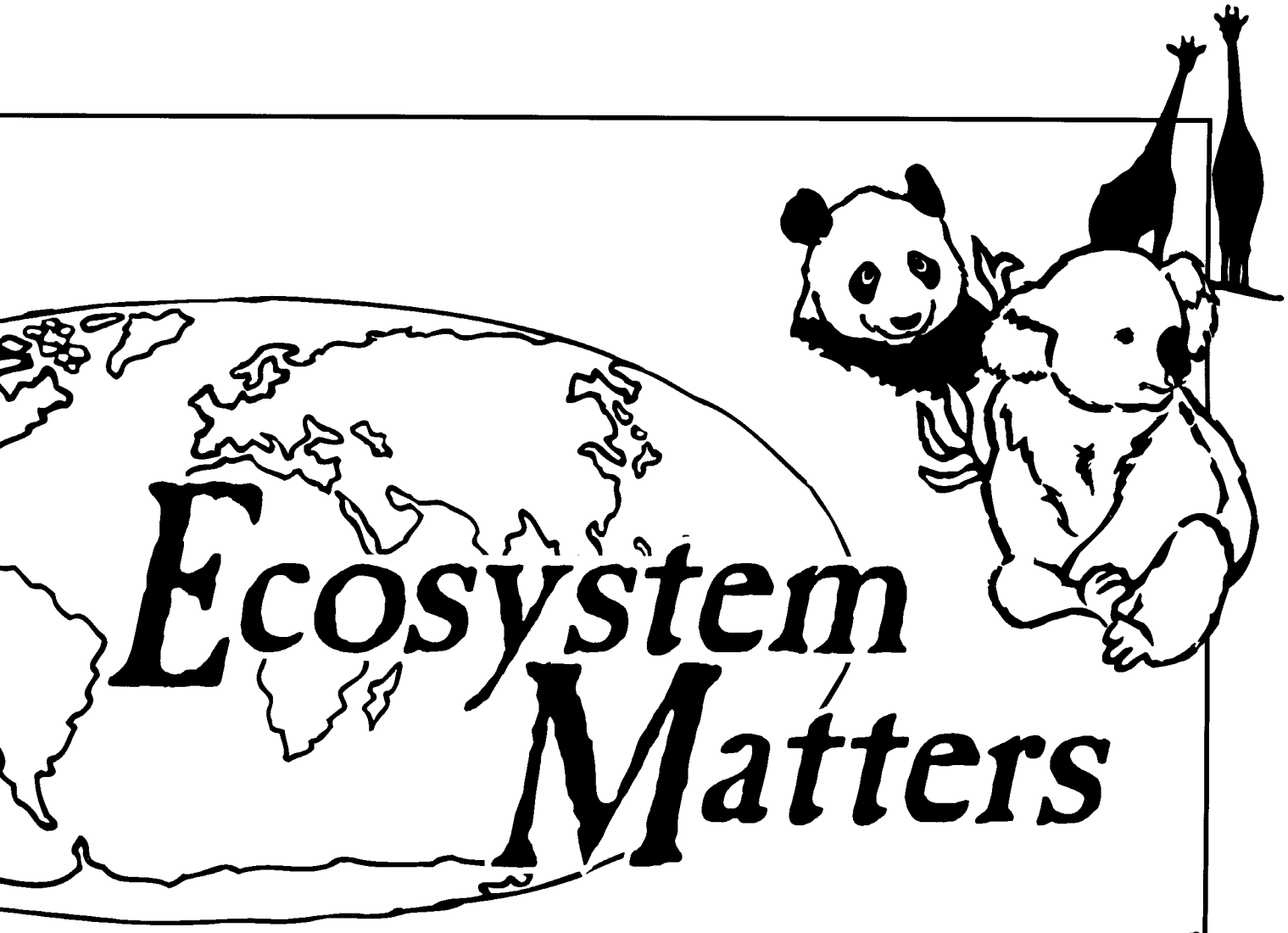
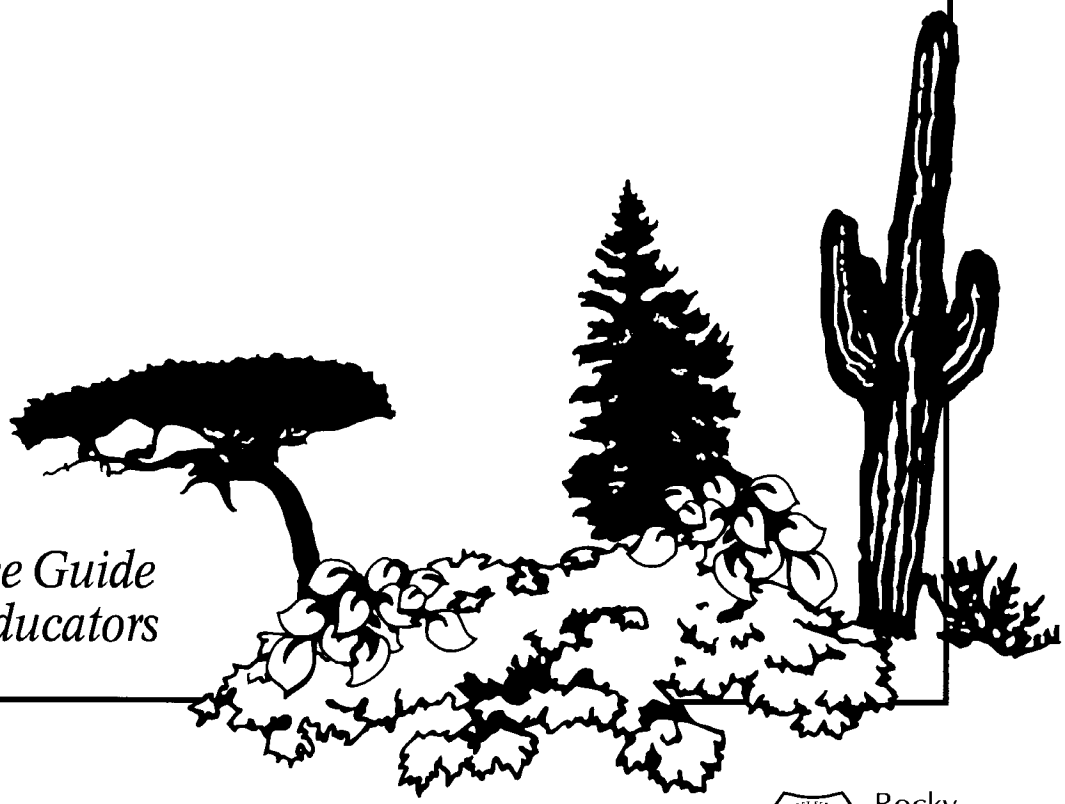


Ecosystem Matters

Activity and Resource Guide for Environmental Educators



United States Department of Agriculture

Forest Service

Rocky Mountain Region

Ecosystem Matters

Educators Resource Guide

DEDICATION:

ECOSYSTEM MATTERS *is dedicated to Elizabeth Estill USDA Rocky Mountain Regional Forester and a former classroom teacher. We share her vision and commitment toward education and the environment.*

The Goal of Ecosystem Matters:

To provide engaging, thought-provoking, relevant, hands-on activities which help your students learn that;

**Ecosystems MATTER. Sustainable ecosystems are important to all life on earth.*

** Ecosystems are made up of energy and MATTER, biological and physical components which interact and are self - sustaining.*

**People are shaped by and in turn shape ecosystems. People MATTER in ecosystem management.*

Printed November 1995

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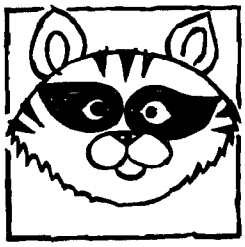

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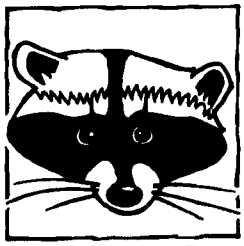

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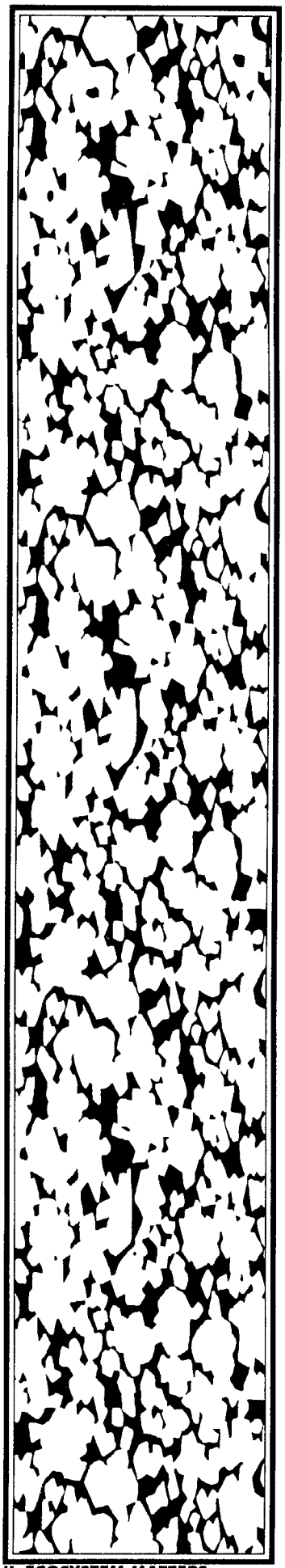

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And finally, I'd like to thank two very special people, Susan Bartell Ford and Ed Nesselroad, whose enthusiasm ,encouragement and support made Ecosystem Matters possible.

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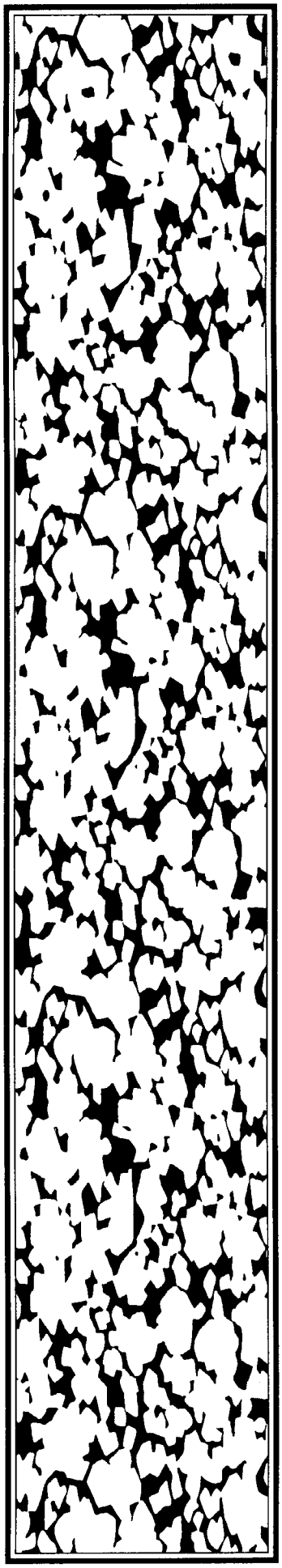


PREFACE

By Dr. Frederick J. Deneke
USDA Forest Service, Assistant Director Cooperative Forestry

Our young people are our future. How they understand and relate to each other and to the earth's natural resources will determine the future of all those who follow in their footsteps.

With all of the focus on the consumption in our daily world, our youth and all of us are presented messages that say having an abundant life comes from getting material things. In reality, having is attained by being present in every moment and by extending ourselves and giving towards a greater good. The highest and most powerful motivation is in doing that which is not for ourselves only, but for the posterity of all.

We are now embarking upon a new way of looking at ourselves and our environment. The new dawn is one of a recognition of our interconnectedness with each other and with all things, living and non-living. It involves people uniting in spirit and working together toward a cause higher than individual material gain.

The term currently in use to describe this new way of looking at our earth and its natural resources is "ecosystem management." An ecosystem approach usually involves four parts:

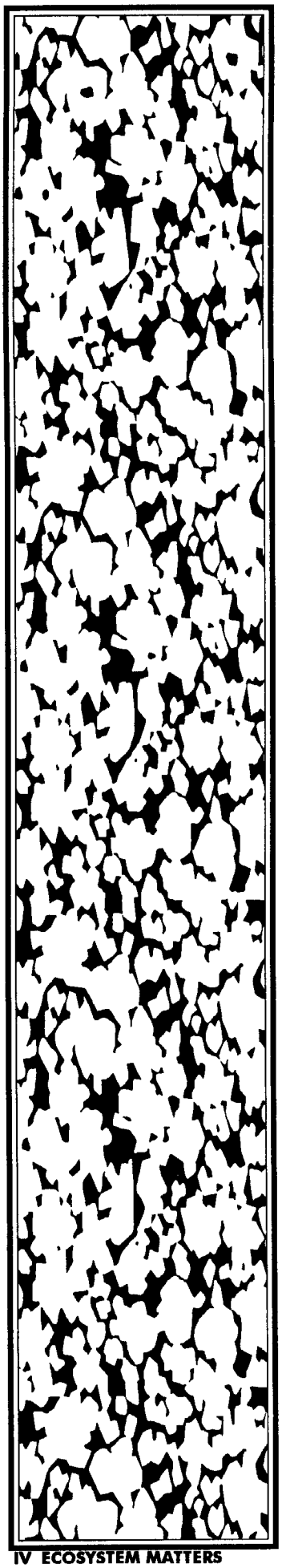
1. *Adopting an holistic view of the natural world;*
2. *Recognizing complexity and interconnections;*
3. *Taking account of the dynamic nature and finite capacities of ecosystems; and*
4. *Encouraging collaboration among all those whose activities affect ecosystems.*

In plain and simple terms, it involves taking an ecological approach to the protection, restoration, care, and use of natural resources. This ecological approach involves making conscious decisions each moment and each day which result in actions that responsibly contribute to the long-term stewardship of our resources. It involves an attitude of abundance rather than scarcity and a focus on contribution (giving) rather than exploitation (taking).

People who live in healthy ecosystems are healthier. People who view themselves as part of that ecosystem, and are actively involved in its protection, care and restoration, develop a sense of empowerment and ownership over their lives. This translate into socially, culturally and economically stronger communities, neighborhoods, cities, and society as a whole.

To have stewardship, we must teach it to learn it. That is what this guide is all about. It is about teaching, learning and co-creating. It is about becoming involved in making informed and heart-felt choices and decisions. And it is about taking personal action to help address the environmental issues of today's world for a better tomorrow.

As educators you know that as you teach you reinforce your own learning. In using this new guide, I encourage you to work with your students and, as a part of their work, have them teach each other about the principles they find in the lessons. Through teaching their learning will deepen along with yours. In the process, all will gain, especially our future generations.



ECOSYSTEM MATTERS INTRODUCTION

On June 4th, 1992, ecosystem management was adopted by the USDA Forest Service as the new framework for using and caring for our National Forests and Grasslands. What is ecosystem management? How is ecosystem management different from past management practices? Why is ecosystem management important and how will it impact your life and the lives of your students? Ecosystem Matters is a kindergarten through 12th grade, user-friendly, hands-on and interdisciplinary curriculum guide designed to help answer these questions. This guide provides the knowledge base and creates the understanding which enables students to participate in the ecosystem management process.

WHAT ARE ECOSYSTEMS?

Ecosystems are interacting systems of groups of species and their non-living physical environment. The word ecosystem is also used to describe the place where these interactions occur. The living organisms make up the biological components of the ecosystem. The variety and complexity of species present and interacting in an ecosystem are known as biological diversity or biodiversity. The physical components of the environment include such things as topography, moisture and temperature.

The physical and biological components of an ecosystem are mutually sustaining and interdependent. The loss of one species or the change in one physical factor could affect the sustainability of the entire ecosystem. When an ecosystem has "integrity," the native biodiversity is intact and the ecological patterns and processes that maintain that diversity are supported.

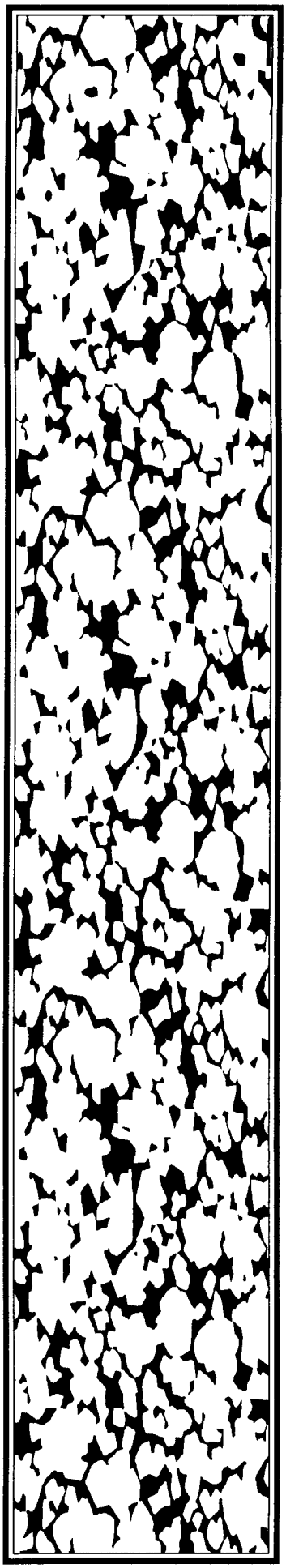
WHAT IS ECOSYSTEM MANAGEMENT?

Ecosystem management is the integrated management of natural landscapes, ecological processes, physical and biological ecosystem components and human activities in a manner which maintains or enhances the integrity of an ecosystem. For the Forest Service this means that ecosystem management blends the needs of people and environmental values in such a way that the National Forest and Grasslands will represent diverse, healthy, productive and sustainable ecosystems. Ecosystem management is a means to achieve sustainable conditions. This will provide wildlife and fish habitat, outdoor recreation, wilderness, water, wood, mineral resources and forage for domestic animals while retaining the esthetic, historic and spiritual qualities of the land. Ecosystem management recognizes that people are an integral part of ecosystems. The cultural identities, family heritage lifestyles, and livelihoods of people are linked with the ecosystems that support them. Ecosystem management requires blending social and economic factors into the equation along with ecological factors. This ensures that those who have an interest in the many natural resources concerns have an opportunity to participate in the decision-making process.

In the past, forest and grassland management often focused on certain species, certain sites or certain components within an ecosystem. Management became more difficult as managers recognized that ecosystems are quite large and usually cross jurisdictional lines. Resource managers want to base their decisions on an ecological approach using the best possible scientific information available at the time. While seeking to find the connections between different parts, patterns and processes in ecosystems, all managers find that managing ecosystem requires cooperation across disciplines and jurisdictions. Ecosystem management encourages forging partnerships among public interest, land managers, land users, biologists, foresters, hydrologists, economists, engineers, sociologists, botanist, geologists and other scientists.

As educators, we have a lasting effect on future generations. We have the opportunity to teach our students to view the world as one interconnected whole of which we are an integral part.

Perhaps the most lasting lesson your students can learn from Ecosystem Matters is that they have the power to make a difference. By taking action, whether it's changing personal behaviors or constructing a nature area on their school grounds, they can feel good about themselves and more hopeful about the future.



ECOSYSTEM MATTERS USERS GUIDE

Instructional activities within ***ECOSYSTEM MATTERS*** *are designed for easy use by both educators and resource managers. Classroom teachers, scout leaders, nature camp instructors, forest rangers, naturalists, and others will all find the activities relevant, fun, quick-to-prepare, and user-friendly.*

ECOSYSTEM MATTERS *activities are designed to be supplemental to existing courses and programs. Each activity is designed to stand alone without other* ***ECOSYSTEM MATTERS*** *activities. There is no need to do all of the activities in order nor do all of the activites, even for a given grade level. For this reason, instructors may choose to use a few activities as part of their study or use all of the activities to serve as the bases for a unit on ecosystem management. Each activity can also be used to teach required concepts and skills while teaching children about ecosystems and how they are managed.*

Where Do I Begin?

Imagine this guide is a new cookbook full of recipes which you have never seen or attempted to prepare. Review the Table of Contents for an overview of what ***ECOSYSTEM MATTERS*** *has to offer. Then scan every page in the book. Look at the pictures. What looks good to you? What would you like to try? Mentally note activites which interest you. Begin to think about some ideas you have for using those activities.*

If you were preparing a recipe, you would want to think about the time of day you might want to eat the dish, how much time it takes to prepare, who might share the meal with you, and what your guests food preferences are. If you only had thirty minutes to make your meal, you would probably not choose to roast a twenty pound turkey. You would probably not fix a lobster dinner for a quest allergic to seafood. Think about the activities that interest you in the same way. When will you do the activity? What age group will you do it with? What are the students' needs, skill level, and preferences? Do the students like games, drama, art, or stories?

This book gives you plenty of coaching to find the right activity to suit your purpose. The SIDE-BAR on the first page of each activity will help you choose an activity which fits your time slot, is suited to the age of the group you are instructing, and covers the particular concepts and skills you want to address. The SIDE-BAR contains the following important information:

**LEVEL indicates the grade levels for which various parts of the activity are recommended. Activities can usually be geared up or down with some modifications.*

**PROCESS provides two or three sentences describing the activity.*

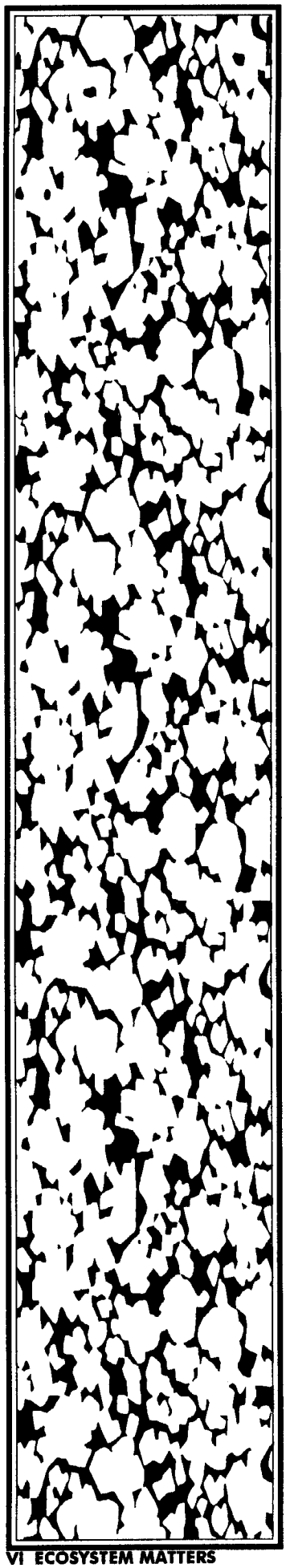
**OBJECTIVES states the concepts that the activity addresses.*

**TIMEFRAME includes the recommended time allotments for each part of the activity.*

**SKILLS lists the thinking processes and skills that the activity develops.*

**MATERIALS lists materials needed to do the activity.*

**VOCABULARY lists key words used in the lesson. The definition for each of these words can be found in the glossary.*



In the space below, write down some of the activities you might like to use and the context they best fit:

Preparing for the Activity

It can be a bit frightening trying out a new recipe or a new activity. In either case, one just has to take the plunge and begin. When cooking a meal, one needs to gather all of the ingredients together, make sure all the utensils and appliances are available, and then follow the directions step by step. The information from the SIDE-BAR lists the materials necessary. Each activity also contains the following parts to get you cooking:

**The TITLE is the attention grabber which relates to the activity's content.*

**The OVERVIEW is selected information to enhance the educator's understanding and perspective of the activity.*

**The PROCEDURE contains step by step instructions for doing any pre-activity preparation and the activity itself. There are sample questions to be used in discussion.*

**EXTENSIONS contain recommendations for exercises that enrich or extend the learning experience in the activity.*

**RESOURCES are references for information used in the activity and additional resources which might be helpful.*

So take a look and take the plunge. Test the waters.

Getting the Most out of the Guide---Mark It Up!

Keep track of how the activities work for you. Just as with cooking, adjust the recipe to fit your personal style and taste. Experiment! Adjust the activities to fit your presentation style and the age group you are presenting to.

Write in this book! That's right--write! Underline! Highlight! Mark! Deface! Scribble in the margins! Keep a record of your successes and challenges. Fill the blank spaces in the guide with ideas the authors didn't include. Write notes to yourself about the impact of each activity on the students. Did the activity challenge the students to think in different ways? Did you think of additional questions or extensions to the activities? Do whatever it takes to make this book a record of your own learning and growth.

Ask for Feedback

Find out how well the activity went. If you are a classroom teacher, ask your students. If you are a resource person, ask the students and their teacher and/or parents. Involve others!. See if anyone else has tried the activities and what their successes were.

Last, But Not Least, Have Fun!

LEVEL: Grades 1-3

SUBJECTS: *Science, Language Arts, Environmental Science, Art, Health, Speech.*

PROCESS: *Through dramatization and role-playing, students will become increasingly aware of the value of fire in a healthy pine forest.*

OBJECTIVES: *The student will:*

1. *Describe the value of fire in a healthy pine forest.*
2. *Identify one biological need of a healthy pine forest.*
3. *Dramatize the succession of a pine forest.*

TIMEFRAME: *1 hour.*

SKILLS: *Analyzing, applying, demonstrating, describing, determining cause and effect, empathizing, evaluating, inferring, listening, predicting, problem solving, role playing, synthesizing, visualizing.*

MATERIALS: *Shoeboxes and soda pop flats, art supplies, construction paper, materials for making dioramas.*

VOCABULARY: *Biological, forest floor, litter, nutrients, pine tree.*

A HAPPY FOREST

OVERVIEW: Many pine forests depend upon fire to keep them healthy. Without fire, litter, or dead branches lying on the forest floor, builds up to a point that the forest becomes a "standing matchbox," ready to burn. It costs relatively little to keep a forest clean and free of this build-up, especially when controlled burns are used. If a large uncontrolled burn occurs, it may threaten houses, cities, and lives, and the cost to bring in fire fighters is very high. These costs include payment not only for people to fight the fire, but their food and housing, as well as the cost of airplanes and chemicals to fight the fire from the sky.

The best plan is to manage for fire before burns begin. To do this, people must understand the value of fire and how it is part of the health of a pine forest. A healthy forest plays many roles in its natural life cycle.

PROCEDURE:

PRE-ACTIVITY:

1. Review what a plant needs to grow. Include sun (light and heat), water (rain and snow), soil, nutrients (in the soil), and space in which to grow.

2. Review the parts of a tree--roots, stem/trunk, leaves, flowers, branches, and seeds. Discuss how a seed is a plant that hasn't grown and a tree is a plant like flowers in a garden. Instead of having a green stem, a tree has a woody stem or trunk. Ask students to stand up, hold their hands up in the air, and then shake the part on their body that could be the roots (they could stomp on the floor), trunk (shake their bodies), leaves (shake their hands), and branches (wave their arms).

3. While standing, ask students to imitate what the following would look like or sound like: sun (arms over their heads in a

half circle), rain, thunder, lightening (give someone a flashlight), fire, wind, and a deer walking. Explain they are playing roles or acting as parts of a forest.

4. Let the classroom become a forest setting. Move chairs and tables to the sides of the room, leaving approximately half of the chairs scattered around the center of the room. These chairs are litter on the forest floor.

Activity:

1. Tell students: "I will be the storyteller for the old pine forest. It has a story to tell about how it can be kept healthy and happy. The forest is very much like all of you--it likes to be healthy and happy. You will all begin as trees in this forest. Sometimes I will call your tree name (tree Julia, tree Sam, and so on) and you will then become something else, which could be the sun, the rain, the thunder, a deer, lightening, or even the wind. You will need to listen to the story so you know what to do next. When I talk about a proud tree with spreading branches what will you proud trees do? (Stand tall and hold out their arms.) Now, I'm going to begin the story of your forest but you all need to find a place to stand in the forest (move to the center of the room around the chairs)."

Storyteller: Once upon a time there was a forest with 25 (or however many students you have) trees. They were proud, tall trees with their branches out (students wave their arms). Around the roots and trunks of these trees were a lot of dead trees and branches that covered up the forest floor (the chairs). There were even dead branches stuck in the living branches of all the trees. There was a lot of crowding in the forest, and too many trees were getting sick because of it. The sun came up each day in the east (tree-child's name/sun) and moved across the forest trying to warm up the forest and reach the forest floor.

Storyteller: Trees, is the sun warming up the tops of your leaves?

Forest answers: [Yes]

Storyteller: But, forest, is the sun warming up the ground that holds the seeds for lots of new trees?

Forest answers: [No]

Storyteller: The sunlight can't get to the soil because of all the litter on the forest floor and all the dead branches in the trees. There is no place for the light to go so the sun goes away. (Sun goes away and returns to the role of a tree.)

Storyteller: One day a hungry deer comes into the forest (tree-child's name/deer) looking for food. Deer like to eat nice green leaves on your plants, but the deer is sad. It keeps looking and looking, but can it find any food?

Forest answers: [No]

Storyteller: There are no new plants growing from seeds on the forest floor. There is no sunlight warming the forest floor helping new seeds grow, and it is too crowded on the forest floor for seeds to find a place to call their own. So, what do you think the deer does?

Forest answers: [It goes away] (The deer goes away and returns to playing a tree.)

Storyteller: There is no food for the deer; the food hasn't been able to grow and leaves that are in the forest are in the tops of your trees, shaking in the wind. (Tree-child's name/wind and the leaves should be shaking.) The green leaves are out of reach of the hungry deer. The forest is sad to see the deer leave so hungry.

Storyteller: The deer goes away and so do almost all of the other animals. They can't live in a forest that doesn't have food for them to eat. They just walk out of the forest and don't come back. The forest is unhappy to be alone and not have animals to watch all day.

One day, though, a nice rain (tree-child's name/rain) falls on the forest. The rain hopes to help and tries to reach the ground to water the new seeds just waiting to grow. Can the rain reach the ground and the seeds with all of this litter on the forest floor?

Forest answers: [No]

Storyteller: So very old and wise trees in

the forest, why can't the rain reach the floor?

Forest answers: [Leaves stopped the rain from entering the forest; there was too much litter on the ground are both acceptable answers.]

Storyteller: A healthy forest is a place where lots of plants are growing. It's not crowded with many large, old dead trees and it is full of healthy, well-fed animals. Are you trees in this fine, old forest healthy?

Forest answers: [No]

Storyteller: Well, one of the old, wise trees says it is time for a storm with lightening to burn away some of the clutter. This surprises and scares the other trees. They don't understand that they need this, and they are afraid of the damage a fire can do. But the old tree says this is natural, so it calls a large eagle to its top branches. It asks the eagle to go and find a friendly storm cloud with lightening and invite it to come visit the forest. The eagle flies away, and flies, and flies until the trees can no longer see it, even as a dot in the sky.

Storyteller: Soon a storm cloud comes over and sees what has happened, and it feels sad. The cloud is wise and friendly and knows it has to help! It calls on its friend the wind, and soon the wind begins to blow (tree-child's name/wind. Students shake leaves like blowing in wind.) Thunder crashes and fills the air with booms and crashes (tree-child's name/thunder), and then lightening flashes (tree-child's name/ lightening with flashlight) and lights up the sky. This goes on and on until finally lightening strikes a dead tree, and it catches on fire (tree-child's name/fire). The fire spreads to the other dead trees and then to the litter. Before long, all the dead trees have burned away. Before the storm cloud leaves, it drops some rain (tree-child's name/rain) to put out the fire and cool off the other trees. The trees in the forest sigh (class sighs) relief that the storm and fire are over and say goodbye to the storm cloud. The storm cloud leaves behind a gentle rain cloud to watch over the forest to be sure the fire doesn't start up again.

Forest answers: [Sighs] (Lightening, thunder, rain, wind, fire become seeds and curl up on the floor. They wave goodbye to the storm cloud.)

Storyteller: Soon the rain finishes falling. Then the sun (tree-child's name/sun) returns after hearing how the cloud has helped the forest. It decides to help the forest, too-- the sun can't be outdone by the storm cloud and the wind. It goes back and forth over the forest, warming up the seeds in the wet ground. After many days what do you think happens?

Forest answers: [New trees began to grow.] (Seeds begin to stretch and sit up.)

Storyteller: After a few weeks the deer and other animals hear from the rain and the sun that the forest is getting better and very green again, so they decide to return (tree-child's name/deer). The forest is enjoying watching the animals and listening to their stories. Is the forest a healthy forest again?

Forest answers: [Yes]

Storyteller: And the forest lived happily ever after. The end.

2. Ask students to evaluate what the forest needed to grow and stay healthy. Discuss what made it possible for the new seeds to grow.

3. Ask students to predict what would have happened if the storm had not come when it did. (A fire starting in a forest with many tall dead trees could get out of control, become too hot, and destroy the entire forest instead of the dry, already dead litter.)

4. Discuss why it is so important that people do not set forests on fire by accident or on purpose. Only in very special cases with lots of planning and safety equipment do foresters do small controlled burns.

5. Have half the class make dioramas on soda pop flats or in shoeboxes showing the unhealthy forest, and the other half of the class make dioramas of the healthy forest after the fire.

ASSESSMENT:

Ask students to:

1. Identify the components of a healthy forest.

2. Describe or draw signs of an unhealthy forest. What one missing part of the forest would tell a stranger walking through it that it was not a healthy forest?

3. Identify the stages of life in the forest. (Just like us, a forest goes through many changes or stages of life. We are babies, first graders, teenagers, grownups, and eventually we die.)

4. Explain why the fire was so important to this forest.

EXTENSIONS:

1. Practice and perform this play for other classes at your school. Have your students ask the audience the assessment questions.

2. Have a forest fire poster contest at your school.

3. Invite your local forester in (almost every large city has one) to explain the value of fire as well as forest fire prevention. If you don't have a forester, call your land-grant university (agriculture university) or extension agent about locating a forester to invite to the class. The forester can also talk about forestry as a career.

4. Visit a local forest and determine how healthy it is. Apply the experiences from the dramatization and observe activities and presence of animals, forest litter, new plant growth, and general health of the forest. Remove some of the litter and look closely at the soil for signs of seeds and growth from seeds.

LEVEL: Grades 3-6

SUBJECTS: *Environmental Education, Language Arts, Science, Social Studies.*

PROCESS: *Through a small-group activity, students evaluate how wild animals and plants can be used to manage some environmental problems.*

OBJECTIVES: *The student will:*
1. Give five examples of how wild animals and plants can be used to manage some environmental problems.
2. Be able to describe and give examples of an organism's niche.

TIMEFRAME: *30 to 45 minutes.*

SKILLS: *Analyzing, deciding, discussing, evaluating, explaining, justifying, reading, sharing.*

MATERIALS: *For each small group: Ecosystem Map, "Critter Cards," "Ecosystem Cards," "Critter Tokens" (attached); have at least three of each different "Critter Token."*

VOCABULARY: *Acorn, construction, ecosystem, erosion, insecticide, irrigation ditch, manager, niche, rodent, stream-bank.*

CAREER CRITTERS

OVERVIEW: This activity introduces the concept that wild animals and plants can "manage" some environmental problems. Sometimes organisms can help solve or mitigate human-induced environmental problems by simply doing their "jobs." An organism's ecological job is called its niche.

PROCEDURE:

PRE-ACTIVITY:

Introduce and define the vocabulary words.

ACTIVITY:

1. Divide students into small groups of four to eight.

2. Give each group a copy of the Ecosystem Map, and a set of "Critter Cards," "Ecosystem Cards," and "Critter Tokens." Have them locate key areas on the map. Ask:

-Where are the 12 ecosystems on the map?

-Where does the stream begin and end? Trace the course of the stream.

-Where is the golf course in relationship to the stream?

-Where are the parking lots in relationship to the stream?

-Where is the town park in relationship to other areas of town. Who do you think visits?

-Where is the prairie ecosystem in relationship to houses?

-Are there areas or neighborhoods on the map that are similar to where we live?

3. Have each group pass out their "Critter Cards." Each student reads the back of the card either silently or aloud to the group and looks at the illustration on the card. Each student must keep his or her card - no trading!

4. Arrange the "Critter Tokens" neatly around the edge of the Ecosystem Map. There should be at least three of each different "Critter Token." They don't need to be in any particular sequence.

5. Shuffle and stack the 12 "Ecosystem Cards" face down beside the Ecosystem Map. One student draws a card and reads it aloud to the group. Each student examines his or her own "Critter Cards" to determine if those animals or plants could help solve the ecosystem problem described. If so, students explain how to the group. If the group agrees, a "Critter Token" of that plant or animal is placed on the map ecosystem. Remember more than one plant or animal **may** be used to solve the problem. There may be several unused "Critter Tokens" at the end of the activity.

6. When all the "Ecosystem Cards" have been drawn and all the ecosystem problems solved, have the groups compare their results with the other groups' results.

7. Discuss and ask:

-Could any of these solutions backfire? In other words could the plants or animals used to help solve certain problems end up being a problem themselves?

-Are there other wild plants or animals (not identified in this activity) that could have been used to help solve the ecosystem problems?

-The gambusia fish is not native to many states. Is it okay to introduce "foreign species" to help with an ecosystem problem? What are the benefits? What are the risks?

-How could the location of the 12 ecosystems on the map be redesigned to reduce some of the environmental problems?

-Are there ways that animals, plants, and humans could work together to solve environmental problems?

-In what ways is this activity realistic? Unrealistic?

ASSESSMENT:

Have students:

1. Summarize five or more of the ecosystem problems described in this activity and explain how a wild animal or plant was helpful in solving those problems.

2. Define "niche." Give examples of the niches held by the animals and plants described in this activity.

3. Think of one ecosystem problem (not used in this activity) and describe how wild plants and animals might be used to help solve the problem.

EXTENSIONS:

1. Students may research more information about the animals or plants on the "Critter Cards."

2. Survey the neighborhood or study the newspapers and news articles for local environmental problems. Could they be solved by using wild animal or plant managers? Have students make their own maps of the community highlighting environmental issues.

PASTE ECOSYSTEM CARDS ON THE BACK OF 3"x5" INDEX CARDS

#1 Prairie Ecosystem

A prairie ecosystem is near a new housing development on the edge of town. The grassy field has prairie dogs in it. With all the new houses, lots of the prairie dog's natural enemies -- coyotes and eagles -- have disappeared. Now the prairie dog population is growing. The prairie dogs are digging burrows and mounds in the lawns of the new homes. They are also eating vegetable gardens and underground telephone wires. Some people are worried the prairie dogs might carry diseases and want to begin poisoning the prairie dogs. As a manager, how could you help solve this problem? What critter(s) or plant(s) could you "employ" to help you? How would they help?

#2 Mountain Ecosystem

Outside of town is a big national park in the mountains. Lots of people come to the park to see wild animals, especially elk. In fact, there are so many elk in the park that they are running out of grass to eat. Now the elk are starting to eat the shrubs, and the bark of trees. Trees are starting to die because so much bark has been eaten. Your job as manager is to reduce the number of elk in the park before they really damage the ecosystem. Remember that hunting is not allowed in a national park. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#3 Golf Course Ecosystem

You are the manager of a golf course. The golf course is your ecosystem. You are very proud of your golf course -- especially the nearby stream, ponds, and water holes on the course. Golfers enjoy trying to get their balls in the holes without hitting them into the water. It's fun! One problem. Mosquitoes lay their eggs in ponds. When the eggs hatch the mosquitoes go after the golfers!

You could spray insecticide around the course to kill the mosquitoes but it's expensive and would probably harm other animals. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#4 Stream Ecosystem

A stream ecosystem runs near a farm. Along the edge of the stream is a nice green area with lots of willows and tall trees. In the spring and summer the farmer takes water out of the stream. The water goes from the stream down an irrigation ditch to water a field of crops. When that happens there is not much water left for the animals in the stream. The stream becomes very shallow. Little fish can live in shallow water, but big fish need deep, cool pools of water. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#5 Farm Ecosystem

You are a farmer. The farm is your ecosystem. Your crops are turning into a field of dreams for insect pests like grasshoppers. They are eating up your crops! You could spray with insecticides to kill the grasshoppers but that would cost a lot of money. Your field is also close to homes. The spray might drift over into the homes and people could become ill. What critter(s) or plant(s) could you "employ" to help out? How would they help?

#6 Pine Forest Ecosystem

In your pine forest ecosystem, all the trees are the same age and the same kind. Thousands of acres of your forest all look the same.

As a manager, your job is to change the forest so that a variety of new plants and animals live there. To do this you must cut/kill some trees. When that happens other grasses, shrubs, and flowers will grow where the trees once were. What critters or plant(s) could you "employ" to help you? How would they help?

#7 Stream Ecosystem

A stream ecosystem runs through town. Most of the time there is only a little water in your stream. But when a thunderstorm hits, lots of rain falls on paved streets and parking lots. The rain can't soak into the asphalt, so it runs downhill into the stream. The stream suddenly fills with fast-moving water. This water is often polluted with the oil and gasoline that has dripped on the asphalt from cars. The stream banks erode so trees and shrubs along the edge of the stream sometimes fall. Soil washes away. When the storm is over, the stream gets low again. It is full of dirt, sand, and pollution. As a manager your job is to stop the erosion of the stream bank and to keep the stream from having big changes in the level of water. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#8 Garden Ecosystem

Your town has a community garden. Townspeople come here to plant vegetables. But this year small insect pests called aphids are eating the vegetables! Lots of people depend on those vegetables for meals. You could spray insecticides to kill the aphids, but some people don't want to use insecticides. They say that insecticides might make people ill. The community garden has another problem: The soil is too hard and packed so roots have a hard time growing. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#9 Town Park Ecosystem

In the town park some of the old oak trees are dying. They need to be replaced by new oak trees. Of course, that costs a lot of money. What critter(s) or plant(s) could you "employ" to help you? How would they help?

#10 Foothills Ecosystem

On the hills at the edge of town many houses were going to be built. The bulldozers scraped the ground and plowed the dirt roads to get ready for the new construction. But the construction project was suddenly called off! The soil is now being blown away by the wind and washed downhill into the stream by rainstorms. As the manager, what critter(s) or plant(s) could you "employ" to help keep the soil on the ground? How would they help?

#11 Downtown Ecosystem

Downtown becomes very hot in the summer. The sun beats down on the sidewalks and black asphalt streets. The sun shines directly into the windows of buildings. Everyone turns on air conditioning, creating more air pollution, which makes being outside even more miserable. What critter(s) or plant(s) could you "employ" to solve this problem? How would they help?

#12 Downtown Ecosystem

There are many pigeons downtown. They like to nest on the ledges of buildings. Some people like the pigeons but others say there are just too many. Their droppings make certain areas really dirty and the birds may carry diseases. What critter(s) or plant(s) could you "employ" to reduce the number of pigeons downtown. How would they

Porcupines

Everyone knows we live in forests and have sharp quills to defend ourselves. But do you know what we eat? We eat the bark of trees. Mmmm, sure tastes good! If we eat too much bark, it will sometimes kill the tree.

Woodpeckers

We like to live in forests where bugs live under the bark of sick or dead trees. We peck out the bugs with our beaks. We also use our beaks to chip deep holes into trees for our nests. Sometimes these holes are used by other birds like bluebirds and nuthatches for their nests. Our holes help to bring new varieties of birds into the forest.

Bark Beetles

Although we are very small, we can kill trees! We bore a hole through the bark of a tree and eat the wood-like layers inside. Sometimes we carry diseases that kill trees.

Beavers

We build dams in streams. Using our big front teeth, we cut down trees and shrubs, chew them into smaller sticks and build small dams. These dams help to slow down the water in streams and make deep pools. Our dams help to stop small floods.

Willows

We are shrubs that like to grow along the edges of streams and beaver ponds. Our roots spread out and grow deep. They help hold the soil and keep it from getting washed away by floods. Some other wetland plants help to clean up pollution, too.

Ladybugs

Yes, we really are cute, aren't we? But not if you are a small tasty bug like an aphid. We chomp those guys down. Yum!

CRITTER CARD CUTOUTS

Bullsnakes

We live in dry fields and around farms. We like to eat little furry creatures like prairie dogs and other rodents! Although we can get to be pretty big (eight feet long and as thick as your leg), we are **not poisonous.**

Badgers

We live in underground burrows in dry fields. We are shy and don't like people. Although we are not much bigger than a small dog, we are tough and mean. We dig underground to eat small furry creatures like prairie dogs and other rodents.

Wolves

We need wild, open places to live. The farther away from people the better, we like it!. We hunt in packs and can kill large animals.

Bats

We are experts at eating pesky flying insects. Using our radar, we swoop around and can eat thousands of flying bugs in one night! Some people are scared of us but we aren't really so bad. Besides, we are active at night when most people are asleep.

Gambusia Fish

We enjoy the nice warm waters of ponds and lakes. One reason is that usually mosquitoes do to! A female adult mosquito lays her eggs in the water. The eggs hatch into a wiggly worm-like stage that stays underwater. Later they hatch and turn into flying mosquitoes. It's those underwater mosquito wigglers we love to eat!

Meadowlarks

We are robin-sized birds that live in fields and on farms. We are known for our beautiful song and the cool black "V" on our chests. Many people don't know we like to eat insects -- lots of them!

CRITTER CARD CUT OUTS:

Squirrels

In the autumn we collect acorns from oak trees and store them to eat later in the winter. Sometimes we hide our acorns in little holes underground. The only problem is that we collect so many acorns sometimes we forget where we bury them! Some of these acorns sprout and grow into tall trees.

Weeds

Weeds are plants that people think are no good. But some weeds are good. We grow fast, even on bare ground. We are usually the first plants to grow where the soil has been disturbed. Our roots grow quickly and help keep soil from blowing away in the wind and washing away in the rain.

Trees

Living trees do many good things for the environment. Our roots help to hold soil down. We provide shade and keep areas cool. Our leaves are colorful and help clear the air of some kinds of pollution.

Falcons

We are hawk-like birds that are built for speed. We like to live and nest near high cliffs, canyon walls, and even sky scrapers. We are not afraid of heights. We swoop around to catch smaller birds to eat. Ecosystems with steep walls and plenty of birds to eat can be good places for us.

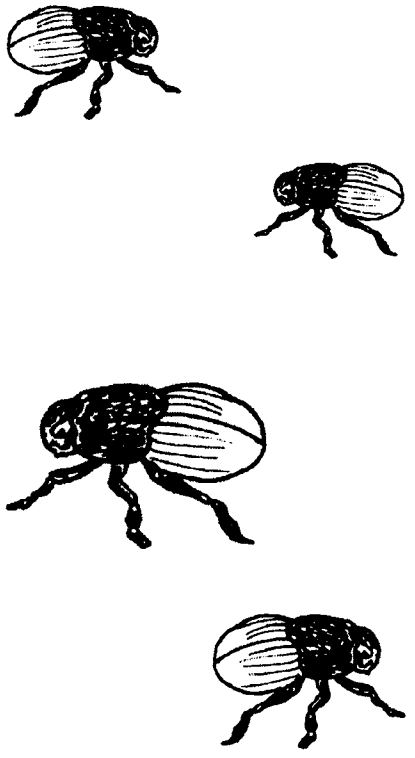
Earthworms

We love dirt and dirt loves us! We crawl around underground loosening the soil as we make our tunnels. Air can now get deep into the ground. Our waste also helps to fertilize the soil.

