Inquiry/Critical Thinking Questions

- What are potential positive and negative impacts of climate change on organisms in various ecosystems?
- How might some populations adapt to climate change?

Subject Areas

- Science (Life, Environmental, Physical)
- Social Studies (Geography, World Cultures, World History)

National Standards Alignment

National Science Education Standards (NSES)

- Standard C: Life 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

Objectives

Students will:

- Explain how a changing climate can increase uncertainty for living things
- Identify ways in which particular organisms will be affected by climate change
- Communicate the effects of climate change on living things to the class

Time Required

50 minutes (Extra time may be required, depending on time allowed for research and presentation preparation.)

Key Concepts

- Variability
- Adaptation
- Ecosystems
EFFECTS OF CLIMATE CHANGE ON LIVING THINGS

Activity

Introduction

1. Ask students to define an ecosystem. An ecosystem includes all of the populations of different species that live together in the same area (a community), as well as the nonliving components of their environment.

2. Ask for examples of ecosystems that students have seen or heard about (e.g., coral reefs, hardwood forests, Arctic tundra). What are the characteristics of the ecosystem they live in? Tell them that they will be exploring how climate change can affect living things in ecosystems around the world. They will create and present informative posters to educate others about ways in which particular organisms are sensitive to climate change.

Steps

1. Divide students into 6 groups. Give each group a Role Card.

   Lesson Variation: Students may conduct their own research into climate change impacts rather than using the Role Cards. Websites for research are provided at the bottom of each card.

2. Ask groups to state whether the Role Card they received represents a population or a community.

3. Have students take turns reading aloud sections of their passage from the Role Card to the rest of their group.

4. Have each group discuss the impacts described in their passages, and then create a poster illustrating and

Vocabulary

- **community**: all of the various species that live in the same geographic region
- **ecosystem**: a community of organisms, together with their environment, functioning as a unit
- **population**: a group of organisms of the same species living in the same geographic region

Materials/Preparation

- Role Cards, 1 per group
- Materials for creating posters (paper and marking pens) or other presentation

Wind and precipitation patterns have changed in many regions during the past century, resulting in increased rainfall in some places and droughts in others.

Student Reading 01, page 99
summarizing the information from their Role Card.

**Lesson Variation:** Alternately, student groups can communicate the information through pamphlets, Power Point presentations, videos, podcasts, or skits.

5. Reconvene the entire class. Allow groups to present their posters one at a time, explaining the impacts shown. Display completed posters around the classroom or in school hallways.

**Reflection**

1. Explain how climate change may cause “uncertainty” for populations, communities, and ecosystems.

2. What areas of Earth do you think are most vulnerable to climate change? Why are these areas more sensitive to climate change than other regions?

3. In what ways might some people benefit from climate change?

4. Which effects of climate change that you learned about today will have the greatest impact on Earth’s ecosystems? Give reasoning to support your answer.

5. What are some other living organisms that may be affected by changes in the ecosystem that your group studied? In what ways might they be affected?

6. How might the ecosystem that you live in change if average global temperatures and sea levels continue to rise? How do you think the human community will adapt?

Have students write their own ecosystem impact cards. They can research particular populations or communities in the ecosystem where they live, or ecosystems elsewhere in the world. Students can publish their information about impacts of climate change on various ecosystems as a school newspaper article, a podcast, or an online news article.

**Additional Resources**

**Film**

*Silent Sentinels,* directed by Richard Smith, produced by the Australian Broadcasting Corporation, 1999, 57 minutes, [http://www.bullfrogfilms.com/catalog/sil.html](http://www.bullfrogfilms.com/catalog/sil.html). This documentary film takes a broad look at coral reefs and how the coral organism has coped with climate change over time.

**Websites**


- [http://amap.no/acia/](http://amap.no/acia/) — The scientific report, Impacts of a Warming Arctic, can be downloaded from the Arctic Climate Impact Assessment website. This report details impacts of a warming climate on Arctic ecosystems.
Impact: Increased agricultural yields

A longer growing season due to increased temperatures will increase growth of plants. Northern European crops such as wheat and sugar beets will benefit from a longer growing season. Farmers will also be able to grow crops such as sunflowers and soybeans formerly grown only in warmer regions. Because plants need carbon dioxide for photosynthesis, increased carbon dioxide in the atmosphere will help plants to thrive.

Impact: Tourism boom

Warmer temperatures will make northern Europe a more inviting tourist destination. Tourists may prefer to visit cooler mountainous regions, rather than travel to hotter tropical destinations.

Impact: Shifting navigation

Melting sea ice will open up navigation channels in Arctic regions. Materials, including food and fuel supplies, will be able to be shipped from northern Europe through the Northern Sea Route, requiring less time and fuel for transport.

Other means of travel may be negative impacted by climate change. Extreme weather events, including rain and wind, may damage land-based transportation systems. Flooding can destroy roads and railways. Extreme winds make any mode of transportation more dangerous; windy conditions are hazardous to boats, airplanes, and automobiles.

Impact: Improvements and threats to human health

Warmer temperatures will result in fewer deaths related to cold temperatures. However, heat-related deaths will increase as temperatures rise. Susceptibility to tick-borne diseases like Lyme disease and mosquito-borne diseases like malaria will increase. Children and elderly persons are most susceptible to these diseases. Increased water pollution from bacterial growth, and air pollution due to smog, also pose threats to human health.

Reference:
Impact: Difficulty getting food

Polar bears hunt seals that live in water underneath floating sea ice. The bears walk on the ice, waiting for a seal to surface for air. This hunting technique takes much less energy for the bear than chasing a seal while swimming. If warmer conditions cause the ice to become unstable or break up earlier in the spring, polar bears will have difficulty getting enough food. In fact, if the ice retreats too far from the shore, bears can drown trying to swim out to the ice.

Underweight females have fewer and smaller cubs that are less likely to survive. When the polar bear mother and cubs leave their den in the spring, it will have been between five and seven months since the mother has eaten. She will need to be successful hunting for her family to survive.

Impact: Loss of shelter

Climate change can affect weather patterns around the world. Increasing numbers and strength of spring rainstorms can cause bear dens to collapse.

Impact: Competition from newly arrived species

As the climate warms, grizzly bears travel farther north. Grizzly bears are more aggressive than polar bears and can out-compete them. They can also interbreed with polar bears, thereby reducing the numbers of non-hybrid polar bears.

Impact: Increased pollution

Many of the air pollutants from the northern hemisphere reach the Arctic through the circulation of air in the atmosphere and the flow of water. Climate change is predicted to bring more precipitation (snow and rain) and higher river flows to the Arctic. This increased precipitation and water flow carries more chemical contaminants. Plants and animals that are low on the food chain absorb these pollutants from the water. Larger animals like seals and polar bears absorb the pollutants from their food in even greater amounts. The concentration of pollutants increases as the pollutants are transferred from prey to predators (bioaccumulation). This pollution negatively affects the health of polar bears and their food.


**Impact: Nest incubation threatened**

Marine turtles in Australia require nest temperatures of 25-32°C (77-90°F) for egg incubation. Turtles from eggs in nests cooler or warmer than this range will not hatch. Increased temperatures may result in decreased numbers of hatchlings and migration to new habitats with nesting sites of an appropriate temperature.

**Impact: Shifting sex ratios**

Like many reptile species, the sex of these sea turtles is determined by nest temperature. Warmer nests will produce more female hatchlings, while cooler temperatures result in more males.

**Impact: Nest sites at low elevations susceptible to flooding**

Sea level rise will have a large impact on low-lying areas, including beaches where turtles lay their eggs. Nesting sites may be destroyed by rising waters and erosion. Turtles may seek new beaches with higher elevation nesting grounds.

**Impact: Reduced food availability**

Increased temperatures result in damage and sometimes death to coral reefs, an important resource for sea turtles. Sea turtles depend on coral reefs for habitat and eat plants and animals found in reef ecosystems. Warmer waters can result in coral bleaching—a whitening of coral caused by loss of algae. Coral bleaching can destroy reef ecosystems.

Higher temperatures also negatively affect sea grasses that turtles feed on. Severe storms such as cyclones and hurricanes, brought about by global climate change, also damage coral reefs and sea grasses.

**Reference:**
Impact: Diminishing food supplies and cultural resources

The Inuit people (Native people of the Arctic, formerly known as Eskimos) hunt caribou (deer relatives), which provide them with an affordable food source and help them survive the cold seasons. Caribou numbers have decreased, perhaps due to an inability to travel over melting snow and ice to reach food.

In addition to using caribou for food, Inuit people also value caribou as an important part of their mythology, spirituality, and cultural identity.

Impact: Difficulty traveling

Many Inuit villages are accessible only by dogsled, snowmobile, or sometimes on roads over permafrost (permanently frozen ground). As snow- and ice-free periods get longer, travel by dogsled or snowmobile becomes difficult or even impossible. The permafrost is melting earlier in the spring, turning the roads into mud pits.

Impact: Erosion of coastal lands

Warmer ocean water and air can melt the permafrost that stabilizes coastal land and shorelines. This melting, combined with rising sea levels and shrinking shore and sea ice that once buffered the shore from stormy wave action, can make coastal buildings, pipelines, and roads fall into the ocean and flood low-lying areas, contaminating them with salt.

Impact: Increased accessibility to ships

As the sea ice diminishes, ocean that was previously locked in ice, and therefore impassible to most ships, can now be navigated. For example, a cruise ship recently arrived and unloaded its passengers in Pangnirtung, a remote Inuit village on the southern tip of Baffin Island in the Canadian Arctic that before was accessible only by air or dogsled.
Impact: Thawing permafrost and soil instability

The ice in the permafrost (permanently frozen ground) helps maintain the structure of the soil. Permafrost supports the weight of buildings and roads. When it melts, trees can begin to fall over and sinkholes can develop, which then can fill with water and drown the trees standing there.

Impact: Potential desertification

Even though the total amount of precipitation is projected to increase in the Arctic, precipitation may come at times of the year when plants do not need it, or it may come in extreme storms where most of it runs off to the rivers quickly. Also, as temperatures get warmer, more water will evaporate and plants will lose more water during transpiration. These processes send water back into the atmosphere. It is therefore possible that certain areas could dry out and become polar deserts.

