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WORLDWISE

A USER'S GUIDE FOR THE PLANET℠

cknowledgments

WorldWise: A User's Guide to the Planet is an official, national publication of Camp Fire Boys and Girls. It is a national project designed to be modified for use with all age groups and delivery systems and lead to the award of the WorldWise National Project Emblem.

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Camp Fire Boys and Girls would also like to gratefully acknowledge Acorn Naturalists for its generosity in providing permission to reprint abbreviated descriptions of books from their catalog in the *WorldWise* Additional Resources section. Books can be ordered and catalogs requested at: 800/422-8886, or write to: Acorn Naturalists, 17300 E. 17th St., #J-236, Tustin, CA 92680.

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Table of Contents

How To Use This Manual:

Directions for Leaders and Youth

This national project manual is designed so that all the units stand alone as sequential but independent learning units. Each unit focuses on a few closely related ecological concepts which are presented in informational, project-based and service-learning formats. The intention of multiple formats is the tremendous flexibility it offers to leaders and children. Users are free to choose whatever format or combination of formats best serves the unique needs of a selected age group or delivery system.

The units are designed to act like puzzle pieces. These pieces can be assembled into an increasingly clear picture of life on earth, as the concepts in each unit are mastered. The final goal is to help kids create their own "big picture" of the way the natural world works. With this accomplished, they will be better able to understand, take ownership in, and make good decisions about their role in protecting the health of the planet. As a final note, each unit is demanding. In order to avoid confusion and overload, **it is strongly advised that only one unit at a time be attempted.**

Unit Formats and How to Use Them

As identified above, each unit attempts to teach children several closely related ecological concepts. Your particular learning audience for *WorldWise* might include children from preschool through 21 years of age and be presented in any of Camp Fire's delivery systems. In an attempt to effectively serve such a wide variety of learners and circumstances, the concepts in each section appear in a number of different formats. These formats can be utilized as independent teaching tools or together as situations dictate for maximum effectiveness.

Information Format

The information format is designed to provide conceptual material to children and leaders with no background in ecology or environmental sciences. The key concepts addressed in each unit introduce each section. This format provides the background necessary for leaders to understand the concepts that the unit is intended to teach, either directly or indirectly through the project and service-learning formats. If too formal or complex for a particular situation, it can be used as reference. Children late middle-school-aged and older should be able to manage this format with little or no assistance.

Critical thinking challenges found at the end of each of these sections are provided as guidelines. There are no "right" answers, and they are not a required activity. The challenges are simply tools to help learners connect the ideas from the section to the real world in which they live. Leaders are encouraged to develop their own locally relevant "critical thinking challenges."

Action Project Format

All but the first unit on ecosystems include a project-based learning section. Units 2-5 offer the outstanding Project WILD activities as a tool to teach the concepts found in the unit. Project WILD is one of the most successful project-based environmental educational programs in the country. It has been officially adopted by state departments of conservation in 47 of the 50 states and is widely utilized in public schools. Project WILD has generously agreed to allow Camp Fire to use a number of their activities in this national project.

Although they fit very well with the information sections that accompany them, action projects can be used independently. Concepts can be introduced before the activity to guide learner discovery, after the activity to reinforce experiential discoveries, or learners can be challenged to discover the main ideas directly from the project experience.

Service-Learning Format

Each section contains a service-learning component. These are suggestions of things that can be done locally by learners that will benefit their communities or their local natural areas. Some of the suggested activities will be age or delivery system limited. Remember, project and service-learning formats are not comprehensive and can be freely adapted or supplemented with other related activities to achieve desired learning objectives. Be creative!

These experiences are intended to help learners experientially understand the concepts found in the information sections. This will serve to increase the personal relevance and ownership of the ideas in learners' everyday life experiences. The desired outcome is the evolution of responsible, *WorldWise* citizens.

Requirements for a WorldWise National Project Emblem

1. Learners must demonstrate an age-appropriate understanding of the concepts presented in each of the five units to the satisfaction of their designated leader. Purple beads can be awarded for each unit completed.

2. Learners must have completed two of the four Project WILD activities that accompany units 2-5. This requirement may be modified or eliminated as appropriate for younger children. All four projects may be opted for if no direct use is made of the information sections of each unit (other than as a reference).

3. Learners must complete one service-learning project. Leaders are free to make age-appropriate modifications or replace suggested projects with other regionally appropriate or age-appropriate projects that address the concepts of one of the five units.

4. Learners must write a letter of concern to their U.S. senator and representative, and/or relevant business leaders, on an environmental issue of personal or regional importance to them. If issues chosen are very localized in nature, then it may be more appropriate to write to their state or even local-level, elected officials. (This requirement may be modified for younger children who can act as a group and have a leader write their concerns.)

The emblem design, as seen on the cover, features the earth surrounded by symbols representing plants, sea animals, land animals and humans. The linked arrangement symbolizes the interdependence of all living things. The earth in the center suggests the dependence of all living things upon the non-living elements with their home planet.

WorldWise and Developmental Assets

The Search Institute has identified 40 developmental assets as forming a foundation for healthy development in adolescents. Of these 40 developmental assets, 20 are external in nature and 20 are internal. Upon completion of the *WorldWise* national project, adolescent participants will have had the opportunity to reinforce 21 of the 40 developmental assets which are identified below.

External Assets

Support

Young person receives support from three or more non-parent adults.

Young person experiences caring neighbors.

Empowerment

Young person perceives that adults in the community value youth.

Young people are given useful roles in the community.

Young person serves in the community one hour or more a week.

Boundaries and Expectations

Parents and other adults model positive, responsible behavior.

Young person's best friends model responsible behavior.

Time Use

Young person spends three or more hours a week in creative activities.

Young person spends three or more hours a week in community organizations.

Internal Assets

Positive Values

Young person acts on convictions and stands up for his or her beliefs.

Young person tells the truth even when it is not easy.

Young person accepts and takes personal responsibility.

Social Competencies

Young person knows how to plan ahead and make choices.

Young person has empathy, sensitivity and friendship skills.

Young person has knowledge of and comfort with people of different cultural/racial/ethnic backgrounds.

Young person can resist negative peer pressure and dangerous situations.

Young person seeks to resolve conflict non-violently.

Positive Identity

Young person feels he or she has control over "things that happen to me."

Young person reports having high self-esteem.

Young person reports that "my life has purpose."

Young person is optimistic about his or her personal future .

Introduction

Becoming WorldWise

The earth is our home. It is the source and support of our lives, and yet, we humans have not treated it well. What has happened? Somewhere in the recent past we began to lose our connections to the natural world. Along with those connections we have lost an understanding of, and respect for, how nature works.

It is easy to see what happened if we look closely. Life for all creatures on earth can be very demanding and often dangerous. Humans have used their ability to think to make life less demanding and dangerous. We produced tools and technology that extended our power. The more developed our technology became, the more insulated and protected we were against nature's demands and dangers. Consequently, in developed cultures around the world, humans now live comfortable and safe lives.

But there is a price to pay for comfort and safety. Humans are no longer required to understand natural systems or pay attention to nature's limitations. Before technology, humans who showed disregard for the limitations of nature were subject to starvation and death, like all other organisms. Now, we have access to food, clothing, shelter and medicine, regardless of our behavior or the uncertainties of nature. We have been allowed to forget the way that our home was designed to work. And technology protects us from the consequences.

The predictable result is we have come to live in ways that damage natural systems. Also, the protective power of technology has allowed

human populations to explode unchecked. This explosion magnifies the speed and extent of the damage being done to the natural world. It now threatens to make our home a dangerous place for all living things.

The picture that emerges is somewhat grim upon first examination. But it is far from hopeless. Much can be done if we act now to protect our home. Today's youth stand in a better position than anyone to make the necessary changes. The only way to stop the damage we are doing is to learn, once again, nature's rules for living things. We must reforge the connections that we have lost. We must remember those things that we humans have forgotten. We must, once again, become *WorldWise*.

The Ecosystem Concept

Key Concept:

An ecosystem is all of the relationships between all of the living and non-living things in a particular place.

Where it All Begins

The first step in rediscovering the way our world works is to identify its basic parts. All of life on earth is dependent upon the relationships between its four basic components. Three of these components are non-living and include the air, the water and the land. The fourth includes all the living things on the planet. **Ecology** is the study of the relationships between the living and non-living parts of the earth. The word ecology comes from two Greek words that mean "study of the house."

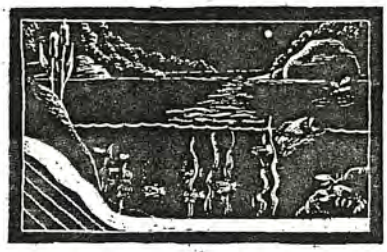
Ecology is the study of the relationships between the living and non-living parts of the earth.

Becoming *WorldWise* requires that we learn the basic ideas of ecology. We must "study our house" to learn what behaviors are helpful and what are harmful. The first important ecological idea that we need to understand is that of **ecosystem**. An ecosystem is made up of several levels. We will look at these one level at a time. In this way, we can piece together the idea of what an ecosystem is, one step at a time, until we have a clear picture in our minds.

Organisms are the first level of organization in ecosystems. In any particular place on earth, you will find individual living things called organisms. An example of an organism would be a bluegill sunfish or a whitetail deer or an oak tree.

At the second level, groups of like organisms that are found in a particular place are called a **population**. Examples of a population would be all the bluegill sunfish in a farm pond, all the whitetail deer in a meadow or all the oak trees in a forest.

Our picture of an ecosystem continues to grow bigger as we come to the third level. At this level we discover the **community**. All the populations

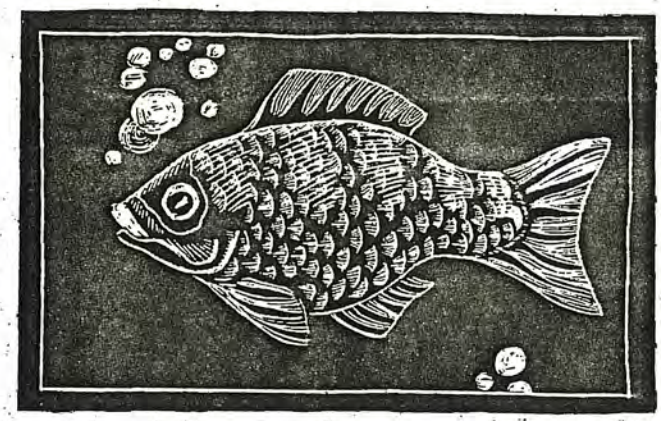


of all the different kinds of organisms in a particular place are called a **community**. An example of a community would be all the plants, animals and other living things that could be found in a particular place like a farm pond or meadow or forest.

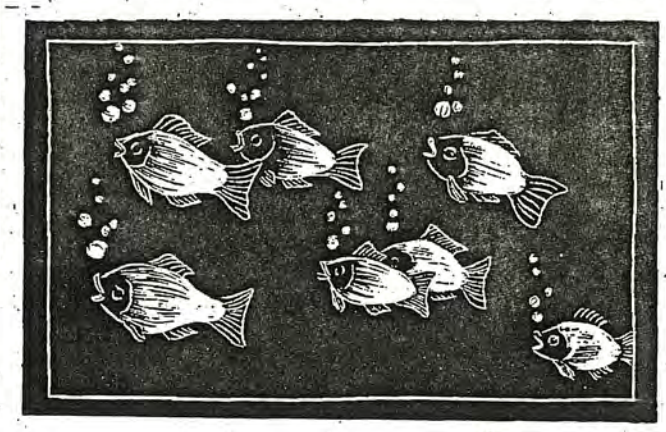
An **ecosystem** is similar to our description of a community. The big difference is that an ecosystem includes all the relationships between the living members of the community, as well as their relationships to the non-living parts of their environment. These include things like soil, water, sunlight, wind, etc. An example is a farm pond ecosystem. It includes the living community and all the non-living components of the pond that affect them like water, mud, runoff from surrounding fields, etc.

An ecosystem then, is all of the relationships between all of the living and non-living things in a particular place. It is important to remember that when we talk about ecosystems we are really talking about an idea or concept that is very flexible. The aquarium in your bedroom could be considered an ecosystem, as well as a farm pond or the Atlantic Ocean. The terrarium in a school classroom is an ecosystem, as are an empty city lot and the Great Basin Desert.

Understanding what ecosystems are completes the first step toward rediscovering the way our world works, to becoming *WorldWise*. In the following sections we will attempt to understand some of the important relationships that occur in ecosystems. In so doing, we may discover how to become more supportive members of the ecosystems in which we live and less disruptive to them.



