Environmental Curricula Review

An Honors Thesis (HONRS 499)

by

Megan Beath and Laura Mynsberge

Thesis Advisors

Dr. Melissa Mitchell

[Signature]

and

Dr. Joel Bryan

[Signature]

Ball State University
Muncie, IN

May 2008

Expected Graduation Dates:

Megan Beath—December 2008

Laura Mynsberge—May 2009
Environmental Curricula Review

Abstract

The use of environmental science curricula in the classroom is an essential tool in educating young children about the ever-changing environment we live in today. Teachers need to expose children to real problems and environmental issues existing in the world, and should allow children to apply knowledge to those problems at hand. Because children are the future leaders for our world, developing an awareness and interest in our world's changing climate may encourage children to take an active role in doing what is best for our planet. In response to this need, we have developed an environmental curricula review that evaluates the content of many environmental educational resources, a resource guide for teachers that explains the strengths and weaknesses of those resources, and adaptations from sample lessons to the Indiana Academic Standards. The Teacher Resource Guide has been electronically sent to the Ball State PDS schools for their use. The curricula we reviewed include Project Wild, Project Wet, Facing the Future: Climate Change, Project LEAP, Project Learning Tree: The Changing Forest, Forest Research Environmental Education Network, and Padilla Bay.

Acknowledgements

We would like to thank Dr. Melissa Mitchell and Dr. Joel Bryan for meeting with and advising us through this project. They were both helpful in the organization, creation, and completion of this thesis project.
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Tab 7 ......................................................... Padilla Bay

Color Code
Divides Portions of Each Curricula

Pink ......................................................... Quick Reference Chart
Green ......................................................... In-Depth Explanation of Content
Orange ....................................................... Adaptations to IN Standards and Sample Lessons
These Questions Were Asked For Each Curriculum Reviewed

General Information
Grade level:
Overall focus or Theme
Affiliation

Teacher Information
1. Does it require additional resources or are materials included?
2. Are assessments included?
3. Does it encourage multiple ways to teach a topic?
4. Are lessons do-able in a reasonable time period (dependent on grade level)?
5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?
6. Does it provide teacher-friendly materials/organization?

Student Information
7. Does it demand higher order thinking?
8. Does it allow students to respond in multiple ways to a given problem or solution?
9. Does it support community involvement? Does it promote the child as a member/citizen of a community?
10. Does it promote social interaction?
11. Does it promote student-centered learning?
12. Is it inquiry based?
13. Does it include some teacher and student materials/books?

Curriculum Information
14. Does it include goals for students/instructional objectives?
15. Does it provide connections that are interdisciplinary?
16. Does it reflect real-world problems?
17. Are multicultural themes included?
18. Does the material build upon prior knowledge?
19. Does it utilize technology?
20. Is it long-term based or short experiments?
21. Does it include direct instruction lessons?
22. Additional Information
Project Wild

Quick Reference Guide and
In-Depth Explanation of Content
### Project Wild Quick Reference

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Project Wild
K-12 Curriculum and Activity Guide

General Information
Grade level: K-12

Overall focus or Theme:
The overall focus or theme of Project Wild is environmental education emphasizing wild life. Project Wild aims to educate children and allow them to make responsible decisions concerning the earth and all of its inhabitants, including humans and their interactions with all non-domesticated animals. The curriculum is further divided into the themes of Ecological Knowledge, Social and Political Knowledge, and Sustaining Fish and Wildlife Resources.

Affiliation:
This curriculum is sponsored by and administered by the Council for Environmental Education and is cosponsored by the Western Association of Fish and Wildlife Agencies.

Teacher Information
1. Does it require additional resources or are materials included?
The curriculum includes many resources and materials within the book. For example, charts, student worksheets, key terms and background information, and useful graphs are all included within the lesson plans provided. There are other required materials that will have to be provided by the school and/or instructor to complete activities involved. However, the materials needed to complete activities are reasonably priced and readily available. Examples of these simple required materials include drawing materials, notebook paper, pH indicators, glassware, seeds, magazine photos, scissors, and glue.

2. Are assessments included?
Evaluations are included, such as questions to answer about the content of the lesson, but paper pencil assessments, such as tests are not included.

3. Does it encourage multiple ways to teach a topic?
Yes, the curriculum does encourage multiple ways to teach a topic. Examples include illustrating an energy route, conducting investigations, portraying meetings between commission officers, pretending to be different animals, creating posters, research, completing activities outside and inside, and simulations. Each lesson does not include multiple ways to teach, but the curriculum overall does include multiple ways to teach environmental science. For example in the grade 5-8 lesson Saturday Morning Wildlife Watching on page 184, students watch and discuss wildlife found in cartoons or comics. In another lesson for grades 5-8, Ethi-Reasoning (p. 203) students read, assess, and write about hypothetical dilemmas concerning wildlife and natural resources.
4. Are lessons do-able in a reasonable time period (dependent on grade level)?
   Yes, most of the activities involved use 1-4 class periods depending on the grade level, and the lesson time per day ranges from 20-50 minutes on average.

5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?
   Each lesson could be modified for special needs and gifted students through differentiation of the lesson or cooperative learning; however, these modifications are not included in the curriculum.

6. Does it provide teacher-friendly materials/organization?
   Yes, Project Wild is very well organized by using the same lesson format for each lesson, and it includes many helpful visuals and tips for teaching the lessons. It also includes essential questions to ask during teaching and provides adequate evaluation techniques.

Student Information

7. Does it demand higher order thinking?
   Yes, it does demand higher order thinking because the lessons focus on real-world problems that demand students to think of possible solutions to these problems. Each lesson includes a Methods section that explains what students will be doing in the lesson. The Methods section uses higher order thinking verbs, such as evaluating a problem, analyzing, and make judgments. In addition, the lessons encourage students to analyze information and form their own opinions on a given issue. For example in the lesson Ethic-Reasoning (p. 203) students must read about different hypothetical dilemmas concerning wildlife and natural resources and assess them.

8. Does it allow students to respond in multiple ways to a given problem or solution?
   Yes. The curriculum does support students in responding to a given problem in multiple ways. Each lesson does not provide students to respond in multiple ways because it focuses on teaching a specific objective; however, throughout the entire curriculum, students are provided many opportunities to respond to their learning about the environment through many ways. For example in the lesson Back from the Brink (p. 355) students are asked to read background information on the recovery of wildlife species and then analyze the issues and make recommendations for their resolution. In another lesson, To Zone or Not to Zone (p. 321) students are asked to portray a meeting of a county commission deciding a land-use issue.

9. Does it support community involvement? Does it promote the child as a member/citizen of a community?
   Yes, Project Wild supports children as members of the community, asking them to observe and take action in their communities with regards to wildlife. For example, in
the lesson *Wildlife Issues: Community Attitude Survey* (p. 297) students are asked to develop a questionnaire and then interview members of the community about their environmental attitudes.

10. Does it promote social interaction?
   Yes, many of the activities involve group and partner work, as well as work within the community. In the lesson *Changing Attitudes*, students are asked to compile many community interviews and summarize their findings. In addition, in the lesson *Improving Wildlife Habitat in the Community* (p. 440) students are to design and complete a project to improve wildlife habitat in their community.

11. Does it promote student-centered learning?
   Yes, the curriculum does promote student centered learning because the lessons and activities are focused on what the student is learning and doing through their activities, and not on teacher-centered instruction. For example in the lesson *Deer Dilemma* (p. 426), students conduct a board of commissioners meeting to discuss the deer population. Students must make a decision about the issue in their meeting. For this lesson students will receive much information concerning the deer population, but will have to make their own decisions about what should happen.

12. Is it inquiry based?
   Yes, students are working on hands-on activities to develop a personal attitude about the environment. For example in the lesson *Owl Pellets*, found on page 100, students must examine their own owl pellets to find what is inside the owl and what is used as a food source. Students may put the skeletons together to find out what the owl ate.

13. Does it include some teacher and student materials/books?
   Yes. The curriculum includes many materials for teachers to use in the lessons through photocopying or cutting them out. It is also very helpful in stating what materials are needed for the students in the lessons and includes group size information. Books are not needed for this curriculum except for the curriculum guide.

**Curriculum Information**

14. Does it include goals for students/instructional objectives?
   Yes, each lesson includes objectives for students to master at the end of the lesson. Most lessons have at least 2 objectives that students are to master by the end of the lesson.

15. Does it provide connections that are interdisciplinary?
   Yes, most of the lessons included consist of other subject areas, such as math, language arts, science, environmental education, and social studies. In the back of the book on page 494, the curriculum guide includes a skills index which highlights every lesson in the guide and which other subject skill areas are covered under which lesson.
16. Does it reflect real-world problems?
   Yes, this curriculum does reflect real-world problems. Students learn about problems in the environment and propose solutions to these problems. They learn about what goes on in the real world and the lessons are geared toward understanding these issues. For example in the lesson Career Critters (p. 371) students must match organisms to environmental problems in a community and evaluate the potential of the organisms to help solve the problem.

17. Are multicultural themes included?
   Yes. The curriculum does support multicultural themes through lessons about social and political knowledge. For example the lesson, Changing Societies, (p. 258) discusses wildlife resources have affected the development of Native American societies and have influenced the culture of Native Americans.

18. Does the material build upon prior knowledge?
   No. Each lesson takes into account the children’s experiences and provides adequate background information in the lesson. However, the lessons are unique to their own objectives, and do not build on previous lessons in the curriculum.

19. Does it utilize technology?
   Yes, many activities require students to do research online and at the end of many lesson there are additional online resources for teachers to extend the lessons. For example in World Travelers (p. 330) at the end of the lesson, it has an area called “Additional Resources” with a link to two other websites to help with this lesson. Also in the “Background” section, it has links to three other websites to be used in this lesson.

20. Is it long-term based or short experiments?
   Both. The curriculum is comprised of short-term projects that students can complete in a few days or a couple class periods.

21. Does it include direct instruction lessons?
   No. However, the activities in the curriculum include many key vocabulary terms necessary for understanding the concepts covered. These terms are presented in the “Background” section of each activity, and may be presented to students using direct instruction. This will allow students to participate in the presented activities with the necessary knowledge to be fully engaged and achieve the highest level of understanding necessary.

22. Additional Information
   This curriculum includes many other additional features for teachers to use. In the back of the curriculum guide are two indexes. One is a skills index, found on page 494, which shows every lesson and what skills it teaches. The other is a topic index, found on page 498, which shows the topics that each lesson covers. It also has an expanded topic index for teachers to access, an early childhood extension, found on page 470, and a section concerning using the outdoor classroom found on page 473. It
includes guidelines for interviewing people and responsible animal usage in the classroom. Finally, it also includes hints for simulated field trips found on page 480.
Project Wild

Sample Lessons and Their Relation to Indiana Standards
Adaptations to Indiana Academic Science Standards

K-4 Lesson Plan, found under Ecological Knowledge
Beautiful Basics Page 58

Science
Standard 1 The Nature of Science and Technology
Scientific Inquiry:
K.1.1 Raise questions about the natural world.
The Scientific Enterprise:
3.1.5 Demonstrate the ability to work cooperatively while respecting the ideas of others and communicating one’s own conclusions about findings.

Standard 4 The Living Environment
Diversity of Life:
1.4.2 Observe and describe that there can be differences, such as size or markings, among the individuals within one kind of plant or animal group.
Interdependence of Life and Evolution:
1.4.3 Observe and explain that animals eat plants or other animals for food.
1.4.4 Explain that most living things need water, food, and air.
2.4.2 Observe that and describe how animals may use plants, or even other animals, for shelter and nesting.
2.4.3 Observe and explain that plants and animals both need to take in water, animals need to take in food, and plants need light.
2.4.4 Recognize and explain that living things are found almost everywhere in the world and that there are somewhat different kinds in different places.
3.4.4 Describe that almost all kinds of animals’ food can be traced back to plants.
4.4.2 Investigate, observe, and describe that insects and various other organisms depend on dead plant and animal material for food.
4.4.4 Observe and describe that some source of energy is needed for all organisms to stay alive and grow.

5-8 Lesson Plan, found under Social and Political Knowledge
Let’s Talk Turkey Page 248

Science
Standard 2 Scientific Thinking
Communication Skills:
6.2.7 Locate information in reference books, back issues of newspapers and magazines, CD-ROMs, and computer databases.
6.2.8 Analyze and interpret a given set of findings, demonstrating that there may be more than one good way to do so.
8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
Standard 4 The Living Environment

Interdependence of Life and Evolution:
5.4.5 Explain how changes in an organism’s habitat are sometimes beneficial and sometimes harmful.

9-12 Lesson Plan, found under Sustaining Fish and Wildlife Resources

Back from the Brink Page 355

Biology

Standard 1 Principles of Biology

Ecology:
B.1.43 Understand that and describe how organisms are influenced by a particular combination of living and nonliving components of the environment.
B.1.46 Recognize and describe that a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.

Standard 1 Principles of Environmental Science

Environmental Systems:
Env.1.2 Understand and describe that if a disaster occurs — such as flood or fire — the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.
Env.1.3 Understand and explain that ecosystems have cyclic fluctuations, such as seasonal changes or changes in population, as a result of migrations.
Env.1.4 Understand and explain that human beings are part of Earth’s ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems.
Objective
Students will identify five basic survival needs shared by people and all other animals, including pets, and wildlife.

Method
Students list and organize needs of people, pets, and wildlife.

Materials
Chalkboard

Background
All animals—including people, pets, and wildlife—need food, water, shelter, and space in which to live. These needs must be in the quality and quantity required by the particular animal. Because animals need food, water, shelter, and space to be available in a way that is suitable to their needs, wildlife biologists say that these components must be available in a suitable arrangement.

NOTE: It may be helpful to do the Project WILD activity “What’s Wild?” on page 7 before this activity so that students know the major differences between pets and wildlife.

Procedure
1. Draw a three-column chart on a chalkboard with the headings People, Pets, and Wildlife. Ask the students, “What do people need in order to be able to live?” List the students’ ideas in a column under the word “People.” Complete the same for pets and wildlife.

2. After the chart is complete, ask the students to cluster ideas together into larger themes. For example, warmth might be combined with physical comfort, and both might fit within the concept of shelter. Help the students to define the lists and to establish the essential survival needs for people, pets, and wildlife. The most basic survival needs will be the same for each of the three groups. The lists could include and be limited to these:

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Evaluation
1. List at least four things animals need for survival.
2. How do human needs differ from animal needs?
Let's Talk Turkey

Objectives
Students will (1) explain the origin and development of a domesticated animal; (2) evaluate the role and influence of the turkey on different cultures over time; (3) describe how human development affected turkey populations; and (4) identify the methods, laws, and management tools used to conserve turkeys in the wild.