Impact: Thriving pests

When winters are long and very cold and when summers are short, as they traditionally have been in the Arctic, numbers of pests like the spruce bark beetle are kept in check. However, warmer winters mean that more bark beetles will survive each year, and these beetles can kill spruce trees.

Healthy spruce trees have natural defenses against bark beetle attacks. When a beetle tries to bore into the tree to lay her eggs, the tree can push sap out against the beetle to keep her from moving far enough into the tree to lay eggs. When trees are stressed from dry conditions and warmer than normal temperatures, however, they do not have enough sap to fight the beetles.

Impact: Competition from foreign species

As temperatures warm, plant species begin to migrate and survive farther north, invading areas previously inhabited by Arctic species only. Many of the adaptations that allow Arctic species to survive in such cold conditions also limit their ability to compete with invading species. For example, when the temperature gets above about 60°F (16°C), black and white spruce trees are not able to grow as well. If temperatures get too hot, the black and white spruce will not grow at all.

**Humans on Small Pacific Islands**

**Salomon Islands, Papua New Guinea, American Samoa**

**Impact: Coastal erosion**

Many of these small islands are less than 4 meters (about 13 feet) above sea level. Sea levels (from glacial melting and thermal expansion) have risen continually in the past century. Higher sea levels encroach on coastal habitat, which affects not only human settlements but natural coastal ecosystems as well. Increased sea levels and saltwater intrusion cause declines in mangrove tree populations. Mangrove roots protect coastlines from erosion, but as sea levels rise over time, mangroves migrate toward the land. If they eventually reach a sea wall or other barrier, they may be reduced to a narrow strip of trees or may disappear altogether.

**Impact: Reduced tourism**

Algae living on coral reefs are sensitive to warmer water temperatures. If the water is too warm, they die, causing coral to appear white (this is called “coral bleaching”). Tourism from diving will be reduced if coral reefs are damaged.

**Impact: Reduced freshwater quality**

Low-lying islands depend on rainfall and natural filters such as mangroves to maintain a clean supply of freshwater. Rising sea levels cause salt water to move farther inland, often contaminating drinking water sources. Mangroves act as natural filters, preventing sediment and toxins from reaching island water sources. Reduction of mangrove habitat from rising sea levels would allow more sediments and pollutants to move inland, polluting fresh water sources.

**Impact: Lack of food resources**

Loss of mangrove and coral reef habitats signals dwindling food resources for islanders. Mangroves provide habitat for many types of seafood, including crabs, clams, and fish. Coral reefs likewise provide habitat for many fish.

References:


Project LEAP

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

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<thead>
<tr>
<th>Questions</th>
<th>Project LEAP-Teacher Information</th>
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<tr>
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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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<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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<td>15. Interdisciplinary connections?</td>
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<td>16. Reflect real-world problems?</td>
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<td>17. Multicultural themes?</td>
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<td>18. Build upon prior knowledge?</td>
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<td>19. Utilize technology?</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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Project LEAP

General Information
Grade level: 3-8

Overall focus or Theme:
Project LEAP is designed to provide educational materials, activities, and curricula to students and teachers in the state of Indiana. It aims to aid teachers in integrating environmental education into already existing science and health related curricula. LEAP is currently unavailable due to a curriculum update. Six units exist within the curriculum, and are based on the topics of air, air pollution, the state of the air, pollutant sources, ozone, and a review. Project LEAP also provides a water module, which focuses on topics such as the watershed, wetlands, and the water cycle.
Source: http://www.in.gov/idem/your_environment/education/leap/index.html

IMPORTANT NOTE:
Since LEAP is currently undergoing curriculum changes, we have reviewed materials that the LEAP curriculum distributed to science educators at the 2008 HASTI Conference in Indianapolis. The topics include basic pH information, a field study related to butterfly observation, and various activities related to air pollution.

Affiliation:
LEAP is associated with the Indiana Department of Environmental Management (IDEM).

Teacher Information
1. Does it require additional resources or are materials included?
LEAP includes many useful materials for the lessons included. For example, the basic information provided about pH includes a rain gauge (pH of rain can be monitored) and pH paper to test everyday liquids. The Butterfly Monitoring Project includes useful butterfly identification cards. Student observation sheets and data sheets are included for lessons. Other common items are required for some lessons. Examples of materials needed include common items such as clay, rubber bands, and hangers.

2. Are assessments included?
Yes. Although no formal assessments such as tests or quizzes are included, the largest activity, Butterfly Monitoring Project, includes many project assessment suggestions. These assessment suggestions include a data comparison for the entire class and an extension activity related to observing the types of plants butterflies most often visit to feed.

3. Does it encourage multiple ways to teach a topic?
No. The lessons included all focus on experimentation. They are all useful, however, for practicing scientific technique and keen observation skills.
construction, and pesticides observed in that area that may affect butterfly populations; (3) observations of plant species in the area that butterflies “dine” on in order to come to a conclusion about what kinds of plants attract butterflies, and students are also encouraged to do research about different plants in the area; or (4) completing an Advanced Research project that researches Monarchs that wash up on lake shores and the possible reasons for this. The other activities do not allow students to respond in multiple ways to the activities.

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

Yes; however only in the Butterfly Monitoring Project does it support community involvement because students are researching butterfly populations in their specific locality. In addition, one of the activities encourages students to interview a neighbor who has a garden about the butterfly activity seen there. However, the other activities do not support community involvement, as they are shorter demonstrations and activities.

10. Does it promote social interaction?

Yes. In the Butterfly Monitoring Project students are encouraged to collaborate to gather data about butterfly populations in their area. In this project, each student is working to make observations and compile data as a whole in order to develop a group hypothesis of the changes in butterfly populations. However, the other activities do not support or promote social interaction.

11. Does it promote student-centered learning?

Yes. In the Butterfly Monitoring Project, it is the students who are completing the observation project by creating the hypothesis, collecting the data, doing all the additional research, and writing the report. In addition, the other activities are also student-centered because they require students to make observations over a long-period of time to understand the principles being addressed.

12. Is it inquiry based?

Yes. Students are guided by the teacher in inquiry based projects that deepen an understanding of observation skills. In the Butterfly Monitoring Project, students collect data and do research to develop a conclusion about butterfly population changes. In another experiment, Visible Pollution students are encouraged to experiment to find out about visible pollution in the air by spreading petroleum jelly on an index card and hanging it outside. Students observe changes after one and two week periods.

13. Does it include some teacher and student materials/books?

Yes. This curriculum sampling includes pH indicators, butterfly cards, student hand-outs, and a rain gauge for use in the activities. However additional resources, such as petroleum jelly, magnifying glasses, rubber bands, hangers, and lumps of clay are not included, but are easily accessible.
Adaptations to Indiana Academic Standards

Grades 5-8
Butterfly Monitoring Project

Science

Standard 1 The Nature of Science and Technology

View of the Scientific World:
5.1.1 Recognize and describe that results of similar scientific investigations may turn out differently because of inconsistencies in methods, materials, and observations*.
7.1.1 Recognize and explain that when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often takes further studies to decide.
8.1.1 Recognize that and describe how scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory* leads to looking at old observations in a new way.

Scientific Inquiry
6.1.2 Give examples of different ways scientists investigate natural phenomena and identify processes all scientists use, such as collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses* and explanations, in order to make sense of the evidence. 06.1.3 Recognize and explain that hypotheses are valuable, even if they turn out not to be true, if they lead to fruitful investigations.
7.1.2 Explain that what people expect to observe often affects what they actually do observe and provide an example of a solution to this problem.
7.1.3 Explain why it is important in science to keep honest, clear, and accurate records.
7.1.4 Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.
8.1.4 Explain why accurate record keeping, openness, and replication are essential for maintaining an investigator’s credibility with other scientists and society.

The Scientific Enterprise
8.1.4 Explain why accurate record keeping, openness, and replication are essential for maintaining an investigator’s credibility with other scientists and society.

Standard 2 Scientific Thinking

Manipulation and Observation
5.2.4 Keep a notebook to record observations and be able to distinguish inferences* from actual observations.

Communication Skills
5.2.7 Read and follow step-by-step instructions when learning new procedures.
6.2.8 Analyze and interpret a given set of findings, demonstrating that there may be more than one good way to do so.
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.
Diversity of Life
7.4.2 Describe that all organisms, including the human species*, are part of and depend on two main interconnected global food webs*, the ocean food web and the land food web.

Standard 5 The Mathematical World
Reasoning and Uncertainty
5.5.7 Explain that predictions can be based on what is known about the past, assuming that conditions are similar.
5.5.8 Realize and explain that predictions may be more accurate if they are based on large collections of objects or events.
8.5.8 Explain how estimates can be based on data from similar conditions in the past or on the assumption that all the possibilities are known.

Standard 6 Common Themes
Systems
5.6.1 Recognize and describe that systems contain objects as well as processes that interact with each other.
OBJECTIVES:

- Students will observe and record information about the butterflies they encounter.
- Students will learn to identify various types of butterflies found to populate their geographic region in Indiana and the plants on which they depend.
- Students will learn to identify diversities in butterflies and butterfly habitats.
- Students will explore the complex relationship between butterflies, the plants they use, and the quality of the environment that we all share.
- Students will research conditions that affect butterfly populations and rate them as positive or negative and the resulting impacts as most important to least important.
- Advanced students will design a research project based on the above exploration and gain experience with the scientific method of investigation.

INTRODUCTION:

The main goal of the butterfly monitoring study is to expose students to scientific sampling procedures and provide an opportunity to participate in a hands-on data-gathering experience. Students will identify the different types of butterflies within the study area. Students will identify or create a suitable butterfly habitat which includes the plant species that butterflies frequent and the time of year when various plants flower. Students will observe environmental factors including weather conditions and the time of day when butterflies are observed.