Organism



Population

Community

Ecosystem

Critical Thinking Challenge

1. Identify some different ecosystems near your home. How many can you find?

2. Pick one of the ecosystems near your home and identify as many members of the community as you can.

3. Identify some ways that humans have changed naturally occurring ecosystems where you live.

Reflections

This page is provided for you to write your thoughts, ideas, discoveries, hopes, dreams and plans for the future in light of what you have learned in this unit about ***ecosystems****.*

Limiting Factors

Key Concept:

Many non-living parts of an ecosystem are critical for the survival of living things. Any that are found in short supply limit the type, numbers and health of living things and are known as limiting factors.

A Lesson in Tolerance

Limiting factors determine what kind of organisms can live in a particular place.

In the previous section we learned what ecosystems are. We discovered that in ecosystems, living things interacted with each other and with the non-living components of their environment. In this section, we will discover one of those critical interactions between living and non-living things. It is the idea of **limiting factors**.

Have you ever been in a store where lots of people showed up at the cash register to check out all at once, and only one line was open? That can be really frustrating, especially when you are number 18 in line. No matter how fast the checker works, only one person at a time can pass through the register. The fact that there is only one line open becomes the *limiting factor* to how quickly you will get out of the store and on your way.

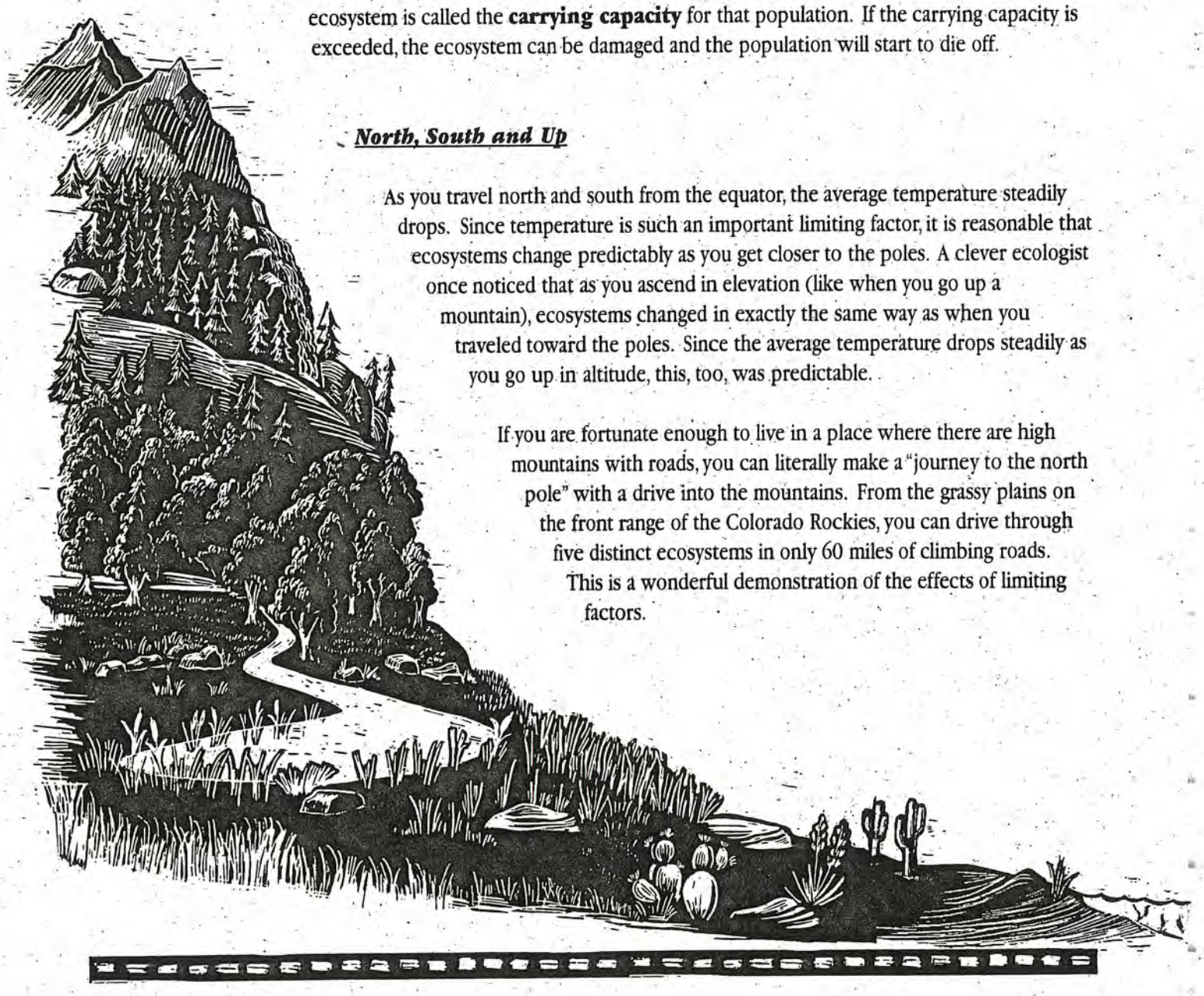
If the manager notices that there is a problem and opens four more lines, the limiting factor is removed. No one is going through a line any faster than before, but up to five people at a time are at a register being checked out. The result is that you get out five times as fast.

The idea of limiting factors illustrated here is a very important component of the way ecosystems work. For example, if the component in short supply is water, then water becomes the limiting factor in that ecosystem. All organisms that are not adapted to living with limited amounts of water must either leave that ecosystem or die. In this way limiting factors actually determine the types of ecosystems that will exist in a particular place. On land, hot, dry climates will produce desert ecosystems with their hot/dry adapted communities. Cool, wet climates will produce temperate rain forest ecosystems with their cool/wet adapted communities.

The amount of flexibility that an organism has with a particular limiting factor (like short supplies of water in the example above) is called its **zone of tolerance**. Take, for

example, tall grass prairie plants that have a zone of tolerance of 25-35 inches of rainfall per year. They will grow very well in eastern Kansas where rainfall averages about 30 inches per year. If you head west, you will soon reach eastern Colorado where rainfall drops to 20 inches per year. This is too dry for the tall grass prairie. It is replaced by the short grass prairie which has a drier zone of tolerance. It stands to reason that organisms with a wide range of environmental tolerance will be found in more places than those that have very narrow ranges of tolerance.

Limiting factors determine **what kind of** organisms can live in a particular place. They also determine **how many** organisms can live in a particular place. The number of trees in a forest is limited by the availability of water and nutrients. A farm pond can only support so many sunfish. The size of a particular population that can be supported by a particular ecosystem is called the **carrying capacity** for that population. If the carrying capacity is exceeded, the ecosystem can be damaged and the population will start to die off.



North, South and Up

As you travel north and south from the equator, the average temperature steadily drops. Since temperature is such an important limiting factor, it is reasonable that ecosystems change predictably as you get closer to the poles. A clever ecologist once noticed that as you ascend in elevation (like when you go up a mountain), ecosystems changed in exactly the same way as when you traveled toward the poles. Since the average temperature drops steadily as you go up in altitude, this, too, was predictable.

If you are fortunate enough to live in a place where there are high mountains with roads, you can literally make a "journey to the north pole" with a drive into the mountains. From the grassy plains on the front range of the Colorado Rockies, you can drive through five distinct ecosystems in only 60 miles of climbing roads. This is a wonderful demonstration of the effects of limiting factors.

Washing Machines and Green Slime

As a general rule, the most important limiting factors for ecosystems on land are moisture and temperature (easily seen in the examples just listed). For ecosystems in water, the most important limiting factors are nutrients and temperature.

You may have noticed that the detergent for your washing machine says **Low** or **No Phosphates** on the box. Phosphates are nutrients that plants, especially water plants like algae, need to grow. Remember, nutrients usually act as important limiting factors in water ecosystems like streams and lakes. That is because under normal circumstances they are only found in small amounts. As washing machines came into widespread use, their waste water began finding its way into local bodies of water. By the 1960s and '70s this was creating real environmental problems.

Laundry detergent caused water phosphate levels to skyrocket. One of the major limiting factors for algae growth was removed. As a result, algae populations exploded. Soon, many streams and lakes were filled with green algae slime. Exploding bacteria populations decomposed dead algae using up oxygen supplies in the water. As the oxygen disappeared, large numbers of fish and other water organisms were killed.

This is just one example of what happens when we ignore nature's rules. In this case we paid no attention to the rule of limiting factors. Fortunately, we now have laws which restrict the use of phosphates in laundry detergent.

Critical Thinking Challenge

1. Wolves were recently restored to Yellowstone National Park. Explain why park biologists have done this in terms of carrying capacity of elk and bison.

2. Explain why oranges are raised in California and Florida but not in Iowa.

3. Explain why a Kentucky bluegrass lawn (the most popular kind) is difficult to maintain in Phoenix, Ariz.

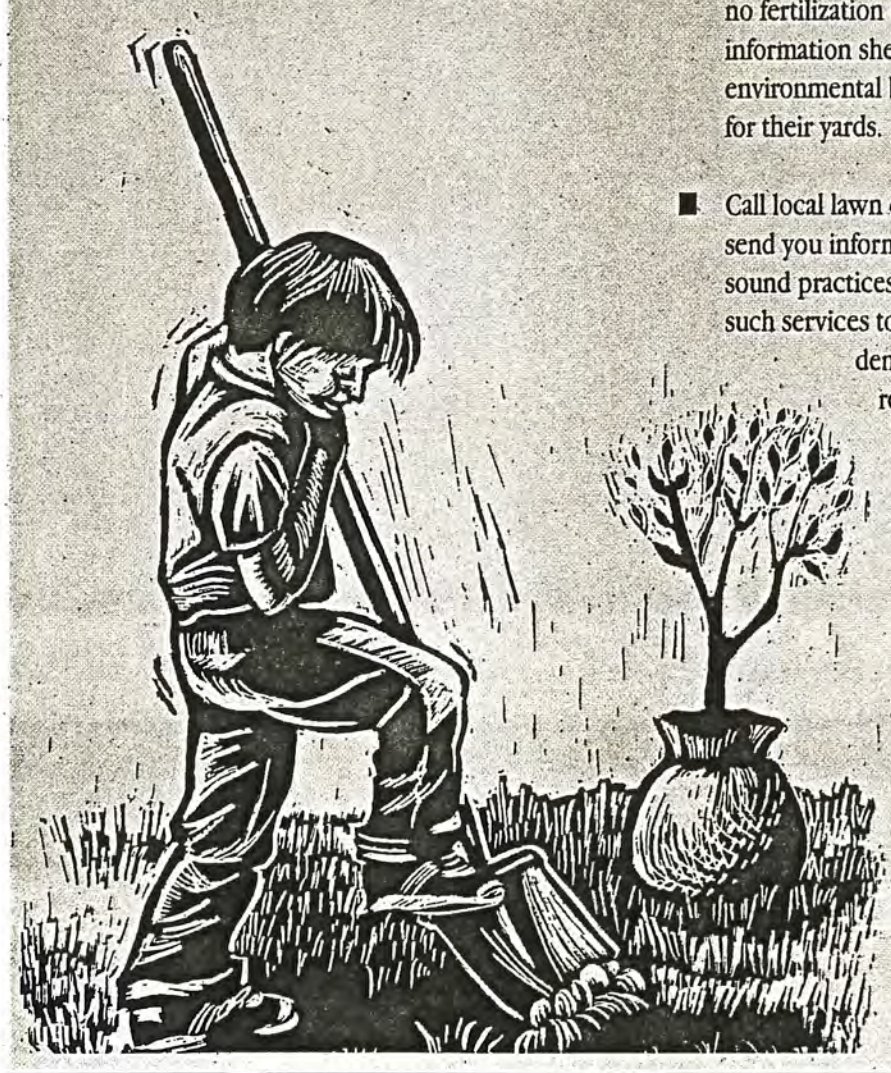
4. Since the elimination of predators, most states control their deer populations by hunting. Explain what would happen if hunting were forbidden.

5. Lots of people fertilize their lawns. Excess fertilizers run off into rain gutters and ultimately into nearby streams. Explain how this can be a problem.

Service-Learning

From Awareness to Action: Service-Learning Ideas

- Contact the nearest university department of biology/botany, and ask to speak with a professor who is familiar with the native grasses of your area. Find out what type of turf grasses grow naturally in your area without additional fertilizers and water. Take your discoveries to a local building contractor who builds housing developments, and propose that they consider putting in native grass lawns that will be low maintenance because they are adapted to the local climate.