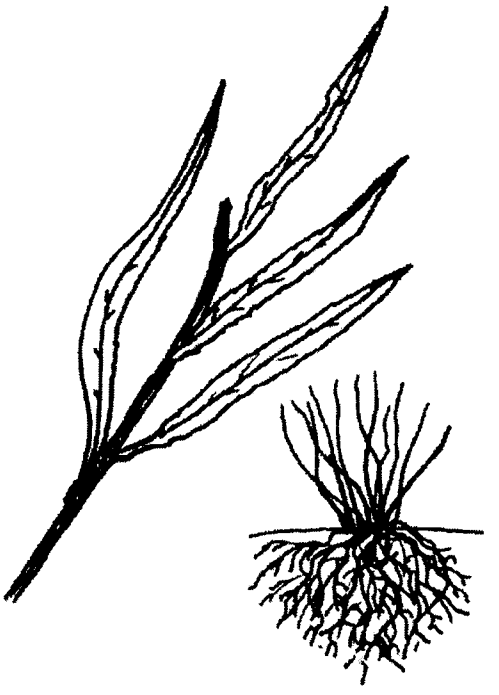
PLACE CRITTER CARD CUTOUTS ON THE BACKS OF CRITTER CARD PICTURES

PORCUPINES

WOODPECKERS

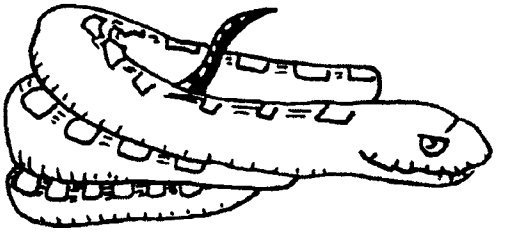


BARK BEETLES



WILLOWS

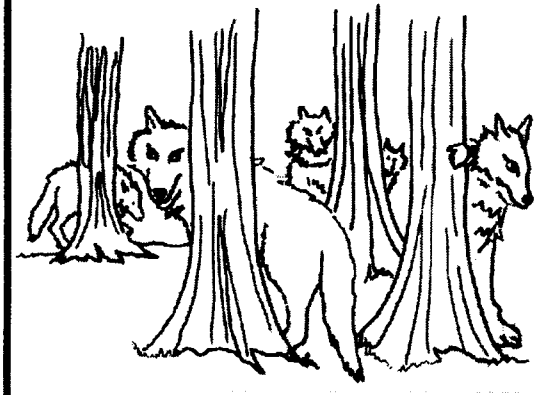
BEAVERS



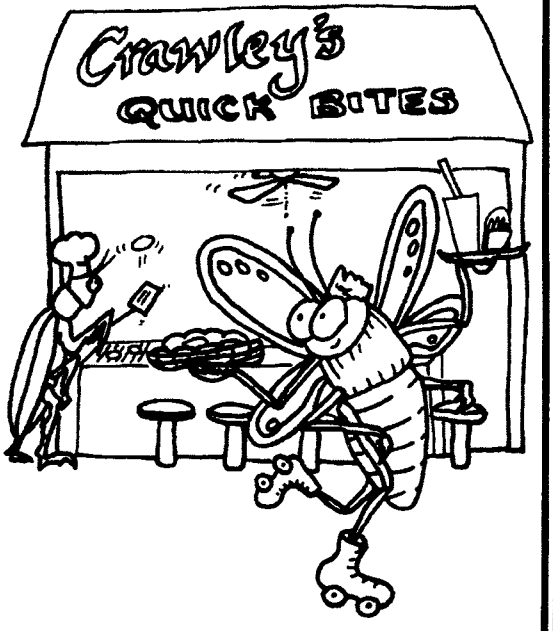
BULLSNAKES

BADGERS

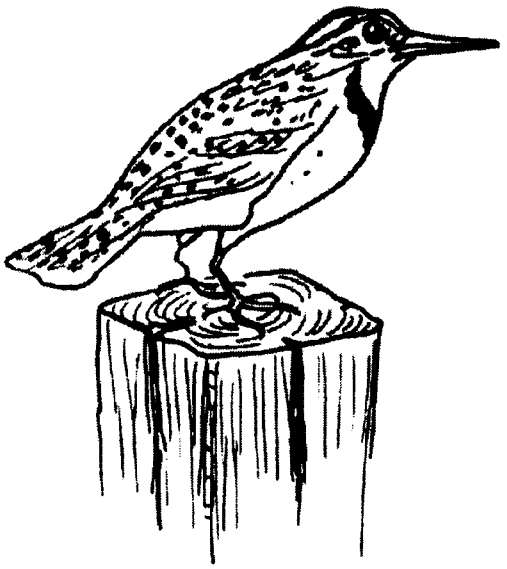
BATS



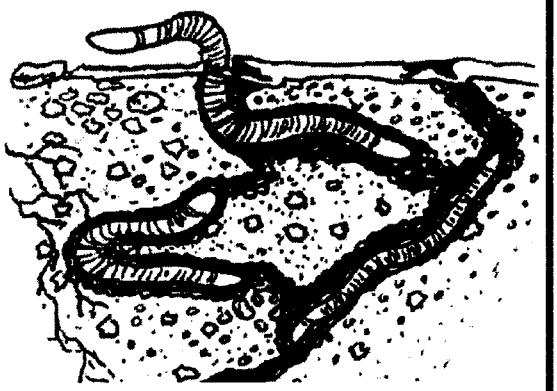
WOLVES



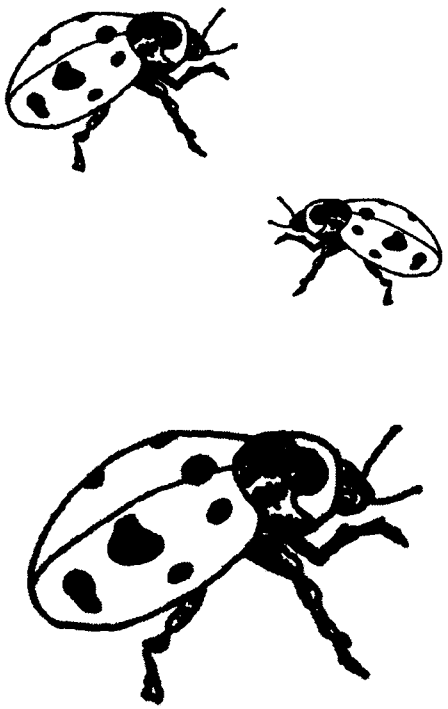
GAMBUSIA FISH



MEADOWLARKS

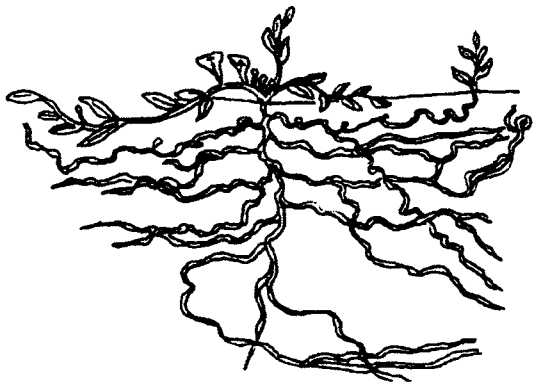


EARTHWORMS

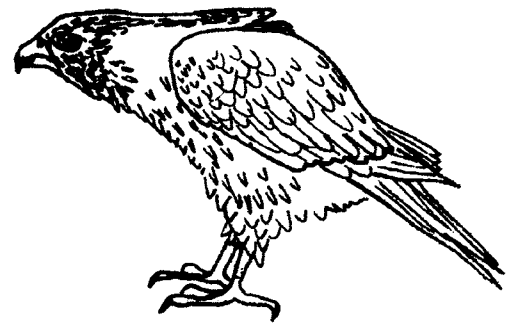


LADYBUGS

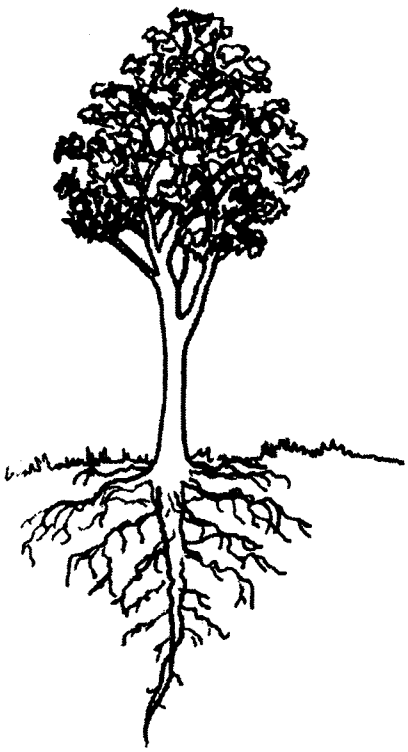
SQUIRRELS



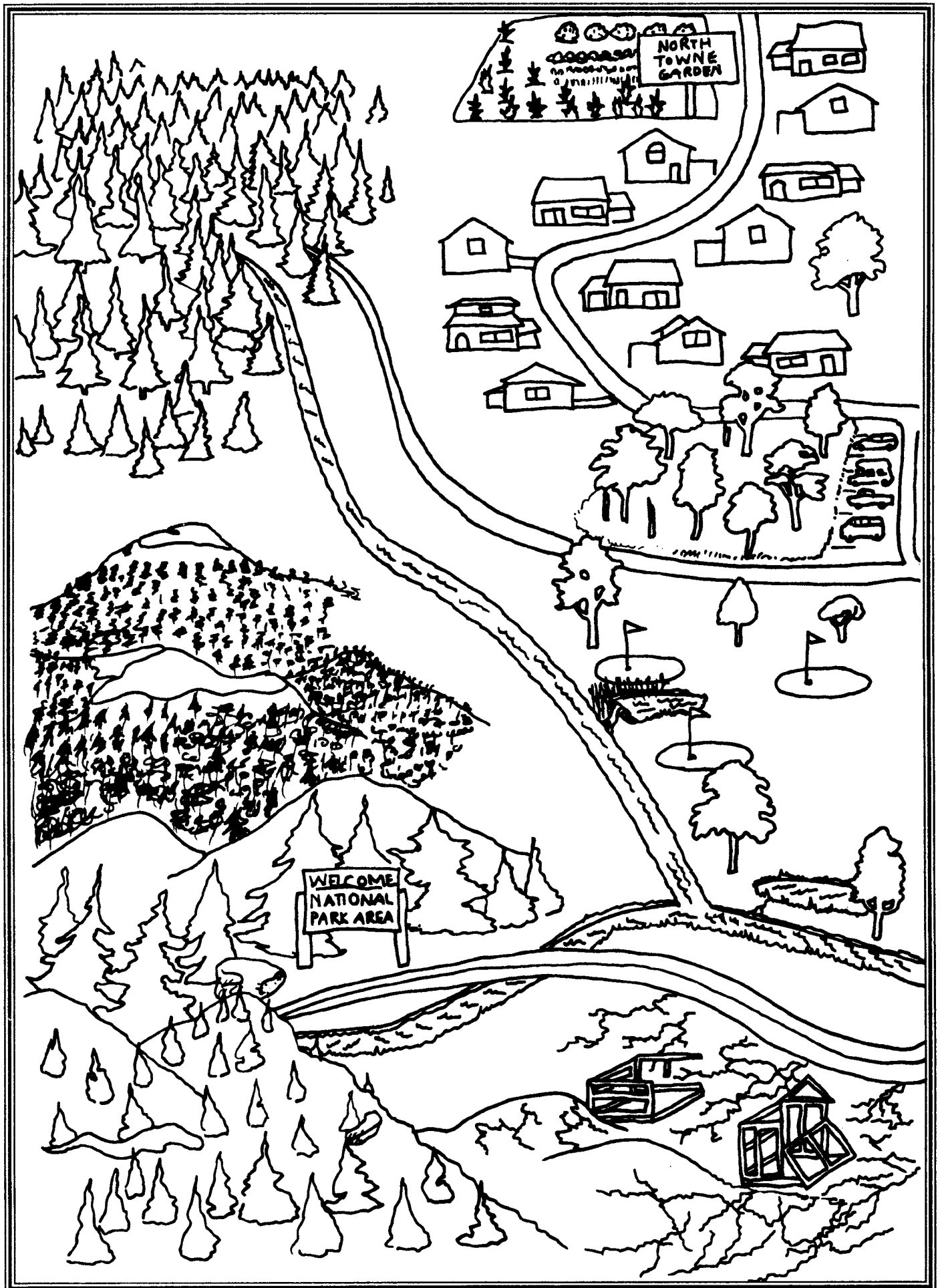
WEEDS

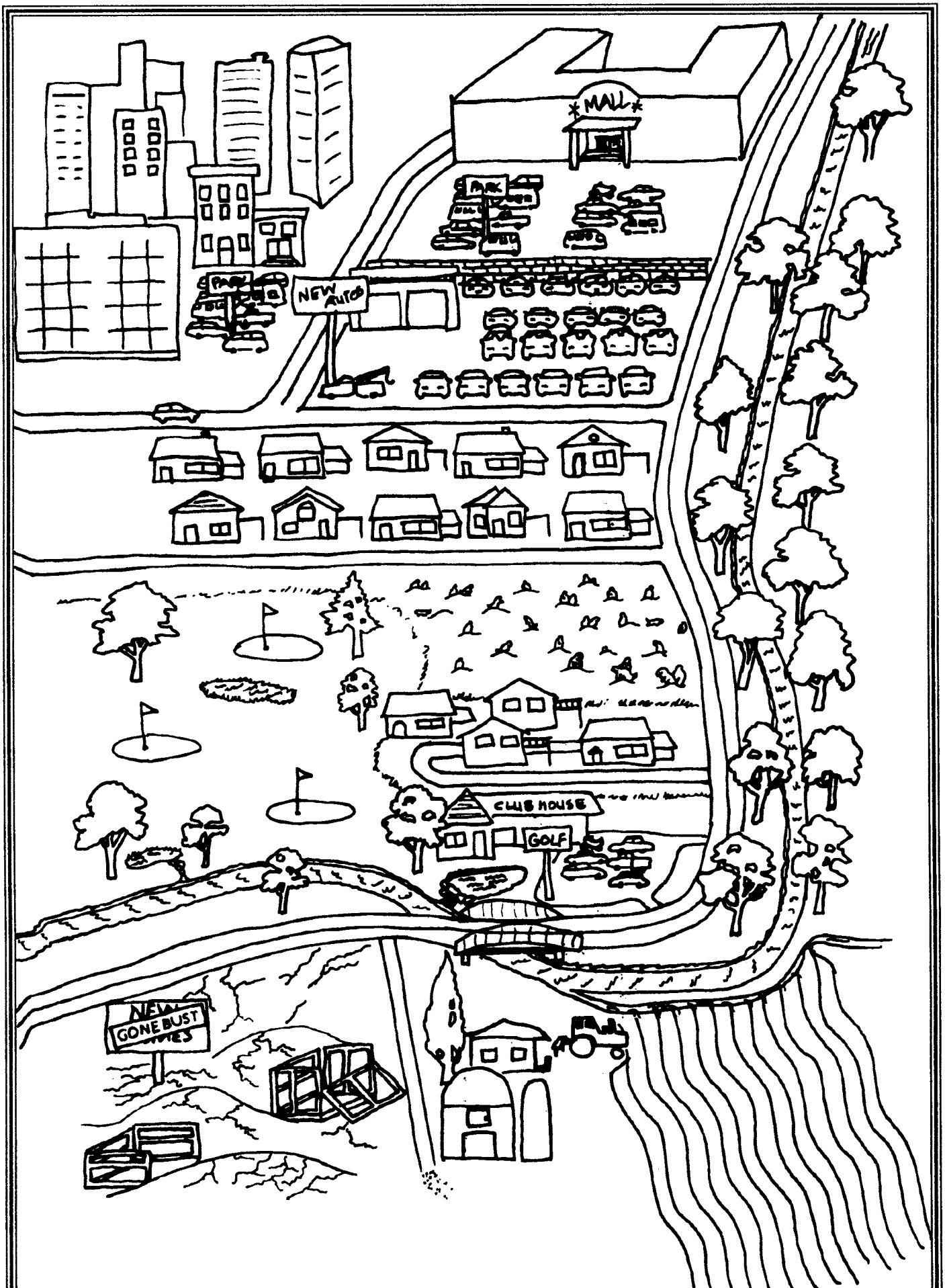


FALCONS

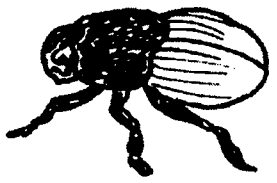


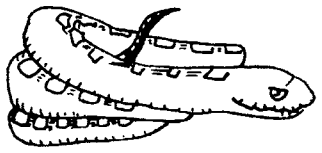
TREES

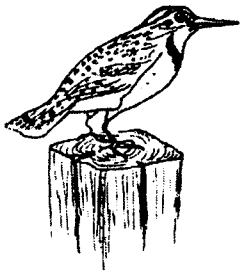

NORTH
TOWNE
GARDEN
WELCOME
NATIONAL
PARK AREA

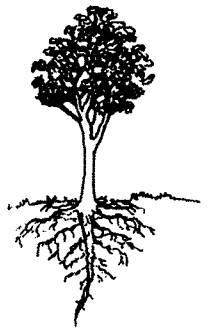

MALL
NEW AUTOS
CLUB HOUSE
GOLF
NEW
GONE BUST

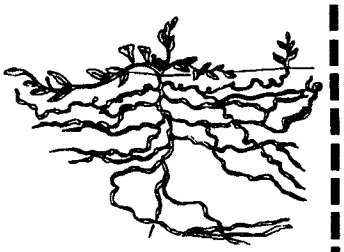
CRITTER TOKENS

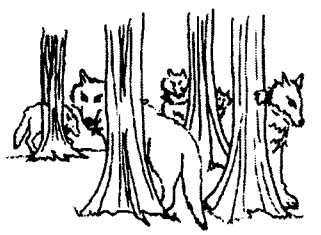


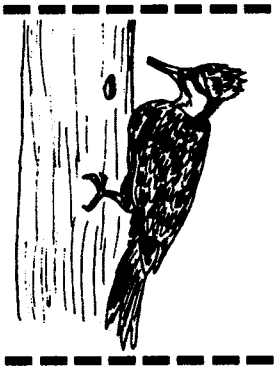


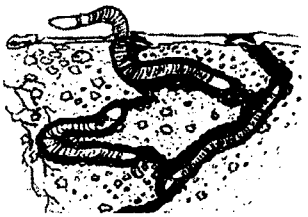












Use open spaces to come up with your own critters.

LEVEL: Grades 4-12

SUBJECTS: Social Studies, Language Arts, Speech.

PROCESS: Through analyzing and discussing dilemmas, students examine their own values and beliefs about archaeological site protection.

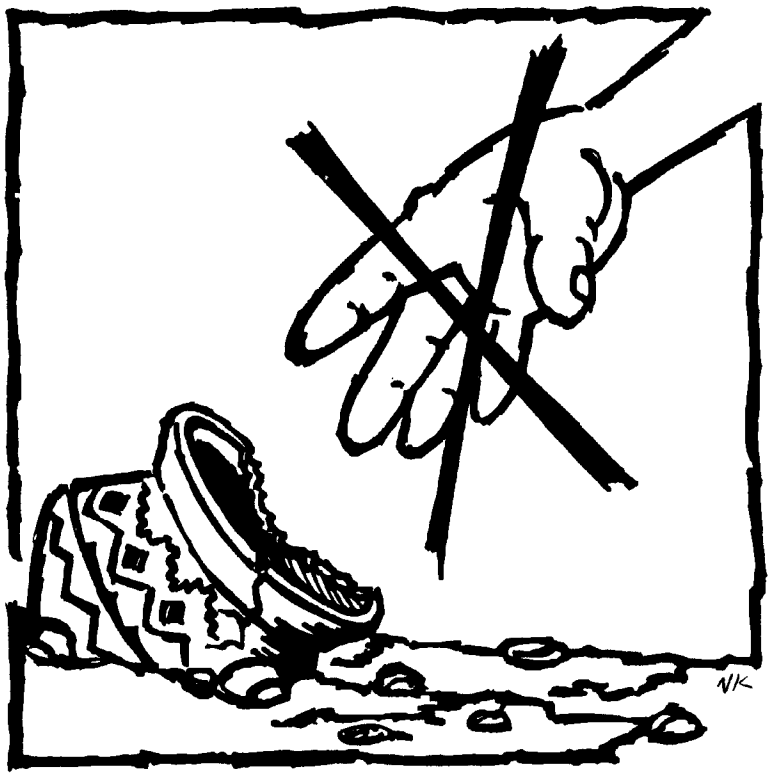
OBJECTIVES: The student will:
1. *State the conduct required by the Archaeological Resources Protection Act of 1979.*
2. *Evaluate possible actions they might take regarding site and artifact protection.*

TIMEFRAME: One to three 45-minute periods.

SKILLS: Analyzing, applying, decision making, debating, discussing, (drawing), evaluating, interpreting, listening, problem solving, public speaking, reading, synthesizing, valuing, working in small groups, writing.

MATERIALS: Pens or pencils, writing paper, "Dilemma Cards" (attached).

VOCABULARY: Archaeological site, archaeological resource, archaeologist, artifact.



DO YOU DIG IT?

OVERVIEW: (See overview for "Long and Winding Road")

Federal and state laws demand severe penalties for those who disturb and destroy sites more than 100 years old. The Archaeological Resources Protection Act (ARPA) was passed in 1979 and prohibits unauthorized digging and collecting of archaeological resources, including pottery, basketry, bottles, coins, arrowheads, tools, structures, pithouses, rock art, graves, and human skeletons. No person may sell or buy any archaeological resource that was illegally acquired. Penalties for those convicted of violating ARPA are:

-First Offense: $100,000 fine and one year in jail. If the cost of repairing the damage exceeds $500, the offender may receive a fine of $250,000 and spend two years in jail.

-Second Offense: $250,000 fine and five years in jail.

-Vehicles and other equipment used in breaking this law may be confiscated.

ARPA offers rewards to people who supply information leading to the arrest and conviction of ARPA violators.

ARPA applies to all public lands, including those administered by the U.S. Forest Service, Bureau of Land Management, the military, Fish and Wildlife Service, and the National Park Service.

Statutes similar to ARPA have been passed in most states and apply to most state lands. State laws often also apply to the digging of archaeological sites on private lands. People should check with state government to determine what laws apply to state and private lands where they live. Archaeologists conducting approved field work are granted permits by federal and state agencies.

People recreating in the out-of-doors frequently discover an archaeological site or artifact. By law, the artifact is to be left in place, and the site left undisturbed. Discoveries of rare or remarkable artifacts and sites should be reported to the land managing agency, or, in the case of private lands, to a local agency archaeologist or state agency.

Some people collecting artifacts and excavating sites are engaged in an illegal market, are armed with weapons, and must be considered dangerous. Students should never approach someone they see collecting artifacts or excavating sites. The best thing to do is to record information about the people: their physical descriptions, their activities, the license numbers of their vehicles. This information should be immediately reported to law enforcement.

PROCEDURE:

PRE-ACTIVITY:

1. Photocopy the "Dilemma Cards" and glue each dilemma on an index card. Other dilemmas could be written that are more specific to problems in your area. (Students could also create "Dilemma Cards," with each student responsible for one dilemma.) You may want to laminate your cards.

2. Ask:

-Have you ever been in a situation when you were not sure of the right way to behave or respond? For example, your best friend has his or her hair cut in a style you think is very unattractive. What do you tell your friend when he or she asks if you like the way it looks? Or, your best friend shows you a video game he or she has stolen from another friend's house. What do you say to your friend? Do you report the incident to someone? If so, whom?

Explain that the following activity will require decision making about difficult situations. As they share solutions to the following dilemmas, students should be prepared to give reasons for their decisions.

ACTIVITY:

1. Read one of the "Dilemma Cards" aloud to the class. Without group discussion, ask the class to write a paragraph or two about how they feel about the dilemma, and what they would do about it. Have them keep their papers for their own values clarification. (Often values change once there is group discussion and other perspectives are introduced).

Another approach to this activity is to have the students turn in their papers (without names) and write several of their dilemma solutions on the blackboard until you have listed many strategies and viewpoints.

2. Have students discuss the pros and cons of each solution and perhaps come to a class consensus. This activity can help students clarify their values while demonstrating that there are many perspectives on any issue. Ask the students to reconsider what they had originally written. Have their values changed after listening to other viewpoints?

3. Now, divide the class into groups of four to five students and give each group one of the "Dilemma Cards." Have the students discuss the dilemma as a group and decide how they would solve the problem. If students create a solution they think is better than the ones listed, allow them to share this solution. Allow about 15 minutes for their discussion. Choose a spokesperson for each group to report to the class the group's decision and their reasons for taking the actions or positions they did. Were they able to all agree on what they would do?

4. Ask the students if they felt they had enough information upon which to base their decisions. Ask them if their opinions changed once they heard different points of view.

TO CONCLUDE:

5. Ask the students to share their overall position concerning the protection of archaeological resources. Or, ask them to create a symbol, story, poem, drawing, or song that summarizes their opinion.

ASSESSMENT: Each student is assigned a dilemma. They each write a short paragraph on the positive and negative effects of all the options listed for that dilemma, indicating what additional information, if any, is needed in order to make a responsible and informed decision.

Finally, students identify which decision is the most appropriate and responsible, explaining their reasoning.

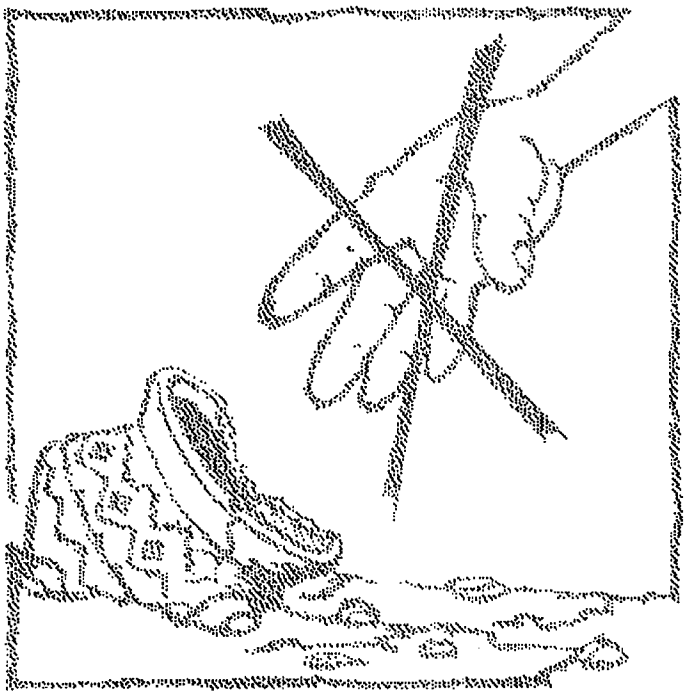
EXTENSIONS:

1. Divide the students into groups as above, but this time give each group the same dilemma. Discuss the ways the different groups addressed the same issue.

2. Use the "Dilemma Cards" for a debate.

3. Ask students to role play one of the "Dilemma Cards" and their solution to the dilemma.

CREDIT: Modified from "Artifact Ethics," *Intrigue of the Past*, Bureau of Land Management.



Dilemma 1

You are on a camping trip in a national park with some of your friends and your family. Your parents stop the car in the parking lot to visit a famous rock art site. You and your friends are walking up to the rock art when you pass a man and a woman carrying a large bag. As you continue walking, you can see the large sandstone wall covered with rock art. You look closer, and see that there are fresh red spray paint signatures covering several of the rock art figures. The paint is still dripping down the wall as you arrive. What do you do?

-Run back to the man and woman and tell them it is against the law to damage rock art.

-Do nothing; mind your own business.

-Get their license plate number, description of the car and the people. Then report them immediately to the national park ranger.

-Use some of the wet paint to write your name too. After all, the settlers and Native Americans wrote their names and symbols on rocks.

-Call the police back home.

-Have your parents make a citizen's arrest of the man and the woman.

-Other:

Dilemma 2

You are on a scouting trip to a national forest to visit an old historic ghost town. Your scout leader takes you into an old building where there are a lot of relics laying around including bits and pieces of pottery. Your teacher has informed you that historic places are protected by the law and that you should take nothing, but your scout leader is picking up several pieces of pottery and some of the other artifacts. Several of the scouts are doing the same thing. When you tell the leader what your teacher said about not taking artifacts, the leader answers by saying, "Taking little things like broken pottery doesn't count." What do you do?

-Act as though you saw nothing; let them take the pottery pieces home.

-Pick up just one piece of pottery as a souvenir.

-Do nothing, knowing that you were obeying the law by not taking anything.

-Find another scout troop.

-Ask your parents to report the scout leader to the Forest Service.

-Ask a professional archaeologist to come and talk to your scout troop.

-Other:

Dilemma 3

You are a judge on a case where a man has been charged with pothunting and selling Anasazi artifacts through an illegal market. He has been unemployed and is using the money to buy food for his family. What do you do?

-Put him in prison for nine months.

-Fine him $5,000.

-Release him with a warning.

-Inform him that there are social services to help him support his family, so that he does not have to destroy the irreplaceable past. Also fine him.

-Sentence him to 100 hours of community service, requiring him to give talks to schools about the importance of protecting archaeological sites.

-Other:

Dilemma 4

You are an archaeologist excavating sites in an area that is going to be the site of a hazardous waste incinerator. Your excavation team has just started uncovering what appears to be a large American Indian burial site. You know that local Indian tribes would be upset to learn that the graves of their ancestors are being disturbed. They may want to halt or attempt to delay construction of the incinerator. What do you and your team do?

-Decide to break the law and continue to dig the site. Then wait until the site is excavated to tell the Indian tribes about the burials.

-Stop excavating immediately and report the site to the local tribe.

-Continue excavating but ignore the burials and don't record them.

-Stop the excavation and recommend that the site somehow be preserved.

-Resign so you won't have to get involved.

-Other:

Dilemma 5

You are an amateur archaeologist aware that the reservoir from construction of a large dam will eventually cover an entire canyon containing many Fremont Indian sites. One of your friends asks you if you want to go to the canyon and retrieve just a few artifacts because, after all, if you don't, the artifacts will just be buried under water. What do you do?

-Go and get just one or two artifacts in the canyon. Maybe the law does not apply to areas that are going to be destroyed anyway.

-Don't go with your friend, and if your friend goes, anonymously report him or her to the law.

-Refuse to go and tell your friend that it is against the law.

-Let him or her go and get a few things for you.

-Organize a local group of amateur archaeologists to work with professional archaeologists so that more information can be recovered before the reservoir is flooded.

-Other:

Dilemma 6

You are a county sheriff and live in a small town. You suspect several people are pothunting on federal land and are illegally selling artifacts. These people claim that they found the artifacts on their own property, and that it is legal to sell them. What do you do?

-Try to follow these people and catch them in the act.

-Call in federal agents from another town to investigate these people because many of them are your neighbors.

-Don't do anything unless you catch them in the act because it is your hunch against their word.

-Try and get them involved in amateur archaeology organizations and classes so they will understand the importance of preserving sites on private and public lands.

-Other:

Dilemma 7

You are hiking in a remote section of a BLM wilderness area and discover a large Anasazi pot that is wedged in between two rocks. What do you do?

-Try to remove the pot and take it back to the BLM office.

-Leave the pot where you found it, photograph it, carefully record on a map where you found it, and turn your information over to BLM.

-Leave the pot there, and don't tell anyone about it or its location.

-Remove the pot, hide it in your car, and take it home.

-Other:

Dilemma 8

You are visiting a state park that is a historic ranch site with several rock buildings partially intact. There is a large sign by the ruins saying: "These walls are very fragile! Do not take anything, and do not walk on or go into the ruins." You are eating your lunch when a family arrives and ignores the sign. Kids are walking on top of the ruins and are picking up glass fragments and old nails and putting them in their pockets. What do you do?

-Ask the family politely if they have read the sign.

-Ignore them; it is really none of your business.

-Tell them they are breaking the law.

-Say nothing and try to hike out first to find a ranger and report them.

-Other:

LEVEL: Grades K-12

SUBJECTS: *Science, Social Studies, Environmental Education.*

PROCESS: *Through using sponge pieces and water in a demonstration, students discover that human populations are resource consumers.*

OBJECTIVES: *The student will:*

1. *Describe at least one personal demand he or she places on a natural resource.*
2. *Explain what happened in the visual demonstration of sponges and water, and how it represents human resource consumption.*
3. *Demonstrate the effects of growing populations on available natural resources using real life examples.*
4. *Give at least one example of conserving a natural resource and justify why it is important to do so.*

(Note: all four objectives are appropriate for upper grades; primary grades may only accomplish objectives one and two.)

TIMEFRAME: *40 minutes to 1 hour.*

SKILLS: *Discussing, drawing, identifying, inferring, observing, problem solving, taking responsibility, understanding cause and effect, valuing, (drama).*

MATERIALS: *A big, clear container with a wide mouth opening, four sponges cut into eight pieces each, water, bowl, marker or masking tape, paper towels, drawing paper and materials.*

VOCABULARY: *Conserve, consumption, demands, environment, increase, natural resources, population.*

DON'T USE IT ALL UP

OVERVIEW: This lesson is not meant to foster anxiety or a doomsday foreboding in students. Rather, it is an introduction to how growing populations can affect the environment and the positive steps individuals and communities can take to lessen the strain on natural resources.

With the Earth's population likely to exceed six billion persons and projections to double to 11 billion by the year 2050, the strain being placed on natural resources is greater than ever before. The sun, water, air, and soil are the most vital natural resources, since all other resources depend on these four for their existence.

The more people in a given area, the more quickly natural resources can be used up. The solution, aside from population control, is conservation and careful use of available natural resources. Conservation practices include reducing the amount of natural resources consumed. Recycling, reusing, and rethinking (substituting plentiful materials for more scarce ones, and finding alternate energy sources that are renewable) are all ways to reduce the consumption of natural resources. Additionally, consumers can refuse to buy products that are not recyclable or biodegradable, or that are considered over-packaged.

This lesson is very effective as an introductory or culminating activity for the study of any natural resource, including water, air, trees, wildlife, and soil. In order to provide examples for this lesson, it is helpful to have researched the specific natural resource, how it can or is being depleted, and how it can be conserved and/or replenished.

Using water as an example, people need and use water daily in many ways, and often in unrealized amounts. Water is used directly for drinking (*1/2 gallon/*

day), cooking (*5-10 gallons/day*), bathing (*20-35 gallons/day*), toilet flushing (21-40 gallons/day), etc. We also use water in many indirect ways such as in the production of manufactured items and food, preparation of food, cooling and heating, etc.

There is an abundance of water on this earth. Unfortunately, nearly all of that water, more than 97 percent, is salt water and is neither easily nor economically available for our consumption. Of the fresh water supply (*about three percent of the total amount of water on the Earth*) most is held as inconsumable in glaciers and icecaps. Less than one percent of the water on the Earth is fresh water and is in the form of ground water, lakes, and streams. A dilemma is created when a limited resource, such as fresh water, has many demands for its use.

PROCEDURE:

Pre-activity:

1. Put about four cups of water in the container. Ask the students to pretend that the container represents the earth and the water represents all the available water.

2. Discuss with students the ways we use water (*drinking, irrigation, recreation, cleaning, processing, cooking, bathing, transportation, etc.*). These can be written on the chalkboard for student reference.

Activity:

1. With a marker or masking tape, mark the water level on the outside of the container. Drop a piece of sponge into the container as you share one personal demand you made on water today. Remove the wet sponge from the container and have students examine the water level. It probably shows very little change.

2. Ask students, one at a time, to name a personal demand they made on water today while dropping a piece of sponge in the container. The students may begin to notice a change in the water level. After all the sponges have been dropped in the container, soaking up as much water as possible, remove all of them (don't squeeze them out) and set them aside in a bowl. Draw attention to the dramatic change in the water level. Help students understand that the demands of a lot of people have more effect than the demands of a few people on natural resources. Ask:

-What happens to the water level as we put in more sponges?

-What will happen if we keep using water at this rate?

-What can we do about this situation?

-How can we give water back to the environment?

3. Once the students have mentioned reducing, reusing, or recycling take one wet sponge, naming a way you can reduce or recycle, and squeeze the water out of the sponge back into the container. There is a change in the water level, but not much. One person reducing or recycling does make a difference. The impact, however, will be greater when many individuals reduce, reuse, and recycle. Ask:

-In what ways can you reduce, reuse, recycle, or be more careful about the demands you make on water (or on other natural resources)?

When students have an idea about how they can give back to the environment, have them squeeze the water out of a wet sponge back into the container sharing their idea with the class. The water level will go up. It won't go back to the original mark, however. Ask:

-Why doesn't the water level return to the original mark even after all the sponges are squeezed out? (*Even by recycling resources, some of them will be used up.*)

-Why is it important to you to reduce, reuse, recycle, and/or make careful demands on water (or other natural resources)?

-Can the water in this activity represent other resources people use? What are some resources which cannot be recycled? Name some. How can they be conserved?

-What one thing have you learned from this demonstration? (*Answers will vary, but should reflect an appreciation for the finiteness of many natural resources, the renewability of some, and the desirability of using natural resources wisely.*)

EVALUATION:

1. Have students draw a four-picture sequence strip of the steps in the water/sponge activity. When evaluating their work, look for an understanding of what is happening with the water level in the container.

2. Have students draw two pictures. In the first picture, showing themselves making a demand on a natural resource. In the second picture, showing how the demand(s) can be made more carefully (*reducing, recycling, reusing, etc.*).

3. Have students write a statement or paragraph about one or more ways they personally can reduce, recycle, and/or reuse, any natural resources.

EXTENSIONS:

1. Use different colored sponges, with each color representing a different natural resource (blue = water, green = plants, yellow = minerals, etc.). Have students identify ways they use water, plants, minerals, etc. each time they drop a piece of colored sponge.

2. Have students draw "Waste/No Waste" pictures showing people "wasting" and "not-wasting." Have students fold pieces of white paper in half and on one side draw a picture showing how they might use a resource. On the other half, students can draw a picture of how they can save that resource.

3. Start a class recycling project. Recycle paper from the classroom, items from the cafeteria, home, etc. Challenge another class to match or beat your efforts.

4. Have students role play a demand they make on a natural resource. Let the student who correctly guesses what is being acted out drop the next sponge in the water and act out another demand on natural resources.

6. Older students can take a different slant on the activity by examining how resources are unequally distributed and consumed around the world. Students use selected thematic maps from an atlas, such as petroleum production and consumption, making observations and analyzing relationships regarding the differences among the patterns shown on the maps.

RESOURCES:

Global Science, John Christenson, Kendall/Hunt.

Project Learning Tree, 1250 Connecticut Avenue N.W., Suite 320, Washington, DC 20036, (202) 463-2472.

Project WILD, 5430 Grosvenor Lane, Bethesda, MD 20814, (301) 493-5447.

Making Connections: Linking Population and the Environment, grades 4-6, Population Reference Bureau, 1875 Connecticut Ave., N.W., Suite 520, Washington, D.C. 20009-5728, (202) 483-1100 or 1-800-877-9881, $15.00 plus postage.

Mineral Information Institute, 475 17th Street, Suite 510, Denver, CO 80202, (303) 297-3226, posters "If It Can't Be Grown, It Has To Be Mined" and "From The Earth...A Better Life," single copies free.

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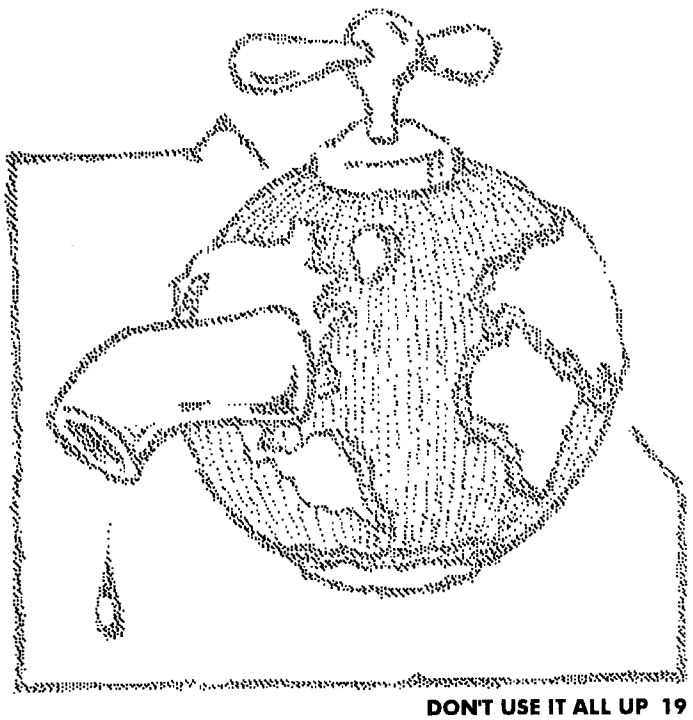

LEVEL: Grades 4-8

SUBJECTS: *Environmental Education, Science, Geography, Physical Education, Math.*

PROCESS: *Through an active simulation game, students learn about the limiting factors that cause the desert bighorn sheep to be considered an indicator species.*

OBJECTIVES: *The student will:*

1. *Identify the four "needs" of desert bighorn sheep.*
2. *Define what an indicator species is.*
3. *Explain why it is important to be aware of an indicator species.*
4. *Describe four impacts of domestic livestock on desert bighorn sheep.*

TIMEFRAME: *Two 45-minute periods.*

SKILLS: *Comparing similarities and differences, counting, developing psychomotor skills, developing vocabulary, differences, discussing, kinesthetic learning, listening, role playing, synthesizing, understanding cause and effect.*

MATERIALS: *Colored copy paper, rope, hoola hoops, "Life Cards," "Food Cards," "Space Cards," "Escape Terrain Cards," "Water Cards" (attached).*

VOCABULARY: *Bedding grounds, benches, bottlenecks, browse, brush, compete, domestic animals, ecosystem, escape terrain, ewe, forage, forbs, graze, habitat, immunity, inbreeding, indicator species, lamb, limiting factor, mortality, parasites, periphery, precipitation, predation, ram, ridge, space, spur, tank, typography, umbrella species, washes, weaned.*

ENVIRONMENTAL CHECK UP

OVERVIEW: Have you ever seen a majestic bighorn sheep? They live in the Rocky Mountains, right? Well, not all species of bighorn sheep do. One species of bighorn is called the desert bighorn sheep. They live in the Canyonlands of Utah and the deserts of Arizona and New Mexico, and some parts of California. This activity focuses specifically on the desert bighorn of Utah.

The landscape of the canyonlands consists of sheer cliffs, broad benches, and deep, dissected canyons. The climate is normally hot and dry. There is little precipitation (between 20 and 25 cm/year). The vegetation varies from steep slopes with little vegetation, to sparse shrubland, to semi-desert grassland, to juniper-pinon woodland, and thickets along the rivers.

Desert bighorns are very sensitive to changes in the environment; therefore, they are often referred to as an "indicator species" or an "umbrella species." A healthy, thriving herd of bighorns is indicative of a healthy, thriving ecosystem. An unhealthy herd of bighorns tells us that the ecosystem is overused or impacted to the point of not being able to support the wildlife that reside there. Recent on-going studies by biologists (see Resources) indicate that for a herd of bighorns to survive long term, there must be a minimum of 100 animals in the herd.

Bighorns are generally a medium gray-brown with white on the rump, backs of legs, and muzzle. This coloring allows them to blend in with the rocky landscape that surrounds their habitat. Desert bighorn depend primarily on their sense of sight to detect danger. They have good hearing. Their sense of smell is used to distinguish between foods, detect enemies, and identify their young.

Desert bighorns need food, water, escape terrain, and space.

they must pay the teacher a "Life Card" for each death card they are holding (ask a few students to help collect these to speed the process if you like). Students collect "Life Cards" if they are holding birth cards.

7. Count the total number of "Life Cards" that students are still holding. Remember the goal is to keep herds over one hundred.

8. Repeat the procedure three more times without restoring "Life Cards" to those who lost them. Move in the outer boundaries by two to three feet each round to represent a narrowing habitat.

9. Now, replay the game, this time cutting the number of "Life Cards" to three for each student. Play four rounds again and record the results. Compare the results of the two sizes of herds after playing four rounds with different beginning amounts of "Life Cards." Ask students if there were any apparent advantages to having a larger herd. Why do they see them as advantages or disadvantages?

10. Ask students to describe some of the cards they drew from the food, water, space, and escape terrain areas. Review vocabulary words that aren't familiar. How did it feel when they drew some of the death situations?

11. Ask students to explain why they think bighorn sheep are an indicator species. Have them give examples of bighorns sensitivity to their environment.

12. What were some of the controlling conditions (also called limiting factors) that determine whether a sheep lived or died? What are some ways humans can help improve bighorn ecosystems?

13. Have students name wild animals that would also benefit from an improved desert bighorn ecosystem.

ASSESSMENT:

1. Have students draw or describe an ideal desert bighorn sheep habitat. Be sure they explain why they included the things they did. How did they provide for the needs of the desert bighorn sheep? What are four ways that domestic livestock could alter the ideal desert bighorn sheep habitat students have drawn?

2. Have students give the definition of "indicator species" and describe what qualities the desert bighorn sheep have that make them a good indicator species.

EXTENSIONS:

1. Have students make a clay or salt dough model of the ideal bighorn habitat.

2. Invite a local wildlife officer to talk to the class about other indicator species, perhaps one from your area. Is there something that can be done to help an indicator species in your area?

3. Challenge students to report on different indicator species. Ask your local wildlife officer for ideas.

4. Have students find the Utah Canyonlands on a map. Research what the area is like and what other animals live there. Find out what human involvement is in this area i.e. recreation, ranching, industry, etc.

RESOURCES:

An Analysis of Composition, Distribution, and Habitat Use of Reintroduced Desert Bighorn Sheep in Arches National Park, Utah, Shirlene C. Haas and Gar W. Workman, 1990.

The Desert Bighorn: Its Life History, Ecology, and Management, Gale Monson and Lowell Sumner, editor, The University of Arizona Press, Tucson, Arizona, 1980.

Bighorn Sheep in the Rocky Mountain Region: Reports of Five Scientific Advisory Committees to the National Park Service (DRAFT), 1991.

competitors for food and water in some areas. Domestic livestock (cattle, horses, burrow, sheep) are significant competitors with bighorn for food and water. Domestic sheep have created the most severe competition for bighorns as they have similar feeding habits and carry parasites and diseases detrimental to bighorn.

Harassment by other bighorn, other large animals, or people can cause individual bighorn to become run down physically, perhaps from an improper diet due to nervous tension. Even hikers and photographers trying to get close enough for a good look can upset desert bighorn. Bighorn seem to be little disturbed by people passing at a distance whether they are walking, driving a car, or riding in a motor boat. They are panicked into a frenzy by low-flying helicopters used to count them. Some bighorn strains are very nervous and others are very calm.

Human impact is most noticeable on the periphery of bighorn escape terrain. Permanent developments are sometimes built on bighorn grazing areas or key lambing areas and will, as a result, cause the bighorn to move away. Many of the scarce water sources of the desert bighorn are completely taken over by people. They are used for irrigation, recreation, and mining. Sometimes, however, humans improve the bighorn habitat with attempts to improve forage conditions and access to water holes.

Bighorns most commonly use established pathways that are dictated by the topography of the land. Unfortunately roadways, fences, and canals built by people tend to cross bighorn travel routes. This limits their movement from feeding grounds to water, from water to bedding grounds, from winter feed to spring feed, from summer feed to fall feed and back again. Restraining the movement of bighorn sheep also creates bottlenecks so herds become isolated from other herds and inbreeding occurs. This condition weakens the immunity and health of the herd, creating a serious concern for the longevity of the herd.

Much bighorn habitat is presently under the protection and management of the United States Fish and Wildlife Service, National Park Service, many state parks, and the Bureau of Land Management. New regulations for land use of bighorn range are being implemented so that there will be less impact on these animals.

PROCEDURE:

PRE-ACTIVITY:

1. Read Overview information thoroughly. It is essential to your understanding of this activity. You may want to photocopy it for students.

2. Photocopy at least 100 "Life Cards" on yellow paper. Make ten copies of the "Food Cards" on green paper, ten copies of the "Space Cards" on white paper, ten copies of the "Escape Terrain Cards" on brown paper, and ten copies of the "Water Cards" on blue paper.

3. Using a playing field or gymnasium, set up a playing field as shown in the illustration. Use a rope or line to indicate the boundaries of the field. Within the playing field mark four areas with a rope or hula hoop.

4. Place "Food Cards" in one, "Escape Terrain Cards" in another, "Water Cards" in another, and "Space Cards" in the last marked area.

ACTIVITY:

1. Give each student six "Life Cards." Each "Life Card" represents a live sheep. Distribute at least 100 "Life Cards" among the students the first time this game is played.

2. Choose two students to be a predator and a poacher. Since predators and poachers are not serious threats, these two people may only walk to tag the other students as they move between the card areas.

3. Students are safe as long as they are in a card area or beyond the lines that mark the boundaries at each end of the playing field.

4. Each student who is tagged must give one "Life Card" to the person who tagged them.

5. The students are to move to each card area, collecting one card at each area. Sometimes their cards have death or birth situations.

6. Upon arrival at the ending boundaries,

they must pay the teacher a "Life Card" for each death card they are holding (ask a few students to help collect these to speed the process if you like). Students collect "Life Cards" if they are holding birth cards.

7. Count the total number of "Life Cards" that students are still holding. Remember the goal is to keep herds over one hundred.

8. Repeat the procedure three more times without restoring "Life Cards" to those who lost them. Move in the outer boundaries by two to three feet each round to represent a narrowing habitat.

9. Now, replay the game, this time cutting the number of "Life Cards" to three for each student. Play four rounds again and record the results. Compare the results of the two sizes of herds after playing four rounds with different beginning amounts of "Life Cards." Ask students if there were any apparent advantages to having a larger herd. Why do they see them as advantages or disadvantages?

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12. What were some of the controlling conditions (also called limiting factors) that determine whether a sheep lived or died? What are some ways humans can help improve bighorn ecosystems?

13. Have students name wild animals that would also benefit from an improved desert bighorn ecosystem.

ASSESSMENT:

1. Have students draw or describe an ideal desert bighorn sheep habitat. Be sure they explain why they included the things they did. How did they provide for the needs of the desert bighorn sheep? What are four ways that domestic livestock could alter the ideal desert bighorn sheep habitat students have drawn?

2. Have students give the definition of "indicator species" and describe what qualities the desert bighorn sheep have that make them a good indicator species.

EXTENSIONS:

1. Have students make a clay or salt dough model of the ideal bighorn habitat.

2. Invite a local wildlife officer to talk to the class about other indicator species, perhaps one from your area. Is there something that can be done to help an indicator species in your area?

3. Challenge students to report on different indicator species. Ask your local wildlife officer for ideas.

4. Have students find the Utah Canyonlands on a map. Research what the area is like and what other animals live there. Find out what human involvement is in this area i.e. recreation, ranching, industry, etc.

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Bighorn Sheep in the Rocky Mountain Region: Reports of Five Scientific Advisory Committees to the National Park Service (DRAFT), 1991.

FOOD CARDS:

GOOD GRASS!

OOPS! POISON WEED! YOU'RE DEAD.

SPRING FORAGING IS GREAT!

BROWSING ON BLACKBRUSH IS GOOD.

HABITAT IMPROVEMENTS MAKE MORE FOOD AVAILABLE.

DROUGHT MAKES FOOD SCARCE. YOU ARE DEAD.

NOT ENOUGH GOOD FOOD MAKES YOU MINERAL DEFICIENT. YOU DIE.

A MOIST YEAR HAS GROWN GOOD RICE GRASS.

DOMESTIC SHEEP HAVE OVER-GRAZED YOUR AREA. YOU DIE.

EARLY SPRING BRINGS EARLY GRASS! YUM!

GOOD FORAGING! YOU'RE FAT!

GOOD GRAZING MAKES YOU HEALTHY.

COMPETITION WITH CATTLE AND BURROS DEPLETES YOUR FOOD SUP-PLY. YOU DIE.

GOOD GRASS!

OOPS! POISON WEED! YOU'RE DEAD.

SPRING FORAGING IS GREAT!

BROWSING ON BLACKBRUSH IS GOOD.

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GOOD FORAGING! YOU'RE FAT!

GOOD GRAZING MAKES YOU HEALTHY.

COMPETITION WITH CATTLE AND BURROS DEPLETES YOUR FOOD SUPPLY. YOU DIE.

WATER CARDS:

TRAFFIC NOISE FROM HIGHWAY SCARES YOU FROM YOUR ONLY WATERING HOLE. YOU DIE.

RIVER RAFTERS SPOOK YOU FROM COMING DOWN TO THE RIVER FOR WATER. TOO MANY DAYS PASS. YOU DIE.

IT IS A WET YEAR AND THERE ARE LOTS OF WATER HOLES.

WATER CARDS:

DOMESTIC LIVESTOCK IS NOT ALLOWED IN YOUR RANGE. MORE WATER AND LESS COMPETITION!

COMPETITION WITH MULE DEER FOR YOUR ONLY WATER HOLE LEAVES YOU DEHYDRATED. YOU DIE.

COMPETITION WITH CATTLE FOR YOUR WATERING HOLE IS TOO MUCH FOR YOU. YOU DIE OF DEHYDRATION IN THIS HOT, DRY CLIMATE.

FENCES BUILT ACROSS TRAVEL ROUTES KEEP YOU FROM GETTING TO WATER HOLES YOU HAVE ALWAYS USED. YOU DIE.