Students will then correlate butterfly populations with habitat availability and environmental conditions in the study area. Students may determine that certain times of the year or specific weather conditions affect population counts for certain butterflies. By comparing data from monitoring sessions and determining if there was a change in population numbers, students can speculate on possible conditions that cause or contribute to the changes in diversity and species population numbers in butterfly populations.
One focus of this study has students consider whether air pollution may affect butterflies indirectly by its effect on plant growth and diversity. Pollution can stress plants making some nutrients unavailable. Consider whether ground-level ozone or other pollutants could be a factor in population changes. Many factors could effect butterfly populations. Students should be directed to consider all possibilities which may reflect either positive or negative population counts.

The first year’s data may be used to establish a baseline study that can be used by future classes to follow trends of populations changes. By yearly counting the number of butterflies and identifying each species, the comparison of that data will present a clearer picture over time of the butterfly population in the area being studied. By identifying and recording the types of plants found in the sampling area, students returning to the site in following years will determine if the plant community remains the same. By collecting and labeling pressed leaves from the plants being studied, a visual historic reference will be created. By comparing butterfly populations and environmental condition data from year to year, butterflies can be used as a bioindicator of environmental conditions in the study area.
Freddie’s Fun Facts

There are nearly 20,000 species of butterflies in the world. In most parts of the United States, there are roughly 100 species of butterflies in any particular region.

An adult butterfly has an average life-span of around one month. The smaller butterflies may only live one week or so, while a few butterflies, such as Monarchs and Mourning Cloaks can live up to nine months.

Most butterflies lay their eggs on plants that will be eaten by the caterpillars once they hatch. Some species lay their eggs on the tops of leaves, some on the bottom, some at the leaf axils (the upper angle between an axis and an offshoot such as a branch or leafstalk).

Almost all butterfly caterpillars eat plant material. Mainly, the caterpillars eat leaves, but some species eat seeds and seed pods while others feed on certain flowers. Most species will eat only a small group of related plant species. Although caterpillars eat plants, very few butterfly caterpillars are agricultural pests. If caterpillars are destroying some of your garden plants, it is unlikely that they are butterflies (unless you planted those plants just to attract butterflies).

Adult butterflies mostly drink nectar from flowers through their tongues, which work much like straws. Certain species of butterflies almost never get their food from flowers; instead, they get food from tree sap, rotting fruit or animal matter, and other organic material.

Butterflies smell with the ends of their antennas and the bottoms of their feet. Their sense of smell is so sharp they are drawn to food sources over a mile away.

Butterflies find shelter at night and during stormy weather by perching on the underside of a leaf, or by crawling deep between blades of grass or climbing in a rocky crevice.

In Indiana, and other areas, where the temperature drops below freezing, at least one stage in the butterfly species’ life cycle must be protected from freezing. Most butterflies that live in cold climates spend the winter as caterpillars. Almost as many spend the winter as pupas. Very few species spend the winter as eggs.

Some butterflies found in Indiana cannot survive our cold winters. As the weather gets colder, those butterflies migrate (move from one place to another) south where they reproduce. Cloudless Sulphurs, Mourning Cloaks, Question Marks and especially Queens and Monarchs can sometimes be found moving south in groups of thousands! We do not know exactly where all of these butterflies go. Monarchs are well known for migrating to Mexico. Monarch Watch follows the Monarch’s travels. (Monarch Watch Website is: www.MonarchWatch.org)
Laboratory Investigation 1
(Grades 5 - 6)

PURPOSE: To observe, identify, and record population data about butterflies and their environments in your region of Indiana.

MATERIALS:
- pencil and paper
- data chart
- weather thermometer
- wind gauge
- weather conditions (check your local newspaper or access local weather conditions on the Web at http://www.weatherbug.com)
- butterfly key (field guide or materials available on the Web, check out this site: http://www.npwrc.usgs.gov/resource/distr/lepidbflyusa/bflyusa.htm)
- flowering plant field guide

BACKGROUND

Did you know that just like panda bears and siberian tigers some butterflies are disappearing and being added to the endangered species list? Many animal species do not have the ability to adjust their lifestyles like we do when their environment changes. If habitats and food sources on which some butterfly species depend begin to change or disappear, so may some butterfly species.

Different kinds of butterflies have various habitat needs and food sources. For example, the Monarch butterfly feeds primarily on milkweed plants (there are many types of milkweed plants). They lay their eggs on the leaves. When the larvae hatch, the plant becomes their food. As a caterpillar eats and grows, it fastens its pupa to the plant and emerges as a brilliant Monarch butterfly. When a plant used as a food source is damaged by pollution or pesticides, the species feeding on the plant may become sick or die. Common Milkweed is one type of milkweed quickly damaged by ozone.

Data from this study will help us see butterfly population changes throughout Indiana. Data from all schools doing this project will be displayed on a map which is now being developed for the Project LEAP Website.
Laboratory Investigation II  
(Grades 7 - 8)

PURPOSE: To observe, identify, and record population data about butterflies and their environments in your region of Indiana.

MATERIALS:
✓ pencil and paper
✓ data chart
✓ weather thermometer
✓ wind gauge
✓ weather conditions (check your local newspaper or access local weather conditions on the Web at http://www.weatherbug.com)
✓ butterfly key (field guide or materials available on the Web)
✓ flowering plant field guide
* binoculars (optional)
* butterfly net (optional web activity)
* tagging equipment (optional web activity)
* Monarch tracking data sheet (optional web activity)

BACKGROUND

One focus of this study looks at whether air pollution may affect butterflies indirectly by its affect on plant growth and diversity. Pollution can stress plants making some nutrients unavailable which may result in some populations decreasing while others increase. Many factors could affect butterfly populations such as: weather patterns, storm damage, pollution, construction, various chemicals like household insecticides and agricultural sprays as well as other factors you may observe. Consider all possibilities which may reflect changes in butterfly species populations.

A baseline or standard will be established from data collected the first year. This data will be used by future classes. By yearly counting the number of butterflies and identifying each species, the comparison of that data will present a clearer picture over time of the butterfly population in the area being studied. By identifying and recording the types of plants found in the sampling area and returning to the site, observation and data collection will determine if the plant community remains the same and show trends in butterfly populations. By comparing butterfly populations and environmental conditions data from year to year, butterflies can be used as a bioindicator of environmental changes in the study area.

Data from this study will be used to identify Indiana's butterfly populations in regions throughout Indiana. As data is compiled, Project LEAP will have a map on our Website which shows data from all participating schools.
GETTING STARTED
All Levels

OBSERVATION TIPS

When to watch. The period of greatest activity is generally between 9:00 a.m. and 4:00 p.m. This varies with early morning and late afternoon temperatures, wind, cloud cover, and other local conditions. An important factor to remember is butterflies cannot fly if their body temperature is below 86 degrees. Fluttering wings do generate body heat, but butterfly sightings may be few to none when the outside temperature drops below 50 degrees. Observations may begin once butterfly activity has been seen. To participate during a nine month school year observation is recommended between April / May for Spring observations and August / September for late summer. Many species live between one to two weeks. Larger butterflies like Monarchs, Mourning Cloaks, Red Admirals, and several other species live from one to several months. Refer to a good field guide which shows individual life spans.

Common Sighting Areas. Wetlands, meadows (open fields), wood’s edge, urban gardens, vacant lots, etc. Do not limit your observation area. Try to find a close location which will allow bi-weekly visits. (If no areas are conveniently located, create your own butterfly garden as mentioned later.)

How to watch. Let the butterflies come to you. Settle down comfortably in an unnoticeable position. Have your Field Journal Data Sheet (a field guide is also very helpful), a notebook, and binoculars (if possible) at hand. Once you find a place to sit quietly, nature will get back to normal. Butterflies will soon be fluttering around.

Field recognition. Many butterflies can be identified on sight once the important field marks (identifying visual features, such as wing shape, color, and pattern) and behavior have been learned. Watch for feeding, drinking, flight habits, mating, egg laying, and position to the sun. Observe the ways butterflies act with other species, including predators and parasites. After a little experience, you will probably recognize some types of butterflies by sight. (Descriptive words for flight habits may be darts, hop, fly, swoop, etc. Use your own words.)
PROCEDURE (all levels):

1. Gather materials and go to a suitable sampling area.

2. At the sampling area, students will sketch a rough outline of the area on the back of their journal/data sheet then label habitat and structures present. For example:

   W = Water
   F = Flowering Plants/Weeds
   T = Trees
   G = Grasses/Weeds
   L = Lawn Grasses
   B = Building

3. Make up codes for your site maps. It is important that each student uses the same codes. Coloring the mapped areas help show what the butterflies see when they fly above the area. The idea is to make a picture to see how the area might look to a butterfly flying overhead.

   Suggestion: Use a ruler to section off areas. Assign specific sections to the students for them to observe and record data.

4. Temperature and wind measurements should be checked and recorded several times.

5. Observations should last 20 to 45 minutes.

6. Try to learn the types of flowering plants in the area with the field guides, or look for distinguishing characteristics of common plants and weeds. Record the names of plants in the spaces provided on the data sheet.

7. Find a suitable place to stop, sit, and observe. Spread out the site map and mark your location. Record general observations of the surroundings using a journal style. Take about five minutes and write about all that you notice, hear, and smell. For example: What is the weather like? Butterflies will have been sighted by now, if they are around.
D. Analyze the data and information.
Examine in detail all your information, begin to sort and organize as you concentrate on what you have. Sort by type of research. Compare the data or information first by type or categories and then compare data / information between all sources. Find common concepts in the research and data.

Example: After gathering data and information, you will find that Monarch butterfly caterpillars feed on the normally poisonous milkweed plants.

E. Make some conclusions about your hypothesis.
Using the information and data you gathered, decide if the hypothesis you developed is accurate. Does the data prove or disprove your hypothesis? If your research has disproven your hypothesis, you need to go back and review the original hypothesis. You may need to alter and retest your hypothesis.

Example: Monarch butterflies develop a natural defense because of feeding on milkweed.

Advanced students can download information from the Internet to design their projects and back up their conclusions. Students may work in groups to design and execute a research project centered around an established hypothesis. Collaboration with other classrooms and other schools is encouraged, both in design and completion of research projects. A question and statement may be chosen at either the beginning or end of this study for this research project.

Abstracts that summarize conclusions from students’ research can be posted on the Project LEAP Website for other schools and interested parties to access and use. Eventually, future classes could develop research or science fair projects using historical data collected from previous classes participating in this program.