- Check with state conservation departments and see if they have stencils to paint warnings on street rain gutter drains. They usually have a message similar to: *Dump No Oil, Drains to Stream.* Often they will even provide special paint. Sometimes paint will be donated by the highway department or city engineer's office for such projects.

- Check with local garden centers, greenhouses and nurseries for plants and shrubs that are well adapted to the local climate and require little or no fertilization or extra water. Offer to develop an information sheet for their customers on the environmental benefits of choosing such plants for their yards.

- Call local lawn care businesses and ask them to send you information on their environmentally sound practices. Encourage adults who may use such services to support those companies that demonstrate the most environmentally responsible practices and materials.

How Many Bears Can Live In This Forest?

Objectives

Children will be able to: 1) define a major component of habitat; and 2) identify a limiting factor.

Method

Children become "bears" to look for one or more components of habitat during this physically involving activity.

Background

It is recommended that this activity be preceded by one or more activities on adaptation: basic survival needs; components of habitat; crowding; carrying capacity; habitat loss; habitat improvement; herbivores, carnivores and omnivores; and limiting factors.

In this activity, black bears are the focus in order to illustrate the importance of suitable habitat for wildlife. One or more components of habitat—food, water, shelter and space in a suitable arrangement—are emphasized as one way to convey the concept of "limiting factors."

Black bear habitat limits black bear populations, especially through the influences of shelter, food supply and the social tolerances or territoriality of the animal. Shelter or cover is a prime factor. Black bears need cover—for feeding, hiding, bedding, traveling, raising cubs and for denning. With limits of space, adult bears will kill young bears or run them out of the area. These young bears must keep moving around either until they die or find an area vacated by the death of an adult.

When food supplies are reduced by factors such as climatic fluctuations, competition becomes more intense. Some adult bears might temporarily move to seldom-used areas of their home range, sometimes many miles away. They must live on what food is available in the area. These individuals may become thin and in poor condition for winter hibernation or, in the case of young bears, be forced from the area by more aggressive adults.

All components of habitat are important. Food, water, shelter and space must not only be available—but must be available in an arrangement suitable to meet the animals' needs. For black bears, shelter is especially important.

All possible conditions are not covered by the design of the activity. However, by this simple illustration, it is possible for children quickly to grasp the essential nature of the concept of limiting factors.

The major purpose of this activity is for children to recognize the importance of suitable habitat. Inadequate food and/or shelter are two examples of what is called a limiting factor—something which affects the survival of an animal or a population of animals.

Materials

Five colors of construction paper (two to three sheets of each color) or an equal amount of light poster board; one black felt pen; envelopes (one per child); pencils; one blindfold; five sheets green construction paper (for extension).

Procedure

1. Make a set of 2" x 2" cards. For a group of 30 children, make 30 cards of each of five colors to represent food as follows:

   Orange—nuts (acorns, pecans, walnuts, hickory nuts); mark five pieces N-20; mark 25 pieces N-10.

   Blue—berries and fruit (blackberries, elderberries, raspberries, wild cherries); mark five pieces B-20; mark 25 pieces B-10.

   Yellow—insects (grub worms, larvae, ants, termites); mark five pieces I-12; mark 25 pieces I-6.

   Red—meat (mice, rodents, peccaries, beaver, muskrats, young deer); mark five pieces M-8; mark 25 pieces M-4.

   Green—plants (leaves, grasses, herbs); mark five pieces P-20; mark 25 pieces P-10.

The following estimates of total pounds of food for one bear in 10 days are used for this activity:

nuts	-	20 pounds	=	25%
berries and fruit	-	20 pounds	=	25%
insects	-	12 pounds	=	15%
meat	-	8 pounds	=	10%
plants	-	20 pounds	=	25%
		80 pounds	=	100%

NOTE: A bear's diet will vary between areas, seasons and years. For example, a bear in the state of Alaska would likely eat more meat (fish) and fewer nuts than a bear in Arizona. One similarity among black bears everywhere is that the majority of their diet is normally made up of vegetable material.

Keeping these figures in mind, make and distribute the appropriate number of food cards for your size group of children. There should be less than 80 pounds of food per child so that there is not actually enough food in the area for all the "bears" to survive.

If you want, you can also include "water" by making an additional 50 squares of light blue paper. Mark each stack of 10 cards with one of these letters: R, L, S, SP and M (representing rivers, lakes, streams, springs and marshes—all places where a bear could find water).

2. In a fairly large, open area (e.g., 50' x 50'), scatter the colored pieces of paper.

3. Have each child write his or her name on an envelope. This will represent the child's "den site" and should be left on the ground (perhaps anchored with a rock) at the starting line on the perimeter of the field area.

4. Have the children line up on the starting line, leaving their envelopes between their feet on the ground. Give them the following instructions: "You are now all black bears. All bears are not alike, just as you and I are not exactly alike. Among you is a young male bear who has not yet found his own territory. Last week, he met up with a larger male bear in the big bear's territory, and before he could get away, he was hurt. He has a broken leg. (Assign one child as the crippled bear. He must hunt by hopping on one leg.) Another bear is a young female who investigated a porcupine too closely and was blinded by the quills. (Assign one child as the blind bear. She must hunt blindfolded.) The third special bear is a mother bear with two fairly small cubs. She must gather twice as much food as the other bears. (Assign one child as the mother bear.)"

5. Do not tell the children what the colors, initials and numbers on the pieces of paper represent. Tell them only that the pieces of paper represent various kinds of bear food. Since bears are omnivores, they like a wide assortment of food, so they should gather different colored squares to represent a variety of food.

6. Children must walk into the "forest." Bears do not run down their food; they gather it. When children find a colored square, they should pick it up (one at a time) and return it to their "den" before picking up another colored square. (Bears would not actually return to their den to eat; they would eat food as they find it.)

7. When all the colored squares have been picked up, the food gathering is over. Have children pick up their den envelopes containing the food they gathered, and return indoors.

8. Explain what the colors and numbers represent. Ask each child to add up the total number of pounds of food he or she gathered—whether it is nuts, meat, insects, berries or plant materials. Each should write the total weight on the outside of his or her envelope.

9. Using a chalkboard, list "blind," "crippled," and "mother." Ask the blind bear how much food she got. Write the amount after the word "blind." Ask the crippled bear and the mother bear how much they got and record the information. Ask each of the other children to tell how much food they found; record each response on the chalkboard. Tell the children each bear needs 80 pounds to survive. Which bears survived? Is there enough to feed all the bears? How many pounds did the blind bear collect? Will she survive? What about the mother bear? Did she get twice the amount needed to survive? What will happen to her cubs? Will she feed her cubs first or herself? Why? What would happen to her if she fed the cubs? What if she ate first? If the cubs die, can she have more cubs in the future, and perhaps richer, years? (The mother bear will eat first and the cubs will get whatever, if any, is left. The mother must survive; she is the hope for a continued bear population. She can have more cubs in her life; only one needs to survive in order for the population to remain static.)

10. If you included the water squares, each child should have picked up at least one square representing a water source, or he or she does not survive. Water can be a limiting factor and is an essential component of habitat.

11. Ask each child to record how many pounds of each of the five categories of food he or she gathered. Ask each child next to convert these numbers into percentages of the total poundage of food each gathered. Provide the children with the background information about black bears so that they can compare their percentages with what are typical percentages eaten by black bears in Arizona. Ask each child to attempt to guess how healthy their bear would be. How do the bears' requirements for a diet seem to compare with the needs of humans for a balanced and nutritious diet?

12. Ask the children to arrive at a group total for all the pounds of food they gathered as bears. Divide the total by the 80 pounds needed by an individual bear (approximately) in order to survive in a 10-day period. How many bears could the habitat support? Why then did only _____ bears survive when your group did this activity? Is that realistic? What percentage of the bears survived? What percentage would have survived had the food been evenly divided? In each case, what percentage would not survive? What limiting factors, cultural and natural, would be likely to actually influence the survival of individual bears and populations of bears in an area?

Extensions

1. Cut the paper or poster board into 2" x 2" squares. For a group of 30 children, make 150 squares. Make five piles of 30 squares each. Mark each set of 30 cards with one of these letters: B, T, D, H and F. These represent B = bedding sites, T = travel ways, D = dens, H = hiding cover, and F = feeding sites. For purposes of this activity, these are defined as follows:

   Bedding Sites—Black bears are usually active in early morning and late evening and bedded most of the rest of the day and night. Bedding sites are usually in areas of dense vegetation, steep topography and/or large trees where the bears feel secure.

   Travel Ways—Bears require corridors of cover (made up of thick vegetation and/or steep topography) to enable them to travel between areas of food, water and shelter within their home range.

   Dens—Black bears use dens as shelter for hibernation from November to April in each year. Bears have been found denning in hollow logs, caves, holes dug into hillsides, under buildings and even in culvert pipes. Bears often prepare and may use more than one den and may change dens during the winter because of disturbance or if the den leaks. Bears seldom re-use dens from one year to the next.

Hiding Cover—Black bears evolved as animals that escape danger from predators and other bears by hiding in thick cover.

Feeding Sites—Bears will often use areas with less cover than hiding areas or bedding sites for feeding. Feeding sites are, however, often found close to thick hiding cover to allow the bear to quickly escape danger if necessary.

NOTE: This information is based on actual research data from a study in Arizona. These components of shelter may vary slightly in different parts of North America.

2. In a fairly large open area (e.g., 50' x 50'), scatter the colored pieces of paper.

3. Have the children line up along one side of the area. Tell them that they are to become "bears" for the purposes of this activity. Review the concept of habitat—that a bear would need shelter, food, water and space in a suitable arrangement in order to survive. Do not tell the children what the letters on the squares of paper represent. Tell them only that they represent one element or component of bear habitat.

4. Direct the children to move as individual bears into the area. Each bear must pick up as many of the components of habitat as possible. Some competitive activity is acceptable as long as it is under control. Bears are territorial. Remember that if bears fight, which they seldom do, they can become injured and unable to successfully meet their needs for survival.

5. When the children have picked up all of the squares of paper in the area, have them return to the meeting room or be seated in any comfortable area. Ask the children to separate their squares of paper into piles according to the letter on each. Using a chalkboard or large pad for a visual reference, ask the children to guess what the letters on the green cards represent—giving them the clue that each is an element of cover or shelter for a black bear.

   What kinds of shelter would a bear need? What do these initials represent? Record how many bears got at least one of each kind of shelter. How many got only four kinds? Three? Two? How many got only one kind of shelter?

For the purposes of this activity, only those bears with at least one of each kind of necessary shelter can survive through one year. Ask the children what would happen if a bear has all types of shelter except a den. (The bear could live from April through October but would not have a secure place to hibernate and might not survive the winter.) Ask the children what would happen if a bear did not have travel ways. (Without travel ways, home ranges become fragmented and bears are not able to reach needed food, water or other shelter.) Suggesting that the children need one of each kind of shelter represents the importance of appropriate shelter as a necessary component of an animal's habitat. Shelter is a very important part of a bear's habitat. A bear needs shelter in which to search for food and water. Bears also need shelter for traveling through their home range and shelter for bedding, hiding and denning.

In this activity, how many bears survived? What was a "limiting factor" for this population of bears? (Shelter.) What other things possibly could become limiting factors? (Water and space, or territory, are two examples.) Would food be a limiting factor for bears? (Yes, however, bears are omnivores and can utilize many sources of food.)

6. Ask the children to summarize what they have learned about the importance of suitable habitat for bears' survival. How is this similar and different to the needs of other animals?

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Reflections

This page is provided for you to write your thoughts, ideas, discoveries, hopes, dreams and plans for the future in light of what you have learned in this unit about ***limiting factors****.*

Unit 3

Habitat and Niche

Key Concepts:

The place where an organism lives is called its habitat.
The job that an organism does is called its niche.

A Place for Everything and Everything in Its Place

We now know that living things are limited by the non-living parts of the ecosystems in which they live. Organisms must live in ecosystems with limiting factors that fall within their zone of tolerance or they cannot survive there. In this section we will learn more about how organisms are specially adapted to the ecosystems in which they live.