A DROUGHT YEAR CAUSED THE TANK YOU DRINK FROM TO BECOME LOW AND DANGEROUS TO DRINK FROM WITH ITS STEEP SIDES. YOU FALL IN AND CANNOT GET OUT. YOU DIE.

WILDLIFE OFFICERS CUT A RAMP DOWN TO A DEEP DRINKING HOLE MAKING IT SAFE TO DRINK FROM.

WILDLIFE OFFICERS CARVE INDENTIONS INTO THE ROCK TO MAKE MORE WATER COLLECTING HOLES.

A SMALL DAM IS BUILT TO PROVIDE STORAGE OF WATER FOR WILDLIFE.

FENCES ARE BUILT AROUND THE PERIMETER OF YOUR RANGE TO KEEP DOMESTIC LIVESTOCK OUT.

ESCAPE TERRAIN CARDS:

COMPETITION FOR SPACE WITH DOMESTIC LIVESTOCK STRESSES YOU OUT. YOU ARE NOT EATING PROPERLY. YOU BECOME ILL AND DIE.

DOMESTIC SHEEP MOVE INTO YOUR AREA. YOU ARE EXPOSED TO A DISEASE THEY ARE INFECTED WITH. YOU HAVE NO IMMUNITY, AND DIE.

NEW LAWS PROHIBIT DOMESTIC LIVESTOCK FROM GRAZING ON YOUR RANGE.

THE OPENING OF NEW TRAILS BRINGS MORE HIKERS THAN EVER INTO YOUR ECOSYSTEM. THEY ARE TOO CLOSE FOR COMFORT. YOU BECOME STRESSED, ILL, AND DIE.

NEW LANDS ARE SET ASIDE FOR BIGHORN HABITAT.

A NEW WILD BURRO PROGRAM CAPTURES MOST OF THE BURROS INHABITING YOUR RANGE. THIS MEANS LESS COMPETITION.

NEW HOUSING DEVELOPMENTS CONTINUE CREEPING INTO THE OUTER PERIMETERS OF YOUR RANGE. YOU ARE STRESSED AND DIE.

NEW ROADS AND INCREASED TRAFFIC BLOCK SPACE AND BRING MORE STRESS TO YOUR ENVIRONMENT. THE HERD BOTTLENECKS AND INBREEDS. YOU DO NOT EAT WELL, BECOME SICK, AND DIE.

PEOPLE ARE BECOMING MORE AWARE OF BIGHORN NEEDS. THEY ARE IMPROVING YOUR HABITAT.

ESCAPE TERRAIN CARDS:

CATTLE ARE NO LONGER ALLOWED TO GRAZE IN YOUR RANGE...LESS COMPETITION FOR FOOD.

A CHOICE TO NOT USE HELICOPTERS TO DO COUNTS ON BIGHORN IS A DEFINITE IMPROVEMENT ON YOUR STRESS LEVEL.

A YEAR OF HIGH PRECIPITATION ALLOWS WILDLIFE TO SPREAD OUT AND NOT HAVE TO COMPETE FOR JUST A FEW WATER HOLES.

SPACE CARDS:

COMPETITION FOR SPACE WITH DOMESTIC LIVESTOCK STRESSES YOU OUT. YOU ARE NOT EATING PROPERLY. YOU BECOME ILL AND DIE.

DOMESTIC SHEEP MOVE INTO YOUR AREA. YOU ARE EXPOSED TO A DISEASE THEY ARE INFECTED WITH. YOU HAVE NO IMMUNITY, AND DIE.

NEW LAWS PROHIBIT DOMESTIC LIVESTOCK FROM GRAZING ON YOUR RANGE.

THE OPENING OF NEW TRAILS BRINGS MORE HIKERS THAN EVER INTO YOUR ECOSYSTEM. THEY ARE TOO CLOSE FOR COMFORT. YOU BECOME STRESSED, ILL, AND DIE.

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A YEAR OF HIGH PRECIPITATION ALLOWS WILDLIFE TO SPREAD OUT AND NOT HAVE TO COMPETE FOR JUST A FEW WATER HOLES.

ESCAPE TERRAIN CARDS:

A HELICOPTER COUNTING BIGHORN SHEEP COMES TOO CLOSE. IN YOUR PANIC TO ESCAPE, YOU LOSE YOUR FOOTING AND FALL INTO A RAVINE. YOU ARE DEAD.

YOU HAVE GIVEN BIRTH TO A SET OF TWINS AND HAVE SAFE BEDDING GROUNDS. COLLECT TWO LIFE CARDS.

YOU HAVE GIVEN BIRTH TO A SINGLE LAMB. COLLECT ONE LIFE CARD.

ESCAPE TERRAIN CARDS:

YOU ARE THE PROUD PARENT OF TWIN LAMBS. COLLECT TWO LIFE CARDS.

YOU WERE NOT CLOSE ENOUGH TO YOUR ESCAPE TERRAIN WHEN A HUNTER SNUCK UP ON YOU. YOU DIE.

AS A LAMB, YOU DO NOT MAKE IT TO THE CLIFF OVERHANG IN TIME TO AVOID THE DEATH CLUTCH OF THE EAGLE. YOU DIE.

A SEVERE STORM HITS. YOU RUN INTO A CAVE AND ARE UNHARMED.

AN EAGLE DIVES FOR YOU, BUT YOU QUICKLY DUCK UNDER A CLIFF OVERHANG AND ESCAPE IT.

YOU SLIP ON THE ICY ROCK AND BREAK YOUR LEG. YOU LIMP TO A WASH, BUT ARE UNABLE TO GET ADEQUATE FOOD AND STARVE TO DEATH.

YOU EASILY OUT-MANEUVER A COYOTE IN THE ROCKY TERRAIN.

FROM YOUR VANTAGE POINT ON THE ROCKY RIDGES AND BENCHES YOU EASILY SPOT HUNTERS AND QUICKLY ESCAPE OVER THE RIDGE.

DOMESTIC LIVESTOCK PREFER THE LOWER, MORE OPEN, LESS ROCKY AREAS; YOU HAVE ABUNDANT SPACE.

ESCAPE TERRAIN CARDS:

A HELICOPTER COUNTING BIG-HORN SHEEP COMES TOO CLOSE. IN YOUR PANIC TO ESCAPE, YOU LOSE YOUR FOOTING AND FALL INTO A RAVINE. YOU ARE DEAD.

YOU HAVE GIVEN BIRTH TO A SET OF TWINS AND HAVE SAFE BEDDING GROUNDS. COLLECT TWO LIFE CARDS.

YOU HAVE GIVEN BIRTH TO A SINGLE LAMB. COLLECT ONE LIFE CARD.

YOU ARE THE PROUD PARENT OF TWIN LAMBS. COLLECT TWO LIFE CARDS.

YOU WERE NOT CLOSE ENOUGH TO YOUR ESCAPE TERRAIN WHEN A HUNTER SNUCK UP ON YOU. YOU DIE.

AS A LAMB, YOU DO NOT MAKE IT TO THE CLIFF OVERHANG IN TIME TO AVOID THE DEATH CLUTCH OF THE EAGLE. YOU DIE.

A SEVERE STORM HITS. YOU RUN INTO A CAVE AND ARE UNHARMED.

AN EAGLE DIVES FOR YOU, BUT YOU QUICKLY DUCK UNDER A CLIFF OVERHANG AND ESCAPE IT.

YOU SLIP ON THE ICY ROCK AND BREAK YOUR LEG. YOU LIMP TO A WASH, BUT UNABLE TO GET ADEQUATE FOOD AND STARVE TO DEATH.

ESCAPE TERRAIN CARDS:

YOU EASILY OUT MANEUVER A COYOTE IN THE ROCKY TERRAIN.

FROM YOUR VANTAGE POINT ON THE ROCKY RIDGES AND BENCHES, YOU EASILY SPOT HUNTERS AND QUICKLY ESCAPE OVER THE RIDGE.

DOMESTIC LIVESTOCK PREFER THE LOWER, MORE OPEN, LESS ROCKY AREAS; YOU HAVE ABUNDANT SPACE.

LIFE CARDS:

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LEVEL: *Grades K-3*

SUBJECTS: *Art, Geography, Science.*

PROCESS: *Through factual information and construction of a bat cave diorama, students learn how the Forest Service has implemented procedures to protect bats while protecting humans from possibly dangerous situations.*

OBJECTIVES: *The student will:*

1. *Describe how environmentalists and government personnel (United States Forest Service Agents) offer protection and safe shelter for bats.*
2. *Describe where bats live and find safe shelter.*
3. *Discuss the importance of not disturbing hibernating bats.*
4. *Locate areas in the United States where bats live.*
5. *Draw a picture of a bat cave with grates in the front.*
6. *Construct a bat cave diorama.*

TIMEFRAME: *Discussion - 45 minutes; diorama activity - two days, 45 minutes per day. Daily observation (10-15 minutes) for cave stalagmite development.*

SKILLS: *Analyzing, applying, constructing media, demonstrating, describing, discussing, drawing, inferring, listening, locating, mapping, measuring.*

MATERIALS: *8 1/2" X 11" white paper, rulers, markers or crayons, photo of bats and bat cave or mine. Materials to construct bat safe mine for each group: shoebox or similar box, black construction paper, string, glue, 5-oz. clear plastic tumblers, three pieces of yarn six inches long, epsom salts, measuring cup, spoon, water, hot plate or stove, punch for holes in box, colored dye, metal pan (large enough for ten cups of liquid).*

VOCABULARY: *Bat grate, cave, colony, concentration, dense, diorama, ecologist, environment, evening, grate, great, guano, hibernating, mine, protection, roost, stalactite, stalagmite, ton.*

GREAT BAT GRATES

OVERVIEW: Bats sleep during the day. They fly, hunt, and feed at night. Bats need a safe daytime location in which to sleep and a safe place to give birth to a baby (pup). Bats sleep in a variety of places including caves, mines, trees, under bridges, in attics, in abandoned buildings and vehicles, in hollow trees, and under rock ledges. They sleep hanging upside down by their toes.

During winter, bats hibernate. They store food in their bodies throughout the winter for energy and to keep up their strength. If a bat is disturbed during the winter, strength might be lost and it might die.

The U.S. Forest Service knows it's important to protect bats, especially since bats eat insects that annoy people and ruin farmers' crops. When mines are no longer being used in some parts of the country, Forest Service personnel sometimes install bat-safe grates on mine openings to keep humans from trespassing and to protect animals from a possibly dangerous area. These grates allow bats to come and go but the strong grate keeps others away. The bat remains safe inside, undisturbed by large animals (including humans).

PROCEDURE:

PRE-ACTIVITY:

Locate, show, and discuss pictures of bats.

ACTIVITY:

1. Read students the following story, pausing to ask questions along the way:

Bats sleep by roosting during the day in dark, cool, safe, quiet places. Caves are ideal places for bats to roost. One of the places Mexican Free Tail bats live is in the Bracken Cave in Texas. The cave is 600 feet long. These bats are the single largest colony of bats in the world. There are from 20,000,000 to 40,000,000 Mexican Free Tail

bats living in Bracken Cave. It is the largest group of warm-blooded mammals on earth.

Ask:

-Where do bats like to live? *(Caves and mines.)*

-Why do bats choose these places to live? *(Safe, cool, spots to hang or roost, dark, rarely disturbed.)*

Locate Texas on a United States map. Ask:

-How far is Texas from where you live?

Bats work hard when they go out at night. How many insects would you guess Mexican Free Tail bats catch and eat when they fly from their cave in Bracken, Texas? Make a guess; it's a lot! *(Pause - for guesses.)* Well, hold your breath. The thousands of Mexican Free Tail bats that fly into the evening eat *250 TON* of insects before morning.

Bat colonies fly as a group, roost as a colony, and hibernate as a colony. They feel safe together and sometimes need help so they can get their rest.

Bat pups are born in the spring and summer. They hang upside down or roost in the bat nursery. Each square foot of the bat cave nursery ceiling is covered by a hundred pink, hairless, squeaky pups. Mother bats carry their newborn pups with them when they hunt for food at night. The pups hang tightly to their mother's fur so they won't fall. When bat pups are about three weeks old, their wings are strong enough for them to fly.

Another special cave in which bats live is the New Mammoth Cave in Campbell County, Tennessee. Thousands of cave-dwelling gray bats live and hibernate here. The cave temperature can change from 50 degrees Fahrenheit to below freezing. During warm spring, summer, and early fall months the gray bats catch thousands of insects each night. When the weather becomes cooler, they store food as fat in their bodies so they can hibernate throughout the winter in safety. Some gray bats live up to 32 years.

Locate Tennessee on a United States map. Ask:

-How far is Tennessee from where you live?

It is very important for bats to roost and hibernate safely and peacefully. To get their bodies ready for hibernation, bats eat and eat and EAT. By the time the temperature is very cold, they will have stored a lot of food energy in their bodies in the form of fat. This energy helps them survive the winter. The bats fly into their caves or mines or safe areas, find their own places to hang upside down, and roost undisturbed until warm weather comes again.

If the roosting, hibernating bats are disturbed and awakened, stored-up food energy is used up quickly. By using this energy early, the bats may not have enough strength to continue roosting throughout the entire cold season. If they lose too much strength, they may fall to the cave or mine or "home" floor and die. Bats without strength cannot fly.

Because bats help the environment, the United States Forest Service has developed bat grates for great bats. (Grate and great are spelled differently. They mean different things but sound the same. Words like this are called homonyms.) The bat grates (strong metal fences) cover the mouth of the cave and protect their living area. The bat grate on New Mammoth Cave weighs 120 ton. The bat grate is made of heavy metal bars spaced far enough apart to allow the gray bats to leave the cave and return to the cave.

A door was built in New Mammoth Cave, so ecologists and Forest Service personnel can check on the number and safety of the bats. These people must walk through guano on the floor of the cave. Guano are bat droppings. The ecologists and Forest Service personnel are very quiet and very careful not to disturb the bats when they enter the cave.

Bat grates are also put on vacant mines. When miners no longer work or operate a mine, the opening to the mine is sometimes left open. Sometimes a sign is posted that says NO TRESPASSING or KEEP OUT to keep people away.

Ask:

-How do ecologists and the United States Forest Service personnel help protect bats? *(Bat grates.)*

-What other groups are protected by bat grates on caves and mines? *(Humans and other animals.)*

Bat grates are GREAT!

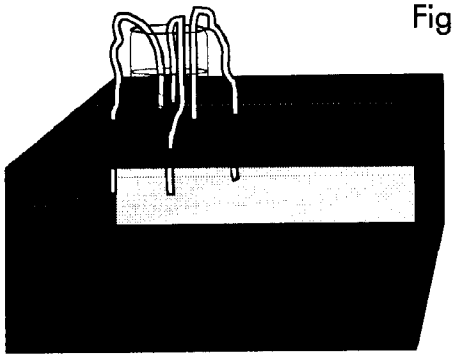
2. Show a picture of a bat cave or mine entrance. Ask students to draw a bat cave or mine showing a grate covering the front.

3. Depending upon amount of materials available, put students in groups to construct bat cave dioramas. Ask them to follow the procedure below to construct their bat caves.

A. Teacher or adult preparation: Prepare the following mixture for tumblers. Combine five cups epsom salts and four cups boiling water. Cook in a metal pan until solution is dense and epsom salts are thoroughly combined with water. Add colored dye. Stir with a spoon and cool. Keep away from students as a safety precaution. Caution children not to taste or touch the mixture.

B. Have students cover the inside of a shoebox with black construction paper, then trace the diameter of the top of a 5-oz. tumbler on top of the box (see figure 1). Punch holes in three places around the circle you have drawn to drop yarn into. Glue bottom of tumbler to the top of the box, inside the three places where holes for yarn have been made (see figure 1). Students may want to repeat this step two or three times depending on the size of their boxes.

Figure 1



C. Soak the six-inch yarn pieces in the solution. Put one end of the yarn in the hole on top of the box and the other end in the plastic container. Add solution about half way up tumbler. The solution should be absorbed by the yarn. The excess will drip from yarn strand hanging into box to form stalactites. Stalactites are formed from the ceiling down from calcareous water (water containing carbonate of lime) flowing down to form a column. Stalagmites may form from the floor of the cave or mine to the stalactite column.

When plastic tumblers are to be refilled, solution must again be heated in metal pan and stirred with metal spoon. The solution may be stored in refrigerator or kept in the pan.

D. When the cave stalagmites have finished forming, use pattern (figure 2) to trace and cut bats from black construction paper. Add them to the scene.

Figure 2

ASSESSMENT: Students pictures and dioramas should show how bats use abandoned mines or caves and how bat grates help protect the bats.

EXTENSIONS:

1. Students research how and where stalagmites form.

2. Locate Carlsbad Cavern on a map.

RESOURCES:

Amazing Bats, Eyewitness Juniors #13, Frank Greenaway, Alfred A. Knopp, New York. ISBN 0-679-81518-X.

Amazing Mammal - Parts I, II, Nature Scope, Ranger Rick, National Wildlife Federation, 1400 16th Street NW, Washington, DC, 20036-2266, 1986.

Bats, A First Nature Fact Book, D.J. Arneson, Kidsbooks, Inc., 3535 Peterson Avenue, Chicago, Illinois 60659, 1993. ISBN 1-56156-253-0.

Bats, Creatures of the Night, Jill Wolf, Antioch Publishing Company, Yellow Springs, Ohio, 45387, 1990. ISBN 0-89954-549.

Bats of Colorado, Shadows in the Night, Colorado Division of Wildlife, Department of Natural Resources, 6060 Broadway, Denver, CO 80216, 1984. (303) 297-1192.

Bats, Wings in the Night, Patricia Lauber, Random House, New York, Canada, 1968. Library of Congress Catalog Number 68-23674.

Bats, Zoobooks, Linda C. Wood, Deane Pink, Frye and Smith, San Diego, CA, Wildlife Education, ltd., 1989. USA ISBN 0-937934-59-3.

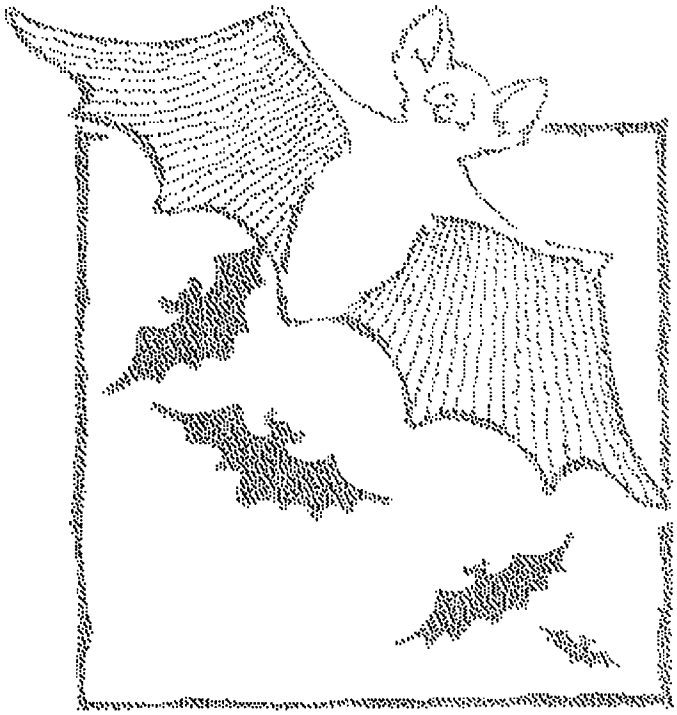
I Can Read About Bats, Elizabeth Warren, Troll Associates, Mahwah, N.J., USA. Library of Congress Catalog Number 74-24928, 1975.

Stellaluna, Janell Cannon, Harcourt Brace d Co, San Diego, CA. ISBN 0-15-280217-7.

Very Elementary Bats, Bat Conservation, International, (catalog) P.O. Box 162603, Austin, TX 78716.

Colorado Division of Wildlife, "Bats are Beautiful" 22 minutes; "Bats: Myth and Reality" 16 minutes, "Bats of America" 15 minutes; 6060 Broadway, Denver, Colorado 80216. (303) 297-1193.

National Geographic, "Bats Aren't All Bad" Alvin Novick, MD, May, 1973.



LEVEL: *Grades 1-3 (extensions for grades 4-6)*

SUBJECTS: *Science, Language Arts, Geography, (History).*

PROCESS: *Through observation, comparison, and evaluation of a habitat, students make predictions regarding appearances of animal homes.*

OBJECTIVES: *The student will:*

1. *Generalize that the common needs for food, water, and shelter are shared needs among all animals including humans.*
2. *Identify basic components of one habitat.*
3. *Discuss the relationship between habitat and adaptations.*
4. *Describe why good habitat is necessary for the health, safety, and continued life of all living things.*

TIMEFRAME: *2 hours in field and 1 hour in class.*

SKILLS: *Comparing similarities and differences, describing, evaluating, inferring, observing, predicting, recording, role playing, synthesizing, visualizing, working in small groups.*

MATERIALS: *Drawing supplies, Hole Homes drawing, "Hole Homes, Prairie Homes" (attached). (Extensions: clear jar, potting soil, grass seeds--oat, bluegrass, and buffalo grass).*

VOCABULARY: *Adaptation, grass, grassland, habitat, prairie, snag, soil, stump.*

HOLE HOMES

OVERVIEW: Between the tall mountains of the west and the long winding Mississippi River, tall grasses blew like waves on the oceans over a vast area. As early pioneers traveled across this prairie land in covered wagons, they saw few trees, suffered extreme heat in the summer and cold in the winter, and continually searched for water. Because the prairie country in the United States is a region of extremes it is a challenge for all living things to survive. The plants and animals that have always lived in this land of hot, cold, and wind have adapted to the conditions.

Animals all over the world share the same needs for survival--food, water, shelter, reproduction of their kind, and space to move. Humans are no different and all adapt to survive in the climates and habitats in which they live.

Animals that live in forests often build their homes in tree trunks, under the bark of trees, on tree branches, or in the stumps and snags of dead trees. Consider where an animal might make a home if there were no trees and only tall grass and the soil under its feet.

PROCEDURE:

1. Ask your students to verbally describe their homes. What is basic to each home? List these on the board in the front of the room for future discussion. Each home has a place to prepare food and eat, a bed to sleep in, and water to drink and clean with.

2. Review with your students the basic needs of animals -- food, water, shelter, space -- and compare these needs to their own lifestyles. An animal's shelter might not have strong walls like ours, so eating in the shelter would not be safe. Discuss why. Likewise, a prairie dog would not have the ability to bring plumbing into its home for running water. Discuss where its water would come

from. The space around an animal's home is part of its expanded home--sort of like a ranch or a farm or even our cities. Discuss the need for expanded homes (i.e. getting things we need, buying groceries, buying clothes, visiting family). Ask:

-Why is shelter important to prairie dogs, coyotes, meadowlarks, and humans?

3. Locate a field free of trees and buildings close to your school. Sit in the field with your students and together describe what everyone sees. Then describe a grassland -- a place where there are few trees, the wind blows a lot, it is usually either very hot or very cold, and it doesn't rain a lot. The land is covered with grass higher than our heads while we are sitting down. When the wind blows, all the grass moves at the same time. Birds fly above the grass, and you can hear insects chirping and frogs croaking during the spring, summer, and fall. The sky has great big, white, fluffy clouds as far as you can see.

4. Ask your students to visualize the grassland. Use the "Hole Homes, Prairie Homes" drawing to help them "see."

-Where might a prairie dog or a coyote live in the grassland?

-Where a meadowlark builds a nest?

-What does your own home look like compared to what a prairie animal's home could look like?

Introduce the concept of building a home under ground.

5. Using the drawing "Hole Homes, Prairie Homes" ask everyone to locate the homes of a coyote, a prairie dog, a ground squirrel, and any other animals living underground in the prairie. Describe the homes that they locate in the drawing. How have these animals adapted to living in the prairie? What happens to any living thing that can not adapt to the habitat in which it finds itself? Optional: Show your students pictures of these animals and discuss their adaptations for digging.

6. Ask your students to work in pairs and carefully patrol the field looking for signs of animals (including insects) living underground. Watch for small holes that can be openings to underground tunnels and dens. As they locate possible homes, have each pair sit and watch the hole until everyone has located a home. After five minutes of observing, ask your students to rejoin you and describe what they saw.

7. In the classroom, have students examine pictures from the October 1993 *National Geographic* article, "The American Prairie" by Douglas H. Chadwick. Compare their predictions from your field work with the painting on the foldout, pages 104-106.

ASSESSMENT:

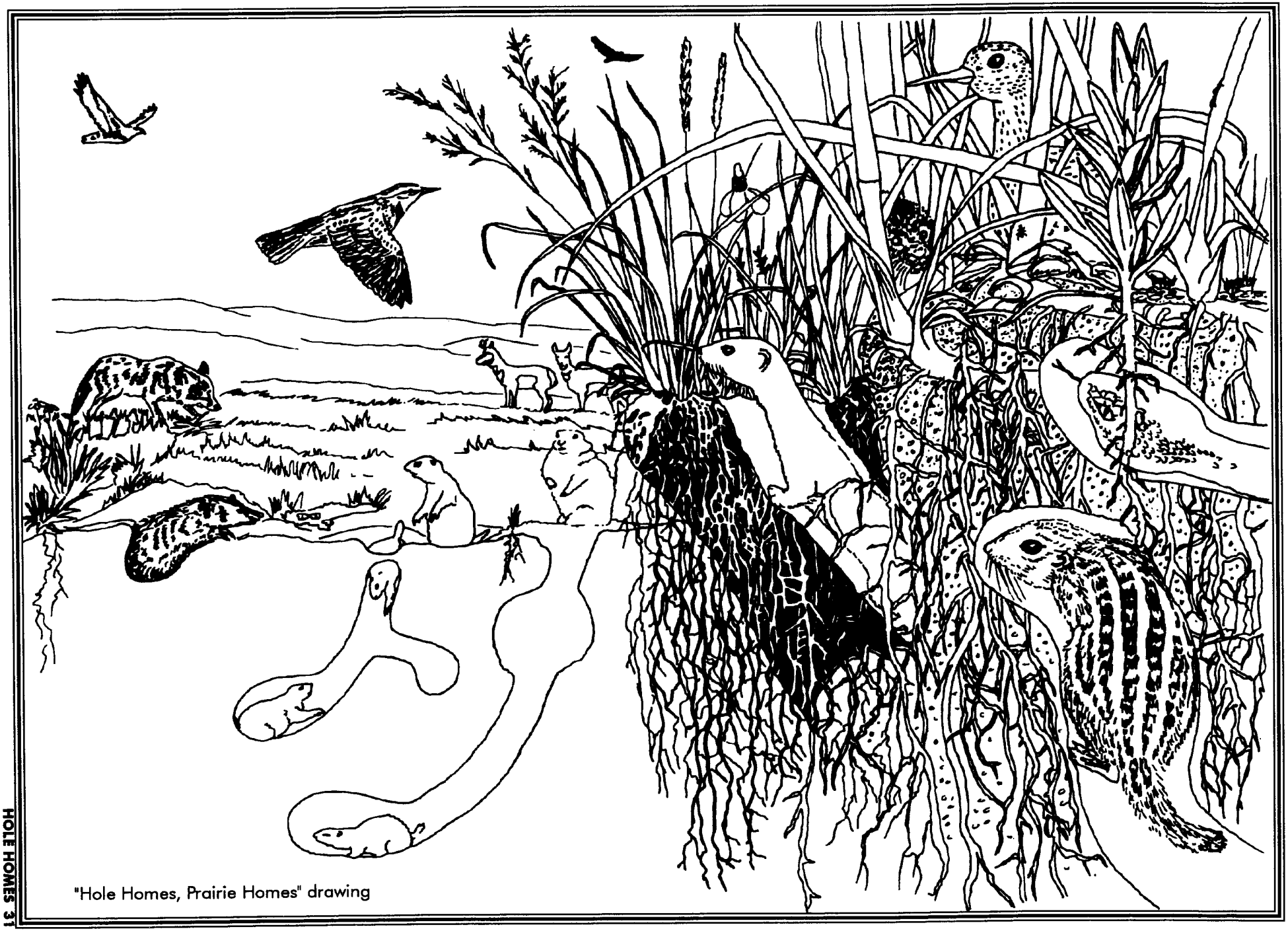
1. Using pictures of a grassland and experiences from the field work, have your students make a diorama or mural of a grassland. If making a diorama use a soda pop box/flat and pipe cleaner or clay animals. Ask them to include at least one nest and one underground home.

2. Name three needs that humans have in common with prairie dogs.

EXTENSIONS:

1. In an open space or natural area that is basically undisturbed by development, search for animal homes and discuss the variety of sites animals find even without trees.

2. Discuss possible ways for early pioneers to build homes in the land of no trees. Until trains were able to cheaply bring lumber in from regions with forests, people living in grasslands studied the examples of the grassland animals. The tall grasses had very long roots in the soil and held the soil together. What is a sod house? Some soil in the grassland had clay in it and clay could be turned into a brick. Everyone's communities varied and the availability of the following will vary with the resources. Locate a brick maker or a sod house builder for a demonstration or visit an efficient underground home. These are modern variations on pioneer attempts to create shelter on the grasslands.



"Hole Homes, Prairie Homes" drawing

3. Buy several types of grass seed from a nursery (oat, bluegrass, and buffalo grass) and grow them in a clear jar with potting soil. Water when dry, keep in a sunny location, and watch as the roots form and the grass seeds grow. Through a period of several weeks, students will observe the heights to which grasses can grow, the types of flowers they produce, and the ability their roots have to fill the soil and bind it together. After one or two months, or when the roots fill most of the jar, pull the grass/soil/roots clump out of the jar to observe what has occurred. Consider how this can prevent erosion and how it can make a sod roof for animals living underground. Also, consider how effective it could be in sod homes for pioneers living on the prairie.

4. Extension appropriate for grades 4-6. Write for information from National Grasslands managers. Ask for materials on the reasons for their existence, historical material, and compare these grasslands that have been protected by the U.S. Forest Service and other government agencies to non-protected regions. Locate each on a map of the United States and discuss the range of the grasslands now compared to before pioneers settled and began ranching and farming. Each is managed by a variety of agencies and you will need to check within your state to locate an address.

RESOURCES:

If your state isn't listed, call your Department of Natural Resources and ask for grassland information.

NATIONAL GRASSLANDS

California: Butte Valley National Grassland

Colorado: Pawnee National Grassland and Comanche National Grassland

Idaho: Curlew National Grassland

Kansas: Cimmaron National Grassland

Nebraska: Ogalala National Grassland

New Mexico: Kiowa National Grassland

North Dakota: Little Missouri National Grassland, Sheyenne National Grassland

Oklahoma: Black Kettle National Grassland and McClelland Creek National Grassland

Oregon: Crooked River National Grassland

South Dakota: Grand River National Grassland, Cedar River National Grassland, Fort Pierre National Grassland and Buffalo Gap National Grassland

Texas: Rita Blanca National Grassland, L.B.J. National Grassland and Caddo National Grassland

Wyoming: Thunder Basin National Grassland

LEVEL: *Grades 4-8 (Can be an extension for 3rd grade, "Eat a Rock")*

SUBJECTS: *Consumer Education, Geography, Science, Art, Language Arts.*

PROCESS: *Through gathering data on uses and sites for mining and comparing uses of minerals mined all over the United States, students will explore the value of mining to our lifestyles and to the economy.*

OBJECTIVES: *The student will:*

1. *List ten of the original sources of ten common consumer products found in their daily lives.*
2. *Match these products to resources mined from the ground.*
3. *Identify mineral production in every state of the United States.*
4. *Evaluate the value of these minerals to their current lifestyles.*

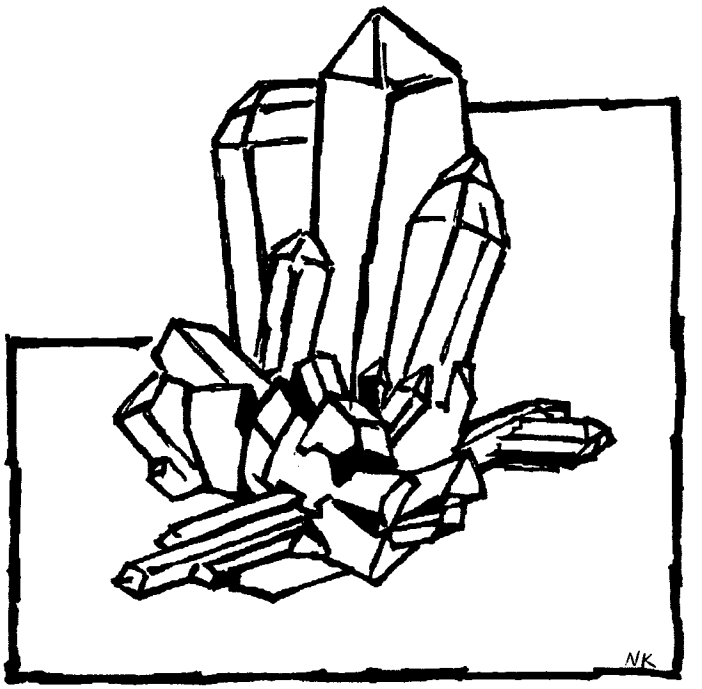
TIMEFRAME: *Three 50-minute sessions.*

SKILLS: *Analyzing, applying, discussing, generalizing and predicting, inferring, listing, mapping, problem solving, reading, reporting.*

MATERIALS: *United States map, 50 small paper slips, library references and encyclopedia, poster board or large construction paper, art supplies (colorful markers, crayons, colored pencils, watercolor and/or poster paints, magazines, glue, etc.), computer (optional), samples of mineral objects: such as copper pipe or wire, plastic pipe, kitty litter, baby powder-talc, clay plant pot, silver, plastic, gold, copper jewelry, pennies, aluminum foil, tin cans, "State Minerals List" (attached), "Mining for Words" (attached).*

VOCABULARY: *Consumers, minerals, mining, resources.*

EXTRA: □
□
Click HERE for a list of □ ***State Geologists and*** □ ***Geology web sites.***



HOME OF MINE STATE OF MINE

OVERVIEW: You wake up each morning, turn on the light and radio, wash your face, brush your teeth, get dressed, eat breakfast, pick up your homework, lunch box, and daypack, and catch the bus to go to school. Almost everything you have done so far would be impossible without minerals that have been mined from the ground. The alarm clock contains petroleum products, copper, and silver; the water pipes are made of copper, lead, or petroleum products; the light bulb contains tungsten filaments; the toothpaste may be in an aluminum tube and the brush is made from petroleum products. Almost everything you touch throughout the day, at home, at school, and at your friends' houses is made with resources removed from the ground. If the objects weren't made from a mined resource, they were most likely manufactured in a way that used mined resources. For example, consider how a tree (not a mined resource) is turned into paper. You can bet it has come in contact with metals of many types. It has been transported on trucks made of metal and fueled by petroleum products, for example.

Like the food webs found in nature, we have a close bond to the earth through our dependence upon minerals. We could live without many of these, but our lifestyles would change drastically.

We use minerals in the amounts of billions of tons of sand and gravel each year, and approximately ten tons of minerals a year for every man, woman, and child in the United States. We also need mineral nutrients to keep healthy. Foods we eat supply us with calcium, copper, iron, phosphorus, and much more. Just look on the side of a box of cereal or vitamin bottle label. Minerals are found in fertilizers that grow our foods. Farmers use metal tractors, and grocers use petroleum-fueled metal trucks to bring foods to consumers.

The walls of our houses, made of bricks, stones, and concrete, are nailed together with nails of steel and other metals. Inside walls are often of gypsum wallboard. Copper wire and pipes running between the walls provide us with water and electricity for cooking our meals.

Minerals also provide the materials for people to express themselves artistically. Minerals are found in paints, and in the clays and marbles used by sculptors. Even soap sculptures are dependent upon minerals since salt is used to manufacture soap.

Scientists would be unable to perform their highly technical research without the aid of computers. Each computer is reported to contain more than 42 different minerals, all mined somewhere.

Like the food we buy in the grocery store, many minerals come from other parts of the country or the world. Minerals come from private property and public lands all across the country including farms, ranches, national forests, and Bureau of Land Management property, especially in the western states. Steel comes from iron ores and blends of metals mined from the ground in places like Pennsylvania, Michigan, and Minnesota. Salt doesn't start at the store, but from places in the earth where there was once sea water like Utah, Louisiana, and Nevada. Coal that is used to generate electricity may come from Wyoming, Montana, and West Virginia; and petroleum used to create plastics and fuel our cars often come from Texas, Colorado, and California. We depend on these resources, yet do we really understand that they come from within the ground and from all over the country and the world?

Mined resources are found in every state within the United States, but not all mined resources are found in every state. For example, copper is found in some states and not in others. Copper is an important mineral in Arizona, Montana, and New Mexico, but not in North Dakota. It might be present, but not in enough quantity that it is worth the cost to mine it. Yet, North Dakota offers other minerals not found in Arizona, Montana, or New Mexico.

PROCEDURE:

PRE-ACTIVITY:

1. Photocopy "State Minerals List" and the U.S. map for each student.

2. Set up a display of items from the materials list and "pretest" students by discussing the sources for these items. Number (1 to 50) and fold 50 small slips of paper and place them in a box or hat for later use.

3. Provide each student with the State Minerals List and U.S. map. This handout provides a list of common minerals from each state. (Note: These are not the only minerals found in the state--just two of the most important ones.) Also included on the list is a common use of each mineral. These manufactured products are not necessarily made in the state, but are made with the minerals mined in that state.

ACTIVITY:

1. On the U.S. map, have the students locate each state and write on that state the two minerals mined there.

2. Ask students to place their initials on states that they have been to or where they have relatives.

3. Create a color key and color in one shade for states with the same mineral. For example, states producing copper could be colored in orange and states producing iron ore could be grey. Select only one duplication per state since there could be many. Identify the climatic and geographic differences in these states. For example, copper is mined in Michigan and in Arizona. Michigan is wet, cool and not a desert while Arizona is hot, dry and definitely a desert. Use travel and family experiences of students to help determine these characteristics.

4. Tell students: 50 slips of paper are numbered 1 - 50 in this box (or hat). As you finish your maps, pull two slips of paper from the hat. Each number will match a state on the "State Minerals List." Number two will be Alaska, three is Arizona, and so on. You are to select the two minerals from the list for each state to report on. Using library resources, including encyclopedias, you need to report

back with three facts about each mineral and two uses for each not shown on the list. Work in pairs, if you wish, to report on four states instead of two states. The report can be bound in a cover with a map of the United States that shows locations of minerals. [Optional--If there's a computer in the classroom, students can enter their researched information into a computer file that can later be printed out at the conclusion of everyone's activities. A printout of the reports can be presented to the school librarian. The report should contain each state in the United States in alphabetical order, with two minerals including three facts and two uses for each.]

5. Evaluate and discuss the display set up at the start of this activity to determine what minerals make up each item and where items might have been mined.

6. Have everyone list ten different manufactured items in their homes that have come from mineral products. Petroleum products are found in plastics; many metals contain iron ores. Bring the lists to school and try to determine, using the maps and other resources, where it might have been mined. Discuss with students their dependence upon mineral resources--especially petroleum.

7. Conclude "Home of Mine, State of Mine" by having students produce a product poster that shows uses for minerals found in their daily lives. They should use facts discovered in their combined reports on common household uses and the uses provided in the "State Mineral List." Each poster should contain a minimum of ten mined resources. Each item should be identified either in the poster or labeled and identified below it. An example of a poster is a person on rollerblades wearing all of the appropriate safety equipment. Students need to identify the raw resource, i.e. petroleum and steel. Posters can be constructed as collages from drawings found in magazines; from freehand drawings using markers, paints, pencils, and/or crayons; or from multimedia assemblies.

8. What would happen if the states that produce copper no longer produced copper? Consider the products made from copper and consider the economy of the state. Discuss how each state benefits from the money earned from the sale of the copper.

ASSESSMENT:

Ask students to:

1. Identify two minerals from two states.

2. List ten items found in the classroom and identify the resource origin.

3. Evaluate their needs for natural resources as they apply to their current lifestyles and report on this in two to three paragraphs.

EXTENSIONS:

1. If the same minerals are found in very different locations around the United States, what predictions can you make about climate conditions when the mineral was forming? (Possible answers can involve geologic history and climatic changes over time.) Is there a relationship?

2. Have students imagine a world without metals. Look around the room, compare everyone's mineral lists from home and classroom activities, and determine non-metal, non-mineral substitutes that would allow us to maintain our current lifestyles. (Would you be able to make these changes in our lives? Try to make these changes for a day in the classroom.) Remember that even pencils and papers come in contact with mined resources.

3. People all over the country work in mining and in the manufacturing processes that change raw resources into consumer items. Have students interview family members (uncles, aunts, grandparents, cousins, etc.) and friends to find out who works where and what they do. The United States economy is very dependent upon mining and manufacturing. Without them, we couldn't have restaurants, doctors, clothing stores, or anything as we currently know it. Encourage students to share interview findings in class. What would happen if these jobs disappeared? What would happen if the minerals disappeared or were no longer available? Why might they no longer be available? What could happen? (There are no wrong answers.) Extend this idea to shopping at Christmas, buying school supplies, and into all levels of the economy. Have students invite some of their relatives/friends in to talk to the class about their

jobs. Invite a geologist from a local college, university, or state geology office to talk about the mining industry.

4. "Mining for Words" contains many of the minerals found in the "State Minerals List." This is a vocabulary enrichment activity that can be completed when students finish their reports.

Hawaii: Hawaii Geological Survey, Division of Water and Land Development, P.O. Box 373, Honolulu, HI 96809, (808) 587-0230

Idaho: Director and State Geologist, University of Idaho, Morrill Hall, Room 332, Moscow, ID 83843, (208) 885-7991

RESOURCES:

This Ouachita National Forest Website provides lots of useful information on minerals, rockhounding and mining in the National Forests as well as links to many other National Forest and other minerals related sites. If you are connected to the internet, you can click here now: http://www.fs.fed.us/oonf/minerals/

For a listing of State Geologists and web addresses, see the table at the end of this activity.

STATE MINERALS LIST

Number/State	Mineral Resource*	Consumer Use**
1. Alabama	salt iron ore	soap iron pipes
2. Alaska	gold petroleum	dental fillings telephones
3. Arizona	copper silver	electric wire radios
4. Arkansas	diamonds aluminum/bauxite	jewelry cooking foil
5. California	asbestos tungsten	roofing material light bulbs
6. Colorado	gypsum copper	wallboards plumbing pipes
7. Connecticut	clay gravel	glossy paper sidewalks
8. Delaware	calcium magnesium	fertilizer lightweight metal alloys
9. Florida	gravel titanium	cement rocket engines
10. Georgia	iron ore talc	highrise buildings baby powder
11. Hawaii	clay volcanic ash	cat litter glass
12. Idaho	cobalt gold	jet engines jewelry
13. Illinois	coal lead	electricity television tubes
14. Indiana	gypsum limestone	plaster buildings
15. Iowa	coal gypsum	electricity cement
16. Kansas	lead salt	batteries food seasoning
17. Kentucky	fluorspar petroleum	toothpaste toys
18. Louisiana	salt sulfur	food seasoning fabric dyes
19. Maine	clay mica	paper coating roofing
20. Maryland	limestone natural gas	caulking cooking
21. Massachusetts	granite limestone	buildings sidewalks
22. Michigan	copper peat	pans houseplants
23. Minnesota	manganese iron ore	pans tractors
24. Mississippi	clay iron ore	dishes airplanes

25. Missouri	barite zinc	pertoleum medicine
26. Montana	silver petroleum	wire dishes
27. Nebraska	clay natural gas	cat litter cooking
28. Nevada	lithium mercury	rockets thermometers
29. New Hampshire	beryl mica	jewelry glass
30. New Jersey	titanium zinc	jet engines fuses
31. New Mexico	molybdenum vanadium	kitchen tools X-rays
32. New York	slate talc	chalkboards glass bowls
33. North Carolina	asbestos lithium	oven mitts batteries
34. North Dakota	lignite salt	electricity ice cream
35. Ohio	salt sandstone	cheese sidewalks
36. Oklahoma	limestone petroleum	roofing grocery bags
37. Oregon	mercury uranium	mirrors submarines
38. Pennsylvania	iron ore coal	school buses trains
39. Rhode Island	sand gravel	cement roads
40. South Carolina	clay mica	statues oven door windows
41. South Dakota	uranium vanadium	energy fabric dyes
42. Tennessee	marble copper	counter tops electric cables
43. Texas	asphalt petroleum	driveways cassettes
44. Utah	salt vanadium	preserving food rockets
45. Vermont	asbestos marble	insulation fudge boards
46. Virginia	coal soapstone	electricity insecticide
47. Washington	lead tungsten	batteries light bulbs
48. West Virginia	coal salt	electricity ice cream
49. Wisconsin	iron ore zinc	food cans car engines
50. Wyoming	diamonds phosphate	stereos fertilizer

MINING FOR WORDS

M T I W E L E A D F Z M L C I F P G D B
O E Z P V R A Z V C S F L X T Q F K Y A
Y E W V C G Y P S U M L E I F I S E A R
Y P E P V E W T Q I G T V I M A W Z N I
H E C B C P V K O R D I A M O N D S S T
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U R E E A G J G U V E F G F I Q A Q K S
D O N R T K S H L L K P C O A L S M I N
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D E T B P J W W U S U E V L O N E C Y P
A U S G O L D F Y C K U T A W P S S K T
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D O M T M I F R Q J R I A Y G Q O U Y D
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A T L E I R F P I M F K O M Q H Z I J E
J P Q T N T T P V I L N C R Y O F M V T
O V F D A A S O Q C U K Z X I G U U H L
J O Z O T G J C T A S B X G Y J J L V P
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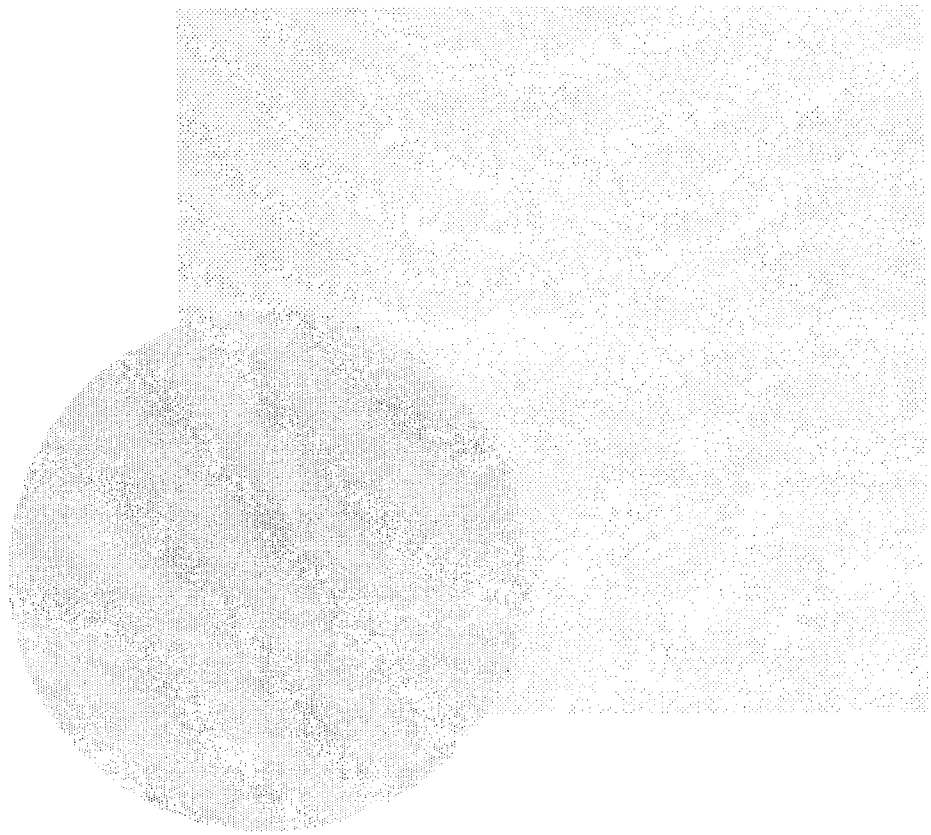
W O D C T Y Q X S T A V S B D J G F S S
T R K U R A N I U M A T E L B R A M Q W

SALT
IRON ORE
GOLD
PETROLEUM
COPPER
SILVER
DIAMONDS
ALUMINUM
ASBESTOS
GYPSUM
GRAVEL
TITANIUM
TALC
COBALT
COAL
LEAD
LIMESTONE
SULFUR
MICA
BARITE
URANIUM
MARBLE



MINING FOR WORDS (SOLUTION)

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Y E W V C **G** **Y** **P** **S** **U** **M** L **E** I F I S E A **R**
Y **P** E P V E W T Q I G T **V** I M A W Z N **I**
H **E** C B **C** P V K O **R** **D** **I** **A** **M** **O** **N** **D** **S** S **T**
Q **T** B S **L** G A S K **E** U D **R** K E Y U **W** J **E**
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D **O** **N** R **T** K S H L **L** K P **C** **O** **A** **L** **S** M I N
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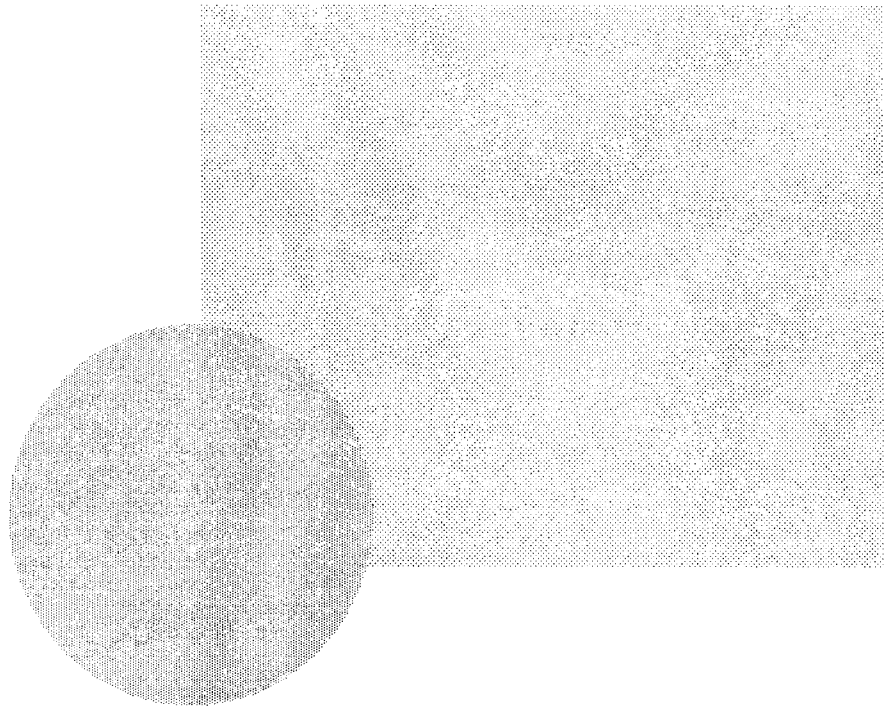
SALT
IRON ORE
GOLD
PETROLEUM
COPPER
SILVER
DIAMONDS
ALUMINUM
ASBESTOS
GYPSUM
GRAVEL
TITANIUM
TALC
COBALT
COAL
LEAD
LIMESTONE
SULFUR
MICA
BARITE
URANIUM
MARBLE



