your teacher) scatters white energy chips on the playing field to represent the energy from the sun that is stored in plants.

Step 2 Remember that the goal of the game is to gather enough energy (white chips) to survive and grow your population of sheep (obtain a Lamb Card). One season is equal to one round of the game. You will begin the game with one blue chip (equal to 10 white chips). As a bighorn sheep you must gather 10 white chips to survive to the next round.

Step 3 You expend energy during the game by running from predators, looking for food, and generally staying alive. Therefore, at the end of each round you must turn in ALL the white chips that you gathered to your teacher. You will always have a blue chip in your hand if you survived the previous round (season). All the possible outcomes of a season are summarized on the Rules Chart.

Step 4 A round of the game, or season, lasts for 30 seconds. When your teacher signals that the round is over, you must stop running and gathering food (white energy chips) and rejoin your teacher.

Step 5 At the end of each round do the following:

a. Turn in your white energy chips and receive Lamb Cards if you earned them.

b. As a class, count and record the following data about the plant and animal populations on the Data Report.

- The total number of surviving plants. (This is the total number of white energy chips scattered by the teacher minus the number of white energy chips gathered by the bighorn sheep.)
- The total number of sheep surviving
- The total number of mountain lions surviving

Step 6 For each round the teacher scatters 100 more white energy chips on the ground. Those white chips represent the new plants that have grown for the next season. Follow Step 5 for three rounds of the energy game.

Step 7 At the end of the third round the person who has the most lambs becomes a mountain lion.

In the fourth round sheep have two jobs. They have to find food (10 white energy chips). And they have to run from the mountain lions. The mountain lion needs to chase and tag 10 bighorn sheep to survive. When tagged by the mountain lion, a sheep is considered dead and must freeze or stop moving. At the end of the round each "dead" sheep must give its blue chip to the mountain lion who tagged it. Then the mountain lion can trade in 10 blue energy chips for one red energy chip. As the game continues mountain lions follow the same rules of survival, death, and population growth as the bighorn sheep. But the mountain lion uses blue energy chips and carries one red chip. If a mountain lion tags a sheep with lambs, the mountain lion can take the extra white energy chips, too. He or she may then trade in every 10 white chips for one blue chip. Five extra blue chips counts as a newborn mountain lion cub.

Step 8 At the end of every round from this point on the person with the most lambs becomes another mountain lion and follows the same rules as described in Step 7.

Step 9 At the end of the game you will create several graphs. These graphs will represent the plant, bighorn sheep, and mountain lion population data you collected at the end of each round. Use these graphs to answer the questions on your Activity Report.

Enrichment 3-2 Resource 1: The Energy Game (Student Reproducible)

TABLE 4.1: Rules Chart

At the end of the round, if you have	**then you**
Less than 10 white chips	**Die**. Turn in your blue chip, sit out the next round and read the Facts on Decomposers below.
At least 10 but less than 15 chips (10-14)	**Survive**. But you receive no lambs.
15 chips or more	Receive a **Lamb** Card. In the next round you must gather 5 extra chips for each lamb. Otherwise you lose the lamb.

The same rules apply to **Mountain Lions**, but they carry red chips and need to gather blue chips to survive.

Game Summary:

Round 1 - Plants and Bighorn sheep

Round 2 - Plants and Bighorn sheep

Round 3 - Plants and Bighorn sheep

Round 4 - Plants, Bighorn sheep, and 1 Mountain lion

Round 5 - Plants, Bighorn sheep, and 2 Mountain lions

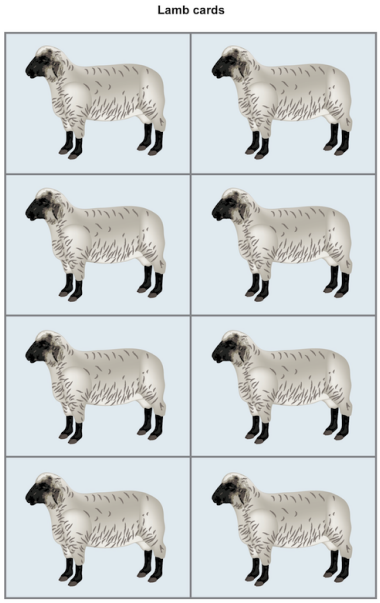
Round 6 - Plants, Bighorn sheep, and 3 Mountain lions

Round 7 - Plants, Bighorn sheep, and 4 Mountain lions

Facts on Decomposers

1. Decomposers are organisms that help in the process of decay in dead plants and animals.
2. Bacteria, microorganisms, worms, fungi, and other decomposers feed on dead organisms, break down nutrients, and recycle those nutrients in an ecosystem.
3. Decomposers are nature's "garbage disposals." Without decomposers dead plants and animals would pile up on the earth. Important nutrients that plants and animals depend on for growth would be locked up and lost to the ecosystem.
4. Decomposers help recycle important nutrients by converting waste back into raw materials.

Enrichment 3-2 Resource 2: The Energy Game (Student Reproducible)



Enrichment 3-2 Data Report: The Energy Game (Student Reproducible)

TABLE 4.2:

	1st Season	2nd Season	3rd Season	4th Season	5th Season	6th Season	7th Season
Surviving Plants							
Surviving Bighorn Sheep							
Surviving Mountain Lions							

Enrichment 3-2 Activity Report: The Energy Game (Student Reproducible)

1. Draw the food chain that represents what happened in the Energy Game.

2. Describe what happened to the population of sheep during the first three seasons.

3. How many sheep could your habitat area support over several seasons?

4. Describe what happened to the population of bighorn sheep in the fourth season after the mountain lion appeared.

5. Consider the mountain lion population data. How many mountain lions should your habitat area support over several seasons?

6. What would happen if there were a drought and half of the plants died? How would this affect the sheep population over time?

CHAPTER 5 Cycling - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

5.1 Planning

Key Idea

- All resources (except energy, which tends to diffuse) are cycled in undisturbed ecosystems.

Overview

The last section concentrated on the interdependence of organisms in a food web. This section introduces the idea of the cycling of resources, such as water and oxygen, in the natural environment. Students identify the major components of the water cycle-evaporation, condensation, precipitation, and transpiration. Students should recognize that water is constantly reused. This is a very important concept for them to appreciate as they examine the different parts of the water cycle because the water we have now-dirty or clean-is all the water we will ever have. Students investigate other important cycles in the natural environment, such as the carbon, nitrogen, and phosphorus cycles.

Objectives

Students:

✓ identify the major components of the water cycle-evaporation, condensation, precipitation, and transpiration.

✓ explain how water cycles on Earth.

✓ recognize that water is constantly reused.

✓ evaluate the effects of different environmental conditions on the rate of evaporation and/or rate of condensation.

✓ identify the carbon, nitrogen, and phosphorus cycles.

Vocabulary

carbonification, cycle, evaporate, fossil fuels, greenhouse gas, groundwater, global warming, open water, precipitation

Student Materials

Activity 4-1: A Day in the Life of a Water Molecule

- None

Teacher Materials

Activity 4-1: A Day in the Life of a Water Molecule

- Resource

Advance Preparation

See Activity 4-1 in the Student Edition

Activity 4-1: A Day in the Life of a Water Molecule

- You may want to make an audiotape of someone reading the story. If you choose not to audiotape the reading, you can read the story to the class.

Enrichment Activities

Enrichment 4-1: What Goes Up Must Come Down-Water Cycle Simulation

Students construct a model of water moving through the water cycle.

Ask the students to collect, or collect yourself, clear plastic containers with lids such as those used for take-out foods.

Enrichment 4-2: Water Underground

Students examine the portion of the water cycle that occurs beneath the surface of the earth by constructing a model of the water cycle that demonstrates groundwater movement and collection.

- Collect empty, clear plastic 2-liter bottles.
- Obtain modeling or potter's clay, potting soil, and gravel.
- An excellent reference for working with plastic bottles is *Bottle Biology*, by P. H. Williams, published by Kendall-Hunt Publishing Company, 1993.

Background Information

Energy and the Carbon Cycle Energy is contained in the chemical bonds holding the carbon, hydrogen, and oxygen atoms in a sugar molecule together. Light energy from the sun was changed into chemical energy stored in the bonds. When sugar is broken down in a cell, the chemical bonds are broken releasing the stored energy and converting it into a form (ATP) that is used by the cell.

One fun demonstration that you might want to try is dropping a bit of concentrated sulfuric acid onto a sugar cube. It will turn black revealing the carbon in a more recognizable form. Alternatively, you can burn a sugar cube to reveal the black carbon in the ash.

Nitrogen and Phosphorus Cycles Plants need nitrogen to make amino acids, which are the building blocks for proteins. Proteins are essential for life because they are needed for cellular growth, repair, and replacement. Proteins

are also enzymes that facilitate all of the chemical reactions that occur in cells. Phosphorus is a micronutrient that is required for the formation of ATP, nucleic acids, phospholipids, and several coenzymes.

5.2 Using Cycling – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section. Why don't natural systems run out of the materials they need? Use this idea to compare the flow of energy in a community to the flow of nutrients (abiotic factors) in a community. Emphasize that nutrients cycle but energy does not.

Brainstorm with students all the forms of water they have observed-oceans, lakes, rivers, streams, puddles, rain, snow, ice, sleet, hail, etc.

Discuss the terms *evaporation, precipitation, condensation,* and *transpiration* as components of the water cycle.

Activity 4-1: A Day in the Life of a Water Molecule can be used to introduce how water cycles through the environment. Activity 4-1 can be used as an introductory activity. *Enrichment 4-1: What Goes Up Must Come Down: Water Cycle Simulation* can be used to reinforce how water cycles through the environment.

Assign *Mini Activity: A Day in the Life of a Carbon Atom* for students to examine the path of a carbon atom, which will demonstrate how carbon cycles through the environment.

To explore how other nutrients such as oxygen, nitrogen, and phosphorus cycle through a natural community assign *Mini Activity: Create a "Cycle Poster."* Display the finished posters around the classroom throughout the study of Ecology.

5.3 Activities and Answer Keys

Activity 4-1: A Day in the Life of a Water Molecule

PLAN

Summary Students listen to a story that describes what might happen to a molecule of water during a period of one day. Imagining themselves as a molecule of water as they follow the water molecule's cycle helps the students learn the parts of the water cycle.

Objectives

Students:

✓ identify the major components of the water cycle.

✓ recognize that water is constantly reused.

Student Materials

- None

Teacher Materials

- Resource (You may choose to prepare copies for all students.)
- Audiotape (if one was produced)

Advance Preparation

You may want to make an audiotape of yourself or someone else reading the story.

Estimated Time

One 50-minute period

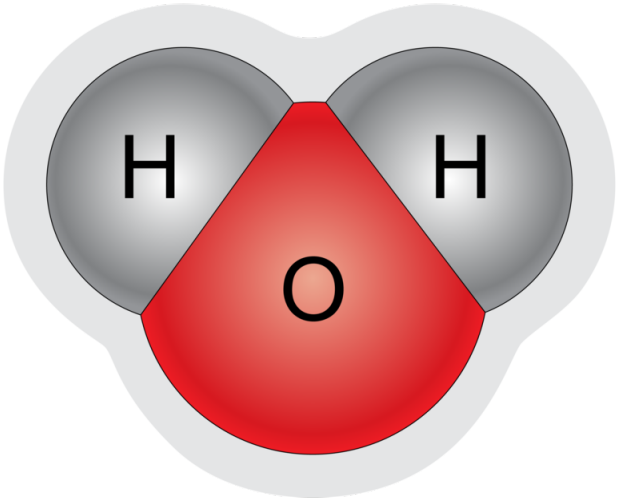
Interdisciplinary Connections

Visual/Performing Arts Encourage the students to illustrate the events from their plays on a poster and add the appropriate labels. Student drawings could be shared with the class through discussion and displayed in the room.

Language Arts Students write their own story about a water molecule traveling through a specific animal or a human being. Then they compare and contrast their story with the one in *Activity 4-1: A Day in the Life of a Water Molecule.*

Prerequisites and Background Information

Before beginning this activity it would be helpful to refresh students' knowledge about atoms and molecules. Draw a water molecule- H_2O -on the board like the one represented below. Remind the students that two parts (atoms) of hydrogen combine with one part (atom) of oxygen to make each water molecule.



A Water Molecule

Discuss with students the terms *evaporation, condensation, precipitation,* and *transpiration.*

IMPLEMENT

Introduce Activity 4-1 by asking students to imagine that they have each been transformed into a water molecule. To emphasize the transformation you could have students hold a small card in each hand to represent a hydrogen atom (H) and tape another card to their foreheads representing an oxygen atom (O) .

Step 1 Remind students about good listening skills. Read the story to your class or play an audiotape of the story recorded previously.

Steps 2-3 After the story, students should have time to offer comments, raise questions, and discuss questions with each other. Student responses can be gathered orally or assigned for written feedback. Ask students to describe the importance of the following:

- evaporation
- condensation
- precipitation
- transpiration

Discuss with students the following questions.

- How could this water cycle vary depending upon your location?
- Do the same water molecules continue to cycle through the environment? Why is this important?
- What other questions do you have about water?

Step 4 Arrange students into groups of four and ask them to choose roles that they will perform as the story is read a second time. Once students are in groups, have them reread Step 4 from the Procedure to be sure that the roles they choose will include all of the parts of the story.

Steps 5-6 Have each group briefly describe the parts of the story. Have the class select the best parts from each group's plan and design a class play based on the story. Then have the class perform the play as the story is read a second time.

Extend Activity 4-1 by encouraging students to illustrate the events on a poster and add the appropriate labels. Student drawings could be shared with the class through discussion and displayed in the room.

Have students write their own story about a water molecule traveling through a specific animal or a human being. Then, ask students to compare and contrast their story with the one in *Activity 4-1: A Day in the Life of a Water Molecule.*

Helpful Hints

You may wish to add suitable background music as you read the story for the class play. For example, George Frideric Handel composed *Water Music* for the birthday of the king of England in the 1700s.

ASSESS

Use the final product-the performance of the story-to assess if students can

✓ describe how water molecules move through the water cycle.

✓ explain that water is constantly being recycled.

✓ explain and represent evaporation, condensation, precipitation, and transpiration.

What Do You Think?

Many scientists are now recommending the planting of trees on a large scale to reduce the effects of global warming. Why do you think this would help? What do you think are some ways to motivate and organize your classmates to volunteer their time to plant trees in your neighborhood?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What would happen to humans if all the plants on Earth died?

Mini-Activity

A Day in the Life of a Carbon Atom Students apply their knowledge of the carbon cycle to write a descriptive story of the path a carbon atom takes when moving through the carbon cycle. Students can use the story *A Day in the Life of a Water Molecule* as a model for their carbon atom story.

Implement You may want to discuss the following questions to help your students focus on components of the carbon cycle.

- What are some of the sources of carbon released into the atmosphere?

Some examples include carbon atoms released when animals exhale; forest fires; and volcano explosions; exhaust from automobiles, trains, and planes; smoke from factories.

- What is the role of carbon dioxide in the carbon cycle?

Carbon dioxide is a form of carbon that can move freely in the atmosphere and become part of the bodies of animals and plants.

Journal Writing

Write a story of what happens to you for the rest of the day. Be sure to include all the major parts of the carbon cycle.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What was the original source of the energy for the plants and animals that eventually became coal, oil, or natural gas?

Mini-Activity

Create a Cycle Poster Students demonstrate their knowledge of a specific resource (water, carbon, oxygen, or nitrogen) by creating a poster that shows how the resource cycles through the ecosystem.

Implement

- Have students select one of the following types of cycles: water, carbon, oxygen, nitrogen.
- Ask students to make a sketch to show the important parts of the cycle they selected. Remind them to use arrows to show the direction that the resource takes through the ecosystem.
- Encourage students to think about their own role in the cycle and be sure to include themselves in the sketch.
- After you have approved their sketches, have students make a final poster showing how the resource they selected cycles through the ecosystem.
- Post the posters around the room and discuss the various cycles the posters demonstrate.

Journal Writing

Imagine the journey that a carbon atom took from the moment it was exhaled by a dinosaur to the moment you exhaled it yourself in a carbon dioxide molecule. Write a story about that carbon atom's journey. Be creative. Try to think of the many plants, animals, and famous historical people the carbon atom could have been a part of.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

- **Explain if it is possible that you could be breathing an atom of carbon that was exhaled by a dinosaur.**
- **Explain why you think it is or is not possible to remove elements from their natural cycles.**

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Why don't forests in Wisconsin run out of the things such as water and carbon dioxide that they need to live and function?
2. What provides the energy for the water cycle?
3. Where can you find most of the fresh water in the United States?
4. Why is the carbon cycle studied by ecologists?

Activity 4-1 Resource: A Day in the Life of a Water Molecule (Student Reproducible)

Imagine you are a water molecule.

You are made up of an oxygen atom and two hydrogen atoms, and you are constantly in motion.

Molecules move faster when it is warm and slower when it is colder.

As you move around, you bump into other molecules and then bounce off into space.

But no matter what, you are always moving.

On this day you are rising through the air, high into the sky.

You approach the clouds and begin bumping into other water molecules more often as the sky becomes filled with other water molecules.

All the while you are moving steadily upwards.

As the sky becomes more crowded, you realize you are gradually becoming colder and colder.

It's harder for you to move quickly because of the cold. So you begin to slow down a little.

You find that you and other water molecules are sticking together.

Soon there are several groups of water molecules stuck together.

Your group is growing in size...and continuing to slow down...

Wait!

Something is happening!

You are falling!

You have become part of a raindrop!

The clouds become distant as you drop toward the ground.

You are rapidly coming closer and closer to the trees.

Other raindrops are falling alongside you.

Suddenly, your fall is broken by a leaf-splat!

As soon as you hit it, you start sliding down onto another leaf...and another leaf...and then slip off onto the ground-splat!

Immediately you flow into the dark gaps between small rock particles in the soil.

As you slide over bits of soil, you sense a different texture.

It feels like you are slithering around the smooth, round body of a worm!

Suddenly you feel yourself being pulled sideways.

Then you realize it's the root of a plant!

You and other water molecules are being drawn through the root into a cell of the plant.

You move from cell to cell, slowly being transported up through the plant's stem.

You have been cold and sluggish all this time, but as you near the surface of the leaves, you feel warm and energized!

You squeeze through a hole in the leaf and pop out into the fresh air again!

You are much warmer now.

You start separating from the other water molecules you've been attached to while on the ground.

Your motion speeds up and you begin bouncing around among the other molecules.

As you rise again toward the sky, you realize you are just one small part of the never-ending cycle of water on our planet Earth.

5.4 Enrichment

Enrichment 4-1: Teacher Activity Notes

What Goes Up Must Come Down-Water Cycle Simulation

PLAN

Summary

Students observe water evaporating and condensing within closed containers to learn about a portion of the water cycle.

Objectives

Students:

✓ identify the relationship between evaporation and condensation in the water cycle.

✓ evaluate the effects of different environmental conditions on the rate of evaporation and/or rate of condensation.

Student Materials

Per Student

- Activity Guide
- Activity Report

Per Group

- 3 containers with clear plastic lids (such as take-out food containers)
- 3 small cups (such as 8 oz. tubs for soft margarine)
- Permanent marking pen; Plastic spoon; Water; Salt
- Food coloring (green, blue, or red)

Teacher Materials

- Activity Report Answer Key

Advance Preparation

One week before doing this activity ask your students and neighbors to collect clear plastic containers from fast food restaurants or from food purchased at grocery stores.

Estimated Time

One 50-minute period to setup the containers

Allow a few minutes over several days for students to observe the containers and record their observations.

Prerequisites and Background Information

Students should be familiar with the terms *evaporation* and *condensation.*

Heat increases the kinetic energy of water molecules. This causes them to move faster and increases the rate of evaporation. Thus, when the containers are in a warm, sunny place, the rate of evaporation should increase. Cold temperatures decrease the kinetic energy of water molecules. This causes them to move slower, which increases the rate of condensation. Thus, when the containers are in a cool, damp place, the rate of evaporation should decrease.

Water molecules are continually moving between locations from the "lake" in the cup to the droplets on the inside of the lid. The changing of water from a liquid to a vapor is called a phase change and is associated with a corresponding energy change. Water molecules are also moving between droplets. Water molecules have a tendency to condense into larger droplets. This condensation is due to a lower average energy level of water molecules in the larger droplets. That is, there is less surface energy per unit volume in the larger droplets.

IMPLEMENT

Introduce Enrichment 4-1 by reviewing with students the difference between *evaporation* and *condensation.* Ask students to give you evidence from their personal experiences that water evaporates and condenses. Some examples are descriptions of how puddles disappear a day after it rains (evaporation) or how water drops form on the outside of a glass of ice water (condensation).

Steps 1-6 Have students work in pairs to set up the experiments as shown in Steps 1 to 6 of Enrichment 4-1. The illustrations should help students construct the containers without your assistance. Remind students to label the different containers.

Steps 7-9 Have students make and record their observations several times during the day or at a certain time each day for a week. You may want them to record their observations and drawings in a data book.

- Students should first observe small droplets of water condensing directly above the small cup of water and then spreading outwards to the edges of the clear plastic top of the larger container. Students may observe a gradation in the size of the water droplets-with the larger droplets appearing directly over the small container and the smaller ones visible near the edges. This would be an ideal opportunity to discuss with students why these size differences occur. See the description in the background information above.
- Container B, salt water: Water will evaporate from this solution, leaving behind a more concentrated salt solution. You may want to explain that this is the principle behind evaporating ponds that are used to concentrate sea salt. This method can also be used to obtain potable water from salty water.
- Container C, colored water: Again, clear water will evaporate, leaving colored water in the container. Unless a material can vaporize (change from liquid to gaseous form), it will remain in the water. This concept can be related to salt and mineral buildup in agricultural lands resulting from the use of certain fertilizers and other products in the water.

Make sure students answer the questions on the Activity Report.

Conclude Enrichment 4-1 by holding a class discussion of the questions on the Activity Report.

> ***Extend Enrichment 4-1*** by having students explain how changes in temperature can account for the formation of steam, snow, or humidity. Encourage students to test their ideas by actually changing the conditions of the containers such as opening the lids of the containers or placing paper around the outside of the containers.

ASSESS

Use the water cycle simulation experiment to assess if students can

✓ explain the critical role that evaporation and condensation play in the water cycle.

✓ describe the phase changes that water undergoes (liquid to vapor and vapor to liquid).

✓ demonstrate the effects of different environmental conditions on their experimental model.

✓ make predictions and designing tests to verify the predictions.

✓ compare and contrast their model and the water cycle in their community.

Enrichment 4-1: What Goes Up Must Come Down-Water Cycle Simulation – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

Discuss the following questions with your partner and record your responses in your own words.

1. Which two parts of the water cycle were shown in this activity?
2. What is the energy source for the water cycle?
3. What could you do to cause the water to leave the air and return to the bottom of the container?
4. Since the contents of each container were different, what predictions can you make about the water droplets in each container? Give reasons for your answers.
5. How could you test to see whether your predictions are correct?
6. How does the water cycle in your community affect your life?

Enrichment 4-1 Activity Guide: What Goes Up Must Come Down-Water Cycle Simulation (Student Reproducible)

Introduction

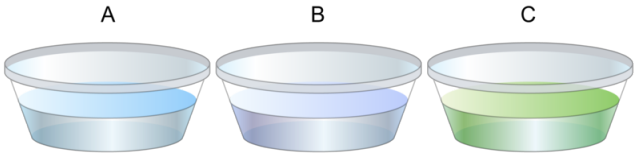
The water cycle is an essential part of our lives. Water moves through our atmosphere during the processes of evaporation, condensation, precipitation, and transpiration. In this activity you construct a model of water moving through the water cycle. As you watch the cycle in progress, remember what you learned about water molecules. Remember how they move apart or evaporate and how they collect together or condense so we have water for life.

Materials

- 3 containers with clear plastic lids (such as take-out food containers)
- 3 small cups (such as 8 oz. tubs for soft margarine)
- Permanent marking pen
- Plastic spoon
- Water
- Salt
- Food coloring (green, blue, or red)
- Activity Report

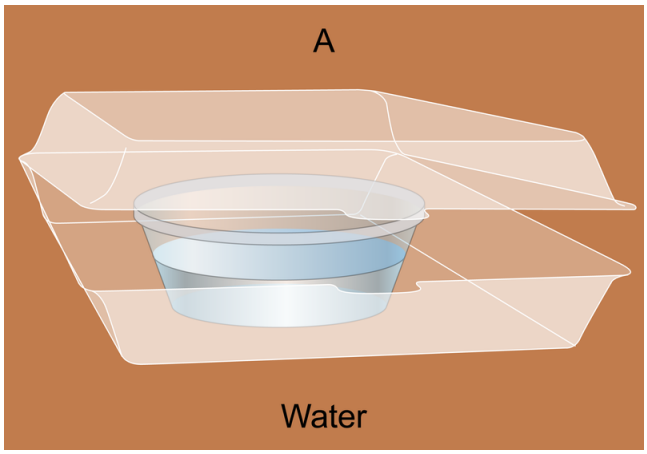
Procedure

Step 1 Mark each small cup clearly with A, B, or C.

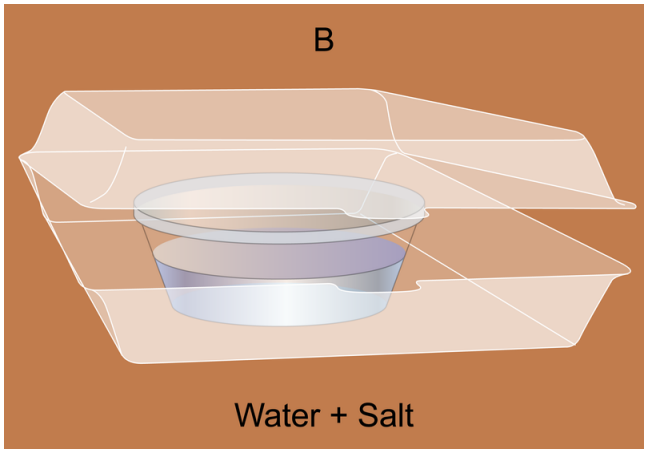


Step 2 Fill each of the three small cups half full of water.

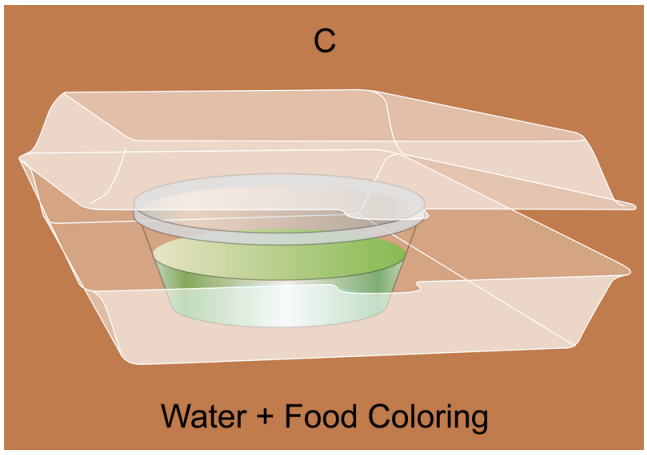
Step 3 Place cup A inside the larger plastic container. Tightly close and tape the clear plastic lid shut.



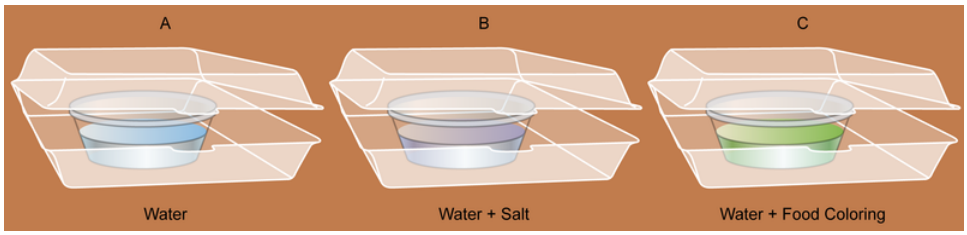
Step 4 Add a teaspoon of salt to cup B and stir to dissolve the salt. Place cup B into a larger container and tightly close and tape the lid shut.



Step 5 Add two drops of food coloring to cup C. Place this cup into a larger container and tightly close and tape the lid shut.



Step 6 Your three experiment containers should look like this.



Step 7 You will put your containers first in a shady, cool place to observe what happens. Then you will put them in a sunny, warm place to observe what happens. Make predictions or form hypotheses stating what you expect to observe. Explain the reasoning behind your predictions or hypotheses.

Step 8 Place all three containers in a shady, cool place and observe frequently over a period of several hours or days. Record your observations including drawings or photos of any changes.

Step 9 Repeat Step 8 in a sunny, warm place.

Enrichment 4-1 Activity Report: What Goes Up Must Come Down-Water Cycle Simulation (Student Reproducible)

Discuss the following questions with your partner and record your responses in your own words.

1. Which two parts of the water cycle were shown in this activity?
2. What is the energy source for the water cycle?
3. What could you do to cause the water to leave the air and return to the bottom of the container?
4. Since the contents of each container were different, what predictions can you make about the water droplets in each container? Give reasons for your answers.
5. How could you test to see whether your predictions are correct?
6. How does the water cycle in your community affect your life?

Enrichment 4-2: Teacher Activity Notes

Water Underground

PLAN

Summary

Students examine the portion of the water cycle that occurs beneath the surface of the earth by constructing a model of the water cycle. Their water cycle model includes groundwater.

Objectives

Students:

✓ explain the cycling of water, especially those portions that occur below ground.

✓ compare a model of the water cycle to how water cycles on Earth.

Student Materials

Per group

- Activity Guide
- Activity Report
- Plastic drink bottle, empty (such as a 2-liter bottle)
- Cutting tools (single-edged razor blade in safety holder or scissors)
- Small metric ruler
- Beaker or cup
- Spoon
- Tape
- Paper towels
- Marking pen

Per class

- Balance or scale
- Gravel
- Clay (modeling or potter's clay)
- Potting soil, lightly moistened
- Water
- Food coloring (green, blue, or red)

Teacher Materials

- Activity Report Answer Key

Advance Preparation

One week before doing this activity have your students and neighbors collect empty plastic drink bottles.

A suggested reference book explaining how to work with plastic bottles is *Bottle Biology*, by P.H. Williams, published by Kendall-Hunt Publishing Company, 1993. This book describes how to fill the bottles with warm (not hot) water to facilitate removal of labels and base. Suggestions are also made for how to mark an even line for cutting- Place the bottle against the corners of a box lid. Hold a marking pen firmly at the desired location on the bottle. And rotate the bottle. This will give you a straight line to cut along.

Caution students to handle cutting tools carefully. Depending upon the needs of your students, an adult helper could be engaged to assist the students with the cutting during class. Another option is to cut the bottles before class.

Estimated Time

One 50-minute period to set up the containers

Allow a few minutes over several days for students to observe the containers and record their observations.

IMPLEMENT

Introduce Enrichment 4-2 by asking students to give examples from personal experience showing that water goes beneath the earth's surface. You may want them to read Section 4 of the text before beginning this activity. If students have completed Activity 4-2, explain that they have already examined how water cycles above ground. Then, explain that now they will examine how water cycles beneath the ground.

Steps 1-11 Have students work in pairs to build the model. The illustrations in the activity should help students construct the model with minimal assistance from you. Some students may experience see page of water below the clay layer if the clay has not been molded carefully to the edges of the bottle. If such see page occurs students may need to be reminded to make notes for later incorporation into their analysis. They can also be asked to relate this to a real-life situation involving the water table.

Step 12 The bottle's top can either be inverted or replaced right side up. In either case the two portions of the bottle should be taped tightly together to make sure there is no leakage.

After the models are constructed have students make observations a few minutes each day for a week.

Steps 13-15 You may want students to record their observations and drawings in a data book. You may want to suggest that they look for condensation on the inside surface of the bottle and carefully watch and measure any changes of water level in the "lake."

Conclude Enrichment 4-2 by assigning the questions from the Activity Report as written class work or homework. Then reconvene the whole class and discuss students' answers to the questions on the Activity Report.

Extend Enrichment 4-2 by

- Having students experiment with bottles of differing volumes. The amounts of gravel, clay, and potting soil will vary depending upon the size of the bottle used.
- Asking students to generate ideas about other experiments that could be done with the model they built. For example, some students may choose to remove the top and observe the effects on the level of the water table under varying conditions. Other students may experiment to find out how different kinds of materials affect the water table including different types of clay or plaster.
- Asking students to design a different model to demonstrate the same processes.

ASSESS

Use the final product, the model of a water cycle, to assess if students can

✓ describe the essential role of groundwater in replenishing the water cycle.

✓ distinguish between the different types of soil conditions that affect groundwater.

✓ demonstrate and explain the effects of different environmental conditions on their model.

✓ compare and contrast their model and the water cycle on the earth.

Enrichment 4-2: Water Underground – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. (a) Describe what you observed on the inside walls of the bottle.
   (b) Give an explanation for your observations.

   (a) Describe any observed changes in the level of the water in the lake.
   (b) How would you explain these changes?
2. Did you observe any changes in weight? Explain.
3. How does what happened to the model compare to the water cycle on Earth?
4. How does what happened to the model differ from the water cycle in your community?
5. Summarize what you have learned about the water cycle. Use diagrams if you wish.

Enrichment 4-2 Activity Guide: Water Underground (Student Reproducible)

Introduction

What happens to rain when it falls on the ground? Is the rainwater that seeps into the ground still a part of the water cycle? To answer these questions you construct a model of the water table and discover how groundwater moves beneath the earth.