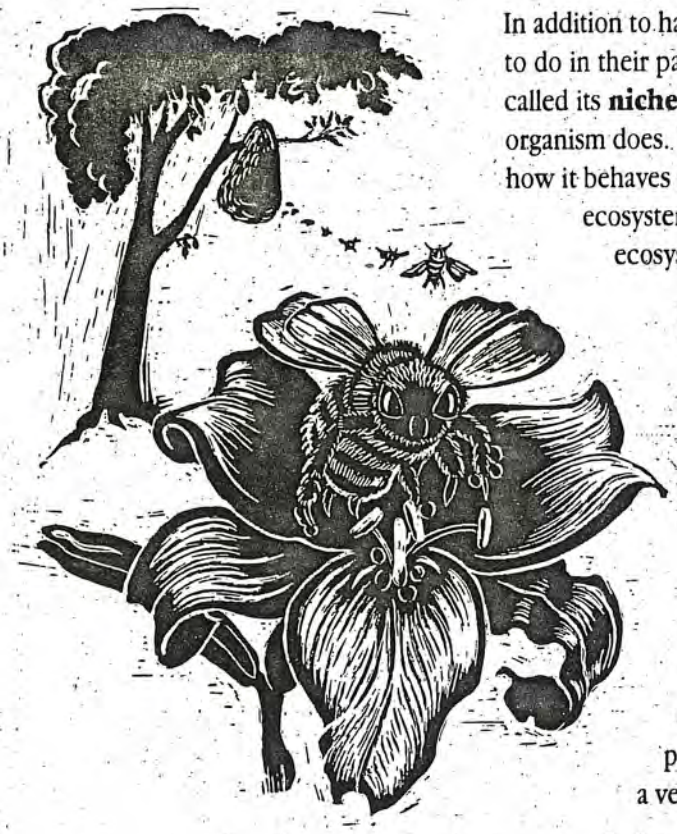
All living things require a place to live and a job to do.

All living things need a place to live. The place where an organism lives is called its **habitat**. An organism's habitat is its home. Your habitat is probably a house or an apartment. They make good homes for you because they are well suited to your needs for safety and shelter. This is the requirement for all habitats. They must provide safety and shelter for the organisms that choose them in ways that meet their needs.

The different kinds of habitat that are available in an ecosystem will determine what kinds of organisms will live there. Ecologists have learned the preferred habitat of thousands of organisms. As a result, they can often discover the exact plant or animal they are seeking by looking for them in their most preferred habitat.

Let's look at an example of a habitat. Pretend that we are scientists looking for some honey bees for a research project. Where would we look for them? After doing some reading about bees, we learn that they need cool, reasonably dry cavities, usually in wood, to construct their hives, which are also located near flowering plants that provide food. Now that we have a description of their preferred habitat we can go looking for places that meet their needs. We decide that large trees on the edge of a forest and an adjoining meadow is a good place to start.

When we investigate, we discover that among the forest trees that border the meadow are several old trees that have rotted-out hollow spaces in the heartwood. Because the meadow is full of flowering plants, this is ideal habitat for wild honey bees. With a little searching, a tree with these habitat requirement is discovered to contain a large hive of bees.



In addition to having a specific place to **live**, organisms have a specific **job** to do in their particular ecosystems. This "job" that an organism does is called its **niche**. There are a number of aspects to the niche or "job" an organism does. These include the things an organism eats, what eats it, how it behaves and the ways in which it interacts with other parts of its ecosystem. Only one type of organism can fill a niche in any given ecosystem at any given time.

If we go back to our example of the honey bees in the tree by the meadow, a careful observation of their behavior soon lets us discover the bees' niche. In addition to collecting nectar from flowers to make honey, the bees collect pollen to store as a food source back in the hive. Because their legs have hairs that collect the pollen, they also serve to take pollen from one flower to another. In this way a relationship has developed between the flowers and the bees. The flowers have become dependent upon the bees to spread their pollen to other flowers so that seeds can be produced. Consequently, pollination of flowers has become a very important niche or "job" for honey bees.

Critical Thinking Challenge

1. Explain how damming a river will change the habitat around the river. Explain how that will affect the organisms that live there.

2. A termite's niche is to begin the breakdown of dead wood in the forest. Explain why this niche becomes a problem in the city where there are few dead trees but still lots of termites. Can you think of other organisms whose niche makes it a problem when human-made ecosystems replace natural ones?

3. If you live in a city, identify ways that you can improve habitat for wild creatures that must live in an urban environment.

4. Explain why it is important to regulate exotic (not native) organisms from other parts of the world and prevent them from being turned loose in the wild.

5. Considering what you have learned about niche, explain why feeding wild animals might cause problems for them and other organisms that share their ecosystem.

Service-Learning

From Awareness to Action: Service-Learning Ideas

- Contact your state department of conservation and explain where you live. Ask if there are animals or plants that need more habitat that you could develop in your yard, school yard or local park. Get suggestions on how to do that. Check with your parents, local school officials or supervisors of local parks, and see if any will allow you to develop habitat for plants and animals that have been displaced by people.

- The same approach as above can be made to the city planning office in large urban areas. Check and see if there are inner-city abandoned lots that could be developed into special habitat areas for displaced wildlife.

- Check with the city planning office and see where developers plan to put new housing. Visit these areas and see if significant habitat will be destroyed in the process. Develop a proposal for the contractor to design the development to leave habitat and migration paths intact for wildlife. State departments of conservation and university resource management departments will be helpful in giving you suggestions on how to do this properly.

- From the same sources get plans for species-appropriate bird houses and feeders. Build them as a group and decide where they could be placed to improve habitat for species of birds in need.

- Get plans for bat houses and get permission to put them up in public parks or places where people gather in summer, especially near water, for mosquito control. This is much better for the environment than spraying pesticides since it utilizes natural controls and replaces habitat for bats often destroyed by development. **Bat Conservation International** has excellent plans for bat houses. They can be contacted at 800/538-2287.

Improving Wildlife Habitat In The Community

Objectives

Children will be able to: 1) apply their knowledge of wildlife by describing essential components of habitat in an arrangement appropriate for the wildlife they identify; and 2) evaluate compatible and incompatible uses of an area by people and specified kinds of wildlife.

Method

Children design and accomplish a project to improve wildlife habitat in their community.

Background

This activity provides an opportunity for children to evaluate and apply much of what they have learned about wildlife and its needs. The major purpose of this activity is to provide children with experience in looking at their own communities; applying knowledge and skills they have acquired; evaluating; and experiencing the possibilities of enhancing their communities as places within which both people and wildlife can live suitably.

Materials

Writing and drawing materials, poster or butcher paper, or model-making materials like plaster of Paris, clay, small replicas of animals, etc.

Procedure

1. Ask children whether their community could benefit from improved areas for wildlife habitat. If yes, this activity provides a process for helping to make such improvements. If a need is identified, the scope of such a project is a major decision. Habitat improvement projects can be large or small. If a project from this activity is actually to be implemented:

    - It should be within the scope and means of the children to experience success with it; and,
    - It should clearly be of benefit to wildlife and the community.

2. After general discussion, ask the children to divide into groups of four or five. Give each group the task of beginning a design for a habitat improvement project. The project should involve native plants and animals and make a contribution to the community. Provide time for the children to discuss and make decisions about the following:

   - What will be its purpose?
   - What animals will it serve? Will people be able to visit? Will it be for plants and animals only? What plants and what animals? If people can visit, what will they be allowed to do? What won't they be allowed to do?
   - What positive contributions might this improved wildlife habitat area make to the community? What possible problems could arise, if any?
   - What costs will be involved? Who will pay? How?
   - Where will the area be? How large will it be?
   - What are the habitat needs of any animals who will live there? What species of animals can live in the size land area that is available? (Some animals need more room than others, and if you are to have a self-sustaining system, you will need a population in an area large enough for successful breeding over time.)
   - What herbivores and carnivores might be needed? Predators? Prey? What specific kinds of plants (herbs, shrubs, trees, grasses, etc.) are needed and in what arrangement?
   - What will be the water sources? How will air and water quality be maintained?
   - What kinds of programs, if any, will be necessary to maintain the area once it has been improved?
   - Who must be contacted in order for this project to be undertaken? What permissions would be needed? From whom?
   - In balance, is it a good idea ... for wildlife, the environment and the people who live in this community?

   Optional: Make a site visit.

3. Ask each of the groups to prepare the following: a) a written description of their habitat improvement project, including its location, characteristics, inhabitants and purposes; and b) a map or model to scale of the area. The map or model can include:

- habitat components for various species
- wildlife living in the area, in their appropriate locations
- bodies of water, natural or made by people
- major areas of vegetation and a key to type of vegetation
- major landmarks; e.g., rock outcropping, roosts for birds, bare ground, meadows, brush, low trees, high trees
- major food sources and types; e.g., berry patch for birds, prairie dog village for coyotes or birds of prey
- areas developed for human access

4. Ask each group to display their plans. After all the children have had an opportunity to read the background information and see the map or model of each habitat improvement project, ask the children to talk about what they learned in the process of creating these designs. They can include discussion of problems they encountered, what seemed realistic and what did not, etc. In discussion—and based on their observations of the various proposed projects—ask the children to summarize what seemed to be the most important things to remember about designing such an area (e.g., size appropriate to wildlife, diversity, native elements, appropriateness to community wants and needs).

Extension

Consider the feasibility of designing and implementing one or more of these projects for your community. Do have a local wildlife specialist and appropriate local officials—e.g., landowners, zoning authorities—critique and cooperate with any proposed project before you get under way. Make sure the project is worthy, feasible and legal—and then proceed!

Evaluation

Rate the following uses of an area as either compatible or incompatible for people and wildlife: houses being built 200 feet from a heron rookery; picnic tables set up in an area heavily populated by squirrels; snowmobile trails through a deciduous forest; swimming beach at a local lake. Think of your own examples. What could be done to make each of these uses more compatible for people and wildlife?

Reflections

This page is provided for you to write your thoughts, ideas, discoveries, hopes, dreams and plans for the future in light of what you have learned in this unit about ***habitat and niche****.*

Energy and Cycles in Nature

Key Concepts:

Energy for life on earth comes from the sun and must continually be renewed. This energy enters living things through green plants and passes through the food chain.

Matter cycles in living things and is recycled over and over by the energy of the sun.

All Things are Connected

Organisms are powerfully connected to each other in a "web of life."

As our understanding of the way the world works has grown, we have learned that there is a close relationship between living and non-living things. Where certain ecosystem types are found, where an organism lives and how successful it is depends, to a great degree, on limiting factors like water, temperature and nutrients. But organisms are also powerfully connected to each other by complex relationships. This "web of life," as it has been called, is an equally critical part of an organism's survival and success. In this section we will discover how the web of life is woven.

Food Chains

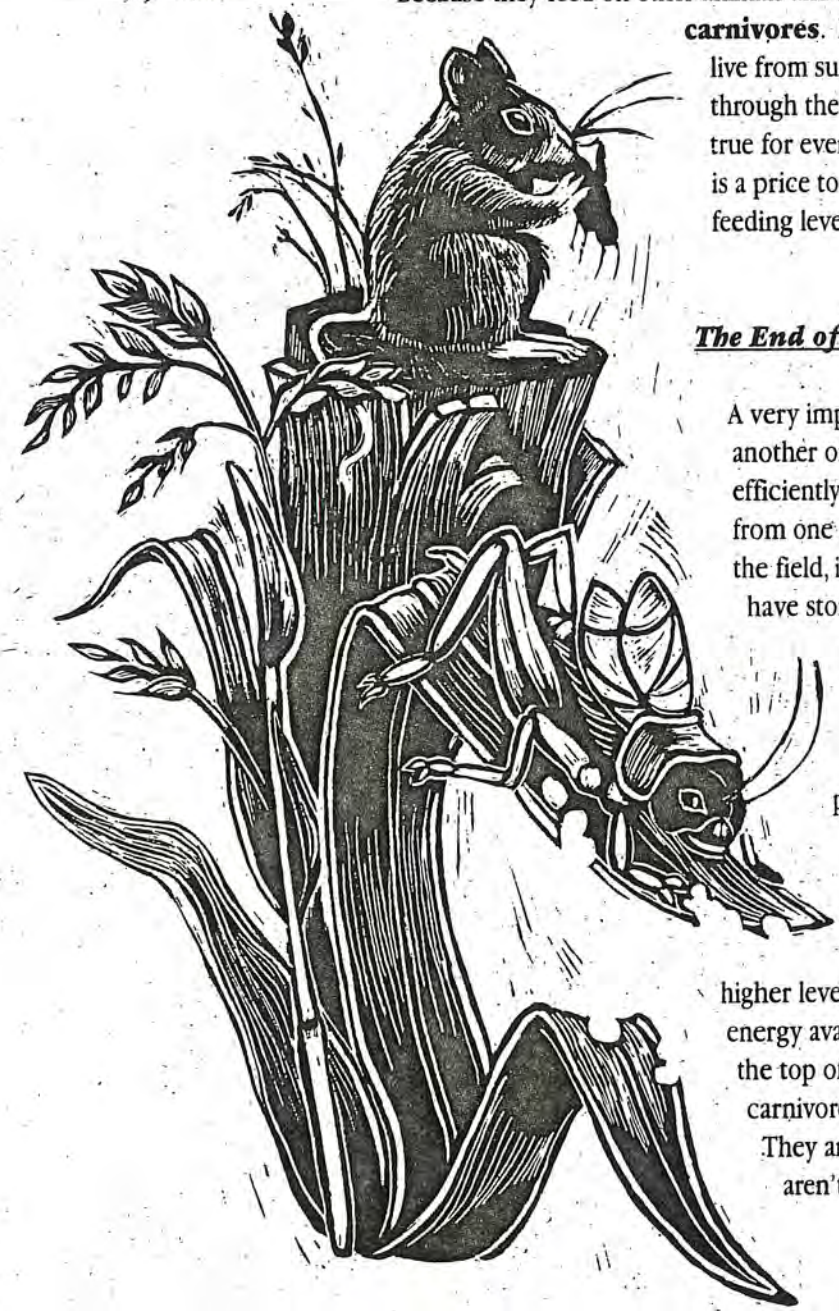
The first important relationship that we need to learn about is **food chains**. Food chains are groups of organisms that depend upon each other as food. All food chains begin with the sun.* The sun's energy is captured by green plants. Sunlight provides green plants with all the energy that is required for them to stay alive. Much of the energy captured by plants is not needed by them immediately. Instead it is stored in a chemical form that we call sugars.