Directory of State Geologists

State	State Geologists
1. Alabama	State Geologist Geological Survey of Alabama P.O. Box 869999 Tuscaloosa, AL 35486-6999 Telephone: (205) 349-2852 Fax: (202) 349-2861 Internet: http://www.gsa.state.al.us/
2. Alaska	Director and State Geologist Division of Geological and Geophysical Surveys Alaska Department of Natural Resources 794 University Avenue, Suite 200 Fairbanks, AK 99709-3645 Telephone: (907) 451-5005 Fax: (907) 451-5050 Internet: http://www.dggs.dnr.state.ak.us/
3. Arizona	State Geologist and Director Arizona Geological Survey 416 West Congress Street, Suite 100 Tucson, AZ 85701-1315 Telephone: (520) 770-3500 Fax: (520) 770-3505 Internet: http://www.azgs.state.az.us/
4. Arkansas	Director and State Geologist Arkansas Geological Commission Vardelle Parham Geology Center 3815 West Roosevelt Rd. Little Rock, AR 72204 Telephone: (501) 296-1877 Fax: (501) 663-7360 E-mail: agc@mail.state.ar.us Internet: http://www.state.ar.us/agc/
5. California	State Geologist California Division of Mines and Geology Department of Conservation 801 K St. MS 12-30 Sacramento, CA 95814-3531 Telephone (916) 445-1825 Fax: (916) 445-5718 Internet: http://www.consrv.ca.gov/dmg/index.htm
6. Colorado	State Geologist and Director Colorado Geological Survey Division of Minerals and Geology Department of Natural Resources 1313 Sherman St., R. 715 Denver, CO 80203 Telephone (303) 866-2611 Fax: (303) 866-2461 Internet: http://geosurvey.state.co.us/

Directory of State Geologists

7. Connecticut	**State Geologist** **Connecticut Geological and Natural History Survey** **Department of Environmental Protection** **79 Elm St.** **Hartford, CT 06106-5127** **Telephone: (860) 424-3540** **Fax: (860) 424-4058** **Internet: http://dep.state.ct.us/cgnhs/index.htm**
8. Delaware	**Director and State Geologist** **Delaware Geological Survey/University of Delaware** **Delaware Geological Survey Bldg.** **Newark, DE 19716-7501** **Telephone: (302) 831-2833** **Fax: (302) 831-3579** **E-mail: dgs@mvs.udel.edu** **Internet: http://www.udel.edu/dgs/dgs.html**
9. Florida	**State Geologist** **Florida Geological Survey** **Department of Environmental Protection** **903 West Tennessee St./Gunter Building** **Tallahassee, FL 32304-7700** **Telephone: (850) 488-4191** **Fax: (850) 488-8086** **Internet: http://www.dep.state.fl.us/geology/**
10. Georgia	**State Geologist** **Georgia Geologic Survey** **Department of Natural Resources** **19 Martin Luther King. Jr., Dr., SW, Rm. 400** **Atlanta, GA 30334** **Telephone: (404) 656-3214** **Fax: (404) 657-8379** **Internet: http://www.dnr.state.ga.us/dnr/environ/**
11. Hawaii	**Hawaii Department of Land and Natural Resources** **Division of Water and Land Development** **P.O. Box 373** **Honolulu, HI 96809** **Telephone: (808) 587-0230** **Fax: (808) 587-0283** **Internet: http://kumu.icsd.hawaii.gov/dlnr/Welcome.html**
12. Idaho	**State Geologist** **College of Mines** **University of Idaho** **Moscow, ID 83844-3025** **Telephone: (208) 885-6195** **Fax: (208) 885-5724** **Internet: http://www.idahogeology.org.**

Directory of State Geologists

13. Illinois	**Illinois State Geological Survey** **Department of Natural Resources** **121 Natural Resources Bldg.** **615 East Peabody Dr.** **Champaign, IL 61820-6964** **E-mail: isgs@isgs.uiuc.edu** **Internet: http://www.isgs.uiuc.edu/isgshome.html**
14. Indiana	**Director and State Geologist** **Mineral Resources Section** **Indiana Geological Survey** **Indiana University** **611 North Walnut Grove** **Bloomington, IN 47405-2208** **Telephone: (812) 855-5067** **Fax: (812) 855-2862** **Internet: http://adamite.igs.indiana.edu/**
15. Iowa	**Geological Survey Bureau** **Iowa Department of Natural Resources** **109 Trowbridge Hall** **Iowa City, IA 52242-1319** **Telephone: (319) 335-1575** **Fax: (319) 335-2754** **Internet: http://www.igsb.uiowa.edu/**
16. Kansas	**Director and State Geologist** **Kansas Geological Survey** **University of Kansas** **1930 Constant Ave., Campus West** **Lawrence, KS 66047-3726** **Telephone: (785) 864-3965** **Fax: (785) 864-5317** **Internet: http://www.kgs.ukans.edu/**
17. Kentucky	**State Geologist and Director** **Kentucky Geological Survey** **University of Kentucky** **228 Mining and Mineral Resources Bldg.** **Lexington, KY 40506-0107** **Telephone: (859) 257-5500** **Fax: (859) 257-1147** **Internet: http://www.uky.edu/KGS/home.htm**
18. Louisiana	**Director and State Geologist** **Louisiana State University** **University Station, P.O. Box G** **Baton Rouge, LA 70893-4107** **Telephone: (225) 578-5320** **Fax: (225) 578-3662** **Internet: http://www.dnr.state.la.us/CONS/Conserv.ssi**

Directory of State Geologists

19. Maine	**Director and State Geologist** **Maine Geological Survey** **Department of Conservation** **22 State House Station, 184 State St.** **Augusta, ME 04333-0022** **Telephone: (207) 287-2801** **Fax: (207) 287-2353** **E-mail: nrimc@state.me.us** **Internet: http://www.state.me.us/doc/nrimc/nrimc.htm**
20. Maryland	**State Geologist and Director** **Maryland Geological Survey** **2300 St. Paul St.** **Baltimore, MD 21218-5210** **Telephone: (410) 554-5559** **Fax: (410) 554-5502** **Internet: http://mgs.dnr.md.gov/**
21. Massachusetts	**State Geologist** **Massachusetts Executive Office of Environmental Affairs** **Office of the State Geologist** **251 Causeway Street. Suite 900 (9th floor)** **Boston, MA 02114-2150** **Telephone: (617) 626-1026** **Fax: (617) 626-1181** **Internet: http://www.state.ma.us/envir/eoea.htm** **Choose MEPA**
22. Michigan	**Geological Survey Division** **Michigan Department of Environmental Quality** **P.O. Box 30256, 735 East Hazel St.** **Lansing, MI 48909-7756** **Telephone: (517) 334-6907** **Fax: (517) 334-6038** **Internet: http://www.deq.state.mi.us/gsd/**
23. Minnesota	**State Geologist** **Minnesota Geological Survey** **University of Minnesota** **2642 University Ave. W.** **St. Paul, MN 55114-1057** **Telephone: (612) 627-4780** **Fax: (612) 627-4778** **E-mail: mgs@gold.tc.umn.edu** **Internet: http://www.geo.umn.edu/mgs/**

Directory of State Geologists

24. Mississippi	**State Geologist** **Office of Geology** **Mississippi Department of Environmental Quality** **P.O. Box 20307** **Jackson, MS 39289-1307** **Telephone: (601) 961-5500** **Fax: (601) 961-5521** **Internet: http://www.deq.state.ms.us/newweb/homepages.nsf**
25. Missouri	**Director and State Geologist** **Division of Geology and Land Survey** **Missouri Department of Natural Resources** **P.O. Box 250, 111 Fairgrounds Rd.** **Rolla, MO 65401-0250** **Telephone: (573) 368-2100** **Fax: (573) 368-2111** **TDD: 1-800-379-2419** **E-mail: dnrdgls@mail.dnr.state.mo.us** **Internet: http://www.dnr.state.mo.us/geology.htm**
26. Montana	**Director and State Geologist** **Montana Bureau of Mines and Geology** **Montana Tech of the University of Montana** **1300 West Park St.** **Butte, MT 59701-8997** **Telephone: (406) 496-4180** **Fax: (406) 496-4451** **E-mail: pubsales@mbmgsun.mtech.edu** **Internet: http://www.mbmg.mtech.edu/**
27. Nebraksa	**Nebraska Geological Survey** **Nebraska Conservation and Survey Division** **Institute of Agriculture and Natural Resources** **University of Nebraska-Lincoln** **901 North 17th St., 113 Nebraska Hall** **Lincolin, NE 68588-0517** **Telephone: (402) 472-3471** **Fax: (402) 472-2410** **Internet: http://csd.unl.edu/csd.html**
28. Nevada	**Director and State Geologist** **Nevada Bureau of Mines and Geology** **University of Nevada-Reno, MS 178** **Reno, NV 89557-0088** **Telephone: (775) 784-6691** **Fax: (775) 784-1709** **Internet: http://www.nbmg.unr.edu/**

Directory of State Geologists

29. New Hampshire	**State Geologist** **New Hampshire Department of Environmental Services** **64 Hazen Drive, P.O. Box 95** **Concord, NH 03302-0095** **Telephone: (603) 271-3503** **Fax: (603) 271-2867** **E-mail: geology@des.state.nh.us** **Internet: http://www.des.state.nh.us/comm_intro.htm#geology**
30. New Jersey	**State Geologist** **New Jersey Department of Environmental Services** **64 Hazen Drive, P.O. Box 95** **Concord, NH 03302-0095** **Telephone: (603) 271-3503** **Fax: (603) 271-2867** **E-mail: geology@des.state.nh.us** **Internet: http://www.state.nj.us/dep/njgs/**
31. New Mexico	**Director and State Geologist** **New Mexico Bureau of Mines and Mineral Resources** **801 Leroy Pl.** **Socorro, NM 87801-4796** **Telephone: (505) 835-5302** **Fax: (505) 835-6333** **Internet: http://geoinfo.nmt.edu/**
32. New York	**New York State Geological** **New York State Museum** **Room 3140 Cultural Education Center** **Albany, NY 12230** **Telephone: (518) 474-5816** **Fax: (518) 486-3696** **Internet: http://www.nysm.nysed.gov/geology.html**
33. North Carolina	**Director and State Geologist** **North Carolina Geological Survey** **Division of Land Resources** **1613 Mail Service Center** **Raleigh, NC 27699-1612** **Telephone: (919) 733-2423** **Fax: (919) 733-0900** **Internet: http://www.geology.enr.state.nc.us/**
34. North Dakota	**State Geologist and Director** **North Dakota Geological Survey** **600 East Boulevard Ave.** **Bismarck, ND 58505-0840** **Telephone: (701) 328-8000** **Fax: (701) 328-8010** **Internet: http://www.state.nd.us/ndgs/**

Directory of State Geologists

35. Ohio	**State Geologist** **Division of Geological Survey** **Ohio Department of Natural Resources** **4383 Fountain Square Dr., Bldg. B** **Columbus, OH 43224-1362** **Telephone: (614) 265-6988** **Fax: (614) 447-1918** **E-mail: geo.survey@dnr.state.oh.us** **Internet: http://www.dnr.state.oh.us/odnr/geo_survey**
36. Oklahoma	**Oklahoma Geological Survey—Energy Center** **The University of Oklahoma** **100 East Boyd, Rm. N-131** **Norman, OK 73019-0628** **Telephone: (405) 325-3031; (800) 330-3996** **Fax: (405) 325-706** **Internet: http://www.ou.edu/special/ogs-pttc/**
37. Oregon	**State Geologist** **Oregon Department of Geology & Mineral Industries** **800 NE Oregon St. #28, Suite 965** **Portland, OR 97232-2162** **Telephone: (503) 731-4000** **Fax: (503) 731-4066** **FTP: open:sarvis.dogami.state.or.us; user:anonymous** **Password: (enter E-mail address or name and FAX number)** **E-mail: Nature.of.NW@state.or.us** **Internet: http://sarvis.dogami.state.or.us/**
38. Pennsylvania	**Pennsylvania Geological** **Bureau of Topographic and Geologic Survey** **Department of Conservation and Natural Resources** **P.O. Box 8453** **Harrisburg, PA 17105-8453** **Telephone: (717) 787-2169, 783-7257** **Fax: (717) 783-7267** **Internet: http://www.dcnr.state.pa.us/topogeo/indexbig.htm**
39. Puerto Rico	**Puerto Rico Bureau of Geology** **Department of Natural and Environmental Resources** **P.O. Box 9066600** **Puerta de Tierra, PR 00906-6600** **Telephone: (787) 722-2526** **Fax: (787) 723-4255**

Directory of State Geologists

40. Rhode Island	**Office of Rhode Island State Geologist** **Department of Geology** **The University of Rhode Island** **Kingston, RI 02881** **Telephone: (401) 874-2191** **Fax: (401) 874-2190** **Internet: http://www.uri.edu/cels/gel/ri_geological_survey.htm**
41. South Carolina	**Director and State Geologist** **South Carolina Geological Survey** **5 Geology Rd.** **Columbia, SC 29212** **Telephone: (803) 896-7708** **Fax: (803) 896-7695** **Internet: http://water.dnr.state.sc.us/geology/**
42. South Dakota	**State Geologist** **South Dakota Geological Survey** **University of South Dakota, Akeley Science Center** **414 East Clark St.** **Vermillion, SD 57069-2390** **Telephone: (605) 677-5227** **Fax: (605) 677-5895** **Internet: http://www.sdgs.usd.edu/**
43. Tennessee	**State Geologist and Director** **Tennessee Department of Environment and Conservation** **Division of Geology** **13th Fl., L and C Tower** **401 Church St.** **Nashville, TN 37243-0445** **Telephone: (615) 532-1500** **Fax: (615) 532-0231** **Internet: http://www.state.tn.us/environment/tdg/**
44. Texas	**Director and State Geolgist** **Bureau of Economic Geology** **The University of Texas at Austin** **University Station, Box X** **Austin, TX 78713-8924** **Telephone: (512) 471-1534** **Fax: (512) 471-0140** **E-mail: begmail@beg.utexas.edu** **Internet: http://www.beg.utexas.edu/**
45. Utah	**Director and State Geologist** **Utah Geological Survey** **Utah Department of Natural Resources** **P.O. Box 146100** **1594 West North Temple, Suite 3110** **Salt Lake City, UT 84114-6100** **Telephone: (801) 537-3300** **Fax: (801) 537-3400** **Internet: http://www.ugs.state.ut.us/**

Directory of State Geologists

46. Vermont	**State Geologist** **Vermont Geological Survey** **Department of Conservation** **103 South Main St., The Laundry Bldg.** **Waterbury, VT 05671-0301** **Telephone: (802) 241-3608** **Fax: (802) 241-3273** **Internet: http://www.anr.state.vt.us/geology/vgshmpg.htm**
47. Virginia	**State Geologist** **Virginia Department of Mines, Minerals and Encrgy** **Division of Mineral Resources** **900 Natural Resources Ave.** **P.O. Box 3667** **Charlottesville, VA 22903** **Telephone: (804) 951-6340** **Fax: (804) 951-6365** **Internet: http://www.mme.state.va.us/DMR/home.dmr.html**
48. Washington	**Washington State Department of Natural Resources** **Division of Geology and Earth Resources** **1111 Washington Street, SE, Room 148** **P.O. Box 47007** **Olympia, WA 98504-7007** **Telephone: (360) 902-1450** **Fax: (360) 902-1782** **E-mail: geology@wadnr.gov** **Internet: http://www.wa.gov/dnr/htdocs/ger/index.html**
49. West Virginia	**Director and State Geologist** **West Virginia Geological and Economic Survey** **Mont Chateau Research Center** **P.O. Box 879** **Morgantown, WV 26507-0879** **Telephone: (304) 594-2331** **Fax: (304) 594-2575** **Internet: http://www.wvgs.wvnet.edu/**
50. Wisconsin	**Director and State Geologist** **Wisconsin Geological and Natural History Survey** **3817 Mineral Point Rd.** **Madison, WI 53705-5100** **Telephone: (608) 262-1705** **Fax: (608) 262-8086** **Internet: http://www.uwex.edu/wgnhs/**
51. Wyoming	**State Geologist** **Wyoming State Geological survey** **P.O. Box 3008** **Laramie, WY 82071-3008** **Telephone: (307) 766-2286** **Fax: (307) 766-2605** **E-mail: wsgs@wsgs.uwyo.edu** **Internet: http://www.wsgsweb.uwyo.edu/**

LEVEL: Grades 5-8

SUBJECTS: *Environmental Education, Science, Language Arts.*

PROCESS: *Through role playing various wildlife species or humans, students make decisions about the use of natural resources within an ecosystem.*

OBJECTIVES: *The student will:*

1. *Describe food and habitat needs for specific species of wildlife and humans.*
2. *Discuss what makes up an ecosystem.*
3. *Discuss effects of different land use choices on the environment and other life forms.*
4. *Identify land uses that are considered good (compatible) versus those that are considered harmful or less desirable (conflicting).*
5. *Demonstrate how land use conflicts are solved.*
6. *Demonstrate cooperative problem-solving and decision-making skills.*

TIMEFRAME: *1 hour 30 minutes.*

SKILLS: *Analyzing, applying, comparing similarities and differences, comprehending, describing, discussing, drawing, evaluating, interpreting, listening, map reading, problem solving, reading, reporting, role playing, understanding cause and effect, valuing, working in small groups.*

MATERIALS: *Writing materials, "The Ecosystem" drawing, "Role Cards" (attached). Optional: Overhead projector, overhead transparencies, dry erase markers.*

VOCABULARY: *Amphibian, aquatic, compatible, conflicting, decaying, decision making, ecosystem, environmentalist, freshwater, global, habitat, mammal, natural resources, nymph, predator, problem solving, reptile, terrestrial, wildlife, woodland.*

IF YOU OWNED THE ECOSYSTEM

OVERVIEW: Ecosystems are interacting systems of living things and their non-living physical environments. The word ecosystem is also used to describe the place where these interactions (relationships) occur. Ecosystems can be as small as a tiny pond or as large as an ocean, forest, or desert.

We call the living parts of an ecosystem the biological component. The variety of the living species in an ecosystem is known as biological diversity or biodiversity. The non-living parts of the ecosystem are referred to as physical components, and include such things as topography, moisture, soil types, and climate.

The biological and physical components of an ecosystem interact naturally in give-and-take, interdependent ways. In a healthy ecosystem, the native biodiversity is intact and the system operates in ways to maintain that diversity. Some ecosystems are very resilient, absorbing much change and impact. Some ecosystems are very fragile. For every change, there is an effect. The loss of one species or the change in one physical factor can make a huge difference. It can even determine whether or not the entire ecosystem can function and survive.

In addition to the stresses put on ecosystems through forces of nature, today's growing human population continues to need and want more and different things. Most human needs (food, clothing, shelter, space, etc.) involves the use of natural resources. That means ecosystems are directly affected.

Sometimes, the ways we use natural resources and impact ecosystems are compatible or not destructive to one another. Other times, the ways we decide to use resources conflict, and what's good for one part of the ecosystem is not good for another.

In this activity, students work in small groups to decide whether or not to make changes to an ecosystem. The changes will be based on a specific wildlife, human, or special interest group they represent. Each group needs to consider what they eat, where they live, what materials they need to build homes or other structures, what they need for protection, how long the changes will last, or how the changes will affect the other groups. Students discover that different groups need many of the same natural resources. Some of the natural resource uses will be compatible and others will not be compatible. Each group has a right to present its members' needs. They must listen to the needs of others, and together make a decision as to the best use of the resources.

PROCEDURE:

PRE-ACTIVITY:

1. Photocopy one ecosystem drawing for every two to three students and one class copy of both role description pages and role pictures. If possible, photocopy the pages back-to-back. Make sure to match the appropriate pages! You can also glue the two pages together. You may want to cover the cards with clear contact paper or laminate them so they can be used again. Option: Provide each group with an ecosystem drawing on an overhead transparency. They use dry erase markers to mark their changes. The transparency can also be used to make a presentation back to the class.

2. Cut the role cards apart.

ACTIVITY:

1. Ask:

-What is an ecosystem?

See Overview for more information. Students must understand that for every change in an ecosystem there is an effect. Everything in an ecosystem is connected at some level.

Discuss "compatible use" with students. What examples can they think of in their personal lives of a common space that is run or managed with many different interests in mind? Have students briefly explain the space and how it is managed. The school building is an excellent example of compatible use if students need assistance. Others are a community center, park, gymnasium, or sports complex.

2. Divide students into small groups of two to three members. There needs to be at least eight groups, each of which represents a different viewpoint: farmers, students, environmentalists, ecosystem managers, and at least insects, reptiles, fishes, and birds. Additional groups can represent other wildlife species.

3. Give each group a copy of "The Ecosystem" and explain that this is the common space about which they will make decisions. Distribute a role card to each group.

4. Have students read the role description on the back of their group's card. They define or look up any vocabulary words that may be unfamiliar, and then answer the following questions in their groups:

-What do you eat?

-Where do you live?

-What are your habits or what do you like to do?

-What kinds of materials do you need to build a home or shelter?

-Where will you get the materials?

-What do you need protection from? *(Predators.)*

5. Each group talks about the kind of adjustments or changes they would like to make to the ecosystem. The changes are made from the point of view of the wildlife or human roles they represent. Changes can include planting, building, removing things, and other actions that will make their life better. They consider how long the changes will last, they are permanent or temporary, and what effect the change will have on the other groups.

6. "The Ecosystem" can be used to make a rough copy of the changes.

7. Each group presents its changes to the ecosystem to the class, including who is being

represented and pertinent information from the role card. They also define for the group any vocabulary words that come up in their group and may not be familiar to the class. (See Vocabulary section of this lesson.)

8. After all presentations have been made, the class works to reach a consensus on changes they will make to the ecosystem.

Ask each group to identify:

A. Who would be affected by their changes..

B. How the ecosystem would be affected by their changes.

C. Which changes are compatible; which are not compatible.

9. Summarize by asking:

-What was the most interesting part of this activity? Least interesting?

-What was the hardest part? Easiest part?

-How can what you learned in this activity help you in the future?

ASSESSMENT:

1. Evaluate students' participation in the group processes.

2. Have each group give reasons for the changes they made to the ecosystem.

3. If there is no consensus on change(s), have students identify reasons why consensus was not possible. What could have made consensus possible?

EXTENSIONS:

1. Have students do research to learn more about each of the birds, fish, and other wildlife described on the cards. For example, find out how they protect themselves from predators (enemies), find an interesting fact (i.e., the importance of a squirrel's tail), etc.

2. Use this activity to lead into a discussion of the food web. Is anything missing from this ecosystem?

3. Have students add different animals to the ecosystem and prepare additional cards. Do the activity again with the new animals.

4. Have students create different land use scenarios. For example, the farmer has decided to sell her land to a developer who wants to build a shopping mall.

5. Individually or in small groups, have students design ecosystems of their own. What animals, land uses, etc., would be included? Include any local land-use controversies near the school or within the community.

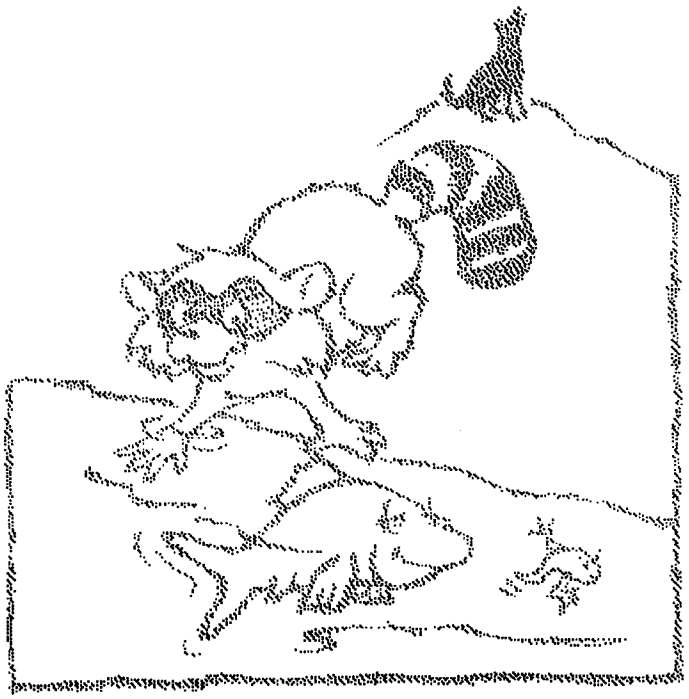
6. Explore and use different consensus-building techniques.

RESOURCES:

Helping Wildlife: Working With Nature, Delwin E. Benson, Wildlife Management Institute, 1977.

North American Wildlife, Susan J. Wernert, Editor, The Reader's Digest Association, Inc., 1982.

Lynn Almer, Beth Boaz, and Pat Mangan contributed to development.



DRAGON FLY (insect): Dragonflies are most often seen flying along the edges of lakes and streams. The larvae, commonly called nymphs, live almost entirely in freshwater. Some species burrow in sand or mud while others cling to vegetation. Nymphs eat microscopic (very tiny) animals, but as they grow they eat mosquitoes, other insect larvae, and small worms. Dragonflies are beneficial insects eating many other pest insects. Birds, frogs, spiders, and fish eat nymphs and adult dragonflies.

FROG (amphibian): In the early stages of growth, frogs are called tadpoles. Tadpoles have tails, live mostly in the water and have gills so they can breathe. Frogs do not have tails. Some frogs live in the water, some live on land, and some live in trees. Frogs eat lots of insects, including grasshoppers. Frogs in turn are eaten by birds, mammals, reptiles (especially snakes), and humans (frog legs).

GRASSHOPPER (insect): Grasshoppers are generally green or brown. They have long slender bodies with large powerful back legs for jumping. They eat the leaves, stems, or young shoots of plants, often feeding on grass, clover, and other plants. Females lay their eggs in the soil and sometimes in rotting wood. Grasshoppers are found in grasslands, fields, deserts, gardens, lawns, woods, and brushy areas. Frogs and skunks eat grasshoppers.

TURTLE (reptile): Some turtles live in the water and some live on land, but all lay their eggs on land. The eggs are usually buried in sand, mud, or decaying vegetation. Some turtles eat mostly plants while others eat only living or dead animals. Turtles have no teeth. The eggs and young turtles may be eaten by other animals.

LIZARD (reptile): Lizards are the most abundant of all reptiles. They are found in many habitats in the warmer parts of the world. Most, if not all, lizards can swim. Most lizards eat insects; some of the larger lizards eat vegetation. Lizards can be found in many places: in or under fallen logs, hiding under brush and piles of leaves, on rocky slopes, canyon walls, patches of sandy soil, and deserted buildings. Coyotes, foxes, bobcats, domestic cats and dogs, hawks, snakes, crows, and ravens eat lizards.

RAINBOW TROUT (fish): Trout are found in cold, clear lakes and streams, especially where the water is moving rapidly. They are often found in the shadow created by overhanging banks and tree limbs. Eggs are laid in the fall or spring and in a stream or on the stream materials (sand, gravel). They eat aquatic insects and terrestrial insects that land on the water. Otters, mink, herons, other trout, and humans eat rainbow trout.

SUNFISH (fish): This fish lives in warm, shallow, weedy ponds and warm, mud-bottomed or rocky streams. They may be in areas of heavy vegetation or under overhanging tree limbs. They eat aquatic insects and terrestrial insects that land on the water. Otters, mink, herons, turtles, water snakes, and other fish eat the sunfish.

FOX SQUIRREL (mammal): The fox squirrel uses trees to build a nest, to hide from enemies, and for food. It eats the fruit, buds, and the bark of twigs and often buries gathered food. They sometimes eat birds. Coyotes, foxes, bobcats, domestic cats and dogs, hawks, snakes, crows, and ravens eat squirrel.

DEER (mammal): Deer can be found in a variety of habitats throughout the world. They feed on grass, leaves, buds, and twigs of woody bushes. Deer have long been used by humans as a source of meat and hides. Coyotes, mountain lions, and domestic dogs eat deer.

MALLARD (bird): Mallards live in marshes, shallow freshwater ponds and coastal waters. They get their food by dipping their bills and heads into the water looking for seeds, aquatic vegetation, and small fish. They also eat grains and vegetation. Their nest is hidden in vegetation near the water's edge. Coyotes, foxes, bobcats, domestic cats and dogs, hawks, snakes, crows, and ravens eat mallards and their eggs.

ROBIN (bird): The American robin lives in open forests, farmlands, parks, and suburbs. They generally build their nests on branches, in forks of trees, or on houses or barns where there are ledges. Mud, twigs, roots, grass, and paper are used to make the nest. They eat berries, worms, and insects. Coyotes, foxes, bobcats, domestic cats and dogs, hawks, snakes, crows, and ravens eat robins and their eggs.

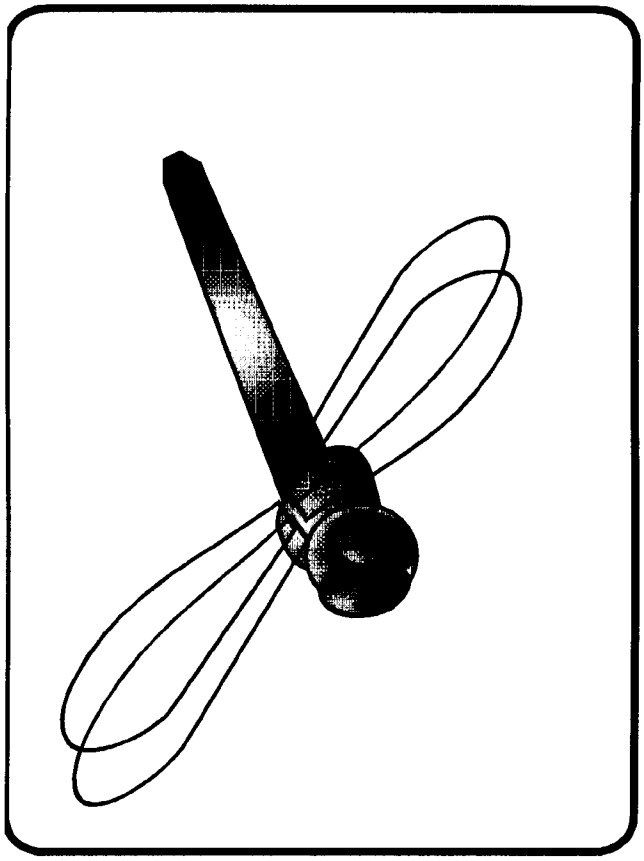
RED-TAILED HAWK (bird): This hawk is usually found in open woodland areas. Nests are built in trees and sometimes in cliffs and human-made structures like tall buildings. The nest is usually large and made of sticks, lined with grass and green leaves. These hawks generally hunt for live animals during the day. They eat mice, rabbits, squirrels, beavers, prairie dogs, and snakes. Coyotes, foxes, bobcats, domestic cats and dogs, other hawks, snakes, crows, and ravens eat the red-tailed hawk.

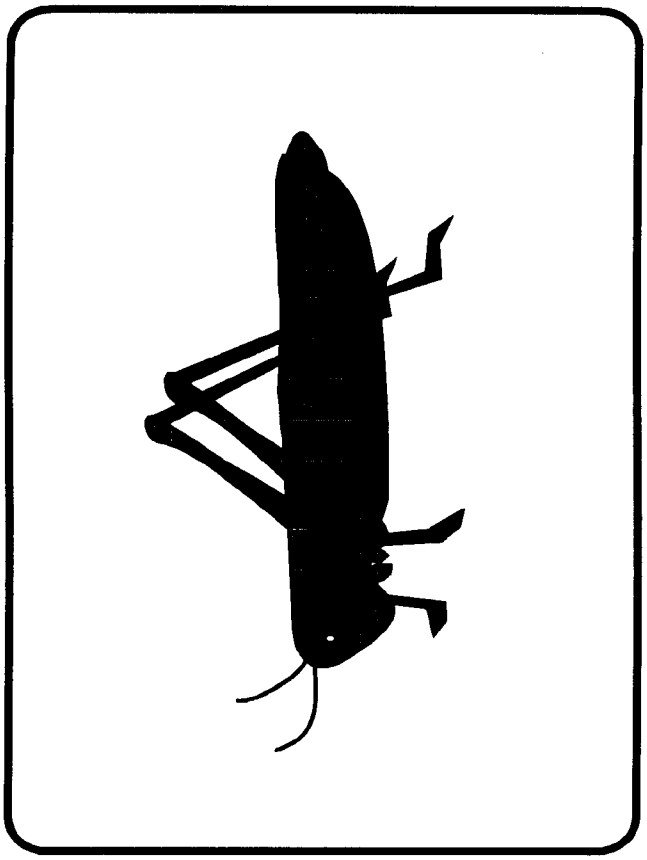
COMMODITY USER (FARMER): In our community, this agricultural producer is growing winter wheat on about 1,000 acres of land. No fertilizers or pesticides are being used. Every two-three years, the wheat crop is rotated with a soybean crop. This crop rotation practice helps maintain good soil quality. A machine called a combine is used to harvest the wheat. Soybean plants return nitrogen to the soil, which helps other plants grow.

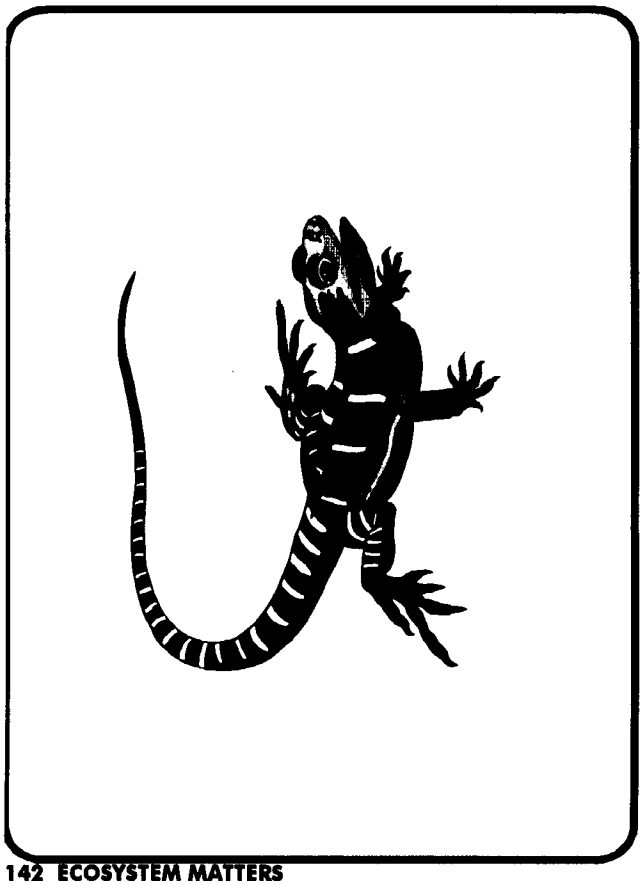
ENVIRONMENTALIST: This person cares about the environment, everything from the air we breathe to the water we drink. Most believe we all can do something to help protect our environment, whether it is recycling or walking to school or work whenever possible. Most believe it is important to balance human needs with the needs of animals and vegetation. This person may be concerned with issues ranging from local government to the global (world) environment. Actions taken by this person vary from writing letters to Congress to cleaning up rivers.

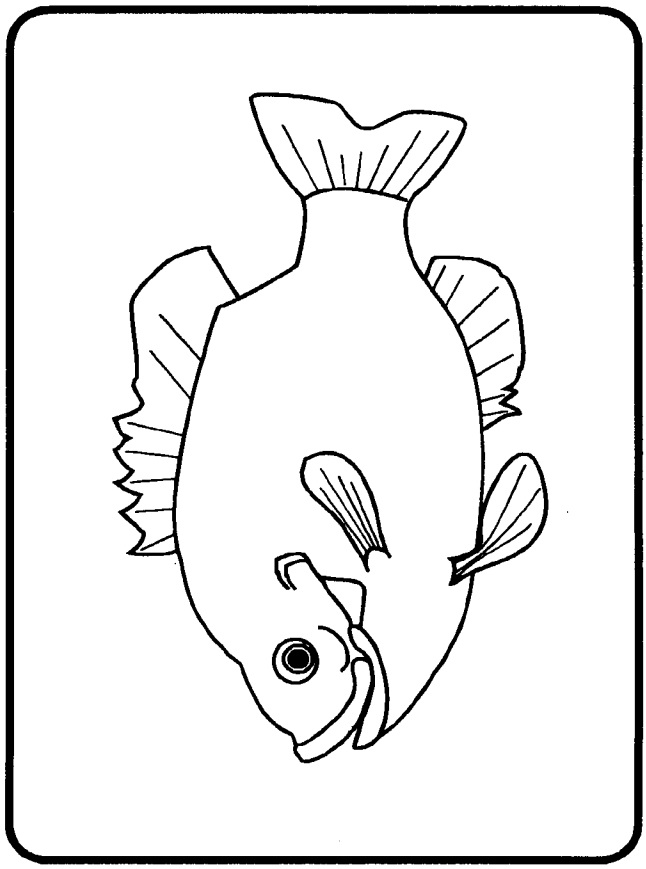
STUDENT: You can create your own role. Think about what you do at home, in school, and outdoors. Prepare your self-description based on: what you eat, where you live, your habitats or what you like to do, materials needed to build a home or shelter, where you will get the materials, and from what you need protection.

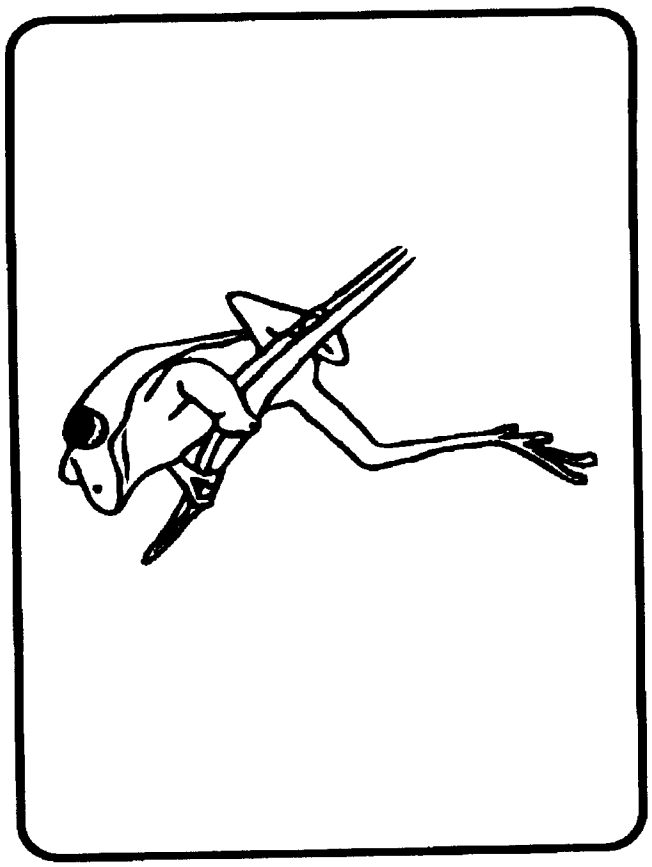
ECOSYSTEM MANAGER: This person is interested in balancing human needs with the needs of animals and vegetation. The Ecosystem Manager's career requires that most of his/her time is spent working with a specific ecosystem. For example, this person might be responsible for taking care of the natural resources (air, water, land, soil, plants, animals) at a wildlife refuge, national park or forest, etc.