Guided Research Topics:

1. Use data gathered during this project. Compare data from the class monitoring sessions and determine if there was a change in population numbers. Speculate on possible conditions that cause or contribute to the changes in diversity and species population numbers in butterfly populations. You may wish to research and gather additional data about local weather conditions, locations of industry, construction, pesticides and household chemicals, land use of upwind neighborhood, etc. Consider a question you may have and develop your hypotheses.

Example: Have butterfly populations numbers increased or decreased due to _______ in the observation area of study?

2. Speak with someone in your neighborhood who has maintained a flower garden. Ask whether the gardener has written or mental notes about butterflies that have visited their garden. Record any relevant information. Have any particular habits of the different species been noticed? Were any changes in the species and population numbers discerned? Ask if flowers have been added or removed from the garden. Ask whether the presence or absence of predators such as wasps, birds, etc. Have there been any new predators observed? Ask if pesticides have been used to control weeds or predators. Research additional data about local weather conditions, locations of industry, construction, household chemicals and other pesticides observed being used in the area, and land use downwind of the neighborhood since the garden’s existence. Research
feeding or habitat needs of only one type of butterfly. Consider a question you may have, then develop your hypotheses.

Example: Have butterfly populations numbers for that species decreased? Have butterfly population numbers for another species increased in your garden?

3. Take the same approach to types of plants on which butterflies feed. For several 20 minute periods over three weeks, observe two or more species of plants that grow next to each other in a flower garden. Count both the species and number of butterflies that “dine” on each plant species during the half hour period. Total the numbers at the end of the project. What are the results? What plants did butterflies visit most? Did certain species of butterflies prefer certain plants more than other plants? Did one or several plant colors draw more butterflies? Select certain plants or one butterfly species to develop a question. Research the special features of those plants: colors, nutrients or chemicals, shape and composition, etc. Research what attracts that one butterfly species to those plants. (If the school has an outdoor lab, students could observe different periods one day a week, or more if possible.)

Example: What plant or plant color drew the most butterflies?

4. (Advanced Research) Each year there are reports of Monarchs that wash up on the shores of large lakes in substantial numbers. Usually these observations are made in late September or early October. Cold fronts and sudden storms are associated with some of these deaths often the weather is moderate (65-75°F) when this occurs. Why? Think physics and muscle physiology! For those with some skills in physics and math, it shouldn't be too difficult to develop a predictive model that would explain the conditions under which Monarchs drown while attempting to cross lakes. www.MonarchWatch.org

Pass your research on to:

Monarch Watch
University of Kansas
1200 Sunnyside Ave
Lawrence KS 66045-7534
Research Helps

After following the previous steps begin here:

Start selecting the publications to be used.

Use index cards to organize the bibliography (4" x 6" is a nice size).
- list in alphabetical order citations of author, subject, or keyword
- general and trade bibliographies
- indexes (books, periodicals, newspapers, booklets, brochures)
- library electronic catalogue
- Web addresses and citations

Design

Draft an outline.

Examine your reference materials; determine essential material from unessential material.

Write your notes on index cards (put the cards in the same order as your outline).

Avoid plagiarism (copying someone's work and presenting it as your own).

Writing the Paper

Finish your outline; review for completeness and organization.

Time to write (think about the audience in terms of who might be reading your paper, write to them).

Write your rough draft.

Take a break.

Review your paper.

Make revisions and rewrite.

Have someone review and make comments on your paper.

Make appropriate revisions and rewrite.

Check the format of the text, citations, notes, and bibliography.

Proofread, correct, and then have someone else proofread.

Write your final draft, and have someone else proofread one more time.
Children’s Butterfly Site

Life Cycle of a Butterfly

Butterflies are highly-developed insects. Butterflies have a “complete” life cycle. Their life cycle is composed of four separate stages. Each stage looks completely different and serves a special purpose in the life of the insect.

The egg is a tiny, round, oval, or almond-shaped, often with fine ribs. The female attaches the egg to leaves, stems, or other objects, usually on or near the caterpillar food.

The caterpillar (or larva) is the long worm-like stage of the butterfly. It often has an interesting pattern of stripes or patches, and may have spine-like hairs. This is the feeding and growth stage. As it grows, it sheds its skin four or more times. Its rapidly growing body becomes wrapped in the skin it sheds. Now the caterpillar is in its pupa.

The chrysalis or pupa stage is the resting stage. This is the non-feeding stage in which the caterpillar cells are broken down and the adult is formed. The pupa of most butterflies is brown or green and blends into the background. Many species spend the winter in this stage.

The adult (or imago) is the colorful butterfly we usually see. This is the reproductive and active stage. The adults undergo courtship, mating, and egg-laying. The adult butterfly is the stage that migrates to or creates new habitats.

How Can I Raise A Caterpillar?

Raising a caterpillar from the pupa to the adult butterfly is an excellent lesson about insect metamorphosis (the complete change of physical form). All you need is a caterpillar, some of its favored food, and a suitable container. You can find caterpillars on most plants during the spring and early summer. Put the caterpillar and a few fresh leaves in a wide-mouth jar or plastic shoe box. Cover the opening with netting or a piece of nylon. Every day change the leaves and put dry paper towels anywhere in the container to help prevent mold. You can put in pencil-size twigs upon which the caterpillar can attach its chrysalis (with the pupa inside).

The insect will hatch in 10-14 days, if it does not remain in the chrysalis for the winter. Before releasing it you can photograph your prize. Don’t be disappointed if small wasps or flies--natural parasites--hatch out instead. Wasps are natural predators that feed on pupae. These insects keep the butterfly and moth populations under natural control.

REFERENCE:
Traits of a Good Butterfly Plant

The shape, color, and fragrance of the flowers should be the first consideration when selecting a plant for a butterfly garden. As long as the following features are provided, butterflies will feed and visit the garden.

**Shape**

The shape of the flower is particularly important because butterflies cannot hover very long and need a place to land. They prefer composites (daisy-like flowers), panicles (large clusters of blooms on a stem, Snap Dragons), and umbels (flat-topped flowers that originate from a single peak, Marigolds).

**Color**

When given the choice, butterflies prefer to visit flowers with strong colors such as orange, yellow, and purple. Butterflies view their environment through polarized light and in the ultraviolet (UV) range. The UV light enables them to see hidden ultraviolet patterns on the petals which guide them to the heart of the nectar source. Polarized light waves allow the butterflies to view objects at right angles to their direction of travel and to identify the sun's position (like a compass).

**Fragrance**

Besides color and shape, the fragrance of the flowers draws the butterflies to the garden. Flowers with the heaviest perfume are most appealing to the butterflies' sensitive sense of smell. The best heavily scented flowers are the "old fashion" seed varieties which have *not* been cross-bred.

**Superior Nectar Plants**

<table>
<thead>
<tr>
<th>Butterfly Weed</th>
<th>Asclepias tuberosa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butterfly Bush</td>
<td>Buddleia davidii</td>
</tr>
<tr>
<td>Common Cosmos</td>
<td>Cosmos bipinnatus</td>
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<tr>
<td>Purple Coneflower</td>
<td>Echinacea purpurea</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Lantana</th>
<th>Lantana camara</th>
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<tbody>
<tr>
<td>Bee Balm</td>
<td>Monarda didyma</td>
</tr>
<tr>
<td>Black-Eyed Susan</td>
<td>Rudbeckia hirta</td>
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<tr>
<td>Zinnia</td>
<td>Zinnia elegans</td>
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</tbody>
</table>

**Common Host Plants**

<table>
<thead>
<tr>
<th>Hollyhock</th>
<th>Alcea rosea</th>
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<tbody>
<tr>
<td>Dill</td>
<td>Anethum graveolens</td>
</tr>
<tr>
<td>Red Clover</td>
<td>Trifolium pratense</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Parsley</th>
<th>Petroselinum crispum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Milkweed</td>
<td>Asclepias syriaca</td>
</tr>
<tr>
<td>New York Ironweed</td>
<td>Veronica nouenhoracensis</td>
</tr>
</tbody>
</table>
To Create a Butterfly Friendly Environment

Butterflies need:

- Plenty of sunshine
- Shelter from wind
- A reliable nectar source
- Host plants (food for caterpillars and egg laying, etc.)
- Protection from danger/predators
- Water sources

A combination of annuals, perennials, trees, and woody shrubs will provide the proper environment for all the life cycle stages of the butterfly. Butterflies can sense which part of the garden produces more nectar than others. Mass plantings of the same kinds of plants and flowers are the best way to draw butterflies to your butterfly habitat.
1. Brushfoot, Meadow Fritillary *Boloria bellona*  
*Wing Span*: 1 3/8 - 2 inches (3.5 - 5.1 cm)  
*Adult Food*: black-eyed susans, dandelions, ox-eyed daisy, other composites  
*Habitat*: usually wet places, open woods, pastures, hayfields, bogs  
*Host Plants*: various violet species including northern white violet and blue violet

2. Whites, Cabbage White *Pieris rapae*  
*Wing Span*: 1 3/4 - 2 1/4 inches (4.5 - 5.8 cm)  
*Adult Food*: mustards, dandelion, red clover, asters, mints, many others  
*Habitat*: almost any open space, weedy areas, gardens, roadsides, cities, suburbs  
*Host Plants*: mustard and occasionally caper families

3. Brushfoot, Little Wood Satyr *Megisto cymela*  
*Wing Span*: 1 1/2 - 1 7/8 inches (3.8 - 4.8 cm)  
*Adult Food*: sap, aphid honeydew, grasses, sedges, rarely flower nectar  
*Habitat*: grassy woods and openings, old fields, especially in limey or acid soils  
*Host Plants*: orchard grass, centipede grass

4. Brushfoot, Morning Cloak *Nymphalis antiopa*  
*Wing Span*: 2 1/4 - 4 inches (5.7 - 10.1 cm)  
*Adult Food*: occasionally flower nectar, rotting fruit, tree sap (especially foaks, they walk down the trunk to the sap)  
*Habitat*: woods, openings, parks, suburbs, (these roam, migrate, and can be found almost anywhere)  
*Host Plants*: willow trees, elm, cottonwood, aspen, paper birch, hackberry