No other organisms can take the energy they need to stay alive directly from the sun. Instead, they must get it from those organisms that can, the green plants. Without green plants, all other life on earth, as we know it, would be impossible.* Since plants can "make their own food," ecologists call them **producers**. Green plants or **producers** are at the bottom or base of all food chains.

* The only known exception to this is a recently discovered ecosystem very deep in the ocean. There is no light at this ocean depth. Organisms have developed a food chain based on bacteria that take energy from superheated, mineral rich waters expelled from volcanic vents.

Food chains are made up of different feeding levels. Those on the level above eat the ones on the level below. As we just learned, the first, or bottom, feeding level of a food chain are green plants called producers. On the second level of the food chain are organisms that eat plants. Because they cannot make their own food they are called **consumers**. Consumers that only eat plants have a special name. They are called **herbivores**. A grasshopper is an herbivore consumer. So is a cow or a deer.

At the third level of the food chain we find consumers that eat the animals that eat the plants. An example would be a field mouse that eats the grasshopper mentioned above. Because they feed on other animals and not directly on plants, these consumers are called **carnivores**. Don't be fooled. Carnivores still get their energy to live from sunlight stored in plants. They just get it **indirectly** through the bodies of animals that do eat plants directly. This is true for every feeding level of carnivore that follows. But there is a price to pay for transferring energy in this way from one feeding level to the next. That price is lost energy.



The End of the Chain

A very important thing happens when one organism eats another one as food. Living things do not use energy very efficiently. Much of it is wasted or lost when it is transferred from one organism to another. When a cow eats grass out in the field, it takes the energy from the sun that the grass plants have stored. It uses this energy to stay alive. But only 10 percent of the energy that has been stored in the grass is usable by the cow to stay alive. That means 90 percent has been lost in the transfer from grass to cow. Consequently, it takes 10 pounds of grass to make one pound of cow.

This is true at each feeding level of a food chain. Because so much energy is lost at each level, there are substantially fewer organisms at each higher level. Clearly, after just a few levels there is no more energy available. At that point the food chain stops. Here at the top of the food chain are the animals that we call top carnivores. Nothing could survive that eats top carnivores. They are predictably very few in numbers. There simply aren't enough of them to make a regular meal for another

organism and support another feeding level. Examples from North America would include hawks, owls, mountain lions, grizzly bears and wolves. It is not surprising that these examples are threatened, endangered or specially protected species. Humans, of course, are also at the top of the food chain. We are an exception to the rule of numbers. This is true only because of the development of technologies which have dramatically increased our population.

The idea of food chains is very useful because it helps us understand the way that energy moves through ecosystems. But in the real world food chains overlap and interconnect extensively. Field mice, for example, do not limit themselves to eating only grasshoppers. A more accurate picture is a web of many interconnected food chain strands. This new picture helps us realize that all living things are in some way connected and dependent on other living things in their ecosystem. As a matter of fact, the more complex and intricate the food webs of an ecosystem are, the less energy loss occurs and the more stable they tend to be.

The Waterwheel of Life

So far, we have discovered the important roles of producers and consumers in the flow of matter and energy through ecosystems. There is one more very important group of organisms that we need to learn about to complete our understanding. The **decomposers** are a very large group of mostly microscopic bacteria and fungi. Decomposers break down the waste products and dead bodies of organisms. They reduce them to their basic molecular components like water, carbon, nitrogen, phosphorus and dozens of other trace elements. Without the decomposers, the basic building block materials of life would quickly be used up, bringing life on the planet to a halt.

In summary then, energy from the sun is captured by plants. It is progressively used or lost as it travels up the food chain until there is no more energy available, and the food chain ends. The energy from the sun that maintains life on earth is like a river that drives a waterwheel. New water must continuously come down river to turn the waterwheel. Although the water is not destroyed, once it passes by it is no longer of any use to drive the wheel.

The waterwheel is like the matter that makes up living things. **Producers** (plants) take matter out of the soil and the air to build their tissue and store energy. **Consumers** (animals) take the matter organized by plants and incorporate it into their own bodies. Dead producers and consumers are reduced by **decomposers** (bacteria and fungi) to the simple matter they came from. Water, nitrogen, carbon, phosphorus and other elements all return to the soil. As they are taken up by plants the waterwheel of life turns again, driven around and around by an endless river of sunlight.

Critical Thinking Challenge

1. Eighty percent of the grain produced in the United States is fed to livestock. In light of what you have learned about energy loss, explain why this practice might be considered wasteful. Remember that people could eat the grain themselves and there is a world hunger problem. What solutions could you suggest?

2. Think of the organisms that live in your yard. Draw as many food chains for these organisms as you can think of. Take time to connect the food chains into a food web. What organisms seem to be important food items for lots of others? Identify the top carnivores in your yard.

3. Poisons like pesticides have been widely used to kill crop pests and mosquitoes. Many do not break down quickly. Explain how food chains might act to magnify the effects of pesticides.

4. Explain why alcohol (made from corn, a producer) as a fuel for cars might be a better choice than gasoline. Hint: Think in terms of matter cycling.

5. Explain why solar heat and electricity makes more sense than energy taken from non-renewable fossil fuels. Hint: Think of producers as examples.

Service-Learning

From Awareness to Action: Service-Learning Ideas

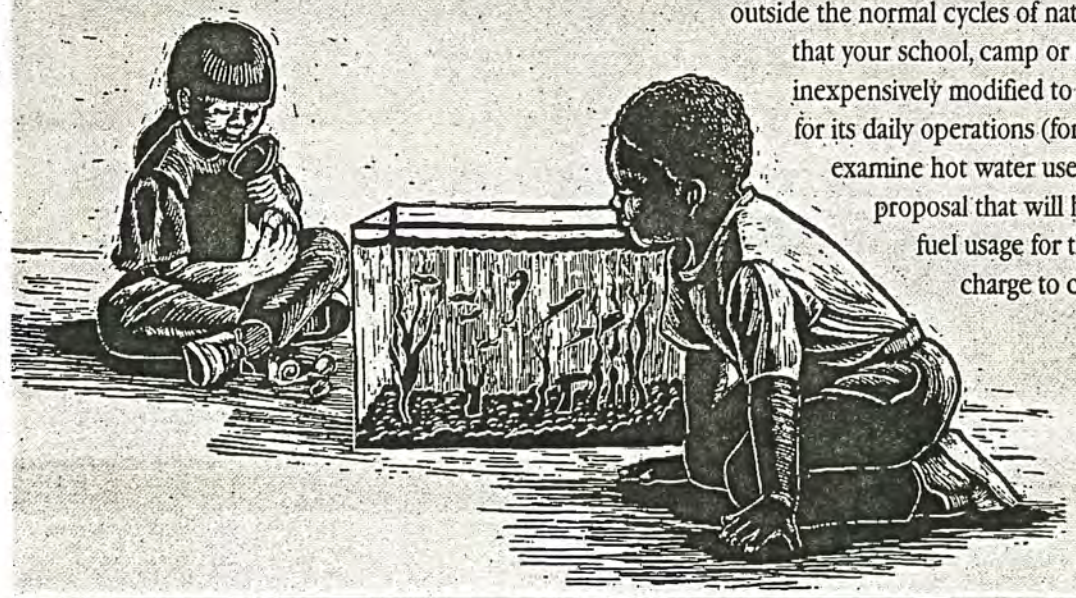
- Contact the local feed lot and find out the average amount of grain fed to a steer during its lifetime until it is slaughtered. Ask the average weight of meat produced per animal at the slaughterhouse. Contact a local flour mill and ask how many pounds of flour would be produced by the lifetime grain consumption of a steer. Compare the amount of flour with the amount of meat. Have a discussion with your parents about how much meat your family consumes in light of what you find out.

- Obtain a sand box toy "waterwheel" and construct a model of the nutrient cycle. Colored peel-and-stick dots can be used to represent nutrients like carbon, nitrogen, phosphorus, water, etc. and be attached to the wheel. Sand in the hopper can represent sunlight. Nutrients will be seen to cycle over and over while the "sunlight" sand must be constantly renewed for the cycle to run. With the model you develop, offer to teach the idea to younger children at camp, school, child care or other programs.

- Investigate the plans to reintroduce wolves to different parts of the country (the National Park Service would be helpful with this). Find out why scientists think restoring a top carnivore to ecosystems where it has been removed is important. Identify why some people are so strongly opposed to this idea. When you have concluded your research, contact your elected officials in Washington and support the view that you believe best represents a *WorldWise* position on this matter.

- Research composting and then brainstorm ways that composting could be made a part of everyday life for your family, your school, your camp. Establish compost piles or bins where it is appropriate, and determine where composted material can be used or sold. Be able to explain to anyone who asked you why composting is important and how it is a perfect example of the way decomposers complete the nutrient cycle.

- In light of your discoveries that fossil fuels are outside the normal cycles of nature, identify ways that your school, camp or home could be inexpensively modified to not use so much for its daily operations (for example, examine hot water use). Make a proposal that will help reduce fossil fuel usage for the people in charge to consider.



Deadly Links

Objectives

Children will be able to: 1) give examples of ways in which pesticides enter food chains; and 2) describe possible consequences of pesticides entering food chains.

Method

Children become "hawks," "shrews," and "grasshoppers" in a highly involving physical activity.

Background

People have developed pesticides to control organisms. Herbicides are used to control unwanted plants; insecticides to control unwanted insects, etc. When these pesticides involve use of poisons, the poisons frequently end up going where they are not wanted. Many toxic chemicals have a way of persisting in the environment and often get concentrated in unexpected and undesirable places—from food and water supplies to wildlife and people, too.

For example, a pesticide (a chemical—frequently synthesized from inorganic compounds—used to kill something identified as a "pest" under some conditions) called DDT used to be applied regularly to crops as a means of controlling insects that were damaging the plants or trees. Then it was discovered that DDT entered the food chain with damaging results. For example, fish ate insects that were sprayed by the chemical; hawks, eagles and pelicans ate the fish. The poisons became concentrated in the birds—sometimes weakening and killing them directly, and over time resulting in side effects like egg shells so thin that the eggs would not hatch or were crushed by the parents in the nesting process. The impact on species, including the bald eagle and the brown pelican, has been well documented. Use of DDT has now been prohibited by law in the United States; however, at least one temporary waiver was granted in recent years to allow its limited use. It has not been prohibited worldwide and therefore still enters the food chain.

Damaging fertilizers as well as pesticides are used by many farmers as a part of the agricultural industry. Again, use of such chemicals—particularly the inorganic, synthesized compounds—has varying side effects. For example, a pesticide (either insecticide to kill insects or herbicide to kill unwanted plants) may be sprayed or dusted on a crop. The pesticide may settle into the soil, or stay on the crop, until it is washed by rain or irrigation into other water sources like groundwater, lakes, streams, rivers and oceans. Testing the water after this has occurred typically does not show a particularly high concentration of these human-made chemicals—but testing the fish often does! Waterfowl and other species may also be affected—including human beings, if people eat contaminated fish or waterfowl, for example. In other words, wildlife and people become the concentrators of the pesticide because the chemicals do not pass out of their bodies but accumulate in their bodies over time.

The major purpose of this activity is for children to recognize the consequences of accumulation of some pesticides in the environment.