Method
Students create a time line chronicling the historical use of wild turkey by societies through time and its ultimate decline and restoration in the wild.

Materials
Copies of the six Wild Turkey Cards on pages 250 to 252, approximately 20 feet of paper for time line (e.g., bulletin board paper), 125 index cards (seventy-five 4" x 6" and fifty 3" x 5"), crayons, pens, pencils or markers, tape

Background
The wild turkey is an ideal species to study when showing how people affect wildlife and what the importance of wildlife is to people. The turkey is divided into two species. Currently, five subspecies of the wild turkey (Meleagris gallopavo) inhabit North America: the eastern wild turkey, the Florida wild turkey, the Rio Grande wild turkey, Merriam's wild turkey, and Gould's wild turkey. A sixth subspecies, the Mexican wild turkey (Meleagris gallopavo gallopavo) is now extinct. The other species of turkey, the ocellated turkey (Meleagris ocellata), is found in a 50,000-square-mile area comprising the Yucatan Peninsula of Mexico, northern Belize, and the El Peten region of northern Guatemala.

The North American wild turkey has been in existence for at least 10 million years. It has provided food and clothing to Native Americans and early settlers, and it provides recreational opportunities to present day hunters and wildlife watchers. The wild turkey was also the genetic source of the domestic turkey, favored for Thanksgiving and other holidays. Settlement of North America by Europeans led directly to a drastic decline in turkey populations but later various groups of people (writers, hunters, conservationists, lawmakers, and others) restored habitat and helped to bring the wild turkey back to its present range. The wild turkey provides a glimpse of the complicated relationship between society and natural resources. (For more detailed information, see the Wild Turkey Cards.)
Procedure

1. Ask the students what they think about when they hear the word “turkey.” After recording all their thoughts, ask students if their thoughts are based on the wild turkey or the domesticated turkey. What is the difference between a wild animal and a domesticated one? Explain to students that in this activity they will be exploring the history of the wild turkey.

2. Divide the class into six groups. Provide each group with one of the six turkey cards. (It is recommended that each student have a copy of the card.)

3. Give each group 10–12 of the 4" x 6" index cards and 6–8 of the 3" x 5" index cards. Referring to the information on the Wild Turkey Card, each group should record the dates and key events/activities important for the turkey on the 4" x 6" index cards. Please instruct students to record only one date and the associated key event/activity on each card. In order to conserve space on the time line, it is best if the students orient the cards vertically with the date highlighted at the top and the key event/activity described under it. Have groups arrange their cards in chronological order.

4. On the 3" x 5" index cards, ask students to come up with phrases or words to describe how turkeys were viewed or used by people during the time period on the Wild Turkey Card.

5. Starting with the group that has Wild Turkey Card #1, have students briefly report their information to the class, as they lay out their cards—along with the associated phrases/word—in chronological order. Attach the cards to the long sheet of paper after all groups have reported to allow for the shifting around of dates.

6. Using spare index cards, ask students to record important facts, if any, about the turkey that are not already included on their time line. After this information is attached, have students decorate the time line with relevant illustrations.

7. After all presentations are completed, have students discuss the following questions: How did people view wild turkeys? Did all people view wild turkeys in the same way at all times? Are there any patterns in how wild turkeys were viewed or used? Is there any correlation between the views or uses of the wild turkey and the reasons for its decline, domestication, restoration, or all three? What laws helped wild turkey restoration? How did writers help set the stage for the restoration of wild turkey populations?

8. Ask students to divide the time line into “eras” or “ages” and to give the ages a name based on what was happening to the turkey (e.g., the “Golden Age of the Turkey”, “Age of the Turkey Feather,” and so on).

Extensions

1. Students can research the history of the wild turkey in their state and can place that information on the time line.

2. Students can research the history of another wild animal in their state and can compare and contrast its fate to that of the turkey.

3. Students can trace another domesticated animal to its origin.

Evaluation

1. Student presentations can be used as an evaluation tool.

2. Describe the differences between a wild animal and a domesticated animal.

3. Describe the contributions and importance of laws, agencies, organizations, and the general public in restoring the wild turkey to North America.

4. Write a poem or essay or create a video that illustrates the interdependence of people, wildlife, and natural resources.
Wild Turkey Cards

Card 1

Scientists estimate that wild turkeys have been around for at least 10 million years. Wild turkeys are native only to the North and South American continents. Once there may have been as many as five different species, but if so, most of these became extinct in prehistoric times. Before European settlement, scientists estimate that 7 to 10 million turkeys were in North America.

Turkeys have been used as a source of food for thousands of years. At the Indian Knoll site in Kentucky, archeologists found large quantities of turkey bones, second only to the number of deer bones. Radiocarbon dating procedures indicated that these turkey bones existed before 3,000 BC.

The use of turkey as food varied among Native Americans. The Navajos, Tonkawas, and Lipans ate turkey, as did the Native Americans living in Connecticut. However, many Apache would not eat turkey, and the Cheyenne believed that eating turkey would make them cowardly.

Turkey feathers were used widely by Native Americans to make blankets, quilts, dresses, coats, and robes. The Cheyenne, as well as other native groups, used turkey feathers on their arrows. In 1612, Captain John Smith noted turkey spurs (from old gobblers) being used as arrow tips in Virginia. Feathers were also used to fashion ceremonial masks and headresses and turkey bones were used to make spoons, beads, and other ornaments.

Many Native American groups—like the Cherokee, Chickasaw, and Mohawk—left turkey hunting to the children. Today's turkeys are very wary of people and are difficult to hunt. However, it appears that in the past turkeys were not shy of people and were considered too easy to hunt to waste the time of the experienced hunters.

Card 2

During the 1600s when Europeans began settling in North America, wild turkeys still were very plentiful. In fact, in 1709 there were reports of turkeys numbering 500 to 1,000 birds in one flock. The settlers began to rely on turkeys as an important source of food because turkeys were so plentiful and the meat was tasty. The turkey's primary feathers also were used for writing quills.

As the continent's population grew (more than 4 million by 1790), more forested land was cleared for farms, towns, cities, industries, roads, and railroads. Wildlife continued to provide food, clothing, and goods for trading and marketing. During this time, there were no effective laws regulating the use of land and wildlife. As expansion continued, wildlife became scarce near towns and cities; consequently, settlers were not able to go out easily to hunt for their own food.

From the late 1700s through the 1800s, market hunters helped supply food for settlers, selling deer, elk, turkey, bison, and other wildlife to markets and restaurants. Initially, wild turkeys sold for as little as 25 cents each. By 1900, turkeys were $5.00 each in Chicago. Continued habitat loss, combined with market hunting, which allowed hunters to sell their game to markets for profit, was taking a toll on many wildlife species.

By 1813, wild turkeys were gone from Connecticut. They were last seen in Vermont in 1842, in New York in 1844, in Michigan in 1897, and in Iowa in 1907. By 1920, the wild turkey was lost from 18 of the original 39 states of its ancestral range and from the Canadian province of Ontario.
Card 3

All turkeys in the world, including the domesticated turkey, are classified into two species. The wild turkey (Meleagris gallopavo) is the most common turkey and is found throughout North America. The ocellated turkey (Meleagris ocellata) is the other species and is found on the Yucatan Peninsula of Mexico, northern Belize, and the El Peten region of northern Guatemala. The wild turkey (Meleagris gallopavo) is divided into six distinct subspecies. Of these, the eastern wild turkey (Meleagris gallopavo silvestris) is the largest and most common subspecies. It originally ranged in the eastern half of the United States. Another subspecies, the Mexican turkey (Meleagris gallopavo gallopavo), is the forerunner of all domesticated turkeys we have in the world today. The Mexican turkey is the smallest of the six subspecies of the wild turkey, Meleagris gallopavo. Originally, it was found in southern Mexico, but it is now considered extinct.

Domesticating a species involves raising the animals in captivity and selectively breeding them for generations. Usually they are bred to benefit people (e.g., more meat, etc.). Eventually, they become very different from their ancestors in behavior and appearance.

When Hernando Cortes arrived in Mexico in 1519, the Aztecs already had large flocks of domesticated turkeys. The Aztecs had domesticated those turkeys from the Mexican wild turkey. How long the Aztecs kept domesticated turkeys is uncertain, but some scientists think those turkeys were introduced to Native Americans in the southwestern United States before 1350 A.D. The Aztecs used these birds mostly for their feathers and for sacrificial ceremonies. There are also reports that Montezuma, Aztec Emperor in 1519, fed about 500 domesticated turkeys daily to his menagerie of hawks, owls, and eagles.

By 1520, Spanish explorers took domesticated turkeys from Mexico to Spain. From there, the turkey quickly spread to Italy and France and then throughout Europe. By 1541, the domesticated turkey had reached England. By 1573, the turkey was so plentiful that it became part of the typical Christmas dinner. With selective breeding, new varieties of domesticated turkey were developed. By 1802, there were at least four standard varieties known in England.

Card 4

When the Spanish arrived in Mexico in the early 1500s, they were greatly impressed with the turkeys that had been domesticated by the Aztecs. Consequently, they took the domesticated turkey back to Spain, where farmers raised it throughout Europe.

Domesticated turkeys soon became part of the standard supplies sent with English colonists to America. In 1607, domesticated turkeys were brought back to North America with the settlers at Jamestown. Domesticated turkeys were also sent to help feed English colonists in Massachusetts in 1629. Soon small flocks of turkeys were being kept by many of the early colonists.

During the 1700s and 1800s, the propagation of domesticated turkeys stayed on a small, local scale. But even at this scale, changes were occurring to the domesticated turkey. The initial domesticated turkeys were smaller than the turkeys of today. They also were smaller than the eastern wild turkey (Meleagris gallopavo silvestris) found commonly throughout the eastern United States. During this time there were reports that local farmers captured wild turkey gobblers (males) and bred them with domesticated turkey hens (females) to obtain a larger bird.

In the 1920s, large commercial turkey farms were established in the United States. By World War II, turkey farming was a major industry. Over the years, selective breeding of domesticated turkeys led to today's domesticated turkey. Domesticated turkeys are now larger and plumper than wild turkeys. Domesticated turkeys come in a variety of colors, and they cannot fly. (Some of the early breeding of domesticated turkeys was done for feather quality and not necessarily meat.) Some of the most popular domesticated turkeys are the Beltsville, Small White, Black, White Holland, and Bronze.

Turkey farming continues to be a major industry. The United States raised about 275 million turkeys in 1999, with North Carolina producing more turkeys than any other state.

continued
Before European settlement, scientists estimate that there were 7 to 10 million wild turkeys in North America. By the 1930s, there were about 30,000 turkeys in the wild. The habitat destruction, unregulated hunting, and market hunting of the 1700s and 1800s decimated the wild turkey population throughout North America.

Land and wildlife were affected as the number of settlers grew. A few laws were passed to try to protect land and wildlife but with the lack of consistent enforcement of the law throughout the country, most settlers did not realize that turkey populations were limited. By the end of the 1800s, the reduction in wildlife populations could not be ignored. By 1900, wild turkeys—along with deer, elk, bison, pronghorns, passenger pigeons, and other species—were reduced to small populations found only in a fraction of their original ranges. By 1914, the passenger pigeon became extinct. Many people feared that the wild turkey would suffer the same fate.

Scientists, hunters, foresters, bird watchers, and others interested in turkey conservation formed organizations to urge conservation. In 1875, the American Forestry Association was founded, emphasizing the conservation of trees and forests. Theodore Roosevelt and George Bird Grinnell established the Boone and Crocket Club, an association of hunters interested in conservation.

Naturalists and writers published books and articles promoting conservation. In 1876, John Muir wrote of the need for the government to protect the forests. Henry David Thoreau published “Walden” in 1854. In 1870, essays and stories were published in Harper’s new Monthly Magazine deploring the destruction of American wildlife and attracting the attention of people throughout the country. In 1849, the Department of the Interior was formed and by the end of the 19th century, some states had formed wildlife agencies. These organizations, as well as popular writings, slowly began to influence the opinions of the general public and lawmakers. The stage was set for the recovery of the wild turkey.

In 1891, the President of the United States was given the power to create forest reserves through the Forest Reserve Act. State laws and the Lacey Act of 1905—a federal law that limited interstate shipment of illegally taken wildlife—curtailed market hunting. The Pitman-Robertson Act of 1937 helped provide funds to states for use in wildlife recovery programs by placing an excise tax on hunting and sporting equipment. Many states established hunting regulations and seasons and, although still small, now had wildlife agencies and personnel to enforce those laws. Some states also established wild turkey refuges, setting aside land for turkeys until the population could rebound.

With the United States’ entry into World War I in 1917 and the Great Depression of the 1930s, the conservation movement slowed. At the same time, abandoned farms and timbered forests reverted to the shrubs and forested land preferred by the wild turkey. After World War II, many state wildlife agencies started to make plans to restore wildlife populations, including the wild turkey.

Obtaining wild turkeys for use in restoration projects was difficult. One widely used method was to raise wild turkeys in pens and release them into the wild. This method was used for almost 20 years but ultimately was not successful. Pen-raised turkeys did not have the skills needed to survive in the wild.

In 1951, biologists began using the cannon-net method to trap wild turkeys for later transfer. A large net was concealed on the ground near bait and quickly propelled over feeding turkeys by an electronically detonated small cannon. Using this method, along with improving habitat for wild turkey, state wildlife agencies were able to increase the wild turkey population in the United States to 1.3 million birds by the 1970s.

Throughout the conservation and restoration movement, volunteer conservation organizations greatly contributed to conserving habitat and wildlife populations. Since 1973, the National Wild Turkey Federation has partnered with state and federal wildlife agencies to provide support in the restoration of wild turkey populations. Today nearly 5 million turkeys can be found in North America, including all states in the United States except Alaska. These birds provide opportunities for bird watchers, hunters, and other people who appreciate wildlife.
Back from the Brink

Objectives
Students will (1) explain the reasons for the decline of certain wildlife species and describe methods used in species recovery, (2) describe the effects of the decline and recovery of wildlife on people and the environment, (3) analyze issues surrounding the decline and recovery of wildlife species and examine strategies to resolve those issues, and (4) describe the importance of an environmentally literate citizen base to the success of the recovery project.

Method
Students are given background information on the recovery of wildlife species, and they are asked to analyze the issues and make recommendations for their resolution.

Materials
Paper; pencils; copies of the background information for the North American alligator, black-footed ferret, and the gray wolf on pages 358 through 361; Issue Analysis Sheet on pages 362 to 363; chalkboard or other large surface; access to research materials or state wildlife agency web sites, if possible

Background
The Endangered Species Act of 1973 requires the U.S. Fish and Wildlife Service to protect federally endangered and threatened species and to develop recovery plans for them. Some of these species are extirpated, or missing from their native range, although they are not extinct. In developing and implementing a recovery plan, you must consider many environmental and societal variables. If recovery of a species is successful, you must consider where reintroduction should occur and how it should be implemented. Biological considerations include researching the habitat (food, water, shelter, and space) needs of each species.