Materials

Per student

- Activity Report

Per group

- Activity Guide
- Plastic drink bottle, empty (such as a 2 liter bottle)
- Cutting tools (single-edged razor blade in safety holder or scissors)
- Small metric ruler
- Beaker or cup
- Spoon
- Tape
- Paper towels
- Marking pen

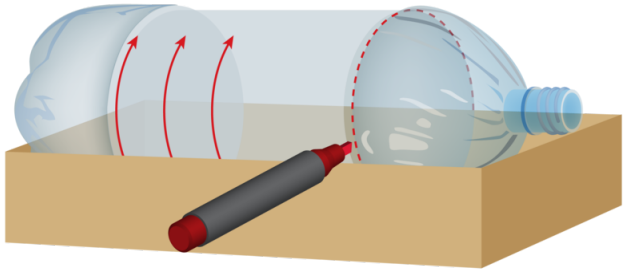
Per class

- Balance or scale
- Gravel
- Clay (modeling or potter's clay)
- Potting soil, lightly moistened
- Water
- Food coloring (green, blue, or red)

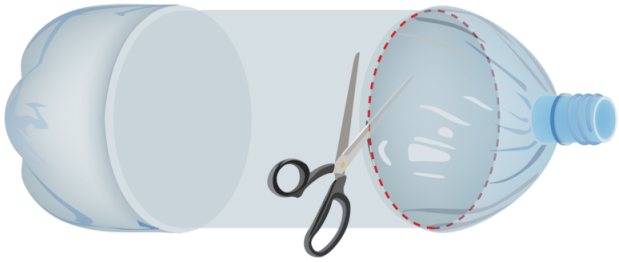
Procedure

Step 1 If necessary remove the plastic base and label from your plastic drink bottle using warm water to melt the glue.

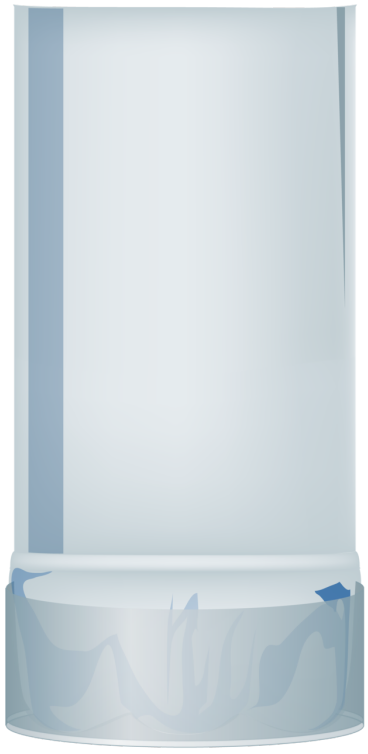
Step 2 Mark your bottle for cutting about 2 centimeters (em) below the shoulder of the bottle.



Step 3 Using the scissors or other cutting tool, carefully cut on the line you have marked to separate the bottle into two parts.



Step 4 Place the bottle upright or in its plastic base.



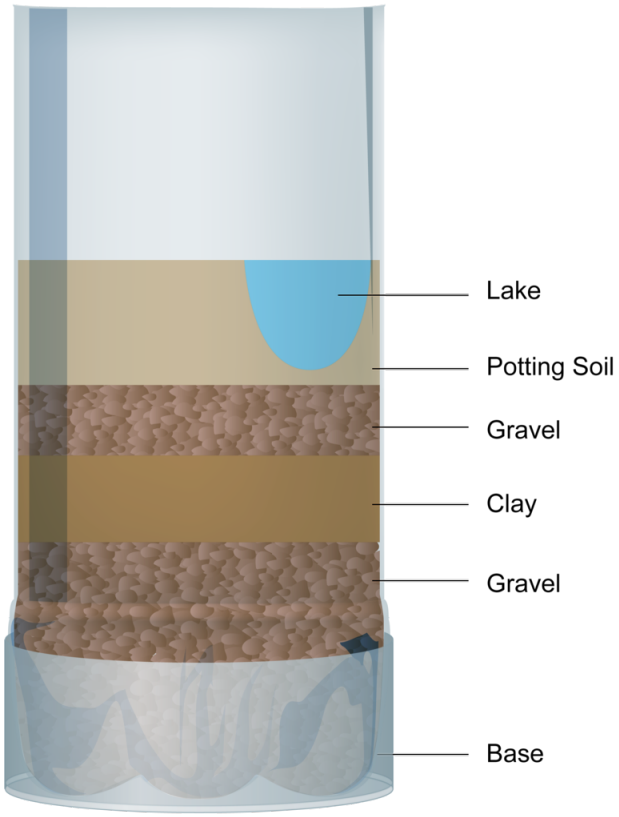
Step 5 Put a layer of gravel about 2 *cm* deep in the bottom of the bottle. (If the bottle is in its plastic base, add gravel to a point 2 *cm* above the top of the base.)

Step 6 Form a $1 - cm$ layer of clay on top of the gravel. Mold the clay carefully against the sides of the bottle so water will not be able to seep down below the clay layer.

Step 7 On top of the clay layer carefully add another layer of gravel about 3 *cm* deep.

Step 8 Above the gravel, use the moist potting soil to make a layer of soil about 4 to 5 *cm* deep. Press the layers down gently but firmly.

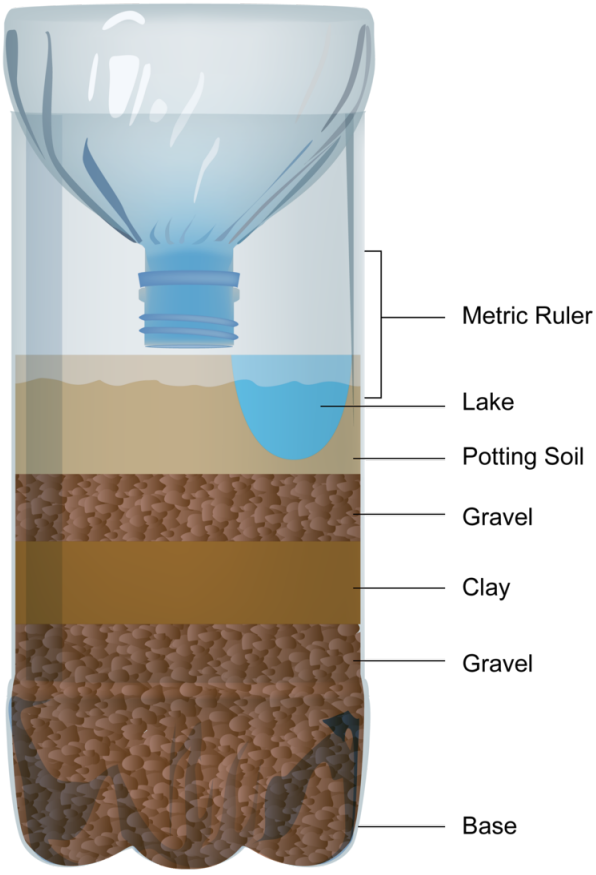
Step 9 Now it is time to make a "lake" in your model so you can observe any changes in the water level. Use a spoon to carefully scoop out a hole 4 to 5 *cm* wide and 3 to 4 *cm* deep along the side of the bottle. Press the dirt at the bottom of the "lake" firmly against the wall of the bottle and make the bottom higher near the side of the bottle. Your model should now look like this.



Step 10 Fill a beaker or cup with water and add several drops of food coloring. Carefully add water to your "lake" until it is about half full. Use a paper towel to clean off any excess dirt or water from the bottle wall.

Step 11 The small metric ruler should be placed at the edge of the "lake" so you can quantify any changes in water level in millimeters. Make sure you can read the ruler from the outside of the plastic bottle.

Step 12 Invert the top of the bottle and tape the two bottle parts together tightly to seal your system tightly.



Step 13 Determine and record the weight of your bottle and its contents. Record your observations.

Step 14 Place the bottle in a cool, dark place. Observe, weigh, and record your results at the same time each day for a week.

Step 15 Next, move the bottle to a warm, sunny place. Observe, weigh, and record your results at the same time each day for a week.

Enrichment 4-2 Activity Report: Water Underground (Student Reproducible)

1. a. Describe what you observed on the inside walls of the bottle.

b. Give an explanation for your observations.

2. a. Describe any observed changes in the level of the water in the lake.

b. How would you explain these changes?

3. Did you observe any changes in weight? Explain.

4. How does what happened to the model compare to the water cycle on Earth?

5. How does what happened to the model differ from the water cycle in your community?

6. Summarize what you have learned about the water cycle. Use diagrams if you wish.

CHAPTER 6

Cycling in Biological Communities - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

6.1 Planning

Key Idea

- Resources cycle in undisturbed ecosystems but may be lost in disturbed ones.

Overview

This section expands on the concept of cycling. Students have been introduced to water and carbon cycles in natural communities. In this section they discover how one group of ecologists developed an experiment to study how nutrients are cycled. The ecologists demonstrated how clear-cutting a watershed affects the nutrient cycles in a natural community. Students build a model of their own watershed and conduct an experiment similar to the experiment a group of ecologists in New Hampshire conducted as they studied the Hubbard Brook watershed.

Objectives

Students:

✓ explain the cycling of nutrients in a watershed.

✓ identify what happens to cycles when ecosystems are disturbed.

✓ explain that resources continue to cycle in undisturbed ecosystems.

✓ use a model to simulate a natural phenomenon.

Vocabulary

recycle, watershed

Student Materials

Activity 5-1: Go with the Flow: Hubbard Brook Watershed

Per Student

- Resource 1
- Resource 2

- Activity Report

Per group or class

- 8 to 10 half-liter milk cartons, rinsed and opened; One 1-liter pitcher; Graduated cylinder; Water; Bucket or sink; Stapler or tape
- Large tray with sides at least 4 *cm* high (A wallpaper tray works well. Or a piece of gutter closed tightly at both ends is another option.)
- Large piece of sturdy cardboard-approximately 1 *m* square

Teacher Materials

Activity 5-1: Go with the Flow: Hubbard Brook Watershed

- Activity Report Answer Key
- Towels if conducted indoors
- Sink or bucket to dump extra water

Advance Preparation

Students should have some introductory knowledge of the cycling of water and nutrients from the previous section. You might wish to review what the students learned about the water cycle in Section 4. You might also discuss what some other types of nutrients might cycle in the environment such as nitrates, potassium, and calcium-the nutrients the ecologists measured in their experiment with the Hubbard Brook watershed.

Activity 5-1: Go with the Flow: Hubbard Brook Watershed

- See Activity 5-1 in the Student Edition
- Begin collecting half-liter milk cartons a few weeks before the simulation. Make sure they are rinsed thoroughly.
- Gather large pieces of cardboard at appliance stores or from cardboard recycling bins.
- For the collection apparatus, use a large baking tray or wallpaper tray from a hardware store.

Enrichment Activities

None

Interdisciplinary Connections

Math The students analyze graphs in this section. Analyzing the graphs demonstrates how math is used in science to represent important scientific data.

Social Studies The content of this section can provide the basis for a discussion about international deforestation and the difficulty in regulating international environmental policies.

Background Information

Hubbard Brook Watershed Experiment If you want to learn more about this series of experiments done at Hubbard Brook, you can find information in the following book. This book can best be found in a local college library:

Bormann, F.H. and G.E. Likens, Pattern and Process in a Forested Ecosystem, *Springer- Verlag, New York. 1979.*

6.2 Using Cycling in Biological Communities – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How do resources cycle in a forested watershed?" This serves as a specific example of a forest community. Remind students to apply the same principles to other natural communities.

Discuss and define the term *watershed.* Assign the *Journal Writing Prompt* to reinforce the concept of a watershed and how it plays a role in the local community.

This section provides a perfect opportunity for students to see how scientists apply the scientific method in order to study the Hubbard Brook watershed. Assign the *Mini Activity: How Do Scientists Know?* to allow students to analyze the use of the scientific method.

Assign *Activity 5-1: Go with the Flow: Hubbard Brook Watershed* to investigate the effects of clear-cutting a forested area on d1e cycling of nutrients. This is a good opportunity for students to practice analyzing graphs.

Journal Writing

Now that you have a good idea of what makes up a watershed, use a map and describe the watershed closest to your community. Include the name of the river and/or creeks that are a part of your local watershed.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Why doesn't the concentration of nutrients flowing past the dam jump immediately after the trees have been cut down?

Mini-Activity

How Do Scientists Know? Students analyze graphs of data from the Hubbard Brook watershed experiment and answer the questions.

What Do You Think?

Look at Figure 5.5. The solid white line represents the concentration of nutrients flowing past the dam at the bottom of the watershed clear-cut by the scientists. The dotted white line is the flow past a dam at the bottom of a watershed that was not clear-cut. Explain why you think the scientists measured the nutrients at the "control" watershed.

6.3 Activities and Answer Keys

Activity 5-1: Go With the Flow: Hubbard Brook Watershed

PLAN

Summary Students learn about the role of trees in the cycling of nutrients in a watershed by building a simulated watershed and measuring the effects of deforestation on the amount of nutrients that remain in the system.

Objectives

Students:

✓ explain the cycling of nutrients in a forest.

✓ demonstrate how clear-cutting alters this cycling.

✓ evaluate the validity of using a model to study natural phenomena.

Student Materials

Per student

- Resource 1
- Resource 2
- Activity Report

Per group or class

- 8 to 10 half-liter milk cartons, rinsed and opened; One-liter pitcher; Graduated cylinder; Water; Stapler or tape
- Large tray with sides at least 4 centimeters high (a wallpaper tray or piece of gutter will work)
- 1 Piece of sturdy cardboard approximately 1 meter square

Teacher Materials

- Activity Report Answer Key
- Towels if done indoors
- Bucket or sink to dump any extra water

Advance Preparation

Ask students to begin collecting half-liter milk cartons a few weeks before the simulation. Make sure they rinse them thoroughly. The pitchers need to hold about a liter of water so the cartons can catch a substantial amount of water.

You may find large pieces of cardboard at appliance stores or in cardboard recycling bins.

For the large tray, you can use a piece of gutter or a wallpaper tray. These items are available at most hardware stores.

Set up a table with all the student materials so students may gather materials as needed. You may want to do this activity outside.

Estimated Time

30 minutes to set up the simulation

15 minutes to run the simulation and record observations

15 minutes to design the deforestation simulation

15 minutes to run the designed simulation and record observations

20 minutes to analyze the graphs and answer the Activity Report questions

Interdisciplinary Connection

Math The graph interpretation portion of this activity could be used in math class as an extended lesson on interpreting double-line graphs. It also demonstrates the relevance of math skills in representing scientific data.

Prerequisites and Background Information

Students should have some introductory information about the cycling of nutrients through a watershed. Students should have the ability to use a graduated cylinder.

IMPLEMENT

Introduce Activity 5-1 by discussing with students the cycling of nutrients in the environment. Lead them into the activity by asking what a watershed is.

Steps 1-3 Ask students to read pages 26-30. You can do this activity as a demonstration. Or you might wish to divide the class into small groups of 4 to 6 students. If enough materials are available a third option is possible by dividing the class into pairs of students. Regardless of how they are grouped, students should be able to complete the simulation on their own. If necessary provide copies of Resource 1 showing the experimental setup.

Steps 4-6 While students are running the simulation:

- make sure that they pour the water slowly in a steady stream.
- remind them that they will need to measure the amount of water caught in the tray, so they don't want to spill any of it on the floor.
- make sure as they remove the cardboard from the tray to turn the cardboard over and empty the cartons of water into a sink or bucket.

Steps 7-9 When students are ready to design their simulation of a deforested hillside, you might suggest that they draw a diagram of the model. One way to simulate the effect of deforestation is to remove the milk cartons from the cardboard and repeat the rainstorm experiment. Make sure they explain their design and the reasoning behind it on the Activity Report.

Question 6 on the Activity Report offers the opportunity to analyze the simulation and relate it to the cycling of nutrients in a natural community. You may wish to discuss this question with the class and ask students to critique how well this exercise simulated an actual watershed.

> ***Extend Activity 5-1*** by doing the graph interpretation portion of this activity in math class as an extended lesson on interpreting double-line graphs. The extension demonstrates the relevance of math skills in representing scientific data.

Step 10 Students analyze a graph of nutrients in the Hubbard Brook watershed. This is an excellent opportunity to review graph interpretation skills. Suggest that the solid line in the graph could represent their simulation data for the forest that was not clear-cut and the dotted line could represent their data for the forest that was clear-cut.

> **Helpful Hints**

Students may notice that the cardboard gets wet. They might conclude that the water is being lost as the cardboard absorbs it. Ask the students if this is true to the simulation only or if there is an analogy in nature. (It is analogous to nature because it simulates how the soil on the hillside would naturally absorb the rainwater.)

Discuss with the class the impact of deforestation on watersheds. Are there local examples of logging that may cause similar problems?

ASSESS

Use the students' written answers and discussion of the Activity Report to assess if students can

✓ demonstrate accurate measurement and data collection skills.

✓ describe how nutrients cycle through a forest watershed in the water, trees, and soil.

✓ interpret graphs.

✓ explain how human activities affect the natural cycling of nutrients in an ecosystem.

Activity 5-1 Go With the Flow: Hubbard Brook Watershed – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the amount of water in the full pitcher?
2. Describe what you observed while pouring.
3. What is the amount of water collected in the tray?
4. Compare the amount of rainwater in the pitcher at the beginning of the experiment (the full pitcher) with the amount of water you collected in the tray. What happened to the water?
5. What does the water collected in the tray represent in the model?
6. Explain the experiment you designed to represent the deforestation of Hubbard Brook watershed. Use another piece of paper if necessary.
7. What was the amount of water in the full pitcher before you poured it on your deforestation simulation?
8. What was the amount of water collected in the tray after you poured it onto your deforestation simulation?
9. Compare and contrast your data and observations for the amounts of water that were collected in the stream *before* and *after* deforestation. Explain your results.
10. Look at the graph of nitrates collected from Hubbard Brook. Was the amount or concentration of nitrates higher or lower in the stream *after* the hill was clear-cut? Why do you think this was so?
11. Clear-cutting changes the amount of runoff from a watershed and the amount of nutrients in the water. What are two more ways that clear-cutting changes a watershed?
12. People use wood for paper, furniture, fuel, buildings, and many other products. What could be done that might reduce the amount of nitrates lost from a forest but still allow the harvesting of trees?

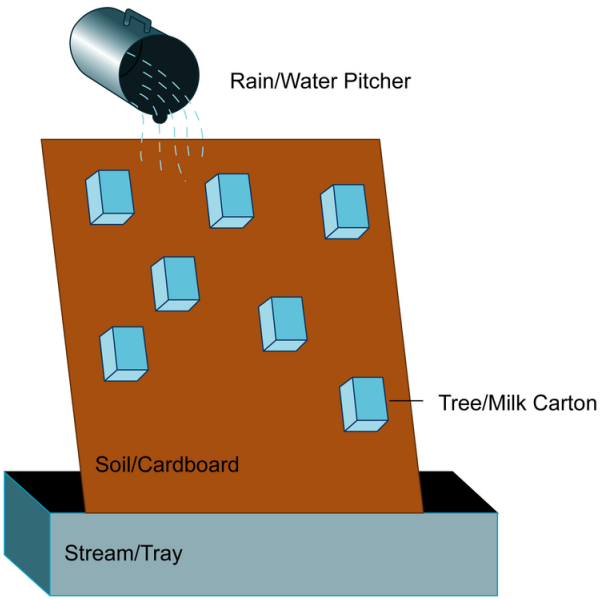
Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is a watershed?
2. What happens to most of the nutrients, such as water and nitrogen, in a forest that is undisturbed by humans?
3. What happens to these nutrients if all of the trees in the forest are cut down?

Activity 5-1 Resource 1 Go with the Flow: Hubbard Brook Watershed (Student Reproducible)

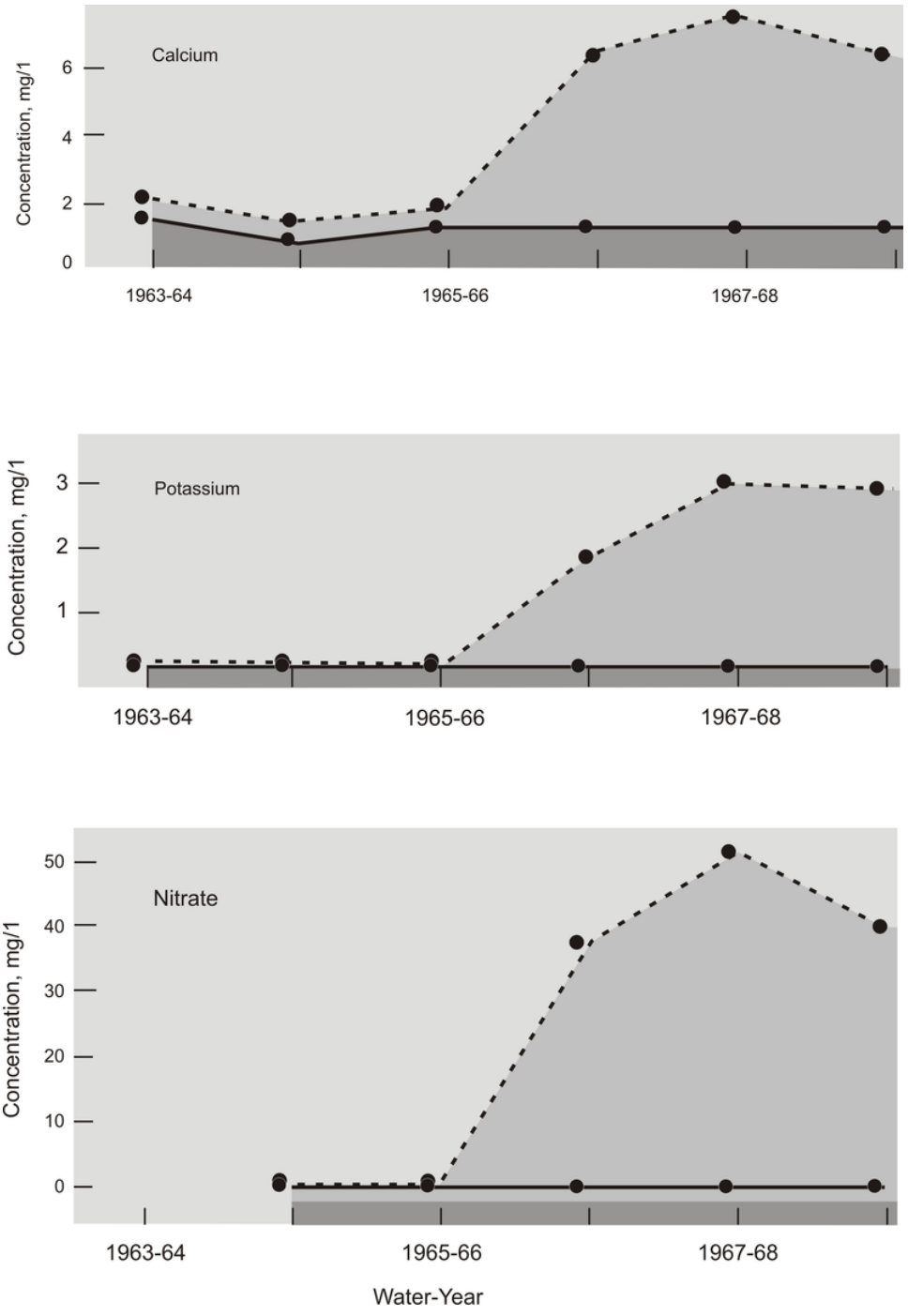
Experimental Setup



Activity 5-1 Resource 2 Go with the Flow: Hubbard Brook Watershed (Student Reproducible)

The **solid** line represents the amount of nutrients that collected in the stream at the bottom of a watershed on a hillside that was not clear-cut.

The **dotted** line represents the amount of nutrients that collected in the stream at the bottom of a watershed on a hillside that was clear-cut in 1965-1966.



Activity 5-1 Report Go with the Flow: Hubbard Brook Watershed (Student Reproducible)

1. What is the amount of water in the full pitcher?

2. Describe what you observed while pouring.

3. What is the amount of water collected in the tray?

4. Compare the amount of rainwater in the pitcher at the beginning of the experiment (the full pitcher) with the amount of water you collected in the tray. What happened to the water?

5. What does the water collected in the tray represent in the model?

6. Explain the experiment you designed to represent the deforestation of Hubbard Brook watershed. Use another piece of paper if necessary.

7. What was the amount of water in the full pitcher before you poured it on your deforestation simulation?

8. What was the amount of water collected in the tray after you poured it onto your deforestation simulation?

9. Compare and contrast your data and observations for the amounts of water that were collected in the stream *before* and *after* deforestation. Explain your results.

10. Look at the graph of nitrates collected from Hubbard Brook. Was the amount or concentration of nitrates higher or lower in the stream *after* the hill was clear-cut? Why do you think this was so?

11. Clear-cutting changes the amount of runoff from a watershed and the amount of nutrients in the water. What are two more ways that clear cutting changes a watershed?

12. People use wood for paper, furniture, fuel, buildings, and many other products. What could be done that might reduce the amount of nitrates lost from a forest but still allow the harvesting of trees?

CHAPTER 7

Recycling in Human Communities - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

7.1 Planning

Key Idea

- Recycling is an attempt by humans to cycle their resources in much the same way that resources cycle in undisturbed ecosystems.

Overview

This section extends the concept of cycling in biological communities to that of human recycling programs. In this section students learn that throwing things "away" does not mean that they cease to exist. Further, they learn that recycling is one important way to conserve the cycling of resources used by humans. By analyzing a bag of their own garbage, students investigate the contents of the garbage they produce, the resources involved in processing their garbage, and some ways to reduce waste.

Objectives

Students:

✓ differentiate between recyclable and non-recyclable waste.

✓ estimate the amount of waste they produce.

✓ explain how humans can recycle resources and reduce waste.

Vocabulary

biodegradable, recycle

Student Materials

Activity 6-1: What's in Your Garbage and Where Does It Go?

Per student

- Activity Report

Per group

- A bag of typical garbage; Tape measure; 5-8 plastic bags; Cardboard box; Gloves; Calculator (optional)

Per class

- 1 bathroom scale

Teacher Materials

Activity 6-1: What's in Your Garbage and Where Does It Go?

- Activity Report Answer Key
- To make your own "bag of garbage": Milk carton; Paper wads; Glass bottles' Juice cartons; Coffee grinds; Vegetable peels; Containers for cleaning products; Used paper towels; Newspapers; Empty boxes or containers; Plastic bottles; Plastic food packages; Dinner scraps

Advance Preparation

See Activity 6-1 in the Student Edition

Activity 6-1: What's in Your Garbage and Where Does It Go?

- Have students bring in garbage from home. If you are concerned about what materials will be brought in, simulate an assortment of garbage by using the items listed above under Teacher Materials.

Enrichment Activities

None

Interdisciplinary Connections

Language Arts Students can write letters to local newspapers to express concerns about issues of reducing the use of or recycling resources.

Math Students can use volume and weight measurements to calculate the amount of garbage their family produces in a month and a year. Students can calculate the impact of recycling by comparing the total volume and weight of the garbage before recycling with the total amount of garbage after recycling.

Background Information

Most of the products that are purchased at a store have many layers of packaging. In many cases this extra packaging doesn't serve any real purpose. In fact the overpackaging usually increases the cost of the product, creates more garbage, and wastes resources. An example might be packaged American cheese slices. Each slice of cheese is individually wrapped with plastic wrap and then all of the slices are wrapped with an outside layer of wrapping. The manufacturer claims that this is necessary to keep the cheese fresh until you are ready to use the individual slices.

Alternatives to purchasing this product might be to buy bulk cheese, wrap it in one piece of plastic wrap, and slice it as needed.

7.2 Using Recycling in Human Communities – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How can humans cycle their resources?" Use this question to review the concept of cycling in natural communities and how humans can rejoin the cycle of resources in our own community.

Ask students what they know about recycling programs in their community and school. Discuss any recycling habits students may have at home.

Discuss the "3-R's"-Reduce, Reuse, Recycle-and what they mean to students on a daily basis.

Assign the *Mini Activity: Draw a Paper Cycle* to compare the consequences of recycling paper versus using it once and throwing it in a landfill.

Assign *Activity 6-1: What's in Your Garbage and Where Does It Go?* as a fun way to analyze students' own garbage with the ultimate goal of changing wasteful behaviors.

Assign the *Mini Activity: Overpackaging* to follow through with students' analysis of their garbage and how waste can be reduced.

What Do You Think?

What sources of energy are used in the process of throwing away a piece of paper? Do you think that the energy sources are being used wisely? Explain your answer.

Mini-Activity

Draw a Paper Cycle Students learn about the cycling of an item (paper) that they use every day.
Implement Your students might draw a paper cycle such as the following:

- A pine tree grows in the forest.
- Loggers cut down the tree.
- The tree is transported to a paper mill.
- The tree is broken down to produce paper.
- The paper is packaged.
- The packaged paper is transported to a distribution center.
- The packaged paper is purchased by a store.
- The student purchases the packaged paper from a local store.
- The student uses the paper.
- The paper is thrown in the trash.
- The trash is thrown in a dumpster.
- The dumpster is emptied into a garbage truck.
- The garbage truck transports the paper and other trash to a transfer station.
- The paper and other trash is transported by a larger garbage truck to the landfill site.
- The paper and other trash is thrown in the landfill.
- The landfill is covered with soil and the paper remains in the landfill.

Notice that those steps listed above do not represent a true cycle. The paper in the landfill can never get back to providing nutrients for the growth of a new tree. However, if the student recycles the paper,

then the paper is not thrown in the trash and doesn't end up at the landfill. The paper to be recycled follows the following steps.

- The paper is collected by a recycling company.
- The paper is sorted and sent to a recycling paper mill.
- The original paper is converted into a piece of recycled paper.
- The recycled paper is packaged.
- The packaged paper is transported to a distribution center.
- The packaged paper is purchased by a store.
- The student purchases the packaged paper from a local store.
- The student uses the paper.
- The student recycles the paper.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What do you think happens to paper bags in a landfill?

7.3 Activities and Answer Keys

Activity 6-1: What's in Your Garbage and Where Does it Go?

PLAN

Summary Students learn about the contents of the garbage they produce, the resources involved in processing it, and the ways they could reduce waste by analyzing a bag of their own garbage. In addition students trace the path of a reusable or recyclable item.

Objectives

Students:

✓ differentiate between recyclable and nonrecyclable waste.

✓ estimate the amount of waste they produce.

✓ determine what portion of their waste is recyclable.

Student Materials

Per student

- Activity Report

Per group

- A bag of typical garbage; Tape measure; Paper and pencil; 5-8 Plastic bags; Cardboard box; Gloves; Calculator (optional)

Per class

- 1 bathroom scale

Teacher Materials

- Activity Report Answer Key
- To make your own "bag of garbage": Milk carton; Paper wads; Glass bottles; Juice cartons; Coffee grinds; Vegetable peels; Containers for cleaning products; Used paper towels; Newspapers; Empty boxes or containers; Plastic bottles; Plastic food packages; Dinner scraps

Advance Preparation

A week before the activity you may want to ask each group to choose one member to bring in a bag of garbage from home. You may also decide to use garbage from the school. If you are concerned about what materials will be brought in you can simulate an assortment of garbage by using the items listed as Teacher Materials.

Obtain the guidelines for recycling plastic from a local recycling center.

Estimated Time Two 50-minute periods

Interdisciplinary Connections

Math Students use the volume and weight measurements and the calculations required for this activity as a springboard into math lessons on volume and weight.

Language Arts Students write letters to the local newspaper expressing their concerns about garbage disposal and include suggestions that would help the general public reduce the amount of garbage generated.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 6-1 by connecting the idea of cycling of natural resources to the recycling and nonrecycling of the materials we use every day. Students enjoy this activity after they overcome the initial repulsion to the idea of going through a garbage bag. Be sure to have students handling the garbage wear gloves.

Steps 1-3 Have students in each group spread a few sheets of newspaper on their table to avoid a mess when sorting the garbage.

Encourage students to take turns weighing their garbage with the scale while others measure the volume of the garbage in the box with a tape measure. Make sure students record their findings on the Activity Report.

Steps 4-7 When sorting the garbage into items that could be reused or recycled you may want to contrast the guidelines set by your local recycling program and the variety of materials designated as recyclable by the manufacturer. For example, you may discuss how some types of plastic containers are designated as recyclable but may not be accepted at your local recycling center.

To conclude Activity 6-1 you may want to have a discussion comparing the energy needed to turn raw materials into a product versus the energy needed to recycle that same item.

Extend Activity 6-1 by asking students to explore what happens when someone illegally dumps motor oil down the drain of a garage. The path of motor oil through a sewage system would be as follows.

i. Motor oil is dumped in the sink of a garage.

ii. The motor oil travels down the drain into the sewer line.

iii. The oil travels down the sewer line of the street to the sewage treatment plant.

iv. The oil is not broken down at the sewage treatment plant because the treatment usually only decomposes human waste.

v. The oil then may pass into open water and contaminate it.

vi. The oil may also take other routes. For example, it may enter septic systems where it could contaminate groundwater or runoff collectors that go straight to open water.

Use the volume and weight measurements and the calculations required for this activity as a springboard into math lessons on volume and weight.

Have students write letters to the local newspaper expressing their concerns about garbage disposal. Ask them to include suggestions that would help the general public reduce the amount of garbage generated.

ASSESS

Use students' written answers and discussion of the Activity Report to assess if students can

✓ demonstrate accurate measurement and calculation skills for volume and weight.

✓ explain how much garbage can be kept out of landfills.

Helpful Hints

Use a common bathroom scale to measure the weight of the garbage.

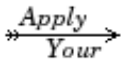
Mini-Activity

Overpackaging Students learn about the problem of overpackaging by examining how various manufacturers package their products.