Materials

White and colored pipe cleaners, one-inch paper squares, six-inch lengths of yarn or any other material that can be picked up by children easily; 30 pieces per each child is recommended in a proportion of two-thirds white to one-third colored pieces; one paper bag per "grasshopper" (approximately 18-20).

Procedure

1. Tell the children that this is an activity about "food chains." If they are not familiar with the term, spend time in establishing a definition. (Food chain: a sequence or "chain" of living things in a community, based on one member of the community eating the member above it, and so forth; e.g., grasshopper eats plants like corn; shrews eat grasshoppers; hawks eat shrews.)

2. Divide the children into three groups. In a group of 26 children, there would be two "hawks," six "shrews," and 18 "grasshoppers." (Work with approximately three times as many shrews as hawks and three times as many grasshoppers as shrews.) Optional: Have grasshoppers, hawks and shrews labelled so they can easily be identified; e.g., green arm ties for grasshoppers, red bandannas for "red-tail hawks" and brown arm ties for shrews.

3. Hand each "grasshopper" a small paper bag or other small container. The container is to represent the "stomach" of whatever animal is holding it.

4. With the children's eyes closed, or otherwise not watching where you place the "food," distribute the white and colored paper squares (or whatever material you use) around in a large open space. Outside on a playing field if it is not windy, or on a gymnasium floor will work; a room will also work if chairs and tables or desks can be moved back.

5. Give the children their instructions. The grasshoppers are the first to go looking for food. The hawks and shrews are to sit quietly on the sidelines watching the grasshoppers; after all, the hawks and shrews are predators, and are watching their prey! At a given signal, the grasshoppers are allowed to enter the area to collect food and place the food in their stomachs (the bags). The grasshoppers have to move quickly to gather food. At the end of **30 seconds**, the grasshoppers are to stop collecting food.

6. The shrews are now allowed to hunt the grasshoppers. The hawks are still on the sidelines quietly watching the activity. The amount of time available to the shrews to hunt grasshoppers should take into account the size area you are working in. In a room, 15 seconds may be enough time; on a large playing field, 60 seconds may be better. Each shrew should have time to catch one or more grasshoppers. Any grasshopper caught by a shrew—that is, tagged or touched by the shrew, must give its bag of food to the shrew and then sit on the sidelines.

7. The next time period (from 15 to 60 seconds, or whatever time you set) is time for the hawks to hunt for food. The same rules follow. Any shrews still alive may hunt for grasshoppers; grasshoppers are hunting for the food chips that represent corn or other plants; and the hawks are hunting for the shrews. If a hawk catches a shrew, the hawk gets the food bag and the shrew goes to the sidelines. At the end of the designated time period, ask all the children to come together in a circle, bringing whatever food bags they have with them.

8. Ask the children who are "dead," having been consumed, to identify what animal they are and what animal ate them. (If they are wearing labels, this will be obvious.) Next ask the hawks to empty their food bags out onto the floor or on a piece of paper where they can count the number of food pieces they have. They should count the total number of white food pieces and the total number of multi-colored food pieces they have in their food sacks. List any grasshoppers and the total number of white and multi-colored food pieces each has; list the number of shrews left and the number of white and multi-colored pieces each has; and finally, list the two hawks and the number of white and multi-colored food pieces each has.

9. Inform the children that there is something called a "pesticide" in the environment. This pesticide was sprayed onto the crop the grasshoppers were eating, in order to prevent a lot of damage by the grasshoppers. If there was a lot of crop damage by the grasshoppers, the farmers would have less of their crop to sell, and some people and domestic livestock might have less of that kind of food to eat—or it might cost more to buy it because a smaller quantity was available. This particular pesticide is one that is poisonous, accumulates in food chains and stays in the environment for a long time. In this activity, all of the multi-colored food pieces represent the pesticide. All of the grasshoppers that were not eaten by shrews may now be considered dead, **if they have any multi-colored food pieces in their food supply**. Any shrews for which half or more of their food supply was multi-colored pieces would also be considered dead. The one hawk with the highest number of multi-colored food pieces will not die at this time; however, it has accumulated so much of the pesticide in its body that the egg shells produced by it and its mate during the next nesting season will be so thin that the eggs will not hatch successfully. The other hawks are not visibly affected at this time.

10. Talk with the children about what they just experienced in the activity. Ask them for their observations about how the food chain seems to work and how toxic substances can enter the food chain, with a variety of results. The children may be able to give examples beyond those of the grasshopper-shrew-hawk affected by the pesticide in this activity.

Extensions

1. Consider and discuss possible reasons for use of such chemicals. What are some of the trade-offs? What are some of the consequences?

2. Offer and discuss possible alternatives to uses of such chemicals in instances where it seems the negative consequences outweigh the benefits. For example, some farmers are successfully using organic techniques (e.g., sprays of organic, non-toxic substances; crop rotation; companion planting); biological controls (e.g., predatory insects); and genetic approaches (e.g., releasing sterile male insects of the "pest species") in efforts to minimize damages to their crops.

3. Find out what research is going on to develop and test effects of pest control efforts—from effects of possibly toxic chemicals, to non-toxic alternatives. With what impacts? Trade-offs? Potential?

4. Check newspapers for relevant local, national or international examples of such issues.

5. Conduct the activity using different examples; e.g., people, shellfish.

Evaluation

- Give three examples of ways in which pesticides could enter a food chain.

- Discuss two possible consequences of pesticides entering the food chain for each of the examples you gave above.

- An ecologist studied the presence of a toxic chemical in a lake. He found the water had one molecule of the chemical for every one billion molecules of water. This is called one part per billion (1ppb). The algae had one part per million (1ppm) of the toxic chemical. Small animals, called zooplankton, had 10 ppm. Small fish had 100 ppm. Large fish had 1,000 ppm. How do you explain this increase in this toxic chemical to 1,000 ppm for the large fish? Use a drawing to help support your answer.

- The ecologist found the chemical was a pesticide which had been sprayed on cropland 100 miles away from the lake. How did so much of it get into the lake?

Reflections

This page is provided for you to write your thoughts, ideas, discoveries, hopes, dreams and plans for the future in light of what you have learned in this unit about ***energy and cycles in nature****.*

Succession: How Nature Heals

Key Concepts:

Ecosystems have the ability to repair damage that occurs to them. This self-healing process is called succession.

The greater the number of different kinds of living things (biodiversity) in an ecosystem, the more stability it has and the better able it is to recover from damage.

The Power to Heal

One of the most remarkable and necessary abilities of living things is their ability to heal. Without the power to repair damage caused by injury or disease, living things could not exist in a dangerous, ever-changing environment. This is true for ecosystems as well as individual organisms. The process of self-repair in ecosystems is called **succession**.

One of the most remarkable and necessary abilities of living things is their ability to heal.

In May of 1980, Mount St. Helens, one of the many Cascade range volcanoes of the Pacific Northwest, exploded violently, completely destroying ecosystems in a wide area around the mountain. In the summer of 1988, major forest fires burned one-fifth of the forested area of Yellowstone National Park. Many people suggested that these places were ruined forever by these natural disasters. Certainly, the affected ecosystems were damaged, and some will not appear the same for several human generations. But in ecological terms, they certainly weren't ruined forever. As soon as the disasters had run their course, the process of succession began. Nature began healing the ecosystems that had been damaged.

Succession on Land

When a community of organisms on land is removed or altered by an outside force like fire, flood or human impact, ground cover (plants) is often removed. Limiting factors change suddenly. Special communities of plants and animals that are tolerant of open space and bright sun, quickly establish themselves. They are well adapted to the severely exposed conditions of the disturbed site. This rapidly growing first community is called a **pioneer community**. Lots of plants that we call weeds are actually very important pioneer organisms.

Pioneer communities are frequently short-lived. As they become established, they start to change the environmental conditions in which they live. Their cover produces shade, which in turn creates cooler and wetter conditions. Since these communities are adapted to conditions different than the ones they have created, they do not survive long. Another community of organisms, ideally adapted to the new cooler, wetter conditions, soon moves in on the pioneers. As the new community continues to change the environment, the pioneer community quickly dies out.

The idea that the success of a community leads to its own destruction may seem strange. But this is a good example of the idea of **niche** that we learned about earlier. It is the niche or "job" of successional plant communities to create new conditions where other communities will thrive and replace them. Without them, ecosystems couldn't heal.

The process of succession continues through several stages. In each stage, a new community will slowly replace the one before it. This happens as conditions, created by the organisms themselves, cause their surroundings to change. When an avalanche wipes out a section of spruce and fir forest in the mountains, the exposed area is hot and dry. Aspen trees, a pioneer organism well adapted to these conditions, grow quickly. They cool the slide area with their shade and hold water in the soil with their roots. In the cool, moist shade, spruce and fir trees begin to grow again. Soon they grow above the aspens and shade them out. Unable to tolerate the shade, the aspens quickly die.

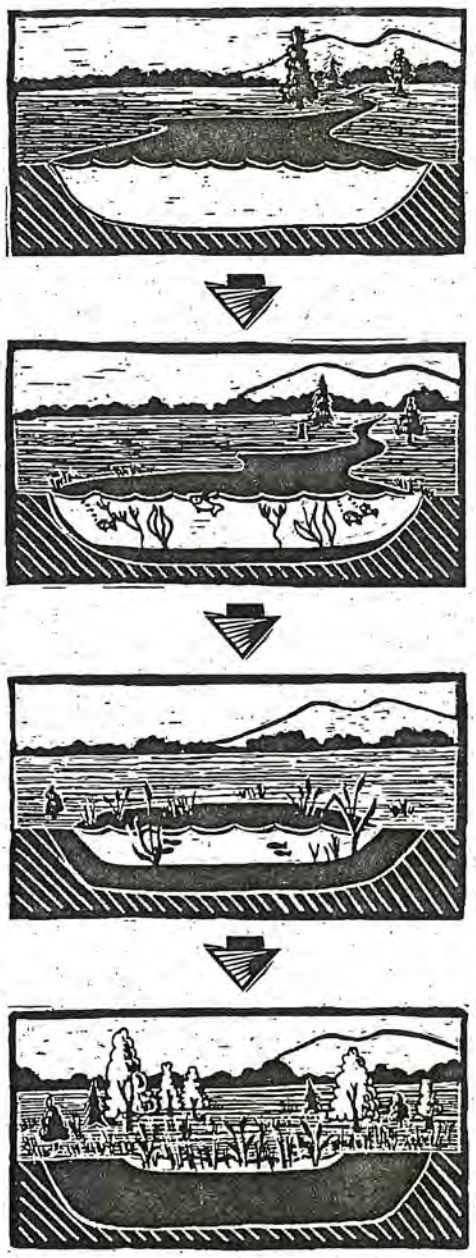
Each new community tends to be more diverse and slower to change than the previous one. Finally, the process of succession ends and the original ecosystem is restored. The end result of succession is called a **climax community**. A climax community creates a diverse and stable ecosystem that will tend to remain relatively unchanged until it is again disturbed.

Succession in Water

Water ecosystems will go through the process of succession as well. Take, for example, a beaver pond in a forest setting in the eastern United States. The pond, created when beavers dammed a stream, will slowly revert back to a forest. As runoff water brings in sediments from the surrounding area, they sink to the bottom and the pond becomes more shallow. Underwater plants which require some depth are slowly replaced by emergent* plants commonly found in shallow water.

* An *emergent* plant is one that is rooted underwater in the soil of the pond bottom but has leaves that emerge from the water. Some common examples of emergent plants include cattails and lily pads.

Before long, emergent plants break the surface across most of the increasingly shallow pond. Eventually, enough filling in has occurred that the pond is actually a marsh. As different successional types of plants become established and filling continues, the marsh becomes a wet meadow and eventually a dry one. In the final stage of succession, trees on the edges of the meadow will begin to encroach until the forest again covers the area. Depending upon other environmental conditions, this process can take hundreds of years.



As a final note, it is easy to view succession as nothing more than a means to an end—that end being the restoration of disturbed ecosystems. However, successional stages are important to stable ecosystems in and of themselves. They force rapid cycling of nutrients and create new food sources and habitat. Naturally occurring fires, disease and other disturbances are important contributors to the long-term health of ecosystems.

Biodiversity

The number of different kinds of organisms in a community is called its **biodiversity**. As damaged ecosystem communities succeed from one stage to another they become increasingly complex. More and more different kinds of organisms make up each successive community. As the numbers of kinds of organisms increase, the more complex and intricate the food webs become.