Biologists must take into account many factors. How will introduced species affect the other inhabitants in the ecosystem? Where will individuals of the species being introduced come from? Is there enough genetic diversity for long-term population sustainability? Why did the species decline in the first place? Have there been changes, events, or regulations that will now enable the species to recover?

Today, individuals involved in reintroduction plans consider a species’ carrying capacity and society’s tolerance for living with the species. How does the species affect people? Historically, how have people viewed and valued the species? If that species is an animal, are they afraid of it? Is the animal considered “cute” or “mean?” Do...
people have an understanding of the natural history of the animal? Is there a perception that the recovery of the species will have an impact on the safety of people? Can the species affect their livelihood or limit resources for people on a local, state, or national level? For some species, few conflicts will occur. In other situations, the recovery of a species may raise many concerns and issues.

Recovery plans address different options. Recovery plans may, or may not, include strategies for the reintroduction of the species to native habitats. Important to the selection of a particular option is the classification of the species under the Endangered Species Act. Some species may be classified as an "experimental population." Experimental populations and their associated habitats are subject to fewer regulations and protections. Management of these populations is more flexible and can include a variety of options not permitted in populations designated as "endangered." Various possible scenarios are considered, as the plan examines the effects on the species, the ecosystem, other species, and people. Cost-effectiveness for the different options is examined as well. Before selecting the final option, individuals, groups, and organizations can voice their support or their concerns in public hearings.

The purpose of this activity is for students to analyze the complex human and environmental issues that are involved when a species is reintroduced to an area. It is important that the agencies and groups involved in developing the recovery plan acknowledge and address those concerns, because the long-term recovery of a wildlife species ultimately depends on the conservation measures developed and supported by people.

Procedure

1. Divide the class into groups. Assign each group one of the animals featured on pages 358 through 361, and provide them with the Issue Analysis Sheet on page 362 and 363.

2. Ask students to read the wildlife background information sheet for their animal and review the Issue Analysis Sheet. Have them conduct further research on their animal.

3. Ask the groups to discuss their species and their recovery. Then have the students complete the Issue Analysis Sheet. The sheet will ask students to address the species' preferred habitat; its food; what contributed to the loss or decline of the species; what has helped the recovery of the species; historical range; current range or status of the species (if available); existing or potential issues involved in the species' recovery; the interest groups, agencies, and people involved in the issue surrounding their species; and the steps that have been taken to help resolve these issues.

4. Have students discuss their responses and suggest additional options that might be considered to resolve these conflicts.

5. Ask students to prepare a media brief about their animal. It can be a short "infomercial," formal presentation, brochure, article, or web page. Have the students emphasize the issues and conflicts involved in the animal's recovery. Include the different options or steps they suggest be taken to help mitigate the conflict.

6. Have the groups poll the class for recommendations the students think would best resolve the issues.

7. Using the information provided in the background information sheet and presentations, ask students to construct a class chart summarizing the following: name of the animal, method of recovery, why recovery was able to occur, potential or existing issues or conflicts associated with recovery of the species, the people or groups involved in these conflicts, and the most common strategies selected for helping to resolve the issues or conflicts. Compare and contrast among the species using the following questions to help guide the discussion.
- What changes or events had to occur before species recovery projects could begin?
- How did the loss of the species affect people? The environment? Are the loss and/or recovery important? Why?
- What issues or potential conflicts are involved in the recovery of each animal? Who are the different "players" involved in these issues or conflicts? Are any of the issues or conflicts similar among the species?
- How has public perception of the species influenced decisions related to the issues?
- Are there reoccurring strategies in resolving conflicts associated with these species?
- How important is it that local individuals and groups understand the natural history of the species and its role in the ecosystem? Why?

8. After the class discussion, have the students return to their groups and finalize their recommendations or strategies to help resolve the issues surrounding their species.

9. Have students present the final strategies that will be used.

Extensions

1. Ask students to choose one of the species in this activity and to research what is being done to resolve issues and conflicts surrounding the recovery of the species.

2. Research rare or declining wildlife species found in your state. Develop a plan to bring about recovery for one of those species. How could it be determined if recovery might be feasible? What method could be used? What would justify the recovery of this species? How could local citizens be involved and help to resolve concerns?

3. In groups, have students construct a personnel chart that includes all job categories that might be needed in the recovery of their animal. Describe the role of each position and indicate possible employers.

Evaluation

1. Identify a wildlife species that is or has the potential to be involved in an issue or conflict on a local, state, or international level. Ask students to identify potential problems, conflicts, or issues. What strategies would they use to help prevent conflicts from arising in the first place? How would they resolve conflicts if they did occur? Ask the students to choose a wildlife species from the activity and to create a position statement portraying their views on the issues involved in that species’ recovery.

2. Ask students to choose a wildlife species from the activity and to create a bumper sticker portraying their views on the issues involved in the species’ recovery.
North American Alligator (*Alligator mississippiensis*)

The North American alligator, a member of the crocodile family, can be found in marshes, swamps, shallow lakes, ponds, and waterways in the southeastern United States—from Texas to Florida and as far north as the Carolinas and southern Arkansas. As adults, these large reptiles can weigh more than 500 pounds and measure 8 to 13 feet or more in length.

North American alligators are predators and eat a wide variety of foods including fish, turtles, snakes, birds, and small mammals. The North American alligator has existed for more than 180 million years. It is well adapted to life in the wet areas of the south. Alligators are exothermic. They have no internal method to control body temperature and rely on water to keep their body temperatures lowered in the hot summers. The North American alligator helps retain water in its habitat by creating holes that retain water in times of drought. These “gator holes” help supply water for wetland plants and wildlife.

During the early colonization of the southeastern United States, alligator populations remained fairly stable throughout most of their range. However, at the end of the 19th century, it became fashionable to use alligator hide in boots, wallets, purses, belts, and other fashion items. Market hunters began to take alligators in large numbers to use their skins in the fashion industry. In the 1920s, 200,000 alligators were killed each year in Florida alone.

During the 1920s, thousands of acres of wetlands also were being drained to provide more land for agriculture and development, and to limit mosquito populations. With the combined pressures of habitat loss and market hunting, alligator populations began to plummet. By the 1950s, the American alligator was on the verge of extinction.

Between the 1940s and the 1960s, the southeastern states began protecting their remaining alligator populations. In 1967, the North American alligator was placed on the federal endangered species list, which provided it complete protection. It remained on the list under the Endangered Species Act of 1973. This act emphasizes protection and recovery of endangered species and helps provide funding for research and recovery projects. An amendment to the Lacey Act and CITES II (Convention on International Trade in Endangered Species of Wild Fauna and Flora) also protects the alligator by regulating interstate and international commerce in alligator products. (A South American alligator, not found in the wild in North America, is not endangered and never has been. Those alligators are sometimes sold in pet stores.) As a result of such efforts, the North American alligator has made a complete recovery. Effective management, habitat protection and restoration, law enforcement, and, in some states, reintroduction and restocking have enabled alligator populations to grow dramatically in recent years. In 1987, the American alligator was reclassified from "endangered" to "threatened."

While North American alligator populations continue to grow in the southeastern United States, the human population and associated development is also increasing. Because many people want to live along water, waterfront property has become a prime area for housing developments. People share these waterways with alligators while fishing, boating, swimming, and so forth. Greater contact has led to increased conflict between people and alligators, and most conflicts are due to alligators being in places where people do not want them. Although these reptiles typically stay away from people, people and alligator incidents can result when alligators lose their fear of people because someone has been feeding them. Alligators are large predators and have also been known to prey on household pets.

To help manage alligator populations, some states now allow closely monitored hunting and trapping. Alligator hide and meat are valued commodities. To help meet this need, alligator farming has become a thriving business. Some states have allowed the limited collection of eggs and hatchlings by licensed alligator farms and have allowed limited hunting by private individuals.

North American alligators remain protected on state, federal, and international levels to help ensure their continued survival.
The black-footed ferret is the only ferret native to North America. These long, slender mammals were once found throughout the Great Plains, ranging from southwestern Canada to northern Mexico. Scientists do not think they were ever very abundant. The black-footed ferret is considered the rarest wild mammal in North America.

Black-footed ferrets are members of the mustelid family, along with weasels, otters, minks, badgers, and wolverines. Although they occasionally eat rabbits, mice, and other small mammals, black-footed ferrets feed almost exclusively on prairie dogs—in fact, prairie dogs make up more than 90 percent of a ferret’s diet.

Prairie dogs are burrowing rodents that live in large groups often referred to as "towns." At one time, there may have been as many as 5 billion prairie dogs sharing the prairie with ferrets and other wildlife. It is no coincidence that the ranges of these two animal species overlap. Not only do black-footed ferrets rely on prairie dogs as their main food, but they also live and raise their young in the burrows of prairie dogs.

Prairie dog towns provide food and shelter for many other animals as well. Prairie dogs are the prey of other predators such as coyotes and red-tailed hawks. Burrowing owls use prairie dog holes for nest sites, and many species of snakes, lizards, and amphibians use the burrows for shelter and hibernation.

Prairie dog towns provide recreational opportunities for wildlife watchers, photographers, and hunters. Although valued or tolerated by many people, others consider prairie dogs as nuisances. Besides eating agricultural crops, they eat the prairie grasses that are also eaten by livestock. Most of the land that could be developed in some areas is inhabited by prairie dogs. In addition, prairie dogs can contact sylvatic plague, which, when transmitted to humans, is called bubonic plague.

Since the late 1880s, many methods have been used to control and eradicate prairie dog communities. At the same time, the majority of their habitat (more than 98 percent) has been lost to development. Poisoning, trapping, shooting, and other control measures; habitat loss; and disease have led to a decline in prairie dog populations. This loss of habitat and their major food supply, in conjunction with disease, caused black-footed ferret populations to plummet as well.

In 1967, the black-footed ferret was placed on the federal endangered species list. By 1980, black-footed ferrets were thought to be extinct. Then in 1981, a population of black-footed ferrets was discovered in a prairie dog colony in Wyoming. Biologists began to study these animals to determine what could be done to protect this colony. By 1985, the colony had expanded to 129 animals. Unfortunately, an outbreak of canine distemper almost wiped out the colony. By 1987, the 18 remaining black-footed ferrets were taken into captivity as a last ditch effort to save the species.

In 1988, the U.S. Fish and Wildlife Service adopted the Black-Footed Ferret Recovery Plan. State and federal wildlife agencies in cooperation with several zoos began a captive-breeding program to try to increase the number of black-footed ferrets. The goal of the program is to reintroduce these ferrets into the wild. Overall, the captive-breeding program has been a success. The first project to reintroduce black-footed ferrets into the wild took place in 1991 in a prairie dog colony in southern Wyoming. Since then, small numbers of ferrets have been reintroduced into Montana, Arizona, Utah, and South Dakota. On-site breeding programs have also begun in Arizona, Colorado, and Utah. In 1998, more than 100 black-footed ferrets were born in the wild, and more than 400 were born as part of the captive-breeding program.

Many challenges remain in this reintroduction effort. Little was known about black-footed ferrets, especially about how to raise them in captivity while maintaining their abilities to survive in the wild. Land-use conflicts among farmers, ranchers, and prairie dogs continue to exist, on public as well as private lands. Today, where some prairie dog species continue to be legally classified as "pests," poisoning and other measures are being used to control nuisance colonies. Urban development continues to affect the land used by both prairie dogs and black-footed ferrets. To help address some of the issues associated with the recovery project, the reintroduced black-ferret populations have been designated as "experimental nonessential" populations under the Endangered Species Act.

As land-use practices change and more prairie dog communities are eradicated, the final challenge may be to maintain enough suitable habitat and prairie dog communities for black-footed ferrets to survive in the wild.

continued
Gray Wolf (Canis lupus)

The gray wolf is a highly social animal, and lives in packs of two to more than a dozen animals. Within the pack there is a definite hierarchy of dominant and subordinate individuals. Typically, only the alpha (lead or highest ranking) male and female mate, which helps limit the size of the pack and the number of newborn pups. The alpha pair, along with its offspring, forms the pack. Wolves hunt in packs and will share their food with pups and other adults in their pack. This arrangement is rare in the animal world.

Gray wolves can survive in many habitats where food is plentiful. They usually live in isolated forested habitats interspersed with grassy areas where their prey—deer, elk, moose, and other ungulates—graze. Wolves are large animals and can weigh up to 175 pounds and measure up to 6½ feet in length, but most wolves are about half this size. Although named the "gray" wolf, the color of these mammals varies in shade from black to white to gray.

The gray wolf once was found throughout North America from Canada to central Mexico. When European colonists began to settle in North America, they relied on many species such as deer and elk for food and clothing and for trade. They had very little knowledge about predators. Wolves, like other predators, were viewed with fear or as competitors for important food sources. Settlers were also concerned that wolves would attack their livestock or themselves. Consequently, as early as 1630, large bounties were paid to people to kill wolves. The Massachusetts Bay Colony paid an average month's salary for the head of a wolf.

As more people settled the land, the pressure on wildlife drastically increased. Between hunting and loss of habitat, many wildlife species, including elk, bison, and deer, were almost eliminated from parts of the country. The wolf was being pushed into an ever-decreasing range with a greatly reduced food supply. Conflicts between wolves and people grew. Programs, including those subsidized by the government, were established to eradicate the wolf. By 1897, the eastern timber wolf (Canis lupus lycaon), a subspecies of the gray wolf, was eradicated from the northeastern United States.

Wolves remained fairly common in the wild lands of the northwest through the early 1900s. However, continued habitat loss and eradication programs persisted. By 1950, wolves had been eliminated throughout the contiguous United States except for some remote wild areas in northern Minnesota. In 1967, the eastern timber wolf was included on the federal endangered species list. In 1973, the northern Rocky Mountain subspecies (Canis lupus irremotus) was listed as endangered. With a relatively large eastern timber wolf population surviving in parts of Minnesota, there was some confusion as to the legal status of the wolf in the United States. To clarify the situation, the U.S. Fish and Wildlife Service (USFWS) reclassified the Minnesota wolf as "threatened," and all other gray wolves south of Canada were listed as "endangered."

The Endangered Species Act of 1973 provides protection for endangered species and requires that plans be prepared for the recovery of these species. Over many years, federal and state agencies, as well as interested organizations, conducted studies, held public hearings, and conducted opinion polls to help assess which recovery strategies would have the best chance of success. In 1987, the USFWS approved the Rocky Mountain Wolf Recovery Plan that designated three official recovery areas in the northern Rocky Mountains. These areas were in northwestern Montana (including Glacier National Park and the Bob Marshall Wilderness); central Idaho (the Selway-Bitterroot and Frank Church River of No Return Wilderness Area); and the Yellowstone ecosystem (including Yellowstone National Park and surrounding areas in Montana, Idaho, and Wyoming).