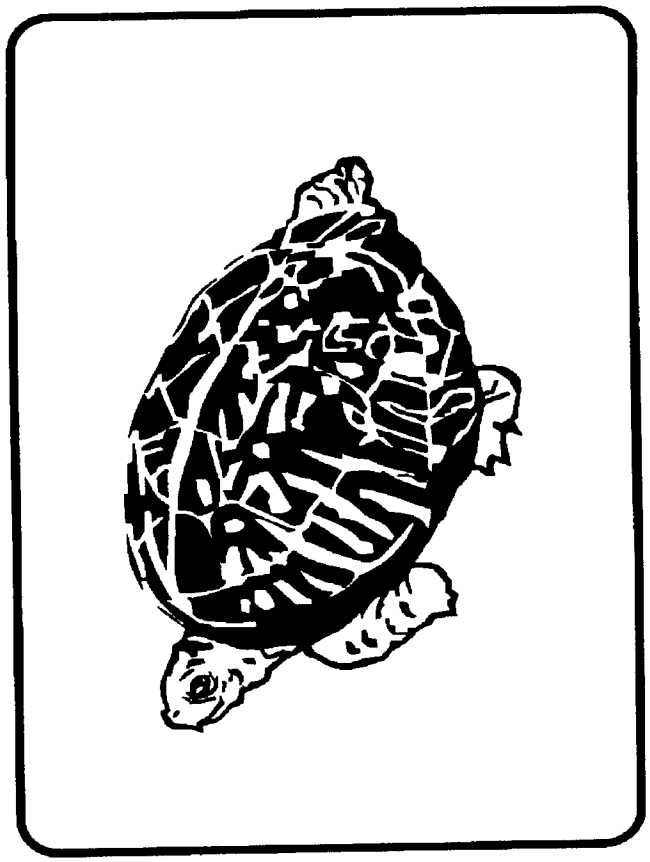


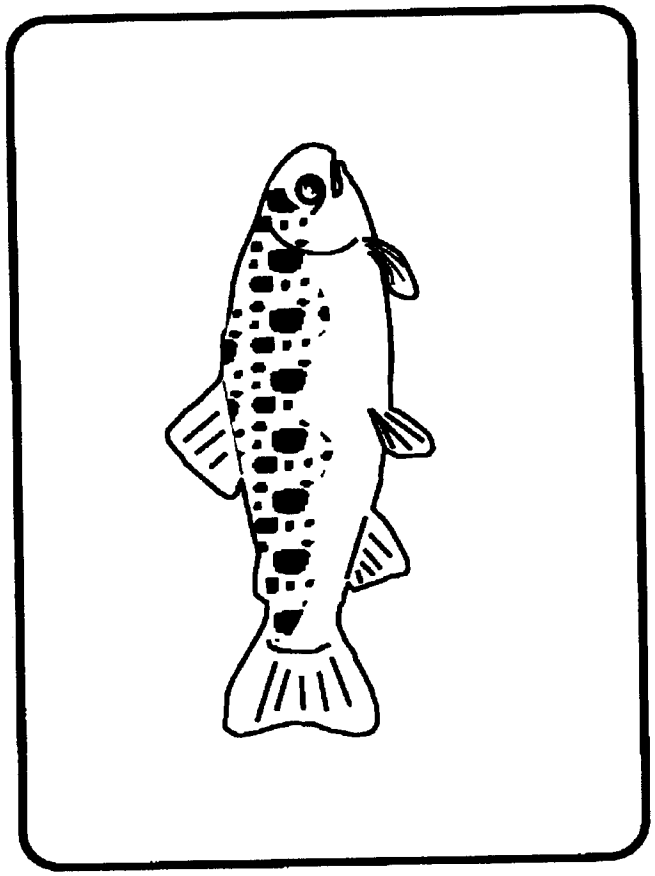


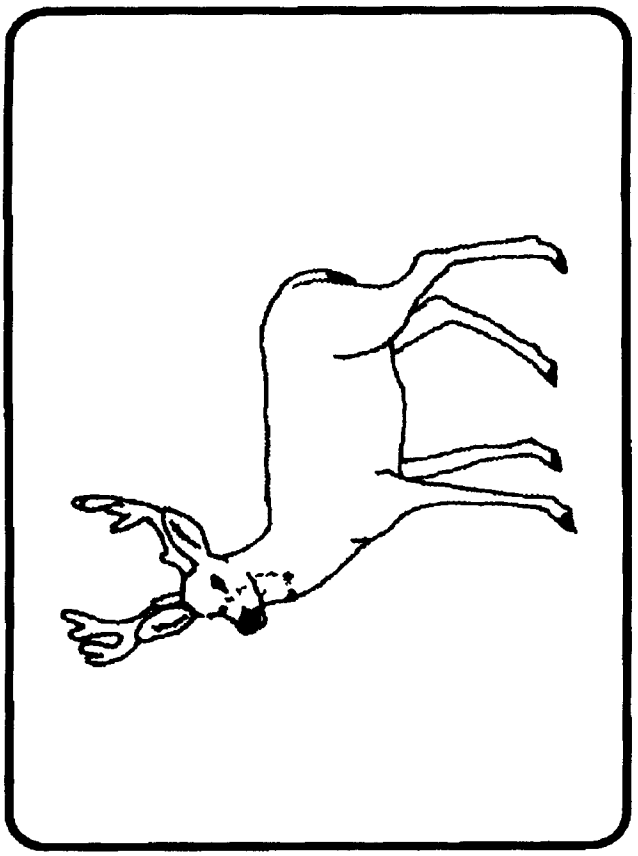


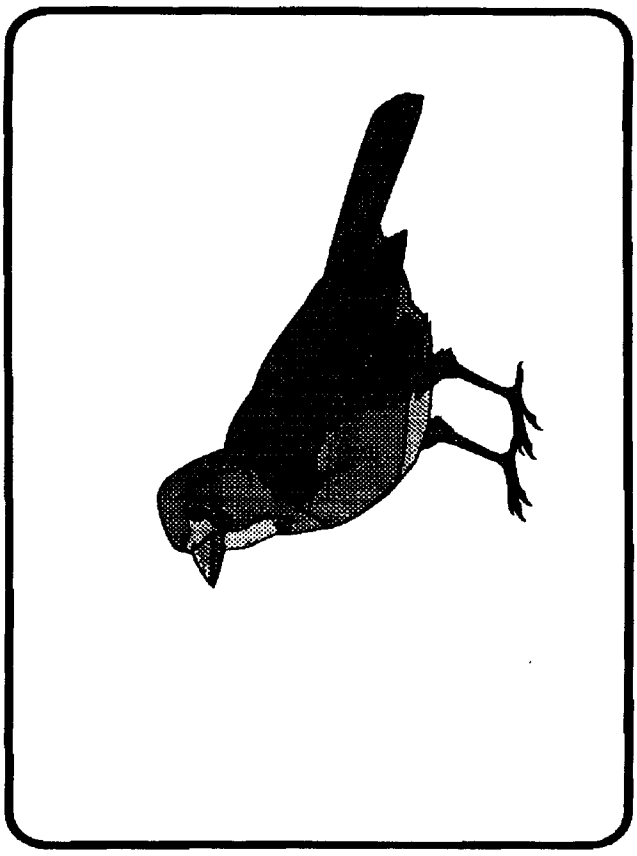


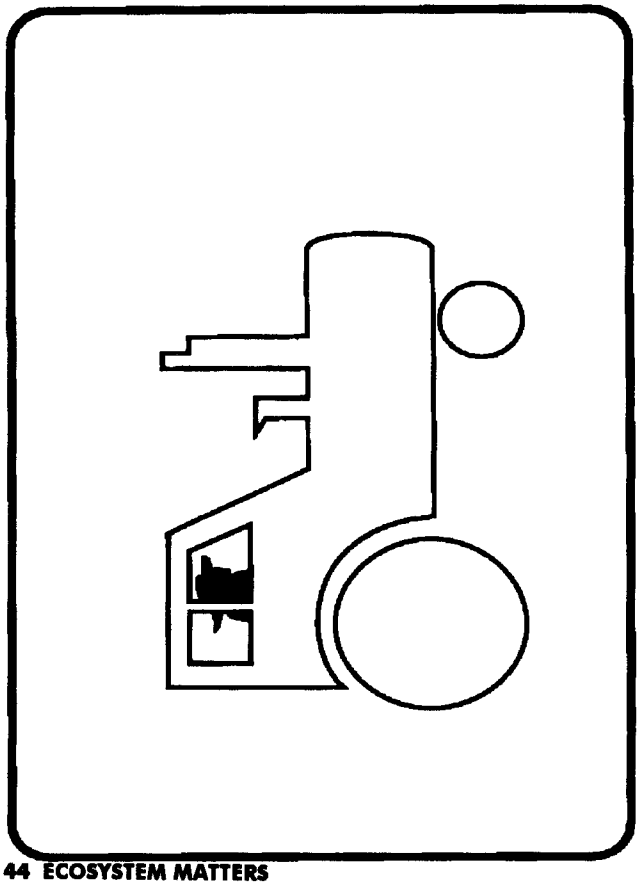


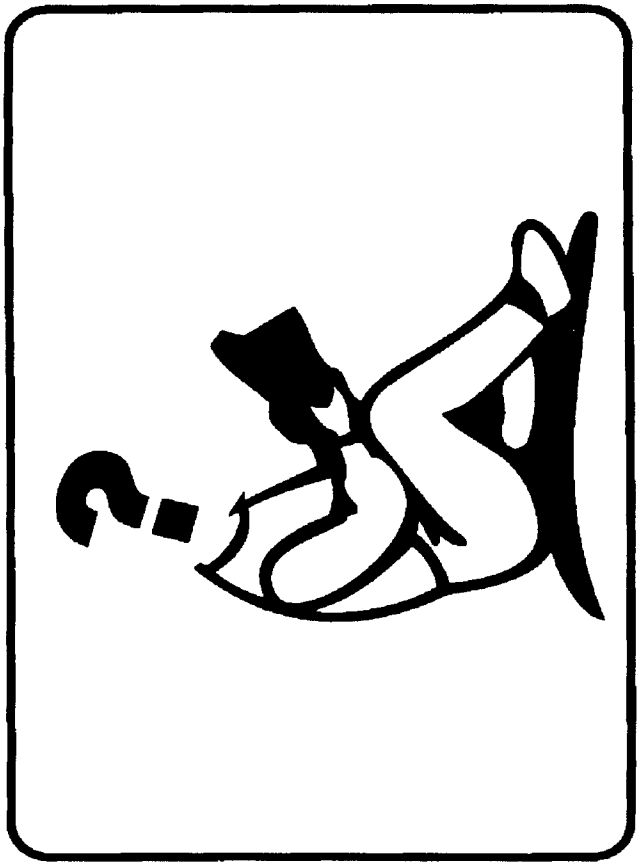


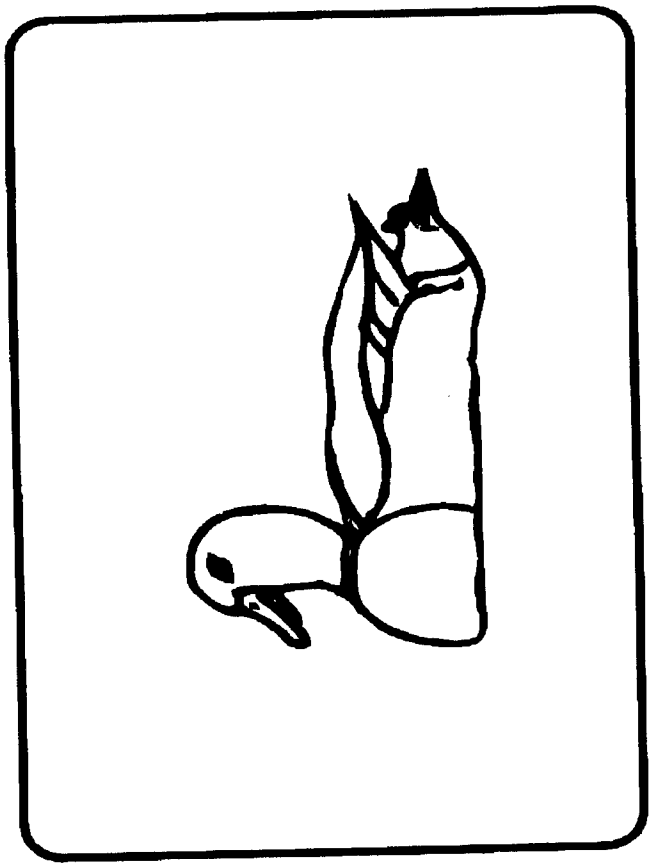


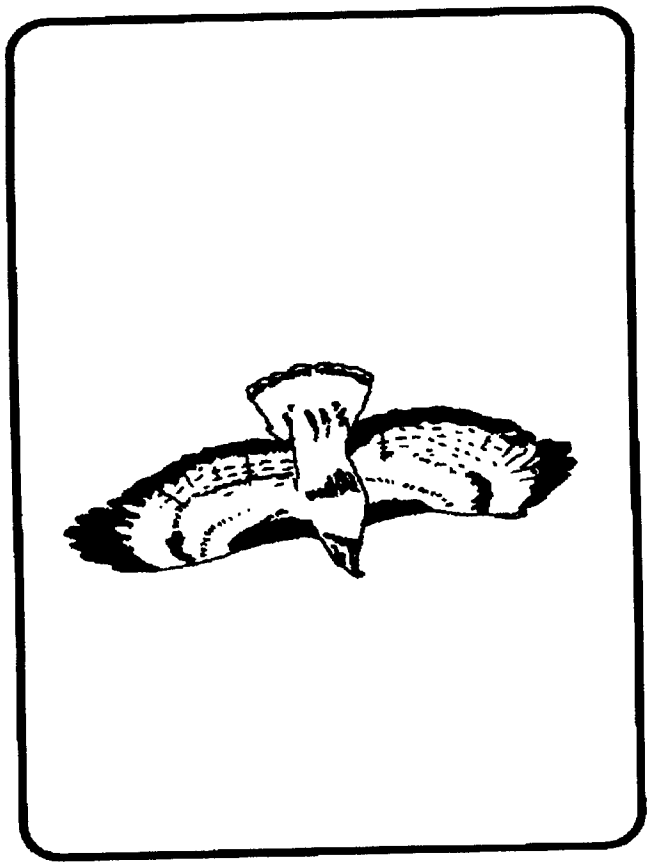


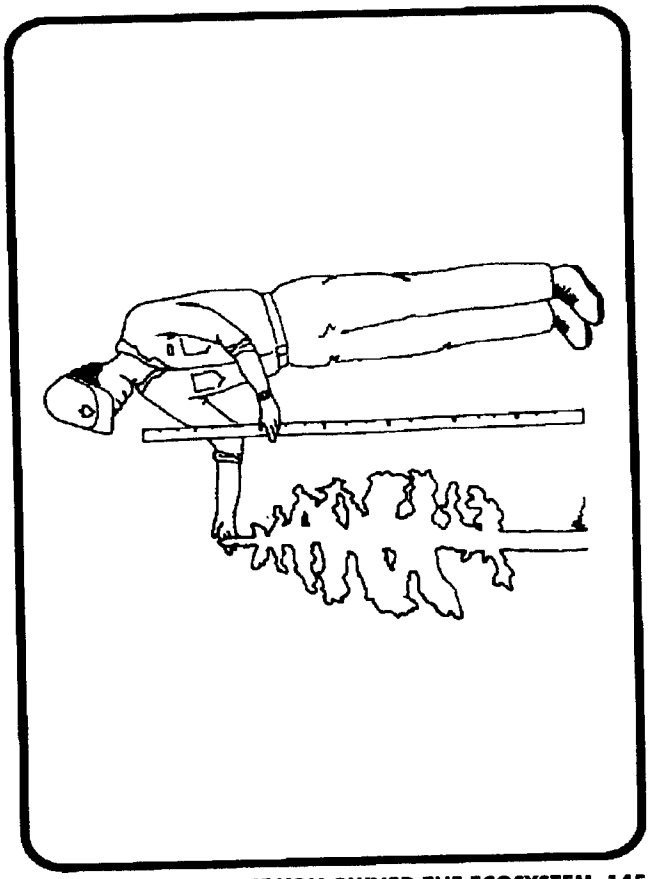


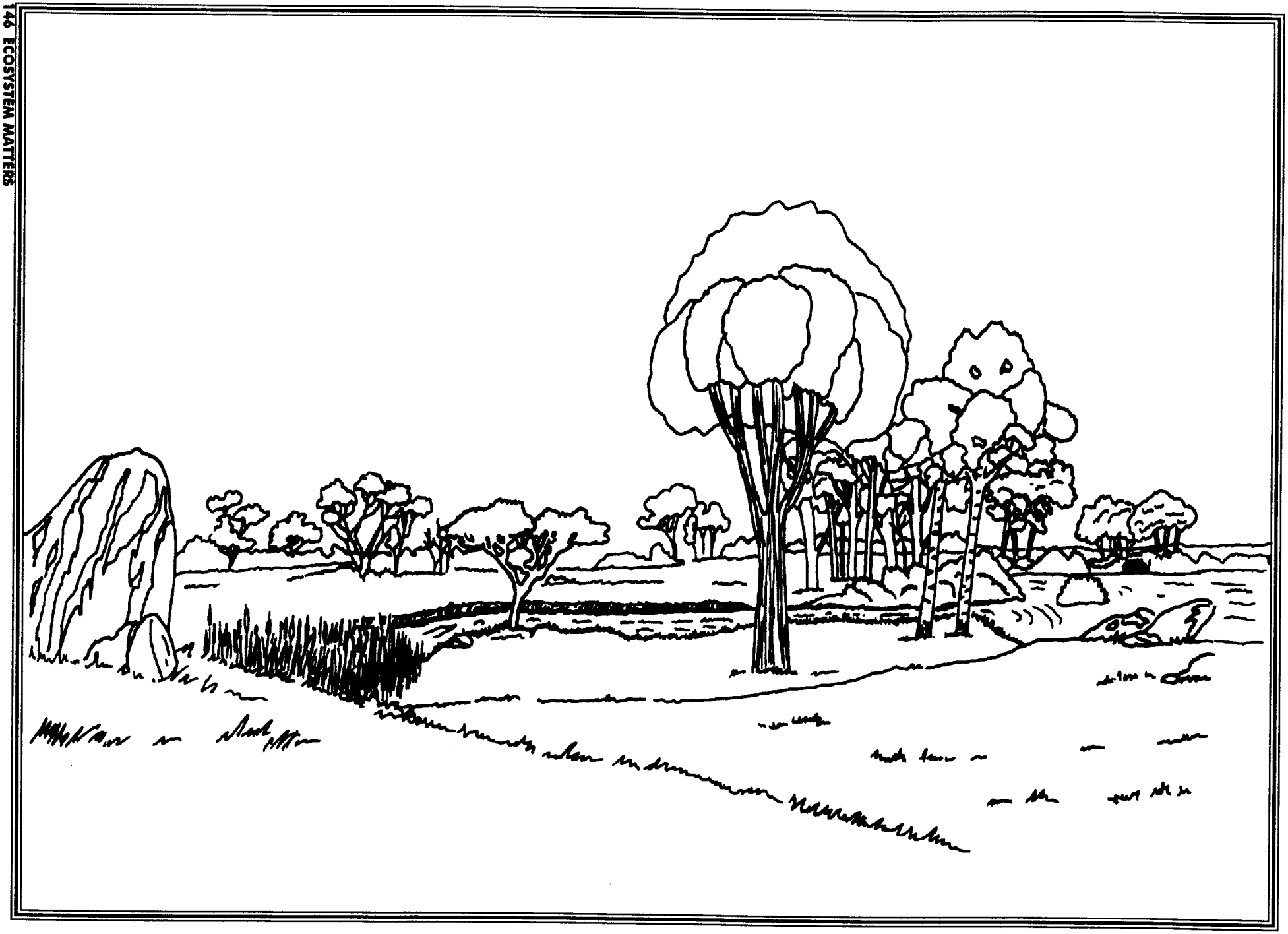












LEVEL: Grades 9-12

SUBJECTS: *Career Education, Earth Science, Environmental Education, Science, Sociology.*

PROCESS: *Through role playing various career persons and community residents, students embark on a challenging simulation in which they develop solutions that must balance water needs, environmental issues, economics, and other societal values.*

OBJECTIVES: *The student will:*

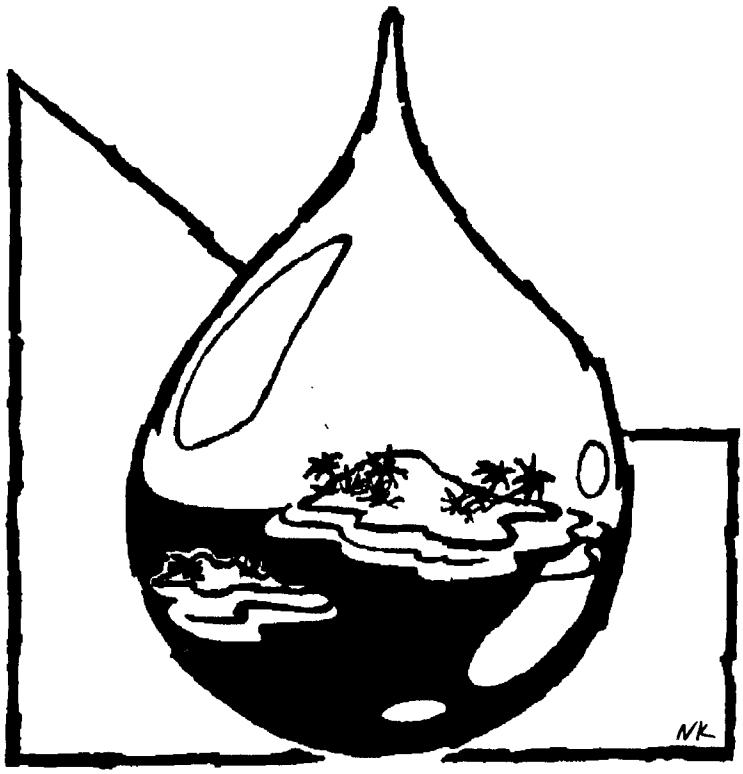
1. *Identify factors that impact water-use decisions.*
2. *Role play various water-resource careers.*
3. *Identify the interaction necessary between the disciplines to make water-resource decisions.*
4. *Identify additional information needed to make a water-resource decision.*
5. *Recognize the difficulty in making resource decisions for a community.*

TIMEFRAME: *Two to three 45-minute sessions.*

SKILLS: *Analyzing, applying, comprehending, debating, describing, discussing, evaluating, listening, listing, problem solving, role playing, understanding cause and effect, valuing.*

MATERIALS: *Poster paper, markers, calculators, "Blue Lagoon Island Fact Sheet" (attached), specific career information (attached), "Background Notes: The Maldive Islands" (attached), maps of the island for general public (attached).*

VOCABULARY: *Archaeology, desalting plant, fault, hydrology, limnology, scouring, spawning.*



MAYHEM IN THE MALDIVES

OVERVIEW: Water is a limited and precious natural resource. All living organisms depend on it. Decisions regarding water resources for a community are complex and require expertise in many different technical disciplines. Some factors to consider include:

1. The location from which water will come.
2. The amount needed.
3. The quality of the water.
4. The method of transportation.
5. The users of the water.

In addition to technical disciplines, public interest must be considered in making decisions. Professional and public groups must work together to find the best solutions based on their resources and priorities. Solutions must balance water needs, environmental issues, economics, and other societal values, such as how the solution affects the current way of life.

In this activity students engage in a simulation about water use decisions. Every student or group of students role plays a specific water-resource career and is given at least one piece of information that no one else has. Students need to take into account specific factors such as endangered plants and fish, faults, archaeological sites, economics, and changes to their lifestyles as they make decisions regarding this water use situation. Some of the background information for this simulation is based on the Republic of the Maldives, a chain of islands in the Indian Ocean.

PROCEDURE:

PRE-ACTIVITY:

1. Photocopy the maps, background information on the Maldive Islands, and the informa-

tion for each of the careers.

2. Cut apart the pages with two careers so each career person or pair is given only one career.

ACTIVITY:

1. Read the following instructions to all students:

You and your classmates live on Blue Lagoon Island, a fictional island located in the Maldive Islands. The Maldive Islands are located in the Indian Ocean, southwest of India. Some of you are members of the Blue Lagoon Island Village Council. At this week's Council meeting, the manager for the fish cannery is presenting a proposal that involves the expansion of the cannery. The expansion requires the cannery to use a larger percentage of the island's domestic water supply. In addition to many villagers and elders in attendance, there are also representatives who are employed on the island, including an archaeologist, fishery biologist, general biologist, civil engineer, economist, farmer, geologist, hydraulic engineer, hydrologist, limnologist, mechanical engineer, social science analyst, tourist board member, and water treatment plant manager. Each person has been invited to speak and assist the Council in making a decision that is in the best interest of Blue Lagoon Island.

After hearing all the concerns, the Council works to reach a consensus on the cannery's proposal. Each member of the Council has one vote.

2. Choose one student (or a pair of students, if the group is large) to represent each of the career roles listed in number 1. Choose one student to represent the fish cannery manager, two or three students to represent the village elders, two to three students to represent the young villagers, five to seven students to represent the Council members, and a Council leader.

3. Give each student or pair of students a map of the island, background notes on the Maldive Islands, and information on their specific roles. Note the archaeologist and geologist each have a different map than the general map of the island.

4. Give students time to read the materials and prepare for the Council meeting. Have students prepare name plates for their roles so members of the Council know their job titles or areas of interest.

A. *CAREER ROLES, THE FISH CANNERY MANAGER AND VILLAGERS* should make strong cases for their positions concerning this water issue.

B. *COUNCIL LEADER AND COUNCIL MEMBERS*
Council members review all the information, list the questions they may have about the project, and decide on a process for making a decision about the proposed expansion of the fish cannery. Each Council member should have a copy of the questions and be prepared to ask presenters about their concerns.

5. The Council leader asks the fish cannery manager to make a presentation to the group first.

6. The Council leader asks Council members to identify possible solutions or alternatives to get extra water to the cannery.

7. The Council leader calls on each career person to make a presentation at the Council meeting. Each career person has information that none of the other careers has and has a concern to present. The Council leader lists the advantages and disadvantages of each position, writing them down as the career person speaks.

8. Village elders and youth are invited to speak about the issue from their own perspectives.

9. After all the Council leaders have made their presentations, the Council members take the issue back into their own hands to discuss, evaluate pros and cons, and decide whether to accept, reject, or modify the fish manager's proposal. The Council leader announces the decision.

10. If there is no consensus on a decision, identify the reasons why consensus was not possible.

11. What additional information was needed to make a decision and how would that

information be obtained?

POSSIBLE ALTERNATIVES

1. Build a dam at the lake and install a pipeline to convey the water to the cannery.

2. Build a dam at the lake and build a canal to convey the water to the cannery.

3. Build a desalting plant and conveyance system next to the cannery and use the desalted water at the cannery.

4. Automate the cannery equipment.

5. Utilize the water supply from the Blue River Water Treatment Plant and convey to the cannery via pipeline or canal.

6. Reject the cannery manager's proposal--no action to be taken.

ASSESSMENT:

1. Have students identify with whom (discipline) they needed to interact in order to address their concerns. For example, the fishery biologist needed to work with the hydraulic engineer and civil engineer to take care of the spawning concern.

2. Have students each write a paragraph stating what his or her own decision would have been in regard to the cannery request and why.

EXTENSIONS:

1. Have the students diagram the interaction using lines or arrows to show (1) information needed between disciplines; (2) disciplines in agreement; and (3) disciplines in disagreement.

2. Add additional players, such as government agencies, that would be involved in enforcing environmental laws.

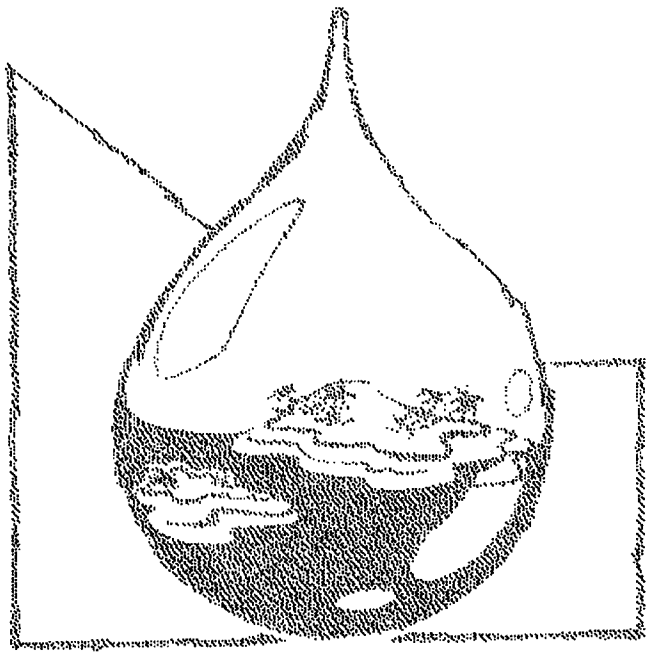
3. Ask students to identify one of the careers that appealed to them as a potential career. Have them bring in a speaker to expand on their career or ask them to research educational requirements and/or where a person with this career might find employment.

RESOURCES:

Working in Reclamation. Saving the Water, Saving the Land for the People, U.S. Department of the Interior, Bureau of Reclamation, brochure.

Engineering Careers, U.S. Department of the Interior, Bureau of Reclamation, brochure.

CREDIT: US Bureau of Reclamation and the Denver Earth Science Project contributed to this lesson.



BLUE LAGOON ISLAND FACT SHEET

General Information for each Person at the Council Meeting

Blue Lagoon Island has been inhabited for the past 300 years by a small group of people who originally came from the mainland. The villagers have a simple lifestyle. Many of them have never left the island. Historically, the villagers have farmed and/or fished for food.

The island has recently become an ideal site for small business ventures. Over two years ago, a hotel franchise built a small resort. A fish cannery was established on the island five years ago.

o Current population of the island is 1,000.

o 600 people are unemployed and they are either over 65 or under 18 years of age.

o 400 people are employable with 360 currently employed.

o 200 of those employed work at the fish cannery. The other 160 people work at the resort or the water treatment plants.

o If the expansion of the cannery is approved, 40 unemployed villagers could be hired at the cannery. An additional 160 people from the mainland could be employed.

BACKGROUND NOTES: THE MALDIVE ISLANDS

(Modified from the United States Department of State, Bureau of Public Affairs Bulletin, *Background Notes: Maldives*, February 1990.)

Official Name: Republic of Maldives

Geography:

- Area: 298 square kilometers (115 square miles)
- 1,200 islands, 202 acres inhabited
- Capital: Male
- Terrain: flat islands
- Climate: hot and humid
- Location: Indian Ocean

Economy:

- Domestic economy: tourism (17%); fishing (16%); agriculture (11%); and industry (6%)
- Exports: $35 million (fish products, garments)
- Major export markets: United States, Thailand, Sri Lanka
- Major fish sold: skipjack and yellowfin tuna
- Imports: $74 million (manufactured goods, machinery, equipment, food products)
- Major import suppliers: Singapore, Thailand, India
- First resort: 1972
- Current number of resorts on the islands: 58

Government:

- Republic: Constitution June 4, 1964
- Independence: July 26, 1965
- Branches of government: executive, legislative, and judicial
- Political parties: none
- Suffrage: universal adult

Climate:

- Equatorial; hot and humid
- Average temperature: 27°C (80°F)
- Relative humidity: 80%
- "Wet" southwest monsoon (May-October)
- "Dry" northwest monsoon (December-March)
- Average annual rainfall: 254 centimeters (100 inches) in the north; 281 centimeters (150 inches) in the south
- Absence of potable water in most places

People:

- Population: 52,000
- Ancient religion: Buddhism
- Official religion today: Islam
- Official language: Dhivehi (Indo-European language related to Sinhala, the language of Sri Lanka)
- Writing system: right to left (like Arabic)

ARCHAEOLOGIST

You are a scientist who studies the life and culture of past (ancient) peoples through excavations, artifacts, etc. Though Blue Lagoon Island is small and has a relatively small population even today, it has been inhabited during various time periods for the past few hundred years.

During the past few years, you have begun to excavate various sites where ancient peoples inhabited the island. You have already excavated a number of dwellings and worship sites from the 12th-century Buddhist civilization. You and your teammates have found pottery (broken pieces and a few entire pots), tools, pieces of fabric, Buddhist worship idols, and wood and stone fragments that outline the ancient dwellings used by the previous inhabitants.

Concern

The 12th-century Buddhist artifacts are located immediately south of the village (see map). Expanding the village southward to accommodate the additional cannery workers would destroy these relics. You are opposed to the expansion of the cannery.

FISHERY BIOLOGIST

You are a scientist who investigates fisheries-related problems, including fish habitat improvement, fisheries protection, and enhancement measures. You work with both native and non-native fish.

Concern

An endangered fish spawns in the South River. These fish require clean materials (gravel, rock, cobble) for spawning (reproduction). Sediment collects on the materials through the year but is flushed out with the rainy season flows, keeping the river bottom clean. The minimum flushing flow is 80,000 gallons a day for two weeks. If this flow is not achieved, spawning will not be successful for that year. Constructing a dam to an elevation of 80 feet would reduce or stop the flows that provide this scouring action. As a result, the substrate would become clogged with silt, and the fish would have no area in which to lay their eggs.

You are also concerned about the change in water temperature and dissolved oxygen content since these changes affect the endangered fish and the other native fish.

Fishery protection would be needed in areas where canals or pipelines withdraw water from the lake or from the rivers. That protection could consist of screens on the intake structures or barriers of some type to prevent the fish from getting out of the waters where they naturally occur. In addition, young fish may be at risk of being eaten by other species (predators) that reside around the pump intake structures. These predators eat enough of some species to threaten their already depressed population.

GENERAL BIOLOGIST

You are a scientist that deals with the origin, history, physical characteristics, life processes, and habits of plants and animals. You are concerned with the impact to the environment when the natural surroundings are changed.

CONCERN

A rare plant that grows around the lake at an elevation of 40 feet is on the endangered species list. If a dam were built at the lake to store more water, the plants would be flooded and die. In addition, wetlands are located along the South River, and you want to see them protected.

COUNCIL MEMBERS

You have been elected to the Blue Lagoon Island Village Council because you are perceived to be a fair and wise member of the community. Your job is to represent all people (present and future) and do what is in the best interest of the island.

CONCERN

You must be open minded and give each person a chance to present his or her viewpoint on the proposed fish cannery expansion. Keep in mind that potable water is a scarce and valuable resource on your island. Your main task is to look over the information about the island and decide what else you need to know to make a good decision.

CIVIL ENGINEER

Civil engineering is the branch of engineering that deals with the design and construction of dams, highways, bridges, tunnels, waterworks, structures, etc. Before these structures can be built, survey crews determine the geologic structure in the area. Raw materials needed for construction, such as gravel and sand to make concrete, are ordered and delivered to the construction site. Land owners in the vicinity of the new construction are contacted for permission to allow workers on or near their land. If the structure is to be built on land not owned by the government, purchase of the land is required before construction can begin.

CONCERN

As a civil engineer, you know that all raw materials for the cannery expansion must be imported to the island. Sand and gravel, averaging $8 per ton, can be brought to the island. You estimate that 3,500 tons of sand and gravel will be needed to expand the cannery.

All of the heavy construction equipment must also be brought to the island. This not only adds considerable cost to the project, but it could also damage the roads that the heavy equipment and supplies must be driven over. The roads were not built to carry heavy loads.

For the dam alternative, an outlet works would have to be designed that would meet the flushing flow requirement of 80,000 gallons a day so the fish can spawn.

The canal and pipeline alternatives would require construction of fish screens to keep the fish out of the pump intake structure.

ECONOMIST

You are a specialist in the science that deals with the production, distribution, and consumption of wealth, and with the various related problems of labor, finance, and taxation. You help companies predict what products are wanted by the people, and help establish production and distribution systems that will get the products to the consumers. You help companies look at the costs of raw materials, labor, buildings, and taxes. You advise them on how to spend and invest their profits.

CONCERN

The cost to build either a pipeline or canal to the cannery from the treatment plant or the lake is about $1 million a mile. The cost for fish screens would have to be added to this cost. The stronger the pump intake structures, the greater the cost for the fish screens.

The cost of building a dam at the lake to an elevation of 80 feet would be $5 million.

Desalting sea water is about $3.50 per 1000 gallons. 50,000 gallons per day would cost $175 a day or $63,875 a year. The cost to convey the desalted water is 1% of the project cost. It would cost about $10 per gallon to build the desalting plant.

FARMER

You represent the agricultural community for the island. Dominant crops include fruit trees and coconut palms.

CONCERN

Agriculture provides 11% of the income to the island. You do not want to see water taken away from agriculture in order to provide water for the expansion of the cannery. As far as you are concerned, agriculture is just as important as the cannery.

You and the other farmers are willing to support expansion of the cannery as long as the water does not come from agriculture.

GEOLOGIST

You are a specialist in the science that deals with the physical nature and history of the earth. This includes the structure and development of its crust, the composition of its interior, individual rock types, fossils, and ground movement along faults. You also study fossils embedded in the rocks to learn about the past climate and organisms inhabiting continents and oceans. Besides studying the basic rock make-up of the earth, you study faults and volcanic activity on Blue Lagoon Island and other islands that make up the Maldives.

CONCERN

There is an active fault between the current cannery and the lake (see map). A fault is a fracture (break, crack, split) or zone of fractures in layers of rock together with movement that displaces the sides relative to one another. A canal or pipeline to carry water from the lake or from the Blue River Treatment Plant to the expanded cannery would be potentially dangerous since it would have to cross the active fault. An earthquake along the fault after such a canal or pipeline is built could potentially cause great destruction as the flood water flows to low lying regions. The fault also makes it undesirable to expand the village to the north to accommodate new employees and their families moving to the island.

HYDRAULIC ENGINEER

Hydraulic engineering is the branch of civil engineering that deals with the physics of the movement of water and the affected structures of channels. You would help in designing outlet works from the dam and intake structures for the canal or pipeline.

CONCERN

An endangered fish spawns in the South River. These fish require clean materials for spawning (reproduction). Sediment collects on the materials through the year but is flushed out with the rainy season flows.

Building the dam to an elevation of 80 feet will reduce the river flow and only allow flows of 50,000 gallons per day.

LIMNOLOGIST

Limnology is the field of science that studies fresh water ecosystems including water quality (chemical), sediments (physical), and the food chain (biological). You are involved in the collection of water and sediment samples and analyzing them to make sure specific water quality standards are met.

CONCERN

Making the lake deeper can change the temperature of the lake, the dissolved oxygen content, and the productivity (food for fish). These changes could reduce the number of native fish in the lake and/or create habitat that would be more suitable for non-native species that would out-compete the native species. Flooding areas that were not previously under water could also change the productivity of the entire lake.

HYDROLOGIST

You are a scientist who deals with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, and flow to the seas. You are concerned with the water level in aquifers and the flow of water in rivers and lakes since all plants, animals, and people depend on one of these sources for freshwater. Islands such as Blue Lagoon often have a limited amount of freshwater because the precipitation runs quickly off the land into the ocean.

CONCERN

The island has a dry season (six months long) and a rainy season (six months long). Rainfall on the island flows to the ocean as follows:

*Blue River: Rainy season = 350,000 gallons per day
Dry season = 200,000 gallons per day

*East River: Rainy season = 100,000 gallons per day
Dry season = 75,000 gallons per day

*South River: Rainy season = 100,000 gallons per day flows into the lake and down to the ocean via the South River

Dry season = Flow into the lake drops to 25,000 gallons per day

When the lake level gets to 60 feet, the South River begins flowing at 50,000 gallons per day. For the lake to supply 50,000 gallons per day during the dry season would require raising the lake level to an elevation of 80 feet by building a dam on the South River.

FISH CANNERY MANAGER

You are proposing the expansion of the cannery. The cannery processes tuna that is "dolphin free." With the recent dolphin-free awareness in the United States, there is great potential in the U.S. tuna market. Processing tuna in a cannery requires large quantities of water. Additional water is needed if the cannery is to expand. A larger cannery would increase jobs and lift the economy.

CONCERN

Current cannery: Processes 5,000 pounds a day
Requires 10 gallons water per pound of tuna (50,000 gallons per day)
Employs 200 people

Proposed Expansion (Doubling Plant Size)

Cost of expansion = $10 million
Requires an additional 50,000 gallons of water a day
Would employ an extra 200 people

Since the cannery is currently using the entire dry season flow of the East River, extra water could come from the Blue River Treatment Plant, which has extra capacity. The cost to get water from the Blue River Treatment Plant to the cannery is not included in the $10 million. You assume the Village Council will pay for it because of the increased revenue your expansion will bring to the island.

MECHANICAL ENGINEER

Mechanical engineering is the branch of engineering that deals with the design, operation, and production of machinery and mechanical systems. You help design new and more efficient machines for production and assembly lines in large companies.

CONCERN

As a mechanical engineer, you know that another option to expanding the cannery is to automate the machinery. Rather than do all the fish processing by hand, you suggest that the addition of specialized machines would help speed up the processing of fish. This type of modernization costs twice what the expansion would, but it requires less water and fewer additional workers.

Alternative Cannery Process -

Cost to double plant output = $20 million

Water usage cut from 10 gallons per pound of tuna to 7 gallons per pound (total of 70,000 gallons per day)

Total employment = 300

SOCIAL SCIENCE ANALYST

You are a specialist who examines how change impacts the lives of people living in a region. You want to know how new businesses, jobs, construction, people, and products affect an existing community.

CONCERN

As the social analyst, you are concerned about how the people of the village will be impacted if a social change occurs. If there is a large influx of people from the mainland, will the customs and traditions of the native islanders be lost? How could this affect future generations if their heritage is not preserved? Can the 160 additional workers commute by ferry back and forth from the mainland instead of living on the island?

TOURIST BOARD MEMBER

As a representative of the island tourist businesses, you would like to see the local resort expanded. You are responsible for bringing tourists to the island for vacations. Since the resort was built two years ago, tourists have eagerly visited the island because it offers rare beauty in a relatively isolated setting. The island offers tourists a wonderful, quiet get-away with many unique historical and cultural attractions like the 12th-century Buddhist artifacts, waterfalls on the Inner River, the Blue Lagoon, and the lush tropical vegetation.

CONCERN

Expanding the resort would compete with the additional water needed by the cannery. Also, the 12th-century Buddhist artifacts and the beauty of the natural waterfalls, found on the Inner River, are crucial to attracting visitors to the island. It has become evident in the last few years that more and more tourists want a vacation that is unique and away from regular tourist crowds.

Sport fishing could be impacted by the dam alternative if flushing flows are not adequate to provide for spawning.

You propose the expansion of the resort at a cost of $10 million rather than the expansion of the fish cannery to boost the economy of Blue Lagoon Island. Tourism currently brings $7 million to the island annually (on the average 100 guests are on the island every day). The resort could easily be expanded to accommodate 200 guests a day.

WATER TREATMENT MANAGER FOR BOTH PLANTS

As plant manager for both the Blue River and East River Water Treatment Plants, you are responsible for providing an adequate, clean water supply to the people living on Blue Lagoon Island. As part of your job, you investigate the available water supplies and determine the quantity of water being used by each resident living on the island. In addition, you must be able to supply enough clean water to businesses such as the cannery and resort.

CONCERN

The water supply system is adequate now, but there will not be enough water if the number of people increases or if the cannery requires more water.

Each villager requires 150 gallons of water a day. The resort averages about 100 guests a day who require 150 gallons of water a day.

The village and resort receive all of their water from Blue River Treatment Plant: 165,000 gallons per day (Capacity = 215,000 gallons per day).

The cannery receives 50,000 gallons per day from East River Treatment Plant. This is the plant's full capacity.

If the cannery expands as proposed, it will require an additional 50,000 gallons per day (the entire extra capacity of the Blue River Treatment Plant). The 160 new villagers will require an additional 24,000 gallons per day. They will require even more water if each of those new villagers has a family.

VILLAGER ELDERS

You represent the local village and its community. You have lived your entire life on Blue Lagoon Island and want to see the island continue as your quiet beautiful home. You continue to carry on the customs begun by earlier generations of island people.

CONCERN

The elders are opposed to the fishery expansion. You believe it will alter the current way of life, create more pollution, and destroy part of the natural rainforest so important to the island people. You are concerned about the political power shifting if many people from the mainland move to the island.

YOUNG VILLAGERS

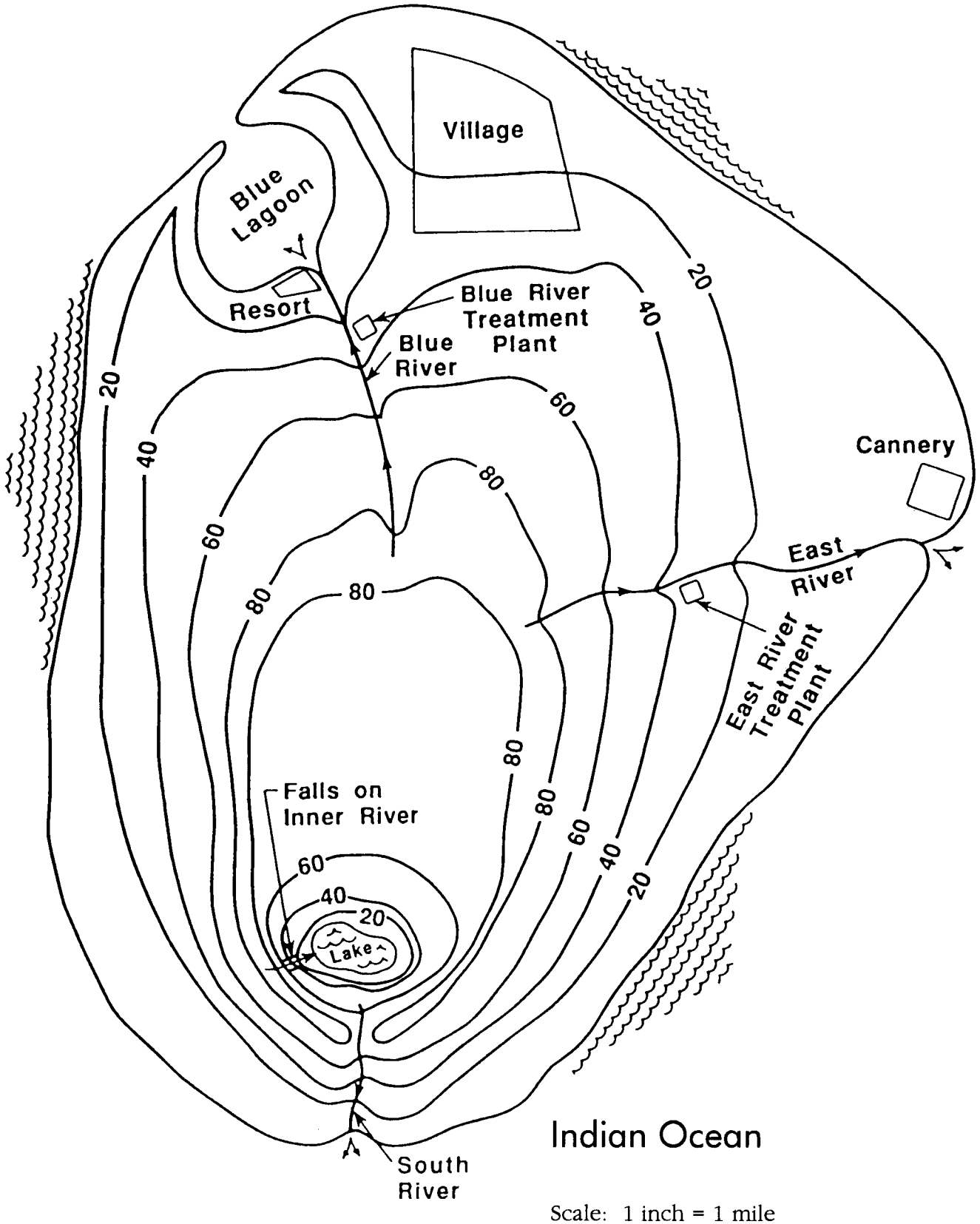
You represent the young people living on Blue Lagoon Island. Although you respect the wishes of the elders and abide by many of the old customs, you realize that change is taking place on the island and throughout the world. You have been introduced to modern electronic equipment such as radios, TVs, and compact disc players through tourists you have met visiting the island. You want modern appliances (refrigerators, stoves, etc.) for your family.

CONCERN

You are definitely in favor of the expansion of the cannery or the resort. You realize that either expansion will result in more jobs on the island. More and better paying jobs are needed by the young people who will be the future leaders of the island.

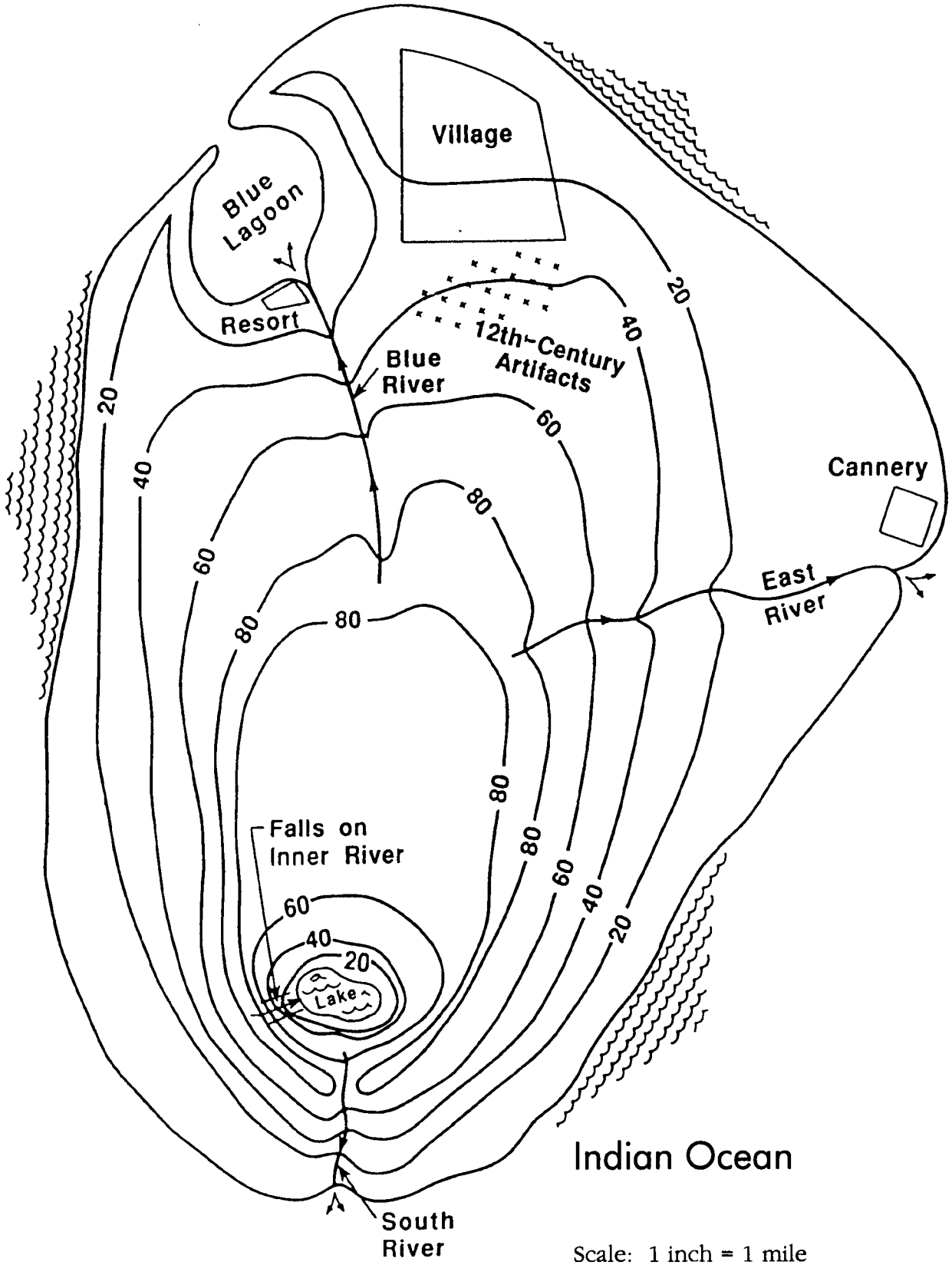
You are concerned about outsiders from the mainland coming to the island for these new jobs. You want control of the island to remain in the hands of local villagers. Like the elders, you do not want to see a shift in political power to outsiders. You are committed to supporting the island if new jobs are provided.

BLUE LAGOON ISLAND (For All)



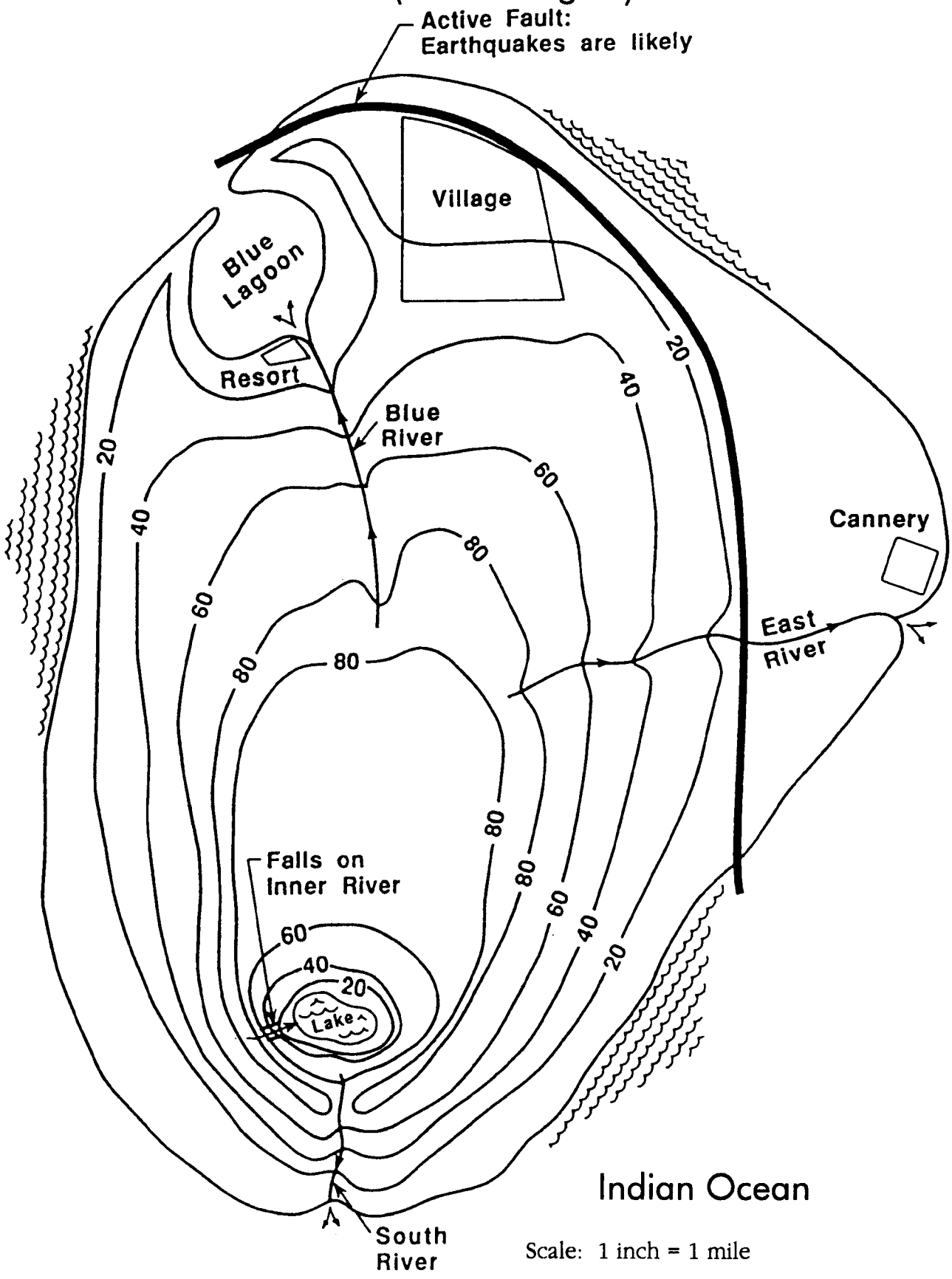
Scale: 1 inch = 1 mile

BLUE LAGOON ISLAND (For Archaeologists)



Scale: 1 inch = 1 mile

BLUE LAGOON ISLAND (For Geologists)



Scale: 1 inch = 1 mile

LEVEL: *Grades 6-12*

SUBJECTS: *Science, Social Studies, Art, Language Arts.*

PROCESS: *Through artwork and reading Aldo Leopold's "The Land Ethic" in* A Sand County Almanac, *students will develop a sensitivity for and understanding of the land ethic, determine the diversity and complexity of natural environments, and discover the impact humans create when they settle in a natural environment.*

OBJECTIVES: *The student will:*

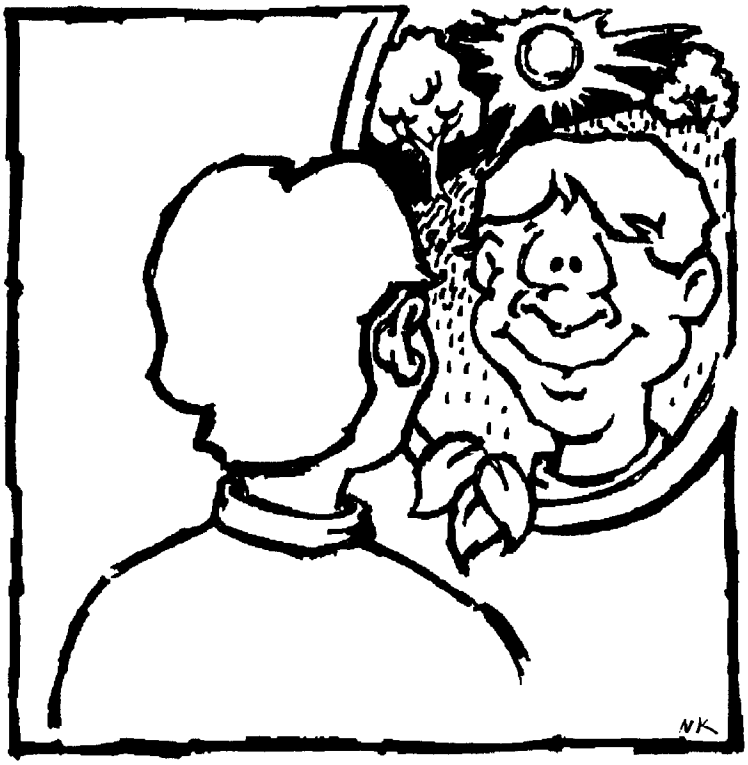
1. *Demonstrate the human impact on natural environments.*
2. *Demonstrate the connections of humans to natural systems.*
3. *Gain an appreciation for Aldo Leopold's "The Land Ethic" in his book,* A Sand County Almanac.