As food web overlap increases, each different kind of organism becomes less important to the survival of the ecosystem. If one type of organism disappears there are others that can fill the niche that is left open. Consequently, ecosystems with a high degree of biodiversity are more stable than those where biodiversity is less.*

Great concern has been expressed at the rapid elimination of tropical rain forests. These ecosystems have the highest biodiversity of any in the world. Some ecologists fear that the loss of biodiversity in the rain forests will have grave consequences for the stability of ecosystems worldwide. Expect to see the issue of biodiversity in the news.

* Although this idea is widely accepted by most ecologists, others are suggesting that stability of an ecosystem produces biodiversity, *not* the other way around as has been suggested above. The debate continues.

Critical Thinking Challenge

1. Explain why farmers have to use large amounts of weed killers (herbicides) after they plow their fields and plant crops.

2. Explain what the process of succession will do to Lake Mead, created by the Hoover Dam on the Colorado River.

3. Explain why the fires of Yellowstone National Park may benefit the animals that live there.

4. From what you have learned about biodiversity, explain why environmentalists are worried about the spotted owl in the Pacific Northwest. What do you think about this issue?

5. Think about how you might discover what everyday products come from the tropical rain forest and contribute to the loss of biodiversity. What could you do with the knowledge you discover?

Service-Learning

From Awareness to Action: Service-Learning Ideas

- Determine areas near you where restoring trees to an area where they have been removed will accelerate the successional healing process.. Always take time to research what trees are native to the area and will not require artificial irrigation. This information is available through state departments of conservation, universities and through local nurseries.

- Determine where construction or other disturbances in your community have left exposed areas where topsoil has been removed and succession inhibited as a result. See if donations from companies that sell topsoil can be acquired to restore the healing process to these areas in exchange for support or endorsement by your group as an environmentally responsible business. After topsoil has been restored, determine the best plants to bring in and secure the new soil. Remember to consider habitat restoration for wildlife any time you are involved in a project of this nature.

- As a group, research the rapid cutting of tropical rain forests and seek to understand the impact on biodiversity of organisms living in these regions. Contact organizations that support the rain forests of the world and identify ways that your group can act to support these efforts.

- Contact state agencies or the U.S. Fish and Wildlife Service to discover what plants and animals are endangered locally for you, and get suggestions on how your group can act in support of these creatures. Be sure to identify the impact their loss would have on the biodiversity of your area and determine the significance of that impact.

Pond Succession

Objectives

Children will be able to: 1) recognize that nature environments are involved in a process of continual change; 2) discuss the concept of succession; 3) describe succession as an example of the process of change in natural environments; and 4) apply understanding of the concept of succession by drawing a series of pictures showing stages in pond succession.

Method

Children create murals showing three major stages of pond succession.

Background

Succession is a term used to describe the ever-changing environment and the gradual process by which one habitat is replaced by another. Many habitats that appear to be stable are changing before us—perhaps at a slow rate to human eyes, but evolving rather quickly according to the earth's clock.

For example, a shallow pond may be transformed into a marshy, then forested, area in only a thousand years or so. Wind-blown or water-borne spores of algae are the first inhabitants. Eggs of flying insects are deposited. Small fish and amphibians arrive through the inlet. Surrounding sediments begin to fill the pond, some borne on wash-out from rainfall, some entering through the pond's inlet. Marshy plants growing along the shoreline spread inward as sediments fill the pond. Land plants also spread inward and replace the marsh plants as the ground is consolidated. As more plants and animals enter the system, more opportunities for habitat become available to others. Changes from ponds to forest are only one example of succession.

The major purpose of this activity is for children to discover that the environment is not static, but changing, and to see an example of how these changes progress over time, through experience with the concept of succession.

Materials

Long pieces of drawing paper for murals; tape for securing paper to walls; crayons.

Procedure

1. Review with children the idea of succession—the orderly, gradual and continual replacement of the community of plants and animals with another.

2. Start by talking about a pond. How many people have seen a pond? What did it look like? After a description of ponds, ask the children to imagine what a pond would look like from a side view if you could see under the water and show the nearby environment.

3. Explain to the children that they will be drawing a series of three views of a pond over a time period of about 800 years. The first (left-hand) section will show the pond as it is today, the middle section how it might look 500 years later, after natural changes, and the third (right-hand) how the pond could look in 800 years. (These time periods are approximate and can vary greatly.)

4. Discuss with them the possibilities of plant and animal life in the first section. What kinds of plants and animals live: in the water; along the shoreline; in the surrounding area?

5. Then give each group their piece of paper which they will divide into three equal sections (by folding or drawing). Instruct them to fill in the first section with their drawing of the pond and the surrounding area. Set a specific time frame for the children to draw (about 10 minutes).

6. Bring the group together again for a discussion of the second section—to be labeled "500 Years Later." Consider the following items:

    a. What changes in the environment have taken place?

    b. How will the pond look now?

    c. What lives and grows in the water now that it is much shallower and smaller?

    d. What lives and grows around the shoreline—which is now marshier? (marsh animals and plants, perhaps some willow bushes)

    e. What lives and grows in the surrounding area? (larger trees, same types of animals) Have each group complete the second section of their mural, labeling it "500 Years Later."

7. Repeat the process for the third section, labeling it "800 Years Later" and discussing the following topics:

    a. By this time, the pond is almost totally filled with sediment, leaving only a small marshy area with perhaps a stream running through. What changes have taken place?

    b. What lives and grows in the environment?

    c. What lives and grows where the shoreline used to be? (bushes, small trees)

    d. What effects does the pond succession have on the surrounding area? (different animals, trees requiring less water)

8. After the murals are completed, children should sign them. Then they may be displayed in the meeting room for all children to see and discuss differences and similarities between the various murals. Ask the children to summarize what they have learned, including how succession is one example of the ongoing process of change in natural environments.

Variation

Use a stream table filled with standard soil to illustrate in three-dimensional, dynamic ways the processes of succession! Fill the table with soil, make an indentation in the center to represent the pond; run water into the table to represent rainfall, streams feeding the pond, etc.; and watch the pond fill as sedimentation takes place. This can show the geologic life cycle of the pond. Add replicas of plants and animals during successional stages for even more interest!

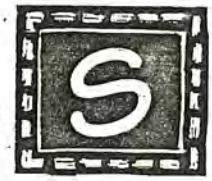
OPTIONAL: Visit the real thing if you can!

Evaluation

Draw a picture, with explanations, to show stages in pond succession.

Reflections

This page is provided for you to write your thoughts, ideas, discoveries, hopes, dreams and plans for the future in light of what you have learned in this unit about ***succession and how nature heals itself****.*



Summary

What We Have Learned

At the beginning of this project, we discussed the idea that we humans have been insulated from nature by modern technology. As a result, we have developed lifestyle habits that disregard natural systems and their limitations. That, in turn, has produced environmental damage that threatens the quality of life for many organisms living on the planet, not the least of which includes ourselves.

Becoming *WorldWise* means relearning how natural systems work. Once we have done that, we can make responsible lifestyle decisions that support the balance of natural systems, not interfere with them. Let's review the ideas we have learned.

We must support the balance of natural systems not interfere with them.

The Concept of Ecosystem

*An **ecosystem** includes all the relationships between the living members of the community as well as their relationships to the non-living parts of the environment.*

- A *community* is all the populations of organisms found in a particular ecosystem.
- A *population* is all the organisms of one particular kind found in an ecosystem.
- An *organism* is an individual living thing of a particular kind.

The Concept of Limiting Factors

***Limiting factors** are essential, non-living parts of an ecosystem like water, temperature or nutrients. Depending upon their availability, they determine what kind of ecosystem will exist in a particular place and the number of organisms that can live there.*

- The amount of flexibility an organism has with a particular limiting factor is called its *zone of tolerance*.
- The size of a particular population of organisms that can be supported by a particular ecosystem is called the *carrying capacity* for that population.
- As you travel up in altitude the limiting factors change the same as traveling north or south from the equator toward the poles.
- As a general rule the most important limiting factors for land-based ecosystems are moisture and temperature. In water ecosystems they are nutrients and temperature.

The Concept of Habitat and Niche

*An organism's **habitat** is the place where it lives in a particular ecosystem. Its **niche** is the job that it does in an ecosystem including what it eats, what eats it, how it behaves and ways that it interacts with other parts of its ecosystem. Only one type of organism can fill a niche in any given ecosystem at any given time.*

The Concept of Matter and Energy Flow in Ecosystems

The energy required for living things to survive comes from the sun. As it travels through food chains, much is lost at each feeding level. Finally, there is not enough energy available for another level and the food chain ends. Energy, therefore, must be continually renewed. Matter, on the other hand, cycles over and over again, being reused in living things.

- Green plants capture the energy from the sun. They are the only organisms that can do this. Consequently, they are the foundation for all food chains and are called *producers*.
- All organisms higher up on the food chain cannot capture energy for the sun. They are known as *consumers*.
- Waste products and dead bodies of organisms are broken down into their molecular parts by *decomposers*. They complete the cycle by making nutrients available to the producers which begin the cycle of matter over again.
- Consumers that eat plants directly are called *herbivores*. Consumers on higher feeding levels that eat animals are called *carnivores*.
- The loss of energy at each level of the food chain is about 90 percent.
- In real life ecosystems, many food chains overlap and interconnect into a complex *food web*. The more complex and intricate a food web is, the less energy loss occurs and the more stable and efficient it tends to be.

The Concept of Succession

*The healing process for a damaged ecosystem is called **succession**. Succession occurs in several stages after an ecosystem has been disturbed. In each stage, a new community of living things replaces the one before it. This is caused by each community changing the environmental conditions where they live. This process continues until those conditions are more acceptable for another community than they are for the previous one. Each stage is more complex and stable than the previous one. This process is repeated until the original ecosystem is restored.*

- The first community to come into a disturbed ecosystem and stabilize it is called a *pioneer community.*
- The final stage of succession, which is the restoration of the original complex and stable ecosystem, is called the *climax community.*
- Successional stages are important contributors to the general health of ecosystems.
- Biodiversity contributes to ecosystem stability.

The Big Picture

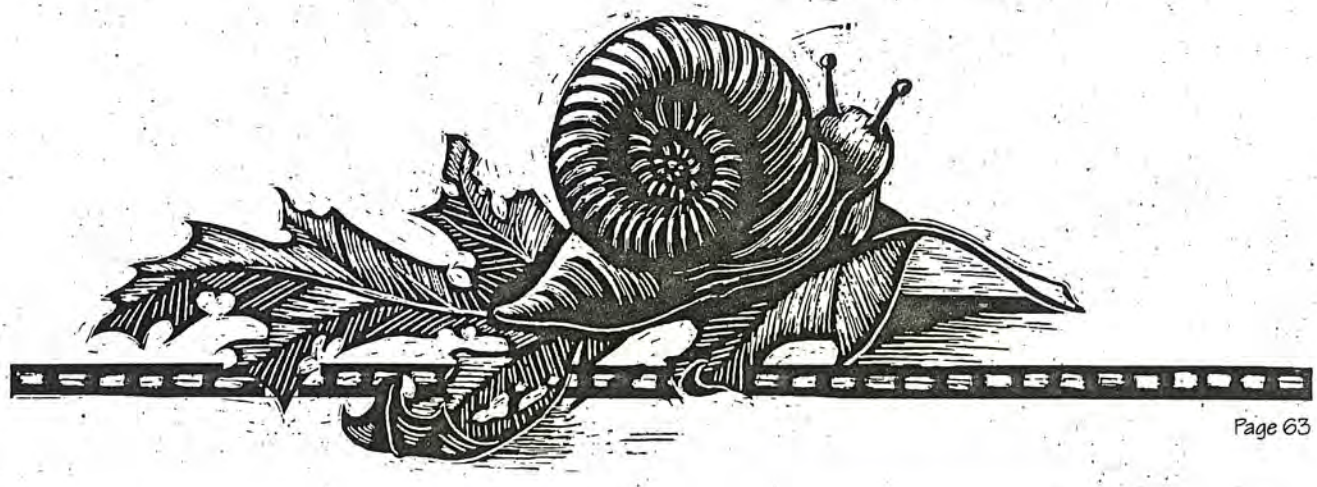
Being *WorldWise* depends on our responsible use of the knowledge we have gained from our national project about the natural world. Everything we do should be affected by our new understanding of nature. We now know that it is a complex, well-balanced system of living and non-living things. We know that the system has natural limits with clearly defined roles and places for living things. We've discovered that it is a complex, sun-driven machine effectively cycling matter but subject to both injury and healing.