During the early 1980s, wolves naturally began to recolonize in northwestern Montana, dispersing south from Canada. By 1994, approximately 64 wolves were in Montana, forming five packs. As a result, plans for wolf reintroduction centered on central Idaho and Yellowstone National Park. In 1994, final plans were made for the reintroduction. And between 1995 and 1996, 66 wolves were brought to the United States from Canada. Thirty-one were reintroduced into Yellowstone National Park, and 35 were reintroduced into central Idaho.
The reintroduction of wolves into the northwest has been very controversial. Wildlife biologists, environmental organizations, and many individuals applaud the return of wolves as a step in restoring the natural balance in the ecosystem. Chambers of Commerce, shopkeepers, and entrepreneurs view the wolves as a way to attract tourists to the areas and increase profits.

In contrast, agriculture and some hunting and outfitting interests feel the introduction of wolves will affect their ability to make a living. Some are concerned that there will be timber harvest restrictions where wolves have been reintroduced. Some hunters are worried that wolves will reduce opportunities for big game hunting. Sheep and cattle ranchers fear wolves will prey on livestock, thereby affecting their livelihoods. Wolves can and sometimes do prey on livestock. However, not all wolves do, even those near livestock. Wolves that do prey on livestock tend to continue to do so and may teach their pups to do so as well. Some people have expressed safety concerns as they enjoy outdoor recreation in areas where there are wolves even though there are no documented attacks on humans in North America.

Before reintroducing wolves, the USFWS examined several options or alternatives: (1) reintroduce wolves with the wolves classified as "experimental populations", (2) take no action—allow wolves to naturally expand into Idaho and Yellowstone, (3) change laws and prevent wolf recovery, (4) establish legislation for states to implement wolf recovery with no federal oversight, and (5) reintroduce with wolves classified as endangered.

In an effort to address the concerns of local citizens, the reintroduced wolves in Yellowstone and central Idaho were designated "nonessential experimental" populations under the Endangered Species Act. This classification allows more involvement on the state level, broader flexibility in managing individual wolves and the pack, and the use of management options that would not be permitted if the populations were classified as endangered. Should the wolves pose a threat to livestock, pets, or property, problem or nuisance wolves can be relocated or, if necessary, killed by designated personnel. In addition, when the wolf is classified as an "experimental" population, private landowners can injure or kill a wolf if it is caught in the act of wounding or killing livestock on private land.

Amid all of the publicity, issues, and controversies, wolves are returning to North America. The gray wolf populations in Montana, Yellowstone National Park, and central Idaho continue to grow and the eastern timber wolf populations in Minnesota continue to thrive. In the early 1990s, red wolves, * a smaller wolf species, were reintroduced into selected wild areas in North Carolina, Florida, and Tennessee. And in 1998, several family groups of the Mexican wolf, a subspecies of the gray wolf, were released in the wilds along the Arizona–New Mexico border. Now, there are some environmental groups examining the possibilities of restoring wolves to areas in the northeastern United States and southwestern Colorado.

* Most scientists classify the red wolf as a distinct species of wolf. Others describe it as another subspecies of the gray wolf.
Sustaining Fish and Wildlife Resources

Issue Analysis Sheet

Species ___________________________ Date ___________________________

Team Members: ___________________________

A. Natural History Information

Preferred habitat:

Food:

Historic range:

Current range:

Current status:

B. Decline and Recovery

Major reason(s) for the decline of this species:

Events, changes, or laws that occurred to enable recovery:

C. Issues/Conflicts

Identify and record existing or potential issues or conflicts associated with the recovery of this species. Then identify all potential interested groups, individuals, or organizations. Identify their views or opinions about the recovery of the species. Consider their reasons or motivations for these views.
### Issue:

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<tr>
<th>Interest Groups</th>
<th>View or Opinion</th>
<th>Reasons/Motivation</th>
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### Issue:

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<th>Interest Groups</th>
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<th>Interest Groups</th>
<th>View or Opinion</th>
<th>Reasons/Motivation</th>
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### D. Issue or Conflict Resolution

1. *What measures or strategies have been taken to resolve these issues? Do you agree with them? Why or why not?*

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Issue It Addresses</th>
<th>Agree Yes/No</th>
<th>Explain</th>
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</table>

2. *What are your recommendations to help resolve the issue or conflicts?*

   | Recommended Strategy | Issue It Addresses |
Project WET

Quick Reference Guide and In-Depth Explanation of Content
## Project Wet Quick Reference

### Questions

<table>
<thead>
<tr>
<th>Project Wet-Teacher Information</th>
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<td>1. Require additional resources?</td>
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<td>2. Assessments included? (Evaluations of lessons)</td>
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<td>3. Encourage multiple ways to teach topics?</td>
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<td>4. Time periods reasonable?</td>
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<td>5. Modifications included for special needs</td>
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<td>6. Teacher friendly materials and organization</td>
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### Questions

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<tr>
<th>Project Wet-Student Information</th>
<th>Yes</th>
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<tr>
<td>7. Demands higher order thinking skills?</td>
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<td>8. Multiple response ways?</td>
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<td>9. Promote child as citizen of community?</td>
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<td>10. Promote social interaction?</td>
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<td>11. Student-centered learning?</td>
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<td>12. Inquiry-based?</td>
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<td>13. Include student materials?</td>
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### Questions

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<tr>
<th>Project Wet-Curriculum Information</th>
<th>Yes</th>
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<tr>
<td>14. Include instructional objectives?</td>
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<td>18. Build upon prior knowledge?</td>
<td>♦</td>
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<td>19. Utilize technology?</td>
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<td>20. Long-term projects?</td>
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<td>21. Short-term projects?</td>
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<td>22. Direct instruction lessons?</td>
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General Information
Grade level: K-12

Overall focus or Theme:
Project WET believes that learning should occur through a meaningful pathway with topics related to the lives of the learners involved. Since water affects all on earth, covers about 70% of our planet, is vital to life on earth, and is the main component of the human body, water is a familiar experience that can easily relate to all children. Project WET aims to create relevant and meaningful learning to all learning styles while advocating water education. Project Wet strives to arm educators with a wide array of teaching strategies, promote the principle of “water for all water users,” and promote an interest for a further, more intense study of principles observed through Project WET activities.

Affiliation:
Project WET is affiliated with the Council for Environmental Education, which aims to create a unique network between educators and natural resources professionals.

Teacher Information
1. Does it require additional resources or are materials included?
Some activities included only require copies of worksheets/transparencies included within Project WET. However, most of the activities require at least some other easily attainable materials. For example, crayons, magnets, markers, notebook paper, string, and sugar are examples of common items needed for activities within the curriculum. Some activities, such as People of the Bog (p. 89) require more expensive and harder to obtain materials. This particular activity requires a 20-gallon glass aquarium, a small container, a watering can, 5 lbs of gravel, a soda bottle, 1 lb perlite, 3.5 lbs activated charcoal, 10 lbs peat moss, 3 lbs sphagnum moss, several plants, potting soil, and snails.

2. Are assessments included?
Yes. Each lesson includes a section entitled “Assessment” at the end of the lesson plan. Each Assessment portion provides multiple ways to assess students over the specific lesson. For example, in the lesson Branching Out! (p. 129), students construct and describe watersheds. The suggested assessments include predicting flow in a watershed model, testing predictions, comparing draining patterns, comparing drainage patterns to other branching patterns, and writing a story or drawing a map of drainage patterns in their watershed. In addition to the Assessment portion, Cross Reference and Planning Charts list the Assessment strategies for many of the lessons at the back of the curriculum, beginning on page 479. This includes categories such as verbal assessment, written assessment, and student and peer evaluation.
3. Does it encourage multiple ways to teach a topic?

Yes. Once again, the Cross Reference and Planning Charts serve as a useful tool for instructors. Activity names are listed in a Teaching Methods Chart that indicates what different teaching strategies are used within lessons. The following methods are utilized throughout the curriculum: whole-body, hands-on, art form, inquiry, reading, writing, calculations, data recording, graphing and mapping, debating, role playing, simulation, modeling, games, experimenting, researching, demonstrating, and group work.

4. Are lessons do-able in a reasonable time period (dependent on grade level)?

Instructors are able to choose from a wide variety of project lengths. This allows instructors to choose the length of time they would like to spend on a particular theme or topic within their classroom. Activities range from one class period up to an extended time period of two weeks or more. Some activity times are again listed in the Cross Reference and Planning Charts at the back of the Project WET book.

5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?

Instructors could modify lesson plans within Project WET to accommodate the needs of special needs or gifted students, but specific instructions or suggestions about how to tier or modify lessons are not specifically included within the curriculum. There are Extension portions within each activity lesson plan which, could potentially be utilized for gifted students or students who want to extend their knowledge on a topic of interest.

6. Does it provide teacher-friendly materials/organization?

Yes. Each lesson plan includes a short summary including grade level, subject areas, duration, setting, skills, vocabulary, and a summary of the activity. Each lesson is then divided into helpful sections entitled Objectives, Materials, Making Connections, Background, Procedure, Assessment, Extensions, and Resources. The curriculum includes teacher materials such as worksheets, data sheets for students to complete, and overhead transparencies.

**Student Information**

7. Does it demand higher order thinking?

Yes. The activities in Project WET include activities based on the skills students utilize, and these include many of the higher order activities associated with Bloom's taxonomy. For example, students are asked to partake in the skills of analyzing, interpreting, applying, and evaluating. One example of an activity that demands higher order thinking is *Cold Cash in the Icebox* (p. 373). In this activity, students apply what they know about insulation and the properties of heat energy and water to design and experiment with their own icebox. They then analyze the results of their creation, comparing the insulating qualities of various materials.
8. Does it allow students to respond in multiple ways to a given problem or solution?
   Yes. Each activity includes an Assessment portion of the lesson plan that provides both instructors and students with multiple options for assessment type. For example, the activity *Geyser Guts* (p. 144), deals with geysers and their physical qualities. The lesson suggests that students either draw a diagram of the geyser demonstration from the activity and relate it to a natural eruption or design their own demonstrations for mud pots, fumaroles, and hot springs. Another assessment option includes drawing a maze that relates to the path of water through a geyser. In addition, Extensions in each lesson allow students to dive further into a subject while being creative and forming their own opinions on the topics at hand. For example, the Extensions portion of the same lesson suggests that students research geothermal energy production and its effect on geysers around the world. Students would then form an opinion and discuss the rights of adjacent landowners versus the rights of public persons with regards to tapping of the hot water, which may destroy geysers.

9. Does it support community involvement? Does it promote the child as a member/citizen of a community?
   Yes. One section of activities within Project WET is dedicated to water as it exists within social constructs. An example of an activity in this portion of the curriculum is *What's Happening* (p. 425). In this activity, students conduct a survey to discover what stance members of their local community take regarding an important water resource issue.

10. Does it promote social interaction?
    Yes. The Cross Reference and Planning Charts list which activities are Small Group and Large Group activities. For example, students work in small groups to discover the effects of heat and salinity on water density in the activity *Adventures in Density* (p. 25).

11. Does it promote student-centered learning?
    Yes. Students discover through hands-on learning in activities throughout the curriculum. For example, students relate how wetlands capture, store, and release water by examining properties of a sponge. This activity relates water awareness to an everyday item, allowing students to create meaningful learning by relating material to their own lives. This activity is entitled *Capture, Store, and Release* (p. 133).

12. Is it inquiry based?
    Yes. Many of the activities are considered inquiry-based. These activities are listed as Inquiry in the Cross Reference and Planning Charts under the topic of Teaching Methods. One example of an inquiry-based lesson is *Dilemma Derby* (p. 377). In this activity, students debate positive and negative aspects of various water management issues. Students form opinions about water management issues and propose a course of action. Students are then encouraged to identify a water-related issue in their community and present courses of action, providing pros and cons of their proposed plan of action.
This activity is not only inquiry-based, but encourages students as active members of the community.

13. Does it include teacher and student materials/books?
   As stated before, Project WET does include resources such as worksheets and overhead projection sheets, which serve as a useful aid to instructors. No student materials or books are provided in the curriculum.

Curriculum Information

14. Does it include goals for students/instructional objectives?
   Yes. Each activity includes student Objectives at the beginning of the lesson. For example, the student objectives listed for *The Pucker Effect* (p. 338) are as follows:
   Students will:
   - describe how underground point source pollutants move through ground water.
   - analyze data from test wells they have “drilled” to identify point source contamination.

15. Does it provide connections that are interdisciplinary?
   Yes. The theme of water intertwines with the subject areas of Fine Arts, Language Arts, History, Social Studies, Math, and Health. These interdisciplinary connections are listed in the Subject Areas portion of the Cross Reference and Planning Charts. An example of an interdisciplinary lesson is *Water Write* (p. 457). This activity relates to the subject of Language Arts, and students express their feelings about water through writing. They also evaluate attitudes about water through observing literary works.

16. Does it reflect real-world problems?
   Yes. The entire curriculum and its contents relate to real-world issues. Water sustains life and makes up the bulk of the human body. With a growing world population, concerns of water quality, abundance, treatment, and awareness affect life at every level, from the entire global perspective to each individual community here in Indiana.

17. Are multicultural themes included?
   Yes. An entire section of activities is dedicated to the theme of water within cultural constructs. An example of an activity relating to multicultural themes is *Raining Cats and Dogs* (p. 435). In this activity, students interpret water sayings by skits, creative writing, etc. to compare figures of speech across different climates and cultures.

18. Does the material build upon prior knowledge?
   Yes. Each activity has a small portion entitled Charting the Course that lists related activities within WET that will enhance the understanding of the activity at hand. For example, the activity *Humpty Dumpty* (p. 316) allows students to relate the challenges of doing environmental restoration to the project of piecing together a puzzle.
Charting the Course for this activity states, “Students are introduced to the costs of water projects in ‘The Price is Right.’ In ‘Perspectives’ and ‘Hot Water’ students present arguments supporting or opposing restoration. Long-term effects of habitat development and restoration can be explored in ‘Whose Problem is It?’”

19. Does it utilize technology?
   No. This curriculum does not include references or utilization of modern technology, such as the Internet.

20. Is it long-term based or short experiments?
   A variety of study lengths are available through the activities within Project WET. The activity lengths are listed in the Cross Reference and Planning Charts. The options for lengths of Time Required include 30 minutes or less, 50 minutes or less, 100 minutes or less, three hours or less, several days, up to one week, and extended time period.

21. Does it include direct instruction lessons?
   No. Most activities do require an explanation of vocabulary related to the activity, but activities are student-centered in this curriculum. Lessons provide a variety of methods for instructors (see question 3 above).