Journal Writing

Select a packaged item from home or school that you think is overpackaged. Write a letter to the company that produced the item and suggest alternative packaging ideas.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**



Apply Your KNOWLEDGE

Name ten things that are thrown away but aren't on the list of most common recyclables.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Why do people who work on waste disposal say that there is no "away"?
2. What are the three steps you can follow to limit the amount of garbage that you send to a landfill?
3. Why is it important to properly sort items for recycling?
4. What is meant by biodegradable? Give two examples of biodegradable items, and explain why each is biodegradable.

Activity 6-1: What's in Your Garbage and Where Does It Go? – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

Questions 1-7: The answers to these questions depend on the amount and type of garbage the students are investigating.

8. Explain some ways you can reduce the amount of garbage that you as an individual produce.

Activity 6-1: Report What's in Your Garbage and Where Does It Go? (Student Reproducible)

1. Weight of garbage _____ Volume of garbage _____

2. a. After 30 days:

Weight of garbage _____ Volume of garbage _____

b. After 1 year:

Weight of garbage _____ Volume of garbage _____

3. List the items you removed from the garbage that could be reused, composted, or recycled. Explain how each item could be treated.

4.

	Weight	Volume
a. After removing recyclable items:	____	____
b. After removing recyclable items for 30 days:	____	____
c. After removing recyclable items for 1 year:	____	____

5. Compare the total volume of garbage to the volume left over when the recyclables are removed. Calculate and record the percent of the volume that is recyclable.

6. Determine which items in your garbage could have been reused or recycled. List the people who will probably have to handle the items and the places the items may travel before reaching a landfill.

7. What kinds of items do you contribute to a typical garbage pile?

8. Explain some ways you can reduce the amount of garbage that you as an individual produce.

CHAPTER 8 Resources, Niches, and Habitats - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

8.1 Planning

Key Idea

- Organisms need specific resources in specific amounts to survive and reproduce.

Overview

This section continues the topic of resources by distinguishing between the three related but separate topics of resources, niches, and habitats. Through the simulation of a bobcat population students learn about resource requirements and carrying capacity. Students learn that all organisms need habitats that provide resources such as food, water, and space. Throughout the section students are reminded that they also require specific resources in order to survive and they are asked to identify the specific requirements of their own niche.

Objectives

Students:

✓ explain that all organisms need certain resources in specific amounts to survive and reproduce.

✓ identify the factors that determine the carrying capacity of a specific area.

✓ define the term *niche* and explain their own niche requirements.

✓ predict the size of a population based on the available resources.

✓ analyze graphs representing a population curve.

✓ evaluate the importance of space for the survival of plants.

Vocabulary

carrying capacity, habitat, niche, resources, species

Student Materials

Activity 7-1: Too Many Bobcats

Per student

- Resource
- Activity Report
- Sandwich-size plastic bag
- Masking tape

Per class

- Colored construction paper: red, green, black, yellow, orange, and blue, cut into 20 rectangles of each color (for a class of 30 students)
- Large open area-large enough to scatter 120 paper rectangles

Teacher Materials

Activity 7-1: Too Many Bobcats

- Activity Report Answer Key

Advance Preparation

See Activity 7-1 in the Student Edition

Make sure you have an area available to conduct the activity.

Enrichment Activities

Enrichment 7-1: What's in a Niche?

Students learn about the components of a niche by listing things they would need in various habitat types.

8.2 Using Resources, Niches, and Habitats – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "What are the things you, or any organisms, need to survive?" Ask students to brainstorm a list of all the things they need for survival.

Use the list generated by students to illustrate the importance of basic resources such as water, food, and space.

Ask students to compare what they need to stay alive with an organism of their choice or the resources needed by a loon.

Assign *What Do You Think?*. Students will compare in writing their use of resources with the resources used by a teenager from another country.

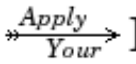
Assign *Activity 7-1: Too Many Bobcats* to illustrate what happens when the number of bobcats exceeds the available resources in a habitat.

Emphasize the difference between a habitat and a niche.

Journal Writing

Think about the resources you use in a typical day. If you had to give up three resources, what would you give up? How difficult would it be to do this? Compare your resource use to a loon's. How difficult would it be for a loon to give up three of its resources?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**



KNOWLEDGE

How do the three main categories of resources differ for plants and animals?

What Do You Think?

How do you think the resources you use differ from those used by a teenager living in Bangladesh? Budapest? Which is a better use of the resources?

8.3 Activities and Answer Keys

Activity 7-1: Too Many Bobcats

PLAN

Summary Students learn about the carrying capacity of a specific area by playing a game in which they play the role of bobcats that must gather resources for survival.

Objectives

Students:

✓ explain that organisms need certain resources in specific amounts to survive and reproduce.

✓ identify the factors that determine the carrying capacity of an area.

✓ predict the size of a population based on the available resources.

✓ analyze a graph representing a population curve.

Student Materials

Per student

- Resource
- Activity Report
- Sandwich-size plastic bag
- Masking tape

Per class

- Colored construction paper: red, green, black, yellow, orange, and blue, cut into 20 rectangles of each color (for a class of 30 students)
- Large open area-large enough to scatter 120 paper rectangles

Teacher Materials

- Activity Report Answer Key

Advance Preparation

This activity has been designed for a class of thirty students. Prepare twenty paper rectangles in each of the following colors to represent the organisms listed below:

rabbits	*red*
rodents	*green*
fawns	*black*
birds	*yellow*
reptiles	*orange*
water	*blue*

If you have more or fewer students count the number of students in your class and subtract 10. This number represents the number of paper rectangles you will need in each of the colors listed.

Estimated Time One 50-minute period

Interdisciplinary Connections

Math Students calculate survival rates and graph the data.

Physical Education Students will be extremely active during this activity.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 7-1 by having students read the introduction. Discuss what the carrying capacity of a habitat is. Explain that students are going to pretend to be bobcats and determine what carrying capacity really means.

Step 1 Read the rules of the game in Step 1 of the Procedure with the whole class. If the students fail to follow rules, the game will turn into a gathering frenzy and the whole point of the activity will be lost. You may want to point out that these rules are needed for the game but do not necessarily reflect real bobcat behavior. At the end of the activity you may want to discuss what some differences might be between these rules and how real bobcats react in nature. For reference the rules are repeated here:

- Bobcats do not fight because it takes energy away from the food-gathering activities.
- Bobcats do not eat more than they need of one kind of food nor drink more water than they need.
- Bobcats do not snatch food away from other bobcats.
- Bobcats do not take food from the den if it belongs to another bobcat.

Step 2 Divide the class into two groups of about 15 students each. Set up boundaries to designate each group's habitat area and "den." Ask each group to go to their den, get a plastic bag, and put their name on it as described in Step 2 of the Procedure. They will keep the plastic bags in the den and return there each time they collect a food or water rectangle and store it in the bag. If you have more than thirty students you may want to divide the class into three groups and set up three habitat and den areas.

Steps 3-6 For a bobcat to survive each round of the game it must obtain paper rectangles in six different colors, which represent water and the five types of food. Any bobcat who fails to obtain the six differently colored rectangles will "die" and be eliminated from the game. It is essential that the students know that only one rectangle (representing one resource) is collected at a time. They must bring each rectangle back to the den to be placed in their plastic bag before collecting the next one.

The total carrying capacity is predetermined by the number of food and water rectangles you place in the habitat areas. At the beginning of round one you spread out 120 food and water rectangles over two habitat areas. After each round you collect the rectangles students have gathered at their dens and spread them out again. In each round

the number of bobcats competing for resources increases. The game is designed so that all five bobcats can survive in round one, all ten bobcats can survive in round two but only ten out of fifteen bobcats can survive in round three.

Steps 7-8 After playing the game, have students analyze the graph on the Resource. The graph represents an idealized model for population growth. A population of organisms grows slowly at first and then begins to grow rapidly. Eventually the growth rate slows down and the rate at which individuals are born is the same as the rate at which individuals die. This is a stable steady-state population. The habitat in which the population lives determines the size of the steady-state population. When the resources of the habitat are limited the habitat can fulfill the needs of a limited number of individuals and no more. The carrying capacity of a habitat represents the maximum number of individuals that can be supported.

Conclude Activity 7-1 by reconvening the whole class and discussing what they learned about carrying capacity. Could the "habitat" you simulated "carry" 5 bobcats? (Yes) Could it "carry" 10 bobcats? (Yes) Could it "carry" 15 bobcats? (No) So the carrying capacity of bobcats for the simulation was somewhere between 10 and 15. You may want to have the students answer the questions on the Activity Report in class or as homework.

Extend Activity 7-1 by introducing the following complexities to the game.

- Add a rule that any bobcat that survives two rounds in a row produces a cub. A bobcat with a cub must collect an additional number of paper rectangles representing food and water for the cub.
- Emphasize what happens to bobcats that die. Designate a decomposing pile (a specially labeled area) where the dead bobcats remain while their nutrients are recycled into the system.

ASSESS

Use students' answers to the Activity Report questions and completion of the game to assess if students can

✓ describe the requirement for resources in specific amounts to survive and reproduce.

✓ explain the concept of carrying capacity.

✓ analyze and draw conclusions from a population graph.

Activity 7-1: Too Many Bobcats – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Explain what happened to the bobcats in your den for each of the three rounds.
2. What factors determined whether bobcats survived or not?
3. What other factors might affect the carrying capacity of a habitat for bobcats? How could you alter the game to include these other factors?
4. Do you think that the earth has a carrying capacity for humans? Explain.
5. Analyze the graph on the Resource. How does the growth of the population change?
6. Explain what is happening to the population in the far right section of the graph. Why does this occur?

Mini-Activity

Define the Niche of an Animal Students choose a specific animal and investigate its niche by identifying the resources it needs to survive.

Help students pick animals that may live in habitats near your school or ask the class to suggest the animals they find most interesting and list them on the board. Then let students pick from the list or an animal of their own choice. Students can make a poster of their animal in its habitat surrounded by its resources.

Review Questions/Answers

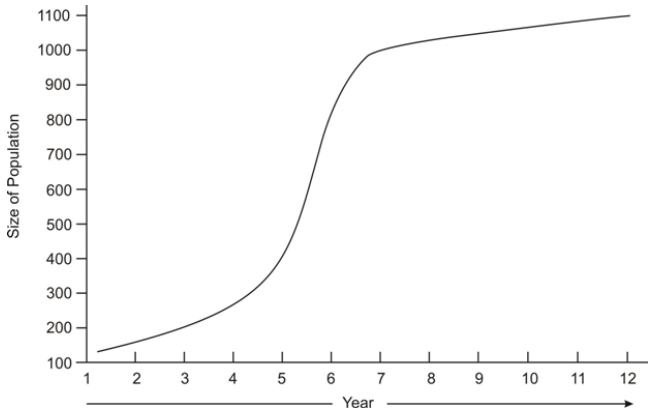
- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is a resource? Describe three general categories of resources.
2. Do all organisms require the exact same resources? Give an example or two to support your answer.
3. Is it possible to have too much of a needed resource? Support your answer with an example.
4. What is the difference between the habitat and the niche of a plant?

Activity 7-1 Resource: Too Many Bobcats (Student Reproducible)

Population Growth

The graph below illustrates one type of population growth. Study the graph and read the description that explains the pattern on the graph.



When organisms are first introduced into an area, the population grows slowly. Soon the population begins to grow very rapidly. Eventually the growth slows down again until the birthrate is equal to the death rate. The population size stabilizes.

Activity 7-1 Report: Too Many Bobcats (Student Reproducible)

1. Explain what happened to the bobcats in your den for each of the three rounds.

2. What factors determined whether bobcats survived or not?

3. What other factors might affect the carrying capacity of a habitat for bobcats? How could you alter the game to include these other factors?

4. Do you think that the earth has a carrying capacity for humans? Explain.
5. Analyze the graph on the Resource. How does the growth of the population change?
6. Explain what is happening to the population in the far right section of the graph. Why does this occur?

8.4 Enrichment

Enrichment 7-1: Teacher Activity Notes

What's in a Niche?

PLAN

Summary

Students learn about the components of a niche by listing things they would need in various habitats.

Objectives

Students:

✓ explain the term *niche.*

✓ define their own niche requirements.

Student Materials

Per student

- Activity Guide

Per group

- 1 poster-sized piece of butcher paper; Colored marking pens

Teacher Materials

- Activity Guide

Advance Preparation

None

Estimated Time

Approximately 30 minutes

Prerequisites and Background Information

The students should have knowledge of the basic resources required for the survival of most living things-air, food, water, and space.

The main point of the activity is for students to see that humans fill a similar niche everywhere they go, even though they might need slightly different things. They eat a certain amount of food. They drink a certain amount of water. They build some type of shelter. They take up about the same amount of space. They need about the same amount of oxygen from the air. However, the food, shelter, space, and even air might be slightly different in each place.

To reinforce the concept of *niche*, you may want to describe examples of animal niches. Explain that there are animals that fill a similar niche in most habitats. For example, in a meadow the deer are the large planteaters. But in a pasture the cows are the large plant-eaters. In a rain forest the tapirs are the large plant-eaters. They eat different plants but they each fill similar niches in their habitat. You may also want to present examples of organisms that share the same habitat but occupy very different niches, such as these seabirds from the Galapagos Islands.

- The Galapagos storm petrel (a small, fast bird) flies above the water and dips down to snatch fish near the surface without entering the water.
- The brown pelican flies above the water and plunges into the water scooping up fish 30 to 60 centimeters (l to 2 feet) below the surface.

- The blue-footed booby flies above the water, plunges deeper into the surface than the brown, and catches fish about 1 meter (3 to 4 feet) below the surface.
- The albatross swims along the surface of the water and catches the fish as it swims.
- The Galapagos penguin cannot fly but swims very well. The penguin dives under the water to chase fish.

IMPLEMENT

Introduce Enrichment 7-1 by reviewing with students the three basic resources of food, water, and space. They need to be able to distinguish between these basic categories and the more subtle and complex conditions that make up an organism's niche.

Step 1 Divide students into groups of four or five to work on their lists as described in Step 1 of the Procedure. Give each group a piece of butcher paper.

Assign each group one of the following habitats on which they landed:

- Desert
- Tropical island
- Arctic tundra
- Forest
- Open plains
- Beach

Remind students that there are no usable items left from the plane.

Step 2 As students finish their lists have them tape the butcher paper on the wall or chalkboard at the front of the classroom.

Steps 3-4 Have a class discussion of the differences and similarities in the lists. Compare the lists of human requirements to the requirements for familiar animals and plants. Use the examples given in the Background Information to discuss the living and nonliving factors that make up an organism's niche.

> ***Extend Enrichment 7-1*** by having students research organisms that have very specific and interesting niches. You may want to provide books that describe the natural histories of endangered species that have very specific niches.

ASSESS

Use students' discussion of their survival requirements and niches to assess if students can

✓ define a niche.

✓ describe the characteristics of their own niche.

Enrichment 7-1 Activity Guide: What's in a Niche? (Student Reproducible)

Introduction

Every living organism requires basic resources to survive: air to breathe, food (energy), water, space, and shelter. But for most organisms, the situation is a lot more complicated than that. Some animals and plants seem to be able to live and grow anywhere. But other animals and plants need a certain kind of food and a certain amount of water and have very specific space and shelter requirements. Like these plants and animals, humans have specific requirements in order to survive. In this activity you will define what your own special requirements are in order to identify the conditions of your own niche.

Materials

- Butcher paper
- Colored marking pens

Procedure

Step 1 Imagine the people in your group are the survivors of an airplane crash. You are stranded in the particular region assigned by your teacher. Help will arrive in one month. Make a list of the items you will need to find in your region until help arrives. Write the approximate amounts of each item you would need. Be specific. Also list what actions you will have to take in that region in order to survive for a month. Remember that there are no usable items left from the plane.

Step 2 When you are done making your list hang it at the front of the room.

Step 3 When all the groups' lists are finished and displayed, compare the items on the lists.

- What things on the lists are the same?
- What things are different?
- Do the amounts vary from region to region?
- What categories or labels can you give the items on each list?

Step 4 The lists of items describe the resources you need and the amounts necessary. These resources define the niche you occupy in that particular environment. Discuss with your group the niche you occupy right now in your school, neighborhood, and home. What things do you need to have and do every day to live and work? What are the extra things you need to relax and be entertained? Would you consider these things part of your niche?

CHAPTER 9 Species Interactions - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

9.1 Planning

Key Idea

- Species, including humans, affect other species in both positive and negative ways.

Overview

In the previous section, students learned that all organisms require specific resources in order to survive and reproduce. This section addresses the ways that different species interact with one another, Students learn that humans interact with other species in much the same way as other organisms do. A variety of species' interactions is discussed in the text and students identify different types of interactions by listening to and then finishing a story about an oak tree habitat. The students examine how organisms live together and how they can help or harm each other.

Objectives

Students:

✓ identify and compare different types of species interaction such as competition, mutualism, parasitism, and predator-prey relationships.

✓ categorize the role each species plays in the different interactions.

✓ define and give examples of the terms *predator* and *prey.*

✓ observe predator-prey relationships.

Vocabulary

camouflage, competition, host organism, mimicry, mutualism, parasite, predation

Student Materials

Activity 8-1: Once Upon an Oak Tree

- Writing materials
- Drawing materials (optional)

Teacher Materials

Activity 8-1: Once Upon an Oak Tree

- Resource

Advance Preparation

Activity 8-1: Once Upon an Oak Tree

- Make an audiotape of yourself or someone else reading the story.
- See Activity 8-1 in the Student Edition
- You might want to prepare copies of *Activity 8-1: Once Upon an Oak Tree* Resource for your students.

Enrichment Activity

Enrichment 8-1: Predator-Prey Relationships

Students observe predation by constructing a model environment consisting of fruit flies and carnivorous plants inside a plastic bottle.

Carnivorous plants can be purchased from most biological supply houses as well as from many nurseries.

Fruit flies can be purchased through a biological supply company.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-227-1150.

Or, you can breed them yourself. To breed your own fruit flies you will need to start 3 to 6 weeks prior to this activity to ensure that you have a large enough population. See Project #2: Population Boom or Bust on TE p. 217 for full details on starting your own fruit fly population.

An excellent reference for working with plastic bottles is *Bottle Biology,* by P.H. Williams, published by Kendall-Hunt Publishing Company, 1993.

Background Information

Monarch butterflies are poisonous to birds because they feed on milkweed as caterpillars. Milkweed has a toxic compound in it known as a cardiac glycoside that can induce a heart attack if taken in too great an amount. The cardiac glycoside remains in the butterflies' bodies when they become adults and provides protection from predation.

9.2 Using Species Interactions – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How do different species affect one another?" To emphasize the variety of interactions, ask students to list specific examples of interactions that they have observed between different species.

When students read their examples, ask them to categorize the interactions as either Win/Lose (such as competition for food and/or habitat, predator/prey, or parasite/host) or Win/Win (such as mutualism).

Assign *Mini Activity: How Do I Interact with Other Species?* as an opportunity for students to think about their interaction with other species.

Ask students to complete *What Do You Think?* on page 48 as a follow-up to *Mini Activity: How Do I Interact with Other Species?*

Assign *Activity 8-1: Once Upon an Oak Tree.* Students can examine why interactions occur between organisms, and they can assess whether those interactions are helpful or harmful.

Highlight the graph in Figure 8.4 to illustrate the interdependent relationship between predators and prey.

Mini-Activity

How Do I Interact with Other Species? Students develop a list of ten ways that they interact with organisms in their local environment, then proceed to list ten ways that they interact with other organisms on a global level.

What Do You Think?

Humans are usually pretty good at competing with other species for resources. Does this mean that humans have a right to use any resources they can get in any way that they think fit? Explain your answer.

9.3 Activities and Answer Keys

Activity 8-1: Once Upon an Oak Tree

PLAN

Summary Students learn about species interactions by listening to and completing the story about the interactions between organisms around an oak tree.

Objectives

Students:

✓ identify the species interactions that occur in the story.

✓ evaluate these interactions and categorize them.

Student Materials

- Writing materials
- Drawing materials (optional)

Teacher Materials

- Resource

Advance Preparation

You may want to make an audiotape of yourself or someone else reading the story.

Estimated Time One 50-minute period

Interdisciplinary Connections

Language Arts Students write the conclusion to a story about an oak tree.

Visual/Performing Arts Students draw and/or perform their stories.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 8-1 by reviewing pages 47-54 of the text and discussing the concept of competition. Encourage students to listen for the concepts described in the text as they hear the story being read to them.

Steps 1-2 Remind students about good listening skills. Use voice intonations to make the story come alive. Read the story to your class or play an audiotape with the prerecorded story.

Extend Activity 8-1 by having students create a story using a food web as a template.

Have interested students develop a role-playing exercise, a dramatic presentation, or a puppet theater to present their stories.

Step 3 After reading the story or playing the audiotape, provide each student or group of students with a copy of the story (Activity 8-1 Resource) and have them work together on Step 2 of the Procedure. Encourage students to offer comments, raise questions, and discuss questions with each other.

Ask students to complete or expand the Story, adding events that might continue to happen during the course of a day. If students need ideas for how to continue the story, direct them to the questions in Step 3 of the Procedure in the Student Edition. You may want to have them present their completed and expanded stories in one of the following ways:

- Small booklets
- Poster displays
- Bulletin boards
- Oral presentations
- Videotaped presentations

Conclude Activity 8-1 by reconvening the whole class and asking the students to consider what would happen if certain events occurred to disrupt some of the species interactions described in the story. Some possible disruptive events include the following:

- One species is affected severely by disease or drought.
- A forest fire sweeps across the area.
- A species is reduced considerably in number because of a particularly hard winter.

Helpful Hints

You may want to have students complete the story in writing or through drawings. Alternatively, you may want to have students take turns adding to the story orally as you go around the room from student to student.

Students can work individually or in small groups on this activity. If you elect to have students work in groups, you may want to assign a specific organism to each student in the group as the group continues the story.

ASSESS

Use the completed and expanded versions of the Story to assess if students can

✓ describe the interaction between different species in the same habitat.

✓ compare and contrast different types of interactions that occur, such as competition, predator-prey, parasitism, and mutualism.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Another example of mimicry is the flower fly, which is shown in Figure 8.7. It is actually a fly and a lot like the ones that buzz around garbage on a hot summer day. But it is black with bright yellow stripes. What do you think the flower fly is mimicking and why? What might be the advantage of this mimicry for the flower fly?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What do ecologists mean by the word *competition?*
2. What is the difference between a predator and a parasite?
3. Describe an example of mutualism with which you are familiar, and that isn't explained in this book.

Activity 8-1 Resource: Once Upon an Oak Tree (Student Reproducible)

Imagine yourself walking along a trail in an oak forest. The wind blows lightly through the trees, and the birds peep and squawk as you pass. The forest floor is slightly damp from the lack of sunlight. You notice the sweet, pungent smell of moist leaves and earth under your feet. It is darker here in the woods than out in the meadow. There isn't a glare from the sun. Here, everything seems clear and distinct. You become aware of individual animals and plants as they encounter each other. One particular oak captures your attention and you decide to sit down by it. You sit cross-legged in front of it and look up as if you're going to have a conversation with it. Instead you sit quietly, watch, and listen.

A fox family has hollowed out the ground around the roots of the tree. This is the fox family's area where they bring meals of mice and squirrels. Your eyes move up the trunk slowly, as you watch a trail of ants marching in line around the tree. The ants seem to spend their whole lives looking for seeds and other bits of food. They have another job, too, one that helps out another organism. The ants carry pale green insects slightly larger than themselves to tasty, tender new plant shoots. While these pale green aphids are eating, a sweet liquid comes out of their bodies. The ants then feed on this sweet liquid. As you look closer, the ants seem to be taking care of the aphids, protecting them from animals that would eat them.

Again your eyes wander over the curves and slopes of the oak tree until you see another insect. It's a bark-boring beetle with a long tube at its head. You wonder what it's up to until you notice that the long tube is drilling into the bark. The beetle is using the long tube to remove the bark. You wonder if it is boring in to eat the layers of the tree underneath.

Or, maybe the beetle is a female boring a place to lay her eggs in the bark so her larvae will have food to eat when they hatch. Or, maybe it's accomplishing both tasks. Bark-boring beetles bore tunnels throughout the bark, eating as they go. Suddenly, the quiet is disturbed by the sound of tapping above you. You glance upward to where the noise is coming from and see a woodpecker higher up on the trunk. Its head moves quickly back and forth. The woodpecker is tapping at the bark to get to the plump, juicy larvae underneath. The woodpecker is probably feasting on the larvae of another bark-boring beetle. Another creature that loves the beetle larvae is a particular kind of fly. It lays its eggs by drilling right through the bark, into the larvae's bodies! The eggs then hatch to devour the flesh of the beetle larvae!

As you consider this tasty thought, a light shower of bits of leaves and bark falls into your hair. You brush off the debris and look up quickly. You see two squirrels scurry across the branch above you. The squirrels leap from branch to branch, finally racing down the trunk to the ground. Eventually, they lose interest in each other as they begin searching the ground for acorns. Several blue jays swoop down from the sky through the branches to join the squirrels in the search for acorns.

The jays squawk and flutter their wings trying to chase the squirrels away. But the squirrels go on searching. While the squirrels and jays forage for food, you notice a black speck on top of an oak seedling drop onto a jay as the bird passes under it. The jay doesn't notice the black speck and keeps looking for food. You realize that the black speck is a tick. The female tick has found a new home on the jay. It may have waited on that seedling for a long time,

even years, for a warm-blooded animal to pass under it. When the tick lands on something warm, it burrows into the animal's skin. There the tick feeds on the animal's blood until it's full. When the tick is gorged with blood, it lets go of the animal, lays its eggs, and dies. Through all of that the jay may only feel a sore spot on its back for a short time.

Suddenly, you realize you're a warm-blooded animal and another tick could find you delicious. So you decide it's time to go. Standing, and backing up a few steps gives you a new view of the oak. You realize that something you thought was part of a branch is actually an owl. Its dark feathers keep it hidden from most creatures until night falls. Then it leaves its nest, which is actually an abandoned craw's nest, to hunt for food. Owls are effective hunters but lazy builders. So they often use other animals' nests. The owl spends much of the night hunting for mice, rabbits, and moles.

As you walk away from the oak, you turn around once more to look at the whole tree. The branches up against the sky show several dense jumbles of twigs, which you can see now are bunches of mistletoe. The mistletoe clings to the tree and drains the nutrients from its branches. If there are enough mistletoe plants on the tree, eventually it will die.

You think about how much was going on during your short visit with the oak tree. And as you walk back down the trail, you wonder if every oak tree is as busy as the one you just visited.

9.4 Enrichment

Enrichment 8-1: Teacher Activity Notes

Predator-Prey Relationships

PLAN

Summary

Students observe predation by constructing a model environment consisting of fruit flies and carnivorous plants inside a plastic bottle.

Objectives

Students:

✓ explain the terms *predator* and *prey* and give examples of each.

✓ observe the interactions between two different species.

Student Materials

Per student

- Activity Guide
- Activity Report

Per group

- 2 two-liter plastic bottles
- Cutting tool (scissors, utility knife, or single-edged razor blade with safety holder)
- 1-3 carnivorous plants, such as Venus's-flytraps
- Potting soil (peat)
- Large sharp needle or push pin

Per class

- 1-2 containers of breeding fruit flies
- Waterproof tape
- Clay

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Carnivorous plants can be purchased from most biological supply houses as well as from many nurseries.

Fruit flies can be purchased through a biological supply company or you can breed them yourself. The following are two sources of plants and fruit flies.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC, 27215. Call 1-800-227-1150.

Etgen's Science Stuff, 3600 Whitney Ave., Sacramento, CA 95821.

Phone: (916) 972-1871.

To breed your own fruit flies you will need to start 3 to 6 weeks prior to this activity to ensure that you have a large enough population. See *Project 2: Population Boom or Bust* on TE p. 217 for full details on starting your own fruit fly population.

Caution: Refer students to safety rules.

Depending upon the needs of your students, an adult helper could be brought in to assist students with cutting the bottles during class. Another option is to cut the bottles yourself before class.

Estimated Time

One 50-minute period to set up the model environments

Allow a few minutes over several days for students to make observations.

Interdisciplinary Connection

Language Arts Students may write a thorough description of the project in a report.

IMPLEMENT

Introduce Enrichment 8-1 by reviewing with students the difference between *predator* and *prey* using pages 47-54 of the text for guidance. Ask students to give examples from their personal experiences with predator-prey relationships. For example, students may have observed cats killing and eating mice or birds.

Steps 1-8 Have students work in groups to set up the model environments as explained in the Student Activity Guide. The illustrations should help students construct the environments without your assistance. Make sure the models are kept moist.

Steps 9-10 Check that students have developed and written hypotheses and a rationale for them. Have students observe their model environment several times during the day or at a certain time each day for a week. You may want them to record their observations and drawings in a data book. Observations can also be recorded as written notes, drawings, photos, or videotapes. Encourage students to think about and devise ways to present data in graph form.

Communication skills can be developed through writing a description of the project. Students could collaborate to put together a booklet or a poster board display of their results. These summaries could be the nucleus of a class or school presentation.

Conclude Enrichment 8-1 by discussing the questions on the Activity Report. You may wish to assign the questions as written class work or homework.

Extend Enrichment 8-1 by

- Having students investigate interactions between other predators and prey. Other possibilities for predators could include praying mantises, spiders, small frogs, snakes, or lizards. These specimens could be captured in the wild or purchased from local pet stores or biological supply houses. Other possibilities for prey could include houseflies, mealworms, and mice. Depending on where you are located, you may have to be careful of poisonous spiders, snakes, and/or lizards. Students should be cautioned not to pick up strange animals without adult supervision.
- Having students create or design different environments to observe predator-prey relationships. For example,

students could use clear tubing to connect a fruit fly breeder container to a container housing a carnivorous plant or animal. Or they could use the tubing to connect a container housing a carnivorous plant with one containing an animal predator. Students could also connect one fruit fly breeder container to three or four predator containers. (See *Project #2: Population Boom or Bust* on TE p. 217 for directions and illustrations on how to build a fruit fly population.)
- Having students investigate the effects of changes in environmental conditions, such as temperature, amount and estimated time of light, and amount of water. Students could also explore the relationship between the number of predators and prey under given environmental conditions.

ASSESS

Use the model environments, along with student observations and drawings, to assess if students can

✓ explain how to provide the necessary resources for the survival of both species.

✓ describe the interactions between the predator and its prey.

✓ define the terms *predator* and *prey.*

✓ explain the importance of predator-prey relationships in the natural environment.

Enrichment 8-1: Predator-Prey Relationships – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What do you think will happen? Why?
2. Which organism is the predator? Which organism is the prey? Explain your answers.
3. Can one organism live without the other? How could you find out?
4. Why do you think predator-prey relationships are a necessary part of our environment?

Enrichment 8-1 Activity Guide: Predator-Prey Relationships (Student Reproducible)

Introduction

One type of interaction between species is a predator-prey relationship. In this situation, one organism usually eats another. The organism that "wins" is called the predator and the organism that "loses" is called the prey. In this activity, you will construct a model environment using plastic bottles to observe the predator-prey relationship between a carnivorous plant and fruit flies.

Materials

- Activity Report
- Safety goggles
- 2 two-liter plastic bottles
- Cutting tool (scissors, utility knife, or Single-edged razor blade with safety holder)
- 1-3 carnivorous plants, such as Venus's-flytraps.
- Potting soil (peat)
- Large sharp needle or push pin

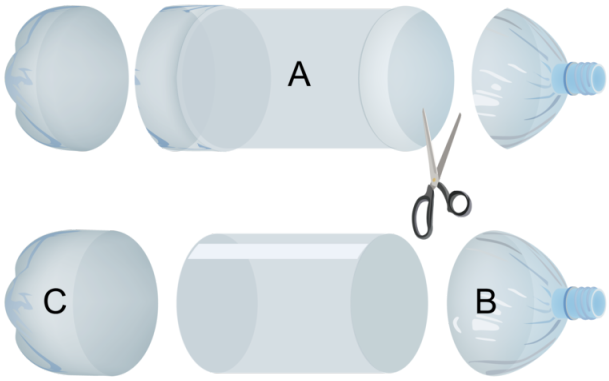
- 1-2 containers of breeding fruit flies
- Waterproof tape
- Clay

Caution: Follow the safety rules when using cutting instruments. Remember to wear safety goggles when cutting.

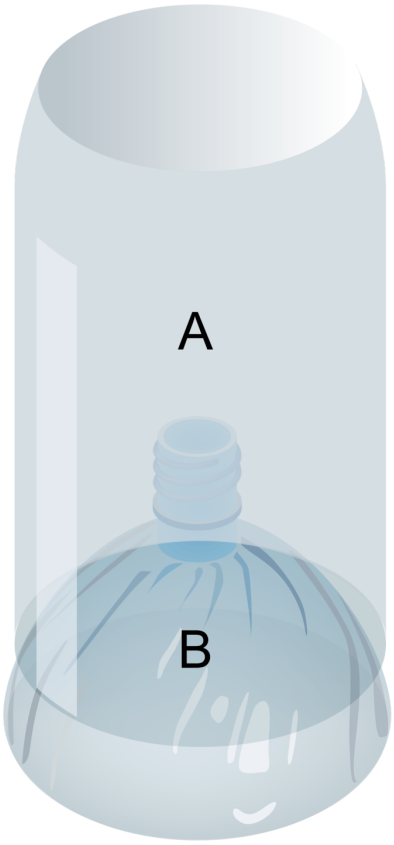
Procedure

Step 1 If necessary, remove the label and base from each of the two plastic bottles. Rinse and dry the bottles thoroughly.