5. Brushfoot, Question Mark *Polygonia interrogationis*  
*Wing Span*: 2 1/4 - 3 inches (5.7 - 7.6 cm)  
*Adult Food*: rotting fruit, tree sap, dung, carrion  
*Habitat*: wooded areas with some open space, city parks, suburbs, fence rows  
*Host Plants*: american elm, red elm, hackberry, japanese hop, nettles

6. Sulfur, Orange Sulfur *Colias eurytheme*  
*Wing Span*: 1 3/8 - 2 3/4 inches (3.5 - 7 cm)  
*Adult Food*: alfalfa, sennas, dandelion, goldenrods, milkweeds, asters, clover  
*Habitat*: clover and alfalfa fields, mowed fields, vacant lots, meadows, and edges  
*Host Plants*: alfalfa, white clover families

7. Brushfoot, Painted Lady *Vanessa cardui*  
*Wing Span*: 2 - 2 7/8 inches (5.1 - 7.3 cm)  
*Adult Food*: composites 3 - 6 feet high, especially thistle, aster, cosmos, blazing star, ironweed, other flowers visited: red clover, button bush, privet, milkweeds  
*Habitat*: almost everywhere, especially open or disturbed areas including gardens, old fields, dunes  
*Host Plants*: more than 100 plants have been noted, favorites include thistles, holly hock and mallow, various legumes

8. Gossamer Wing, American Copper *Lycaena phlaeas*  
*Wing Span*: 7/8 - 1 3/8 inches (2.2 - 3.5 cm)  
*Adult Food*: common buttercup, white clover, butterfly weed, yarrow, ox-eye daisy, various composites  
*Habitat*: pastures, landfills, vacant lots, road edges, old fields  
*Host Plants*: herbs of buckwheat family including sheep sorrel, curled dock

9. Gossamer Wing, Acadian Hairstreak *Satyrium acadica*  
*Wing Span*: 1 1/8 - 1 1/2 inches (2.9 - 3.8 cm)  
*Adult Food*: butterflyweed, meadowsweet, milkweeds, New Jersey tea, thistles  
*Habitat*: willow-lined streams, marshes, moist woodlands  
*Host Plants*: Various willow species including black willow and silk willow

10. Swallowtail, Eastern Tiger *Papilio glaucus Linnaeus*  
*Wing Span*: 3 5/8 - 6 1/2 inches (9.2 - 16.5 cm)  
*Adult Food*: butterfly bush, lilac, honey suckle, butterfly weed  
*Habitat*: Deciduous broadleaf woods, forest edges, river valleys, parks, and suburbs  
*Host Plants*: birch, poplar, tulip, ash, willow, wild cherry, basswood, cottonwood

11. Skipper, Common Checkered *Pyrgus communis*  
*Wing Span*: 1 - 1 1/4 inches (2.5 - 3.8 cm)  
*Adult Food*: white-flowered composites: shepherd’s needles, fleabane, and asters; also red clover, daisy, purple coneflower  
*Habitat*: open, sunny places, meadows, fields, roadsides, yards, gardens, trails in woods  
*Host Plants*: several plants in the mallow family

12. Brushfoot, Monarch *Danaus plexippus*  
*Wing Span*: 3 3/8 - 4 7/8 inches (8.6 - 12.4 cm)  
*Adult Food*: all milkweeds; before milkweed blooms: dogbane, lilac, red clover, lantana, thistles; in the fall adults visit composites including goldenrods, blazing stars, ironweed, tickseed, sunflower  
*Habitat*: open fields, pastures, weedy areas, marshes, roadsides  
*Host Plants*: common milkweed, swamp milk weed, showy milkweed
Field Identifier - Common Indiana Butterflies

1. Brushfoot, Meadow Fritillary  
2. Whites, Cabbage White  
3. Brushfoot, Little Wood-Satyr

4. Brushfoot, Mourning Cloak  
5. Brushfoot, Question Mark  
6. Sulfur, Orange Sulfur

7. Brushfoot, Painted Lady  
8. Gossamer Wing, American Copper  
9. Gossamer Wing, Acadian Hairstreak

10. Swallowtail, Easter Tiger  
11. Brushfoot, Common Checkered  
12. Brushfoot, Monarch

There are over 20,000 butterfly species around the world. Indiana has approximately 100 species. Look up common butterflies in your region at: http://www.npwrc.usgs.gov/resource/distr/lepid/bflys/abflyusa.htm
Illustrations by Jerri N. Curless, Project LEAP
Butterfly Name or Description: ___________________ ___________________ Number seen: ___________________

Describe Flight Pattern: ___________________ ___________________ ___________________ ___________________

Plants visited or Description: ___________________ ___________________ ___________________ ___________________

Butterfly Name or Description: ___________________ ___________________ Number seen: ___________________

Describe Flight Pattern: ___________________ ___________________ ___________________ ___________________

Plants visited or Description: ___________________ ___________________ ___________________ ___________________

Additional Notes: ___________________ ___________________ ___________________ ___________________
Project Learning Tree: The Changing Forest

Quick Reference Guide and In-Depth Explanation of Content
## Project Learning Tree: The Changing Forest-Forest Ecology

### Quick Reference

#### Questions

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<thead>
<tr>
<th>Question</th>
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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>6. Teacher friendly materials and organization</td>
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#### Forest Ecology-Teacher Information

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<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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#### Forest Ecology-Student Information

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<td>15. Interdisciplinary connections?</td>
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<td>16. Reflect real-world problems?</td>
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<td>17. Multicultural themes?</td>
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<td>22. Direct Instruction lessons?</td>
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#### Forest Ecology-Curriculum Information

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<td>22. Direct Instruction lessons?</td>
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General Information
Grade level: 9-12

Overall focus or Theme:
In this module students study a forest ecology including the interdependence of organisms that live there and consider outside factors, like fire, in their study.

Affiliation:
This module is affiliated with Project Learning Tree. Viewers can access the website for this particular module at http://www.plt.org/cms/pages/21_21_11.html

Teacher Information
1. Does it require additional resources or are materials included?
In this module, the teacher guide books are available for download but may only be obtained by attending a workshop that teaches teachers how to use it. However, according to the website, background information and all of the student activities are available. Additional resources, such as access to a forest, are needed.

2. Are assessments included?
No. According to the website that lists all of the included parts, assessments are not included.

3. Does it encourage multiple ways to teach a topic?
Yes. This module does encourage multiple ways to teach a topic because it is actively engaging students in the lessons. For example in the activity, Adopt-a-Forest, students are encouraged to actually visit a forest near to them in order to complete the activity through observation. Students create a forest profile and identify the different life zones and the stratification of the forest. In another lesson, Saga of the Gypsy Moth, students are divided into teams that advocate for a specific kind of control of moths in order to find out what could happen.

4. Are lessons do-able in a reasonable time period (dependent on grade level)?
Yes. Although no time frame is provided on the website, by looking through the module, it would seem as though each activity would need a good 50 minute period to complete. The number of activities ranges from 1-5 in order to finish the entire lesson.

5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?
No accommodations or modifications are included, however it seems as though the activities could be modified for special needs by including group work or modifying
the activities to suit the student’s individual needs because the lessons seem quite flexible in that way.

6. Does it provide teacher-friendly materials/organization?
   Yes. The website is very organized and allows a viewer to click on different links to preview different modules. In addition, each module page does list all of the parts included in it in the actual book, which helps a viewer to see what would actually be included in the module. It also allows a viewer to download most of the student pages and activities for each module.

Student Information
7. Does it demand higher order thinking?
   Yes. The activities that can be viewed online do demand higher order thinking skills. For example, in the lesson, Cast of Thousands, students are asked to include math skills such as finding circumference and using triangle theorems to solve problems like crown spread. Students must apply their math skills knowledge in real world problems.

8. Does it allow students to respond in multiple ways to a given problem or solution?
   No. This curriculum does not allow students to respond in multiple ways because students are doing investigation for a certain problem and not looking for creative ways to solve an issue.

9. Does it support community involvement? Does it promote the child as a member/citizen of a community?
   Yes. This curriculum does support community involvement because it encourages the student to go out into his or her community to find out about the ecology of the forests that are there. This helps students understand the health and life of the area forests.

10. Does it promote social interaction?
    Yes. This curriculum does promote social interaction because collaborative group work is included. For example in the lesson, Saga of a Gypsy Moth, students are divided into teams in order to determine the best way to control moths. Students must work together to develop a platform in order to persuade other teams of students to believe that their team has the way to control moth populations.

11. Does it promote student-centered learning?
    Yes. Each of the lessons has students diving into what they are learning. Students are actively engaged in their learning because the activities require students to do the thinking and complete the activities. For example, in the lesson, Fire Management, students are asked to examine problems that occur when humans live in or near forested areas and its relationship to forest fires. The lessons and activities included are not about students sitting by passively as a teacher lectures about the ecosystems in a forest.
12. Is it inquiry based?
Yes. This curriculum is asking students about the health of the forests in their local areas. Students must do the research to find out about how those forests work in order to make them healthy and to keep them healthy. For example, in the activity The Nature of Plants, through a series of experiments students learn about how important photosynthesis is and the factors needed for it to take place.

13. Does it include some teacher and student materials/books?
Yes. Teacher materials and all of the student worksheets are included, such as worksheets to fill out, cards for activities, and readings for students to complete for an activity. Some experiment materials are not included, and students also need access to a forest.

Curriculum Information
14. Does it include goals for students/instructional objectives?
No. According to the website, no instructional goals or objectives are included.

15. Does it provide connections that are interdisciplinary?
Yes. Each lesson contains a variety of interdisciplinary connections including biology, chemistry, environmental science, language arts, math, geography, social studies, ecology, and history.

16. Does it reflect real-world problems?
Yes. This curriculum focuses on the ecosystems of forests and why some are not as healthy as they should or could be. This also investigates some outside factors that are influencing the health of the forests and why this is occurring, and provides opportunities for students to explore these factors.