TIMEFRAME: *1 hour 30 minutes.*

SKILLS: *Communicating, comprehending, critical thinking, discussing, drawing, gathering and using information, identifying, inferring, interpreting, reading, researching, understanding cause and effect, working in small groups.*

MATERIALS: *Mirror, butcher paper (approximately an eight to ten foot piece), crayons, paint and/or colored pencils, construction paper, scissors, glue or tape, "The Land Ethic" in* A Sand County Almanac, *Aldo Leopold.*

VOCABULARY: *Biotic community, ecosystem, ethic, phenomena.*



MURAL, MURAL ON THE WALL

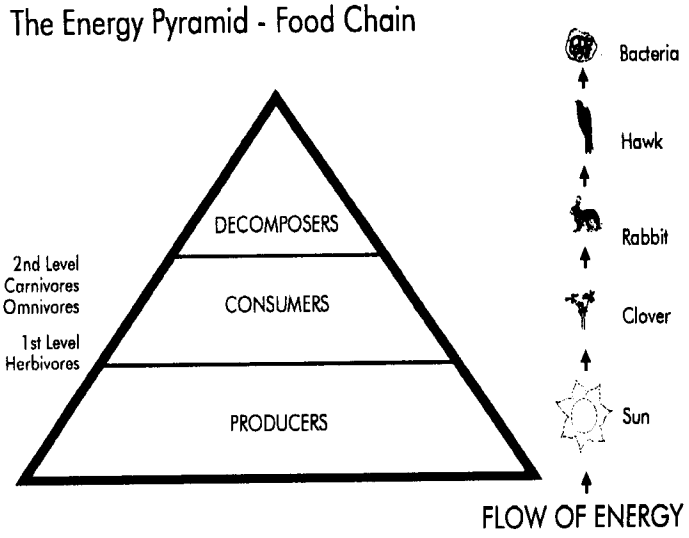
OVERVIEW: When you look in the mirror, you see your reflection in much the same way others see you. Look at what else is in the mirror, however. In the background you will see other images, such as the sun, trees, or grass. Now consider what else is a part of the reflection that you cannot see. Think of air, water, and energy. What you are seeing is what scientists call an ecosystem: the connection of the physical environment with living organisms in a specific area.

Since all living organisms require energy to live, energy is one important link that ties the various components in an ecosystem together. Plants, called producers, are the first link. They transform the sun's energy into food for other organisms, storing extra energy in structures like leaves, seeds, stems, roots, and flowers. Since omnivores or herbivors cannot directly transform the sun's power into energy, they consume food from the plants.

Energy is continually transformed for a variety of needs in order to sustain a diversity of living organisms. This transformation of energy is best understood if you think of a food chain. For example, the clover stores extra energy from the sun in its leaves. A rabbit eats clover, transforming the energy to carry out its basic life functions. A predator such as the hawk, preys on the rabbit, further transforming the energy for its needs. Finally, at the top level of the food chain are the decomposers that turn remaining matter into usable raw materials for the soil so plants may again begin the cycle. Even though energy is consumed at each of these levels, less energy becomes available the further we move up the food chain.

Visually this process of transforming energy in a natural environment takes the shape of a pyramid. Imagine the energy

pyramid as a model for energy flow. Each level represents the transformation of energy and suggests the amount of energy available for the next level of living organisms. The direction of energy flow is based on the structure of the ecosystem and on who is next in the food line. It is illustrated in the following model:



The area at the bottom of the pyramid represents the greatest amount of energy in the system. As the energy passes from producers to decomposers, the areas of the triangle become smaller, reflecting the decreased energy at that level. This, of course, represents a simplified ecosystem. In natural systems there is much more complexity.

Humans are part of the energy pyramid. Since humans do not receive energy directly from the sun, we are primarily omnivores who are dependent upon the energy produced by plants. We are consumers who form links in the food chain along with other plants and animals. Therefore, we are interconnected with other organisms in this complex ecosystem. Rather than just a "reflection in the mirror" and separate from our physical environment, we are an integral part of the system.

According to Aldo Leopold in "The Land Ethic" (*A Sand County Almanac*), the understanding and valuing of the natural environment is a moral issue, a matter of right and wrong. "The Land Ethic" places humans as citizens of the "land community" and implies that humans must value their place in their physical environment. We must consider future generations in the biotic communities. According to Leopold, the harmony between human populations and the land is an intrinsic value that influences the lifestyles and actions of humans to conserve for future generations.

The impact of human development can be quantified and qualified to include the total human experience, helping us make personal day-to-day decisions about the use of natural resources. These personal choices of individuals impact natural environments more than any other physical or biological phenomena. Human choices today influence the sustainability of lifestyles in the years to come as human populations increase.

PROCEDURE:

1. Have one student hold up a large mirror at arm's length and describe what he/she sees in the reflection. (Many students will describe themselves, but not what is in the background of the reflection.) This part of the activity could be done outdoors to have a part of the natural surroundings reflected in the mirror. Ask:

-What do you see?

-What else is in the reflection?

Have students make the connection between their reflections in the mirror and the reflection of the natural environment.

2. Have students identify the changes over time that have occurred in their region of the United States. This can be a discussion of the geological and climatic changes that have occurred over thousands of years. Determine the components that were present in one or two of the biotic communities in the area before settlement of human populations in North America. Ask:

-What kinds of trees, shrubs, and animals were present? *(If reference materials aren't available to answer this question, students can make inferences.)*

-Were there human influences on natural environments? When did they occur? What kinds of impacts were there? *(A timeline of human impacts leading to the settlement of your area will give your students the perspective of time and of human impact after settlement.)*

3. Divide the group into two. Ask one group to draw and color a mural of a natural environment, preferably with local qualities, on an eight-to-ten foot piece of butcher paper. Discuss with the group the changes that have occurred in the past and include drawings of as many wildlife and plant species as possible. (Research materials will need to be readily available.) What wildlife and plant species did you include in your mural? What are some of the connections between them? Describe a food web from the drawing you are making. Describe how energy flows in one of the food chains depicted in your drawing. (Drawing and tracing the landscape on the butcher paper takes time. You will want to give this group as much time as it needs to draw and color because it will better represent the concept of geological time as the activity progresses. Don't forget to include the physical environment. Water, air, and soil are essential in establishing the types of biotic communities in your region.) How have the climatic changes in geologic time determined the presence, absence, or distribution of natural resources in the physical environment, like water or soil? Predict what would happen to your natural environment after a fire.

4. Ask the other group to secretly draw and cut from construction paper human "stuff," including buildings, roads, cars, motorcycles, parking lots, power lines, etc. What are some of the raw materials needed to produce the products we use? Where do these raw materials come from?

5. Come together as one group, tape the natural environment mural to the wall, and then ask the second group to tape the human "stuff" on the mural. Describe the human settlement that has occurred in your area in comparison to geological time. Discuss the reactions of each group as well as the impacts made on the land. (Collectively, this includes plants, animals, water, soil, air, use of natural resources, etc.) What is the impact on the natural environment when we add human "stuff" to the mural? Can you determine the influences on a food chain, food web, uses of natural resources like soil and water, and on the flow of energy? Summarize in your own words the impact of human development on natural environments. Discuss the reactions of each group as well as the impact made on the land. How is human impact different than the impacts of other natural phenomena, like fire or drought, in a natural environment?

6. Read Aldo Leopold's "The Land Ethic" from his book *A Sand County Almanac* to your group. Discuss with your students the value of conservation. Encourage voluntary testimony of individual actions that have minimized human impact on the natural environment. What individual actions at school and at home minimize the impact and influences of human development on natural environments? What else can be done?

ASSESSMENT:

1. Have students describe a food chain, food web, and ecosystem.

2. In writing, have students describe their reactions to taping human "stuff" on the mural of a natural environment. Relate this to Aldo Leopold's "The Land Ethic" in his book, *A Sand County Almanac.*

EXTENSIONS:

1. In writing, have students summarize the meaning of "The Land Ethic."

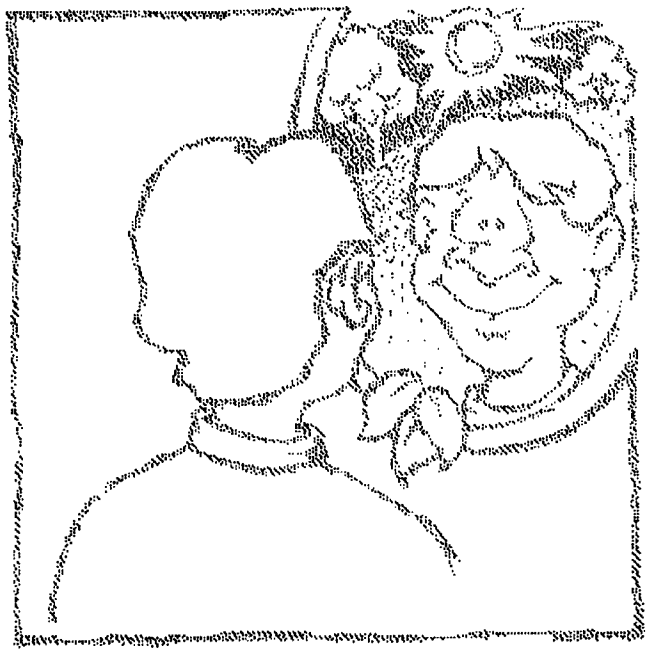
2. Build a classroom model of an energy pyramid from another biotic community in your region, in another region, or another part of the world. Construct a diorama or an aquarium to represent an ecosystem of your choice.

3. Write reports that combine the social, cultural, economic, and political influences from your region with other regions of the world. Compare the similarities and differences in understanding and valuing of the "land" and conservation for future generations. What are the significant ramifications for developing a regional or world wide "land ethic?"

RESOURCES:

A Sand County Almanac, Aldo Leopold, "The Land Ethic," First Ballantine Books Edition, New York, 1966.

Local reference materials on natural resources including plants, animals, history of settlement, and information about natural resources can be obtained through several natural resource management agencies in your area.



LEVEL: Grades 8-12

SUBJECTS: *Science, Biology, Ecology, Environmental Education, Communication, Social Studies.*

PROCESS: *Through group communication, students solve an ecological mystery.*

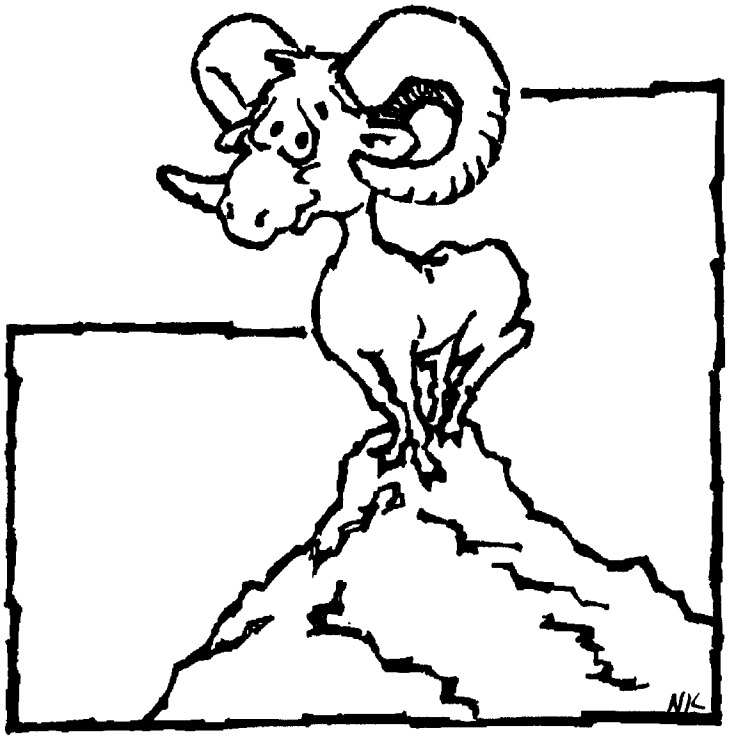
OBJECTIVES: *The student will:*
1. *Analyze information and solve a mystery.*
2. *Diagram the solution.*
3. *Create alternative plans to prevent the combined conditions from reoccurring.*

TIMEFRAME: *45 minutes to 1 hour.*

SKILLS: *Analyzing, debating, discussing, evaluating, listening, problem solving, public speaking, reading, synthesizing, working in small groups.*

MATERIALS: *Writing materials, dictionaries, encyclopedias, resource books with information about bighorn sheep, "Mystery Story," "Mystery Questions," and "Mystery Fact Cards" sheets (attached).*

VOCABULARY: *Alpine, ewe, fetus, kid, larval stage (larvae), lifecycle, parasites, placenta, pneumonia, public land, ram.*



MURDER EWE WROTE

OVERVIEW: Bighorn sheep, *Ovis canadensis*, live in the rugged terrain of the Rocky Mountains. They are tan-to-brown color, weigh about 75-200 pounds and stand about two-and-a-half to three-and-a-half feet tall. Adult males are called rams, adult females are called ewes (pronounced like "you"), and young are called lambs. They eat grasses and similar plants in high mountain meadows and rocky cliff areas. They are usually found in herds numbering 10 to 100. Rams are very muscular and known for their large curling horns which they use in dramatic collisions with other rams during breeding season. Ewes have small horns that don't curl very much. Bighorn sheep should not be confused with the Rocky Mountain goat, its shaggy, white, small-horned cousin.

The overall population of bighorn sheep has rebounded somewhat from destruction by market hunters in the late 1800s. Limited hunting is now allowed under strict regulations. Throughout recorded history, bighorn sheep herds were known for precipitous die-offs. The reasons for these population crashes have remained a mystery and only recently have they been thoroughly investigated. Die-offs still occur today, but with proper wildlife and ecosystem management techniques, they are less severe.

The bighorn sheep die-off example used in this activity is fictional, but it is based on several case studies of bighorn population crashes in the west.

Students will solve an ecological mystery using the information provided, thinking and problem solving skills, and perhaps some resource books.

PROCEDURE:

PRE-ACTIVITY:

Photocopy one copy of "Mystery Fact Cards" to be cut apart, and a photocopy of the "Mystery Story" and "Mystery Questions" for each group of four to five students.

ACTIVITY:

1. Ask students to share what they know about bighorn sheep. Discuss any additional background information about bighorn sheep with students (see Overview). Tell students they will be solving a mystery about bighorn sheep as a class using fact cards. They will also have a copy of a story and questions in their small group for reference.

2. Divide into groups of four to five students. Distribute the "Mystery Story" to each group. Have them read the story as a class or in their small groups.

3. Share the following guidelines with students: Using the story and 24 fact cards, we will solve this ecosystem mystery. Once you are given a fact card, you may not pass or trade it with others. Only as a group, using good communication skills, can we solve the mystery. The fact cards will be read to the rest of the class one at a time and in order.

As the facts are read aloud, we will begin to piece together the solution to the mystery. It will be helpful to focus on the "cause," "weapon," and "motive," as well as previewing the questions.

4. Distribute a set of "Mystery Questions" to each group, so students can preview them.

5. Distribute one fact card to each student. Remind students they may not trade fact cards or give them to someone else!

Have students read their fact cards one at a time in order. As fact cards are read, let students decide how best to organize the information and begin to solve the mystery. Students may struggle at first with the wealth of information, but that is part of the process. A possible strategy is to designate students as recorders of specific information for the class.

Good group communication and participation are critical. Beware of letting a few students dominate the activity. It may be helpful for you to preview the questions and answers.

6. Discuss the questions as a class or have students address them in their small groups. Leave ample time for thorough discussion of mystery questions nine and ten.

Mystery Questions and Answers:

The overall message in this activity is that numerous factors, not one or two, lead to the population crash.

1. How many bighorn sheep died between the summer and February 5? *(Approximately 202 sheep died.)*

2. What unusual wildlife behavior could have been an early clue that something was wrong with the herd? *(On January 18, tourists were getting very close to the bighorns. Wild animals very rarely let humans approach them.)*

3. Why did so many of the herd die in such a short period of time (January through February 5)? *(Once the disease established itself in the unhealthy herd, deaths occurred quickly.)*

4. Why did the rams die earlier than the ewes? *(Rams were tired and worn out as a result of fighting during the breeding season.)*

5. Why were there only a few kids in December, though there were many in the summer? *(The lungworm is passed from the ewe's body through the placenta and into the fetus' body. Kids are more likely to eventually succumb to an infection of lungworm.)*

6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm? *(Bighorn sheep accidentally eat small snails while they graze. These snails are a host for lungworm larvae. The larvae penetrate the intestinal wall and travel to the lungs where they become adults. Lungworms lay eggs in the lungs. The eggs hatch and the young larvae enter the air passages where they are coughed up and swallowed by the bighorns. The lungworm larvae are excreted in fecal pellets and seek the host snail.)*

7. Why don't all bighorn sheep die of pneumonia/lungworm? *(Many bighorn herds are infected with both lungworm and bacteria. Healthy herds are usually able to cope with these disease-causers. Unhealthy herds cannot.)*

8. What is the relationship between the pneumonia bacteria and the lungworm? *(In weakened, stressed, or young bighorn, the lungworm lesions provide suitable sites for the pneumonia-causing bacteria to grow.)*

9. Who or what caused the die-off of the bighorns? *(No one intended to harm the bighorn sheep. Numerous factors working together caused the population crash. These factors include:*

A. Presence of lungworm and pneumonia-causing bacteria.

B. Extreme weather caused bighorns to expend more energy than usual and this weakened them. Crowding caused by deep snows allowed the diseases to transmit from one animal to another easily.

C. Heavy grazing by cattle in the valley bottoms during the summer left little for wintering bighorns.

D. Stresses caused by the breeding season.

E. Stress caused by elk hunters riding snowmobiles nearby.

F. Habitat loss of critical winter grazing areas by real estate development.)

10. As a class or in small groups, assume the role of an ecosystem manager. Discuss and/or write a management plan about how you will prevent such a die-off in the future. What will be the best management practice(s)? What will be the least expensive management practice(s)? How will privately-owned land affect your plan? How will you include others in your planning efforts? If you don't have suggestions for the preceding questions, how can you learn more so you can form an opinion? *(Numerous possibilities. Be sure to include the issue of private and public lands in the management proposal.)*

7. To summarize the activity, ask:

-What was the hardest part of this activity? The easiest?

-What information was the most helpful? Why? Least helpful? Why?

-What was the best way for you to organize all the information? Why?

-How did you find your mind working when you knew you were trying to solve a mystery?

-What is something you learned that you will share with others?

-How can what you learned doing this activity help you in the future?

ASSESSMENT:

1. Have students list the various factors that lead to the bighorn sheep population crash.

2. Using the factors on their lists, they create diagrams to show how the factors are connected.

3. Have students create a diagram showing the lifecycle of the lungworm from the information given.

EXTENSIONS:

1. Have students research other parasitic lifecycles. Other animal species, including humans, have had dramatic population crashes as the result of parasites. What were the parasites, why, and how were they eventually controlled?

2. Working in small groups, ask students to research and report about the techniques used by wildlife agencies to trap and medically treat bighorn sheep for diseases. Ask each group to also report how they decided where to go for the information they were seeking.

RESOURCES:

Bighorn Sheep Mortality in the Taylor River-Almont Area, Feverstein, Schmidt, Hibler, and Rutherford, 1978-1979: A case study. 1980.

MYSTERY STORY

The Taylor Canyon bighorn sheep herd lives in a typical Rocky Mountain ecosystem characterized by rugged mountains, canyons, and small grassy valleys. Valley bottoms are privately owned; most of the other higher terrain is public land.

During the summer months, wildlife biologists estimated the bighorn sheep herd to number 250. This was the largest herd size in many years. Numerous ewes with kids were sighted in alpine meadows and scattered bands of rams were noted at higher elevations.

Late-season (December) elk hunters in the area reported lots of bighorns. All appeared healthy, although there seemed to be few kids. Many male rams were observed fighting other male rams for females with whom to mate.

January brought heavy snows and cold weather. Snow depths were up to five feet and mid-day temperatures were as low as -20 degrees (F).

On January 18, wildlife biologists noted ski tourists pulled off the highway taking pictures of the bighorn sheep. One tourist came within ten feet of a ram. Bitter cold and deep snows persisted.

Ranchers noted that many of the bighorns appeared to be tired, ragged, and weak. The bighorns staggered and mucous discharge was observed coming from their mouths and noses. Many bighorns were coughing. On January 21, one rancher notified wildlife officials.

Two days later, wildlife officers found eight dead rams and two extremely sick ewes. Two dead bighorns were sent to a university lab where autopsies were performed to determine the cause of death.

On February 5, ground surveys and aerial fly overs found only 48 bighorn sheep alive. Some of the remaining bighorn sheep were netted and medically treated. Food was brought in. No more deaths occurred.

What caused this dramatic population crash?

MYSTERY QUESTIONS

1. How many bighorn sheep died between the summer and February 5?

2. What unusual wildlife behavior could have been an early clue that something was wrong with the herd?

3. Why did so many of the herd die in such a short period of time (January through February 5)?

4. Why did the rams die earlier than the ewes?

5. Why were there only a few kids in December, though there were many in the summer?

6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm?

7. Why don't all bighorn sheep die of pneumonia/lungworm?

8. What is the relationship between the pneumonia bacteria and the lungworm?

9. Who or what caused the die-off of the bighorns?

10. From the role of an ecosystem manager, discuss and/or write a management plan about how you will prevent such a die-off in the future. What will be the best management practice(s)? What will be the least expensive management practice(s)? How will privately-owned land affect your plan? How will you include others in your planning efforts? If you don't have suggestions for the preceding questions, how can you learn more so you can form an opinion?

Mystery Fact Cards:

(Cut the facts apart on dotted lines and give one to each student.)

Fact #1
The autopsies revealed that the dead bighorns had pneumonia-causing bacteria.

Fact #2
Autopsies revealed dead bighorn were found to have parasites called lungworms.

Fact #3
The elk hunters were riding snowmobiles. Bighorn are easily spooked by the presence of these noisy machines. They get nervous.

Fact #4
Heavy snows make travel difficult for bighorn. Herds begin to congregate on the few pieces of bare ground (or shallow snow accumulation areas) available.

Fact #5
When grazing, bighorn sometimes eat small land snails by accident.

Fact #6
The lungworm larvae can move across the placenta from the pregnant ewe into its fetus.

Fact #7
Lungworms form open sores in the lungs.

Fact #8
During cold weather, bighorn sheep spend lots of energy trying to stay warm. Their caloric needs increase.

Fact #9
Young lungworm larvae are excreted in bighorn sheep fecal pellets.

Fact #10
During the summer, bighorn sheep stay at high elevations on public lands eating nutritious alpine plants. When winter snows arrive, they typically move down onto private lands in the valleys and canyons.

Fact #11
Pneumonia causes bighorn sheeps' lungs to fill up with mucous. They try to cough it out.

Fact #12
During winter bighorn paw through the snow to eat grass. This is tiring.

Fact #13
Even healthy bighorn sheep have the bacteria that causes pneumonia.

Fact #14
The larval stage of the lungworm is found in small land snails.

Fact #15
The breeding season for bighorn sheep is November and December. Rams actively fight for the right to breed ewes.

Fact #16
The larval stage of the lungworm travels from the bighorn's stomach to its lungs.

Fact #17
Diseases spread easily among herds in crowded conditions.

Fact #18
Generally speaking, only unhealthy wild animals allow humans to get close.

Fact #19
Bacteria that cause pneumonia can only cause this disease if it finds open sores in the lungs.

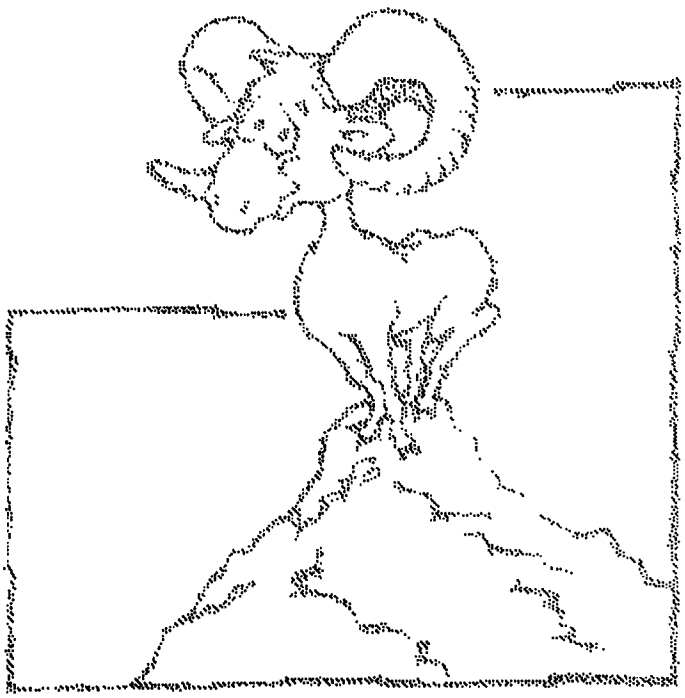
Fact #20
Healthy bighorn sheep rarely get diseases. Young or physically stressed animals are more likely to succumb to diseases.

Fact #21
Ranchers grazed large numbers of cattle on their private lands in canyon/valley bottoms during the summer.

Fact #22
Once in the lungs, the lungworms mate and lay eggs. When the eggs hatch, the young larvae are coughed up and swallowed.

Fact #23
High activity levels tire and stress bighorns.

Fact #24
During the summer, one rancher sold some of her valley land to a real estate developer. A few homes were built that summer. A few more are planned.



LEVEL: *Grades 4-8*

SUBJECTS: *Science, Language Arts, Art.*

PROCESS: *Through the construction of dioramas, students will develop the connection between living in different rooms of their homes with living in different biomes (rooms) in the earth's environment.*

OBJECTIVES: *The student will:*

1. *Construct the major biotic units of plants and animals that make up a community.*
2. *Compare the characteristics of a room in a house with the characteristic vegetative forms in the different rooms (biomes) on the earth.*
3. *Describe the distinctive vegetation of a living environment of a particular region and the climate of the area.*

TIMEFRAME: *1 hour 30 minutes.*

SKILLS: *Applying, classifying, comparing similarities and differences, comprehending, describing, discussing, generalizing, identifying, researching, understanding cause and effect.*

MATERIALS: *Shoeboxes (six), construction paper, clay, glue, paint, scissors, colored pencils, crayons, reference books, "My Home, Our Home" task cards one per group (attached). Individual and group assessment checklists are printed on the back of the task cards. Reference materials will need to be available on tundra, desert, grasslands, woodlands, tropical forests, and marine biomes.*

VOCABULARY: *Biome, desert, grassland, marine, tropical forest, tundra, woodland.*

MY HOME, OUR HOME

OVERVIEW: Think of the various rooms in your home. Each of the rooms has its own design, and its own kind of furnishings to meet the needs of that room. In the kitchen, for example, you'll find a stove and a refrigerator for preparing and saving food. In the living room, you'll find a couch, chairs, and perhaps a television so family and friends can spend time relaxing together. In the bedrooms, you'll find beds for sleeping and places for storing clothes. Just like the many rooms in your home, earth is filled with various rooms or ecosystems.

Ecoregions (geographic areas) are unique combinations of climate, topography and geology (characteristics). The specific combination within an ecoregion determines the particular plants and animals which grow and live there.

Because of the many combinations of soil, flora, fauna, and climate, different kinds of ecosystems have developed on earth. Each of these distinctive systems is known as a biome. A biome is the set of characteristics. Like the rooms in your home, biomes meet specific purposes and are "furnished" with unique plants and animals. These biomes are named after their dominant plants such as woodland, tundra, tropical forest, desert, grassland, and marine biomes.

PROCEDURE:

1. Discuss with students the kinds of furnishings found in different rooms of their homes. Make a chart on the chalkboard listing the rooms in their homes in rows and a list of furnishings and/or appliances that are usually found in each room. Use the example below to get students started. Ask:

MY HOME, OUR HOME TASK CARD

1. ASSUME ROLES.

Each person in your group should choose one of the following tasks:

Recorder:_____
(This person completes this task card.)

Materials Manager:_____
(This person makes sure the group has all materials necessary and organizes the group clean-up at the end.)

Observers:_____
_____
_____
_____
(These people look for the answers to the task card questions.)

Task Manager:_____
(This person makes sure that the group completes the task in a timely manner and that everyone is equally involved.)

2. LIST THE PREDOMINANT PLANTS IN YOUR BIOME.

3. WHAT ANIMALS LIVE IN THIS BIOME?

4. LOCATE ON A MAP AND DESCRIBE

best describes the biome in which we live?

-What are the predominate plants and animals in our biome?

ASSESSMENT:

Evaluate:

1. Group oral reports.

2. Description of the distinctive characteristics of each biome.

3. Completion of task cards.

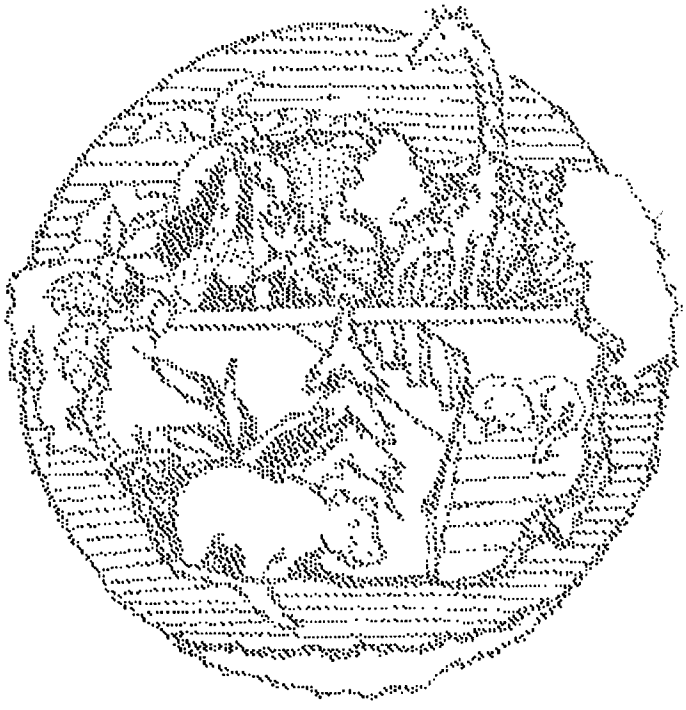
4. Cooperative group work checklists.

EXTENSIONS:

1. Have students construct biomes in an aquarium with live plants to replicate the condition of the different biomes. This will result in varied problems of climate control in the confines of an aquarium that may or may not be achievable depending on the resources at your disposal. The in-class observations of aquarium biomes will create opportunities for problem solving.

2. Have each student choose a biome and report on the characteristic adaptations of plants and animals in that biome. Students should include in their reports the environmental factors that are distinctive to the biomes like soil, water, climate, and geographical locations in the United States or the world. Encourage them to include in their reports how human populations have adapted or how the environmental factors in biomes have determined cultural differences.

RESOURCES: Reference materials on plants and animals in different locations of the United States and the world can be found in most libraries.



Arctic Circle. This small (around 20 grams in weight) bird travels 20,000 miles every year!

Not all shorebirds migrate such long distances. Some, like the American Avocet, have short migrations as they breed in the northern part of the United States and winter in the southern part of the United States.

In North America three primary flyways are heavily used migration routes, connecting the shorebirds' breeding grounds in the north to their wintering grounds in the south. One of these flyways follows the Pacific coast from Alaska to the southern part of South America. A second flyway follows the Atlantic coast from northwestern Canada to the very southern tip of South America. The third flyway stretches from north central Canada down through the center of the United States into northern South America. This is the route we will focus on in this activity.

Shorebirds must prepare themselves physically for their strenuous migrations. Before leaving their wintering grounds in the south, they must put on a fat load, which is mainly stored lipids (fats), but includes protein and water. Shorebirds feed almost constantly for two weeks, often doubling their weight for the migration to the north.

Some shorebirds fly non-stop to their destination, but others make several stops along the way to replace their body fat. These stop-over areas along the migratory route are called 'staging' areas. They are usually lowlands flooded from the spring snow melt and are very rich in newly hatched insects. Many shorebirds increase their body masses up to 100 percent at these staging areas!

One of the most critical *wetland* staging areas is the Prairie Pothole region. Located in the northern Great Plains of the United States and southern Canada, it spreads across hundreds of miles forming many small wetlands. Tens of thousands of shorebirds use this area as a feeding and resting place along their migration route to or from the northern breeding grounds and the southern wintering grounds.

Weather can be a factor in the shorebird's departure from the wintering ground. Poor weather may keep them from leaving, delaying the journey until cold weather offers no threats.

Shorebirds usually fly in large flocks and migrate at night. If a bird is left behind, it usually waits for another flock to join. But while it is alone, it has less time to feed because it has to be more watchful of predators.

Once the migration north begins, there is no time to waste. Semipalmated Sandpiper males for instance, usually migrate to the breeding grounds several days before the females to establish territory for nesting. The males normally reestablish the same territory they claimed the previous year. When the females arrive and pair with mates, nest building begins. Four to six days after pairing, egg laying begins. Incubation of the eggs is about 20 days. After hatching, the juvenile shorebirds (young birds that have not yet reached sexual maturity) must eat constantly to become strong enough and put on enough fat to leave for the wintering grounds. Juvenile shorebirds often do not start their southern migration until three to four weeks after the adults have left.

Shorebirds travel over several different countries during their migration. That makes it difficult to protect them. Shorebirds must contend with a number of problems.

During migration, Peregrin Falcons and Merlins often attack shorebirds in flight. There can be the impact of oil spills and agricultural pesticides along the migration route as well, both contaminating shorebirds' food supplies. Agricultural pesticides are widely used throughout North America. DDT, a highly poisonous pesticide, was banned in the United States in 1972, but continues to be produced in the United States and sold to Central American and South American countries for agricultural use. Shorebirds have died as a result of the application of DDT to agricultural fields.

Migratory staging areas and southern wintering grounds are being impacted by increased human development. Many wetlands have been drained for agricultural or building purposes. The Prairie Pothole region has lost about 50% of its wetlands with some areas having lost 90%.

LEVEL: Grades 4-12

SUBJECTS: *Environmental Education, Math, Science.*

PROCESS: *Through an interactive game, students gain an understanding of how forest ecosystems change.*

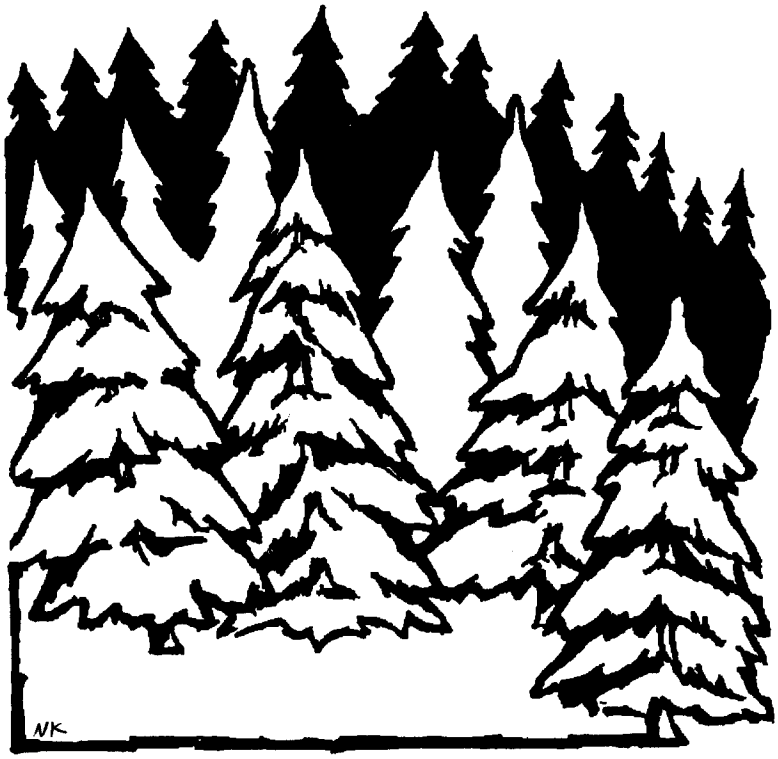
OBJECTIVES: *The student will:*
1. Evaluate the roles of at least five variables that cause change in a forest ecosystem.
2. Evaluate the changes to a forest ecosystem caused by tree harvesting.

TIMEFRAME: *45 minutes.*

SKILLS: *Analyzing, debating, evaluating, generalizing, hypothesizing, inferring, role playing, understanding cause and effect.*

MATERIALS: *Two different colored bandannas, string, "Role Cards," (attached) "Damage Cards."*

VOCABULARY: *Bobcat, ecosystem, harvest, interior, lumber mill, niche, stand, tree harvester, tree species.*



ON THE EDGE OF CHANGE

OVERVIEW: Forest ecosystems are in a constant state of change. As trees live, grow, and die, changes in the makeup of the forest occur.

This activity focuses on the ecological changes that occur in a mature forest when it is disturbed. Although the ecological concepts portrayed in this activity could apply to any mature coniferous forest, an even-aged stand of lodgepole pine probably is most representative. An even-aged stand is a group of trees all the same age.

This forest ecosystem consists of "interior trees" and "edge trees." Interior trees have grown up in a crowded and very competitive environment. Individual trees compete for a finite amount of water, sun, and soil nutrients. Typically, the interior trees are thin and weak with poor root systems. The interior of the stand has its own micro-climate: sunlight, moisture, temperature, and other factors that are relatively constant.

Edge trees are typically bigger. Because they grow on the edge of the stand, they do not have such intense competition for water, sun, and soil nutrients. Root systems are more developed. In many respects, edge trees serve to protect interior trees from wind, fluctuations in temperature, and some diseases.

When the edge trees are disturbed by natural factors like fire or by human factors like logging, changes occur to the interior of the stand. For example, if the edge trees on the windward side of the stand die or are removed, the interior trees become vulnerable to wind. Because of their weak root systems, newly exposed interior trees "windfall" easily.

As windfall creates larger gaps in the interior forest, changes to the micro-climate occur. Heat and

moisture are lost more easily during winter months as wind penetrates the forest. During the summer months the sun's rays filter to the forest floor more easily. These changes may stress the remaining interior trees, making them more susceptible to damage by existing insects and disease. Sometimes openings in the edge also allow easier access to the interior of the forest by certain animals or wind-borne parasites and disease.

Clearings created in the interior of the stand invite new species to fill the new niches available. The composition of both plant and animal species changes. Grasses and forbs grow where sunlight now penetrates to the ground; rabbits and big game species may move in to eat those plants.

How humans value these changes is a matter of perspective. To some people these changes may be viewed as bad. To others these changes may be good. Their value judgements may be determined by whether or not the forest changes were natural or human-caused. In either case, forest ecosystems are never stagnant. Change is the rule.

PROCEDURE:

PRE-ACTIVITY:

1. Prepare "Role Cards" as "Packet A." Each "Role Card" should be copied on stout paper and have a different identifying color. Lace the "Role Cards" on a string to hang around students' necks for visibility. The numbers below are for a class of 25 students. You may need to make adjustments for smaller or larger class sizes. Add extra students as interior or edge trees. One or two students could act as "scientific observers" to watch how the forest ecosystem changes throughout the course of the activity.

Packet A: 25 "Role Cards"
1 tree harvester
1 bobcat (wears bandanna as headband)
1 woodpecker (wears bandanna as headband)
8 edge trees
14 interior trees

2. Prepare the "Damage Cards" as "Packet B."

Packet B: 65 "Damage Cards"
3 rabbit damage
2 porcupine damage
5 insect damage
10 temperature damage
15 disease damage
30 wind damage

3. Preview each "Role Card" and "Damage Card" carefully.

ACTIVITY:

1. Discuss forest changes with the students and introduce vocabulary words. You might open with these questions:

-How has your neighborhood/school changed over time? Who or what caused the change? Are these changes good or bad?

-What "natural changes" have there been in the neighborhood/school?

-Do forest ecosystems change? If so, how? Who causes the change? Are these changes good or bad?

2. Explain the roles and rules of the activity. Students are to become parts of a changing forest ecosystem. Encourage students to act out the behaviors when appropriate (for example, rabbits hop). Make it clear that trees don't move until harvested or their role changes. *For safety reasons, have students WALK and not run during this activity.*

3. Take the class outside or to a gymnasium-like area.

4. Distribute Packet A. Each student receives one "Role Card" to hang around his or her neck. Scatter Packet B (the "Damage Cards") 20 feet from the perimeter of the playing area. Have the interior trees gather at the center. Edge trees surround the interior trees, facing out and holding hands. Living in the interior of the forest are the bobcat, who eats rabbits and porcupines, and the woodpecker, who eats insects. Be sure the bobcat and the woodpecker have different colored bandannas. See attached diagram.

DAMAGE CARDS

TEACHER

TREE HARVESTER

EDGE TREES

EDGE TREES

EDGE TREES

INTERIOR TREES

WOODPECKER

INTERIOR TREES

INTERIOR TREES

INTERIOR TREES

BOBCAT

EDGE TREES

EDGE TREES

EDGE TREES

EDGE TREES

DAMAGE CARDS

DAMAGE CARDS

5. The tree harvester begins the game by selecting and harvesting one edge tree. The harvester first takes the edge tree's card, then brings the edge tree to the "Damage Card" pile. Next the harvester brings the edge tree's card to the lumbermill (teacher). At the mill, the harvester describes what he or she plans to do with the wood. The teacher tallies points collected (they are on the edge tree's card).

-1 point builds a kitchen table
-3 points supplies a school with paper for one day
-5 points builds a small house.

Before harvesting another edge tree, the tree harvester walks around the forest stand three times to find the best edge tree to cut. The harvester continues until he or she gathers enough points to produce one of the above wood products. The tree harvester does not cut down interior trees.

6. Meanwhile, the edge tree that was cut picks up and reads one of the scattered "Damage Cards" and assumes the new role described on the card. This student brings the "Damage Card" to one of the interior trees. This student may only access the interior trees through a place where an edge tree has been removed, however. In other words, damage enters the interior forest through a break in the forest edge. The student returns for another "Damage Card." Continue until activity is over.

7. When an interior tree collects any combination of five "Damage Cards," it dies and is not considered to be a harvestable resource. When an interior tree dies it must drop its "Role Card" (with string attached) and move outside to the "Damage Card" pile. There, the interior tree disperses the five "Damage Cards" in his or her hands. Then, the interior tree picks up a new "Damage Card" and assumes a new role.

8. Some special "Damage Cards" give students unique directions. Encourage this touch of drama if your groups age and personalities are conducive to it.

-If a **Rabbit Damage Card** is selected, the student **hops** to the interior trees. Rabbits cause forest damage by eating young trees. Careful, bobcats love to eat rabbits! If the bobcat catches the rabbit **before** it delivers the "Damage Card," the rabbit becomes an interior tree by picking up any dropped interior tree card. This signifies that the rabbit has enriched the soil, allowing a sapling to grow. If no dropped interior tree cards are available, the rabbit remains dead until one becomes available. The bobcat returns the rabbit card to the "Damage Card" pile and then goes back to the interior of the forest to hunt. The bobcat may only prey on rabbits when they are in the interior of the forest.

-If a **Porcupine Damage Card** is selected, the student **crawls** (or pretends to crawl) to the interior trees. Porcupines eat the bark of trees and can kill them. Again, watch out for the bobcat! The bobcat can only catch you if it touches your underside (front waist - belt buckle area). Porcupines can protect their undersides by bunching up into tight balls. (Predators can usually kill porcupines only by attacking their undersides.) If the bobcat catches the porcupine **before** it delivers the "Damage Card," the porcupine becomes an interior tree by picking up any dropped interior tree card. Other rules apply, as above.

-If an **Insect Damage Card** is selected, the student **flies** into the interior forest by flapping his or her arms. Some insects or the diseases they carry can kill trees. Watch out for the woodpecker! The woodpecker may only catch you when it has one arm touching any interior tree. This signifies the woodpecker perched on a tree trunk. If the woodpecker catches the insect **before** it delivers the "Damage Card," the insect becomes an interior tree by picking up any dropped interior tree card. The woodpecker returns the insect card to the "Damage Card" pile and then goes back to the interior forest to hunt. Other rules apply, as above.

9. The game continues until:

-the tree harvester has collected enough points for his or her wood product, or

-there is an obvious change in the forest ecosystem, or

-the forest chaos is too much!

10. Post-activity discussion:

a. Tally the types of trees remaining (edge trees, interior trees without damage, interior trees with damage). Hypothesize why these results occurred.

b. Discuss the experiences of the different roles. Be sure to:

-have the tree harvester share how many points he or she acquired and the plans for the use of the trees.

-have the interior trees discuss what killed them. Was it one kind of damage or many kinds of damage working together? Which "Damage Card" was most common?

c. Have students describe the changes that took place in the forest. Have the scientific observers discuss their observations.

d. Why do some foresters advocate cutting small interior areas as a means of harvesting wood, rather than edge trees? Based on what you learned about the lumber quality of interior trees, when might this practice not be acceptable?

e. What are some other ways forest ecosystems can change? How would these changes affect the ecosystem? Are these changes good or bad?

f. Sometimes humans cause change to a forest ecosystem. Sometimes natural forces cause these changes. Which is better? Why do you feel this way?

g. How does timber harvesting affect forest ecosystems? How and when do tree harvesters reforest areas after cutting trees?

h. Do old, mature forests (old-growth forests) have value if they are left unharvested? When? Why?

i. In the Pacific Northwest, the Spotted Owl requires old-growth forests to survive. Tree harvesters need to cut large, old trees to provide lumber and maintain local jobs. Some people say it's a battle between two species (owls vs. humans). Others say the owl symbolizes an ecosystem in trouble. What do you think?

j. Emphasize the fact that the use of natural resources is necessary. Knowledge of the effects of resource extraction and use leads to better forest management.

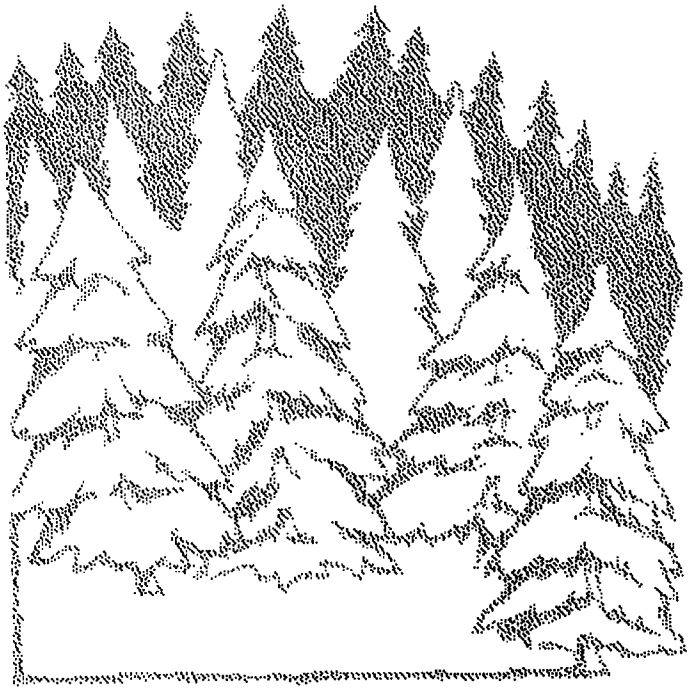
ASSESSMENT: Have students evaluate the causes and results of five changes to the forest ecosystem as a result of the tree harvesting described in this activity. Observe their evaluations for overall understanding of the lesson content.

EXTENSIONS:

1. Have students hypothesize the situation if a beaver or a fire, instead of a human, were to change the forest ecosystem.

2. Dig a little deeper into ecosystem debates. For example, use newspapers and other periodicals to follow the debate about "old-growth forests." What species may depend on undisturbed old forests?

RESOURCES: *Managing Forested Lands for Wildlife*, Colorado Division of Wildlife, 1987.



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THE TOTAL NUMBER OF CARDS (AFTER ALL COPIES ARE MADE):

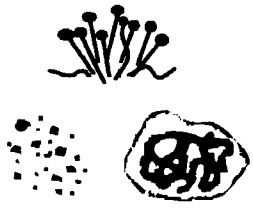
ROLE CARDS

- 1 *Tree Harvester*
- 1 *Bobcat*
- 1 *Woodpecker*
- 8 *Edge Tree*
- 14 *Interior Tree*

DAMAGE CARDS

- 3 *Rabbit*
- 2 *Porcupine*
- 5 *Insect*
- 10 *Temperature*
- 15 *Disease*
- 30 *Wind*

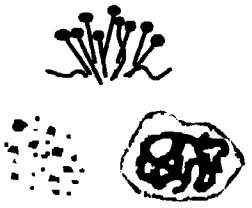
DAMAGE CARD



- *Walk to the interior of the forest.*
- *Give this card to an interior tree.*
- *Return to the damage card pile to assume a new role.*

DISEASE

DAMAGE CARD



- *Walk to the interior of the forest.*
- *Give this card to an interior tree.*
- *Return to the damage card pile to assume a new role.*

DISEASE

Make one (1) copy of this page.

ROLE CARD

1. *When you have been given a total of 5 damage cards, drop this role card and go to the*
2. *damage card pile.*

Scatter the 5 damage cards
3. *you've collected.*

Pick up a new damage card and assume a new role.

INTERIOR TREE

DAMAGE CARD

- *Crawl to the interior of the forest. Watch out for bobcats!*
- *Give this card to an interior tree.*
- *Return to the damage card pile to assume a new role.*
- *If the bobcat kills you, pick up an interior tree card. You are now an interior tree.*

PORCUPINE

ROLE CARD

1. *When you have been given a total of 5 damage cards, drop this role card and go to the*
2. *damage card pile.*

Scatter the 5 damage cards
3. *you've collected.*

Pick up a new damage card and assume a new role.

INTERIOR TREE

DAMAGE CARD

- *Crawl to the interior of the forest. Watch out for bobcats!*
- *Give this card to an interior tree.*
- *Return to the damage card pile to assume a new role.*
- *If the bobcat kills you, pick up an interior tree card. You are now an interior tree.*

PORCUPINE

Make three (3) copies of this page.

ROLE CARD

1. When you have been given a total of 5 damage cards, drop this role card and go to the damage card pile.
2. Scatter the 5 damage cards you've collected.
3. Pick up a new damage card and assume a new role.

INTERIOR TREE

ROLE CARD

1. When you have been given a total of 5 damage cards, drop this role card and go to the damage card pile.
2. Scatter the 5 damage cards you've collected.
3. Pick up a new damage card and assume a new role.

INTERIOR TREE

ROLE CARD

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2. Scatter the 5 damage cards you've collected.
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INTERIOR TREE

ROLE CARD

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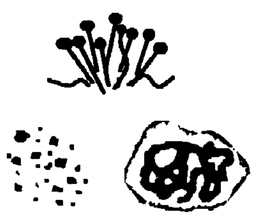
2. Scatter the 5 damage cards you've collected.
3. Pick up a new damage card and assume a new role.

INTERIOR TREE

Make three (3) copies of this page.

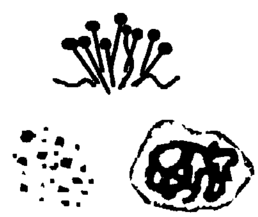
DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

DISEASE

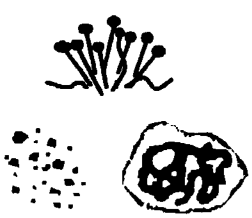
DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

DISEASE

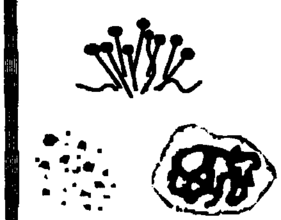
DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

DISEASE

DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

DISEASE

Make two (2) copies of this page.