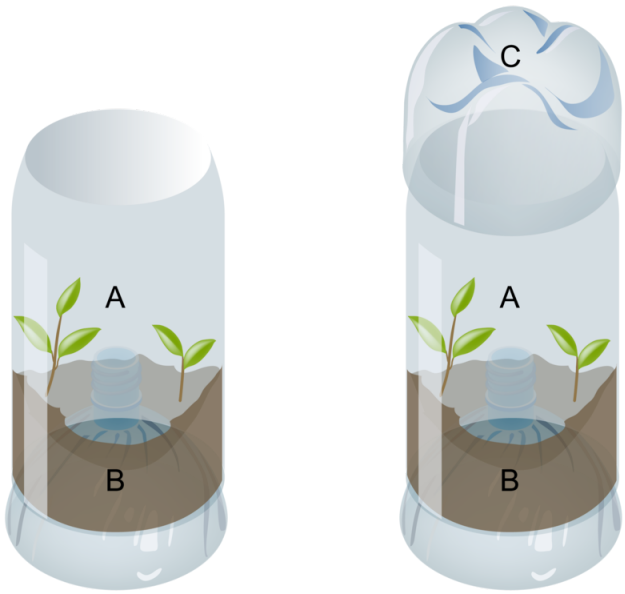
Step 2 Cut the two plastic bottles as shown in the picture. Be sure to make the cut on parts Band C so the curve of the bottle is included on each.



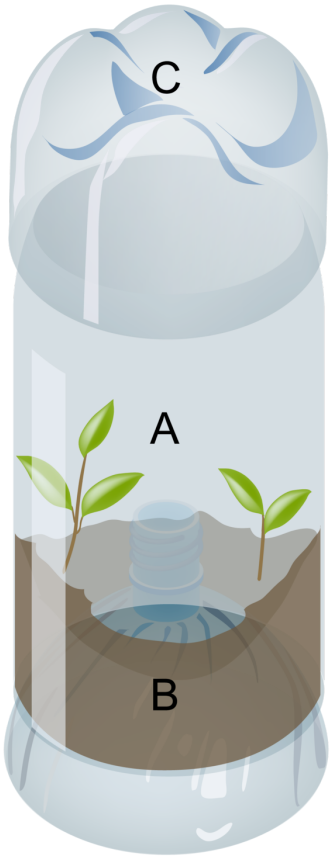
Step 3 Slide part A over part B as shown in the picture below. It may help to tape these parts together with waterproof tape.



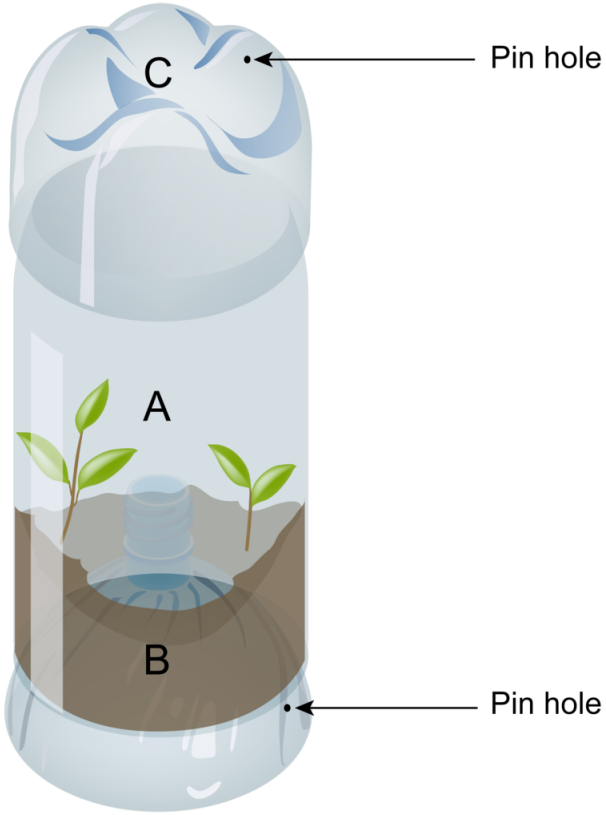
Step 4 Using the potting soil, plant the carnivorous plant on top of part B as shown below.



Step 5 Tape part C on the top of part A. Your model environment should now look like this:

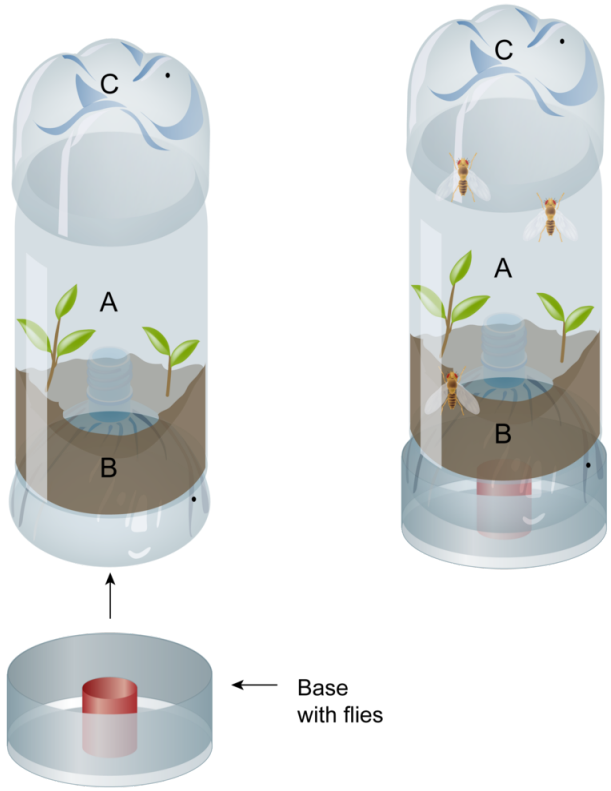


Step 6 Using a needle or a push pin, poke small holes into part C to allow air to enter, but not large enough to allow flies to escape. Also, poke holes on the sides of part B to allow the soil to drain.



Caution: Be very careful when using a sharp instrument.

Step 7 Select one or two food containers from your mature fruit-fly breeder that contain(s) the fruit flies. Place the food container(s) into the base. Fit part B snugly over the food containers and into the base. If desired, seal with tape.



Step 8 Be sure to keep the environment moist and to make any needed adjustments to the environment.

Step 9 Write down your hypothesis as to which organism is the predator and which is the prey. Give reasons for your answers on your Activity Report.

Step 10 Observe the interactions between the carnivorous plant and the fruit flies. Record your observations and include sketches or photos as appropriate.

Enrichment 8-1 Activity Report: Predator-Prey Relationships (Student Reproducible)

1. What do you think will happen? Why?
2. Which organism is the predator? Which organism is the prey? Explain your answers.
3. Can one organism live without the other? How could you find out?
4. Why do you think predator-prey relationships are a necessary part of our environment?

CHAPTER 10 Human Population Growth - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

10.1 Planning

Key Ideas

- Humans alter the environment greatly.
- Human impact is proportional to both the number of humans and how they use their resources.

Overview

The last section introduced students to different types of species interaction. This section addresses the important concept of how humans affect other species. Students explore patterns of human population growth and resource use. Emphasis is placed on how the impact of humans on natural systems is related to both the number of humans who exist and how those humans use their resources. Students learn that populations change in size because of birthrate, death rate, immigration rate, and emigration rate. Students observe how changes in resources can impact a population by graphing information about a rabbit population.

Objectives

Students:

✓ define the term *population* and explain ways in which a population can change in size.

✓ explain how the number of humans *and* the way they use their resources impact the environment.

✓ distinguish between linear growth and exponential growth patterns.

✓ analyze and interpret graphs.

Vocabulary

birthrate, demographers, doubling time, emigration, gigajoule, immigration, mortality rate, population, terrestrial net primary productivity

Student Materials

Activity 9-1: Brush Rabbit Boom

- Resource

- Data Sheet: Graph A
- Data Sheet: Graph B
- Activity Report
- Pencils
- Graph paper (optional)

Teacher Materials

Activity 9-1: Brush Rabbit Boom

- Activity Report Answer Key

Advance Preparation

See Activity 9-1 in the Student Edition

Review basic graphing skills with students.

Interdisciplinary Connection

Math Students will be analyzing graphs in this section. Analyzing the graphs also demonstrates the use of math skills in representing scientific data.

Enrichment Activities

None

Background Information

- Growth rates can be characterized by two different kinds of growth curves.
- Linear growth increases by a constant amount over time (e.g., $10 per year).
- Exponential growth increases by a constant proportion over time (e.g., 10% per year).
- To present the ideas of constant growth (linear) and increasing growth (exponential), compare what happens when you put $10.00 per month into a bank account with compound interest and $10.00 per month in a piggy bank. The bank account will demonstrate increasing growth (exponential). The amount of money in the piggy bank will demonstrate constant growth (linear).

10.2 Using Human Population Growth – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How do humans affect other species?"

Define the term *population* and discuss ways to increase (birthrate or immigration) or decrease (death rate or emigration) the size of a human population.

Highlight the graph in Figure 9.1 to illustrate the dramatic increase in human population in the last 30 years. Assign *What Do You Think?* on page 56 so students can discuss the data presented in the graph.

Assign *Activity 9-1: Brush Rabbit Boom.* A brief review of graphing would be helpful before students begin the activity.

What Do You Think?

How many people do you trunk the world needs? Did we have enough in 1900? In 1950? Do we still need more people? Explain your reasoning.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What is the population size of your class? Your school? Your town?

10.3 Activities and Answer Keys

Activity 9-1: Brush Rabbit Boom

PLAN

Summary Students learn about population growth by analyzing two scenarios in the life of a brush rabbit population.

Objectives

Students:

✓ distinguish between linear growth and exponential growth patterns.

✓ organize information to be presented in graph format.

Student Materials

- Resource
- Data Sheet: Graph A
- Data Sheet: Graph B
- Activity Report
- Pencils
- Graph paper (optional)

Teacher Materials

- Activity Report Answer Key

Advance Preparation

None

Estimated Time One 50-minute period

Interdisciplinary Connection

Math Students create and analyze graphs in this activity.

Prerequisites and Background Information

Students should have some basic graphing skills.

Growth rates can be characterized by two different kinds of growth curves.

1. Linear growth increases by a constant amount over time. Graph A in this activity demonstrates linear growth.
2. Exponential growth increases by a constant proportion over time. Graph B in this activity demonstrates exponential growth.

IMPLEMENT

Introduce Activity 9-1 by reviewing basic graphing skills with students. To present the ideas of constant growth and increasing growth, compare what happens when you put $10.00 per month into a bank account with compound

interest and $10.00 per month in a piggy bank. The bank account demonstrates increasing growth (exponential). The amount of money in the piggy bank demonstrates constant growth (linear).

Steps 1-3 Make sure students complete the graphs in Part A and Part B so that they have a basis for comparing the different types of growth. You may want to have students answer the Activity Report questions individually in class or as homework.

Conclude Activity 9-1 by discussing the graphs with the whole class. Ask students to explain what the graphed trends indicate about the brush rabbit population.

ASSESS

Use the students' graphs and written answers to assess if students can

✓ present information in a graph format.

✓ explain the differences between a linear growth pattern and an exponential growth pattern.

Activity 9-1 Brush Rabbit Boom Data Sheet: Graph A Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Summarize your data below.
2. On the graph below, plot the population growth of brush rabbits over five years when some coyotes were killed by ranchers. Graph the data on the graph below.

Activity 9-1 Brush Rabbit Boom Data Sheet: Graph B Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Summarize your data below.
2. On the graph below, plot the population growth of brush rabbits over a five-year period when most of the predators have been eliminated. Graph the data on the graph below.

Activity 9-1: Brush Rabbit Boom – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Which graph shows the most rapid increase in population growth? Explain.
2. Study the growth curve in Graph A.
   (a) What type of growth curve is represented in Graph A? Explain.
   (b) Predict what would happen to the brush rabbit population five years from now if the conditions remain unchanged.

3. Study the growth curve in Graph B.
   (a) What type of growth curve is represented in Graph B? Explain.
   (b) An ecologist surveyed 7,635 brush rabbits after the five years. Give a reason why there is a difference between the ecologist's number and the number plotted on the graph at year 5.
4. Refer to the graph on the Activity 9-1 Resource, which shows human population growth. There are now more than 6 billion people in the world, and the human population is expected to double in about 40 years. Why should we be concerned with human population growth?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

How many calories are there in 300 gigajoules?

Journal Writing

Suppose you wanted to reduce the amount of resources humans consumed in an area.

- Explain one strategy to keep the number of people in the area from growing.
- Explain one strategy to reduce the amount of resources that each person used.

Which countries would you advise to use each strategy?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Suppose that the world's population doubles in 40 years, and energy consumption rates remain the same. What percentage of the world's net primary productivity will be used by humans in 40 years? What percentage will be left over for all of the other living things on Earth?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

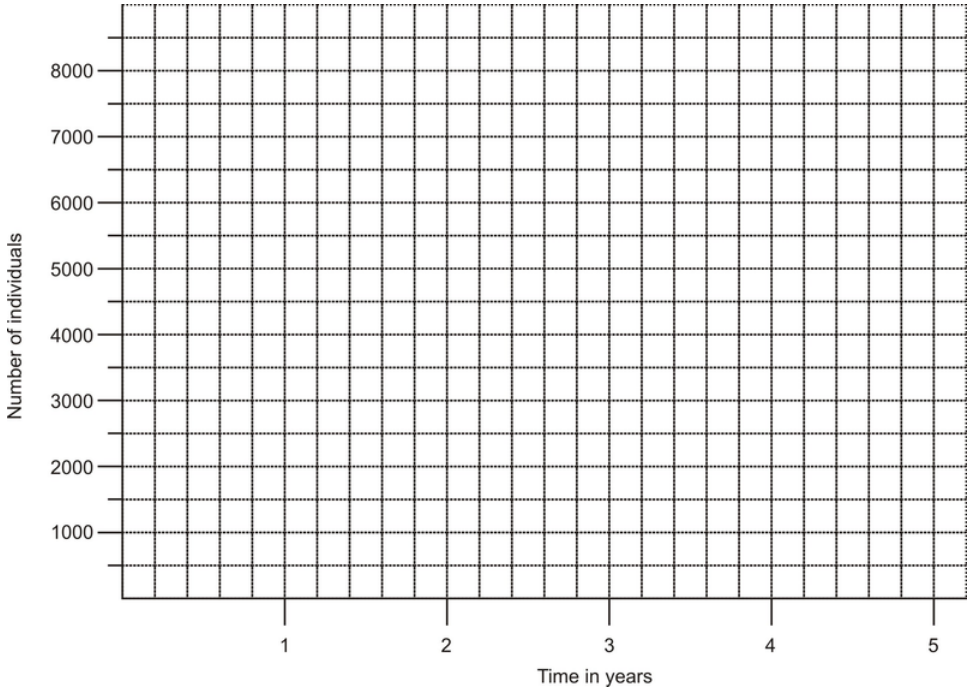
1. What is a population? What are four ways in which its size may change?
2. Suppose the doubling time for a population of algae in a pond is 24 hours. Also suppose the pond is now at capacity for algae. How long ago was the pond only half full of algae? How long ago was the pond one-fourth full of algae?
3. Is the size of the world's human population growing or shrinking? Is it doing this at a constant rate?
4. Do 100 people living in developing countries such as Nigeria have the same impact on the environment as 100 people living in the United States? Explain your answer.

Activity 9-1 Data Sheet: Graph A Brush Rabbit Boom (Student Reproducible)

1. Summarize your data below.

Year	Number

2. On the graph below, plot the population growth of brush rabbits over a five-year period when some coyotes were killed by ranchers.

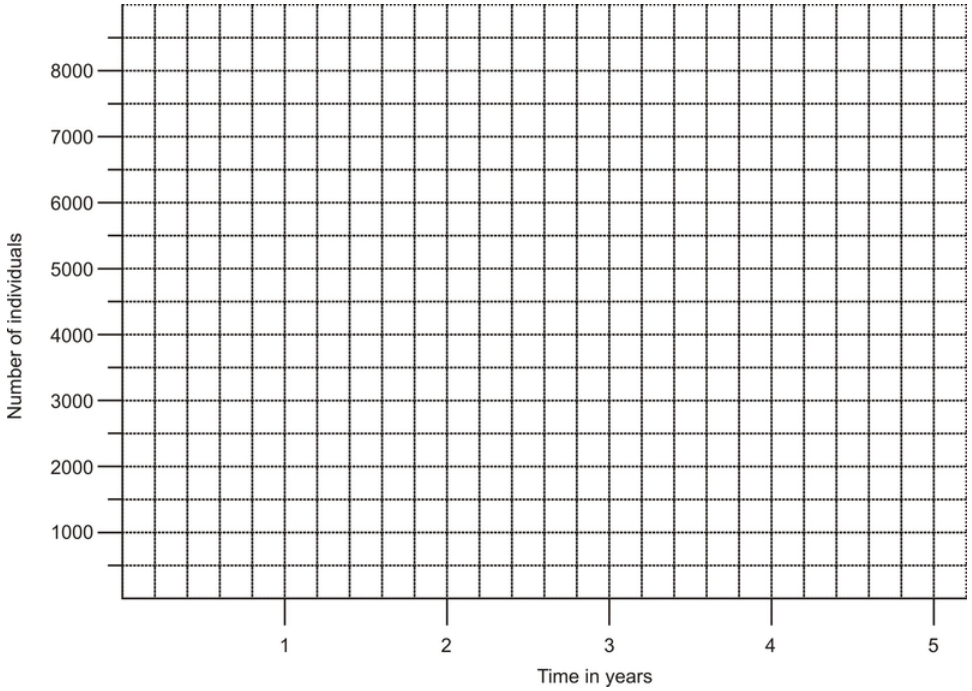


Activity 9-1 Data Sheet: Graph B Brush Rabbit Boom (Student Reproducible)

1. Summarize your data below.

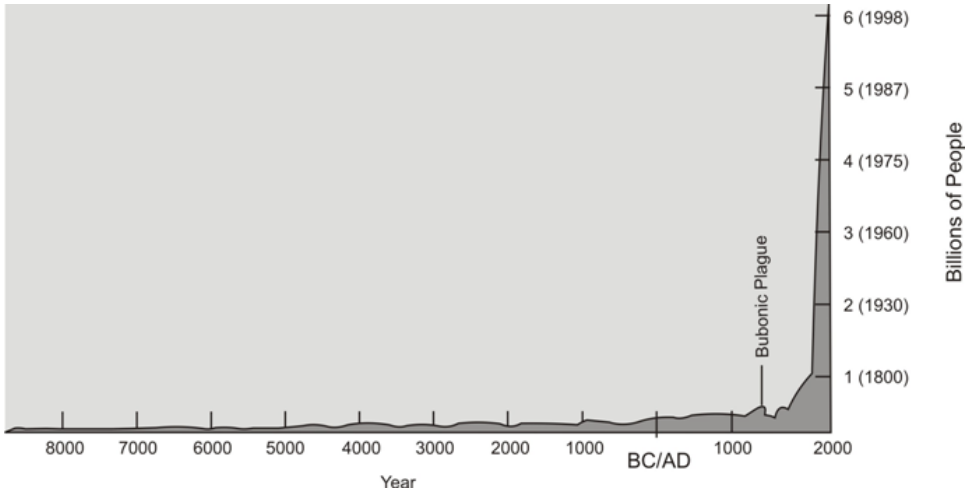
Year	Number

2. On the graph below, plot the population growth of brush rabbits over a five-year period when most of the predators have been eliminated.



Activity 9-1 Resource: Brush Rabbit Boom (Student Reproducible)

The graph shows the approximate growth of the world's population since 8000 BC. The line wobbles up and down but basically stays flat from 8000 BC until after AD 1000. Then all of a sudden the population starts to increase dramatically. The graph shows that it took thousands of years for the human population to reach 1 billion. Then it took 130 years to reach 2 billion, 30 years to reach 3 billion, and 15 years to reach 4 billion. Then it took only 13 years to reach 5 billion. How many years did it take to go from 5 billion to 6 billion?



Activity 9-1 Report: Brush Rabbit Boom (Student Reproducible)

1. Which graph shows the most rapid increase in population growth? Explain.

2. Study the growth curve in Graph A.

a. What type of growth curve is represented in Graph A? Explain.

b. Predict what would happen to the brush rabbit population five years from now if the conditions remain unchanged.

3. Study the growth curve in Graph B.

a. What type of growth curve is represented in Graph B? Explain.

b. An ecologist surveyed 7635 brush rabbits after the five years. Give a reason why there is a difference between the ecologist's number and the number plotted on the graph at year 5.

4. Refer to the graph on Activity 9-1 Resource, which shows human population growth. There are now more than 6 billion people in the world, and the human population is expected to double in about 40 years.

Why should we be concerned with human population growth?

CHAPTER 11

Global Change - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

11.1 Planning

Key Idea

- Humans alter the environment on continental and worldwide scales.

Overview

In the last section, students learned about the impact of human populations on the environment. This section takes an in-depth look at the ability of humans to affect the environment on a large scale by examining the topics of acid rain and global warming. Students learn how acid rain is formed and the harmful effects of acid rain on the environment. Students also learn about the different gases that contribute to the greenhouse effect. Then they construct a model of Earth and simulate the greenhouse effect and global warming by altering the model's conditions.

Objectives

Students:

✓ identify the gases that contribute to acid rain and the greenhouse effect.

✓ explain how acid rain is formed and its impact on the environment.

✓ explain how greenhouse gases contribute to global warming and its impact on the environment.

✓ discuss how they can reduce the current levels of acid rain and greenhouse gases.

Vocabulary

acid rain, acidity, CFCs (chlorinated fluorocarbons), global change, global warming, greenhouse effect

Student Materials

Activity 10-1: Feeling the Heat: The Greenhouse Effect

Per student

- Activity Report
- Materials may vary.

Per group

- Glass bowls or containers of various sizes; Lamp; Dirt; Ice; Water; Colored paper; Thermometer

Teacher Materials

Activity 10-1: Feeling the Heat: The Greenhouse Effect

- Activity Report Answer Key

Advance Preparation

See Activity 10-1 in the Student Edition

Interdisciplinary Connection

Social Studies Students explore environmental issues affected by economics, policies, and cultures.

Background Information

Acidity and Alkalinity Acidity is measured in terms of pH. What makes a liquid acidic is the amount of free hydrogen ions that are floating around. The pH is actually the negative logarithm of the hydrogen ion concentration, $[H^+]$. The pH scale is a logarithmic scale that runs from 1 to 14. A liquid with a pH of 7 is considered neutral. Those liquids with a pH lower than 7 are acidic and those with a pH higher than 7 are alkaline. Because the pH scale is logarithmic, a liquid with a pH of 6 is ten times more acidic than a liquid with a pH of 7. A liquid with a pH of 5 is 100 times more acidic than one with a pH of 7. Acid rain in the northeastern United States has been measured as having a pH of 3!

Alkalinity is a measure of a liquid's hydroxide ion concentration, $[OH^-]$. Alkalinity can be measured on a scale similar to pH called pOH. On the pOH scale, a liquid with pOH 7 is neutral. A liquid with pOH lower than 7 is alkaline. A liquid with pOH greater than 7 is acidic. Generally, alkalinity is inversely related to acidity, so it is more common to refer only to acidity.

Chlorinated fluorocarbons (CFCs) CFCs were used as propellants in most aerosol cans until this use was banned in the United States. However, CFCs are still found in some older refrigerators and air conditioners, in making plastic foam for packing and insulation, and as medical sterilizers. Industries are trying to devise economical replacements.

11.2 Using Global Change – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "How do the activities of humans affect the environment on a continental and worldwide scale?" Relate the concept of population growth from the previous section to the effects humans have on the environment. Discuss the difference between the impacts that a small human population with little technology might have as compared to our current population and technology.

Define and discuss the term *global change.* Scientists now know that human activities are causing many natural systems of the environment to change. Make sure students know that many of the effects of human activities are indirect but nevertheless are supported by much scientific research.

After students have read about acid rain, assign *What Do You Think?* on page 63 as a discussion, debate, and/or writing prompt. Ask students to choose a policy decision concerning acid rain and defend it using evidence from the text.

Discuss the difference between global warming and the greenhouse effect. Then assign *Activity 10-1: Feeling the Heat: The Greenhouse Effect* as a hands-on way for students to see and explore the greenhouse effect in action. You can use student models and analyses of their models' accuracy as a method of assessment for this section.

What Do You Think?

How would you solve the problems caused by acid rain in the northeastern United States? Would your solution be fair to the people in the Midwest? Would it be fair to the people in the Northeast? Explain your reasoning.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Suppose you found a water boatman, a salamander, and a mayfly while you were exploring a stream. What would you guess the pH of the stream would be? If you found only water boatmen in a second stream, would you guess that the second stream has a higher or lower pH than the first? (Hint: look at Figure 10.2 and make sure that you notice that the pH gets lower as you go up the vertical axis.)

Journal Writing

Which of the effects of global warming do you think is more dangerous to humans-sea levels rising or rainfall patterns changing? Why? Should people who are not directly affected by these global warming effects do anything to decrease greenhouse gases? Why or why not?

11.3 Activities and Answer Keys

Activity 10-1 Feeling the Heat: The Greenhouse Effect

PLAN

Summary Students first construct a physical model of the greenhouse effect. They then use this model to teach the class about this environmental problem.

Objectives

Students:

✓ explain how greenhouse gases affect the temperature of the earth, and subsequently, ecosystems of the earth.

✓ demonstrate how the greenhouse effect can be modeled and tested.

✓ describe how humans might decrease the emission of greenhouse gases.

Student Materials

Per student

- Activity Report
- Materials may vary.

Per group

- Glass bowls or containers of various sizes; Lamp; Dirt; Ice; Water; Colored paper; Thermometer

Teacher Materials

- Activity Report Answer Key

Advance Preparation

None

Estimated Time

60 minutes

Interdisciplinary Connection

Social Studies Students can discuss the controversial issues surrounding the greenhouse effect and national and international policies.

IMPLEMENT

Introduce Activity 10-1 by asking students where they think the term *greenhouse effect* came from. Discuss the similarities and differences between farmers' and gardeners' greenhouses and the greenhouse effect.

Step 1 Discuss how the layer of greenhouse gases such as CO_2 in the atmosphere acts like a barrier preventing the loss of heat. Designing a model of the greenhouse effect may be difficult for students at first. But a clear understanding of the greenhouse effect will help.

Step 2 Divide the class into small groups to plan their models. Students can use the glass bowl to represent high levels of greenhouse gases and the lamp to represent the sun. Make sure students first measure the air temperature at a fixed distance from the lamp. Then, with the thermometer at the same distance from the lamp, they should cover the thermometer with the glass bowl and measure the temperature after a few minutes.

Ask students how they could change other parts of their model to see if and how each part affects air temperature. For example, they can add a container of water, with its high heat capacity, to decrease the ambient temperature of the air trapped in the inverted bowl. This models the way the ocean dampens the temperature range in coastal cities. Students could also experiment with different colors of paper to test how different surfaces may affect the air temperature. This models the way surfaces such as asphalt, grass, and snow absorb and reflect energy differently.

Steps 3-4 Give each small group of students an opportunity to plan its presentations and present its results to the class.

Extend Activity 10-1 by:

- Asking students to refine their physical model of the greenhouse effect. For example, you might ask students to use different layers of glass or different colors of glass to represent the various greenhouse gases- CO_2, O_3, and NH_4 . Students could then explore how these different layers or colors affect the temperature in their physical model.
- Asking students to research one of the greenhouse gases. They should find out what sources emit the greenhouse gas, the effects on global temperature when increased amounts of the gas accumulate in the atmosphere, and some possible ways to reduce emissions of this gas.
- Asking students to develop an opinion paper or presentation based on the following questions: Should trying to reduce the amount of greenhouse gases in the atmosphere be a national priority? Should it be an international priority? What activities in your own life contribute to the problem of global warming? Would you be willing to eliminate those activities?

ASSESS

Use the model, presentation, individual Activity Report, and group discussion to assess if students can

✓ explain how greenhouse gases affect the temperature of the earth, and subsequently, ecosystems of the earth.

✓ demonstrate how the greenhouse effect can be modeled and tested.

✓ describe how humans might decrease the emission of greenhouse gases.

Activity 10-1 Feeling the Heat: The Greenhouse Effect – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the greenhouse effect?
2. How is the greenhouse effect expected to influence human life? How is it expected to affect the environment?
3. Describe your physical model of the greenhouse effect. What are the strengths and limitations of your model?
4. What are ways to reduce the amount of greenhouse gases in the atmosphere? Are such steps worth taking? Explain.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What causes acid rain?
2. Does acid rain affect only the people who live near its source?
3. What is global warming?

Activity 10-1 Report Feeling the Heat: The Greenhouse Effect (Student Reproducible)

1. What is the greenhouse effect?

2. How is the greenhouse effect expected to influence human life? How is it expected to affect the environment?

3. Describe your physical model of the greenhouse effect. What are the strengths and limitations of your model?

4. What are ways to reduce the amount of greenhouse gases in the atmosphere? Are such steps worth taking? Explain.

CHAPTER 12 Defining Biological Diversity - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

12.1 Planning

Key Idea

- Biological diversity is the variety of living organisms that occurs at all levels of life including the levels of genes, species, and habitats.

Overview

The previous section focused on the global impact of acid rain and the greenhouse effect on the environment. This section introduces the topic of biodiversity and explores the many levels at which it exists. Students examine the biodiversity of their local area by observing the diversity of living organisms, recording data, and interpreting the data. In addition, students analyze the reduction of biodiversity by interpreting graphs. Finally, students evaluate the importance of biodiversity in their own lives.

Objectives

Students:

✓ define the terms *biological diversity, species diversity,* and *extinction crisis.*

✓ identify and give examples of three levels of biological diversity: habitat diversity, species diversity, and genetic diversity.

✓ describe the correlation between human population growth and species extinctions.

✓ explain the importance of biodiversity.

Vocabulary

aesthetics, biological diversity (biodiversity), diversity, endangered, ethics, extinct, gene, habitat, species

Student Materials

Activity 11-1: Expedition to the Kalimantan Rain Forest

- Resource 1
- Resource 2

- Activity Report
- Marking pens, colored pencils, crayons; Paper; Maps, drawings, photographs of the rain forests of Indonesia

Teacher Materials

Activity 11-1: Expedition to the Kalimantan Rain Forest

- Activity Report Answer Key
- Maps, drawings, photographs of the rain forests of Indonesia (optional)

Advance Preparation

See Activity 11-1 in the Student Edition.

Interdisciplinary Connections

Math Students analyze graphs in Enrichment 11-2.

Enrichment Activities

Enrichment 11-1: Measuring Species Diversity

Students learn how to measure the species diversity of an area by observing, recording data, and interpreting data in an outdoor area at their school.

Enrichment 11-2: Extinction Crisis

Students analyze and compare two graphs. One graph shows the rapidly increasing rate of species extinctions in the world. The second graph shows the rapidly increasing rate of human population growth.

Enrichment 11-3: How Do You Value Biodiversity?

Students become more aware of what they value in nature by answering questions about the impact and importance of other living things on their lives. Students decide what kinds of organisms are important to them and why.

12.2 Using Defining Biological Diversity – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "What is biological diversity?" Relate the concept of human impact on the environment from the previous section to one specific consequence of human activities-species extinction. Many students have heard about endangered species in the media. Now you can help them connect those individual animals and plants to the loss of biological diversity as a whole.

Define and discuss the difference among *habitat diversity, species diversity*, and *genetic diversity*. Use the *Mini Activities* to help students see that these terms do not apply only to exotic tropical rain forests but also to their own neighborhood environment.

Assign *Mini Activity: Count Your Habitats* on page 69 and *Mini Activity: Local Species* on page 70 to encourage students to apply the concept of habitat diversity to their own school.

To ease any confusion students may have with the concept of genetic diversity, you may want to spend some extra time talking about genes and how they code for particular traits in organisms.

Assign Activity 11-1: Expedition to the Kalimantan Rain Forest to help students apply the concept of biological diversity to an imaginary trek through a rain forest.

Assign Enrichment 11-1: Measuring Species Diversity, which is an outdoor investigation, to let students scientifically measure (within reason) their own environment's species diversity.

After discussing the reasons for valuing biological diversity, *assign Enrichment 11-2: Extinction Crisis and Enrichment 11-3: How Do You Value Biodiversity*? Discuss how the extinction rate now is so much more severe than the extinction rate was in the past and why students mayor may not care about the extinction "crisis."

You may want to assign the final *What Do You Think*? on page 77 as an essay to be used as assessment for this section.

Count Your Habitats

Students identify and count the number of different habitats found at school. For specific information about local flora and fauna, consult Peterson's field guides.

Local Species

Students identify and categorize all the species found at school. As mentioned above you may want to consult Peterson's field guides for specific information about local flora and fauna.

12.3 Activities and Answer Keys

Activity 11-1: Expedition to the Kalimantan Rain Forest

PLAN

Summary Students learn about one of the most biologically diverse ecosystems in the world by planning an expedition to, then listening to a story about a tropical rain forest called the Kalimantan Rain Forest. This activity also serves as preparation for Enrichment 11-1 in which students perform their own field study and Enrichment 11-3 in which they discuss the value of biodiversity.

Objectives

Students:

✓ explain the term *biological diversity.*

✓ describe several species found in the Indonesian rain forest.

✓ identify some of the problems and obstacles to performing scientific field studies.

Student Materials

- Resource 1
- Resource 2
- Activity Report
- Marking pens, colored pencils, crayons; Paper; Maps, drawings, photographs of the rain forests of Indonesia

Teacher Materials

- Activity Report Answer Key
- Maps, drawings, photographs of the rain forests of Indonesia (optional)

Advance Preparation

To enhance the guided imagery experience of the reading, you may want to make an audiotape of yourself or someone else reading the story.

Estimated Time 50-60 minutes

Interdisciplinary Connections

Language Arts Students complete the story.

Social Studies Students may discuss the economic, political, and cultural issues surrounding deforestation of rain forests.