17. Are multicultural themes included?
No. Multicultural themes are not included in this curriculum.

18. Does the material build upon prior knowledge?
Yes. The activities included in the module do build on prior knowledge because the students begin by learning about the aspects of the forest ecosystem and how it works. Then they begin learning about the diversity in a forest and why that is important. Following this, students learn about different plants including exotic plants that may by inhabitants of a particular forest ecosystem. After this students then begin learning about different factors that are detrimental to a forest including natural and man-made factors. Each lesson builds off the one prior in this way.

19. Does it utilize technology?
Yes. On the website, under each activity for the module, there is a section entitled Website Connections. It is here that additional online resources are available to enhance the lessons and make technology connections.
20. Is it long-term based or short experiments?
   The curriculum is comprised of mostly shorter activities, however under each lesson for the module could last 2-3 days doing a 50 minute activity each day.

21. Does it include direct instruction lessons?
   No. This curriculum does not include direct instruction lessons.

22. Additional Information
   Included in this module are several appendices that are very useful for the teacher including field trip considerations, bringing nature indoors, and a sample nature guide. This website also offers a conceptual framework so that the teacher can see how the module is aligned with different standards under the themes of diversity, interrelationships, systems, structure and scale, and patterns of change. The website also offers viewers a way to access upcoming module workshops near to them.
Project Learning Tree: The Changing Forest

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

High School 9-12
Activity 8-Fire Management

Environmental Science
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.1.4 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.

Environmental Hazards
Env.1.33 Identify natural Earth hazards, such as earthquakes and hurricanes, and identify the regions in which they occur as well as the short-term and long-term effects on the environment and on people.
Env.1.34 Differentiate between natural pollution and pollution caused by humans and give examples of each.
Resources for Activity 8: Fire Management

Overview
Students will learn about the many interdependencies of forests and fire in healthy ecosystems. They will research plant and animal species that depend on fire, and will determine some of their relationships. They will also look at problems that occur when humans live in or near forested areas.

Subjects: Environmental Science, Ecology, Social Studies.

Student Pages
The Crisis in Our Forests
Fire Suppression Equals Bigger, Hotter, and More Destructive Wildfires
Protecting Your Home from Wildfire

Urban and Community Forestry Website Connections

Earth & Sky Radio Correlations
This activity can be supplemented with that you can download for use in your classroom.

Additional Resources

Two Sides of Fire Video explores the role of fire in a forest ecosystem. Videos are available for $15 for 1-4 orders. For ordering information contact the Temperate Forest Foundation at 503-579-6762.

ELC's "Firestorm: Thinking Critically About Environmental Issues"

This US Government Photos, Graphics, and Multimedia Webpage includes a wealth of resources—from blogs to podcasts to photo galleries and more. Under the Science and Technology Podcasts, check out the "Earth Science Topics from the US Government Survey" for several podcasts on wildfires.

State-Specific Resources
Georgia fire information and pictures, made available by the Georgia Forestry Commission
Forest Research
Environmental Education

Quick Reference Guide and
In-Depth Explanation of Content
## Forest Research Environmental Education Network
### Quick Reference

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Forest Research Environmental Education (F.R.E.E.) Network

General Information

Grade level: K-12 Information, K-5 Unit Plan Included

Overall focus or Theme

The F.R.E.E Network began as a coalition of representatives from both state and government agencies to distribute and facilitate the distribution of information regarding forest resources and products. The Network collects and evaluates existing educational materials related to forests, forest management, and forest products. They ensure that material is scientifically accurate, that it links consumption and production of forest materials, and that it accurately addresses raw material consumption, forest management, and the environmental impacts related to forest consumption. The F.R.E.E. Network's home page online is http://www.freenetwork.org/index.html. The Network not only lists approved material, but includes many teacher resources on their website. The website includes a children's page, teacher resources, including a curriculum and PowerPoint presentations, and related research.

Affiliation


Teacher Information

1. Does it require additional resources or are materials included?

This website includes many resources for teachers (under the heading of “Teachers’ Tools”), such as PowerPoint presentations on topics such as forest succession and tropical deforestation, which could be utilized as lecture material by instructors. It also includes many articles related to these PowerPoints, which could be utilized as supplemental student reading. Some examples of articles included on the website are
PDF files entitled “Strategies for Ensuring the Survival of the Tropical Forests—Can Logging be one of Them?” and “Tropical Deforestation—Uncovering the Story.” These two articles compliment the PowerPoint related to tropical deforestation. The actual curriculum included within the Teachers’ Tools is a unit plan entitled “Understanding the Forest and its Uses.” This unit has seven activities for grades K-5 and requires additional resources. The unit utilizes kits/curriculums reviewed and approved by the F.R.E.E. Network. For example, one K-3 activity, *Competition and Forest Harvesting*, requires a Georgia Pacific “Education in Nature” leaf and stencil kit.

2. Are assessments included?

The web page does include an assessment tool called the Environmental Quiz. This Quiz may be found under the Teachers’ Tools portion of the site, and includes assessment over knowledge of the world population and our world’s forests. The unit plan included on the web page includes an Evaluating Results portion for most of the lesson plans. Some lessons also have Extra Activities that could be utilized as an extra form of assessment. For example, the K-3 activity, *Competition and Forest Harvesting*, asks students to have students describe tree overcrowding and evaluate why harvesting might be useful. An Extra Activity in the same lesson asks students to make a list of every product they have used during the day/week that comes from trees.

3. Does it encourage multiple ways to teach a topic?

Yes. The unit plan involved encourages lecture, hands-on activities, discussion, brainstorming, and utilizing role-playing in the classroom.

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

Yes. Lessons, smaller lessons range from 30 minutes to 90 minutes, while one lesson extends over a number of weeks.

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

No. No accommodations for special needs or gifted students are included. However, the Extra Activity portion of the lessons could be utilized for enrichment. Another example of an Extra Activity from the lesson *Forest Disturbances* reads as follows:

Sometimes forest managers let forest fires burn instead of immediately putting them out. Ask students to brainstorm about why a forest manager might want to choose this management approach.

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

Yes. Lecture PowerPoints, PDF articles for extra reading, and an online activity page for children are some examples of the materials included on the website. Additional materials are required for most of the lessons within the unit plan. Each lesson within the unit plan is organized into the following teacher-friendly categories: Grade Level,
Student Information

7. Does it demand higher order thinking?
   Yes. This unit plan allows students to reflect on their personal habits with regards to wood usage and understand the impact this has on the environment. This real-world connection allows students to create meaningful learning and think about their activities on a national or world scale.

8. Does it allow students to respond in multiple ways to a given problem or solution?
   Yes. Students are allowed to explore the concepts related to forest ecology though many different means throughout the curriculum. They are encouraged to write, read, role-play, create art, and investigate issues. For example, students role play to represent forest succession in *The Succession Play*, and students investigate recycling and paper usage issues within their classroom in *Paper Patrol*.

9. Does it support community involvement? Does it promote the child as a member/citizen of a community?
   Yes. For example, the lesson *Paper Patrol* encourages to create a Recycling Campaign within their school and to share the results of their group projects with other classes to encourage their participation in the campaign.

10. Does it promote social interaction?
    Yes. The lessons within the unit promote group work and cooperation between students. For example, students must work together carefully to act out and understand succession in *The Succession Play*. As mentioned before, students work in groups to discover issues related to paper usage in the lesson *Paper Patrol*.

11. Does it promote student-centered learning?
    Yes. Learning is hands-on and allows students to learn through the activities and their own opinions and creative thoughts. For example, the lesson *Life Without Wood*

12. Is it inquiry based?
    Yes. Students must research and form their own conclusions in lessons. For example, *Paper Patrol* allows students to write a creative essay. This essay includes a description of products made from wood and how their lives would differ without wood. For example, their house may be made entirely of metal and they would brush their teeth with something other than toothpaste.

13. Does it include some teacher and student materials/books?
    Yes. Teacher PowerPoint presentations are included. An extensive list of resources that may be purchased are also listed on the website. Student readings are also included related to topics such as tropical forests and forest succession.
Curriculum Information

14. Does it include goals for students/instructional objectives?
Yes. Each lesson within the unit plan includes Learner Objectives. The following are Learner Objectives from the lesson *The Succession Play*:
After completing this activity, students should be able to:
- act out the cycle of succession
- integrate past knowledge of disturbance and succession to explain the dynamic nature of a forest

15. Does it provide connections that are interdisciplinary?
Yes. Each lesson in the unit plan contains an area where it lists interdisciplinary subjects related to the lesson. For example, the lesson *Uses of the Forest*, students utilize Art and Writing to create their own forest on construction paper. Students then brainstorm and write or draw out the uses of their forest to complete the project. Ties to math are utilized in the Extra Activity, where students are asked to create a pie chart representing various uses of the forest.

16. Does it reflect real-world problems?
Yes. The entire unit plan and the F.R.E.E. Network web page are dedicated to providing education related to the responsible use of the world’s forest and the gathering and processing of natural resources and the subsequent environmental impacts.

17. Are multicultural themes included?
No multicultural themes are directly addressed in the lessons within the unit plan. However, readings and PowerPoints related to the tropical forests are found on the web page, which could be used to create a multicultural lesson.

18. Does the material build upon prior knowledge?
No. The lessons within the unit plan are specific to various grade levels. Each lesson can stand on its own with relation to specific topics related to forests, from succession to recycling paper products.

19. Does it utilize technology?
Yes. The web page itself is on the Internet, and students can utilize this resource to explore information related to trees and play games related to tree utilization. The teacher resources, including PowerPoint lectures and PDF documents are also examples of the use of technology within the curriculum.

20. Is it long-term based or short experiments?
Six of the activities last between 30 and 90 minutes. One activity, however, is an ongoing activity over many weeks. This activity, *Paper Patrol*, splits a class into various groups. Each group researches and participates in a project about a different aspect of paper usage. For example, one group calculates the amount of paper in pounds that is utilized over a period of time. The activity suggests that each group reports weekly on findings specific to their group activity.
21. Does it include direct instruction lessons?
   No. Direct instruction lessons are not included in this curriculum.