22. Additional Information
   Project Wet provides several indexes in the back of the curriculum guide to help guide teachers in their search for a particular lesson that fits a desired need. Examples of these indexes include a Topic Index, Subject Area Index, Teaching Methods Index, Skills Index, and an Environmental Education Framework Index. In addition, on the beginning page of each lesson a section entitled “Charting the Course” is included which helps to explain how that particular lesson builds off of other previous lessons. It also explains how certain aspects of that particular lesson can be enriched by the other noted lessons. This helps teachers if they are focusing on a particular topic or idea.
Project WET

Sample Lessons and Their Relation to Indiana Standards
Adaptations to Indiana Academic Science Standards

*In the back of the curriculum guide, Project Wet shows how it demonstrates and addresses the environmental education standards.

**Lower Elementary, Upper Elementary**
* Aqua Bodies Page 63

**Science**

**Standard 1** The Nature of Science and Technology

**Scientific Inquiry:**
1. Raise questions about the natural world.
2. Use tools — such as thermometers, magnifiers, rulers, or balances — to gain more information about objects.
3. Describe, both in writing and verbally, objects as accurately as possible and compare observations with those of other people.

**Technology and Science**
1. Use tools, such as rulers and magnifiers, to investigate the world and make observations.

**The Scientific Enterprise:**
3. Demonstrate the ability to work cooperatively while respecting the ideas of others and communicating one’s own conclusions about findings.

**Standard 2** Scientific Thinking

**Communication Skills:**
1. Draw pictures and write words to describe objects and experiences.
2. Describe and compare objects in terms of number, shape, texture, size, weight, color, and motion.
3. Make sketches and write descriptions to aid in explaining procedures or ideas.
4. Use numerical data to describe and compare objects and events.

**Standard 4** The Living Environment

**Interdependence of Life:**
1. Explain that most living things need water, food, and air.

**Human Identity:**
5. Explain that like other animals, human beings have body systems.

**Middle School**
* The Great Stony Book Page 150

**Science**

**Standard 2** Scientific Thinking

**Communication Skills:**
6. Organize information in simple tables and graphs and identify relationships they reveal. Use tables and graphs as examples of evidence for explanations when writing
essays or writing about lab work, fieldwork, etc.
6.2.6 Read simple tables and graphs produced by others and describe in words what they show.

**Standard 3 The Physical Setting**

**Earth and the Processes that Shape it:**
6.3.15 Explain that although weathered* rock is the basic component of soil, the composition and texture of soil and its fertility and resistance to erosion* are greatly influenced by plant roots and debris, bacteria, fungi, worms, insects, and other organisms.
7.3.8 Describe how sediments of sand and smaller particles, sometimes containing the remains of organisms, are gradually buried and are cemented together by dissolved minerals to form solid rock again.
7.3.9 Explain that sedimentary rock*, when buried deep enough, may be reformed by pressure and heat, perhaps melting and recrystallizing into different kinds of rock. Describe that these reformed rock layers may be forced up again to become land surface and even mountains, and subsequently erode.
7.3.10 Explain how the thousands of layers of sedimentary rock can confirm the long history of the changing surface of Earth and the changing life forms whose remains are found in successive layers, although the youngest layers are not always found on top, because of folding, breaking, and uplifting of layers.
8.3.3 Explain that the solid crust of Earth, including both the continents and the ocean basins, consists of separate plates that ride on a denser, hot, gradually deformable layer of earth. Understand that the crust sections move very slowly, pressing against one another in some places, pulling apart in other places. Further understand that ocean-floor plates may slide under continental plates, sinking deep into Earth, and that the surface layers of these plates may fold, forming mountain ranges.

**High School**

*Whose Problem Is It?* Page 388

**Environmental Science**

**Standard 1 Principles of Environmental Science**

**Natural Resources:**
Env.1.23 Recognize and describe the role of natural resources in providing the raw materials for an industrial society.
Env.1.27 Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit.
Env.1.28 Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources.
Env.1.29 Recognize and describe important environmental legislation, such as the Clean Air Act and the Clean Water Act.
Aqua Bodies

What is the difference between a raisin and a grape? Water!

Summary
Students trace their bodies and color portions to represent the amount of water their bodies contain. How does their water content compare to that of a cactus, lettuce, or a whale?

Objectives
Students will:
• conclude that water is the main ingredient of living organisms.

Materials
• Dried fruit
• Ripe fruit
• Balance (optional)
• butcher paper (about 120 feet [36 m] for a class of 30) or 2-3 sheets of newspaper taped together for each student
• Chalk (optional)
• Crayons
• Scissors
• Bathroom scale
• Containers to hold water (e.g., gallon jug, buckets, zip-lock bags, balloons)
• 4"x6" (10 x 15 cm) index cards
• Tape

Making Connections
People drink water every day, but they rarely think about the proportion of their bodies that is composed of water. Learning how much of their bodies are composed of water encourages students to appreciate life's dependence on water.

Background
Active living organisms are composed of at least 50 percent water. This is true whether they live in a desert (certain cacti have 90 percent water content) or in the oceans (body water content of many whales is 75 percent). Regardless of the environment, organisms are able to acquire and maintain a healthy water balance.

The human body is about 65 to 70 percent water. If humans lose more than 8 percent of their body weight, they will die. Where is this water located within the human body? About 67 percent of the water in the body is located within cells; about 25 percent is located between cells; and the rest, about 8 percent, is located in the blood.

Procedure
Warm Up
Present students with the following situation: two people are stranded in a desert. One person has a basket of food including canned meats, bread, cake, etc.—enough to last a month. The other has only a one-month's supply of water. Which of the two will survive longer? Compare how long we can go without food (about a month) to how long we can go without water (approximately three days).

Explain that the bodies of most living organisms are at least 50 percent water. Display samples of ripe and dried or wilted fruits and vegetables and compare water content (see table) or weight (e.g., raisin versus grape or plum versus prune). Demonstrate the percentage of the fruit or vegetable that is water by cutting off a representative piece. (For example, carrots are 88 percent water, so cut off about 88 percent of the carrot.) Emphasize that the 88 percent water in the carrot is actually within tissues and cells and therefore did not spill out when the carrot was cut. (This may counter a misconception that water is loosely sloshing throughout the body.) Do students think humans have water in their bodies? Ask students to guess what
percentage of their bodies is made up of water.

<table>
<thead>
<tr>
<th>Food</th>
<th>Percent Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato Chips</td>
<td>2</td>
</tr>
<tr>
<td>Pizza</td>
<td>49</td>
</tr>
<tr>
<td>Ice Cream</td>
<td>61</td>
</tr>
<tr>
<td>Beef Liver</td>
<td>70</td>
</tr>
<tr>
<td>Bananas</td>
<td>74</td>
</tr>
<tr>
<td>Grapes</td>
<td>81</td>
</tr>
<tr>
<td>Oranges</td>
<td>87</td>
</tr>
<tr>
<td>Carrots</td>
<td>88</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>94</td>
</tr>
<tr>
<td>Lettuce</td>
<td>96</td>
</tr>
</tbody>
</table>


The Activity

Part I

NOTE: K–2 teachers may wish to focus on Part I only.

1. Have students work with partners to trace their body shapes onto butcher paper. An alternative is to have students stand against a wall or lie on the blacktop and trace each other with chalk.

2. Explain to students that the percentage of water in their bodies is approximately 65-70 percent. (For this activity, 70 percent [about 3/4] will be used; the actual amount varies with age and gender. For younger students, demonstrate 3/4 by showing them a circle, or a block divided into four equal parts, and move three of the four equal pieces.)
3. Have students color 70 percent of the figures they have traced onto the paper. It may help to show 70 percent of various objects. Or students might fold their drawing into ten equal parts and color seven of the ten sections. Have students color (using a contrasting shade) the rest of their bodies, then cut them out for display.

**Part II**

Assign students a random body weight and have them calculate the approximate amount of water, using the following formula: multiply body weight by 0.70. For example, 100 pounds x 0.70 = 70 pounds of water. Students can then calculate the amount of water in their own bodies. Containers can be filled with 70 pounds of water, to represent the water weight of a 100-pound person. (Because one gallon of water weighs about 8.3 pounds, 70 pounds of water is around 8.3 gallons [70 lbs. x 1 gallon/8.3 lbs. = 8.4 gallons]). Students can do the same for their own weights. (This activity may be coordinated with the school nurse’s weigh-in health program.)

**Part III**

1. Either assign or have students select a plant or animal.

2. On 4” x 6” (10 x 15 cm) index cards, have each student draw the outline of the organism. Direct students to estimate the organism’s percentage of water content and color the corresponding portion of the outline. Despite dry or wet conditions, all living organisms have at least 50 percent water content. If necessary, students can correct their drawings to represent more accurate proportions of water in the organisms. Exact proportions of body water content are not necessary, but actual amounts may be available in reference books. Following are the body water contents of several organisms:

<table>
<thead>
<tr>
<th>ORGANISM</th>
<th>PERCENT WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>62</td>
</tr>
<tr>
<td>Dog</td>
<td>63</td>
</tr>
<tr>
<td>Deer</td>
<td>64</td>
</tr>
<tr>
<td>Corn Plant</td>
<td>71</td>
</tr>
</tbody>
</table>

3. Tape cards to the wall in groups, based on habitat. Put all desert plant and animals in one group, while another has rain forest organisms.

**Wrap Up**

Have students compare the water content of plants and animals in their drawings to that of humans. Students’ outlines of themselves may be given to parents as gifts (“growth charts”) or displayed in school halls. Students could calculate the number of gallons (liters) of water contained in the bodies of their parents or friends.

**Assessment**

Have students:
- indicate what proportion of their bodies is water (Part I, step 3).
- calculate how much of a body’s weight is water (Part II).
- represent water content values of different organisms (Part III, step 2).

Upon completing the activity, for further assessment have students:
- produce a comic strip that illustrates how organisms would look without water.

**Extensions**

Obtain a food drier or build a solar food drier; have students dehydrate several food items (such as grapes—they can make their own raisins). Have students predict what the foods will look like when dried.

Compare the taste of dried foods to the hydrated forms. Use the dehydrated food to prepare a meal for the class.

Older students may illustrate body organs on their cutout figure and research the water content of each organ (e.g., the brain is 74.8 percent water). Challenge students to identify places in their bodies without water. (Water in the wrong places—such as the lungs—can be deadly).

**References**


The Great Stony Book

You are walking along a path one mile above sea level, when suddenly you step on a sea shell ... how did it get there?

**Summary**

Students create layers of buried fossils to learn how ancient, elevated ocean floors create a history book of stone.

- **Objectives**
  - Students will:
    - demonstrate water's involvement in the processes of sedimentation and erosion.
    - recognize that layers of sedimentary rock can contain a record of earlier life (fossils) and environments.

**Materials**

- 3 different colors of soft modeling clay or modeling dough (The different colors represent types of sedimentary rock in which fossils are most commonly found—limestone, sandstone, and shale. See the activity “A-maze-ing Water” for recipe for dough. One recipe will make enough dough for about one layer.)
- A small, empty, rectangular aquarium (must be at least 12 inches [30 cm] tall)
- A rolling pin
- Student-provided fossils or artifacts
- A putty knife (or other implement to cut into layered modeling dough)
- Pencils
- Marking pens
- Large piece of poster board
- Water (to sprinkle on clay)
- Glass sheet or plastic wrap (to cover aquarium)

Some students know that ancient oceans covered much of Earth's surface at different times during the geologic past. Many will be aware of major landforms like the Grand Canyon, where dozens of once buried rock layers are exposed. Investigating how history is preserved in stone helps students learn about Earth's past.

**Background**

In 1869, Major John Wesley Powell led an expedition down the Colorado River. He and his companions were the first people known to record their travels through the Grand Canyon. As the explorers ventured deeper into the great incision cut into Earth by the river, Powell observed that the Colorado had opened a "Great Stony Book," the page of which contained a record of millions of years of Earth's history.

Powell, head of the United States Geological Survey, knew that some of the layers of exposed rock in the canyon walls had formed in ancient seas and contained evidence of earlier environments and life forms. These layers, dating back millions of years, also held clues to Earth's water history.

The Great Stony Book tells an interesting story. Traces of the plants and animals that lived during various time periods are now preserved as fossils in the Earth's rock record. Nature continually adds pages to the book, which in some places is open to reveal chapters in the history of Earth and its inhabitants.

Change is an enduring quality of the process that we call nature: but in the short span of a human life, alterations to the landscape are often nearly imperceptible. People observe changes that occur as a result of sudden, spectacular events—a flash flood gouging a new stream channel or washing away topsoil, a sandstorm reshaping a desert landscape, or an earthquake creating a lake. But the slow, endless process of water...
and wind picking up soil, weathered rock particles, and other debris; transporting them; and depositing them in other places (only to become rock again) is measured in *mountain time*—millions of years. As rivers, moving relentlessly toward the sea, cut into layers of rock, they open the pages of the stony book and reveal evidence of the earlier work of wind, water, and other natural agents of change.

Some of the rock layers of the Grand Canyon were formed from sediments that settled to the floor of shallow seas that once covered this land—when it was lower and flatter. Other layers are the remnants of vast deserts that covered this area at other times in the past.

The process of sedimentation is slow and continuous. Over time, layer upon layer of sediments may stack up to great thicknesses. The weight of one layer upon another creates pressure. This pressure compacts the sedimentary particles together. Given enough time and the addition of a cementing agent, usually calcium carbonate (CaCO₃) or silica (SiO₂), this process results in the formation of a sedimentary rock. Three examples of sedimentary rock are sandstone, shale, and limestone. Sandstone is formed from deposits of sand. Shale is created from silt and clay; thus shale is finer grained than sandstone. Limestone is of either organic or inorganic origin. It may consist of decomposed shells and skeletons of marine organisms that settled to the seafloor and combined with calcium carbonate; or it may be composed of only calcium carbonate that chemically precipitates from the water.

When a plant or animal dies, its remains are often buried by sediments. Most of the organisms buried in the sediments decompose and leave no trace of their existence. In some cases, organisms leave an imprint of their shape in the sediments before they solidify. Sometimes parts of the organisms—such as shells and bones—are replaced by minerals, but retain their shape and internal structure and are preserved in the rock. These records of early life are called fossils. In addition to fossils, the surface of a sedimentary layer often has *ripple marks*; these are made by water flowing over an exposed surface (a beach or tidal mud flat) or by wind (as on the surface of a sand dune).

Over millions of years, immense geologic processes associated with mountain building raise these layers of sedimentary rock above the surface of the sea. Most sedimentary rocks, including those that are now far from the sea or other large bodies of water, were formed in marine or freshwater environments. According to a geologic principle, the principle of original horizontality, the sediments were originally deposited in horizontal layers. Another geologic principle, the principle of superposition, tells us that the bottom layer or formation is the oldest; the newest or youngest layer is on top. Thus, we must read the Great Stony Book backward in time, from the top down.