Math Students may graph the rate of rain forest destruction in various countries.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 11-1 by reviewing the idea of biological diversity with a discussion of what students learned from reading pages 68-71. Have students compare the biodiversity of local habitats to those described in the text.

Step 1 Divide the class into groups of 4 or 5. You may want to assign each group one topic or characteristic of the rain forest environment. Possible topics include climate, rain forest animals, rain forest plants, and topography. Show students any pictures, photos, maps, and written resources about rain forests you have collected. Each group can then share its findings with the class.

Steps 2-3 Give students about 20 minutes to develop their packing lists. You may ask to check the lists to make sure they are realistic before allowing students to go on to their drawings.

Encourage creativity and humor when students make drawings of their teams about to begin their expedition into the rain forest, as described in Step 3 of the Procedure. You may want to hang the pictures on the wall or have students present them to the class.

Step 4 Read aloud or play a prerecorded audiotape of the Descriptive Story on Activity 11-1 Resource 1.

You may want to use some of the following items to enhance students' sensory experience:

- spray water from squirt bottles to "mist" students as they listen.
- brush a paper bag or paper towel against their arms to simulate contact with plants and insects in the forest.

Conclude Activity 11-1 by assigning the Activity Report as a written assignment or using the questions for class discussion after completing the activity.

Helpful Hints

More information about the rain forest and deforestation is available from the following sources.

The Rain Forest Action Network, 450 Sansome, Suite 700, San Francisco, CA 94111.

The August 1992 issue of *National Geographic* magazine contains a large map showing the geographic locations of tropical rain forests, the vertical levels of the rain forest, and examples of plants and animals at each level. The map can also be purchased as a poster, #20068. Call 1-800-638-4077.

Extend Activity 11-1 by:

- Asking students, either individually or in groups, to continue the story by writing about the second day of their trip into the Kalimantan. Have students read their stories aloud in the same storytelling format as the original reading.
- Having students investigate another tropical rain forest and the biodiversity it contains. Possible examples include rain forest areas in Borneo, the Amazon River region, or the Congo River region. Students may want to focus their research on a particular rain forest species.
- Having students research products that come from rain forest regions, such as pharmaceuticals, tropical oils, emulsifiers, nuts, fruits, and coffee. Ask them to find out which are sustainably farmed products and which require the clear-cutting of rain forests.
- Having students explore the issues relating to deforestation in developing countries. Often these countries exploit their forest resources because they are in debt to developed countries such as the United States. The issue becomes more complicated when environmentalists from developed countries try to impose their views about conservation.
- Having students chart or graph the rate of destruction of various rain forests around the world. Ask them to use their graphs to make predictions about the amount of rain forest that will be lost in the future (in 5 years, 10 years, and so on) if the same rate of destruction continues.

ASSESS

Use the "packing list," the written answers, and discussion of the Activity Report to assess if students can

✓ describe the rain forest as an example of biodiversity.

✓ explain the conditions for living and working in the rain forest.

✓ plan a field study.

Activity 11-1: Expedition to the Kalimantan Rain Forest – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Based upon what you have experienced on your first day in Kalimantan ...
   (a) Name two problems that you and your team might face as you attempt to count the number of species living there.
   (b) Describe one or more ways to solve each of these problems. (Remember that you nave only one month and a relatively small area to sample.)
2. Describe how you could count the species living high in the canopy layer of the forest.
3. What would you do if you had more money to spend on this project?
4. Give several reasons why it would be helpful to learn how many different kinds of plants, animals, and other organisms live in a tropical rain forest.

Journal Writing

The huge biological diversity of rain forests, coral reefs, and wetlands has been attracting many tourists to areas with these habitats. These tourists learn and appreciate the biodiversity, but also consume local resources and create waste. How should the local communities deal with this new development? What policies would best promote a balance between these two concerns?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Take a moment to consider how disturbance affects species diversity. Which do you think would have more species in Figure 11.4, the undisturbed meadow or the street with buildings? Explain the reasons for your answer.

What Do You Think?

Do you think that it is important for humans to keep other species from becoming extinct? Review the four reasons listed above. What are some other reasons you can think of for humans to preserve biodiversity?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is biological diversity?
2. What are three levels of biodiversity?
3. Who are conservation biologists and what do they do?
4. How do humans affect biodiversity?
5. What are three reasons to preserve biodiversity?

Activity 11-1 Resource 1: Expedition to the Kalimantan Rain Forest (Student Reproducible)

Our journey on the plane is a very long one. But as we approach the islands of Indonesia, the view is breathtaking. Nearing our destination of Borneo, we can see the top of the rain forest, which appears on the horizon like an endless green sea of trees. This is our first glimpse of the uppermost canopy layer of the Kalimantan rain forest.

We land, gather our exploration equipment, and head for the vans. After riding in a van as far as the roads will take us, we journey deeper into the rain forest on motorcycles. We have to make our way through the rain forest on foot as the forest gets more and more dense. After a full day's walk, we finally reach our research area deep in the rain forest. It's dark and wet this deep into the interior of the forest. We look up and observe how thick the canopy of trees overhead is. The canopy is so thick that very little light finds its way to the paths we're navigating. This canopy forms a roof of interlacing tree branches about ten stories above our heads. There must be a lot of animals up there because of most of the activity and noise in the forest seems to be coming from above us in the trees.

Every tree looks different from the one next to it, smaller leaves, larger flowers, fatter trunks, straighter branches, more prickly leaves. The variations are endless. The trunks and branches of the b trees are intertwined with vines and hundreds of smaller plants that anchor themselves to the trees.Each tree appears to have its own web of flowers, insects, birds, and microorganisms living on it. And so far we've only seen a very small percentage of the forest. Just imagine the biological diversity of § the whole Kalimantan!

The sun is very important for life in the canopy branches. Energy from the sun helps many plants grow. The various plants provide homes, food, and protection for many different kinds of animals. We dip under a branch with a dangling vine. Suddenly, the vine moves. It's not a vine at all. It's a snake that moves slowly, then slithers away. At least it wasn't a king cobra, which is a common snake of the Kalimantan!

As we hike deeper into the forest, a deep breath refreshes us with a new scent. The rain forest has a scent all its own. Everything is moist from the frequent rains, so smells are more pronounced sweet and pungent. Sometimes we pass a simple white flower, and the strong perfume makes us stop to get another whiff! Kalimantan has 800 different kinds of orchids, and that's just one family of flowers!

Ouch! What was that? Oh, it was another insect! Insects seem to be everywhere in this forest. The flying insects are constantly buzzing in our ears! And there are always ants under our feet as we walk. There seem to be thousands of shapes, sizes, and colors. As we walk swatting at the insects, the biggest beetle we've ever seen crosses our path. With a start, we lean up against a tree to catch our balance, touching another insect, camouflaged so it blends in with the tree trunk. Wow, you didn't even see that one!

Wait! Did you just feel a raindrop on your face? Yes, and now the drops are coming faster... Whoa! It's a downpour! The leaves of the trees make a loud racket as the water hits them and drops to the next layer of vegetation. This is the first of many hours of our day that we will spend wet from the constant rain. Our clothes and equipment always

seem to be wet. But we can't have a rain forest without rain! Besides, if the plants and trees were not here, the rain would fall onto bare dirt. That would create flooding and erosion of the soil that plants need to survive. The constant cycling of water, combined with the tropical heat, provides the conditions for the tremendous diversity of plants and animals in the rain forest. These conditions also allow rain forest plants and animals to grow larger than creatures in other ecosystems. That giant beetle in the path was just one of the over sized insects in this forest. Keep your eyes open!

Our task in the forest this time is to count the different kinds of organisms that live here. But, we will see only a small fraction of the animals in the flesh. Others will just leave their evidence of having beenthere. Tracks, bird nests, bits of fur, and animal scat will be important in helping us accurately estimate how many animals there are.

It's grown very dark. The rain stopped at least for now. And the day has been very tiring. So it's time to set up camp right here under the canopy and think about the wonderful diversity of living things we'll see tomorrow and count over the next month of our Kalimantan adventure.

Activity 11-1 Resource 2: Expedition to the Kalimantan Rain Forest

Facts About Rain Forests and the Kalimantan

Tropical rain forests are defined primarily by two factors.

- Location: They are found in the tropics, near the equator.
- Level of rainfall: Five meters of rain fall on the rain forests of Borneo each year.

Rain forests have no "seasonality"-no dry or cold season of slower growth.

A typical 4-mile patch of rain forest may contain as many as 1,500 species of trees, 125 mammal species, 400 bird species, 100 reptile species, 60 amphibian species, and 150 different species of butterflies.

Indonesia, a country in Southeast Asia, is made up of 13,000 islands.

Kalimantan is a part of the island of Borneo. Kalimantan has 28 percent of Indonesia's landmass.

Kalimantan is Southeast Asia's largest contiguous rain forest. *Contiguous* means in constant contact. A contiguous rain forest is one in which there are no meadows, plains, or anything that is not filled with trees.

Indonesia is second only to Brazil in total acreage of rain forest.

Indonesia ranks first in number of known mammal species and third behind Brazil and Colombia in total number of known animal species.

Kalimantan has 800 kinds of orchids, 40,000 known plant species, and well-known animals and plants that have come to symbolize the diversity of the rain forest. Some are orangutans, king cobras, *Rafflesia* (the world's largest flower), proboscis monkeys, and clouded leopards.

As of the summer of 1994, Indonesia was second to Brazil in the area of forest that is destroyed every year.

In Indonesia, the number of endangered species of mammals and birds surpasses that of all other countries in the world.

Activity 11-1 Report: Expedition to the Kalimantan Rain Forest

1. Based upon what you have experienced on your first day in Kalimantan ...

a. Name two problems that you and your team might face as you attempt to count the number of species living there.

b. Describe one or more ways to solve each of these problems. (Remember that you have only one month and a relatively small area to sample.)

2. Describe how you could count the species living high in the canopy layer of the forest.

3. What would you do if you had more money to spend on this project?

4. Give several reasons why it would be helpful to learn how many different kinds of plants, animals, and other organisms live in a tropical rain forest.

12.4 Enrichment

Enrichment 11-1: Teacher Activity Notes

Measuring Species Diversity

PLAN

Summary

Students learn how to measure the species diversity of an area by observing, recording data, and interpreting data for an outdoor area at their school.

Objectives

Students:

✓ observe and collect observations of animals and plants in the outdoors.

✓ explain the term *species diversity*.

✓ compare and analyze data they've collected with the data of classmates.

Student Materials

Per student

- Activity Guide
- Data Sheet
- Activity Report
- Pencil or pen; clipboard
- Field guides (optional)
- Hand lenses (optional)
- Metric rulers (optional)

Teacher Materials

- Data Sheet

Advance Preparation

You may want to prepare an outline map of the outdoor area ahead of time. You can either draw it on the chalkboard or create a handout. Give each study area a number for ease of reference. You can also take the class out the day before the activity and have students sketch their own maps.

Estimated Time

Approximately two to three 50-minute periods

Interdisciplinary Connections

Math Students calculate and graph data throughout.

Social Studies The loss of biodiversity is currently a global, political, and economic issue. Students can discuss ways this issue crosses international borders.

Prerequisites and Background Information

Human disturbance tends to reduce species diversity in an area. Species diversity generally follows a continuum from a lower number of species in the most disturbed area to a greater number of species in the least disturbed area. For example, a listing of sites along this continuum might be

- building (most disturbed, low species diversity)
- parking lot
- asphalt playground
- landscaping and planter boxes
- grassy area in a park
- overgrown vacant lot
- meadow or forest (least disturbed, high species diversity)

Sometimes, however, human disturbance may enhance species diversity. For example, students may observe that a planted flowerbed is more diverse than a vacant lot. You may want to discuss with students why such a situation could occur.

IMPLEMENT

Introduce Enrichment 11-1 by reviewing the terms *biological diversity* and *species* with students to emphasize that they will be looking for different kinds of species. Remind students that the point of this exercise is to count the species, not to identify them. They need only distinguish between species in order to record them. Encourage the use of any extra equipment, such as rulers for measuring leaf sizes or hand lenses for closer viewing.

> **Helpful Hints**
>
> The map is a vital tool when assessing biodiversity and comparing the species diversity of the sites. Students can visualize where sites are located in relation to each other and predict how this may affect diversity.
>
> Have students design their own field notes sheet by brainstorming what a scientist would need to know to use the species diversity data.

Steps 1-2 Before taking the class outside:

- Define the study areas by using your map.
- Assign one group of 4 to 5 students to each numbered area.
- Explain your rules for student behavior outside the classroom.

Step 3 You may want to require each student to fill out his or her own Data Sheet, or have one person in each group record the whole group's observations. While students are studying their area, check periodically that they are

- thorough in their observations: checking for soil organisms, and under leaves and bushes.
- not disturbing the area excessively.
- actually observing the organisms they write down.

Step 4 When you come back into the classroom, draw a large chart like the one in Question 1 on the Activity Report. Have each group give you its data for their area.

Species diversity data can be analyzed in a variety of ways both in groups and as a class. The following are some questions to use in analyzing your data. You can also have students hypothesize before they go outside based on the way you plan to analyze the data.

- Does species diversity increase with habitat diversity? Compare sites that include several different "habitats" on campus: an area under a tree, a sidewalk with plants growing up through the cracks, a grassy field, a vacant lot, a landscaped flower bed. Look at whether the sites with more habitats in them also have more species.
- Is species diversity related to the size of the area observed? In general, a larger area is more likely to support a larger number of species. This is related to the likelihood of finding many habitats in a larger space. Greater habitat diversity means more niches for different organisms to fill.
- How does human disturbance affect the biodiversity of an area? Have students rank the sites from the one that is most disturbed by humans to the site that is most natural. See the Background Information for an explanation of the relationship between human disturbance and biodiversity. For any of the above questions, students can rank each site and make a graph comparing one of the above variables to species diversity. For example, put the number of species on the y-axis. Rank the sites from smallest to largest area and put this on the *x*-axis. Or rank the sites from most disturbed to least disturbed and put this on the *x*-axis.

Conclude Enrichment 11-1 by having students answer the questions on the Activity Report as a written assignment or as part of the class discussion.

Helpful Hints

Although all students should make observations, you can assign specific tasks to each student in the group. Roles and tasks could be divided as follows:

Facilitator: Acts as group leader, keeps people on task.
Field Recorder: Keeps notes and writes down all results of observations.
Timer: Keeps track of time.
Surveyor: Measures the area to be studied.
Reporter: Reports to the class the findings of the group.

You may want to require students to give evidence for the numbers of species they claim to have found (sometimes they get competitive and exaggerate their numbers).Have them write their direct or indirect evidence next to each item.

Extend Enrichment 11-1 by

- Having students make repeated visits to the same site during different times of the day. They could also visit the site over a period of days, or weeks, or during different seasons.
- Having students visit other sites and collect data using the same Data Sheet. For example, they could collect data from another part of the school grounds, on the way home from school, at home, or at a park nearby. Be sure to caution students not to enter private property without obtaining special permission from the property owner.

ASSESS

Use students' discussion and written answers to the Activity Report to assess if students can

✓ identify species diversity in a variety of areas.

✓ explain the factors that may affect species diversity.

✓ demonstrate their ability to collect, analyze, and present data.

Enrichment 11-1 Activity Guide: Measuring Species Diversity (Student Reproducible)

Introduction

How do scientists measure biodiversity? The most common method is to count the number of different kinds of organisms in an area. This number is a measure of the species diversity of the area. In this activity, you use the same methods that ecologists use to conduct a field study of the species diversity around your school. An important point to remember is that scientists try to have minimal impact on the areas they study. Do not step on plants unnecessarily. Don't disturb animals that aren't disturbing you. And dig up only a small amount of soil to examine microorganisms.

Materials

- Data Sheet
- Activity Report
- Pencil or pen
- Clipboard

Procedure

Step 1 Prepare your materials and fill out the top of your Data Sheet before you go outside so that you can concentrate on making observations when you are outdoors.

Step 2 Determine what area your group will study. On a piece of paper, draw a map of the area the whole class will study. Mark the boundaries for each group's field study area. Represent different kinds of bushes and trees by drawing the outlines of their shapes on your map. Add labels such as "sidewalk, tree, asphalt, path."

Step 3 At your field site, write a description on your Data Sheet for every kind of plant and animal you see. The important thing is not to label or name every organism. Just describe how it is different from other organisms. Use detailed descriptive words and try to draw what you see. Use the back of the sheet or another piece of paper to draw organisms. Don't forget to leave the area as undisturbed as possible.

Step 4 Analyze the data from your group and your class by answering the questions in the Activity Report.

Enrichment 11-1 Data Sheet: Measuring Species Diversity (Student Reproducible)

Date_____

Group Members _____

_____

Location of Field Site _____

Time of Day_____ Length of Observation_____

Habitat Description

- Describe the physical characteristics of this area. Is it hot or cold? Is it sunny or shady? Is it wet or dry?
- Describe the most abundant plant (type of tree, shrub, or grass).
- What plant or other material covers most of the ground?

Species Diversity

Plants Describe every different type of plant you can find in your area. Do not worry about specific names. You may also want to draw these plants.

Total Number of Kinds of Plants _____

Animals Describe every different type of animal of which you see evidence. You may see an actual animal. But it's more likely you will see signs that an animal has been there such as tracks, nests, chewed leaves, or animal waste. You may also want to draw these animals.

Total Number of Kinds of Animals _____

Other Observations

Enrichment 11-1 Activity Report: Measuring Species Diversity (Student Reproducible)

1. Make a chart like the one below for the data collected by the whole class. Record the number of species each group found and the location of the field site.

TABLE 12.1:

Group	Site	Number of Kinds of Plants	Number of Kinds of Animals

2. Look closely at the class data. Which two areas had the most species diversity?

3. Which two areas had the least species diversity?

4. Why do you think these areas have different species diversity?

5. Scientists often assume that they have not found every single species in a given area. How could you improve your study to try to find more species?

6. Now that you've had some first-hand experience measuring species diversity, what recommendations could you make to a group planning to study the species diversity in the tropical rain forest?

Enrichment 11-2: Teacher Activity Notes

Extinction Crisis

PLAN

Summary

Students analyze and compare two graphs. One graph shows the rapidly increasing rate of species extinction in the world. The second graph shows the rapidly increasing rate of human population growth.

Objectives

Students:

✓ explain the term *extinction crisis*.

✓ interpret data about human population growth and species extinction.

Student Materials

- Resource 1

- Resource 2

Teacher Materials

- None

Advance Preparation

None

Estimated Time

50 minutes

Interdisciplinary Connections

Math Students interpret graphs in this activity.

Social Studies Students study population growth trends in this activity.

Prerequisites and Background Information

Students should have some basic graph interpretation skills.

IMPLEMENT

Introduce Enrichment 11-2 by reviewing the concept of exponential growth with students before beginning the activity. As students work, make sure they notice the changes in the degree of slope for each graph. You may want to point out that the steepest parts of the graph show the most rapid periods of change. Encourage students to observe that both the rates of extinction and population growth are increasing most rapidly in the most recent time period.

Steps 1-3 Depending on how much help students need in interpreting the two graphs, consider discussing the following questions.

- What caused the shape of the curve on each graph?
- Why are these shapes similar?
- What are some possible connections between the data on these two graphs? (For example, students may infer that more people create more habitat destruction that causes an increase in extinction. You may want to point out that correlation Goes not prove cause and collect. Ask students to think about how this inference could be tested.)

Helpful Hints

To help students interpret the graphs, you may want to tell them to begin by taking the graph apart. First, they can examine what each axis represents. Then they can look at what direction the line is sloping to see if it indicates a downward trend, upward trend, or stasis. You may also want to ask students to find specific information in the graph by using a ruler to draw two lines from the plotted line to the axes.

You should point out that the scale on the y-axis on Graph A is exponential. It increases by powers of 10. The scale on Graph B is linear.

Extend Enrichment 11-2 by

- Explaining the effect one species extinction can have on an entire community. Review with students the ecological relationships in a food web. Ask, What happens if you remove a producer? a herbivore? a carnivore? You may also want to do *Activity 3-1: Classifying the Players in a Willow Forest*.

- Having students do library research to explore the following questions: What were human societies like when human populations started to explode? How did population sizes differ in a hunter-gatherer society, an agricultural society, and an industrial society? How do each of these methods of survival affect the number of people who can be supported? Students can choose to report on one type of society, analyzing the society and trying to explain how the society affected the habitats and wildlife around it.
- Discussing the relationship between population, technology, affluence, and impact on natural resources. Though population growth is a significant factor contributing to environmental problems, it is not the only one. Just as important as the number of people in a population is how those people use their resources. In August 1994, the United Nations held an international conference in Cairo, Egypt, on the topic of population and development. A wealth of discussion topics may be found in magazines and news articles about the UN Conference.
- Discussing the impact of human activities on wildlife and what happens when humans cause species extinction. This discussion can be used to lead into *Enrichment 11-3: How Do You Value Biodiversity?*

ASSESS

Use students' discussion and written answers on the Activity Pages to assess if students can

✓ read and interpret graphs.

✓ interpret apparent correlations.

✓ explain why the growing rate of extinction is called an extinction crisis.

Enrichment 11-2 Activity Guide: Extinction Crisis (Student Reproducible)

Introduction

Why are scientists today so concerned about the "extinction crisis"? New species evolve and old species die out, or become extinct, as a result of natural processes on the planet. Animals such as trilobites, stegosauruses, and woolly mammoths lived long ago but don't exist today. So why do many people think that an extinction crisis is taking place in rain forests and other parts of the world? In this activity, you analyze data on the rate that species are becoming extinct to answer this question.

Materials

- Resource 1
- Resource 2
- Pen or pencil

Procedure

Step 1 Analyze Graph A: Annual Species Extinction and answer the following questions.

a. Explain in your own words the information given on this graph.

b. Look at the increase in the number of species becoming extinct annually between 1600 and 1900. Compare this with the increase in the number of species becoming extinct annually between 1985 and 1990. Use this difference to explain the term *extinction crisis*.

c. Give at least two possible reasons for the changes in the number of extinctions per year shown on this graph.

Step 2 Analyze Graph B: Human Population Growth and answer the following questions:

a. Explain in your own words the information given on this graph.

b. Look at the increase in the number of humans on the planet between 1600 and 1900. Compare this with the increase in the number of humans on the planet between 1950 and 2000. Use this difference to explain the term *population explosion*.

c. How would you explain the changes indicated by this graph?

Step 3 Now compare Graph A and Graph B and answer the following questions.

a. What similarities and differences do you see in these two graphs?

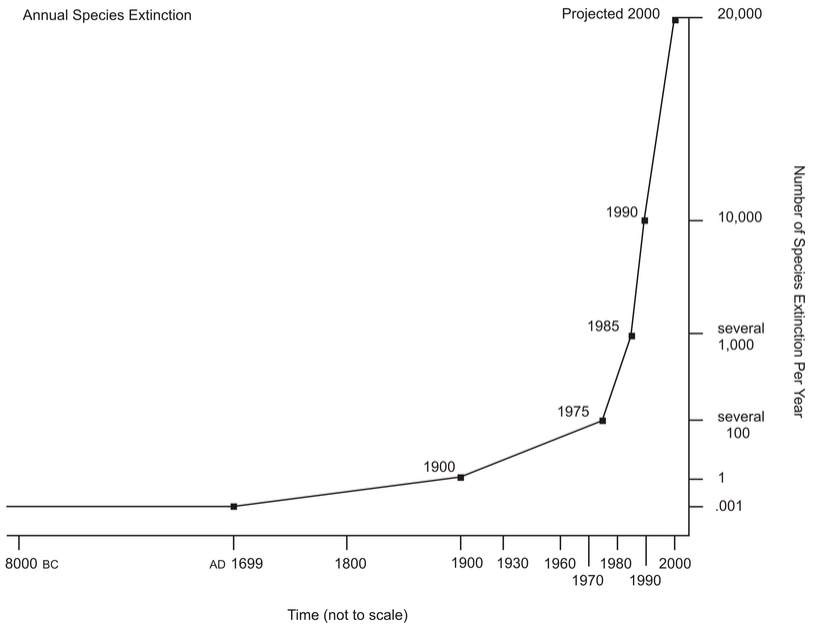
b. What possible relationships might exist between the data on one graph and the data on the other graph?

c. How could you determine if there was any actual relationship between the data shown on one graph and the data shown on the other graph?

d. What conclusions could you make about human population growth and species extinction?

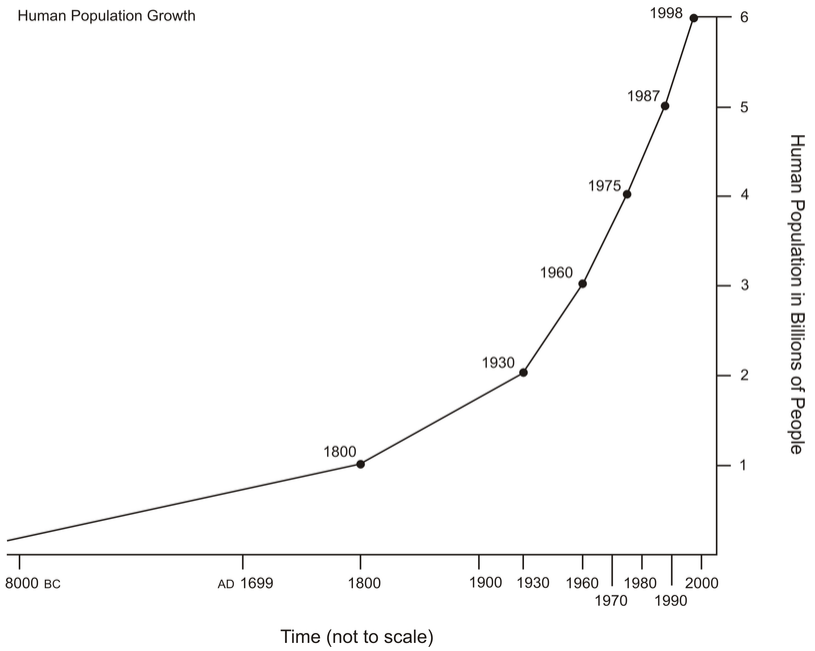
Enrichment 11-2 Resource 1: Extinction Crisis (Student Reproducible)

Graph A



Enrichment 11-2 Resource 2: Extinction Crisis (Student Reproducible)

Graph B



Enrichment 11-3: Teacher Activity Notes

How Do You Value Biodiversity?

PLAN

Summary

Students become more aware of what they value in nature by answering questions about the impact and importance of other living things on their lives. Students decide what kinds of organisms are important to them and why.

Objectives

Students:

✓ explain that preserving biodiversity often involves difficult decisions based on many conflicting sets of values.

✓ make personal decisions concerning the value of biodiversity.

Student Materials

- Activity Guide
- Activity Report
- Pen or pencil

Teacher Materials

- None

Advance Preparation

None

Estimated Time

One 40- to 50-minute period

Interdisciplinary Connection

Social Studies Students explore their own opinions about a variety of issues.

Prerequisites and Background Information

One way of explaining the different reasons people value biodiversity is to place them under four categories: aesthetics, ethics, ecosystem services, and economics. Some people feel nature and biodiversity are important to humans only if they provide a direct economic benefit, such as the pharmaceuticals found in the rain forest. Others value biodiversity for the aesthetic pleasure they get from walking or camping in the wilderness. Usually, any reason students have for placing value on nature will fit in one of the four categories.

IMPLEMENT

Introduce Enrichment 11-3 by reviewing with students the importance of respecting the opinions of others during discussions. This is critical in the discussion of many issues. The classroom atmosphere should be comfortable enough for students to speak without worrying that other students will make negative comments.

> **Helpful Hints**
>
> Values clarification can be an effective way to have students reflect upon what their values are, why they value certain things, and how they can look beyond themselves into the world around them. You may want to discuss the definition of *value*, allowing students to devise their own definition as well as using the one from the dictionary.
>
> Specific questions could be assigned to small groups for later sharing with the class, rather than having all students complete all of the questions. To give students additional time to digest these ideas, this topic could be extended over several class periods by assigning a few questions for discussion on each of several days.

During the activity, the role of the teacher should be that of a facilitator who does not impose his or her own values on the discussion. If a student chooses not to participate in the discussion that choice needs to be respected.

Steps 1-3 The following are discussion points for the questions in the activity:

- Many students don't realize the number of things they use and see every day that are made from plant or animal materials, nor do they realize the amount of labor and energy it takes to make and transport these items. Thinking about the paper towels, furniture, cardboard, and junk mail that come from trees could help students see how much they take for granted.

- Often, people place more value on the furry, cute, dynamic animals than on other creatures that may be more important to the ecosystem. Microorganisms and decomposers like snails come at the bottom of most people's lists. But if we didn't have them, we'd be up to our necks in dead things and waste.

- When discussing any environmental issue, it is important to present more than just the conservationist, "save the planet" side. Students need to realize that the things they listed as valuable to them could come into conflict. Explain that there isn't always one right answer and that people sometimes need to make decisions based on their priorities.

Extend Enrichment 11-3 by having students gather other opinions on the topic of valuing biodiversity by constructing a survey of public opinion on environmental issues for the school, parents, or community. Opinion surveys lend themselves to graphing their results in order to make generalizations about a population's overall attitudes on a topic. Students can graph the results of their surveys if they create multiple choice questions. You may want to have students compare the results of their opinion surveys to the results of national opinion polls on similar topics. Alternatively, students could conduct interviews of other students, parents, or community members. Students can then give oral or written presentations of their findings.

ASSESS

Use discussion and written answers from the Activity Guide and Report to assess if students can

✓ identify the potential conflicts that may arise when making decisions on environmental issues.

✓ explain the logic and validity involved in forming personal opinions.

Enrichment 11-3 Activity Guide: How Do You Value Biodiversity? (Student Reproducible)

Introduction

What do you value? What is important to you? Scientists, economists, and policy makers all over the world are currently trying to figure out how important biodiversity is to humans and what is valuable about it. In this exercise, you are asked to think carefully about what is important to you as an individual and as a human being living on this planet. You apply what you know to decide how you value biodiversity.

Materials

- Pen or pencil

Procedure

Step 1 Which people, things, or qualities do you value most and why do you value them? Answer the following questions individually.

a. List the five people, things, or qualities that you value most.

b. What characteristics do these people, things, or qualities have that make them valuable to you? (Are they useful? Are they beautiful? Are they people who support you?)

c. How much are these items worth to you? What would you be willing to give up or do in order to keep these items as part of your life?

Step 2 Discuss the following questions about how your life is affected by biological diversity.

a. What are five objects in your home that come from a plant or an animal?

b. Explain which would have a greater impact on your life and why you think so: if all the bears in the world became extinct or if all the snails in the world became extinct.

c. Bacteria, fungi, and other microorganisms are responsible for decomposing dead things and waste. What would happen if these organisms no longer existed on Earth?

Step 3 Answer the following questions individually. Then discuss your answers with your group.

a. In order to build a shopping mall, a developer wants to plow local fields that contain some of the last remaining populations of an endangered plant. Would you be for or against this decision? Explain your answer.

b. What if the land were to be developed as housing for low-income families or a retirement home for senior citizens? Would your decision be different? Why or why not?

c. If you won a lottery prize of $100, how much of it would you give to save an acre of rain forest?

d. Was it hard for you to put a dollar value on the rain forest? Why or why not?

Step 1

a.

b.

c.

Step 2

a.

b.

c.

Step 3

a.

b.

c.

d.

Rank the five species in order of their value to you by arranging them on the continuum. Then explain your reasons for ranking them the way you did.

fox fish snail venomous snake moss

Most Important

Least Important

SPECIES	Reasons for Ranking
1.	
2.	
3.	
4.	
5.	

Suppose the organisms above were endangered, and you have to decide which three to save from extinction. Which would you save and why?

CHAPTER 13 Conserving Biological Diversity - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

13.1 Planning

Key Idea

- Humans can prevent the loss of biological diversity.

Overview

The previous section explained the concept of biodiversity and the importance of habitat, species, and genetic diversity. This section shows some of the ways that conservation biologists attempt to limit the loss of biodiversity. Students learn about the role of human activity in the health or extinction of species. Students construct a nature reserve and propose ways that they can prevent the loss of biodiversity.

Objectives

Students:

✓ define and give examples for the term *extinction*.

✓ compare and contrast proximate and ultimate causes of extinction.

✓ explain what humans can do to prevent the loss of species through extinction.

Vocabulary

nature reserve, proximate cause, ultimate cause

Student Materials

Activity 12-1: Design a Nature Reserve

Per student

- Resource 1
- Resource 2

Per group

- Butcher paper
- Marking pens or colored pencils

Teacher Materials

- None

Advance Preparation

See Activity 12-1 in the Student Edition

Interdisciplinary Connections

Social Studies Students design a nature reserve while considering a variety of ethical, economic, and political factors.

Enrichment Activities

Enrichment 12-1: Endangered Species-Do or Die

Students analyze the case history of an endangered species, the California condor.

13.2 Using Conserving Biological Diversity – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section. "How do species become extinct and what can humans do to prevent this loss of biodiversity?" Students learned about the rapid rate of loss of biological diversity in the previous section. Now they can connect specific human actions such as farming to species extinction.

Discuss the difference between ultimate and proximate causes of extinction. Emphasize that rarely are human activities the proximate causes of a species becoming extinct, but they are often the ultimate cause due to development, agriculture, or pollution.

Assign *What Do You Think?* on page 79 so students can write about DDT. Encourage them to think about the international controversies that often accompany environmental issues.

Activity 12-1: Design a Nature Reserve can be used as an open-ended culminating activity and assessment tool for this section or for the entire Ecology unit. The activity asks students to draw on most of the major concepts from the unit and apply them to a particular endangered species.

What Do You Think?