22. Additional Information
   This website is unique and very easy to navigate through compared to similar online resources. The list of reviewed resources is very extensive and thorough. It includes not only Curriculums that may be purchased, but also various pamphlets and posters that would be useful to instructors who want to encourage forest ecology within their classrooms. The Kids' Corner is a fun way to encourage young students to use the technology of the Internet and also allows them to play games and learn fun facts related to forest ecology. Overall, the unit plan was well-organized and integrated related F.R.E.E.-reviewed and approved materials.
Forest Research
Environmental Education

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

Paper Patrol,
Grades 3-5

Science

**Standard 1** The Nature of Science

**Scientific Inquiry**
3.1.3 Keep and report records of investigations and observations* using tools, such as journals, charts, graphs, and computers.
3.1.4 Discuss the results of investigations and consider the explanations of others.

**Technology and Science**
3.1.8 Describe how discarded products contribute to the problem of waste disposal and that recycling can help solve this problem.
4.1.9 Explain how some products and materials are easier to recycle than others.
5.1.5 Explain that technology extends the ability of people to make positive and/or negative changes in the world.

**The Scientific Enterprise**
4.1.3 Explain that clear communication is an essential part of doing science since it enables scientists to inform others about their work, to expose their ideas to evaluation by other scientists, and to allow scientists to stay informed about scientific discoveries around the world.

**Standard 2** Scientific Thinking

**Computation and Estimation**
3.2.1 Add and subtract whole numbers* mentally, on paper, and with a calculator.

**Manipulation and Observation**
3.2.3 Keep a notebook that describes observations and is understandable weeks or months later.

**Communication Skills**
4.2.5 Write descriptions of investigations, using observations and other evidence as support for explanations.

**Standard 5** The Mathematical World

**Numbers**
5.5.1 Make precise and varied measurements and specify the appropriate units.
Paper Patrol

Grade Level: 3-5
Subjects: Math, writing, art
Concepts: Wood products are recyclable, paper has many uses

Materials needed: Several boxes, art supplies (for extra activity), scale

Time needed: ongoing through several weeks

F.R.E.E. supporting materials:
- Paper Recycling Post (TAPPI)
- Paper Making Activity (Project Learning Tree)

Learner Objectives:
After completing this lesson, students should be able to:
- understand how paper is made and recycled
- work in groups and share group responsibilities
- start a recycling initiative in their classroom
- understand the impact paper production has on the wood resource

Preparation:
The Earth Answers "Paper Recycling" poster should be displayed in the classroom. Make overheads of the U.S. Paper Recovery Rate and the Paper Recovery Rate vs. Landfilling from Earth Answers "Why Recycle?" Also make an overhead from "How Much Paper Can Be Made From a Tree".

Doing the activity:
Show students the paper recovery rate overheads and discuss the improvements in paper recycling. Make sure students understand that their efforts to recycle will contribute to the increased paper recycling efficiency.

As a class, brainstorm on the paper products which students use every day. These will include obvious things such as paper, notebooks, books, and less obvious items such as toilet tissue and Kleenex. Stress how important paper products are to students' lives. Now show students the overhead regarding how much paper products can be made from a cord of wood. Explain that a cord of wood is a stack of wood 4' high, 8' long, and 4' wide. Using the Earth Answers "How is Paper Recycled?" and the "Paper Recycling" poster, explain the paper production process. The process is complicated and while details are not important, a general understanding of the process beneficial.

Next split students into four working groups. Tell students they are going to do a paper project and that each group will be responsible for a different aspect of the project. Groups should be encouraged to collaborate and share ideas or information throughout the project. Delegate group responsibilities as follows:
Group 1: This group should calculate the amount of paper (in lbs.) used in the classroom. This can be done on a daily, weekly, or monthly basis, depending on the amount of detail desired. The group should also calculate the amount of paper that is used a second time in class before being recycled. Students should be able to see this number increase with increased efficiency.

Group 2: Responsible for getting used paper into two boxes: "paper written on one side" and "paper written on both sides". The group should also keep track of the amount of paper in each box (for Group 1). The group should make sure paper is not mixed in with other classroom trash.

Group 3: Responsible for thinking of and implementing new uses for the "paper written on one side". An example could be using the paper for in-class exercises or quizzes. Encourage students to be creative in new uses of this paper.

Group 4: Responsible for the "paper written on both sides". This group will decide if this paper can be used again or should be recycled. If it can be used again, the group should collaborate with Group 3 on possible classroom uses.

Groups could present weekly reports of their progress and ideas. For an added challenge, this could include graphs to model efficiency in classroom paper use. Groups should be rotated periodically so that students have the opportunity to be in each group. Also each group should keep a journal regarding their group calculations/ideas/information for the next rotation of students to utilize.

For an art lesson, Groups 3 and 4 could collaborate on making "recycled" art using paper already used once in class. Students could make "recycled" cards, gifts or collages. Even a papermaking exercise could be done using classroom paper (Project Learning Tree's Paper Making Activity). Again, encourage creativity.

Evaluation:
Are students actively participating in and contributing to the group? Are students creative and innovative in uses for partially used paper? Do students have a generally understanding of the paper process? Can students list paper products they use everyday?

Extra Activities:
Students could start a "Paper Recycling Campaign" by presenting their paper recycling project to other classrooms and encouraging others to start their own projects.
Padilla Bay

Quick Reference Guide and
In-Depth Explanation of Content
## Padilla Bay Quick Reference

### Questions

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General Information
Grade level: K-12

Overall focus or Theme:
The Padilla Bay unit focuses on estuary life and its importance. Padilla Bay incorporates themes related to water quality of estuaries as an ecosystem, and the importance of taking action to protect America and Worldwide.

Affiliation:
The Padilla Bay unit is affiliated with the National Estuarine Research Reserve and is sponsored by the Washington State Department of Ecology. It can be accessed online at http://padillabay.gov/educationcurriculum.asp.

Teacher Information
1. Does it require additional resources or are materials included?
   Yes. Because this curriculum aims to teach about the value of estuaries and improving coastal environments, it does require additional resources because this curriculum describes a field trip to an estuary. Worksheets for students and work to be completed before and after the field trip are included, such as worksheets to make food chains, along with notes for the teacher and parents. However an actual estuary is essential for this curriculum, unless teachers modify this and use a simulated field trip.

2. Are assessments included?
   No. Pre-tests and post-tests are not included in this curriculum. Activities and projects for students to complete after their field trip are included, but no actual formal assessments are included.

3. Does it encourage multiple ways to teach a topic?
   No. The curriculum is divided into 3 levels, K-3, 4-8, and 9-12. These levels are parallel and a great majority of the activities include crossword puzzles or word searches. In addition, other activities presented seem very difficult to modify and therefore would not support or encourage multiple ways to teach a topic.

4. Are lessons do-able in a reasonable time period (dependent on grade level)?
   Yes. The few lessons that are described in the curriculum are doable in a reasonable time period, however no time estimates are given for the lessons. However, the field trip component would take a longer amount of time to complete.
5. Is it easily modified for special needs/gifted? Are accommodations or modifications included?

No. Because the lessons do not encourage multiple ways to teach a topic, it would be difficult to modify this for children with special needs unless a teacher used heterogeneous grouping. No, accommodations and modifications are not included.

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

No. The curriculum is not very organized. Many worksheets and readings are included, but it is difficult to distinguish one lesson from another. There are no labels for the lessons, nor are they numbered in any way. However, it does include information for teachers and parents for the field trip aspect, which is beneficial for both.

**Student Information**

7. Does it demand higher order thinking?

No. The activities within the curriculum do not have goals and objectives for students, and only a few critical questions for student reflection within each activity. These critical questions usually reflect knowledge or recitation of simple concepts, and do not aim to form deeper connections and critical thinking skills. Here are examples of student questions from the 9-12 activity *Water Quality Monitoring* (p. 73):

1. On the pH scale, what readings indicate an acid?
2. A solution with a pH of 9 has how many times more OH- than a solution with a pH of 7?
3. True or false? Organisms cannot live in areas where the pH changes? Explain your answer.

8. Does it allow students to respond in multiple ways to a given problem or solution?

Yes. Although no formal assessments are included in the curriculum, many activities include multiple ways to respond to information learned. For example, in the activity *Taking an Estuary Field Trip* (p. 65), the curriculum suggests that students could partake in an included writing activity, or that they “could draw, paint, sculpt, or compose.”

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

Yes. One of the activities included in the 9-12 curriculum is entitled *What We Can do For Estuaries*? (p. 100). This activity allows students to survey their water usage behavior, become experts on estuary issues affecting our nation, observe how other youth have made a difference in our nation, write letters to make a difference, and to speak their minds at public hearings.
10. Does it promote social interaction?
   Yes. Some of the activities encourage social interaction through group work. For example, in the 9-12 curriculum activity *Water Quality Monitoring* (p. 73), students work in groups to brainstorm local, state, and federal agencies that may monitor water quality at a body of water near their homes.

11. Does it promote student-centered learning?
   Yes. Activities in this curriculum are hands-on and do not focus around instructor lecturing. For example, one Middle Level activity, *Estuary Community Dance*, allows students to discover members of an estuary community by being assigned the role of an organism in an estuary. They are unaware of their identity, and work to discover who they are by mingling with other classmates and asking yes and no questions. Each member of the class serves as a different member of the estuary community.

12. Is it inquiry based?
   No. Most of the activities are rather vague and are presented in experiment form. For example, many of the activities require the use of testing kits, and simply tell students to follow instructions on the kits to perform an experiment. Once such experiment is entitled *Water Quality Monitoring* (p. 73), instructs students to follow instructions on pH testing equipment, dissolved oxygen kits, Millipore Sterile Filtration Apparatuses, and Nitrate Test kits. Many of the Middle Level activities are crossword puzzles and word searches.

13. Does it include some teacher and student materials/books?
   Yes. The curriculum includes chapters of readings for each grade level. There are activities, worksheets and data sheets, and a list of resources for instructor utilization.

**Curriculum Information**

14. Does it include goals for students/instructional objectives?
   No. The curriculum does not include any goals or objectives for any of the lessons. Many of the activities are flexible in nature and leave the planning up to the instructor. The first activity of the 9-12 curriculum, *Taking an Estuary Field Trip* (p. 65), suggests that the instructor creates objectives and activities for the trip. The activity also suggests that these objectives and activities should match coursework, the site, and should gain the school’s support.