We can take the metaphor of the Great Stony Book further: It is a book with many parts and characters. The rock pages and chapters are exposed as water (and wind) erode Earth's surface. Earth is the author, illustrator, and designer. Each geologic
The Activity
1. Explain that during the next two weeks, students will be creating a stony book that will record each day’s events. Each day will represent several hundreds of thousands, or millions, of years.
2. Each day for a week, a different group of students will deposit layers of rock (clay) and randomly place “fossils” or artifacts in the layers. The days of the week will represent periods of geologic time.
3. Discuss with students what types of fossils they should use. Each group should think of approximately 15 small fossils they would like to bury. The groups should not see each other’s fossils. They will discover many of them next week. The fossils should be unique or have some special significance, but should not be valuable or sentimental. All items should somehow relate to the day during which they are placed in the layers (i.e., the fossils of Monday’s group should be objects they brought to school or found in the classroom on Monday).
4. Divide students into five small groups. Give the first group three mounds of modeling dough or clay, each a different color. Instruct students to roll out the mounds into layers about 3/4 inch (1.9 cm) thick. The length and width should match the inside dimensions of the aquarium.
5. Have students place one layer of modeling dough on the bottom of the aquarium. Explain to students that this represents the process of deposition of ocean sediments, which normally occurs over a great period of time.
6. Tell students that, along with sediments, sometimes shells and bones of animals settle to the bottom of the ocean floor. To represent this, each student in the group should then randomly press a fossil or artifact into the surface of the layer. Repeat the process for the next two layers. The last layer can contain ripple marks to serve as an additional clue to the marine origin of the sediments. Ripple marks can be made by lightly and repeatedly pressing the rounded surface of the rolling pin into the surface of the modeling dough.
7. The next day, another group will repeat this same procedure. They should vary the arrangement of layers, so that layers of the same color are not adjacent. For example, students on the first day layered red, then white, then blue. The second group could put a red or white layer next, but not a blue layer.
8. Repeat the above steps with a different group each day, until each group has deposited three layers of sedimentary rock (modeling dough) and has randomly embedded their fossils in the layers. By the end of the first week, the aquarium should contain a total of 15 layers and 75 different fossils or artifacts. To keep the clay moist, sprinkle it with water and cover the tank with a glass sheet or plastic wrap.
9. Inform students that geologists use this same principle when studying layers of rock. They view the layers as a Great Stony Book.

Warm Up
Tell the class about a careless student who, after undressing at night, throws her clothes on the floor. She does not pick them up the next day. Instead, she throws another layer of clothes on top of the pile. Tell students that this pile represents a record or storybook of the clothes this student has worn. Where would students find the clothes she had worn the first day?
Inform students that geologists use this same principle when studying layers of rock. They view the layers as a Great Stony Book.

Present students with information about the sedimentation process. Discuss how ancient ocean bottoms can now be found far above sea level. Refer them to the Grand Canyon and how water erodes the layers of rock, slowly revealing history—from the present to the distant past.
Have students list things they think geologists might find when studying these layers. Make students aware that many sedimentary layers do not contain fossils. Have students keep a journal throughout the activity, recording observations, sketches, and interpretations.
illustration on page 151. Assign dates along one side of the diagram, with each arrangement of three layers representing one period of time. It is not necessary to use actual geologic dates and terms, but each group of layers should represent a large span of time (e.g., thousands or millions of years). Students may wish to create names for their group’s time periods.

11. On the first day of the second week, have a group from the previous week begin forming the canyon by carefully cutting about 1/5 of the way into the layered model, tracing the outline of the river. Be certain to vary the order so that no group discovers its own fossils. This represents water eroding through layers of rock. As they encounter fossils or artifacts in the layers, students should record, in the group’s journal, a description of the items as well as the layer in which they were found. The fossils or artifacts should then be placed on the appropriate spot on the cross-sectional chart. Students may wish to include a sketch of the fossil or artifact in the journal.

12. Repeat the above process with each group throughout the week until the bottom (oldest) layer is reached. Each successive group will need to increase the width of the canyon as they cut deeper.

\[ \text{**Wrap Up**} \]

Have students explain the Great Stony Book metaphor, and discuss how layers of rock and the fossils they contain are windows into the past. What is the role of water in this process? Ask students to look at each group’s records and compare observations, sketches, and interpretations. Moderate a class discussion on the role of water as an agent of geologic change. (Water deposits the layers of sediments and wears them away.) Display the model and the "Mock Geologic Chart" derived from it in other classrooms or a school hallway.

\[ \textbf{Assessment} \]

Have students:
- use a mock fossil record to interpret geologic events or classroom daily events (step 11).
- record and/or sketch fossils or artifacts in their journals (step 11).
- relate how water and its role in erosion and sedimentation help create a book of stone that contains a record of Earth’s history (Wrap Up).

\[ \textbf{Extensions} \]

If a stream-cut canyon or valley exists nearby, take a field trip to it. Otherwise, go to a nearby quarry or roadside where students can observe the layering of sediments. Sometimes fossils can be seen in these locations.

Visit a local natural history museum or the geology/paleontology department of a local college or university.

Write to Grand Canyon National Park and request titles of books, films, videos, and other educational materials. Grand Canyon Natural History Association, P.O. Box 399, Grand Canyon, AZ 86023. (602) 638-2481.

Depending on time and student interest, a more elaborate model (using real sediments [sand, gravel, mud], real bones and shells, and flowing water) might be made for display at a school science fair or in the classroom throughout the year. To construct a model, enlist the aid of an industrial arts teacher.

\[ \textbf{Resources} \]


Geological Society of America, 3300 Penrose Place, Boulder, CO 80301.


NOTE: MacTimeliner (Tom Snyder Productions) is a computer program that can be used to generate geologic time lines.
Why should the world care about a leaky faucet in your home? Why should you care about a drought in central Africa?

**Objectives**
Students will:
- analyze how water issues affect individuals as well as world populations, and how these issues can have short- and/or long-term implications.
- illustrate the scope and duration of water-related issues.

**Materials**
- News reports on water-related issues (can be collected by students)
- Copies of Water Issue Analysis Chart
- Chalkboard and chalk, or butcher paper and markers, or overhead transparency and markers

**Making Connections**
Too often people become so involved in everyday problems that they forget to pay attention to issues that are of a statewide, national, or international scope. While it is important for young people to focus inward and learn about themselves, they should also be aware of the community and world around them. Analyzing water issues of concern to students helps them understand that local issues have global implications and global issues affect individuals.

**Background**
Ensuring that human activities sustain, rather than damage, water resources involves ecological and consequential thinking. That is, we need to understand the processes by which balanced ecosystems are maintained and to develop long-term thinking and our planning skills. Employing these understandings and skills enables us to predict how actions might affect water resources in the future. Students may develop these qualities by considering how the scope and duration of water-related problems can simultaneously affect the individual, the community, and the world.

The scope of water-related problems ranges from local to global. Local problems usually involve a small number of people and take place in a limited area. However, if left unchecked, local issues may affect other communities. For example, if individuals in one town carry a waterborne disease, the bacteria could multiply and spread to other towns. A drought in one part of the world may raise prices of certain foods at your grocery store.

Global problems affect the lives of individuals. For example, many scientists predict that changes in global climate increase world temperatures, sea levels will rise. This would bring a global problem to the direct attention of individuals living in coastal areas.

The duration of water-related concerns may be short-term (e.g., within a week's time), long-term (e.g., over 500 years from now) or both. A leaky roof creates a short-term problem if fixed within a reasonable amount of time. Toxic wastes dumped into oceans will remain an issue for humans many years into the future. A hurricane may pass through a town in a few hours, but it may take several years for people to recover from the damage to property and a lifetime to mourn the loss of life.

People are more likely to act on issues that affect them directly. The challenge
for educators is to help people appreciate how they can be personally affected by global problems and how individual actions can help solve not only local, short-term problems but also broad-scale concerns.

Individuals resolving local problems (cleaning trash out of a river, landscaping a hillside to prevent erosion, etc.) contribute to the well-being of the planet. Individuals can also act directly on global issues (educating others about environmentally responsible behavior, lobbying a government official about the nation's water quality laws, etc.). Local actions may produce immediate results, but an individual working to resolve global issues may not see the result of his or her efforts for many years, if at all.

Procedure

Warm Up

Ask students to think of a problem they face. When posing the following questions, have students raise their hands to indicate a positive response: Does the problem affect their lives directly? Will it concern them during the upcoming week? Does the problem concern their family? Will it be an issue a year from now? Does it concern the community? The nation? The world? Will it still be on their minds in five years? Most students will raise their hands for the first questions, fewer for the last.

The Activity

1. Have the class brainstorm a list of current issues related to water. (This can be supplemented by news articles collected by students.) A current-events bulletin board or wall could be designed in the room.

2. Have students, working in groups, choose a water-related issue. Ask them to discuss the following questions:
   - What caused the problem?
   - Who is affected by the problem (a few individuals, an entire town, the population of a country, etc.)?
   - How long has the problem persisted?
   - Can the problem be resolved in the near future or will it take a long time for a solution to be found?
   - Will the solution be costly?
   - How realistic is the solution? (For example: "Air pollution could be reduced if everyone stopped driving cars." Is this practical?)

3. Provide each group with the Water Issue Analysis Chart, or have them draw the chart on butcher paper or an overhead transparency.

4. Ask students to decide in which box of the chart the issue belongs. Decisions will be based upon the issue's scope (who is affected: individual, community, state, etc.) and duration (how long the problem will affect those involved: weeks, months, years, etc.). For example, students may conclude that a leaky faucet in a house will affect the individual/family in the next week—until the faucet is fixed. The issue of acid rain affects several countries and may take many years to correct; therefore, students may place it at the intersection of international and over 100 years.

5. Discuss why students categorized issues as they did. Was there any debate among the students about the scope and duration? Did students find the task easy or difficult? Challenge students to see that a single issue may vary in scope and duration. (For example, what if the leaky faucet is not fixed? What about the individual property owner whose trees are affected by acid rain?)
Wrap Up
Have the groups share results with other groups and transfer their conclusions to a master copy of the chart posted on the board, wall, or overhead. Ask the groups to discuss similarities and differences among findings. Is there a correlation between who is affected and which issues get the most attention in the media? Do global or local issues get mentioned more frequently in the media?

Ask students to rank 10 of the water-related concerns from most to least important. What criteria did they use? Did they consider scope and duration? Which of the issues do students think affect them the most? Why? Students can review periodicals and news reports to learn how the media address these issues.

Have students draw pictures or cut photographs and articles from newspapers to create a collage for each of the issues. The collage should reflect who is affected by the issue (scope). A time line can be incorporated into the collage, showing when the problem originated and how long it likely will persist. Student work can be posted in the school hallway or sent to local or national government officials.

Assessment
Have students:
* analyze the scope and duration of water-related issues by using the Water Issue Analysis Chart (step 4).
* create a collage and coordinate it with a time line to show how water-related local issues can have global implications and how world-wide issues can affect the individual (Wrap Up).

Extensions
Divide students into groups and have students pretend to be members of a think tank or conservation group focusing on particular issues. Groups can study issues that affect different levels of society. What are possible solutions? How would students persuade people to participate in resolving these problems? Will local, state, and global issues require different approaches?

Ask students to imagine they work for an advertising agency developing a campaign to motivate people to become involved in local or global water issues. Different groups can be assigned different types of issues. For example, one issue could involve a toxic waste site near a stream within an inner city; another could focus on water sanitation in a developing country, and a third on preserving wetlands. Groups can compare strategies they used to involve individuals for each type of issue. Have students use the results of the advertising campaign activity to publish a brochure for the school or community.

Considering geographic and cultural differences, students may investigate the unique perspectives and approaches of other countries in avoiding and solving water issues. If students have a sister school in another country, they may contact the school to learn how water resources are managed and protected.

Resources
Facing the Future: Climate Change

Quick Reference Guide and In-Depth Explanation of Content
### Facing the Future: Climate Change Quick Reference

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Facing The Future
Climate Change: Connections and Solutions

General Information
Grade level: K-12
*Only the curriculum guides for 6-12 are free to download, and therefore the only curricula analyzed in this document.

Overall focus or Theme:
Climate Change: Connections and Solutions is an interdisciplinary unit that is matched to national science and social studies standards. The two-week unit plan describes the "forces behind climate change," including the carbon cycle, greenhouse effect, and other issues related to climate change.

Affiliation:
This curriculum is affiliated with Facing the Future, a nonprofit organization that provides resources on global issues for teachers, students, and the public. This is also affiliated with Hewlett Packard, which allows for the free downloads of this curriculum.

Teacher Information
1. Does it require additional resources or are materials included?
   Yes. This curriculum requires additional resources for experiments and activities included in the curriculum. The materials needed for the two-week curriculum, however, are easily attainable and relatively low-cost. For example, the first day's activities for the High School program include an experiment related to Greenhouse Gases (Greenhouse Gas Investigations, p. 10). This experiment requires thermometers, glass jars/containers, paper towels, graph paper, warm water, and a sunny location or heat lamp.

2. Are assessments included?
   Yes. The curriculum includes suggested assessment and instructor answer keys for both weeks of the curriculum. For example, the High School portion of the curriculum includes a first week assessment plan. This plan includes a pre-assessment quiz for students and a quiz over the first week of unit material. The second week includes a 5-paragraph essay assignment and a rubric for grading provided for the instructor. A summative project that can either be utilized as individual or small group work is also included for the last week of the curriculum. The project, which deals with the concept of common objects having a carbon footprint, also includes a rubric for the instructor.

3. Does it encourage multiple ways to teach a topic?
   Yes. There are a variety of teaching methods displayed throughout the two-week course. Lessons range from experiment or guided inquiry (Greenhouse Gas Investigations, p. 10) to utilization of the Internet (It All Adds Up! P. 34) to short film and graph trend interpretation (Carbon Dioxide Trends, p. 18). The activities and role of the instructor vary because of this diversity of curriculum lessons.
4. Are lessons do-able in a reasonable time period (dependent on grade level)?
   Yes. The entire curriculum is scheduled to fit into two weeks (ten school days) of regular 50-minute classes. This time frame is consistent for both the Middle and High School curriculum.

5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?
   Yes. This curriculum is well organized and easy for teachers to follow. Instructors could easily modify these lessons themselves to cater to the specific needs of their students. There are no specific accommodations for special needs students, but various Extension activities are included with some of the lessons. For example, Greenhouse Gas Investigations (p. 10), includes a Writing Extension, which involves students creating a research paper related to greenhouse gases. Activities such as these “Extensions” could be utilized as enrichment activities for gifted students.