The federal government banned the use of DDT in the U.S. But the government did not ban its manufacture or exportation. Several U.S. companies still make and sell DDT to farmers in other countries. Should the U.S. ban the manufacture and sale of DDT to people in other countries or should those people have the right to buy DDT if it helps them grow food?

Journal Writing

When a species such as the brown pelican becomes endangered, how much money, time, and effort do you think humans should spend trying to save it from extinction? Do you feel it is as important for governments to spend money on endangered species as on health care, the homeless, education, weapons, roads, and transportation? Explain why or why not.

Mini-Activity

Students create a nature refuge in their backyard. You may want to have the class work together to create a nature refuge near the school.

13.3 Activities and Answer Keys

Activity 12-1: Design a Nature Reserve

PLAN

Summary Students apply their knowledge of ecology and biodiversity to a real-life conservation problem by designing a nature reserve for an endangered species, the Kirtland's warbler.

Objectives

Students:

✓ explain the habitat requirements of the Kirtland's warbler.

✓ describe the interaction between the warbler and the cowbirds.

✓ describe the impact humans have on the survival of the Kirtland's warbler.

Student Materials

Per student

- Resource 1
- Resource 2

Per group

- Butcher paper
- Marking pens or colored pencils

Teacher Materials

- None

Advance Preparation

You may want to get maps of the region in Michigan where the Kirtland's warbler is found. You can obtain the topographical map for Mio, Michigan, from the U.S. Geological Survey. Before you begin, read over the information on the Kirtland's warbler on Resource 1 and Resource 2.

Estimated Time One to three 50-minute periods

Prerequisites and Background Information

Students should have a basic understanding of the terms *species, habitat,* and *endangered*.

IMPLEMEMT

Introduce Activity 12-1 by discussing the terms *species, habitat,* and *endangered*. Ask students if they know of any endangered species. Write correct responses on the chalkboard.

Helpful Hints

Point out to students that the process of research and planning they are using is similar to how biologists actually plan and design nature reserves. Explain that inappropriately planned and designed nature reserves are often unnecessarily expensive, costly in lives of the threatened species, and unsuccessful. Therefore, the design of nature preserves is the subject of increasing concern and research.

As an alternative way for students to present their reserve plans, you can set up a"funding committee," which will determine which group has the most efficient and effective reserve plan. Students submit their proposals as well as a presentation, and the "funding committee" can make its decision based on predetermined criteria.

Steps 1-2 Have students design their reserves according to the activity instructions. Encourage them to be as accurate and as realistic as possible, especially considering that funding for reserves is usually very limited. This project can be quick or very in-depth. So make time limits clear while students work.

Schedule the presentations and guide students as they present their papers to the rest of the class.

Conclude Activity 12-1 by discussing the differences and similarities between the groups' designs for the same species. You may want to include the following questions in the discussion:

- Which design is more inclusive of the warbler's habitat requirements?
- Which design is more economical?
- Which design will be the least controversial with regards to human needs?

Extend Activity 12-1 by

- Including basic map reading skills as well as map drawing. Students can use topographical maps from the U.S. Geological Survey and/or road maps to locate and draw the area covered by their reserve. Students can locate areas of human impact in relation to the remaining habitats of endangered species.
- Having groups of students research different endangered species and produce case studies explaining the habitat requirements of the species and its other characteristics. Have the groups trade case studies and develop appropriate reserve plans. Afterward the groups that originally researched the species can critique the reserve plans prepared by their classmates.

ASSESS

Use the nature reserve plans to assess if students can

✓ identify the specific habitat requirements of the Kirtland's warbler.

✓ demonstrate and explain how humans can conserve species by carefully managing a reserve.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the difference between a proximate and an ultimate cause? How does this apply to the causes of extinction of a species?
2. What are nature reserves? How do they help prevent the loss of biodiversity?
3. If the Department of Parks put a wire fence around an empty lot in your town and claimed that it was a reserve for grizzly bears, would you say that the reserve designers had done a good job or not? Why or why not?

Activity 12-1 Resource 1: Design a Nature Reserve (Student Reproducible)

TABLE 13.1: Case Study of the Kirtland's Warbler (Dendroica kirtlandii)

Time	Status
1880s-1890s	→ People cut down large areas of forest in the midwestern United States. → Loss of mature, fire-resistant forest leads to many forest fires. → Forest fires allow growth of new forests of jack pine in southern Michigan. → Populations of Kirtland's warbler, normally rare, expanded into their increased habitat. → Clearing of forests also benefits the brown-headed cowbird, a nest parasite that lays its eggs in the nest of a host bird and then leaves. The eggs of the host bird do not survive in this process.
1999s	→ People fear losing houses, crops, and timber and begin routine efforts to stop and prevent forest fires. → Without fires, jack pine forests mature beyond the point at which warblers will nest in them. → The forest fire prevention that helps humans survive also greatly reduces the warbler's habitat. → Food supply for cowbirds is now more plentiful because of the mechanical harvesting of grain. → Cowbirds are no longer limited by the scarcity of food in their wintering range. → Cowbird populations spread and increasingly parasitize the nests of Kirtland's warblers. This causes a decline in the warblers' reproductive success.
1961	→ Five hundred nesting pairs of Kirtland's warbler are scattered through 16,000 square kilometers (6,200 square miles) of forest.
1967	→ Kirtland's warbler is listed as an endangered species under the federal Endangered Species Act.
1971	→ An intensive program begins to trap cowbirds. → This trapping program results in a 65 percent drop in nest parasitism, leaving only about 5 percent of the warbler nests affected by cowbird parasitism. → Four times as many baby warblers survive to leave the nest.
1976	→ The U.S. Forest Service begins expanding warbler habitat by cutting jack pines.

TABLE 13.1: (continued)

Time	Status
1982	→ Two hundred nesting pairs of the warbler now live in 3,400 square kilometers (1,300 square miles) of forest. → The warbler will not be out of danger of extinction until there are at least 1,000 breeding pairs, according to the Office of Endangered Species. → 265 singing males are counted. This large increase is attributed to increased habitat areas created by a wildfire in 1981. The young jack pines grow to a suitable nesting size.
1993	→ 485 singing males are counted. → The U.S. Fish and Wildlife Service removes 4,600 parasitic cowbirds.
1994-1995	→ A record number of jack pine seedlings-4.5 million-are planted by the Michigan Department of Natural Resources and the U.S. Forest Service on about 2,500 acres.

Activity 12-1 Resource 2: Design a Nature Reserve

Background Information on Kirtland's Warblers

The Kirtland's warbler is a small, colorful songbird. It's about 14-15 centimeters long and has a short, stout bill. Adult males have an upper body of bluish gray with black and white markings and dull yellow underparts streaked with black. Adult females have an upper body of bluish gray with streaks and underparts of pale yellow with a speckled breast.

Kirtland's warblers nest and raise their young during the summers in the northern Lower Peninsula of Michigan. Every winter they fly to the Bahamas, a group of islands off of Florida. The trip to the Bahamas is so long that the birds must stop along the way to rest. These resting spots are important to the birds and must include the ecological requirements necessary for survival. Food requirements for Kirtland's warblers include a plentiful variety of insects. Kirtland's warblers often like to hover at the ends of branches in order to pluck insects out of pine needle clusters. They also eat berries.

The warblers generally lay five eggs. The eggs hatch about the middle of June. If there are no predators, the average number of surviving warblers can be as many as four fledglings per adult pair. However, the brown-headed cowbird (*Molothrus ater*) lays its eggs in the nests of other birds including the warbler. The warblers do not realize they are incubating cowbird eggs. The warblers then care for the cowbird eggs as if they were their own. When the baby cowbirds hatch, they grow quickly at the expense of warbler chicks. The result is a decrease in numbers of fledgling warblers and an increase in numbers of fledgling cowbirds. If cowbirds are allowed to breed unchecked in warbler territory, the nesting success of warblers can average as low as 1.4 new fledglings per-season. This reproduction rate is not high enough to support a continuing population of warblers.

The Kirtland's warbler has very specific habitat and breeding requirements. A breeding pair of Kirtland's warblers requires a territory of about 12 hectares (30 acres) of young jack pine habitat that has many small areas, few or no hardwood trees, and minimal ground cover. Jack pines are a species of pine tree (*Pinus banksiana*) in which the warblers build their nests. A jack pine forest must be at least 30 hectares (74 acres) or more in area in order to be large enough to support breeding warblers. In the past, forests of jack pine caught fire periodically and burned. The fires stimulated the growth of new jack pine so there was a continuous natural renewal of jack pine forests.

The Kirtland's warbler requires stands of young jack pine trees about 2 to 6 meters high (about 8 to 21 years old).

The warblers will live in a young forest until it becomes too old (about 6 meters high) and then move to a new, younger jack pine forest. However, more recently, humans have tried to control forest fires for their own protection. As a result, the growth of new jack pine forests has declined. This decline in jack pine forest renewal has caused a decline in suitable breeding habitats for the warbler. The result has been a decrease in the number of warblers.

There is not much information available about the warbler's preferred winter habitat in the Bahamas. There is some indication that the birds require low, broad-leafed scrub, which is the main form of natural vegetation on the islands. With the development of homes and resorts on the islands, the natural vegetation is being cleared. While the habitats along the way to the Bahamas must also be suitable for warblers, there is little information known about these sites.

Once a population of warblers declines to a certain size, there is little hope of saving that population from extinction. In order to introduce a population of warblers into a new area, one ought to plan for a habitat capable of supporting 250 breeding pairs.

13.4 Enrichment

Enrichment 12-1: Teacher Activity Notes

Endangered Species-Do or Die

PLAN

Summary

Students analyze the case history of an endangered species, the California condor.

Objectives

Students:

✓ describe how a species can become endangered and distinguish between proximate and ultimate causes.

Estimated Time

One 50-minute period

Student Materials

- Activity Guide
- Resource

Teacher Materials

- None

Prerequisites and Background Information

Students should have an understanding of the terms *ultimate cause, proximate cause,* and *endangered* species.

Helpful Hints

You may want to locate and bring in some of the following articles about the California condor.

- Anonymous. "Condor redux." *Discover*, v. 11, July 1990 pp.10-11.
- Anonymous. "California Condor *(Gymnogyps californianus)." World Wildlife Federation Guide to Endangered Species.* Beacham Publishing, Washington, D.C., 1990, pp. 621-623.
- Anonymous. "Comeback trail of the California condor." *National Geographic World*, v. 171, November 1989, pp.25-29.
- Cohn, Jeffrey. "The Flight of the California Condor." *Bioscience*, v. 43, April 1993, p. 206.
- Oliwenstein, Lori. "Nine Months of the Condor." *Discover*, v. 10, January 1989, p.62.
- Oliwenstein, Lori. "Free as a Bird." *Discover*, v. 14, January 1993, p. 41.

IMPLEMENT

Introduce Enrichment 12-1 by reviewing with students what it means for a species to be considered endangered.

Steps 1-2 You can use the questions for whole class discussion and read aloud the California Condor timeline on the *Enrichment 12-1 Resource* or show it on an overhead projector. You can also have students read the timeline and answer the questions individually, then discuss the case in small groups.

You may want to assign this activity as homework, having students read the timeline and answer the questions to prepare for a discussion in class the next day. During the class or group discussion, encourage students to reflect upon what role they feel humans should play in preserving endangered species. Ask them to think about what the costs of this role might be.

Extend Enrichment 12-1 by substituting an example of an endangered species more typical of your immediate environment. Use the reference given for the *World Wildlife Federation Guide to Endangered Species* to find information about a local endangered species.

ASSESS

Use the discussion and written answers from the Activity Pages to assess if students can

✓ define the terms *endangered* and *extinct*.

✓ explain how to distinguish between proximate and ultimate causes of species extinction.

Enrichment 12-1 Activity Guide: Endangered Species-Do or Die (Student Reproducible)

Introduction

What factors cause some species to become endangered or extinct while others continue to survive and reproduce? How are some human activities helpful or harmful to endangered species? In this activity you will analyze the case study of the California condor, which is currently endangered. Join other conservation biologists in trying to figure out why the condor has become endangered.

Materials

- Enrichment 12-1 Resource
- Paper
- Pen or pencil

Procedure

Step 1 Read the timeline outlining the decline of the California condor as well as the conservation efforts to restore a healthy condor population to the wild. Discuss and answer the following questions:

a. What are the habitat requirements of the California condor?

b. What were the ultimate causes of the condor becoming endangered?

c. How were these ultimate causes related to human activities?

d. What were the proximate causes of the condor becoming endangered?

e. What are humans doing now to prevent the extinction of the California condor?

Step 2 Develop your own plan for the preservation of species. What general role do you feel humans should play in the preservation of species? Should we leave things to happen as they will, or should we intervene?

Enrichment 12-1 Resource: Endangered Species-Do or Die (Student Reproducible)

California Condor Timeline *(Gymnogyps californianus)*

California condors are the largest birds in North America. They may weigh up to 11 kilograms (about 25 pounds) and have wingspans of 2.9 meters ($9\frac{1}{2}$ feet). Their heads and necks are bare of feathers, and the rest of their body is black. When they fly, they can go as fast as 88 kilometers per hour (55 miles per hour) and reach altitudes of 4,572 meters (15,000 feet). Condors nest in caves or clefts on cliffs that have trees nearby for roosting and a clear area for them to take off and land. They eat carrion, which is dead animals such as deer, cattle, and sheep. If they eat a big meal, they have to stay on the ground for several hours before they can take off again.

TABLE 13.2:

Time	Status
100,000 years ago	The fossil record indicates that condors once ranged along the entire Pacific Coast from British Columbia to l. Northern Baja, California. Fossils have been found as far east as Texas, Florida, and New York.
1 Bc	Condors range to West Texas, Arizona, and New Mexico.
1800s	Condors are last seen in the Pacific Northwest.
1800s	The condor is last seen in Northern Baja, California. Scientists say many were poisoned by ranchers who put out poison for livestock predators. People also collect condors and their eggs as a novelty.
1947	The number of condors dwindles to 100. The Los Padres Forest Sanctuary is established. Condor numbers continue to drop due to the construction of roads, cities, housing tracts, and weekend mountain retreats in the open country needed by condors to find food.
1951	The San Diego Zoo proposes breeding condors in captivity as a last resort, due to the dangerously low numbers of condors left in the wild.
1960	Only 50-60 condors are estimated to be left in California. Part of the decrease in numbers is due to accidents such as collisions with power lines and other structures.
1967	The California condor is listed as an endangered species under a law that preceded the Endangered Species Act of 1973.
1979	The estimated population of California condors has dropped to 25-30 birds. The American Ornithologists Society and the National Audubon Society develop a study and preservation program for the condors. They find that condors will lay another egg or even two if one egg is lost or removed.
1980	All the remaining condors in the wild belong to only one breeding population.

TABLE 13.2: (continued)

Time	Status
1983	The Captive Breeding Program is developed at the San Diego Zoo. Biologists begin removing condor eggs laid in the wild because d1ey know the birds will lay another egg. The first California condor to hatch in captivity is named Sisquoc. He and other captive-born condors are raised in boxes that simulate caves and fed by puppets that look like adult condors.
1984	Researchers begin capturing young condors and start breeding them as quickly as possible before the wild population dwindles further. Their plan is to leave some condors in the wild to serve as role models to the captive condors when they are released into the wild.
1985	The capturing of four of the five remaining breeding pairs of condors over the winter reduces the wild population from 15 birds to 9 birds.
1987	Biologists decide to capture all the remaining condors and put them in the captive breeding program.
1988	Two of these captured birds mate and produce the first captive-bred condor chick at the San Diego Wild Animal Park.
1989	Scientists release female Andean condors (a species closely related to the California condor but not endangered) into the Los Padres National Forest. This experiment is an effort to observe how they adapt to the wild, as well as to perfect release techniques.
1991	Two California condors bred in captivity are released into the wild at Sespe Condor Sanctuary in the Los Padres National Forest. Two Andean condors are released along with them because condors like to live in social groups.
1991	One of the released California condors dies from swallowing antifreeze.
1993	There are 63 condors alive: 56 in the San Diego Wild Animal Park and 7 in the wild.
1994	Eighty-four condors exist in captivity, while only 3 are still alive in the wild. The U.S. Fish and Wildlife Service plans to continue releasing California condors but is having trouble finding suitable habitats.
1995	The captive breeding condor population grows to 103 by the end of the year.
1996	The U.S. Fish and Wildlife Service releases six young California condors on October 29, 1996, in Arizona.
1997	There are 121 California condors in the world. There are 17 in the Los Padres National Forest in California and 104 in the captive breeding facilities in San Diego.

CHAPTER 14 Conclusion: You and the Environment - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

14.1 Planning

Key Idea

- You make a difference. Think globally, act locally.

Overview

The final section reminds students that their relationship with the environment is a two-way street-the environment affects them and they affect the environment. The concluding activity is identical to the first activity in the unit. This activity can be used to assess how the students' views of ecology and the environment have changed with the study of this unit.

Objectives

Students:

✓ identify and explain the biotic and abiotic resources in their environment.

✓ demonstrate their personal connection to the environment.

✓ demonstrate knowledge of the interrelationships between the physical and biological aspects of the environment.

✓ explain how a change in one part of the environment impacts the rest of the system.

Vocabulary

None

Student Materials

- Activity Report
- 1 piece of butcher paper
- Colored marking pens, pencils, or crayons

Teacher Materials

- Activity Report Answer Key

Advance Preparation

See Activity 13-1 in the Student Edition

Interdisciplinary Connections

None

Enrichment Activities

None

14.2 Using Conclusion: You and the Environment – Student Edition (Human Biology)

Begin by discussing the main question posed at the beginning of the section, "What is your environment and how is it related to ecology?" Encourage students to draw from everything they've learned in their study of ecology and relate it to this question.

Assign *Project #1, Question 4: Ecology in the News.* Ask students to bring in news articles related to. ecology and the environment. Encourage them to look critically at what is written and who wrote it. Ask them to apply what they now know about ecological concepts to the articles they review. Consider making this project an ongoing project for the rest of the year.

Assign *Activity 13-1: Map Your Environment, Revisited* as a closing activity or as a homework assignment. Most importantly, have students compare their original maps from Section 1 to their new, more informed maps. Ask them to look at what they learned and at how their attitudes have changed as they worked through this unit.

Journal Writing

Find a newspaper article that is related to the topics you've studied in this ecology unit. Write a letter to the author of the article. Include in the letter what you think he or she should have included about ecology in the article to make it more thorough. Explain to the author what questions are left unanswered that could be researched.

14.3 Activities and Answer Keys

Activity 13-1: Map Your Environment, Revisited

PLAN

Summary Students review and evaluate how they depend on various living and nonliving factors for survival and comfort by drawing themselves and these factors on a page. Students then connect these components with lines to delineate relationships between themselves and these factors.

Objectives

Students:

✓ identify and explain the major biotic and abiotic resources in their environment, based on what they know after studying ecology.

✓ demonstrate their connection to other factors in the environment.

Student Materials

Per student

- Activity Report
- 1 piece of butcher paper or other drawing paper
- Colored marking pens, pencils, or crayons

Teacher Materials

- Activity Report Answer Key

Advance Preparation

None

Estimated Time 10-30 minutes, depending on discussion time

Interdisciplinary Connections

Social Studies Students discuss many issues that have been raised throughout this unit.

Visual Arts Students create a mural that maps their environment.

Prerequisites and Background Information

None

IMPLEMENT

Introduce Activity 13-1 by asking students to brainstorm topics you've discussed in the unit.

Steps 1-7 Have students follow the instructions for Activity 13-1 in the text. Supply them with paper and colored pens or pencils. During the activity, make sure students label each factor and its importance to them.

After students complete the activity, you may wish to assign the questions from Steps 5 and 6 of the Procedure as written class work or homework.

Conclude Activity 13-1 by asking for volunteers to describe how they think their views of ecology and the environment have changed since the class began this unit together.

ASSESS

Use the map of the environment to assess if students can

✓ distinguish between biotic and abiotic factors.

✓ explain the connections between various resources within their environment.

✓ describe the integration of the concepts presented in the unit.

✓ explain the importance of considering all possibilities when analyzing environmental issues.

Helpful Hints

For an example of a map of an organism's environment, review with students the map of a dog's environment in Figure 1.1 of the student text.

Activity 13-1: Map Your Environment, Revisited – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. List all the biotic factors in your environment.
2. List all the abiotic factors in your environment.
3. Which of the factors listed in 1 and 2 is the most important to you?
4. Which of the factors listed in 1 could you live without?
5. What factors in your environment do you have in common with your classmates?
6. How are your environmental factors similar to your classmates'? How are they different?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is your environment and how do you affect it?
2. What are ecologists and what do they do? Do you think that you can devise and answer questions about your environment now that you are a student ecologist?
3. How has studying this unit changed your views of how you fit into the workings of the world?

Activity 13-1: Report Map Your Environment, Revisited (Student Reproducible)

1. List all the biotic factors in your environment.

2. List all the abiotic factors in your environment.
3. Which of the factors listed in 1 and 2 is the most important to you?
4. Which of the factors listed in 1 could you live without?
5. What factors in your environment do you have in common with your classmates?
6. How are your environmental factors similar to your classmates'? How are they different?

CHAPTER 15 Additional Resources Ecology - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

15.1 Using GroupWork Activities

Learning science is a process that is both individual and social. Like researchers, engineers, mathematicians or physicians who work in teams to answer questions and to solve problems, students in science classrooms often need to interact with their peers to develop deeper knowledge of scientific concepts and ideas. The GroupWork activities were developed to foster an environment in which groups of students work cooperatively to:

- plan experiments,
- collect and review data,
- ask questions and offer solutions,
- use data to explain and justify their arguments,
- discuss ideas and negotiate conflicting interpretations,
- summarize and present findings,
- and explore the societal implications of the scientific enterprise.

The GroupWork environment is one in which students are "doing science" as a team. Suggestions about when to introduce these group activities are included in the Teacher Activity Notes.

Format and Organization of GroupWork Activities

Each GroupWork activity includes teacher activity notes, an activity guide, an individual report, resource materials, and at times, data sheets. The activity guide contains instructions for the group's task and questions to be discussed as students plan for and work on a group product. Resource materials are varied. They might include textual information, visual resources such as photos, drawings, graphs or diagrams, video, or audiotapes. Individual reports by students are an integral part of each activity to be completed in class or as part of a homework assignment. Planning information for the teacher is found on the Teacher Activity Notes page.

Sets of GroupWork activities are organized around a central concept or a basic scientific question-a "big idea." Ideally, as students rotate to complete these activities, they encounter this central idea, question, or concept in different scientific contexts or in different social settings. These rotations provide students with multiple opportunities to grapple with the material, explore related questions and dilemmas, look at different representations, and think of different applications. Figure 1 shows how students rotate from activity to activity around the "big idea."

The GroupWork activities were designed to be open-ended to foster the development of higher-order thinking skills. Such open-endedness allows students to decide as a group how to go about completing the task, as well as what the final group product might be. Open-ended group activities increase the need for interaction as students serve as resources for one another, draw upon each other's expertise and knowledge, and take advantage of their different problem-solving strategies. When groups are heterogeneous and include students with many different intellectual abilities, the repertoire of strategies and previous experiences is rich and diverse. As students interact with their peers, they learn how to communicate effectively, justify their arguments when challenged, and examine scientific problems from different perspectives. Such interaction scaffolds students' knowledge of scientific concepts and principles.

These GroupWork activities then are quite different from traditional lab activities that include more step-by-step procedures and are crowded with details. In addition to reading, writing, and computing (the traditional academic abilities), students use many different intellectual abilities to complete their task. They make observations, pose questions, plan investigations; they use and create visual models, access and interpret scientific information from different sources and from different media, and convey scientific findings in diagrams, graphs, charts, or tables. The use of a wide array of resource materials provides students with additional ways to access and use information, as well as with additional opportunities to demonstrate their intellectual competence and be recognized for their

contributions. We have included in the Teacher Activity Notes a partial list of some of the multiple abilities students might be observed using in these group activities.

When group activities are open-ended, rich, and intellectually demanding, a single student will not be able to complete the task in a timely fashion by himself or herself. Making students responsible as a group to interpret a challenging task and to design a common product or group presentation increases group interdependence. Teachers know, however, that it is also important to hold each student personally accountable for contributing to the group's success and for mastering the concepts or the big idea of the activity. To do so, students are required to complete individual written reports in which they respond in their own words to key discussion questions and summarize what they have learned in the group activity. These written responses can be useful for teachers in gauging and monitoring student understanding and progress.

Role of the Teacher Planning ahead and organizing the classroom for GroupWork is important for the successful implementation of group activities. We suggest that you refer to Elizabeth Cohen's book, *Designing GroupWork: Strategies for Heterogeneous Classrooms*, published by Teachers College Press in 1994. (See also Lotan, R.A.,J.A. Bianchini, and N. C. Holthuis (1996). "Complex Instruction in the Science Classroom: The Human Biology Curriculum in Action," in R. J. Stahl, (Ed.) *Cooperative Learning in Science. A Handbook for Teachers*, Addison-Wesley Publishing Company.)

Many teachers have realized that when students work in groups, direct instruction is no longer practical. The teacher can't be everywhere at once, telling students exactly what to do and how to do it. Thus, teachers delegate authority to students and students take responsibility for their own behavior and their own learning. Rather than constantly turning to the teacher for help, students talk with each other to find out what they should be doing and to solve the challenging problems assigned to them. Teaching students to work collaboratively and to be responsible to one another as a group is an important prerequisite for successful GroupWork. Students also support the smooth operation of groups when they have learned to play different roles in their groups effectively. For example, the facilitator sees to it that everyone in the group knows what has to be done and gets help when necessary. The recorder keeps notes of the group's discussions and checks to see if individual reports have been completed. The materials manager sees to it that the group has all the equipment necessary and that the tables are cleared at the end of the lesson. The reporter presents the findings of the group during wrap-up time. When the activity involves hazardous materials, a safety officer might be needed. Every student must have a role to play, and roles rotate so students learn how to perform each role competently.

Delegating authority doesn't mean that the teacher withdraws from the class or completely stays out of the action. Instead of being the focal point of the classroom, the teacher carefully observes the students as they work in the groups, stimulates and extends their thinking, and provides specific feedback.

Equalizing Participation among Members of the Group Making sure that all members of the group have access to the materials and that one group member doesn't take over or dominate the group while another withdraws are among the principal challenges of GroupWork. Teachers can increase participation of students by explaining how the different intellectual abilities are relevant to the successful completion of the task. The teacher states that while no one group member has all the abilities, everyone in the group has some of the intellectual abilities necessary to complete the task successfully. Furthermore, after careful observation of the students' work in groups, tl1e teacher can publicly acknowledge those students who have made relevant contributions and explain specifically how these contributions made the group move forward and become more successful. It is important that the teacher be able to notice the intellectual contributions of students who have low academic or peer status, and who are frequently left out of group interactions. These strategies are particularly relevant in untracked classrooms, where students have a wide range of previous academic achievement (mainly in reading) or where significant proportions of students are English-language learners. Teachers, classmates, and the low-status students themselves need to understand that when many different intellectual abilities; are necessary to complete a task successfully, everybody's contribution becomes critical to the success of the group. As more previously low-achieving students feel and are expected to be competent, their participation in the group increases, and subsequently their learning achievements increase as well.

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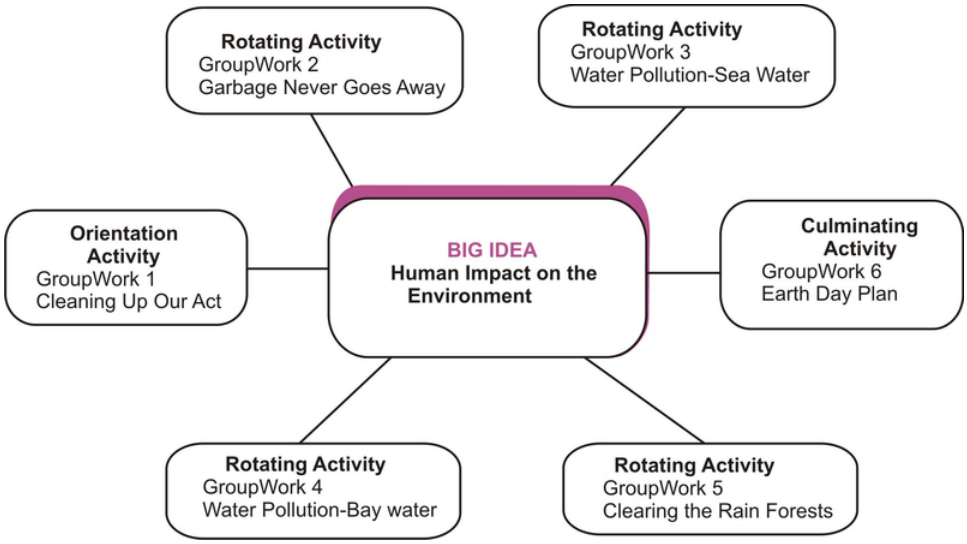


Figure 1: Activity Rotation in GroupWork

GroupWork Contents

TABLE 15.1:

Activity	Duration	Materials	Activity Summary
1. Orientation Activity: Cleaning Up Our Act	40 minutes	None	Students explore how people in their own community impact the environment. They are asked to identify human activities that are beneficial or harmful.
2. Garbage Never Goes Away	50 minutes	Boxes, containers, dirt, clay, rocks, water, plastic wrap or bags, and soil organisms such as worms, insects, and beetles. Other objects, such as buttons and plastic worms, can be substituted for real soil organisms.	Students learn about traditional landfills. Then, they design and construct a model of a more efficient landfill.
3. Water Pollution-Sea Water	55 minutes	Audiotape of newscast, cassette player, salad oil, motor oil, screw-top jar, sand, paper towels, newspaper, and bird feathers. (Miscellaneous items students may require: water, mineral oil, toothbrush, towels, and/or sponges)	Students learn ways of cleaning up after an oil spill by attempting to clean oil off water, sand, and feathers. They then apply this information to make recommendations for an oil spill cleanup off the coast of Alaska.

TABLE 15.1: (continued)

Activity	Duration	Materials	Activity Summary
4. Water Pollution-Bay Water	60 minutes	Live brine shrimp, glass or plastic containers, spoon, and clean and "polluted" water solutions	Students read a report describing the water pollution problem in Peaceville Bay. They then study the effect of pollution on brine shrimp and apply their findings to solve the town's problem.
5. Clearing the Rain Forests	50 minutes	Art supplies for props paper, and costumes	After learning about deforestation and indigenous peoples, students create a role-play of a debate over the use of a rain forest.
6. Culminating Activity: Earth Day Plan	50 minutes	None	Students apply what they have learned in this unit to their own lives.

Groupwork 1: Teacher Activity Notes - Orientation Activity: Cleaning Up Our Act

Big Idea: Human Impact on the Environment

PLAN

Summary Students explore how people in their own community impact the environment. They are asked to identify human activities that are beneficial or harmful.

Multiple Abilities

- Making astute observations (visual and analytic abilities)
- Clearly articulating a position, explaining clearly and fully, using words precisely, being persuasive (communication ability)

Interdisciplinary Connections

- Science
- Social Studies

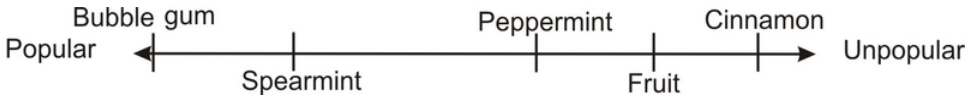
Estimated Time 40 minutes

Student Materials

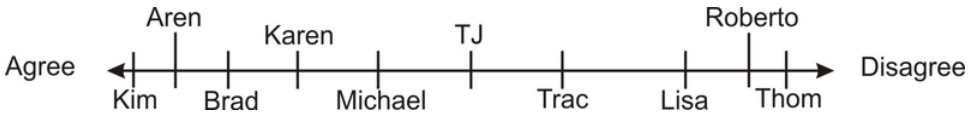
None

IMPLEMENT

- Before beginning this activity, introduce the notion of continuums to students. Below is one example of a *fictitious* continuum showing the popularity of chewing gum with middle school students.



Below is a second example of *fictitious* continuum. Ten teenagers were asked to respond to the following statement: The state driving age should be raised to 18.



- During the wrap-up discussion, you may choose to have students create a human continuum. To do so, first tape a line on the classroom floor with signs-beneficial and harmful-at each end. Then choose a human activity and ask students to stand where they think it belongs on the continuum.

Extension Questions

- How has human activity changed over the last several hundred years? human interaction with the environment?
- Is human activity today more or less harmful to the earth than human activity 100 years ago? How do you know?

ASSESS

Use the group data sheet, presentation, individual report, and group discussion to assess if students can

- explain how humans have changed the environment around them.
- describe the costs and benefits of human activity on the environment and on humans themselves.

Extend GroupWork by having students research presettlement vegetation patterns. Clues can often be found in historical societies or pictorial histories with photos of familiar sites around town.

Groupwork 1: Activity Guide (Student Reproducible)

Orientation Activity: Cleaning Up Our Act

Big Idea: Human Impact on the Environment

How do humans affect their environment? More specifically, how do you and the people in your community-your family, friends, and neighbors-affect land, water, air, and other species? In this activity, you will take a closer look at how your activities impact the environment.

Procedure

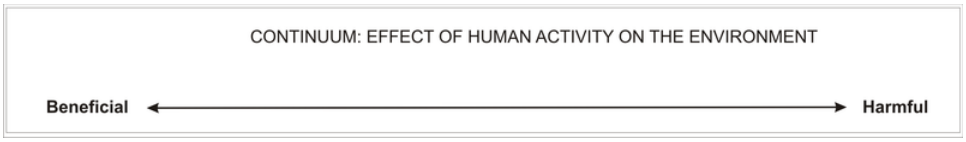
1. Imagine what the land around your school looked like before humans arrived on the scene. Was there a grove of trees? a bubbling brook? many different species of animals? Share your ideas with your group.
2. Discuss the following question: How do you and others in your community affect the environment? On your data sheet, write down specific examples.
3. For each example of human impact you discussed above, decide whether it is helpful, neutral, or harmful to humans. Place it on the continuum for humans (see bottom of data sheet). Then decide whether it is helpful, neutral, or harmful to the environment. Place it on the continuum for the environment. Attempt to explain your results. Are there any cases in which a human activity is both good for humans and for the environment? Explain.
4. Prepare to present your ideas to the rest of the class.