ROLE CARD

- Stand around the interior trees.
- You are an older, healthier large tree with fine wood.
- Value 1 1/2 points.

EDGE TREE

ROLE CARD

- Stand around the interior trees.
- You are an older tree that is begining to rot on the inside. You do not have much value for lumber use.

Value Zero points.

EDGE TREE

ROLE CARD

- Stand around the interior trees.
- You are a younger tree, just reaching adulthood. Your wood is strong.

Value 1/2 point.

EDGE TREE

ROLE CARD

- Stand around the interior trees.
- You are a mature tree that has had plenty of room to grow.
- Value 1 point.

EDGE TREE

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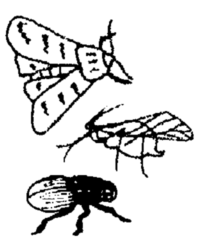
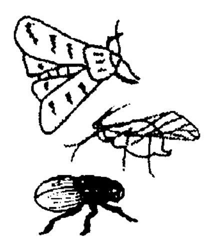


DAMAGE CARD

- *Fly* to the interior of the forest. Watch out for the woodpecker!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the woodpecker kills you, pick up an interior tree card. You are now an interior tree.

INSECT



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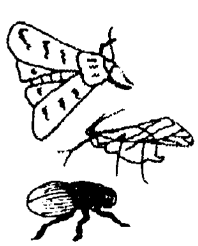
INSECT



DAMAGE CARD

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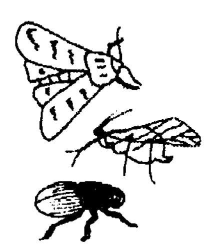
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the woodpecker kills you, pick up an interior tree card. You are now an interior tree.

INSECT



DAMAGE CARD

- *Fly* to the interior of the forest. Watch out for the woodpecker!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the woodpecker kills you, pick up an interior tree card. You are now an interior tree.

INSECT

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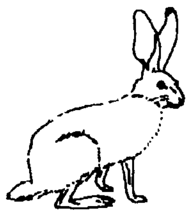
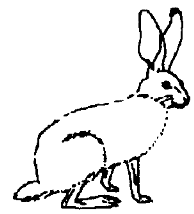
DAMAGE CARD



- Hop to the interior of the forest. Watch out for bobcats!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the bobcat kills you, pick up an interior tree card. You are now an interior tree.

RABBIT

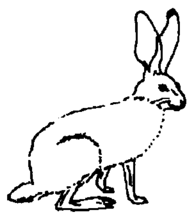
DAMAGE CARD



- Hop to the interior of the forest. Watch out for bobcats!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the bobcat kills you, pick up an interior tree card. You are now an interior tree.

RABBIT

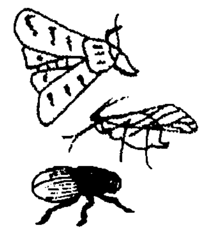
DAMAGE CARD



- Hop to the interior of the forest. Watch out for bobcats!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the bobcat kills you, pick up an interior tree card. You are now an interior tree.

RABBIT

DAMAGE CARD



- Fly to the interior of the forest. Watch out for the woodpecker!
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.
- If the woodpecker kills you, pick up an interior tree card. You are now an interior tree.

INSECT

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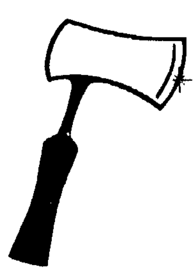
ROLE CARD



1. Choose an edge tree. Take its card.
2. Bring edge tree to damage card pile.
3. Report to lumber mill (teacher) to determine how the tree will be used and how many points its worth.

TREE HARVESTER

ROLE CARD

1. Hunt for hopping rabbits and crawling porcupines.
2. Try to tag the rabbits. You must touch the belly button of the porcupines.
3. If you catch a rabbit, or porcupine, bring their damage card to the damage card pile.

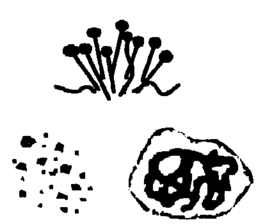
BOBCAT

ROLE CARD

1. Hunt for insects flying to the interior forest.
2. If you catch an insect bring its damage card to the damage card pile.
3. Return to the interior forest to hunt.

WOODPECKER

DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

DISEASE

Make ten (10) copies of this page.

DAMAGE CARD

- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

WIND

DAMAGE CARD

- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

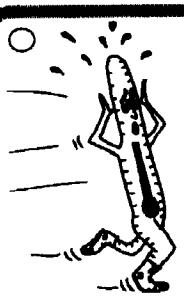
WIND

DAMAGE CARD

- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

WIND

DAMAGE CARD



- Walk to the interior of the forest.
- Give this card to an interior tree.
- Return to the damage card pile to assume a new role.

TEMPERATURE CHANGE

LEVEL: *Grades K-8*

SUBJECTS: *Social Studies, Physical Education, Science.*

PROCESS: *Through inventing and playing games with a benign effect on the environment, students look for evidence of games that harm the environment.*

OBJECTIVES: *The student will:*
1. Distinguish between games that are damaging and not damaging to the environment.
2. Invent games that don't damage the environment.

TIMEFRAME: *30 to 45 minutes.*

SKILLS: *Analyzing, comparing similarities and differences, evaluating, inventing, problem solving, synthesizing, working in small groups.*

MATERIALS: *Access to going outside.*

VOCABULARY: *Game, harm.*

PLAYING LIGHTLY ON THE EARTH

OVERVIEW: Personal choices of all kinds can affect the environment. We can look at the games we play outside and choose those that do little damage to the environment rather than playing games that leave scars.

The major purpose of this activity is for all of us to become more aware of the choices we make each time we play games outside and to consciously experience games that are earth friendly. By playing games that are not damaging we help maintain and improve the quality of our own environments.

PROCEDURE:

1. Most of us like to play. In fact, playing is an important way to learn as well as to have a good time. Ask students to think of examples of ways to play outside that do no serious or permanent damage to the environment, and then to list ways that are damaging. The damage might affect non-living things, like putting graffiti on cement walls. It might be damaging to plants and animals like carving initials on tree trunks. Ask:

-Are there any games we can play that do no damage? *(There may not be, but we can think about how much damage, how permanent it is, and what it affects.)*

2. Go outside on the school grounds and look for evidence of games that have damaged the environment. Ask students whatcould have caused the damage and how it might have been prevented.

3. Introduce the concept of playing games that do not seriously harm the environment.

4. Ask the students to work together in small groups of two to eight in order to invent a game that does no serious harm to the environment, including the plants and animals living there. The students could also try to invent games that could make this a better environment. Give students about 15 minutes to invent their games.

5. Ask each group to present their game to the other students. Play each of the games. Ask students to talk about their feelings about the importance of playing games that do little if any damage to the environment.

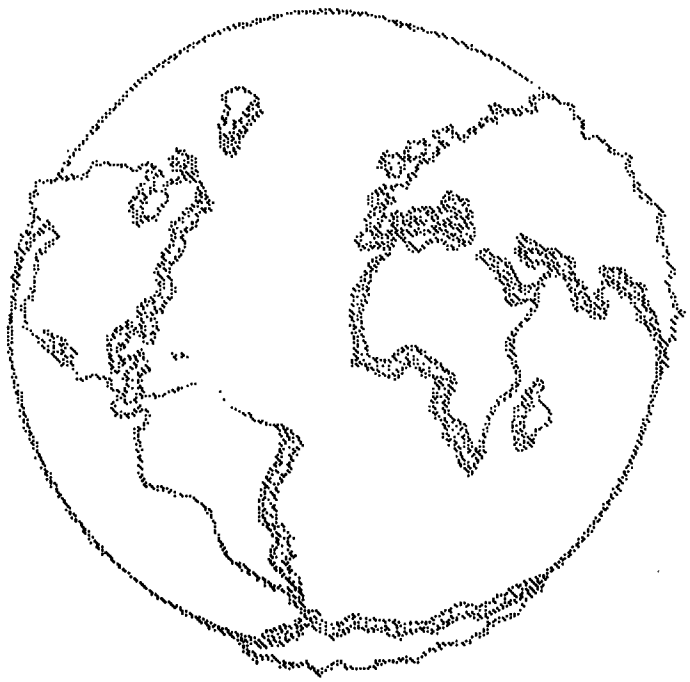
ASSESSMENT:

1. Ask students to keep a record of the games they play outside for one week. Identify which, if any, are harmful to the environment. For one week or longer, play only games that do no serious harm to the environment.

2. Have students invent a game for younger children that does no serious harm to the environment. Teach it to a younger child or group of children. Explain what the younger child or children learned about care for the environment.

EXTENSIONS: (For older students.)

Analyze a variety of kinds of recreation for their impact on wildlife, vegetation, and other natural resources, etc. What would students recommend to have recreational fun and still protect the earth.



LEVEL: Grades 3-12

SUBJECTS: *Science, Language Arts, Physical Education.*

PROCESS: *Through a physical activity, students discover the components and relationships of ecoregions and the role of ecosystem management in these ecoregions.*

OBJECTIVES: *The student will:*

1. *Describe some non-living and living components of an ecoregion (a geographic area where the combination of climate and soils produce a distinct plant community).*
2. *Demonstrate a component of an ecoregion.*
3. *Describe how each living component in an ecoregion is related to the sun and to other ecoregion components.*
4. *Describe how different ecoregions are related to each other and how they form a larger ecosystem.*
5. *Identify and demonstrate the role of ecosystem managers.*

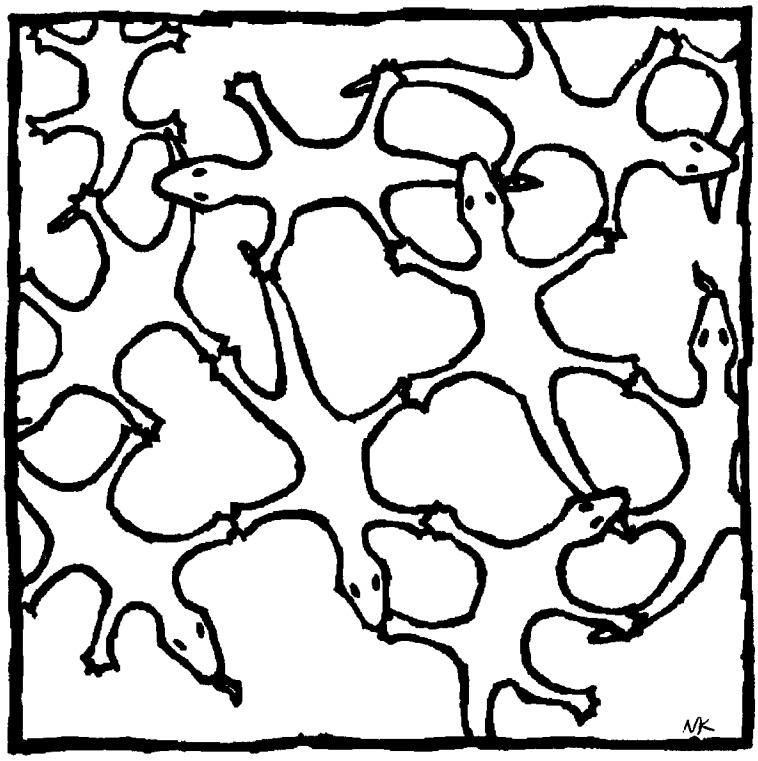
(Note: Younger students may only accomplish the first three objectives, while all five objectives are appropriate for upper grade levels.)

TIMEFRAME: *30 to 50 minutes.*

SKILLS: *Analyzing, comparing similarities and differences, critical thinking, demonstrating, describing, discussing, generalizing, identifying, listening, observing, predicting, role playing.*

MATERIALS: *A 3" x 5" index card and 12" string for each student, scissors, tapes, pencils or markers, large piece of yellow paper, yarn or string (two colors 200 ft. of one color cut into ten 20-ft. lengths (yellow yarn is ideal), and a 100-ft. length of the other color rolled into a ball), "Ecoregion Chart" (attached). (Extensions: Camerecorder or video camerecorder.)*

VOCABULARY: *Biodiversity, biosphere, ecoregion, ecosystem, ecosystem management, natural resources, predator, topography.*



SPINNING THE ECOWEB

OVERVIEW: Ecosystems are systems formed by the interaction of a group of organisms with each other and their environment. Ecosystems include interdependent plants, animals, the physical environment, and the ecological processes (such as exchange of matter and energy) that connect them. Areas of different sizes can be considered ecosystems, depending upon who is drawing the lines of distinction. A jar of pond water, a rotting log, a grassland, or the entire earth can each be considered an ecosystem. In this activity, the term ecosystem will be used to represent the entire earth. The entire earth's ecosystem is commonly referred to as the biosphere.

On earth, there are geographic areas in which the combination of climate, topography (lay of the land), and geology determine what types of plants and animals grow and live there. These areas are called ecoregions. A desert, with its characteristic dry climate, sandy soils, and unique wildlife is an example of an ecoregion. Other examples include grasslands, rainforests, coniferous and deciduous forests, oceans, arctic areas, fresh water streams, riparian zones, and wetlands. All of the ecoregions on earth interact to form one large ecosystem.

Human cultures have developed within different ecoregions and have been sustained by them. All of the resources humans have depended on for survival and comfort have come from natural resources. Over time, attitudes and beliefs about the natural world and the use of natural resources have changed. In the not-too-distant past, the human population was sparse compared to the natural resources available. Human impact on ecoregions was minimal. As human populations have increased, so have demands on various ecoregions. Some parts of the ecosystem are being heavily impacted and some species have

ecoregions?

-What can you tell me about an ecosystem?

-Why are ecoregions important to one another?

-What helped you know how ecoregions are related?

-If ecosystem managers discovered one plant or animal in an ecoregion in trouble, how do you think they would work to help that species?

12. Choose any organism from any ecoregion and identify that organism as a species in trouble. (Examples: toucans in the rainforest are being collected, clams in an estuary are being poisoned by pollution, the Florida panthers are disappearing due to shrinking habitat, etc.) Pose the problem to the ecosystem managers. Ask:

-What might they do to help the species?

-What information do you need to make a good decision?

-What do you need to know about this species and its relationship to other species?

-How does knowing that ecoregions are connected influence your decision?

-How will your management decision affect other organisms or other ecoregions?

-What is the role of ecosystem manager?

-What are some other roles humans play in ecoregions besides managers?

-In what ways can humans be good caretakers of the ecoregions? The ecosystem?

-What can you do to be a good caretaker?

13. What would happen if one of the ecoregions disappeared? Have one group drop their strings and discuss the implications for other ecoregions and the ecosystem. Ask:

-Which ecoregion is the most important?

-Is any ecoregion more important than another?

14. Conclude the activity by asking:

-What surprised you the most during this activity?

-What did you find most interesting?

-How might what you've learned in this activity help you in other areas of your life?

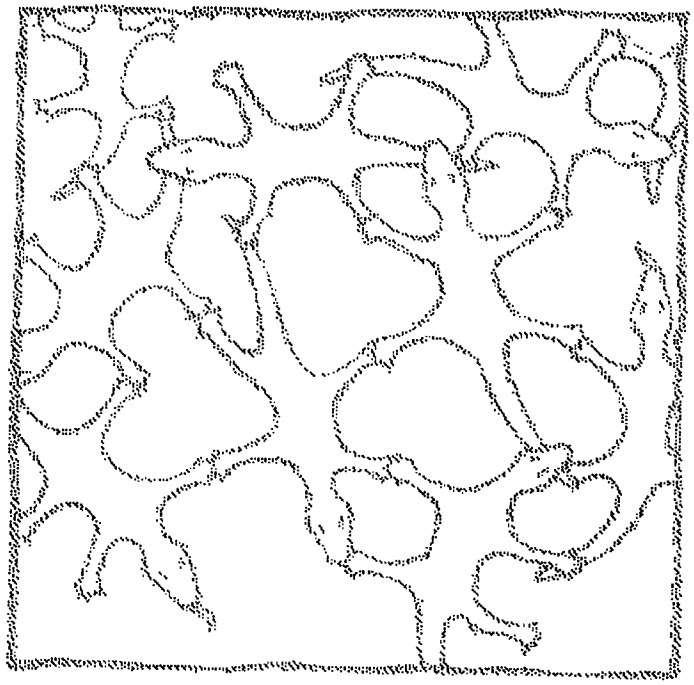
ASSESSMENT:

Have students:

1. Choose one ecoregion to draw, including both living and non-living components.

2. Take two ecoregions and demonstrate ways they are connected by any method of choice such as drawing, writing, role playing, etc. Students can choose ecoregions not previously discussed: or can discuss soil as an ecosystem and its connection to the total ecosystem.

3. Complete a paragraph, "If I were an ecosystem manager, I would...."



assign organisms ahead of time.

4. When student's cards are completed, have each ecoregion group stand together. Have the groups form a circle. (See diagram.) Students who represent the ecosystem managers remain outside of the circle at this time.

5. Place the large yellow circle in the center of the larger circle of students. Tell students the yellow circle represents the sun. Tape one end of each of the 20-ft. pieces of yarn to the "sun" circle. Ask students what they think the pieces of yarn represent (the sunlight traveling through space to the earth).

6. Standing in their groups, ask students to name the organism from their ecoregion most dependent upon sunlight. Hopefully, they will name the plant in their ecoregion. Hand the "plant" student in each ecoregion the unattached end of the 20-ft. string. All the pieces of yarn are now attached to the sun and stretched out to the ecoregion groups, creating the appearance of the "spokes of a wheel" or the "rays of the sun."

7. Students in each ecoregion must now determine which organism might get the sun's energy next. In other words, which organism might eat the plant? The "plant" student gives the next student (plant-eater) in his or her group part of the piece of string to hold also.

8. The "plant-eating" student now passes a piece of the string along to the organism that eats it, the predator. At this point, all students in each ecoregion will be holding on to their groups' piece of string. Ask:

-How is each organism in your ecoregion dependent upon the sun?

-How do all the organisms in your ecoregion need each other?

-What would happen if there were no plants in your ecoregion? No plant-eaters? No predators?

-In what ways is the sun important?

-Besides the sun, what else do plants need to grow? *(Soil, air, water.)*

9. Have students in each ecoregion mention one or more of the non-living components on which they depend (water, soil, rocks, wind, etc.).

10. Introduce the ecosystem managers. Ask students sitting in the circle what they think ecosystem managers do. (Ecosystem managers manage the natural resources in ecoregions in order to maintain biodiversity or variety of life in each ecoregion and to protect the larger ecosystem. They assess and evaluate the conditions of an ecoregion considering both living and non-living components. Ecosystem managers make and carry out decisions about ecoregions while making sure people are able to use necessary natural resources.)

11. Ecosystem managers enter the circle with the 100-ft. ball of yarn. Starting with any ecoregion group, the ecosystem managers pose the question written on the board. Write responses on the board. Students, after the first group, can repeat an answer already written on the board or respond with a different answer. One of the ecosystem managers, holding onto the end of the string, gives students in the ecoregion the string and then carries or passes the ball of string to the next ecoregion that was mentioned as being connected in some way to the first ecoregion. Repeat the question and this process of passing the ball of string until there are no further connections. At that time, the other ecosystem managers hold onto part of the string also. You can suggest some connections to the students if necessary. When groups' responses are complete, a large web will have been spun, demonstrating the large ecosystem made up of connecting ecoregions. Students have spun an eco-web! Have students stay in place and ask:

-How is your string from the sun different from the string to other ecoregions? How is it similar?

-What do the strings between the ecoregions represent? *(The larger ecosystem.)*

-What can you now tell me about

ECOREGION CHART

ECOREGION	NON-LIVING COMPONENTS AND DESCRIPTORS	POSSIBLE ORGANISM
Grasslands	Escarpment (cliff like), buttes, soil, fire, wind	**grass**, mice, grasshoppers, prairie dogs, bull snake, red-tailed hawk, etc.
Rainforest	Humidity, heavy rainfall, soil, equatorial, nutrient pool, little temperature variations	**fig tree, periwinkle**, howler monkey, toucan, beetle, tree frog, jaguar, etc.
Forest-Coniferous* (cone-bearing evergreens)	Granite rock formations, rocky soil, wind, snow, high elevation	**pine tree**, pine beetle, mosquito, deer, black bear, mountain lion, etc.
Forest-Deciduous* (leaf-bearing) *choose based on your location	Moderate rainfall, fertile soil, low elevation, temperature variation	**oak tree, maple tree**, squirrel, cicada, white-tailed deer, black bear, etc.
Ocean	Salt, coral reef, rock, sand, waves, wave action, wind	**plankton**, coral, fish, whale, shark, etc.
Estuary, Tide Pool	Mixing of salt and fresh water, tides, nutrient-rich soil, high humidity	**saltgrass, reedgrass**, clams, crayfish, fish, heron, seagull, etc.
Arctic	Glaciers, high latitude, permafrost, low temperature, short growing season, wind	**forget-me-nots**, musk ox, caribou, seal, wolf, polar bear, etc.
Fresh Water Stream	Water, rocks, gravel	**algae**, mayfly, dragonfly, fish, otter, bald eagle, etc.
Desert	Low rainfall, intense sunlight, daily extreme variation in temperature, sandy soil	**cactus**, gila monster, kangaroo rat, peccaries, road runner, coyote, etc.
Riparian (streamside)	High water table, moderate temperatures, banks	**willow, cottonwood, birch,** rabbits, moose, raccoons, owls, etc.
Wetlands	Water, high humidity, water-logged soil, nutrient-rich soil	**cattails**, redwing blackbirds, ducks, fox, Northern Harrier, etc.

EXTENSIONS:

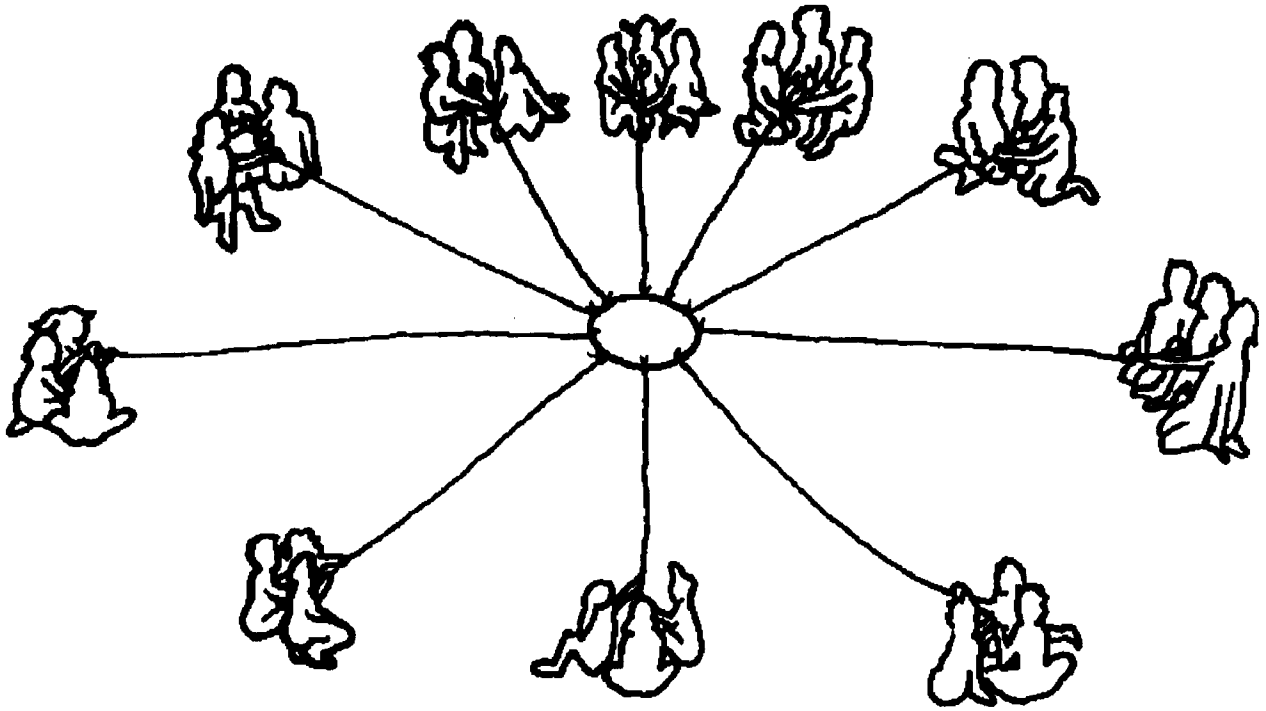
1. Invite students to photograph or videotape a local ecoregion to illustrate the non-living and living components of that ecoregion. Have students describe the connections between the components.

2. Construct a classroom ecoregion (on paper, a diorama, a mobile, etc.).

3. Play "Ecoregion Charades." Have groups role play different ecoregions while their classmates guess which ecoregion they are portraying.

4. Have students design advertisements to promote the importance of ecosystem management.

5. Have older students research a real-life situation in which a variety of management decisions are possible. (Examples: Northern Spotted Owl controversy, reintroduction of the wolf and grizzly bear to former historic range, salmon runs in dammed rivers, fishing with drift nets, etc.) They research all sides of the issue, including social and economic connections, and make a management decision. Have them then write a position paper supporting their management decisions and present their decisions to the class.



Ecoweb
Circle of kids holding string.

the leaf drop. Wildfires do not generally occur when the fuels (trees, shrubs, and grasses) are wet and cold.

Fire was an important tool in Native American cultures and is in other cultures around the world. Some Native American people set fire to prairies knowing that new growth would attract game. Fire has traditionally been used to drive game, reduce populations of unwanted animals, enhance crop growth, and clear forests.

Fire can be an effective management tool for state and federal agencies to manage their wildlands, which include forests, grasslands, and other ecosystems. Over the years, fire management policies and techniques have changed. A controlled, or prescribed burn (one that is lighted by trained fire personnel within prescribed fuel and weather conditions) can prepare a logged area for reforestation, enhance wildlife habitat, protect a native tree species, control insect populations or disease, or reduce future fire hazards by reducing burnable fuels. They are not risk free and they can be expensive.

Fire is an essential component in the lifecycle of several tree species. Some depend on the heat of fire to open their cones and release the seeds, while others simply need fire to open the forest canopy to provide light. In general, fires return nutrients to the soil in the form of ash.

Preventing, controlling, and suppressing wildfires is becoming more vital as more urban people seek woodland settings for their homes. More and more homes, property, and lives are endangered by fire along the wildland-urban interface. Once again, we learn that it isn't easy to balance the needs of humans against the needs of forest systems.

PROCEDURE:

PRE-ACTIVITY:

1. Make photocopies of the "Fire Triangle" worksheet (student page 1) for each student. Gather materials for the demonstration. You may want to invite a local firefighter or forester who is involved with fire management to visit your class.

2. Variation: You need an outdoor area or large room for the game. Make four green headbands out of construction paper for the "rangers." Make one red headband for "wildfire." Make 20 "fire protection necklaces." These can be made by cutting squares out of blue poster board and tying string through them. (Or, simply make loops or bands of blue construction paper large enough to go over students' heads and rest on their shoulders.)

ACTIVITY:

PART A: FIRE TRIANGLE

1. Pass out the "Fire Triangle" worksheets. Have students read and work through it on their own. When everyone is finished, ask the class what three things are needed for fire to burn. Draw the fire triangle on the board. Ask them under what conditions they think it would be easy to start a fire, and when they think it would be hard.

2. Demonstrate how a candle burns in a glass (from a science lab) when each of the three different elements are limited:

A. Place a small, lighted birthday candle in a jar (you may want to mount it in a dab of modeling clay). Then seal the jar with the lid to cut off the supply of oxygen. As the flame consumes the oxygen in the jar's air, the flame will go out. Explain that cutting off oxygen is one way of managing a fire.

B. Open the jar, relight the candle, and put the lid back on. Only this time, when the flame starts to go out reopen the lid to let more oxygen in; the candle will reignite. Explain that this illustrates what happens when the wind picks up during a fire; the fire may reignite or burn out of control.

C. Take the lid completely off and allow the candle to burn until all the fuel (paraffin) is consumed and the fire extinguishes itself. Give the students time to see how long it takes. Set up a wooden match and a paper match (similar size) in bases of clay. Light them both and see which burns longer. How do these two tree products - wood and paper - burn differently? Place a corn or potato chip on a piece of tin foil and light it. See how long it takes to burn. What fuel in the chip made it burn? (Vegetable

LEVEL: Grades 5-12

SUBJECTS: English, Social Studies, Drama.

PROCESS: Through a parable, students learn that ecosystems are valued in diverse ways.

OBJECTIVES: The student will:
1. Recognize the values held by various groups and individuals regarding an ecosystem.
2. Evaluate their own personal values related to an ecosystem.
3. Listen to and respect the rights of others to maintain different values.

TIMEFRAME: 30 minutes to 2 hours.

SKILLS: Acting, creative writing, debating, discussing, researching.

MATERIALS: Parables (one enclosed), writing materials, props for student-developed skits.

VOCABULARY: None.

THE BLIND MEN AND THE ECOSYSTEM

OVERVIEW: Ecosystems are made of many parts, all interacting with each other. Plants, animals, bacteria, fungi, water, air, and soil are all parts of whole dynamic ecosystems. People are part of ecosystems too! We interact with all the other parts of our ecosystem every day, though we may not realize it.

Sometimes people only "see" one part of an ecosystem. That is, they become keenly aware of only the one part of the ecosystem that's most important to them. Frequently, they assume that everyone else sees -- and values -- the ecosystem in the same way they do. Of course, this isn't true. People have different perspectives about ecosystems and their management.

In the management of ecosystems, whether forest, desert, or watershed, conflicts are inevitable. But by understanding the various perspectives and the values behind those perspectives, sometimes people can avoid or mitigate those conflicts.

In this activity, students take the old Indian parable, "The Blind Men and the Elephant," analyze its message, research the perspectives of various "blind people" in an ecosystem management conflict, and rewrite the parable as, "The Blind Persons and the Ecosystem." They may choose to write and perform a skit or melodrama.

PROCEDURE:

1. Read the story of the "Blind Men and the Elephant" and discuss its message. (Story is attached.)

2. Ask:

-How can this message be applied to an ecosystem management conflict?

Have students research an ecosystem management conflict and determine the various perspec-

tives of the people involved. Often students will only identify two opposing sides to a conflict. Usually there are many more than two sides.

3. Rewrite the parable or perform it as a skit. (See attached as an example.)

4. Leave ample time for discussion.

ASSESSMENT:

1. Have students list the "blind persons" involved with an ecosystem management conflict. What are their perspectives? Why do they have those perspectives?

2. Have students write two or three paragraphs describing:

-In what ways are you "blind" to other perspectives of an ecosystem management conflict?

-How can you improve your eyesight?

3. Evaluate students' contributions as they discuss some of the purposes of parables.

EXTENSION: Find other parables and rewrite them to emphasize an environmental lesson.

The "Blind" Men and the Elephant

Once upon a time, six blind men lived together in India. They had often heard about elephants, but because they were blind, they had never seen one. The Rajah had many elephants. So, the blind men went to the Rajah's palace to "see" an elephant first-hand. They traveled together, walking one behind the other, communicating with each other so they wouldn't fall down. Each man put his hand on the shoulder of the man in front.

An elephant was standing in the courtyard of the palace. The blind men touched the elephant with their hands.

The first blind man touched the side of the elephant. "An elephant is like a wall," he said.

The second blind man touched the trunk of the elephant and jumped back. "An elephant is like a snake!" he said.

The third blind man reached out and touched the tusk. "Sharp! An elephant is like a spear," he said.

The fourth blind man grasped the leg of the elephant. "How thick and tall," he said. "An elephant is like a tree."

The fifth blind man touched the ear of the elephant. "An elephant is like a fan," he said.

The sixth blind man reached out ant touched the tail of the elephant. "It is thin and tough. An elephant is like a rope."

The blind men were tired and sat down to talk about the elephant. "An elephant is like a wall," said the first blind man.

"What? A wall? You're wrong," said the second blind man. "An elephant is like a snake."

"A snake? You're wrong," said the third blind man. "An elephant is like a spear."

"A spear? You're wrong," said the fourth blind man. "An elephant is like a tree."

"A tree? You're wrong," said the fifth blind man. "An elephant is like a fan."

"A fan? You're wrong," said the sixth blind man. "An elephant is like a rope."

The blind men could not agree. They shouted and argued! Their argument got louder and louder!

The Rajah was awakened by the shouting. He called out his palace window, "Stop!"

The blind men stopped arguing. The Rajah said, "The elephant is a very big animal. Each man only touched one part. You must put all the parts together to find out what an elephant really is like."

The blind men listened. They rested under a cool tree and talked quietly. "The Rajah is a very wise man. Each one of us knows only a part. To find out the whole truth, we must put all the parts together," said one blind man. And they did.

They left the courtyard traveling together, walking one behind the other, communicating with each other so they would not fall down. Each man put his hand on the shoulder of the man in front.

The "Blind" Persons and the Watershed

Once upon a time, seven blind persons from the Land of Stereotypes came to the Big River Watershed. They all marvelled at the rich natural resources the area had to offer. Because they had on blinders they could not see well, they traveled together, walking one behind the other, communicating with each other so they would not fall down.

Soon they came to a tributary stream and followed it downhill. Eventually, the groups were at the banks of the Big River.

The first person was a miner. He felt the geologic formations nearby and decided they held gold, silver, and other minerals that the world needed to make important things. To get the minerals from the mountains and to dissipate mining's waste, he needed water from the river. "This river was made for mining," he said.

The second person was a farmer. She noticed all the level land in the valley and nearby plains, and thought, "This is a good place to grow food for the people of the world. Too bad it doesn't rain much around here." She then decided to divert water out of the river to water her crops. As she began to dig the ditch, she said, "This river was made for agriculture."

The third person was a fisherman. He felt the splash of the river and a mayfly tickle his arm. This is a good place for the people of the world to catch fish, he thought. He prepared for the first cast and said, "This river was made for fishing."

The fourth person was a city mayor. He knelt down and tasted the river; it was good to drink. "But my city is so far away," he said. "I will ask my engineers to divert this water to my city; then it will grow and prosper. It will be a great city of the world." The mayor was pleased and said, "This river was made for cities."

The fifth person was a rafter. She said, "Wow! The holes in this river are awesome. Class four or five, for sure." This is a great place for the people of the world to scream, laugh, and get an adrenaline rush, she thought. As she strapped on her life jacket, she said, "This river was made for rafting."

The sixth person was an environmentalist. He thought, this watershed is so fresh and clean. "Back in the land where I came from everything is so polluted and scarred. I can't let that happen here," he said. "I must save the river for the world. This river should be left alone."

The seventh person was a bureaucrat. With all these people competing for the use of the river, they will need my help, she thought. I will have to regulate all of them. I can show the world how effective government works. As she made her budget request to Congress, she thought, "This river was made for regulating."

At the end of the day, the blind persons were tired. They began to talk about the Big River Watershed.

"This river was made for mining," said the first person.

"What? You're wrong. This river was made for farming," said the second.

"Whoa," said the third person. "This river is for fishing."

"You're wrong. This river is for cities," said the fourth.

"NOT!" said the fifth person. "This river is for rafting."

"Rafting?" said the sixth. "This river should be left natural."

"I am with the government," said the last. "I am here to help you."

The group could not agree. Each person shouted louder and louder -- and called his or her lawyer.

Finally, a voice from the watershed said, "Stop!"

The seven people stopped shouting. "The Big River Watershed is a very big ecosystem. Each person has only considered one part. You must put all the parts together to understand what the watershed really is," said the voice.

The seven people listened. They sat down together and talked quietly. Although they did not agree on everything, they listened to each other sincerely.

Afterwards, they took off their blinders and saw more than they did before. And even though they were no longer visually impared, they travelled together, one beside the other, communicating with each other, so they would not fall down.

The "Blind" Persons and the Watershed

A Parable of the Big River (or your own local) watershed

Props for Cast:

Narrator: Large Story Book (with title on cover)

Persons carry clothing "props" in day packs.

Person #1 -sunglasses, day pack, mining hard hat, geologists hammer or gold pan, long white stick.

Person #2 -sunglasses, day pack, cowboy hat, irrigation boots, bandanna, shovel.

Person #3 -sunglasses, day pack, fishing vest, waders, fly rod.

Person #4 -sunglasses, day pack, drinking glass and pitcher.

Person #5 -sunglasses, day pack, shorts, "teva" sandles, lifejacket, paddle.

Person #6 -sunglasses, day pack, Earth-day t-shirt.

Person #7 -sunglasses, day pack, tie and sportcoat, clipboard.

NARRATOR: (read slowly, as if telling an ancient story)

Once upon a time, seven blind persons from the Land of Stereotypes came to the Big River.

(From the rear of the auditorium enters the line of "blind" persons comically shuffling down the center aisle, each with one hand on the shoulder of the person in front.)

They all marveled at the rich natural resources the area had to offer.

(Group stops, pause, "look around.")

(in unison) Oooooo! Eeeeee! Ahhhhh!

(Group then continues shuffling forward.)

NARRATOR: Because they were wearing blinders, they travelled together, walking one behind the other, talking and communicating with each other so they would not fall down.

PERSON #1: Whoa! Say, there's a log here. Be careful. Take a big step.

(One person at a time, in sequence, help each other over the log. "Be careful," "Let me help you," etc. Keep shuffling along.)

NARRATOR: Soon they came to a tributary stream...

PERSON #1: Whoa! Hey, there's a little creek here...

PERSON #2: (Putting a toe in the creek.) Oh, yeah, it's nice and cool.

PERSON #3: Hey, let's follow it downstream.

PERSON #4: Good idea!

NARRATOR: And so they did. More tributaries joined it, and eventually the blind persons were at the banks of the Upper Arkansas River. They all marvelled at the river....

ALL PERSONS: Oooooo! Eeeeee! Ahhhhh!

(Group begins to explore the river with their hands, etc....)

Person #1 notices a rock in the river and bites it. Its gold! He gets excited! Repeat.

Person #2 notices the river but is also hungry. Notices how hot and dry and flat the landscape is. Repeat.

Person #3 notices a mayfly land on him. Tries to catch it. Finally does and examines it. Repeat.

Person #4 notices the cool, good taste of the river water. Gets out drinking glass, fills it and drinks. Repeat.

Person #5 notices the splashing waves; gets very excited about the waves. Repeat.

Person #6 notices the river smells and swishes hand in the river. Picks a flower. Repeat.

Person #7 notices what the other blind persons are doing and begins to take notes. Repeat.

(Then the groups take off backpacks and begin to dress in appropriate attire. When all dressed, be still as narrator discusses each person.)

NARRATOR: The first person found gold, silver, and other precious metals near the river. He was a miner and mined ores that all the world would need to make important things. To get the minerals from the mountains, to process the ore, and to dissipate the waste, he would need water from the river.

PERSON #1: This river is made for mining!

NARRATOR: The second person noticed all the level land in the valley and the nearby plains and thought...

PERSON #2: This is a good place to grow food for all the people of the world but, it sure doesn't rain much around here.

NARRATOR: Then she had an idea. She could dig a ditch to divert water out of the river to water crops. A reservoir cold store spring run-off water for when she needed it in late summer. As she began to dig the ditch, she said...

PERSON #2: This river is made for agriculture!

NARRATOR: The third person was a fisherman. He noticed a mayfly flit nearby and saw a trout jump for it. He scrambled for a fly rod in excitement. This is a good place for the people of the world to catch fish, he thought. And as he readied for the first cast, he said...

PERSON #3: This river is made for fishing!

NARRATOR: The fourth person was a city mayor. He knelt down and tasted the river and thought...

PERSON #4: My, this is good tasting water. My people would like to drink this water and use it in their homes. Too bad my city is so far away. If only I could get this water to my city, it would grow and prosper.

NARRATOR: And his city could be a great city of the world. Suddenly, the mayor had an idea! He would hire an engineer to build a dam to hold the river water and pipe it to his city. He was pleased and said...

PERSON #4: This river is made for cities!

NARRATOR: The fifth person was a rafter...

PERSON #5: Whoa, dude! This river is like totally awesome. The holes are like class four or five, for sure.

NARRATOR: This person thought the river is a great place for the people of the world to scream, laugh, and get an adrenalin rush. As she strapped on her life jacket, she said...

PERSON #5: This river is made for rafting!

NARRATOR: The sixth person was an environmentalist. He thought this watershed is so fresh and clean.

PERSON #6: Back where I come from, that is...the land of stereotypes, everything is so polluted and scarred with so many people, I can't let that happen here.

NARRATOR: The person thought that he must save this river for the future generations of the world. As he pondered the meaning of life while eating a granola bar, he said...

PERSON #6: This river should be left alone!

NARRATOR: The last person was a government bureaucrat. Therefore she wasn't really blind, just visually impaired. With all these people competing for the use of the river, she thought, they will need my help.

PERSON #7: I will have to regulate all of them. I can show the world how effective government works.

NARRATOR: And as she made her budget request to Congress, she thought...

PERSON #7: This river is made for regulating!

NARRATOR: At the end of the day, the people were tired. They came together and began to talk about the (your local) watershed.

PERSON #1: Boy, I had a great day. Found lots of gold and silver. This river is made for mining. Don't you think so?

PERSON #2: Maybe it can help you with mining, but this river really is made for irrigating farmland. Yes, this river is made for farming!

PERSON #3: Whoa! Wait a minute. This river is made for fishing. That's what's important!

PERSON #4: You're wrong. People are important. This river is for cities!

PERSON #5: NOT!! Hey man, this river is made for rafting!

PERSON #6: Rafting? Cities? Farming? Mining? Fishing? That will all ruin this river. This river should be left natural!

PERSON #7: Whoa, whoa. Wait a minute. I, am with the government. I, am here to help you.

(The group argues and fights, repeating their claims.)

NARRATOR: The people could not agree. They could not listen. Each person shouted louder and louder....and called his or her lawyer.

(In unison, blind persons pick up phone. "Hello?")

NARRATOR: Finally a voice from the watershed said...

WATERSHED VOICE: (Thunder-like, booming voice.) STOP!

(The group stops fighting immediately and look around/up.)

WATERSHED VOICE: (your local) Watershed is a very big ecosystem. Each person has only considered one part. You must put all the parts together in order to understand what the watershed really is.

ALL PERSONS: Oooooo! Eeeeee! Ahhhhh!

NARRATOR: The seven people listened to the watershed voice. They sat down together and talked quietly. And although they did not agree on everything, they listened to each other sincerely.

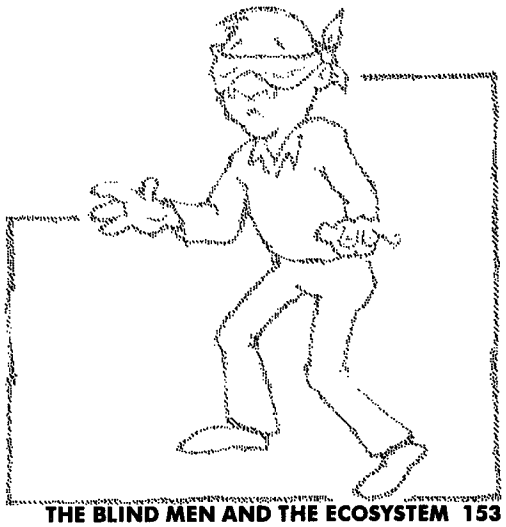
Afterwards, the group takes off their blinding glasses and see more than they did before.

(Persons take off glasses. Look around in amazement. They line up to leave down center aisle. Begin walking more confidently, no hand on shoulders.)

NARRATOR: And even though they were no longer visually impaired, they travelled together, one beside the other, never to return to the Land of Stereotypes. They still talked and communicated with each other, so they would not fall down.

(Group leaves. Helping each other walk back over the log.)

THE END



LEVEL: Grades 4-8

SUBJECTS: *Environmental Education, Science, Geography, Physical Education, Social Studies, History, Math.*

PROCESS: *Through an active simulation game, students learn characteristics of migratory shorebirds and the importance of wetlands to them.*

OBJECTIVES: *The student will:*

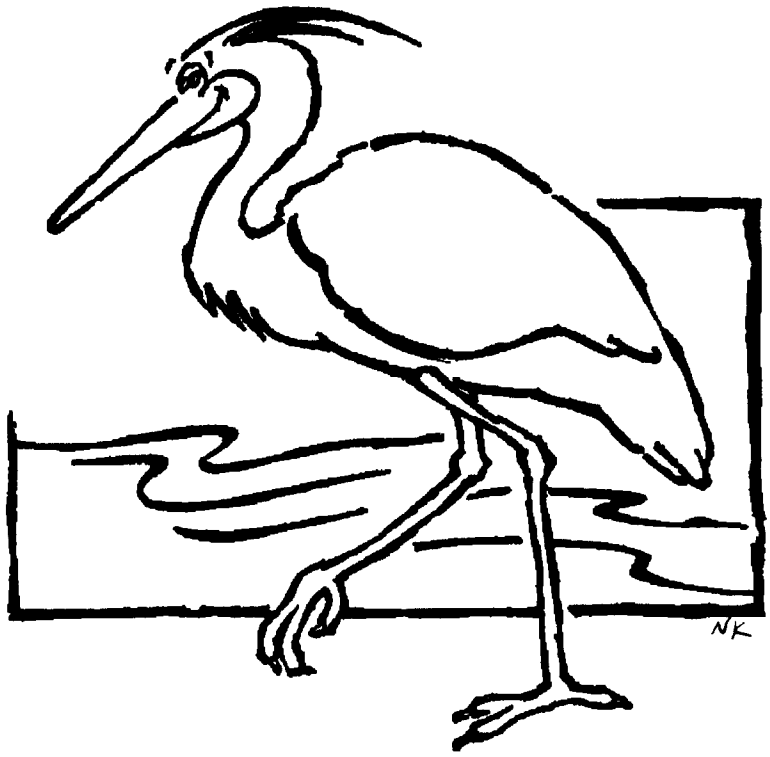
1. *List five characteristics of a shorebird.*
2. *Locate the three main flyways in the United States.*
3. *Name four hazards shorebirds encounter along their annual migrations.*
4. *Explain why these birds migrate from the far north to the far south of the Western Hemisphere.*
5. *Explain what "fat load" is and why it is important to migrating shorebirds.*

TIMEFRAME: *1 hour to 1 hour 30 minutes.*

SKILLS: *Comparing similarities and differences, counting, developing psychomotor skills, developing vocabulary, listening, kinesthetic learning, role playing, understanding cause and effect.*

MATERIALS: *Playing field or gymnasium, cones, string, rope or hula hoops to mark breeding grounds, wintering grounds, and staging areas, "Norther Cards," "Southern Cards," and "Staging Area" cards (attached).*

VOCABULARY: *Aquatic habitat, aquatic insects, body mass, clutch, fat load, fledging, flyway, foraging, invertebrates, juvenile, migration, migratory route, nesting, pesticide, pothole, predator, probing, shorebird, species, survivorship, territory, wetlands, (amphipods, critical habitat).*



THE INCREDIBLE JOURNEY

OVERVIEW: There are approximately 49 different species of shorebirds throughout North America. Shorebirds all have two common characteristics: longer legs and longer beaks than other bird species. Their body shapes, sizes, habitat uses, and foraging behaviors (how they collect food) are quite varied. Shorebirds feed along the edges of ponds, lakes, wetlands, coastal beaches, and any other places that they can find food in the mud and shallow waters. Many different sizes and shapes of beaks help them specialize in ways of eating. Some, like the Semipalmated Sandpiper, have thin beaks for probing in the mud; others, such as the Lesser Golden Plover, have shorter, thicker beaks for gleaning invertebrates from the surface of mud and water. Still others have beaks for snatching flying insects. The Wilson's Phalarope is a unique shorebird because it swims in deeper water, kicking up food with its feet.

Shorebirds have certain needs that can only be met in very specific habitats. They must live by shallow water and muddy shores in order to find their food. They eat mostly freshwater worms (bloodworms = fly larvae), shoreflies, danceflies, craneflies, amphipods, and snails.

Most shorebirds spend their summers in the northern areas of the United States and in Canada and Alaska. They migrate to southern United States, Central America, and South America to spend their winters in a warmer climate. Countries south of the equator have the opposite seasons to ours. When we are having winter, countries south of the equator are having summer.

The White-Rumped Sandpiper is one shorebird that has an especially incredible migration. Each year it migrates from the Arctic Circle to the southernmost tip of South America and back to the

4. Ask players to recall some causes of the birds' deaths. Have them categorize the causes as "Natural" and "Human Caused." They may need to define the criteria for each of these categories before listing the causes. Write the lists on the chalkboard.

5. Discuss the list of "Human Caused" and evaluate the pros and cons of each of these situations. How do they affect other animals and people? (i.e. DDT, outlawed in the United States for over twenty years, is very poisonous and is passed on from one animal to another poisoning each. Yet it saves crops from infestation of insects.)

ASSESSMENT:

1. Have students locate the three main flyways on a map of North America and South America. Ask:

-What are some of the weather changes shorebirds experience during their migration?

-What are some of the more predominant wetlands, lakes, or coastal shores they pass during their migration?

Students draw their own maps and plot possible staging areas on it.

2. Have students draw or design the perfect shorebird from junk and be ready to explain the adaptations they have added to their birds.

EXTENSIONS:

1. Working in small groups, students research to learn more about specific shorebirds in their local area. Have students report on it and trace its migration route.

2. Visit a wetland area near your community and list the different birds you find. Perhaps a person from the local Audubon Society or State Wildlife Agency could accompany you.

3. Invite your local State Wildlife officer to speak to the class about what impacts wildlife in your community and how students can help to lessen the negative impacts.

4. Have students research the formation and history of the Prairie Pothole Region.

5. Have students create a role play/debate between a person in support of draining wetlands for agricultural or urban building purposes and a person in support of saving wetlands for migratory shorebirds. Allow students time to prepare their arguments.

RESOURCES:

Conservation Biology, Susan K. Skagen and Fritz L. Knopf, "Toward Conservation of Midcontinental Shorebird Migrations," 7(3) (September 1993): 533-541.