6. Does it provide teacher-friendly materials/organization?
   Yes. The curriculum includes many features that are teacher-friendly and aid in lesson preparation. For example, the curriculum includes assessment suggestions, student readings, student lab sheets with experiment instructions, and data sheets that could be distributed to student groups. In addition, each lesson is divided into the following categories: Inquiry/Critical Thinking Questions, Objectives, Time Required, Key Concepts, Subject Areas, National Standards Alignment, Vocabulary, Materials/Preparation, Activity (Steps, Reflection, Extension), Action Project, and Additional Resources.

Student Information

7. Does it demand higher order thinking?
   Yes. Climate Change provides many lessons that expand on knowledge of the climate. The lessons direct students to think about why changes in the climate and environment are happening. For example in the first lesson of the Middle School (6-8) curriculum guide, The Carbon Link directs and encourages students to become part of the carbon cycle. The curriculum provides many pivotal questions for students to answer during the lesson, such as, “What do you think will happen to the carbon stored in fossil fuels as the world population increases? In your opinion, why would increased population create this change in the carbon cycle?” These questions are forcing students to critically think about the carbon emission problem as they learn about the carbon cycle on the planet.

8. Does it allow students to respond in multiple ways to a given problem or solution?
   Yes. This curriculum supports student’s responses in multiple ways to problems presented through the lessons. Each lesson allows students to respond and explore the problems of climate change differently, such as becoming part of the carbon link in The Carbon Link, or graphing data to understand and examine carbon dioxide trends over the
past 5 decades in *Carbon Dioxide Trends*. In addition, in the assessments that are included in the curriculum guide, students are asked to respond in many ways, such as multiple choice, short answer, research paper, or a group project. This allows students to show they understand the material in a variety of ways.

9. Does it support community involvement? Does it promote the child as a member/citizen of a community?

Yes. One lesson in particular demands community involvement through an interview. In the lesson, *My Carbon Footprint*, students, in an action project, are asked to interview an adult who does not live with them using the questions from the Zerofootprint Kids Calculator. Students are asked to find that adult’s carbon footprint and then develop ideas for ways to reduce the carbon footprint. The student and the adult can work out a plan to work on reducing carbon emissions in this way.

10. Does it promote social interaction?

Yes. In most of the lessons students are working in groups to solve problems of the climate change. For example, in the lesson *Energy Exploration*, students are working in small groups to identify various sources of energy used for electricity. Students have to identify pros and cons of each and take a stand to encourage or discourage certain methods. In these groups, each member has a certain role to follow, making sure each member is therefore engaged in the learning. With this group work, not only are students learning about different energy production methods, but are also learning how to work as a team to collaborate and defend a certain idea chosen by the group.

11. Does it promote student-centered learning?

Yes. Each and every lesson promotes student-centered learning and discovery instead of a teacher lecturing about climate change. Students are able to discover on their own through a variety of experiences how climate change is affecting our planet and what they can personally do to change it. For example, in the third lesson, *Effects of Climate Change on Living Things*, students learn about different ecosystems around our planet through role cards and must develop ways in which climate change could affect that certain ecosystem. Then in their groups, students demonstrate and communicate these impacts through skits performed in class.

12. Is it inquiry based?

Yes. The entire curriculum is inquiry based because the lessons ask students important questions that pertain to the world they are living in right now. For example, in the fourth lesson, *My Carbon Footprint*, students calculate their own carbon footprint and must develop ways to decrease it. Research, thought, and time are required for students to develop these ways and share them with other students and people in their school and community. Each of the other lessons pertains to student inquiry and investigation also.
13. Does it include some teacher and student materials/books?
Yes. Teacher information for the lessons is included, and all of the worksheets, role playing cards, and materials for group work are included. However, other materials, such as light bulbs, maps, and computers are obviously not included.

Curriculum Information
14. Does it include goals for students/instructional objectives?
Yes. On the second page of each lesson, two/three objectives are listed for students under the Objectives section of the lesson. These objectives describe exactly what the student will be doing in the lessons.

15. Does it provide connections that are interdisciplinary?
Yes. The curriculum is called interdisciplinary and focuses primarily on science and social studies, but also includes communications, math, technology business, health, and language arts. These interdisciplinary subjects are necessary to the curriculum because for example, it shows in social studies, how people from around the world are being impacted, and math is used in the graphing of carbon emission data. Each lesson incorporates other areas of study making the curriculum more enriching for the student.

16. Does it reflect real-world problems?
Yes. Climate change is an imminent problem that needs to be addressed globally. This curriculum allows students to focus on how and why this problem is happening in our world and on discovering ways to change it.

17. Are multicultural themes included?
Yes. This curriculum is multicultural because climate change impacts globally. In the lesson, Making Climate Change Connections, students discover how climate change is experienced in different environments around the world. Students read about different locations around the world and how the people and the place are affected by climate change because every place is different. Students then also learn about different people from around the world. In addition, in the lesson Energy Policies for a Cool Future, students compare energy used from different countries. Students learn about how different countries use energy and about how much carbon emissions they are creating. After comparing and analyzing the data from these countries, students participate in a mock “World Climate Change Summit” to discuss imperative global change.

18. Does the material build upon prior knowledge?
Yes. This curriculum does build upon prior knowledge. Because it is a two week unit plan, the lessons are arranged in such a way that builds knowledge on climate change by first building a foundation for understanding climate change and then takes a larger step to allow students to explore its connections to various other factors. Included in this unit, is an outline for the 2-week unit that shows the order of the lessons and the student readings to be addressed with certain lessons. Both the middle school and the high school units are designed in this way.
19. Does it utilize technology?
Yes. This curriculum utilizes modern technology for exploration and also provides students with the opportunity to observe the most current data and information about the climate change our world is facing today. For example, students utilize the Internet in the lesson *It All Adds Up!* (p. 34). Students use an online carbon calculator to determine their average daily carbon emission. Students are introduced to modern technology and data in the lesson *Carbon Dioxide Trends* (p. 19). In this lesson, students interpret data and graphs related to the correlation between Carbon Dioxide in the atmosphere and temperature.

20. Is it long-term based or short experiments?
The unit plan curriculum consists of lessons that can be completed in one class period. The unit itself is 2 weeks long, but daily lessons take on average 50 minutes with the exception of some outside research that may be needed.

21. Does it include direct instruction lessons?
No. The unit consists of all inquiry based, student-centered lessons. No direct instruction lessons are included, and these lessons would be very difficult to modify for direct instruction.

22. Additional Information
This curriculum includes climate change activities for grades K-12. Only the Middle (6-8) and High School (9-12) versions are available for free and downloadable online. Therefore, only the Middle and High School versions were reviewed. The Middle and High School curricula are each two weeks long, and the themes for each lesson mirror one another between the two curricula. The ten-day curricula include the following unit lessons, in order:

1. Greenhouse Gas Investigations
2. Carbon Dioxide Trends
3. Effects of Climate Change on Living Things
4. *It All Adds Up!*
5. Energy Exploration
6. Changes All Around
7. How Much Does Carbon Cost?
8. Shopping Heats Up
Making Climate Change Connections

In pairs, students read about the impacts of climate change experienced by people living in different environments around the world. As a class, students discuss how these climate change impacts are connected.
Inquiry/Critical Thinking Questions

• How is climate change impacting people in different environments around the world?
• How are the impacts of climate change in different environments around the world connected?
• What are some ways that we can lessen the impacts of climate change on different environments?

Objectives

Students will:
• Examine environments in different regions of the world
• Consider the impacts of climate change on different environments
• Explore the connections between the impacts of climate change on different environments
• Think about ways they can contribute to preventing or reducing the impacts of climate change on different environments

Key Concepts

• Geography
• Climate change impacts
• Interconnections

Subject Areas

• Social Studies (Geography, Global Studies, World History, Contemporary World Problems)
• Science (Earth, Environmental, Life, Physical)

National Standards Alignment

National Science Education Standards (NSES)
• Standard B: Physical Science
• Standard C: Life Science
• Standard D: Earth and Space Science
• Standard F: Science in Personal and Social Perspectives

National Council for the Social Studies (NCSS)
• Strand 3: People, Places, and Environments
• Strand 7: Production, Distribution, and Consumption
• Strand 9: Global Connections
• Strand 10: Civic Ideals and Practices
**Materials/Preparation**

- Handout: Climate Change Eyewitness Accounts, 1 per student pair
- (Optional) World map for locating countries

**Activity**

**Introduction**

1. Have students describe the environment of the place where they live. Are there mountains, forests, fields, lakes, etc.? What is the climate like? Is it hot, windy, humid, rainy, etc.?

2. Have students think about what the earth looks like in other places they have visited or heard/read about – for example, deserts, icecaps, rainforests, etc. (They can also think back to earlier lessons in the unit.)

3. Tell the class that they are going to hear about some of the impacts of climate change from witnesses living in different environments, and then explore how these impacts are connected.

**Just as climate change does not affect all places in the same way, it does not affect all people in the same way either.**

Student Reading 04, page 113
Steps

1. Divide the class into pairs. Give each pair a Climate Change Eyewitness Account.

2. Ask if any pairs do not know the place their scenario describes. If so, have a world map available for students to find their location.

3. Give the pairs a few minutes to read their scenarios, using the reading questions to guide them. Tell students to be ready to share their climate change impacts with the rest of the class.

4. (Optional) Write the following reading questions on the board for students to answer:
   - Where is the story located? How would you describe the environment there?
   - What species (animals or plants) are mentioned? How have these been affected by climate change?
   - How are humans using the environment in your story? How have these activities been affected by climate change?
   - Is the eyewitness doing anything to try to reduce the impacts of climate change?

5. While students are working in pairs, make a circular list of all the environments from the scenarios on a large blackboard or whiteboard. (Write the names of all the environments from the scenarios so that they form a large open circle.)

6. Bring the class back together to complete the activity. Starting with the pair that has Pohnpei, ask them to share the impacts of climate change on the people and the environment in their scenario. (Give each pair about 1-2 minutes.)

7. Now ask the rest of the pairs if they think people living in the environment in their scenario will be impacted by the changes in Pohnpei. Encourage students to consider possible effects and connections beyond those specifically mentioned in their scenario. You can also ask students to note similarities and differences in how climate change is impacting their environments.

8. As students point out connections between environments, draw a line between those connected environments on the board.
Lesson Variation: Have pairs join 2 other pairs so that now each group has 6 students with 3 scenarios. Ask each group to make a 3-ring Venn diagram showing which impacts are shared and not shared among their environments.

9. Ask another pair to share their impacts. Again, have the pairs that would be affected by these impacts raise their hands and explain how they will be affected. Then draw a line between affected environments on the board.

10. Continue until each pair has had a turn, and conclude with the following reflection questions.

Reflection

1. What does the diagram on the board show about climate change?

2. Are the impacts on any one environment isolated from other environments (that is, do any impacts affect only one environment)?

3. Are some environments impacted more than others? If so, which ones? Why do you think these environments are more sensitive to climate change?

4. Can you think of any examples of climate change having a positive impact for environments or humans? What are some possible benefits for certain environments?

5. Could some of the impacts described by your eyewitness have been caused by something other than climate change? What could some other causes be? How might these other causes relate to climate change?

6. What, if anything, are people in the various scenarios doing to respond to climate change? Which actions mentioned do you think are more effective? Which are less effective?

7. How can we, as individuals living in our environment, contribute to reducing the impacts of climate change on other environments?

Writing and/or Drama Extension

Have students, either in pairs or individually, imagine a conversation between themselves and the person in their scenario. Have them think about what they would want to ask this person, and what they would want to tell them. Ask students to suggest how they might cooperate with the person in their scenario to have a positive impact on the world with regard to climate change. Have students write up their dialogue as either a story or a script.
Interview a climate witness. Collect oral histories from older relatives or community members. Ask them to explain how climate (temperatures, rainfall, long-term weather patterns) has changed during their lifetime. Document climate change in your community by combining these oral histories in a book to share with other community members. For more information, including a sample interview form, see the World Wildlife Fund’s Climate Witness project, available at [http://www.panda.org/climatewitness](http://www.panda.org/climatewitness).

**Film**

*Rising Waters: Global Warming and the Fate of the Pacific Islands*, directed by Andrea Torrice, 2000, 57 minutes, [http://www.bullfrogfilms.com/catalog/rw.html](http://www.bullfrogfilms.com/catalog/rw.html). Through personal stories of Pacific Islanders in Kiribati, the Samoas, the atolls of Micronesia and Hawaii, as well as researchers in the continental United States, this documentary film puts a human face on the international climate change debate.

**Websites**

- [http://www.panda.org/climatewitness](http://www.panda.org/climatewitness)—Climate Witness is the World Wildlife Fund’s initiative to document the direct experiences of people who are witnessing the impacts of climate change on their local environment. WWF works with scientists around the world who provide scientific background information to the climate witness testimonies.

BEN NAMAKIN WORKS AS AN environmental educator in Pohnpei in the Federated States of Micronesia, a Pacific island nation.

During his childhood, Ben experienced storms but never severe sea flooding. Sea levels have continued to rise due to warmer ocean temperatures (as water gets warmer, it takes up more space) and melting glaciers. High tides and storm surges are eroding the coasts, flooding graveyards, and destroying homes. The intrusion of saltwater onto the land has affected the quality of water in wells, ruined gardens, and damaged plants and trees, killing the pandanus trees, which are used for building houses, as well as for medicine, food, and clothing.

Many islands are less than three meters (10 feet) above sea level, and some islets have already been submerged. Ben used to hang out with friends on a small islet on the barrier reef near his school in Pohnpei. In 2005, he was surprised to find that sea flooding had split the islet in two.

In the last five years, villagers on the coast of Pohnpei have started to build their houses on raised foundations and construct walls to avoid flooding during high tides and heavy rains.

Ben has spoken about what people can do to stop global warming at the International Youth Summit of the 2005 United Nations Climate Change Conference, and during a climate change tour across the United States in 2006.

MARCO BOMIO LIVES IN GRINDELWALD, Switzerland, at the foot of the Eiger mountain in the Alps. Grindelwald is a well-known tourist destination. Marco is a teacher and school principal and has also worked as a mountain guide for almost 30 years.

Up until about 20 years ago, the glaciers were directly visible from the school windows, and only a half-hour hike away from the village. Now Marco has to walk an hour and a half to reach them. The shrinking of the glaciers and the thawing ground have made the rock face more brittle and unstable, leading to more rock falls.

At the beginning of the record warm summer of 2003, peaks like the Eiger and the Wetterhorn could be climbed a month earlier in the summer than usual. Instead of snowing, now it rains. Mountain resorts have started using more artificial snow, but in the winter of 2006-07, temperatures were too high to produce even artificial snow.

Marco is concerned about the predicted drop in water levels due to a loss of glaciers. The Alps are Europe's major water reservoir, and Switzerland produces 60% of its electricity from hydropower.