15. Does it provide connections that are interdisciplinary?
   Yes. The curriculum includes several ties to various sciences, history, and the language arts. Many chapters of readings are included for each grade level, and relate to these themes. An example of an interdisciplinary activity at the 9-12 level includes interdisciplinary themes is *Writing with Estuaries* (p. 94). This activity includes various writing assignments, including poem writing, journaling, and a research paper. One creative exercise ties together science, history, and writing skills into one
assignment by providing various historical prompts for journal writing. The following is an example of one of the interdisciplinary questions in this activity (p. 98):

1. You are a Native American living near the Cascade Mountains 10,000 years ago. The great glacier has been gone for many generations, but oral tradition still tells of the colder times. Small glaciers still cover parts of the Cascades and send torrents of water down the many rivers. A remnant of the great glacier can still be seen blocking what is now the Strait of Juan de Fuca. You live on the shore of the huge, fresh water lake that the glacier created.
Retell a story about the old times.

16. Does it reflect real-world problems?
Yes. The curriculum focuses on many real-world problems related to our environment. It observes water quality, effects of human activity on the environment, and the delicate balance of estuary ecosystems.

17. Are multicultural themes included?
Yes. For example, the 9-12 curriculum observes a worldview on estuaries in the activity Thinking Globally about Estuaries (p. 99). This activity allows students to relate the importance of estuaries and rivers to the development of the world’s largest cities.

18. Does the material build upon prior knowledge?
No. Because the curriculum is centered on a field trip, it is difficult to have the material build upon prior knowledge of the students.

19. Does it utilize technology?
No, technology is not utilized in this curriculum unless it is doing research on the internet.

20. Is it long-term based or short experiments?
The curriculum is long-term based, but could be completed in about two weeks. The lessons included are short and could be done in a short period of time, but the unit itself, because its central focus is on a field trip with activities to complete before and after is long-term based.

21. Does it include direct instruction lessons?
No. This curriculum does not include direct instruction lessons.

22. Additional Information
The Padilla Bay curriculum is unique in that it focuses on a unit about estuaries in a specific area. This could be adapted however by other states that are coastal or by using a simulated field trip, for the field trip component. This also includes many details that are important for field trip management, such as an outlined schedule for the field trip, and information for parents that will be accompanying the trip. It describes details about
clothing and food and what will be happening during the day. In addition, many of the worksheets are included in this, which makes things very simple for teacher, but as it was stated earlier, it does not seem to be very organized or labeled very well.
Padilla Bay

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

Level 1 - Salt Water-Fresh Water (p. 26)

Science
Standard 1 The Nature of Science and Technology
Scientific Inquiry:
K.1.1 Raise questions about the natural world.
1.1.2 Investigate and make observations to seek answers to questions about the world, such as "In what ways do animals move?"
The Scientific Enterprise:
2.1.5 Demonstrate the ability to work with a team but still reach and communicate one's own conclusions about findings.
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:
K.4.1 Give examples of plants and animals.

Level III-Taking an Estuary Field Trip (p. 65)

Biology I
Ecology:
B.1.37 Explain that the amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials. Recognize, therefore, that human activities and technology can change the flow and reduce the fertility of the land.
B.1.40 Understand and explain that like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. However, also understand that ecosystems can always change with climate changes or when one or more new species appear as a result of migration or local evolution.
B.1.41 Recognize that and describe how human beings are part of Earth's ecosystems. Note that human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.
B.1.43 Understand that and describe how organisms are influenced by a particular combination of living and nonliving components of the environment.
B.1.44 Describe the flow of matter, nutrients, and energy within ecosystems.
B.1.47 Explain, with examples, that ecology studies the varieties and interactions of living things across space while evolution studies the varieties and interactions of living things across time.
Students observe the difference between salt and fresh water and discuss how plants and animals live in one or the other.

Talk about salt water and fresh water. Fresh water is water without salt in it, not necessarily clean water.

Let your students observe tap water. They can look at it, smell it, taste it. Then let them make salt water by adding 1 teaspoon of salt to 1 cup of fresh water (the approximate amount in ocean water). If the salt is dissolved, the two should look and smell the same.

Place a small amount of salt water (maybe collected from a nearby beach) in a shallow dish. Let the water evaporate and observe the salt crystals left behind. Even though we can't see dissolved salt, we know it's there!

Make two lists on the board: one of plants and animals that your students think might live in fresh water and one of plants and animals that might live in salt water. Can they think of any that live in both? Most plants and animals are specially adapted to live in either salt water or fresh water, seldom both.

Copy the two wetland habitat pictures and let your students draw and color in animals in their appropriate home. Here's a list to get them started:

**Freshwater wetland**
cattails
duckweed
frog (and tadpoles)
skunk cabbage
water lily
fish
salamander
turtle
snake
dragonfly
crayfish
snail
great blue heron
salmon eggs

**Saltwater wetland (estuary)**
algae
eelgrass
saltgrass
crab
snail
worm
clam
shrimp
fish
seastar
hermit crab
great blue heron
salmon smolt
Taking An Estuary Field Trip - Activity 1

By all means, take your class to an estuary near you. Your possibilities are endless. Here are a few ideas to get you started.

Things to Do on a Field Trip
1. Focus on changes. Look for signs of natural change (eroding bluffs, sedimentation, evidence of wave action). Look for signs of human influence. Take along someone who has seen the changes happen.

2. Focus on estuary life. Observe and identify. Examine the sediment (maybe with a shovel and sieve). Check an ecology textbook for field study techniques that your class could employ. Try a beach seine. Collect and observe plankton. Compare several sites or habitats. Return all organisms to a habitat in which they can survive.

3. Focus on quantifying. You can count a population, study waves, profile a beach, monitor water quality...

4. Customize a "Scavenger Hunt" to help focus attention. Ecological concepts, historical perspectives, geological formations, inspirational objects or events could be included. (See the "Copies and Overheads" section for an example.)

5. Make your own site-specific field guide.

6. Observe and create. Do some exploring, then try the writing activities on pp. 97-101. Instead of writing, you could draw, paint, sculpt, or compose.

7. Invite an "expert" to join you: wildlife biologists, fisheries biologists, historians, geologists, marine biologists, poets, artists, and naturalists could be a valuable resource on a trip.

8. Don't hesitate to contact your local marine science center for suggestions.

9. Look through the curricula listed in the Resources section for other field trip ideas.
✓ Pre-trip Checklist
1. Visit the site
   - When will the tide be high? low?
   - Is it a public beach? Do you need permission to use the beach?
   - Are there bathrooms?
   - Are there hoses or faucets for clean up?
   - Is there protection from adverse weather?
   - Is there a phone for emergencies?
   - Is the access steep or dangerous?

2. Define trip objectives and activities.
   - Do they match the coursework?
   - Do they match the site?
   - Will the school support it?

3. Arrange transportation
   - Are buses available for the whole day?
   - If not, can car pooling be arranged?
   - Do you need to supply a map?
   - Is emergency transportation available?

4. Class preparation
   - Do they know their responsibilities?
   - Do they know what equipment to bring?
   - Has acceptable behavior been agreed to?

5. Arrange assistance
   - Do any parents want to help?
   - Are college students available?

✓ Trip Checklist
1. Enthusiasm- Field trips are enjoyable!

2. Emergency Numbers and First Aid Kit

3. Communicate responsibilities
   - Introduce goals, expectations, boundaries, equipment.

4. Communicate Mandatory Behavior
   - Tread lightly! Your presence in the estuary will damage the site. Please minimize that damage.
   - Observe, don't collect.
   - Fill in all holes.
   - Return rocks to exact positions.
   - Return animals to appropriate tide zone.
   - Collect marine debris.

5. Equipment needs will vary, but here are some suggestions:
   - for observing
     - jars (plastic)
     - shovels
     - sieves (for benthic organisms)
     - trays
   - for measuring
     - Field Notebooks, pencils
     - Meter stick, measuring tape, thermometer, monitoring equipment
   - for identification/recording
     - Field guide to habitat. (See Resources)
     - Binoculars
     - Microscopes, magnifying glasses
     - Video cameras, cameras
     - Clipboards and data sheets
   - for cleaning
     - Water source, hose, and sprayer
     - Buckets, brushes
     - Plastic bags for storing wet items

✓ Student Checklist (Absolutely required!)
1. Old shoes or snug boots.

2. Rain and cold weather gear.

3. Extra socks, shoes, and sweatshirt.

4. Bag for wet clothes.

5. Food and beverage.
# Possible Field Trip Sites

<table>
<thead>
<tr>
<th>County</th>
<th>County Parks &amp; Rec. Phone Number</th>
<th>Sample of Public Facilities</th>
<th>Habitat</th>
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<tbody>
<tr>
<td>Whatcom</td>
<td>(360) 733-2900</td>
<td>Semiahmoo Co. Park</td>
<td>Sand Beach</td>
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<td></td>
<td>Birch Bay State Park</td>
<td>Sand Beach</td>
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<td>Larrabee State Park</td>
<td>Rock, Gravel</td>
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<tr>
<td>Skagit</td>
<td>(360) 336-9414</td>
<td>Padilla Bay Reserve</td>
<td>Mudflat</td>
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<td></td>
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<td>Skagit Habitat Mgt. Area</td>
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<td></td>
<td>Washington Park</td>
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<td></td>
<td></td>
<td>Deception Pass State Park</td>
<td>Rock, Gravel</td>
</tr>
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<td>Island</td>
<td>(360) 679-7373</td>
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<td>S. Whidbey Co. Park</td>
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<tr>
<td>Snohomish</td>
<td>(425) 388-3415</td>
<td>Kayak Pt. Co. Park</td>
<td>Gravel</td>
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<td>Mission Beach Park</td>
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<td>Olympic Beach Park</td>
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<td>King</td>
<td>(206) 296-4232</td>
<td>Richmond Beach Park</td>
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<td>Saltwater State Park</td>
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For More Information

| WA Parks and Recreation Commission | (800) 233-0321 |
| WA Dept. of Ecology                | (360) 407-6000 |
| WA Dept. of Fish and Wildlife      | (360) 586-2762 |
| WA Dept. of Natural Resources      | (360) 902-1004 |