Groupwork 1: Data Sheet (Student Reproducible)

Orientation Activity: Cleaning Up Our Act

Big Idea: Human Impact on the Environment

List of Ways People in Your Community Affect Their Environment



Groupwork 1: Individual Report (Student Reproducible)

Orientation Activity: Cleaning Up Our Act

Big Idea: Human Impact on the Environment

1. What would the land around your school look like if people had never existed? In what ways would it be the same as today? In what ways would it differ?

2. Can human activity be good for both humans and the environment? Support your answer with specific examples.

3. What is one human activity that is beneficial to humans but harmful to the environment? Should this activity be stopped? Can it be changed to cause less harm? Explain your answers.

Groupwork 2: Teacher Activity Notes - Garbage Never Goes Away

Big Idea: Human Impact on the Environment

PLAN

Summary Students learn about traditional landfills. Then they design and construct a model of a more efficient landfill.

Multiple Abilities

- Making connections between concepts, logically analyzing the problem (reasoning ability)
- Thinking of new uses for familiar objects (artistic creative ability)
- Creating a physical model from a written description (visual/spatial ability)

Interdisciplinary Connection

- Social Studies

Estimated Time 50 minutes

Student Materials

Boxes, glass bowls or containers of various sizes, dirt, clay, rocks, water, plastic wrap or bags, soil organisms such as worms, insects, and beetles. Other objects, such as buttons and plastic worms, can be substituted for real soil organisms.

IMPLEMENT

- Instead of using live soil organisms, you can represent worms, beetles, and other insects with inanimate objects such as buttons, yarn, gummy worms, etc.

ASSESS

Use the group product, presentation, individual report, and group discussion to assess if students can

- describe how landfills work.
- explain how landfills affect the environment.
- identify how landfills could be constructed to be less harmful to the environment.
- show how a landfill could be represented using the materials provided.
- draw and label the parts of their landfill model.

Extend GroupWork by

- planning a class field trip to your community landfill.
- inviting a guest speaker to talk about the local landfill.

Groupwork 2: Activity Guide (Student Reproducible)

Garbage Never Goes Away

Big Idea: Human Impact on the Environment

Looking at the amount of garbage your family collects each week, it is easy to assume that garbage is not a big deal. However, if you combined your family's garbage with your many neighbors' garbage, you would soon have mountains of garbage. Most communities deposit their mountains of garbage in landfills. In this activity, you will explore the parts of a landfill and have the opportunity to "build a better landfill."

Materials

- Will vary. Suggested materials include boxes, glass bowls or containers of various sizes, dirt, clay, rock, water, plastic wrap or bags, and soil organisms such as (plastic) worms, insects, and beetles.

Procedure

1. Discuss a *traditional* landfill.

- Explain the costs required to build and maintain a landfill.
- Where are landfills built? Why?
- What types of materials are used?
- How does a landfill work?
- How do landfills affect humans who live nearby? Other living organisms? The surrounding environment?

2. Use the resource card and materials provided to design and build a *new* and *more efficient* landfill. Consider

- the cost and location of your landfill.
- reasons why your landfill is more efficient than traditional ones.
- how your landfill will affect humans and the environment.

3. Prepare to present and explain your landfill model to the class.

Groupwork 2: Individual Report (Student Reproducible)

Garbage Never Goes Away

Big Idea: Human Impact on the Environment

1. On a separate piece of paper, make a large drawing and label each part of your landfill. Describe the purpose or function of each part of your landfill.

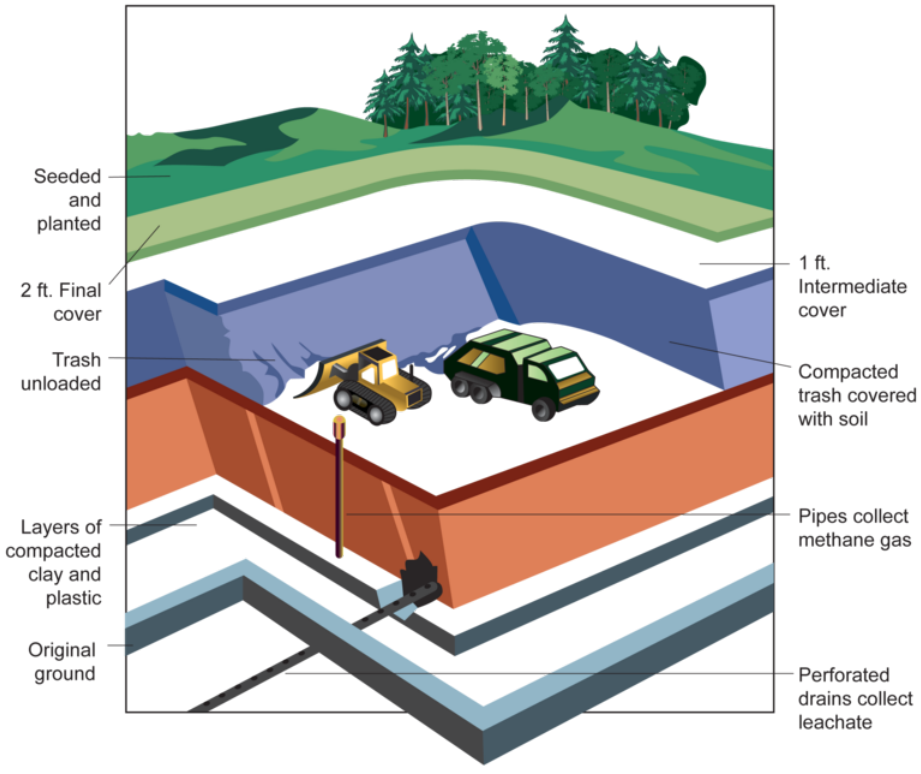
2. Explain what makes your landfill more efficient than a traditional landfill.

3. How will your landfill affect humans and the environment?

Groupwork 2: Resource (Student Reproducible)

Garbage Never Goes Away

Big Idea: Human Impact on the Environment



How a Traditional Landfill Works

- When you throw a piece of garbage into the garbage can, it goes on a long journey to a landfill.
- The garbage is thrown into a dumpster and transported by a garbage truck to a transfer station.

- At the transfer station, the garbage is placed in a larger garbage truck and is driven to a clay-lined landfill and dumped.
- At the end of each day, soil is placed on top of the garbage to make it a "sanitary" landfill.
- When the landfill is completely full, the whole landfill is covered with a clay top to prevent rain from leaking chemicals from the garbage that might be harmful to the environment.

How waste decomposes (or doesn't decompose)

- Tiny *microorganisms* in the soil feed on the organic materials in our garbage.
- In order for these microorganisms to live and eat, they must be in contact with the *air*.
- *Water* helps these microorganisms live as well as breaking down the big chunks into smaller ones.
- *Sunlight* also helps the microorganisms decompose things quickly.
- Larger soil creatures such as *worms* and *beetles* or other insects help decompose as well. Gophers help churn the soil and organic material to expose them to the air.
- In a traditional landfill, there are substances that can cause a lot of problems. Some garbage such as plastic and toxic substances does not decompose. It may remain in a landfill for a long time. Other wastes such as paint, motor oil, household cleansers, and industrial chemicals are very toxic to the environment. They can seep into the soil and water. Your new landfill should address these problems.

Groupwork 3: Teacher Activity Notes - Water Pollution-Sea Water

Big Idea: Human Impact on the Environment

PLAN

Summary Students learn ways of cleaning up after an oil spill by attempting to clean oil off water, sand, and feathers. They then apply this information to make recommendations for an oil spill cleanup off the coast of Alaska.

Multiple Abilities

- Making connections between ideas/concepts, logically analyzing the problem, solving a problem experimentally, making a hypothesis (reasoning ability)
- Thinking of new uses for familiar objects (artistic/creative ability)

Interdisciplinary Connection

- Social Studies

Estimated Time 55 minutes

Student Materials

Audiotape of newscast, cassette player, salad oil, motor oil, screw-top jar, sand, paper towels, newspaper, and bird feathers. (Miscellaneous items students may require: water, mineral oil, toothbrush, towels, and/or sponges)

IMPLEMENT

- You may wish to make your own audiotape by simply reading and recording the script provided on the student resource card.

- Remind students to consider the effectiveness, feasibility, practicality, and side effects of all their recommendations. For example, students should find that the mineral oil works quite well in taking oil off the feathers and sand. However, using mineral oil in a real oil spill can have deleterious effects on the environment.

Extension Questions

- What important factors must be considered when designing a plan to clean up oil (e.g., weather, tide, temperature of water, location, proximity to land, money)?
- Is it possible to eliminate all oil spills? How?

ASSESS

Use the group product, presentation, individual report, and group discussion to assess if students can

- explain how oil spills affect the environment.
- identify ways spills can be effectively cleaned up.
- identify the costs, benefits, and feasibility of various cleanup plans.
- describe how oil spills can be prevented, rather than just treated.

Groupwork 3: Activity Guide (Student Reproducible)

Water Pollution-Sea Water

Big Idea: Human Impact on the Environment

In a typical year, one to 10 million tons of oil are spilled into the ocean. In this activity, your group will act as a team of experts hired to clean up a huge spill off the coast of Alaska.

Materials

- Tape of newscast, tape recorder, salad oil, motor oil, screw-top jar, sand, paper towels, newspaper, and bird feathers. (Miscellaneous items: water, mineral oil, liquid soap, toothbrush, towels, and/or sponges)

Procedure

1. Listen to the news reports on the audiotape. Transcripts of these reports are provided on the resource card. Then discuss the following questions.

- What effect does an oil spill have on the ocean?
- How are animals and plants affected by an oil spill? Be specific.

2. The people of Alaska are very lucky to have your group help clean up this messy spill. In order to make informed decisions about how the spill should be cleaned, experiment with the following. Record your findings on the data sheet.

a. Motor oil in water: Investigate ways to clean the water. What methods did you use? How successful were you? Explain whether the methods are possible for a large body of water.

b. Motor oil on feathers: Investigate ways to clean the oil off the feathers. What methods did you use? How successful were you? Explain whether the methods are possible for live birds.

c. Motor oil on sand: Investigate ways to clean the oil off the sand. What methods did you use? How successful were you? Explain whether the methods are possible for an entire beach.

3. Based on your findings, create a presentation on how to clean up the oil spill. Include an estimate of how much it will cost, how effective it will be, and what problems will remain after the cleanup.

Groupwork 3: Individual Report (Student Reproducible)

Water Pollution-Sea Water

Big Idea: Human Impact on the Environment

1. What are some of the many costs of an oil spill?

2. What procedure or method was the most successful in removing motor oil from water? from bird feathers? from sand? Explain whether or not you think the procedure can be used to clean up a large oil spill.

3. What steps are needed to *prevent* oil spills? Explain whether or not you think people believe these steps are possible and necessary.

Groupwork 3: Resource (Student Reproducible)

Water Pollution-Sea Water

Big Idea: Human Impact on the Environment

News Report

March 25, 1989

Last night the 987-foot *Exxon Valdez* was sailing through Prince William Sound, Alaska, when the oil super tanker containing 40 million gallons of crude oil collided with the rocks of the Bligh Reef. Cleanup officials estimate that eleven million gallons of oil spilled out of the tanker into the water and that thousands of Alaskan animals have died as a result. The cost of the cleanup is expected to run into the millions of dollars.

While the cause of the disaster is still undetermined, investigators are questioning the captain of the ship. Crew members report the captain had been drinking prior to the collision.

April 3, 1989

Environmental scientists reported the result of a recent study done one week after the *Exxon Valdez* disaster. They found that two-thirds of the birds living in Prince William Sound had died. Apparently thousands of birds died either immediately after or within a few days of the oil spill. Theresa Perez, a scientist studying the damage, expects it will take from twenty to seventy-five years for the bird population to return to its prespill size.

In addition, the scientists estimate that 85% of the otters in the Sound died as a result of the spill. While the population of otters before the spill exceeded 4,000 animals, today only a few hundred remain. Perez explains, "Some suffered nosebleeds. Others were blinded. Their livers and kidneys were damaged when they ingested oil while cleaning their coats. When their fur became matted with oil it lost its insulating ability. Otters lack thick blubber, which other sea mammals have. They contract hypothermia and die." The recovery period of the otters has yet to be determined. But whatever the length of time, the effects of the *Valdez* oil spill will be devastating.

Groupwork 4: Teacher Activity Notes - Water Pollution-Bay Water

Big Idea: Human Impact on the Environment

PLAN

Summary Students read a report describing the water pollution problem in Peaceville Bay. They then study the effect of pollution on brine shrimp and apply their findings to solve the town's problem.

Multiple Abilities

- Recording data correctly and clearly, measuring accurately, explaining clearly and fully, observing carefully and accurately (ability to be precise)
- Applying empirical data to a natural setting (reasoning ability)

Interdisciplinary Connection

- Social Studies

Estimated Time 60 minutes

Student Materials

Live brine shrimp (or paramecia), glass or plastic containers, spoon, and clean and "polluted" water solutions

IMPLEMENT

- If there are concerns about experimenting with multicellular organisms, paramecium can be substituted for the brine shrimp.
- Making the solutions:
  - Acid rain can be simulated by adding approximately 20 *ml* of vinegar to 100 *ml* of water.
  - Adding table salt to the water can simulate farm fertilizers, which contain salts. Add approximately 5 *g* of *NaCl* to 100 *ml* of water.
- The concentration of the solutions can be altered for different results. For example, if you don't want the shrimp to die, the solutions can be diluted. Depending on the exact levels of "pollution" in your water, students may find that the brine shrimp are killed by the acidic water but not the salt water.
- After the presentation, tell the group how you simulated the polluted water. Explain that *NaCl* (table salt) is a mineral salt that is similar to salts found in fertilizer, for example, potassium sulfate and magnesium phosphate. While brine shrimp live naturally in salt water, high levels of salt could be harmful. Also explain that acid rain, caused by factory pollution, can increase the acidity of lakes, streams, and rivers.

Extension Questions

- If fertilizer is so beneficial to crops, why isn't it good for lakes too?
- What other pollution problems may face this bay as a result of the town's development?
- Do you think this bay can ever be returned to its natural, unpolluted condition? Explain.

ASSESS

Use the group data sheet, presentation, individual report, and group discussion to assess if students can

- describe how different pollutants affect brine shrimp.
- explain how the death of the brine shrimp affects the rest of the bay's ecosystem.
- demonstrate the procedure of a scientific experiment (e.g., having a control, keeping variables the same, etc.).
- identify how policy decisions may be based on scientific data.

Extend GroupWork 4 by having

- students test the pH of the polluted water using pH paper.
- students give houseplants too much fertilizer so that they chemically "burn."

Groupwork 4: Activity Guide (Student Reproducible)

Water Pollution-Bay Water

Big Idea: Human Impact on the Environment

Help! The mayor of Peaceville Bay desperately needs your advice. The city's bay is polluted. The mayor has hired a number of teams to investigate the problem. She would like your team to investigate the effects of pollution on brine shrimp. Here's a little information about brine shrimp to start.

Brine Shrimp

Brine shrimp are small crustaceans. They feed on green algae and are found in salt lakes or brine ponds worldwide. The water in which brine shrimp live is usually 25°*C* to 30°*C* and neutral to slightly alkaline. The water's saltiness varies from place to place and is related to the salt tolerance of the brine shrimp's predators. Some species of brine shrimp show a positive response to light and some show a negative response.

Brine shrimp reproduce often. Their eggs can survive dry or anaerobic conditions for up to three years. Brine shrimp are often sold as food for fish and other small animals in aquariums.

Materials

- Live brine shrimp, glass or plastic containers, spoon, and clean and "polluted" water solutions

Procedure

1. Read the attached report (Resource), which describes the history of the bay.

2. Before your team begins, discuss the following.

- How does polluted water affect aquatic organisms such as brine shrimp?
- Are there safe levels of pollution?
- Are some pollutants more deadly than others?
- What would happen to a bay if all the brine shrimp died?

3. The mayor of Peaceville Bay has been informed that polluted water from factories and farms has been draining into the bay. She would like your team to pinpoint what's killing the bay's brine shrimp. Two possible pollutants are acid rain and farm fertilizers. Using the materials provided, conduct an experiment to determine the effects of these two pollutants on brine shrimp. Record your results on the data sheet.

4. Discuss with your group other possible pollutants in the water. Design an experiment to test the effects of these other pollutants on brine shrimp.

5. Create a report for the mayor and city council, which presents your findings. Include the following.

- the effect of acidic water and fertilizer on brine shrimp
- a plan to test the effect of other pollutants on brine shrimp
- steps the community can take to save the brine shrimp and other life in the bay

Groupwork 4: Individual Report (Student Reproducible)

Water Pollution-Bay Water

Big Idea: Human Impact on the Environment

1. What procedure did you use to test the effects of acid rain and fertilizer on brine shrimp? Explain the specific steps of your procedure so that someone else can repeat the experiments.

2. Why is it important for Peaceville Bay to save its brine shrimp? How does acidity affect brine shrimp? Fertilizer? Include evidence from your experiments.

3. What can the community do to save the bay and improve its own quality of life? What kinds of human activity are polluting Peaceville Bay? How do you know?

Groupwork 4: Resource (Student Reproducible)

Water Pollution-Bay Water

Big Idea: Human Impact on the Environment

History of Peaceville Bay

A large community of organisms lives beneath the surface of Peaceville Bay. Light that penetrates the surface and minerals in the water support plants, which are the basis of the bay's food web. All the plants and animals in the bay are part of this food web. Some of the organisms in the food web are algae, fish, frogs, clams, and birds.

Originally, a Native American tribe lived near the shore. The Native Americans apparently had been there a long time because their village and fields were well established. The first Europeans to find the bay were fur trappers. Like the Native Americans, they were attracted to the bay. The land was fertile and moist, and crops grown there could provide food for many families. There were also many animals, and trapping was easy.

As word about the bay spread, more and more people were attracted to the area. Forests were cleared to develop more farmland and grazing land for cattle and sheep. When the forests were cut down, fur-bearing animals disappeared, putting the fur traders out of business. They solved this problem by producing items such as cloth, guns, plows, and luxuries in their own workshops. Then the settlers expanded their workshops into small factories.

Many factories were successful and people came to work in them. As a result, additional food was required and the remaining forests were converted into cropland. Slowly but surely, the bay area evolved into the massive industrial and agricultural center it is today.

Soon there were no more forests that could be cleared for farming. In order to feed the growing population, the farmers needed to increase the amount of food produced on their farms. About this time, fertilizers were developed. By using fertilizers, farmers could plant all their fields every year without worrying about affecting the quality of the soil.

A few years later, people noticed more algae in the bay than before. Soon swimmers complained about the slime that clung to their bodies. The mayor's office was swamped with many angry descriptions of the foul odor coming from the water. A reporter for the local newspaper wrote that the crowds of Sunday afternoon swimmers and picnickers on the beaches had been replaced by dead fish and masses of rotting algae.

Groupwork 5: Teacher Activity Notes - Clearing the Rain Forests

Big Idea: Human Impact on the Environment

PLAN

Summary After learning about deforestation and indigenous peoples, students create a role-play of a debate over the use of a rain forest.

Multiple Abilities

- Creating a role-play, taking the role of an imaginary person, directing group's role-play, expressing emotions, imagining an experience you have never experienced (creative/dramatic ability)
- Considering multiple perspectives, logically analyzing the problem, applying previous knowledge (reasoning ability)
- Reading comprehension (conventional academic ability)

Interdisciplinary Connection

- Dramatic Arts

Estimated Time 50 minutes

Student Materials

Art supplies for props, paper, and costumes

IMPLEMENT

- When introducing this activity, you may wish to share the following quote with your students. Although uttered in the 1800s, it makes a point that is still relevant today: how you perceive the land influences how you treat it.

  You must teach your children that the ground beneath their feet is the ashes of our grandfathers. So they will respect the land, tell your children that the earth is rich with the lives of our kin. Teach your children what we have taught our children-that the earth is our mother. Whatever befalls the earth, befalls the sons of the earth. If men spit upon the ground, they spit upon themselves. This we know. The earth does not belong to man; man belongs to the earth. This we know. All things are connected like the blood, which unites one's family. All things are connected.... (Source of this quote is in question. However, it is sometimes attributed to the Native American Chief Seattle)

- The video is titled *Race to Save the Planet: The Diversity of Life* and is 15 minutes long. Please feel free to use another video of approximately the same length.
- The role of recorder is especially important in this activity. Emphasize to the group(s) that the recorder should take careful notes of the points discussed so that they are included in the role-play.

Extension Questions

- Do some people want to save the forest only because they see it as a commodity, as a source of plants and animals that could be useful to humans? Are these the *right* reasons?
- If removal of the rain forests continues, how will life be different for future generations? How will the earth be different?

ASSESS

Use the role-play, individual report, and group discussion to assess if students can

- identify how and why humans have changed the face of the rain forests.
- explain that rain forest destruction is a very complicated issue. There are both costs and benefits to deforestation, and what's *right* depends on one's perspective. Thus, there is no one easy solution to the problem of deforestation.

Groupwork 5: Activity Guide (Student Reproducible)

Clearing the Rain Forests

Big Idea: Human Impact on the Environment

Tropical rain forests are disappearing at an alarming rate. People in the countries with rain forests are cutting them down to make the land available for people to use and live on. These countries are often poor and view land development as a money-making opportunity. Who wins and who loses when rain forests are cleared?

Materials

- Art supplies for props, paper, and costumes

Procedure

1. Watch the video about the clearing of rain forests. Discuss the following questions.

- Why develop the rain forests? Use specific examples from the video to support rain forest development.
- Why preserve the rain forests? Use specific examples to support rain forest preservation.
- Which position do you take? Why?
- What factors influence a person's opinion about this issue?

2. A large piece of rain forest in the Amazon is being considered for development. Create a role-play in which the following groups debate what should happen to this land-farmers, native Indians, ecologists, local government officials, and international banks and corporations. (See the resource card.) Your role-play should include a script, present *all* sides of this issue, and offer a possible plan for the future of this rain forest.

3. Prepare to present your role-play to the class.

Groupwork 5: Individual Report (Student Reproducible)

Clearing the Rain Forests

Big Idea: Human Impact on the Environment

1. What are the best reasons for cutting down rain forests? What groups of people, in general, support cutting down the rain forests? Why?

2. What are the best reasons for preserving rain forests? What groups of people, in general, support protecting the rain forests? Why?

3. Which group in the rain forest conflict do you support? Why?

Groupwork 5: Resource (Student Reproducible)

Clearing the Rain Forests

Big Idea: Human Impact on the Environment

The following groups wish to have a say in the development of the rain forest land.

Farmers, with "western technology" (tractors and other heavy machinery, chemical fertilizers, and pesticides), are waiting to clear the forest so they can farm the land and feed their families.

Native Indians of the Amazon have lived and raised food on this land for centuries; they believe the land is sacred.

Ecologists who study the rain forest know that clearing the land causes the extinction of many species. This loss of diversity could mean the loss of many benefits to humans and the destruction of the entire rain forest ecosystem.

Local Government Officials want to give land and jobs to the thousands of people crowding their cities. This rain forest could help the country make money and payoff some of its debts.

International Banks and Corporations from foreign countries know it is very profitable to build roads and towns deep in the rain forest. That way people can raise cattle and harvest the trees, rubber, and other products of the rain forest.

Groupwork 6: Teacher Activity Notes - Culminating Activity: Earth Day Plan

Big Idea: Human Impact on the Environment

PLAN

Summary Students apply what they have learned in this unit to their own lives.

Multiple Abilities

- Considering multiple perspectives, logically analyzing the problem, applying previous knowledge (reasoning ability)
- Reading comprehension and writing (conventional academic ability)
- Explaining ideas clearly and fully, sharing information (communication ability)

Interdisciplinary Connection

- Social Studies

Estimated Time 50 minutes

Student Materials

None

IMPLEMENT

- Encourage students to develop a realistic Earth Day plan. Remind them they will be asked to enact their plan. We suggest the following lesson plan.

Day 1: Arrange students in groups. Ask each group to research *the causes* of one to several environmental problems examined during the Group Activities. Provide the groups with additional resource materials.

Day 2: Conduct a class discussion. Ask each group to present its research. List the causes of each environmental problem.

Day 3: Arrange students in groups. Ask each group to complete the Culminating Activity described on the Group-Work 6 Activity Guide.

Day 4: Ask students to make any necessary arrangements in preparation for Earth Day.

Day 5: Students enact their Earth Day plan.

Day 6: Conduct a class discussion. Ask students to reflect on their Earth Day experiences. How did the day go? Was it a worthwhile experience? What things would they change if they repeated the activity? Will they make any permanent changes to their daily routine?

Extension Questions

- What are ways to encourage others in your community, state, or country to be "earth conscious"? Do you think such efforts are worthwhile? Explain.
- Will you change how you live as a result of completing this activity? Explain.

ASSESS

Use the discussions, individual report, and Earth day plan to assess if students can

- identify how humans have changed the environment around them.
- explain how they can make changes in their behaviors to decrease the harm done to the environment.

Groupwork 6: Activity Guide (Student Reproducible)

Culminating Activity: Earth Day Plan

Big Idea: Human Impact on the Environment

In the orientation to the group activities, you were asked the following questions: How do humans affect their environment? More specifically, how do you and the people in your community-your family, friends, and neighbors-affect land, water, air, and other species? The group activities allowed you to begin answering these questions. Now, in the culminating activity, you will attempt to apply what you have learned to your own life.

Procedure

1. Individually, write down your schedule during a typical school day-what you do from the time you wake up to the time you go to bed.

2. Share your schedule with the rest of your group. Did you leave out anything of importance?

3. As a group, discuss the following questions (refer to the class discussion and your own research):

- Which activities in your schedule harm the environment or other species? How does each do so?
- Which activities harm the environment but are too difficult to change?

- Which activities could you change to be more environmentally conscious? Which could you eliminate? What could you do in their place?

4. As a group create an Earth Day plan. In other words, revise your typical school day schedule to make it more environmentally conscious. What would you need to do to enact this plan?

5. Prepare to present your Earth Day plan to the class. In your presentation, include a proposal to the principal of your school for an Earth Day.

Groupwork 6: Individual Report (Student Reproducible)

Culminating Activity: Earth Day Plan

Big Idea: Human Impact on the Environment

1. What are several activities in your daily routine that harm the environment or other species? How do they do so?

2. Which activities in your daily routine harm the environment but are impossible to change? Did you eliminate these activities from your Earth Day routine? Explain.

3. In light of this activity, will you make any permanent changes to your daily routine? Explain.

4. Is it realistic to ask people to change their lives to protect other species and to preserve the environment? Use examples to support your answer.

15.2 Projects

The following Projects are an assortment of long-term activities that can be completed individually, in groups or as a class. We have provided starting points for research and development; you and the students can work together to create a more detailed plan of action. Consider the following two recommendations. First, because of the amount of work involved in a Project, students should choose one of great interest to them. Second, to encourage excellence and promote student-student learning, students should present their finished projects to the rest of the class, to the school and to the community, if appropriate.

Project 1: Research Questions and Action Projects

Project 1 differs from the others: it is a list of possible research topics organized according to some key ideas and addressed to students.

In assigning a Research Question or Action Project, we ask that you allow students to choose their topic-either one provided or one of their own. You might also:

1. Specify length of piece.
2. Make clear the purpose and the audience.
3. Suggest sources and ideas for information.
4. Provide in-class time for compiling information and writing.
5. Require students to exchange papers and provide written feedback.
6. Provide a breakdown of due-dates for the following stages: choice of topic, outline, rough draft and final draft.
7. Permit students to supplement a written report with a skit, a piece of artwork, a piece of music, a dance, a video, or a multimedia presentation.

ASSESS

Provide the students with evaluation criteria that include:

- accuracy of the content based on guiding questions.
- clarity of writing.
- effective organization of main ideas.
- use of detailed examples or citing evidence to support their conclusions.

Project 1: Teacher Activity Notes - Research Questions and Action Projects

1. **Learn About Natural Communities.**

Research local examples of energy flow from producers to consumers, the cycling of water, carbon and nitrogen, niches and habitats, species interactions, or human impacts on the environment. You can visit local parks, vacant lots, and backyards to conduct your research.

2. **How Do You Interact with the Environment?** Take an active role in improving this interaction. You can:

- collect information that illustrates the uniqueness of your own natural communities.

- decide what major living and nonliving factors must be kept in balance in order to keep the environment functioning well.
- identify some problems that threaten the continuing ecological balance of your community.
- explore some possible solutions to these problems. Which solutions are best and why?

3. **Eat Low on the Food Chain.** Find and implement ways of eating low on the food chain, that is, by eating more grains and vegetables and fewer meat and animal products. You can:

- plan a meal based on grains, fruits, and vegetables. Emphasize the nutritional benefits of eating low on the food chain by including a nutritional breakdown of your menus.
- plan and grow a vegetable garden. The garden could be as small as a bowl of bean sprouts sprinkled on a clean, wet sponge, or as large as rows of vegetables on a plot of ground at the school site. You can grow herbs such as basil, parsley, and chives in window boxes or pots in the classroom.

4. **Ecology in the News.** Gain awareness of the importance of knowing about ecological principles by analyzing newspaper and magazine articles focused on ecology and the environment. This activity can be an ongoing activity throughout the year. You can use the information sources to find articles relating to the environment. Some suggested topics are

- use of pesticides in agriculture
- deforestation
- water pollution
- toxic materials in the environment
- endangered species
- food shortages caused by drought

5. **Cleanup Projects.** Ask school, town, and park officials what needs cleaning up in your community. Cleaning up parks, public nature areas, local streams, or lakeside areas can be done in supervised groups sponsored by the school or in conjunction with other community groups. During and after the project, you may write articles for the newspaper and prepare photos or videos to help share your experiences with the school and community.

6. **Upkeep and Improvement of Wildlife Preserves.** Check with your local park department or state offices of Fish and Wildlife Services for possible restoration or park management projects. You can help trim plants, build animal shelter, restore damaged streambeds, participate in beach cleanups, or perform a multitude of other helpful tasks. You may also want to learn more about the particular plants and animals living in the area in which you are working.

7. **Wildlife Rescue Shelters.** If your community already has a facility that takes in injured or sick wild animals, contact it and find out if there are any projects with which you can help. Perhaps a guest speaker from the shelter can introduce the operation.

8. **Find-Raising for Contribution to Environmental Organizations.**' Many environmental organizations have programs for schools in which they send information and posters in return for your contribution.

Contact

- Rainforest Action Network, 300 Broadway, Suite 28, San Francisco, CA 94133
- World Wildlife Fund, 1250 24th St. NW, Washington, DC 20037
- Sierra Club, 730 Polk St., San Francisco, CA 94009
- Nature Conservancy International, 1800 North Kent St., Suite 800, Arlington, VA 22209

or local organizations according to your class's interests. The Rainforest Action Network sponsors a "Protect an Acre" program for this purpose. For further information about this project and other related resources, contact the main office of the Rainforest Action Network.

Make sure that this type of fund-raising project is within school and district guidelines. In addition to student suggestions, fund-raisers can include bake sales within the school, PTSA, and community; sales of items on which students earn a "commission" for the project, such as reusable lunch sacks with a school emblem; auctions of student services, such as homework tutoring or baby-sitting; car washes; or holiday gift sales.

9. **Eco-Shirts.** You can increase community awareness of environmental problems while making money to donate to an environmental organization by selling T-shirts with an ecology theme. Buy white T-shirts in bulk (only a few dollars per shirt) and permanent marking pens. Set up a table at school or a community gathering and let people make their own Eco-Shirts for 7 or 8 dollars each. Posters and information about environmental problems may provide people with ideas for their shirts. You can also use fabric paints, but they are more expensive than marking pens.

10. **Improving Efficiency of Home Energy Usage.** Local utilities offices often have educational outreach departments that provide materials and speakers to educate the public about efficient use of energy in the home and workplace. Invite a guest speaker or ask for printed materials to help you develop a project. One possibility is a home energy-use evaluation to help you assess energy efficiency at home.

11. **Community Recycling Projects.** If your community has a recycling program, find out ways in which you can participate in the program both at school and at home. If your community doesn't have a recycling program, join with your PTSA and other local organizations to begin one. For financial assistance, contact local business people either directly or through service organizations.

12. **Research an Endangered Species.** Find out which local organisms are on the endangered species list, and learn about the characteristics and habitat requirements of those organisms. Investigate programs designed to help preserve these organisms. You can answer the following questions to guide your research:

- What are some endangered species in our state?
- How can I find out about these species?
- Why are these species on the endangered species list? What is threatening them?
- What is being done to protect these species?
- What can I do to help?

The first step in any research should be to contact your local library. Additionally, you can write business letters to organizations for information such as state natural resource agencies, the Sierra Club, or the Nature Conservancy. You can also conduct phone interviews to find out about efforts to protect endangered species. Periodical searches, both in the library and on-line, can also be invaluable in finding up-to-date information on the status and politics of endangered species.

Project 2: Teacher Activity Notes - Population Boom or Bust

PLAN

Summary Students observe a population of fruit flies growing in an environment that has certain limitations. Students consider how this population is similar to a human population growing in an environment with a limited carrying capacity.