As a teacher, Marco feels passionate about educating youth and adults about what is happening: "Why not establish a research institute for climate research in our valley? The subjects to study would be right at our doorstep."

*Unless otherwise noted, accounts are adapted from the World Wildlife Fund's "Climate Witness" initiative. Teachers and students can visit WWF's
VAN BEACHAM LIVES IN NORTHERN New Mexico in the United States. Coming from four generations of fly fishermen, he has been fishing since he was six and working as a fly fishing guide for 27 years.

As a boy, Van remembers the snow sticking around all winter, without the spikes of warm weather that are common now. He has noticed that the time between the last and first frost is one month less than it used to be. For the last 8-10 years, Van has observed a loss of snow during the times of year when it would normally be accumulating. Even when it snows above the average amount, the snow melts faster than it used to. Instead of a slow continual runoff, the rivers rage violently before dropping down to a trickle by early summer. Some streams and small rivers have been drying up completely.

The spawning season has been changing because the fish won't spawn when the water is too warm. Van is seeing increasing algal blooms, sediments, and aquatic weeds, all of which hurt the fish. Van has also noticed a change in the hatching times of the aquatic insects that the fish eat. The fish are often too sluggish to feed during the summer months, which used to be Van's busiest time for fly fishing. Water temperatures above 21 degrees Celsius (70 degrees Fahrenheit) start to kill the fish.

Sometimes Van feels it is his duty to tell his clients why the fishing is poor, and how people are partly responsible for the warming of the globe. While some do not believe him, he says that more and more are starting to see the connections and the big picture.

NORBU SHERPA IS A TREKKING guide in the Khumbu region in Nepal, not far from Mount Everest, the highest peak in the world.

When he was 19, a glacier lake above Norbu's village collapsed. His family had barely enough time to grab a few belongings and run out of their house before it was swept away by the flood, along with rocks, trees, cattle, crops, and all of their possessions.

To support his family, Norbu gave up his plans to become a monk to start a trekking business. During more than two decades of expeditions he has seen many glaciers melting and mountain lakes expanding, increasing the risk of glacial lake outburst flood events. For example, Imja Lake used to be small enough to walk around just a few years ago. Now it is the biggest lake in the Khumbu region.

In his early days of trekking, an expedition to Mount Everest would take around 90 to 100 days with no guarantee of success. As the glacier has shifted upward, people complete the climb in 30 to 40 days.

The decline in rainfall has resulted in droughts, killing trees and crops. There has been less precipitation in the winter, with unexpected snowstorms in the spring instead. Norbu and his family no longer have to make the wall of their houses as thick for insulation.

Norbu is glad he has a chance to tell people around the world about the impacts of climate change that he has witnessed, and to encourage everyone to act quickly to help reduce the impacts.
Grasslands—Argentina

OSVALDO BONINO LIVES IN THE small town of Aarón Castellanos in the Province of Santa Fe, Argentina. The province belongs to the region of La Pampa, where the land is very flat and mainly used for agriculture and farming. Osvaldo has served as Head of the District of Castellanos since 2003.

Due to increased rainfall over a period of seven years, a large lagoon named La Picasa tripled in size, washing away farms, crops, and homes. Many members of the community had to switch from farming to fishing. The main road and the railway connecting the region to the rest of Argentina were flooded. Before the lagoon’s rise, Aarón Castellanos had more than 600 inhabitants; now it has 300.

When the lagoon began to grow, people thought it was temporary because it is common for lagoons to expand during certain seasons of the year and then return to their normal size. But La Picasa just kept on growing, until recently, when drainage measures were implemented and the region had a year of slightly less rainfall. Still, the grassland that was inundated will take a long time to recover its agricultural value – assuming the lagoon remains at its current, smaller size.

Osvaldo hopes that governments will do something to cut CO₂ emissions and prevent things from getting worse so that his region can regain its grasslands.

Icecap—Antarctica

ROBERT SWAN IS A POLAR explorer who has been visiting the Antarctic continent for 23 years. On his expeditions, Robert used to visit the Larsen B ice shelf, a giant floating extension of the permanently frozen land of Antarctica. In 2002, the Larsen B ice shelf (over 3000 km² of ice) broke off from the mainland, and hundreds of billions of tons of ice dissolved into the sea in less than a month. Larsen B is one of five huge ice shelves that has broken off in recent years.

The ice sheets that form in Antarctica each winter are larger than the continent’s total land area. When the water freezes to form ice sheets, salt is released into the ocean. Ice sheets are frozen freshwater. The saltier, colder ocean water is denser than the ice, so it sinks to the bottom of the ocean. From there it flows under the oceans of the world, breathing life into the algae and deep sea plants and animals. With the Antarctic ice sheets melting, more freshwater is flowing into the oceans, threatening to slow the circulation of deep sea waters.

The Antarctic continent contains approximately 90% of the world’s ice. If all of this ice were to melt, sea levels would rise about 61 meters (200 feet). Because it reflects 90% of the sun’s rays, the Antarctic ice is also crucial in keeping Earth’s temperatures lower.

In recent years, Robert has seen fewer Adelie penguins on the peninsula, which require the sea ice to hunt and feed. He has observed more rainfall and more grass growing.

Robert gives talks about his expeditions around the world in order to urge individuals, businesses, and government to reduce greenhouse emissions and meet the challenge of global warming.
JOSE LUIS OLIVEROS ZAFRA IS a farmer in Villanueva de Alcardete, a town in the region of Castilla La-Mancha in Spain. He has been working in the fields for 30 years.

In recent years the seasonal cycle has changed, going straight from summer to winter and back to summer. Spring and autumn seem to have disappeared completely. It has become difficult for farmers to adjust their growing cycle to the unpredictable frosts and heat waves, such as snow in May and extreme heat in February.

As a boy, José Luis liked going to a stream in his town to hear the frogs croak and look for watercress. Now there is no stream, no frogs, and no watercress anywhere. It rains much less than it used to in the fall. Serious droughts in the spring and summer have caused José Luis and farmers across Spain to lose some of their harvests.

With the hotter temperatures, the region suffers more insect plagues. A locust plague recently occurred in Castilla-La Mancha. José Luis had never heard of a locust plague in Castilla-La Mancha. They used to happen only in subtropical places such as the Canary Islands.

José Luis worries that “if the changes keep coming as fast as they currently do, we have no chance to adapt to them.”

ZHA ZHENGSUO IS 41 YEARS old and has spent her life near Qinghai Lake (also called Lake Koko Nor) on the Qinghai-Tibet Plateau in China. Fed by glacial rivers from surrounding mountains, Qinghai Lake is the largest inland saltwater lake in China.

In the last three decades, many of the rivers that empty into the lake have dried up, and the lake’s water level has dropped 3.7 meters (12 feet). The lake has shrunk and split off into smaller lakes.

When she was growing up, Zha Zhengsuo remembers seeing 20 or 30 pairs of black-necked cranes nested in the marshes behind her two-room house. Now only one pair comes each summer. Other bird populations have declined as well, and some animals are facing extinction, including a rare antelope of which there are only 300 left in the wild.

The remaining water is becoming increasingly salty, causing changes in the lake’s ecology. A species of rare carp that feed and grow in the water have adapted by drastically changing their physiology. Still, in the last few years, the number of carp has fallen to 10 percent of what it was 40 years ago.

On the eastern shore of Qinghai Lake, Zha Zhengsuo and her family say that life has gotten better over the last decade. They recently bought a television and a motorcycle and a few shops renting go-karts to tourists have opened nearby, providing jobs. But locals are concerned that the black-necked cranes, considered holy by many Tibetans, have stopped nesting in the area. “Everyone says it’s bad luck that the cranes aren’t coming,” Zha Zhengsuo says.

References:
GEORG SPERBER LIVES IN BAVARIA, Germany. He has worked as a forester harvesting timber for more than 30 years.

In the last couple of decades, Georg has noticed a weakening of the trees, especially spruce trees, which cover 28% of Germany's forest and support the country's forest industry.

It used to rain most in the spring and early summer when the plants needed the extra water. However, since the 1990s, the peak in rainfall has moved to autumn. The weather has become unpredictable, with more frequent droughts and violent storms wreaking havoc on the forests.

The spruce trees are also under attack from growing numbers of bark beetles. Georg has observed a spread in other previously rare parasites such as the oak procession moth, which attacks people with its poisonous hairs, causing painful skin irritations that can last two years. Local authorities have had to hire fire brigades to battle the moths and seal off oak forests to protect the public.

Every spring the migratory birds return a bit earlier than usual, and they leave much later in autumn. Some Chiffchaffs or Blackcaps don't leave at all these days, but try to stay over winter. Sometimes Georg sees species he would not have seen in the past. Even though he is excited about these encounters, they also worry him, because they show that things are changing.

Georg is co-founder of the German working group on Sustainable Forest Management and the German Ecological Hunting Association.

JONATHAN BANKS LIVES IN THE town of Pialligo near the Australian capital of Canberra. He has been an apple farmer since 1984. The orchard has been certified as organic since 1994.

In the 1980s and 1990s, Jonathan remembers having to pick apples between rain showers. These days it is always drier and hotter. The apple trees come into bloom one week earlier than they used to, and the growing season lasts longer.

Jonathan can now grow new types of apples, such as Lady William, which used to not have enough time to ripen. He has also seen less fungus. But other pests have become more damaging. In the early years of the orchard, there used to be only an occasional occurrence of fruit flies, because it was too cool for the flies to breed in large numbers. Now flies are increasing in number every year. In 2005, a third of the crop was lost due to fruit flies. He has seen more fruit bats as well.

Water no longer runs continuously throughout the year in a creek on the property, so Jonathan has to irrigate the orchard from the lake as early as spring. He is also losing more trees and fruit to sunburn.

Even with increased fruit prices, the farm is less productive and less profitable, and Jonathan is seriously considering what else to grow— even though the 50-year-old orchard is still potentially productive in “normal” seasons.
KATSUO SASAKI LIVES IN MIYAGI, Japan, where he has been a rice farmer for more than 40 years.

Miyagi is known as a high-quality rice producing area, but during the last ten years Katsuo has noticed the rice quality degrading. When the summer temperature is high, the rice grains become more opaque and cannot be sold. Farmers like Katsuo are trying to adapt by delaying the planting so that the rice will ripen in autumn, when the temperature is lower.

Katsuo has also been experiencing more frequent extreme weather than when he started as a farmer. Summer temperatures have been fluctuating – one year they are hotter than average, the next year colder. Both extremes are detrimental to rice growing. There have been unusual weather events such as torrential rainfall in December, something Katsuo had never seen before.

There has also been an increase in shield bugs that cause black spots on the rice, reducing the crop's commercial value. While many farmers are using more pesticides to control the insects, Katsuo has been focusing on growing organic rice and has managed to keep his rice resistant to the bugs. He believes humans should live in harmony with nature rather than abusing it. Still, he fears that Miyagi will no longer be a suitable place for growing rice in the coming decades.

RAJABU MOHAMMED SOSELO IS A fisherman in Kunduchi, a coastal village north of Tanzania's capital Dar Es Salaam. Kunduchi's sandy beaches are famous as a tourist destination.

In the last 50 years, Rajabu has seen the beach in Kunduchi being gradually eroded by increasing headwater waves. The seashore has moved 200 meters (660 feet) closer to the village. A mosque, a hotel, a fish market, and five residential houses have been washed away by the sea. Dune structures along the beach are decreasing and disappearing, and sea grasses are being buried by sand.

Rajabu has noticed the cold season being less cold, and the rainy season getting shorter, reducing the river flows entering the Indian Ocean. The decreased supply of freshwater has made water in the delta near the mouth of the river more salty. Fish species that were normally caught there are no longer part of the catch. The saltwater intrusion has also affected the cultivation of agricultural products like grains and legumes that are critical for the village.

Rajabu's business is struggling since people who usually buy his fish can no longer afford the high prices. Rajabu hopes that governments and individuals will do whatever they can to stop the climatic changes and help his community to cope.
ATHENA ANGEL SAM IS 16 years old and lives in Huslia, a small town in Alaska in the United States. In 2006, she worked with other students to record the stories of some of the elders in her town about changes they are experiencing in the climate.

People in Athena’s town have noticed that it stays warm longer into the winter and that cold spells are shorter. Fifty years ago it never rained into November like it does now. The ground that used to be permanently frozen (permafrost) is thawing. It is more dangerous to travel across the land by snowmobile or dog team, and more difficult to hunt for food in the wintertime.

Lakes are draining into the thawed ground, and many have dried up completely. The beavers have had to move from the lakes to the rivers, and there has been a drop in the population of muskrats. While there used to be hundreds of geese flocking in the springtime, now hunters see only five or six geese at a time.

Some fish populations are disappearing, causing problems for both bears and people who rely on eating fish. At the same time, new species of fish that locals have never seen before are appearing. The warmer winters makes the snow soft and therefore harder for large animals like bears and moose to move on it. Some get stuck in the snowdrifts and die.

Because it rains less in the springtime, there are fewer blueberries for the bears to eat, which can lead to starvation. As a consequence, the bigger brown bears started killing moose and black bears. People have also noticed the tops of trees drying up and turning brown, even evergreen trees such as the spruce.

NELLY DAMARIS IS A FARMER who lives in a village called Kipchebor, in western Kenya. She grows maize, tea, and tree seedlings, and also has a few dairy cattle. Nelly is a volunteer working with the Forest Action Network to educate her community about forest conservation. Nelly has witnessed destruction of forest land to allow more room for farming and human settlements.

The most frightening changes to the environment in Kipchebor are related to weather patterns. Kipchebor used to receive rainfall throughout the year, but now part of the year is completely dry. She remembers 20 years ago that even during the dry season, the grass would remain green. Now the dry season is warmer and all the grass dries up.

Starting in the 1980s, warmer temperatures have led to an increased number of mosquitoes. 20-30 years ago, almost no one in the region had malaria because it was too cold for mosquitoes to survive in the high altitude region. But now people there are dying of malaria.

Warmer and drier weather has affected agriculture in the region. Some of the edible insects that people used to depend on when food was scarce are now extinct. People are now even more dependent on the food crops they grow, which are vulnerable to changes in rainfall. There are also more crop pests now that it's warmer, so farmers in Kipchebor use more pesticides.

In 2006, Nelly Damaris spoke of the climate impacts she has witnessed at the World Wildlife Federation's Climate Witness event at the annual UN Climate Change Conference in Nairobi, Kenya.
Effects of Climate Change on Living Things

In small groups, students learn about potential impacts of climate change on living things in a variety of ecosystems. Students communicate these impacts to their school community through informative posters or other media.

Adapted from “Communities of Living Things” by Elizabeth K. Andre, Will Steger Foundation