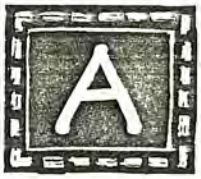
Through the information sections, critical thinking challenges, service-learning activities, action projects and reflection pages, we have had the opportunity to think and act in ways that consider the way the world works. If we are able to keep the "big picture" in mind, the earth will always have a bright future. Congratulations on becoming *WorldWise*!

Online Computerized Resources

Listed below are 17 web sites where you can search for environmental, program-related information. These sites provide a very wide range of information that might prove useful for just about any environmentally related concern you may have.

1.	***E*** the Environmental Magazine	http://www.emagazine.com
2.	EcoMall	http://www.ecomall.com/ecomall/
3.	EcoNet	http://www.econet.apc.org/econet/
4.	EcoWeb	http://ecosys.drdr.virginia.edu/EcoWeb.html
5.	Envirolink Network	http://www.envirolink.org
6.	Environmental News Network	http://www.enn.com:80
7.	Essential Information	http://www.essential.org./monitor/monitor.html
8.	Green Market	http://www.greenmarket.com
9.	Greenpeace International	http://www.greenpeace.org/
10.	League of Conservation Voters	http://www.lcv.org/
11.	National Audubon Society	http://www.audubon.org/audubon/
12.	The Nature Conservancy	http://www.tnc.org
13.	PETA	http://www.envirolink.org/arrs/peta/index.html
14.	Project WILD	http://eelink.umich.edu/wild/
15.	Rainforest Action Network	http://www.ran.org
16.	20-20 Vision	http://www.2020vision.org
17.	WebActive	http://www.webactive.com





dditional Resources

The following are some additional environmental educational resources that will help you tailor the factual information in WorldWise *for your specific delivery system and age group needs. Many are also excellent sources of additional program, project and service-learning ideas that will help youth develop environmental responsibility.*

Environmental Problem Solving, Theory, Practice and Possibilities in Environmental Education. Brawl, Morn and Tudor
Focus on the theory of environmental problem-solving with practical examples. A systematic, positive approach to problem-solving. Grades 6-12. About $16.

Taking Action, An Educator's Guide to Involving Students in Environmental Action Projects. Project WILD and the World Wildlife Fund
An analysis of over 30 successful environmental action projects from around the country with a synthesis and recommendations on what you can do. About $7.

Earth Child, Games, Stories, Activities, Experiments & Ideas About Living Lightly on the Earth. Sheen and Wander
Kid-tested activities. Motivational curriculum ideas presented in a ready-to-use format. Grades K-8. About $20.

ECO-Inquiry, A Guide to Ecological Learning Experiences for Upper Elementary and Middle School Grades. Hogan
Cooperative approach organizes kids into research teams to carry out investigations and present findings to their peers. Grades 4-8. About $30.

Earth Education, A New Beginning. Van Matre
Unorthodox approach that argues for a change in direction and then carefully lays out a clear educational path made up of powerful outdoor learning adventures. About $22.

Naturescope Series. National Wildlife Federation
Outstanding soft cover guides for a wide range of nature topics. Excellent action-oriented, hands-on activities. Grades K-8. About $8 each, but the full set of 18 volumes is often available as a package for about $100.

Nature Puzzlers. Hillman
Shows you how to take any nature topic and turn it into an open-ended, inquiry-based exploration. Grades 5-12. About $20.

Bottle Biology, An Idea Book for Exploring the World Through Soda Bottles and Other Recyclable Materials. Bottle Biology Project Team
Explore science and the environment using free, recycled soda bottles. Twenty projects adaptable to a wide range of ages, preschool to college. About $16.

Kids Can Make a Difference! Environmental Science Activities. Dashefsky
This book is about empowerment — using the experimental method to increase awareness and provide children with hope and a sense of positive direction. Ages 8-14. About $13.

The Amateur Naturalist, Explorations and Investigations. Roth
Open-ended, engaging hands-on activities and many wonderful suggestions for further study. Ages 8-Adult. About $7.

Ecology Discovery Activities Kit, A Complete Teaching Unit for Grades 4-8.
Galle and Warren
Forty-nine high interest, easy-to-do, hands-on activities all broken down by topic. All activities easily adapted to ability level. Basic ecological concepts emphasized throughout. About $28.

Ecological Literacy, Education and the Transition into a Postmodern World. Orr
Challenge to mainstream environmental education programs and educational processes in general. About $17.

Educating for an Ecologically Sustainable Culture. Bowers
Presents new models of community and environmental renewal that encourage creativity and the development of ecological awareness. About $18.

The Nature Specialist, A Complete Guide to Programs and Activities. Miller
Excellent guide for developing a field science program for any delivery system. About $25.

Easy Green: A Handbook of Earth-Smart Activities and Operating Procedures for Youth Programs. Westerman
Written for camp directors, teachers and counselors who would like to "green up" their programs. About $20.

Hands-On Nature, Information and Activities for Exploring the Environment with Children. Linglebach
A multi-disciplinary approach linking science with other subjects. All the guidance you need to develop your own exciting, hands-on activities. About $20.

Keepers of the Animals, Native American Stories and Wildlife Activities for Children. Caduto and Bruchac

Twenty-four stories teach children about Native American culture, wildlife ecology and environmental issues. Interdisciplinary activities in all academic disciplines. About $23. Teacher's guide available. About $10.

Keepers of Life, Discovering Plants through Native American Stories and Earth Activities for Children. Caduto and Bruchac

Nineteen Native American stories and a complete program of study in botany, plant ecology and natural history. About $23. Teacher's guide available. About $10.

Keepers of the Earth, Native American Stories and Environmental Activities for Children. Caduto and Bruchac

Original book of the "Keepers" series. Similar approach to later "Keepers" books but stories and associated activities are different. About $23.

Keepers of the Night, Native American Stories and Nocturnal Activities for Children. Caduto and Bruchac

Eight Native American stories coupled with activities focusing on stargazing, nighttime weather, nocturnal animals, sensory awareness games and campfire activities. About $15.

Outdoor Education

Tips and Tricks in Outdoor Education, Approaches to Providing Children with Educational Experiences in the Outdoors. Swan, ed.

Newly revised 5th ed. contains the collective wisdom of dozens of outdoor educators. About $23.

Teaching in the Outdoors. Hammerman

Wide range of topics. Fourth ed. of this classic resource. About $20.

Education Goes Outdoors. Johns, Liske and Evans

Integrates the traditional educational disciplines into outdoor-adapted experiences. About $20.

Investigating Nature Through Outdoor Projects, 36 Strategies for Turning the Natural Environment into Your Own Laboratory. Brown

The practical experience of renowned naturalist Vinson Brown's lifetime packed into one concise volume. About $15.

Reading the Outdoors at Night. Brown

One of the best resources for studying nature at night. About $13.

Discover Nature at Sundown, Things to Know and Things to Do. Lawlor

Contains many suggestions for explorations and activities. Excellent tips for helping individuals make better use of their senses as the light dims. About $15.

The Cornell Collection:

Sharing Nature with Children. Cornell

Best selling methods book detailing Cornell's teaching philosophy along with practical ideas for environmental educators. About $8.

Sharing the Joy of Nature. Cornell

Expansion of the initial methods book, contains many new exercises and practical suggestions for developing your own customized program. About $10.

Journey to the Heart of Nature. Cornell

Cornell's latest book designed specifically for older children, grades 8-12. About $10.

Urban Environmental Education *(Great for urban-based programs)*

City Kids and City Critters. Houston Arboretum and Nature Center, Roberts

Activities designed to educate children living in densely populated areas about the value of protecting wildlife habitats in urban environments. About $16.

Backyard and Beyond, A Guide for Discovering the Outdoors. Duesing and Millmoss

A superb how-to-do book. Wide variety of topics. About $15.

Discover Nature Close to Home, Things to Know and Things to Do. Lawlor

Encourages children to take another closer look at the familiar world right outside their door and discover new and amazing things. About $15.

Natural History of Vacant Lots. Vessel and Wong

This one-of-a-kind, "how-to-identify-it" book is designed for those who work with children in urbanized environments. About $16.

Wild School Sites, A Guide to Preparing for Habitat Improvement Projects on School Grounds. Project WILD
Designed for classroom teachers but easily adaptable for other environmental programs. Focuses on field studies in any urbanized environment. About $5.

One Small Square: Backyard. Silver and Wynne
Wonderful hands-on introduction to "nature at your doorstep." About $15.

Nature and Storytelling *(Great resources for camp)*

1996 National Storytelling Directory and Guidebook. National Storytelling Assoc.
Excellent resource for educators, naturalists, camp leaders — anyone involved in storytelling as an educational tool. About $12.

Wonder Series. Denver Museum of Natural History
Series of eight books using stories to describe the lives of animals. About $8 each.

Native American Stories. Bruchac
Native American Animal Stories. Bruchac
Native Plant Stories. Bruchac
All three of these books are excellent resources which collect all the Native American stories found in the well-respected "Keepers" books by the same author. (see above) About $13 each.

The Man Who Planted Trees. Giono
Wonderful classic story that has inspired reforestation projects around the world. About $8.

The Lorax. Dr. Suess
Magnificently written parable about the consequences of natural resources abuse. About $14.

Red Oaks & Black Birches, The Science & Lore of Trees. Rupp
Legends and lore of 20 popular trees are presented. About $13.

For Younger Children *(Excellent resources for child care programs)*

Nature Watch, Exploring Nature with Young Children. Katz
Fifty fun, easy-to-do projects accessible to everyone. About $10.

Trails, Tails & Tidepools in Pails, Over 100 Nature Activities for Families with Babies and Young Children. Nursery Nature Walks
Excellent field-tested resource of preschool trail activities. About $11.

Snail Trails and Tadpole Tails, Nature Education for Young Children. Cohen and Tunick
Five well-developed units using mini-habitats. Ages 3-7. About $14.

Environmental Education at the Early Childhood Level. Wilson
Focus on fun, positive, empowering exercises for preschoolers. About $16.

Earthways: Simple Environmental Activities for Young Children. Petrash
Great hands-on activities with supplemental ideas and activities for customizing your own programs. Ages 3-8. About $17.

Ecology for All Ages, Discovering Nature through Activities for Adults and Children. Hunken.
Emphasis on hands-on learning with readily available materials. Lots of innovative games, experiments and activities for a variety of outdoor circumstances. About $17.

Basic Nature Projects, 101 Fun Explorations. Tucker
A nature activity book for exploring the natural world through a variety of indoor and outdoor projects, games and crafts. Creative, open-ended explorations.
Ages 9 up. About $17.

Nature for the Very Young, A Handbook of Indoor and Outdoor Activities. Bowden
Specifically for pre-school children. Topics include color recognition, sequencing, body awareness and reading readiness. About $13.

Nature Smart, A Family Guide to Nature. Tekiela and Shanberg
Outdoor experiences to enhance walks and field trips. Focus on midwestern and eastern ecosystems. Ages 7-Adult. About $18.

Long Live Earth. Morrison
A delightful book written in verse with quilt square pictures about taking care of the earth. Large pages and colorful quilt images make this an excellent choice for preschoolers and kindergarten age. About $5.

Exploring the Forest with Grandforest Tree, A Story of Seasonal Activities for the Curious Child. Denee and Hand
Children are invited to step into the forest — either a real one or one they create indoors. Cooperative, multidisciplinary learning approach is both hands-on and hearts-on. Ages 5-10. About $19.

The Tree in the Ancient Forest. Jones and Canyon

This beautifully illustrated children's book portrays the plants and animals living in old growth forests. Discusses interdependence, biological diversity and forest ecology. Ages 6-11. About $8.

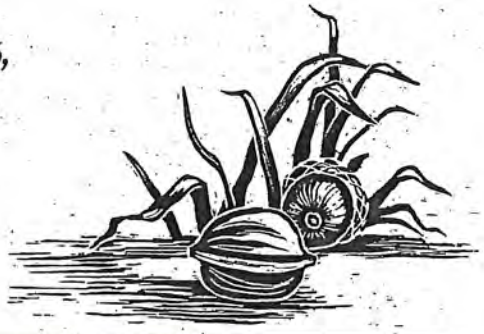
Once There was a Tree. Romanova

Inspirational book traces the events that occur following the cutting of a tree, from the animals that live in and around the stump, through the growth of a seedling that replaces the tree. Ages 7-11. About $5.

Coyotes in the Crosswalk, True Tales of Animal Life in the Wilds of the City. Swanson

Just like the title says. Delightful stories stimulate the imagination in creative ways. Ages 6-11. About $15.

Nearly all of the above selections are available from Acorn Naturalists, 17300 E. 17th St., #J-236, Tustin, CA 92680. Orders and catalogs can be requested at (800) 422-8886.



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