Estimated Time

One 50-minute period for setting up the containers

An ongoing weekly or monthly project throughout the year

Twenty minutes a week for checking progress of populations

Student Materials

- Safety goggles
- 2-liter plastic drink bottle, empty
- Cutting instruments, such as single-edge razor in safety holder, scissors, exacto knife
- 2 to 3 small bottle lids or empty 35 – mm film canisters
- Plastic lid, sized to fit snugly into the bottom of bottle base
- Hammer
- Small nail
- Piece of wood (to protect table when pounding in nail)
- Tape
- Food for fruit flies, such as fresh ripe banana or canned pumpkin
- Yeast, dried (optional)

Reference: *Bottle Biology* from the Bottle Biology Program, University of Wisconsin-Madison, Department of Plant Pathology, 1630 Linden Drive, Madison, WI 53706, (608) 263-5645.

Product

Functioning fruit fly breeder

IMPLEMENT

The purpose of this project is for students to observe and maintain a living population of organisms. Students can watch the population of fruit flies grow and decline with the manipulation of various variables, such as food types and amount of space. Choose from the following investigations to experiment with your population.

1. See the Resource for setting up the fruit fly breeder.

2. Maintain the fruit fly colony.

To maintain the fruit fly colony, you will need to give the flies fresh food. You can access the food containers to replace them by moving the top of the breeder carefully and pulling it out of the base. This disturbance should cause the flies to move into the top of the breeder where they cannot get out. Then you can carefully and quickly remove the old food containers and replace them with new ones. Replace the top part of the breeder securely when you have finished.

3. Start a new fruit fly colony.

What can you do with the old food containers, which contain fruit fly eggs? You could make another breeder by placing them into a new breeder apparatus. The fruit flies will hatch out into the new breeder while new fruit flies enter through the hole in the lid. In this way, you can begin a new population of fruit flies.

4. Try different kinds of foods to find out which ones the fruit flies like best.

Which kinds of foods do fruit flies prefer? Do they prefer foods with or without added yeast? Cooked or raw? Design experiments to test different types of foods. Make observations and then explain what you have observed.

5. Try different sizes of bottles for a fruit fly colony.

Which size bottle seems to work best for starting and maintaining a fruit fly colony? Try a 1-liter bottle, and even a smaller sized bottle. How can you tell which type is best? Observe and record your results.

6. Design a better fruit fly trap and breeder. Experiment to create other designs for making a fruit fly trap and breeder.

Assess if students can

- describe the characteristics and behaviors of fruit flies, *Drosophila melanogaster.*
- make accurate observations of the fruit fly population through the use of drawings as well as text.
- identify what happens to the fruit fly population as a result of changes in type of food and/or amount of space.

- graph the fruit fly population growth over time.
- design and maintain a more efficient fruit fly trap/breeder.

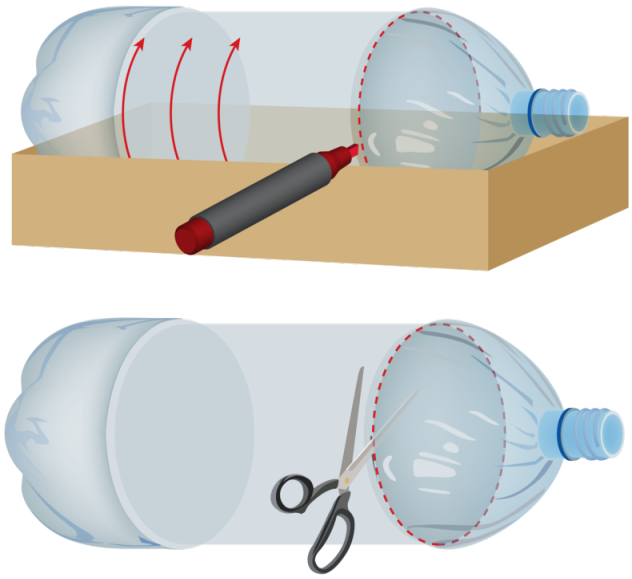
Project 2: Resource Population Boom or Bust (Student Reproducible)

Caution: Follow safety rules and wear safety goggles when using cutting instruments and hammers.

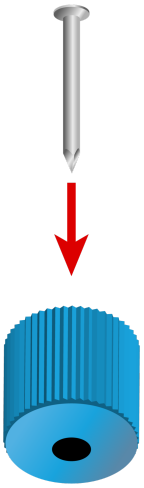
Procedure

1. Remove label and base from bottle by using warm water.

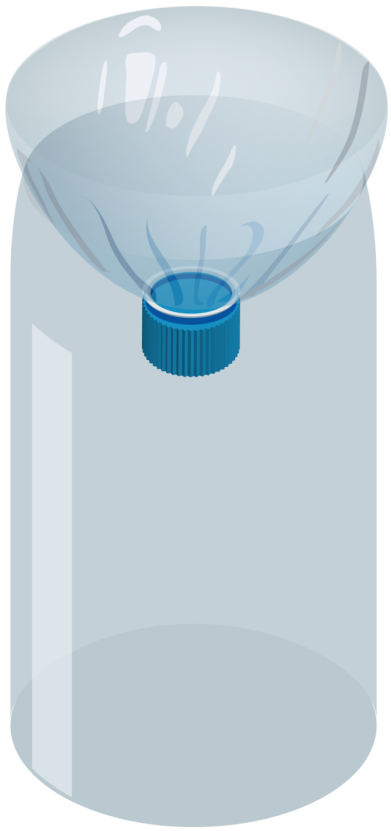
2. Cut bottles as shown in the diagrams below.



3. Place the bottle lid on a piece of wood with the open end up. Using a hammer and a small nail, make a hole in the lid. It is important to create the hole in the direction shown to make it easy for the flies to enter the breeder and difficult for them to leave. It is also critical that the hole is *only* large enough to allow a single fly to enter.

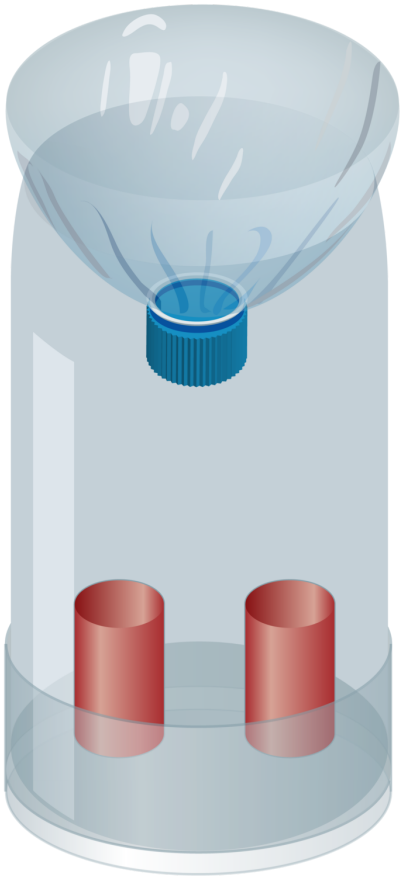


4. Invert the bottle bottom and place it into the straight portion of the bottle, as shown at right. Tape *carefully* and securely so the flies will not leave the container.



5. Fit a small plastic lid snugly into the bottom of the base to block the holes.

6. Add some mashed banana to the "food containers" (lids or film canisters). Place the food containers into the base.



7. Now put the top of the breeder completely down into the base. It should fit firmly.

8. Place the breeder in a place where you think there might be fruit flies. If the weather is warm, the breeder could even be put outside near a garbage can. Eventually, wild fruit flies should be attracted by the food to fly into the bottle through the hole in the lid. In general, flies will come more quickly in the warm weather of summer. You may catch more than fruit flies. Make sure that you eliminate the other insects you have attracted and start a colony only with fruit flies.

9. Flies will lay their eggs in the fruit. Larvae will hatch shortly and the flies will soon become adults. The fruit fly life cycle is about 10-14 days (at $24 - 27^{\circ}C$).

Project 3: Teacher Activity Notes Species Diversity of Birds

PLAN

Summary Students learn about the species diversity of birds in their area by designing an experiment that uses bird feeders to observe and analyze local bird species diversity.

Estimated Time

One 50-minute period to design experiment

Two 50-minute periods for setup

Student Materials

- Safety goggles

For Bird Feeder 1:

- Plastic drink bottle
- Plastic lids from containers (plastic lid must be about 4" larger in diameter than the bottle)

Examples:

- individual water container + 2 lids from 8-ounce soft margarine containers
- 1-liter soft drink container + 2 lids from 2-pound coffee cans
- 2-liter soft drink container + 2 lids from larger cans
- Cutting tools (such as scissors, single-edged razor in safety holder, knife)
- Wooden dowels or sticks for bird perches (6 inches longer than the diameter of the bottle)
- Strong cord for hanging bird feeder
- Hammer
- Nail

For Bird Feeder 2:

- Empty milk carton, 1-qt or 2-qt size
- Stick or dowel for perch (6 inches longer than the diameter of the bottle)
- Strong cord for hanging bird feeder
- Cutting tools (such as scissors, single-edged razor in safety holder, knife)

References:

- *Ranger Rick's Nature Scope,* Volume 1, Number 4, "Birds, Birds, Birds," published by the National Wildlife Federation.
- *Birdwise* by Pamela M. Hickman, Addison Wesley Publishing Co.
- "Bottle Biology," University of Wisconsin.
- *An Illustrated Guide to Attracting Birds,* Sunset Publishing Corporation.

End-Products

Functioning bird feeder

Experiment design for testing a variable in bird feeders, or measuring species diversity in birds

Lab report of experiment on birds and bird feeders

IMPLEMENT

1. Have students design an experiment to test one of the following variables or questions, or a question that they can create:

What type of food will best attract certain kinds of birds or the largest number of birds: cracked corn, peanut nibs, millet, or wild bird seed mix?

What kind of bird feeder will best attract certain birds or the largest number of birds?

What location of the bird feeder will attract certain birds or the largest number of birds: near shrubs, high or low off the ground, on different kinds of trees?

What is the species diversity of birds in a specific habitat?

What is the species diversity of birds in different proximities to human activities?

2. Make sure students outline the following considerations in their experiment design: Who will make the observations?

How will they be conducted?

Will photographic, videotape, or tape recorder data be gathered?

How often will observations be made?

What will be the duration of each observation?

At what time of day will observations be made?

At what time of year will the experiment be conducted?

How will you plan to provide food on an ongoing basis?

3. Students can make observations and collect quantifiable data as well as drawings of the different birds they see. Have them graph any data that they collect. Some examples are number of birds attracted by several different kinds of food, types of birds attracted by one type of food, and different locations that attract the most birds.

4. Extensions of this project could include designing your own bird feeder, with specified limitations such as using only recycled materials.

Assess if students can

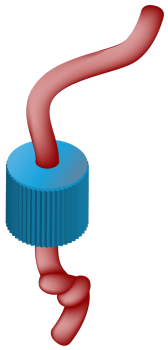
- design and conduct an experiment to test a variable related to bird feeders.
- identify the variable(s) to be tested and include a control in the experimental design.
- write an experimental procedure that can be repeated by someone else.
- develop a procedure for collecting and recording data.
- make observations and collect quantifiable data, as well as create drawings of the different birds.
- construct a graph of data.
- prepare a report to explain the results and conclusions.

Project 3: Activity Guide Species Diversity of Birds (Student Reproducible)

Caution: Follow safety rules and wear goggles when using sharp instruments, hot instruments such as a soldering iron, and hammers.

Procedure for Bird Feeder 1

1. Using the hammer and nail, puncture a hole in the lid. Tie a knot in a piece of string and thread string through the hole in the lid.



2. Measure and mark each plastic lid to indicate the size of the circle that must be cut out to allow the lid to be slipped tightly around the bottle.

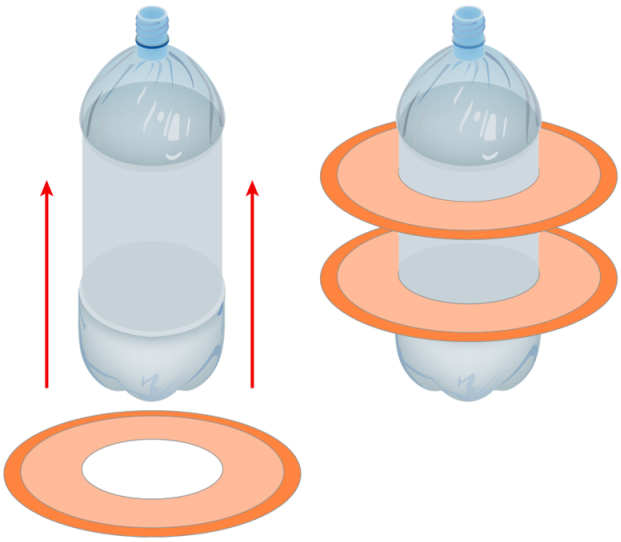
- Place bottle on lid and trace around it.

OR

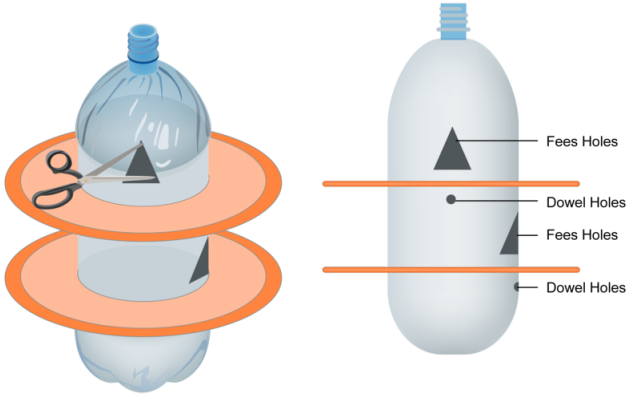
- Use a piece of string to measure the circumference of the bottle. Using the formula for circumference of a circle, calculate the diameter. Using this diameter, mark a circle on the lid.

3. Using scissors, cut out the marked circle from each lid, being careful not to make the circle too large as the lid needs to fit snugly onto the bottle.

4. Fit one of the lids near the top of the bottle. If the lid is too snug, make four small cuts inside the circle at right angles to make it fit. Repeat this process with the second lid, placing the lid closer to the bottom of the bottle.

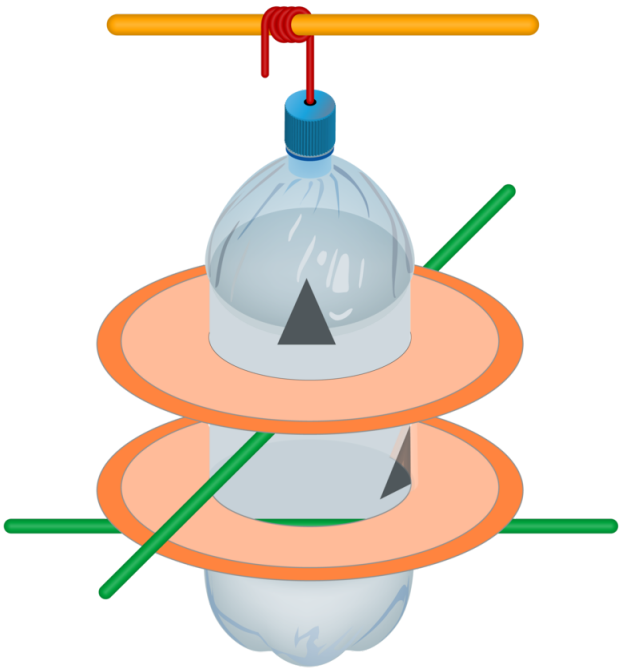


5. Using a soldering iron or scissors, make a hole just under the plastic plate on each side of the bottle to fit the stick or dowel. Now make a small hole above each perch to allow bird seed to fall out onto the plastic lid, as shown in the diagram.



6. Push the dowel through the holes. Be sure that this perch is at **right angles** to the first wooden perch (see above).

7. Cut a length of strong cord and tie it securely through the top of your bird feeder. You are now ready to fill your bird feeder, hang it up, and begin making observations!

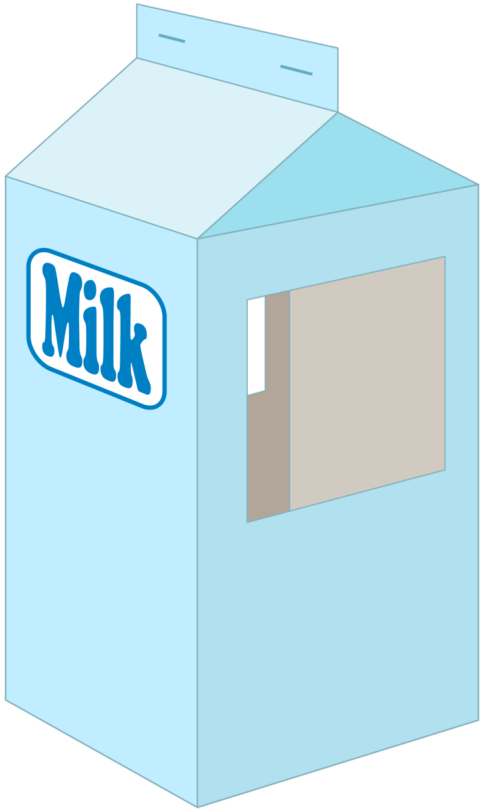


Caution: Follow safety rules and wear goggles when using sharp instruments, hot instruments such as a soldering iron, and hammers.

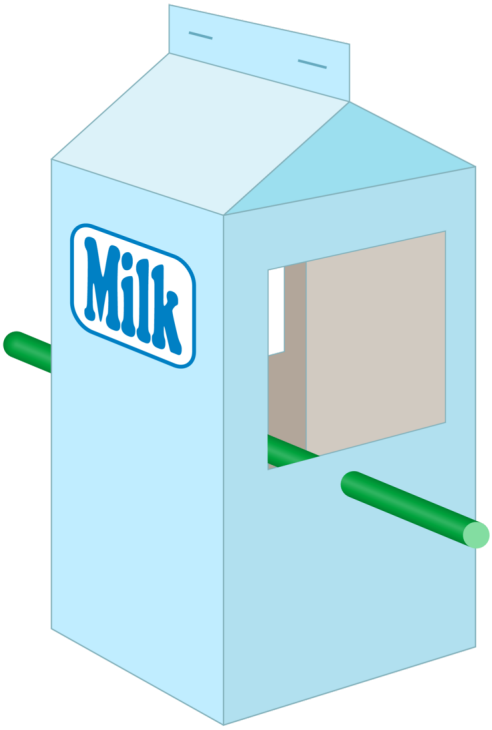
Procedure for Bird Feeder 2

1. Using a pencil, mark the milk carton for two openings. They should begin about 3-4 inches above the bottom of the carton, and extend to not more than 1-2 inches from the top and 1 inch from each of the sides.

2. Cut out each of the openings. Your milk carton should now have two "windows" of equal size on opposite sides.

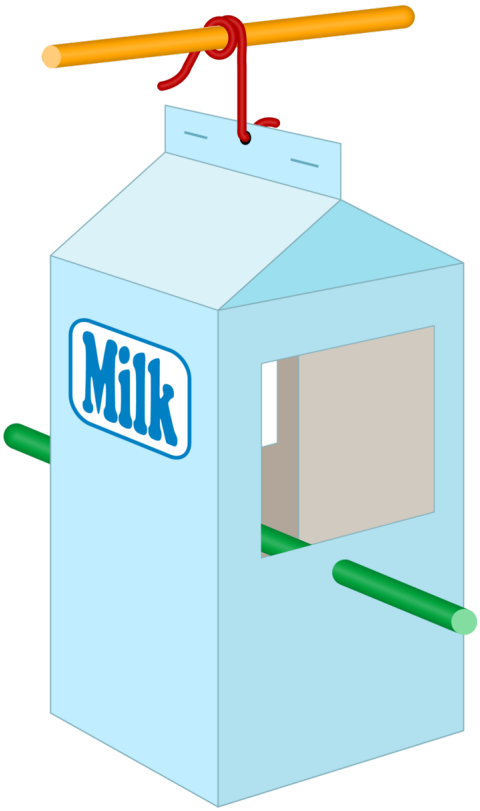


3. Make holes for the perch under each window, and put the stick or dowel through the holes.

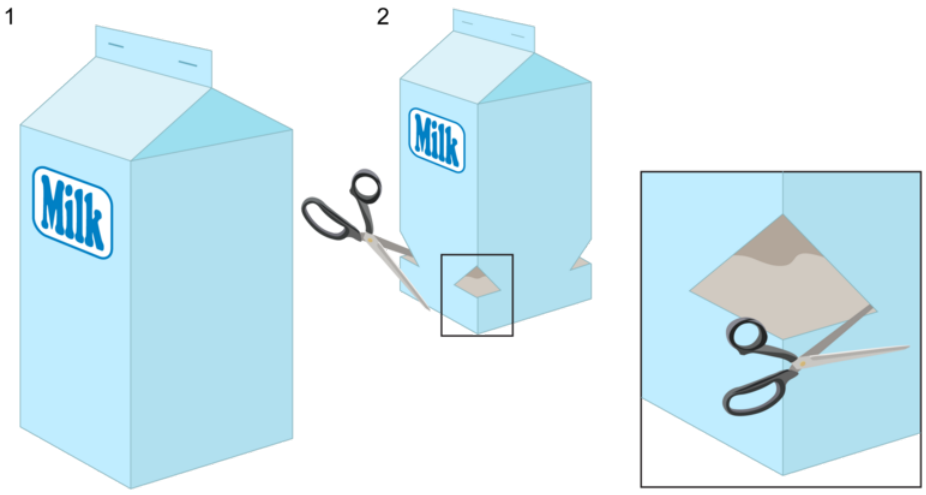


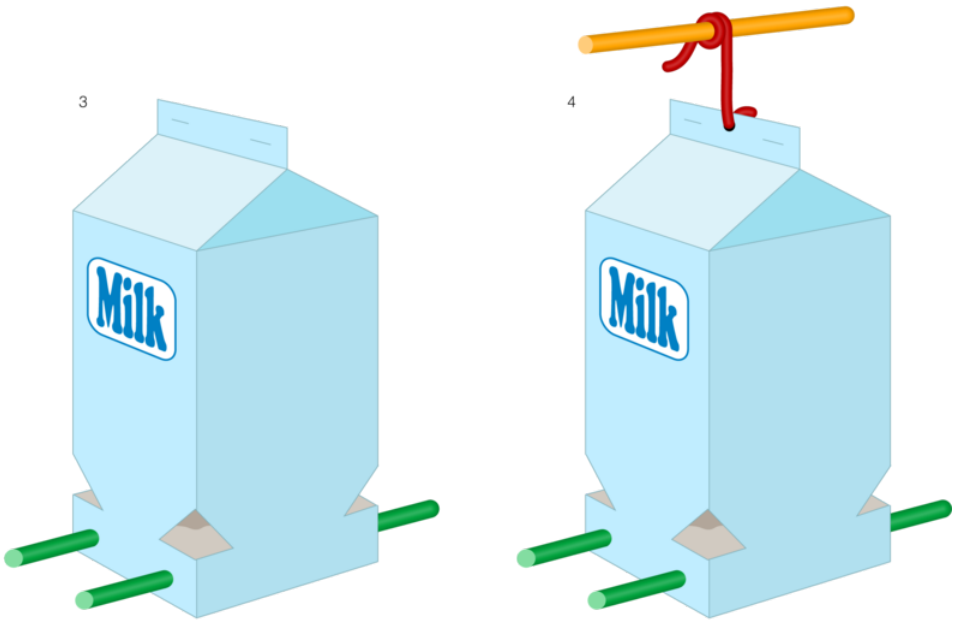
4. Cut a length of strong cord and tie it securely through the top of your bird feeder.

5. Now you are ready to fill your feeder with seeds, hang it up, and begin observations!



6. Another option for creating a bird feeder from milk cartons is given in the illustrations below. Or, be creative and think of your own designs for a bird feeder made from a milk carton.




3
Milk
4
Milk

15.3 Additional Resources

Books and Magazines

Acid Rain. Great Explorations in Math and Science (GEMS), Lawrence Hall of Science, University of California-Berkeley, Berkeley, California 94720, (510) 642-7771.

This unit was developed for students in grades 6-10 to explore the basics of the problem of acid rain.

Appelhof, Mary, Mary Frances Fenton, and Barbara Loss Harris. *Worms Eat Our Garbage: Classroom Activities for a Better Environment.* Kalamazoo, Michigan: Flower Press, 1993.

Integrates earthworm activities with soil science, plant growth studies, and ecological issues.

Attenborough, David. *The Living Planet.* Little, Brown, 1986.

Bottle Biology. Bottle Biology Program, University of Wisconsin-Madison, Department of Plant Pathology, 1630 Linden Drive, Madison, Wisconsin 53706.

Hands-on biology, models exploring ecosystem interactions, population dynamics, biodegradations, microbial fermentation made from plastic containers.

Changes in Ecosystems. Macmillan McGraw, 1993.

Cornell, Joseph. *Sharing Nature with Children.*

Dawn Publications, 1979.

Activities that help introduce children to nature.

Includes calm, reflective activities as well as good group games.

Ecology, Earth's Living Resources. Prentice Hall Science, Prentice Hall, 1993.

Global Warming and the Greenhouse Effect. Great Explorations in Math and Science (GEMS), Lawrence Hall of Science, University of California-Berkeley, Berkeley, California 94720, (510) 6427771.

This unit was developed for students in grades 7-10 to explore the basics of the problem of global warming due to the greenhouse effect, including laboratory activities, simulations, and discussions.

Hickman, Pamela M. *Birdwise, Forty Fun Feats for Finding Out about Our Feathered Friends.*

Addison Wesley Publishing Company Inc., 1988.

Hughes, Monica. *Ring-Rise, Ring-Set.* New York:

Julia McRae Books, 1982. Fiction.

A group of scientists battles to halt the advance of the glaciers. The story explores changes in an ecosystem.

An Illustrated Guide to Attracting Birds. Menlo Park, CA: Sunset Publishing Corporation, 1990. Includes bird identification, plant lists, bird feeders, houses, and baths.

Linden, Eugene. "The Last Eden." *Time*, July 13, 1992. 62-68.

Oliwenstein, Lori. "Free as a Bird: Release of Two California Condors." *Discover,* January 1993, 41.

Ranger Rick's Nature Scope. Washington, DC: National Wildlife Federation, 1985-1992.

A great series on geology, oceans, mammals, astronomy, reptiles, tropical rain forests, birds, trees, dinosaurs, wetlands, weather, pollution, and insects.

Schlein, Miriam. *Project Panda Watch.* New York: Atheneum, 1984.

A true story of how people almost destroyed the panda's ecosystem and nearly caused its extinction, and how people in China are trying to reestablish the panda's natural habitat.

Science Project Cards: Environmental Science.

The Center for Applied Research in Education, Inc., 1978.

"Atmospheric Pollution"

"Do Earthworms Help Soil?"

"The Leaky Faucet"

"Water Testing for Impurities"

Studying Birds at a School Feeder, Teaching Models. The Bird Feeders Society, P.O. Box 243, Mystic, Connecticut 06355.

Thomas, Jack Ward, Robert O. Brush, and Richard M. DeGraaf. "Invite Wildlife to Your Backyard." *National Wildlife Magazine,* April/May 1973.

Violoa, Herman J., and Carolyn Margolis. *Seeds of Change.* Smithsonian, 1991.

Traces the Old and New World exchanges of sugar, maize, potatoes, wine, and horses, as well as diseases brought by Christopher Columbus and others who followed him, causing radical cultural, biological, and environmental change. Beautifully illustrated.

Wilcove, David. "In Memory of Martha and Her Kind." *Audubon,* September 1989.

The death of the last passenger pigeon.

Witty, Helen, and Dick Witty. *Feed the Birds.* New York: Workman Publishing, 1991.

A complete guide to store-bought, recycled, and wild foods for birds of all kinds.

Wong, Karry K., and Malvin S. Dolmatz. *Biological Science, The Key Ideas.* Globe Book Company Inc., 1986.

** Biodiversity Resource Center, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118. (415) 750-7361, Fax (415) 750-7106. The center has many publications available, for example:

Endangered Species

Ehrlich, Paul and Anne. *Extinction: The Causes and Consequences of the Disappearance of Species.* New York: Ballantine Books, 1983.

The Endangered Species Act: A Commitment Worth Keeping. Washington, D.C.: The Wilderness Society, 1992.

Nilsson, Greta. *The Endangered Species Handbook.* Washington, D.C.: The Animal Welfare Institute, 1990.

The Official World Wildlife Fund Guide to Endangered Species. Washington, D.C.: Beacham Publishing, Inc., 1990.

Biodiversity

Challenges in the Conservation of Biological Resources: A Practitioner's Guide. Boulder, Colorado: Westview Press, 1991.

Genetic and Ecological Diversity: The Sport of Nature. London: Chapman and Hall, 1991.

Films, Filmstrips, and Videos

Can Tropical Rainforests Be Saved? 120 min. PBS Home Video. Written and Produced by Robert Richter.

The Diversity of Life. 25 min. National Geographic, 1993. #c 51577. Grades 9-12/adult.

Ecological Biology. 16 min. Coronet Film #38; Video. 16*mm* . or video. Color.

Never Cry Wolf. video. Life of a field researcher in Alaska, based on a book by Farley Mowat.

Software and CD-ROM

Ecosystems. Sunburst CD-ROM. For Grades 4-8.

Designed by Bank Street College of Education. Students learn about food chains, relationships within an ecosystem, and how human activities impact the environment.

The Rainforest. REMedia CD-ROM. Order from Educational Resources, 1-800-624-2926.

An educational guide to rainforests, featuring sections on rainforest ecology, peoples, and debates.

Other Goodies

Hysom, Dennis. "Cloud Forest: Last Great Place on Earth." Nature Company Audio Library Presents.

"Tropical Jungle." 60 min. Cassette of jungle sounds. Produced by Bernie Krause. Nature Company.

15.4 Ecology Glossary

abiotic nonliving materials.

acidity the amount of acid in a substance.

acid rain precipitation containing impurities that can make it highly acidic.

aerobic respiration a chemical process that uses oxygen and produces water and carbon dioxide. It stores energy in the form of ATP.

aesthetics beauty.

biodegradable materials that decomposers can break down fairly easily.

biological community all the organisms living together in a specific area.

biological diversity the variety of life at all levels of organization that exists in an area.

biotic those things that are alive or were recently alive.

birth rate the number of children born each year.

calorie the amount of energy it takes to raise the temperature of one gram of water one degree Celsius. (The calories used to describe food are actually *k* calories or 1,000 calories.)

camouflage the color, markings, body shape, or behavior that helps an animal or plant hide in its surroundings.

carbonification the process by which dead plants and/or animals are turned into coal, oil, or natural gas.

carnivores animals that eat only other animals. Some plants are also considered carnivores because they "eat" insects.

carrying capacity the number of organisms that a habitat can support indefinitely.

CFCs (chlorinated fluorocarbons) gases used in air conditioners and refrigerators that are being released into the atmosphere.

community a group of organisms that lives in the same place.

consumers organisms that get energy by eating other organisms.

cycle a chain of events that happens regularly and has no distinct beginning or end.

decomposers organisms that break down dead matter.

dehydrate dry up.

demographers ecologists who study human populations.

diversity variety.

doubling time the amount of time it takes for a population to double in size.

ecological pyramid a snapshot of the amount of energy or number of individuals at different levels of a food web in a specific location.

ecologists scientists who study the distribution and abundance of organisms in the environment.

emigration a move away from an area.

endangered a species that is threatened with becoming extinct.

environment the physical, chemical, and biotic (living) factors that you affect and that affect you.

ethics a set of moral principles or values.

evaporate change into water vapor.

extinct a species of which all members have died.

food chain a description of the path by which energy moves from the sun to plants and animals.

food web a diagram that shows how food chains in a community are related and interlinked.

fossil fuels coal, oil, and gas that are made up of the remains of ancient plants and animals.

genes structures in almost every living cell that carry genetic information from one generation to the next.

giga one billion.

gigajoule a unit used to measure energy.

global change any worldwide change in the environment.

global warming a warming trend around the world that is caused by an increase of greenhouse gases such as carbon dioxide in the atmosphere.

greenhouse effect the trapping of heat in Earth's atmosphere due to the presence of gases such as carbon dioxide.

greenhouse gas gases that trap heat from the sun in the atmosphere, much like glass traps the heat of the sun in a greenhouse.

groundwater water within the earth that supplies wells and springs.

habitat the physical place where a plant or animal usually lives.

herbivores organisms that eat only plants.

host organism an organism that is used as food by a parasitic organism without the host being killed.

human community all of the people who live around you and help you live where you do.

immigration a move into an area.

joule 0.24 calories.

melanin a pigment that gives color to hair, skin, and eyes.

mimicry a method of protection in which one species or organism looks like another species.

mortality rate death rate.

nature reserves protected areas for wildlife and plants.

niche the full range of biotic and abiotic conditions under which a particular species can live and reproduce.

omnivores organisms that eat both plants and animals.

open water water on the surface of Earth.

organism a complete and whole living thing.

parasite an organism that feeds off another organism without killing it immediately.

photosynthesis a process in which a plant uses sunlight, water, and carbon dioxide to produce sugar and release oxygen.

population all of the individuals of a species living in a certain area at a certain time.

precipitation rain, snow, sleet, hail.

predation an interaction in which one organism kills and eats another.

producers organisms that make sugars through photosynthesis.

proximate cause an action that happens right before an event and that causes the event to happen.

recycle use materials over again, thus saving resources and energy.

resource a substance, object, or space needed by an organism to live, grow, and reproduce.

species a group of organisms that are so much alike that they can reproduce and make others like themselves.

terrestrial net primary productivity a name for all of the sun's energy that is trapped and stored by all of the plants on Earth's land surfaces during photosynthesis.

ultimate cause an action that starts a series of events.

watershed the area of land drained by a stream or river.