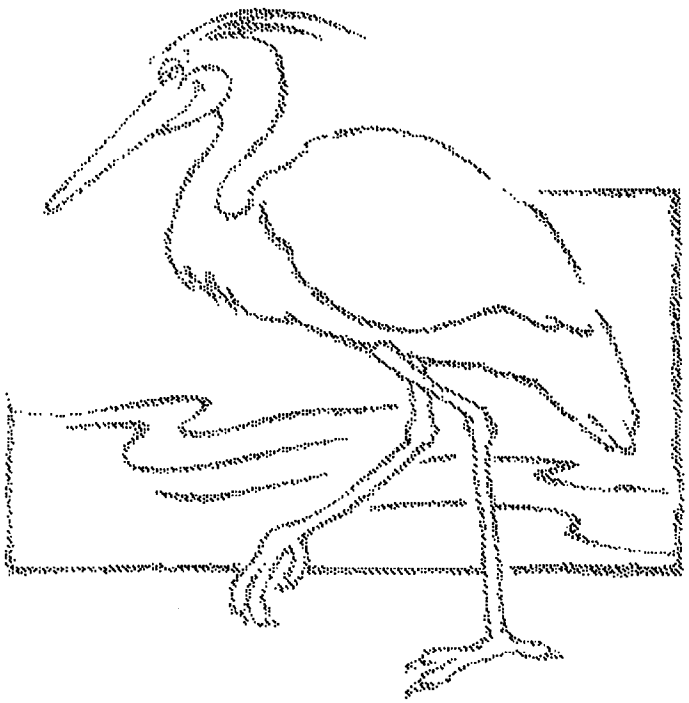
Shorebirds: an identification guide to waders of the world, P.J. Marchant Hayman and T. Prater, Houghton Mifflin Co., 1986.

Shorebird Education Project Newspaper, Julie Sibbing.

Shorebird Management Manual, Douglas L. Helmers, Western Hemisphere Shorebird Reserve Network.

"Semipalmated Sandpipers," *The Birds of North America 6*, (1993): 1-20, Cheri L. Gratto-Trevor.

"Protecting Prairie Potholes Saves Shorebirds," Shorebird Education Project.



The loss of wetlands has caused declines in shorebird populations of 60 - 80% in some species. The remaining birds must then compete for less food with more birds. If birds using the potholes as a staging area cannot get enough food to replenish their fat load, they will have to make many more stops. They may not reach their breeding grounds in time to mate and hatch their young before returning south for the winter.

Human recreation and hunting also affect nesting areas and some nests are deserted or destroyed. In the late 1800's many shorebirds were hunted in great numbers by market hunters in Canada and the United States. These two countries signed the Migratory Birds Convention in 1916, agreeing to protect migratory birds. Some hunting still exists in northern South America.

Efforts are being made to protect shorebirds. The Western Hemisphere Shorebird Reserve Network identifies important shorebird sites and helps protect them. There is an increased awareness of the importance of wetlands and the need to preserve them. These efforts will insure the shorebird populations a more secure future.

PROCEDURE:

PRE-ACTIVITY:

1. Read "Overview" thoroughly. It is essential to your understanding of this activity. Read through the game cards as well to be aware of situations presented to students!

2. Using a playing field or a gymnasium, identify one end as the northern breeding grounds and the other end as the southern wintering grounds.

3. Place a rope or other line across each end of the playing field to mark the wintering grounds and the breeding grounds. Then place three circles spaced out between these grounds. (See diagram.) The circles represent the staging areas.

4. Disperse the "staging area" cards evenly among the three "staging" circles. Spread the "Northern Cards" in the breeding grounds area and the "Southern Cards" in the wintering grounds area.

5. Talk briefly about migration, staging areas, breeding grounds, and wintering grounds. Explain that students will be playing the parts of migrating shorebirds.

ACTIVITY:

1. Each player must pick up one card at the wintering ground, each staging area, and the breeding ground. They must follow directions written on the cards and return the cards to the pile before they continue their migration. For example, a card from the breeding grounds may instruct its holder to take a person that has been labeled "dead" by another card and return them into the game as a young bird. Any player that picks up a card indicating death of the bird must drop out of the game and stand along the sidelines until an opportunity (eggs hatching in the North) arises to rejoin the game.

2. Select one or two players to represent the Peregrin Falcon and/or the Merlin as predators in flight. Their job is to tag students as they move among the staging areas. They must escort each tagged victim to the edge of the playing field before tagging another migrating student.

3. As the players run to the other side of the playing field, they must stop at each of the staging areas to refuel (unless otherwise instructed). They collect one card at each staging area and follow directions.

4. Players must make four complete migrations (that is from south to north and back to south). Each migration (in one direction) will begin upon the teacher's signal.

AFTER THE GAME:

1. Plot the survival rate of each migration.

2. Locate the three main flyways on a map of North and South America. For purposes of this game, players are to imagine they have migrated on the central flyway.

3. Ask players to share some of the unexpected situations described on their cards. Discuss how these things affect the migrating shorebirds.

THE INCREDIBLE JOURNEY
GAME CARDS

On these five pages cut out the following game cards:

10 - Northern Cards

10 - Southern Cards

14 - Staging Cards

NORTHERN CARD

Bad news! Unusually bad weather has limited your feeding time. You are too weak to make it to the first staging area. You die and must go to the sideline.

NORTHERN CARD

Yeah! Good weather and only a few predators have made it a great nesting season. Pick two people from the sidelines to migrate with you.

NORTHERN CARD

Hurrah! It's been a warm, wet summer. You have had an abundance of shore flies and dance flies to feed on. Your nesting is successful. Take one person from the sidelines with you. Begin migration.

NORTHERN CARD

Great! You have successfully hatched and fledged one of your young. Pick one person to migrate with you.

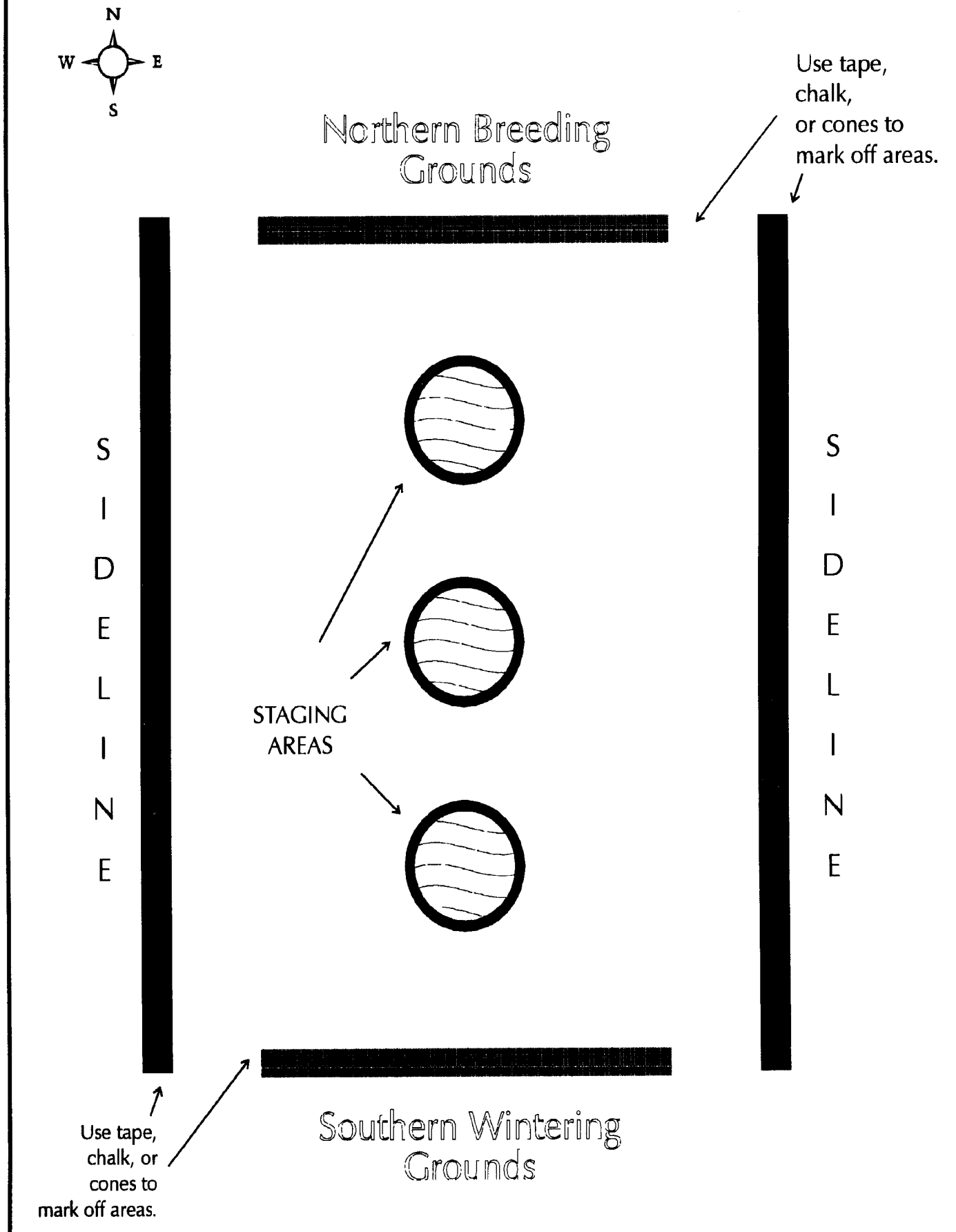
NORTHERN CARD

Bummer! A large fox population this year has increased fatalities. You are eaten. Go to the sideline.

NORTHERN CARD

Yum! There is an abundance of amphipods and snails this year. You have doubled your body weight easily. You have had a successful nest, take two people to migrate with you. Begin migrating!

THE INCREDIBLE JOURNEY



THE INCREDIBLE JOURNEY

GAME CARDS

SOUTHERN CARD

Oh no! More wetlands have been drained and turned into agricultural areas. You are unable to find enough food and eventually die. Go to the sideline.

SOUTHERN CARD

Worms! Oodles of Freshwater worms! It's been a great winter with lots of food. You are easily able to increase your body weight from 20 grams to 40 grams for the long migration to the Arctic tundra. Migrate to the first staging area.

SOUTHERN CARD

Good News! Educating people about the need to preserve wetlands has paid off. You have more wetlands and abundant food. You begin your next migration in good health.

SOUTHERN CARD

Moo! The cattle industry is booming in South America. Your winter habitat is severely overgrazed making it difficult to eat enough to put on an adequate fat load for migration. You must skip to your first staging area.

SOUTHERN CARD

Starvin' Arvin'! Overcrowding due to loss of wetlands has increased competition for what little food there is. You do not have an adequate fat load and your migration is difficult. You may skip to your first staging area.

SOUTHERN CARD

BANG! Hunting of shorebirds is still legal in South America. You are shot by a hungry hunter. Go to the sideline.

SOUTHERN CARD

Yuck! You are feeding on aquatic insects that have been contaminated with DDT in the run off from agricultural lands surrounding your wetland habitat. You become sick and die. Go to the sideline.

THE INCREDIBLE JOURNEY

GAME CARDS

NORTHERN CARD

You are young and are not able to put on a sufficient fat load before migration begins. You are not as strong. Skip to the first staging area.

NORTHERN CARD

Yipes! It's been a good year for weasels and a bad year for eggs. You have no young survive. Food was abundant. Begin migration.

SOUTHERN CARD

How disappointing! You have had a rough nine months at your wintering grounds. Part of the wetlands you have always returned to have been drained, causing more birds to compete for less food. You are weak, hop on one foot to the first staging area.

NORTHERN CARD

Lost wetlands on the way to your breeding grounds made you late on arrival time and weak. You do not have time to reproduce. Craneflies and blood worms are abundant, you double your weight. Begin your migration.

SOUTHERN CARD

Yipee! It's been a good winter! A new wetland reserve area has been added to your winter grounds. There was plenty of food. Fly to your first staging area.

NORTHERN CARD

Continued severe weather in the Arctic tundra caused you to not lay eggs. You have difficulty finding a sufficient supply of invertebrate prey (animals you eat). You struggle to keep up with the flock. Hop on one foot to your first staging area.

SOUTHERN CARD

Too bad! Agriculture is spreading on your wintering grounds, and as a result so is DDT. You are poisoned by this lethal pesticide and die. Go to the sideline.

THE INCREDIBLE JOURNEY

GAME CARDS

STAGING AREA

Bye, bye! You did not find enough food to replenish your fat load and the flock you were traveling with has left without you. You must wait one turn to continue on with another flock.

STAGING AREA

This is unnerving! You are on the perimeter (outer edge) of the flock and must constantly be on the look out for predators. You do not eat enough to put on an adequate fat load. Hop to the next staging area.

STAGING AREA

Gooey! You find one of your coastal staging areas to be covered with the results of an oil spill. You become covered with the thick goo and are unable to eat, fly, or maintain any body heat. You die. Go to the sideline.

STAGING AREA

Ugh! You have run into a head wind (wind blowing against you) and you are burning up a lot of energy. Take two steps forward and one step back as you make your way along your migration.

STAGING AREA

Whoopeee! Education about wetlands has gained public support for the restoration of wetland areas. You have an abundance of snails and freshwater worms to feed on! You begin your migration in good health.

STAGING AREA

ZAP! New radio towers have been built across your migration route. You are zapped and die. Go to the sideline.

STAGING AREA

You find yourself feeding in the safety of the flock. Craneflies, danceflies and shoreflies are abundant. You double your weight easily. Move on to the next staging area.

THE INCREDIBLE JOURNEY

GAME CARDS

STAGING AREA

What!? Your usual staging ground is swarming with people! A new recreation center has been opened at your staging area. Being around so many people makes feeding difficult. You do not store enough energy. Walk to your next staging area.

STAGING AREA

Hooray! The Western Hemisphere Shorebird Reserve Network has done a great deal to preserve important shorebird sites along your migration route. You find a surplus of food and quickly refuel for your continued migration.

STAGING AREA

Brrrr! Bad weather makes for a slow migration! Side step to your next staging area.

STAGING AREA

Bad stuff! You find that this staging area has been contaminated with pesticides from surrounding agricultural lands. You become ill and die. Go to the sideline.

STAGING AREA

WHEEEEEEE! You've got a full stomach and a tail wind pushing you on to your next staging area. A predator can't even catch you! Arrive at your next staging area quickly and safely.

STAGING AREA

Yikes! Your usual staging area has been drained for farming. You must scrounge to find enough food for the next leg of your journey. Hop on one foot to the next staging area.

STAGING AREA

Gobble, gobble! You have had warm weather and abundant food at this staging area. You have easily increased your weight by 100%! Begin your migration again.

LEVEL: Grades 4-12

SUBJECTS: *Science, Social Studies, Language Arts.*

PROCESS: *Through role playing, students examine various societal values related to archeological resources.*

OBJECTIVES: *The student will:*

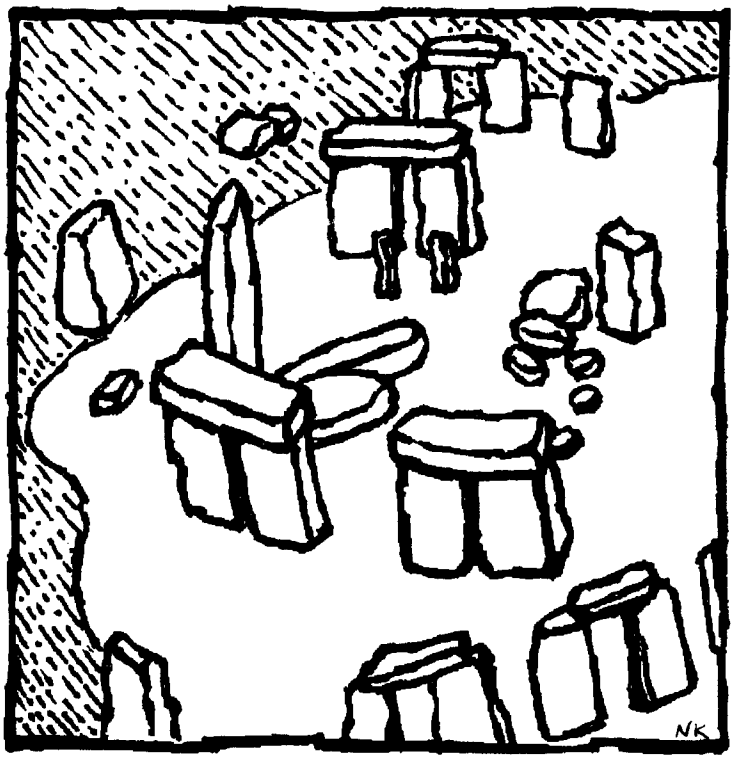
1. *Debate the viewpoints of four different interest groups regarding an archaeological site and a road construction project.*
2. *List eight societal values concerned with archaeological sites.*
3. *Label various uses of an archaeological site as consumptive or non-consumptive.*
4. *Formulate his or her own decision about the proper course of action.*

TIMEFRAME: *One to two 45-minute periods.*

SKILLS: *Analyzing, debating, decision making, evaluating, problem solving, role playing, synthesizing, valuing, visualizing, writing.*

MATERIALS: *Writing materials, "The Road Showdown" for each student (attached).*

VOCABULARY: *Aesthetic, archaeological site, archaeologist, artifact.*



THE LONG AND WINDING ROAD

OVERVIEW: Many people care about the past, and for many different reasons. Sites and artifacts (human-made objects) provide meaning on several levels. Using the example of Stonehenge in England, we can list some values people hold toward the past. Archaeologists (people who study history through items left by earlier peoples) value Stonehenge for its scientific potential. Many people appreciate its aesthetic (beauty) value. Druids, even today, believe Stonehenge has spiritual or religious significance. British people gather there every year to make social and political statements. The concessionaires and businesses around Stonehenge value it for its commercial and economic value. To some people, Stonehenge has an intrinsic value, that is, it has value just because it exists. To many Britons, Stonehenge also holds heritage or historical values.

We can examine these meanings by placing them in one of two categories: consumptive and non-consumptive. Consumptive uses are those that "use up" or deplete the past-sites, artifacts, and the opportunity for knowing about other people and other times. Non-consumptive uses are those that do not deplete sites, artifacts, or the knowledge base.

To some people, places and things of the past are tangible reminders of their heritage and history. If a person explores the site by observation they are acting in a non-consumptive way. The thing or place will be there for them to experience again and for others to experience. If a person takes an arrowhead, pottery shard, or old bottle, or writes a name on the wall of a historic cabin or rock art panel, it is consuming the past and removing parts of it from others' experience.

Other consumptive actions include collecting artifacts to sell or trade and construction projects,

which include the destruction of the site by plowing and erecting buildings.

Non-consumptive uses include aesthetic, scientific, spiritual, or religious values. Sites and artifacts, when studied where they were left by their owners, provide data and scientific insight to archaeologists.

In a gray area between non-consumptive and consumptive use is site excavation by a qualified archaeologist. The use of the site is consumptive, since physically the site is no longer intact. It is non-consumptive in the sense that information gained from the site is through scientific excavation and becomes public knowledge.

Archaeology is a rapidly changing field. New scientific techniques are developed every year that allow us to learn more from sites and artifacts. Archaeologists have adopted the ethic of conservation, and laws concerning cultural resources also recognize that we need to wisely use sites in order to conserve them. There will not be any more of them, and an archaeologist has to have a good reason to "consume" a site by excavation.

Archaeologists and managers who make decisions about projects on public lands spend a lot of time and energy analyzing how sites and artifacts are to be conserved. The issues surrounding use of the past are complex and often strike at the core of personal values. Responsible citizenship means being knowledgeable about these issues and taking informed and thoughtful actions.

PROCEDURE:

PRE-ACTIVITY:

Photocopy "The Road Showdown" for each student.

ACTIVITY:

1. People often have conflicting ideas about what is the best use of a resource, and some uses prevent others. Ask:

-What are some examples of land uses that conflict with one another if done on or near the same property? *(Possibilities include wildlife (hunters versus wildlife watchers), rivers (dams and energy versus river running and fish habitat), and fields (farming or housing development).)*

These same kinds of conflicts affect archaeological and historic sites and artifacts as well.

2. Divide the students into four groups: archaeologists, American Indians, business owners, and recreationists.

3. Distribute "The Road Showdown" copies to students. Ask them to read the story through the eyes of their assigned roles to adopt the viewpoint of that interest group. They will be arguing for their viewpoint to a manager who will make the final decision about the project. The manager can be the teacher, a student, or a panel of students.

4. Give students 10 to 15 minutes for discussion in their groups. Each group appoints a spokesperson to present their arguments. They propose solutions to the problem that they believe could meet the concerns of all parties, as well as their own.

5. Call a "town meeting" to order and establish two ground rules: (a) no interrupting another person, and (b) be brief and to the point with your arguments. Set a time limit on presentations.

6. Each group presents their desired outcome to the manager(s), supporting their goal with solid reasons. General discussion and rebuttal follows.

7. Summarize the discussions by asking each group to choose one or two words that describe the value with which their group is most concerned. Examples may be science, heritage, religion, money, progress, fun.

8. Discuss how each of these values and concerns has validity, and that there is no absolute right or wrong answer to the problem. Point out that being a responsible citizen means understanding all the viewpoints about an issue before making a decision or taking an action. The manager now decides what to do about the problems presented. Challenge the students to

think of other solutions to the problem that could meet everyone's concerns.

To CONCLUDE:

Students abandon their assigned roles and write what they would personally decide if they were the land manager, and why.

ASSESSMENT:

1. While in their groups, students list the societal values that their group holds towards the hypothetical archaeological site. Groups should also determine whether their desired use(s) of the site are consumptive or non-consumptive.

2. To assess the debate and the decision-making process, evaluate students on participation in their groups, the clarity and reasoning of their arguments, and the reasoning skill exhibited in their written decisions.

EXTENSION: Alter the scenario and interest groups to fit a local situation. Students write about the viewpoint of each of the interest groups.

CREDIT: Adapted from the "The Road Showdown," *Intrigue of the Past*, Bureau of Land Management.

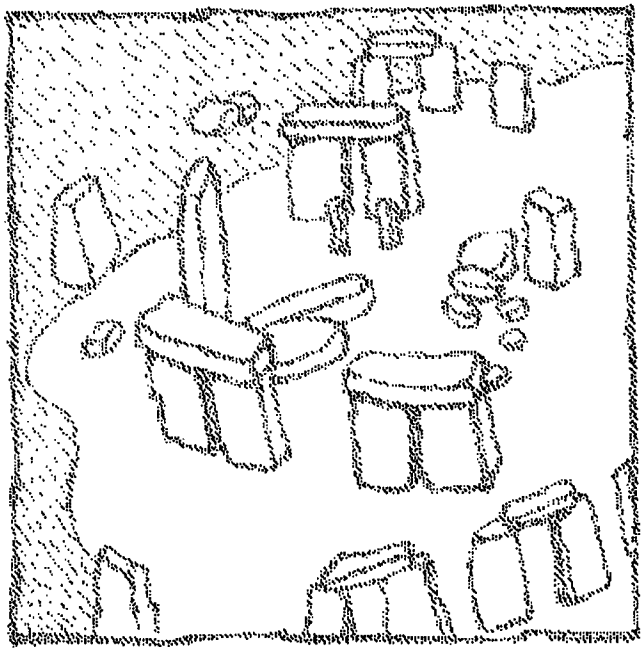
THE ROAD SHOWDOWN

The highway department is building a road connecting your town to a new reservoir. Archaeologists are excavating a site that will then be destroyed because it is directly in the path of the new highway. They have used up all the money the highway department budgeted for the excavation, but the site is much larger and more complex than they could tell when they first started. They say that the site is of tremendous scientific value and could help answer many questions about your state's past. They need $50,000 to finish the excavations.

Last week, the archaeologists uncovered some human burials. Following the law, they stopped excavating immediately and notified the nearby Indian tribe. Tribal leaders visited the site and told the archaeologists that the site included a cemetery of their ancestors and that it had significant religious and heritage values to the tribe. Their wishes are that the site be covered up and left in peace - no further excavation, no road over the site.

The local business owners are very concerned that the road will be delayed or not built at all. This affects their income significantly. If motorists aren't traveling through the town on their way to the reservoir, they won't be buying gasoline, food, or lodging.

Recreationists are also very concerned. Fishermen and women, motorboat enthusiasts, and water-skiers all have been waiting for years for the chance to use the new reservoir. Some have even bought expensive new boats and fishing tackle. They will have to travel 60 extra miles on a dirt road to get to the reservoir if the new highway isn't built.



LEVEL: K-7

SUBJECTS: *Science, Social Studies, Language Arts.*

PROCESS: *Through experimenting with physical distance and levels of comfort in humans, students will estimate appropriate distances between humans and wildlife under various conditions, hypothesize about indicators of animal discomfort, and summarize reasons to avoid animal discomfort through crowding.*

OBJECTIVES: *The student will:*

1. *Describe possible negative consequences for people and wildlife under conditions of crowding.*
2. *Identify ways people can behave to help reduce negative consequences of crowding for wildlife.*

TIMEFRAME: *Ten 30-minute classes, depending on age of students.*

SKILLS: *Hypothesizing, inferring.*

MATERIALS: *None needed.*

VOCABULARY: *Behavior, crowding, disturbance, safety.*

THREE'S A CROWD

OVERVIEW: Sometimes wildlife seems to want to say, "Don't get too close!" From a tree branch a bird watches a person approaching; when he or she gets too close, the bird takes flight.

Animals are often threatened when crowded by humans, even though the humans may mean no harm and merely want to observe the animal. Animals may display their discomfort by fleeing, grinding teeth, coiling, hissing, stomping feet, snarling, coughing, or woofing. Flight is the usual way of showing stress. Noises may come when an animal is ready or threatening to attack.

Wildlife photographers have learned that they have probably gotten too close when the wildlife they are photographing begin to act strangely. Animals may run away if humans are outside a certain distance. At closer range, they may charge or respond in other aggressive ways to the threat of human presence.

One way of understanding how a wild animal acts when crowded is to recognize that many animals have certain distances they keep even from their own kind. Wolves may demand large areas of range which no other wolf outside of their own pack (family) may enter. Studies show that certain kinds of finches always leave a certain distance between themselves when they perch on a telephone wire or fence line.

When crowding occurs, many animals react with bizarre, aggressive, disordered behavior, and may develop skin diseases like mange. They may adjust to the crowded situation, over time, by ceasing reproduction.

In the United States, great blue heron rookeries have been disturbed by the mere presence of people. Rookeries are the birds' breeding grounds. Herons live

most of the year as lone individuals; when they come together to breed - to go through courtship and nesting - they experience stress, if disturbed by humans. When stressed they may stop breeding, lay few eggs, or abandon the rookery, leaving eggs or young birds to perish. At a heron rookery in Colorado, wildlife managers have established a 1000-foot limit; no human disturbance is allowed close to the rookery. They are not sure this limit will save the rookery from development pressures, but they know any closer range would certainly disrupt the rookery.

The major purpose of this activity is for students to recognize the possible negative consequences for people and wildlife as a result of conditions of crowding.

PROCEDURE:

1. Introduce the concept of discomfort from crowding by asking one student to stand in front of the class. Approach the student slowly, asking the student to hold up a hand to show when your closeness makes him or her begin to feel uncomfortable. Ask:

-Why does it feel uncomfortable?

-If I were to step in closer, what would you feel like doing?

Have students experience the feelings themselves by lining up in two rows facing each other. Each student in one row slowly approaches the person across from him or her. The stationary person gives a signal to stop when it gets too close. Have them hold their positions and really "feel" the closeness. Look up and down the row. Why are some spaces between people bigger then others? Repeat with the opposite row doing the approaching. Ask:

-Do you allow strangers to approach you as closely as you do friends or family? Why?

-How do you feel in the middle of strangers on a crowded bus or elevator?

-How might your body react in some kinds of crowded conditions? *(Nervousness, sweaty palms, hard to breath, don't look at people, etc.)*

2. Ask:

-Why might animals in the wild also be uncomfortable when approached by strangers? *(Fear of being attached, need to protect young, etc.)*

-What other things might increase or decrease fear? *(Ability to fly away, climb quickly, run fast, swim fast, animal size, whether the animal is alone or with a group, is on a nest, or has young, etc.)*

3. Have the students make a list of animals they are likely to encounter in the environment. Have them estimate what distance should be maintained from each animal species - both for personal safety and for the comfort and safety of the animal. Emphasize that these are just estimates. It's better to stay farther away than you think is necessary than to get too close.

4. Have students hypothesize about animal behaviors that might indicate discomfort such as foot stomping, teeth grinding, raising up on hind feet, looking around nervously, and eventually flight. OPTION: Students mime or role play such situations. Classmates guess the animal they are, and in what situation.

5. Discuss ways in which wildlife harassment might occur unintentionally such as flying too close in small airplanes, getting too close to photograph, calling or heckling for animals to react (especially at zoos), hiking near a nesting site, and using loud vehicles near baby animals or in places where animals are unaccustomed to seeing them. Explain that there are certain times of the year when some animals may be more sensitive to being disturbed. Mating season or during severe climatic conditions such as heavy winters or drought are examples. How can communities minimize disturbances? What can individual people do? Summarize reasons it is important to minimize such disturbance from people for wildlife.

ASSESSMENT:

Ask:

1. What behaviors might show that a person speaking in front of a group is nervous?

2. How might a mother dog let you know you are getting too close to her and her pups?

3. Rank order the following, from animals you could get closest to without harming to those you should stay the furthest away from: a heron rookery during breeding season, young raccoons in a forest, a large garter snake in the grass of your yard, honey bees around their hives, frogs in a freshwater pond in the summer.

4. Describe negative results of crowding for humans. Describe negative results of crowding for animals.

EXTENSIONS:

1. Draw life-size outlines of some animals and mount them on an outside wall of the school building. Break into small groups; have each group establish a distance from each species that the group feels would be far enough for the animal not to be threatened by the pressure of a person. Using measuring tapes, each group measures and records the established "comfort zone" for each species under different conditions - and then presents their suggested distances for the animal comfort zones. Contact a wildlife resource person to check the accuracy of these distances. Is there a general rule about the relationship between the size of the comfort zone to things such as size of the animal, presence of young, ability to flee, single or group of animals, etc.?

2. What are reasons it is important to help domesticated animals like pets, dairy cows, etc. feel more comfortable in "close" conditions? How do humans "tame" animals? Why is it usually not a good idea to try to tame wild animals?

3. What happens to people when they feel too crowded? How do we show respect for someone when they say "Give me some space!"

CREDIT: Used and Modified with permission from *Project Wild's* "To Close for Comfort".

LEVEL: Grades 6-12

SUBJECTS: *Language Arts, Consumer Education, Environmental Education, English, History, Government, Communication, Debate.*

PROCESS: *After conducting research, students express their opinions about a controversial issue by writing a letter.*

OBJECTIVES: *The student will:*

1. *Identify a controversial issue.*
2. *Collect information about the identified controversial issue.*
3. *Define, identify, and collect examples of facts, opinions, and opinions stated as facts.*
4. *Analyze the collected information to form an opinion.*
5. *Write and mail a letter of opinion to an individual, group, or organization.*

TIMEFRAME: *Seven 30 to 45-minute sessions.*

SKILLS: *Analyzing, applying, classifying, comparing similarities and differences, comprehending, discussing, empathizing, evaluating, identifying, inferring, interpreting, listening, reading, recording, researching, synthesizing, taking responsibility, valuing, working in small groups, writing.*

MATERIALS: *Writing materials, current issues of newspapers, magazines, newsletters, etc., phone book, envelopes, postage stamps, "Issue Investigation," "Issue Facts and Opinions," "Their Point of View," and "My Point of View" sheets (attached).*

VOCABULARY: *Constituents, controversy/controversial, emotional appeal, fact, opinion, sidestepping.*

TO WHOM IT MAY CONCERN

OVERVIEW: Being a responsible citizen requires knowledge, involvement, and the ability to take action. Being well informed is important for a citizen in order to take effective action. Citizens have a voice that can be exercised and is heard when elected officials receive letters from constituents. Public opinion is also important to most businesses and organizations.

Controversial issues are rarely simple or limited to two sides. When issues involve the interrelationships of ecosystems and human populations, they can become very complex and often emotional. (Please see the activity "The Blind Men and the Ecosystem" for more information on seeing many sides of an issue.) In examining a controversial issue, it is critical that students are able to identify factual information, opinionated information, and information that is opinionated, but stated as if it is factual. Facts are neutral statements and can be proven to be true. Opinions, on the other hand, are points of view, judgements, or conclusions. Generally, opinions are drawn from facts, but that does not make them facts.

When gathering information and researching issues, it is also important for students to understand that different techniques are used in the discussion of controversial subjects. Issues can be sidestepped rather than directly addressed. Sometimes, responses are designed to have a certain emotional appeal that may make it difficult to find resolutions based on factual information.

Letter writing is an effective tool for expressing an opinion and making an individual's voice heard. Letters from constituents do have an impact on elected officials and their voting. Most government offices at the local level, businesses and organizations are concerned about the opinions of their customers and members as well.

Some suggestions for effective letter writing include:

-Write a personal letter in your own words rather than using a form letter.

-State the issue early in the letter.

-Be constructive and polite, not insulting or sarcastic.

-Say what needs to be said in one page.

-Limit your letter to one topic.

-Send letters about different issues in separate envelopes.

-Ask for a response and to be informed of possible action regarding the issue.

Some important addresses include:

1. Dear President _____, The White House, Washington, D.C. 20501.

2. Dear Senator _____, U.S. Senate, Washington, D.C. 20510.

3. Dear Representative _____, U.S. House of Representatives, Washington, D.C. 20515.

Other addresses can be found in the phone book or at your local library. The United Nations, United Nations Plaza, New York, NY 10017 can help you find the address of a world leader. Write to the person's embassy in care of the above address.

PROCEDURE:

PRE-ACTIVITY:

Photocopy the "Issue Investigation," "Issue Facts and Opinions," "Their Point of View," and "My Point of View" sheets (attached) for each student or pairs of students.

ACTIVITY:

SESSION ONE: **Issue Investigation**

1. Survey the class to discover which current issues involving ecosystems, people, and/or their interrelationships students are aware of. Brainstorm some issues and list them on the board. Have students classify these issues according to whether they are local, statewide, national, or international issues. Some issues may fit in all the categories.

2. Ask students to rank the issues according to *HOW MUCH* they personally know about an issue. In a separate ranking, ask them to list the issues according to their *OWN LEVEL OF CONCERN* or interest about each one.

3. Compile the ranking information for both categories using the top three issues from each student's list. Decide as a class which issue(s) to investigate for a class action project. Explain that students will be conducting research and gathering information to better understand an issue. Ultimately, they each will form their own opinion about the issue and write a letter expressing it.

In choosing, an issue, take into account which issues are the best understood by students, easiest to research, and generate the most interest. For older students, each student can choose an issue and work individually. Another option is to have students work in pairs or have those who share an interest in the same issue work together in small groups.

4. Have students begin collecting and reading sources of information about the issue(s) for session three. Discuss possible sources of information (newspapers, radio, magazines, interviews, council meetings, newsletters, brochures, television, etc.). Distribute the "Issues Investigation" sheet to students to complete during their research. Explain your expectations for completeness.

SESSION TWO: **Issue Facts and Opinions**

1. Discuss briefly with students the information they have gathered on their "Issue Investigation" sheet. They can continually add to this sheet as they collect information about their issue.

2. Assess students' knowledge of facts and opinions. Define and discuss the differences. Facts are neutral statements that can be proven. Opinions are points of view, judgements, or conclusions. Opinions are sometimes stated as facts, but that does not make them

facts. For example:

Fact: Many groups use fresh water.

Opinion: I think agricultural producers (farmers) should be able to use as much water as they need.

Opinion stated as fact: It is more important for urban areas to have priority in water use decisions.

3. With older students, discuss the use of the techniques of sidestepping and emotional appeal. An example of sidestepping is talking about increased pollution levels of water in general, when the issue is prioritizing who will get the use of a state's fresh water.

An example of emotional appeal is presenting an agricultural producer who had a mental breakdown when he lost his great-grandfather's farm due to receiving no water. The issue is prioritization in the distribution of water.

4. Distribute the "Issue Facts and Opinions" sheet to students to complete. Have them give personal examples of a fact, opinion, and opinion stated as a fact about their issue. As homework, students can gather and record more examples. Explain your expectations for completeness.

Session three: **Points of View 1**

1. Discuss briefly with students the information recorded on their "Issue Facts and Opinions" sheets.

2. Help students understand that there are often many sides or positions about an issue. Have them use their "Issue Investigation" sheets and ask:

-Are there more than two sides to your issue? How many positions are there?

-What are some of the different positions of your issue?

-What areas of agreement exist between the different positions of your issue?

-Exactly what are the differences about which individuals or groups find it hard to reach an agreement?

3. Students may need assistance identifying individuals, groups, and organizations involved in their issue. It may not be critical for them to identify all the parties involved in the issue, however at least two parties are essential. Make sure students take the necessary time to do their research and understand the history leading up to the controversy.

Session four: **Points of View 2**

1. Distribute the "Their Point of View" and "My Point of View" sheets to students. Have them use their "issue" and "fact and opinion" sheets to assist in identifying and stating at least two different positions held by others about the issue for the "Their Point of View" sheet. Explain to students that it is important for them to understand, as fully as possible, other points of view to better be able to form their opinion about the issue. Explain your expectations for completeness.

2. Encourage students to begin forming their own opinion about the issue, if not already formed, for the "My Point of View" sheet.

Session five: **Points of View 3**

1. Discuss briefly with students the information recorded on their "Their Point of View" sheets.

2. Have students complete their "My Point of View" sheets in preparation for writing their letter. Students' opinions may be similar to or a combination of another point of view. Students' opinions may be original, however. Explain your expectations for completeness.

Session six: **Letter Writing**

1. Have students compose a draft letter expressing their opinion about the issue. The letter can be addressed to a public official, group, or organization holding a similar or opposing point of view. The letter may also be addressed to an uninvolved public official, group, or organization in order to bring the issue to their attention and/or to ask what their position is on the issue. Ask students what they think effective letter writing techniques are and introduce any important points they didn't cover. (See Overview.) You may want to record the

techniques in a visible place for easy reference.

2. Have students peer edit the draft letters first for clear understanding, a statement of opinion or resolution, good letter writing techniques, punctuation, grammar, sentence structure, etc.

SESSION SEVEN: **Summarize**

1. When the editing process is complete, have students write the final drafts of their letters. Mail the letters and wait for a response. Encourage students to share letter responses with the rest of the class and continue to track the progress of their issues.

2. Ask:

-What is the most useful thing you learned researching your issue? Least useful?

-What is the most interesting thing you learned conducting your research? Least interesting?

-What surprised you the most?

-How can what you learned conducting your research help you get involved in other issues?

-What other issues interest you?

-In what other ways can you get involved in issues besides writing letters?

-Is writing letters an effective way to get involved in issues? Why or why not?

ASSESSMENT:

1. Evaluate students' four activity sheets for understanding and completeness. Note students' level of participation during the discussions.

2. Evaluate the students' letters. Establish predetermined criteria for students such as: being concise, polite, position identified and clearly stated, explanation of personal concern, demonstration of research and understanding of issue, resolution offered, etc.

EXTENSIONS:

1. Make a bulletin board DISPLAY by posting all the gathered research information. Also, post copies of the students' letters and the responses they receive.

2. Have students write letters every quarter about issues that concern them.

3. Have students gather the names and addresses of public officials at the local, county, state, and national levels. Publish a directory for any future letter writing to be completed by the students, their families, other students. Put a copy of the directory in the school library.

4. Invite an elected official or his or her representative to speak to the students about the importance and influence of citizen voices in the public decision-making process.

5. Videotape a debate of students representing various sides of a controversial issue. Based on assigned roles, students research, clearly state their positions, and offer a resolution.

6. Give students some basic information about a real or imaginary controversy. Have them write two newspaper articles, one factual and one slanted or opinionated. Discuss the differences.

7. Research an issue in history that was decided based on the influence of a vocal, mobilized, and informed citizenry.

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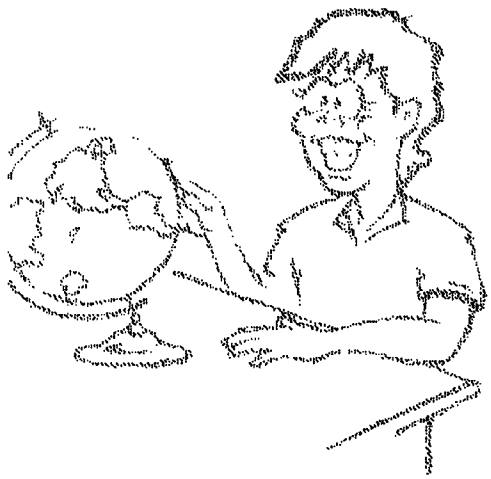


Their Point of View

Date:_____

Name:_____

Issue I am researching:_____

The position of_____
is:

The position of_____
is:

The position of_____
is:

Issue Investigation

Name:_____ **Date:**_____

Issue I am researching:_____

What I personally know about this issue:	My sources of information for research:	Individuals and groups involved in this issue:	Who or what this issue affects:	History of this issue:

My Point of View

Date:_____

Name:_____

Issue I am researching:_____

My opinions about this issue are:

My opinions are based on the following facts:

Issue Facts and Opinions

Name:_____ **Date:**_____

Issue I am researching:_____

Facts about this issue: (neutral statements that can be proven)	Opinions about this issue: (points of view, judgements, conclusions, etc.)	Opinions stated as facts about this issue:

Ghost towns' revival haunting

A "Sample" Controversial Issue Involving Ecosystem Management: Development of Abandoned Platted Townships in Gunnison County, Colorado.

By Ian Olgeirson
Special to The Denver Post

CRESTED BUTTE - A century after it was carved into a wooded hillside in the rarefied air above Crested Butte, the town of Irwin is gearing up for a second boom.

It's one of several Gunnison County ghost towns, vanquished to disrepair and decay after the mining boom of the 1890s, that is coming back to life.

And the towns are haunting government officials in the process.

Irwin - which once boasted 5,000 residents, two dozen saloons, the county's busiest post office and a red-light district - was almost wiped out when the silver market crashed nearly 100 years ago.

The brothels and hotels probably won't be returning, but the people are.

Platted in dense blocks

Virtually empty town sites such as Irwin, Schofield and Floresta were platted during the silver rush in dense city blocks and were home to thousands of people.

A century later, the development rush and subsequent housing crisis is making the remote sites attractive to owners of second homes, as well as the local workforce.

Irwin poses the most immediate problem.

Gunnison businessman Jim Stratman is behind plans to revive the high-mountain spread, much to the dismay of environmentalists and county officials who are horrified by the prospects of uncontrolled growth in the fragile alpine area.

"There are a number of areas in the county where land has been platted into towns. While they are no longer incorporated, you still have a township platted into little lots," said County Manager Gary Tomsic.

Stratman recently bought 180 lots and plans to squeeze in as many as 50 home sites, all using septic systems and pit toilets.

His project has spurred county officials to begin developing a strategy to deal with the resurgence of abandoned towns. But they have come up with few solutions, County Planner Joanne Williams said.

Three years ago, nobody lived in Irwin year-round. But with the population boom of the 1990s and the exhaustive search for affordable housing, as many as 30 people now live up the unplowed road, commuting by snowmobile.

Potential 'pseudo-town'

"Its potential for turning into a whole new pseudo-town is a possibility," Williams said.

The more isolated but equally beautiful Schofield is also ripe for development. Two men recently bought 13 full blocks and six partial blocks, or more than 500 lots, in the ghost town between Crested Butte and Carbondale on the Crystal River.

Hans Peter Hansen, of Carbondale, and Christopher Smith, of Aspen, plan to sell 20 lots for summer cabins on nearly 60 acres.

Hansen said the cabins won't have running water but will use outhouses and vaults.

They plan to begin selling lots this summer, regardless of county approval.

"We don't need it," he said. "This isn't a subdivision. These lots are already plotted town lots."

Floresta, vacated shortly after the coal mine of the same name closed, is owned by the Wilson Margaret Scarbrough Trust of Austin, Texas.

A gate blocks entrance to the town, but its potential for development still poses a problem, Williams said, because it has easier access than the other ghost towns.

The crux of the county's dilemma is lack of control over these developers.

"They have to be treated differently than someone who comes in with a brand new subdivision proposal because the property is already divided," Tomsic said.

The problems in Irwin are exacerbated by its prominence in Crested Butte's watershed and the effluent that can be expected with a new population.

"In the worst of my dreams, I see it all running downhill into whatever," Williams said.

The town of Crested Butte also has been watching the project and is working on contingency plans to protect its water supply.

New subdivisions in Gunnison County must be either tied to a central septic system or provide lots larger than an acre.

But the tightly platted abandoned townships threaten to put individual septic systems on lots much smaller than an acre.

(Reprinted with permission: The Denver Post, article first printed Monday, May 30, 1994 in The Denver Post)

Issue Investigation

Name:_____ **Date:**_____

Issue I am researching: Development of abandoned plotted townships in Colorado

What I personally know about this issue:	My sources of information for research:	Individuals and groups involved in this issue:	Who or what this issue affects:	History of this issue:
Because of a current housing shortage and lack of affordable housing, there are plans to put homes on townships of former ghost towns. Three towns in Colorado were mentioned: Irwin, Schofield, and Floresta. They were towns during the silver rush. The old townsites are not subjest to the same development rules as new townsites. Environmentalists and county officials are worried about the effects on the watershed and the environment.	The Denver Post article: I can contact the developers and county officials mentioned in the article for more information. I can contact the existing towns of Crested Butte and Carbondale and see if they have published articles in their local paper.	County officials: County Manager Gary Tomsic County Planner Joanne Williams Environmentalists Developers: -Gunnison Businessman Jim Stratman -Hans Peter Hansen of Carbondale -Christopher Smith of Aspen Existing towns: Crested Butte Carbondale People needing affordable housing	-People who work in this county who need affordable housing. -Crested Butte, a town that needs to maintain a clean water supply. -Businessmen seeking to make a profit. -Ecosystems that will be harmed by uncontrolled growth.	A centry ago, the ghost towns were thriving during the silver boom. They were tightly packed with people. The towns were abandoned but the town lots are still on record as already plotted. Anyone who has the money to develop these sites can do so without the interference of current development rules. Most of these new developments will not have adequate sewage treatment, which can harm the watershed and affect the water supply of existing towns.

Issue Facts and Opinions

Name:_____ **Date:**_____

Issue I am researching: Development of abandoned plotted townships in Colorado

Facts about this issue: (neutral statements that can be proven)	Opinions about this issue: (points of view, judgements, conclusions, etc.)	Opinions stated as facts about this issue are:
Virtually empty town sites such as Irwin, Schofield, and Floresta were plotted during the silver rush in dense city blocks and were homes to thousands of people. Gunnison Businessman Jim Stratman plans to revive Irwin.	"In the worst of my dreams, I see it (sewage) all running downhill into whatever," Williams said.	The tightly plotted abandoned townships threaten to put individual septic systems on lots much smaller than an acre.

Their Point of View

Name:_____

Issue I am researching:*Development of abandoned plotted townships in Colorado*

The position of *county officials* is: they lack control over the developers. They are worried about the effects on the watershed and the fragile alpine area. They believe the septic systems and outhouses at the new development will be inadequate to deal with the waste.

The position of *the developers* is: they do not need county approval to begin selling lots and developing the subdivision. They will proceed with their plans because people desire housing that they can provide and on which they (developers) will make a profit.

The position of *local workforce* is: affordable housing is hard to find.

The position of *town of Crested Butte* is: they are worried about keeping their water supply clean.

LEVEL: *Grades 1-3*

SUBJECTS: *Environmental Education, Science, Language Arts, Art.*

PROCESS: *Through a sensory exploration of a pond community, students will improve their observation skills and their awareness of animals that depend on a pond community.*

OBJECTIVES: *The student will:*
1. *Identify and describe five characteristics of a pond community.*
2. *Analyze the adaptations of three pond dwellers that depend on a pond community.*

TIMEFRAME: *3 hours or more.*

SKILLS: *Analyzing, comparing and contrasting, describing, experimenting, hypothesizing, inferring, observing, reporting, visualizing.*

MATERIALS: *Toilet paper tubes for each student, yarn, 4-5 blank notebooks, craft paper,* Pond Life, *George K. Reid, Ph.D. (Extensions: bucket, clear one-gallon jar, aquarium aerator, aquarium hose, magnifying glass, light, foamcore board, art supplies, journal, ten hoola hoops,* Beaver at Long Pond, *William T. George and Lindsay Barrett George or* Between Cattails, *Terry Tempest Williams).*

VOCABULARY: *Adaptation, habitat, muck, pollutants, pond, senses, signs, soil, wasteland.*

WET AND WILD WORLD

OVERVIEW: Recently, you've probably been hearing about wetlands. They are often discussed in the news and at public meetings. They even show up on your drive home on bumper stickers. "Save the Wetlands" is everywhere, but why?

Wetlands are more than swamps or smelly bodies of water collecting trash. They are more than an inconvenience to a housing developer or a highway builder. They are habitat for many animals and plants and have value to people as well as to our total environment. Ponds are not scary, stinky mosquito-breeding wastelands, but instead home to frogs, ducks, fish, and beaver. Deer, coyote, and mountain lions drink from the edges, hawks and eagles hunt from above. Frogs, sparrows, and night hawks may feed on the mosquitos, while eagles and bats may feed on the frogs. Entire food webs can be observed at the pond's edge.

Wetlands come in many forms, locations, and climates. They appear differently across the United States. Swamps surrounded by trees dripping with Spanish moss provide many of the same functions as wetlands in the rolling, glacier, pothole country of the northern prairie. Wetlands are riverlands, swamps, wet meadows, marshes, tidal lands, bogs, and more.

Wetlands are valuable resources. They play varied roles critical to a balanced environment. They provide habitat for birds, amphibians, mammals, and insects just the same as they do for many trees, grasses, reeds, and water plants.

Ponds are a type of wetland. Similar to small lakes, they can be found in farmlands, cities, prairies, and mountains. Some have water all year. Others have water only part of a year, when they fill up with extra rainfall and help prevent

floods.

Water contained in ponds moves through the ground to replenish the groundwater that many farmers and cities depend on, especially in the dry Western states. Ponds trap pollutants that wash off the ground and filter them out of the water before it reaches the groundwater. People who fish use ponds and lakes for recreation as do people who simply enjoy looking at the surrounding plants and animals.

People often fail to look closely at wetlands. Without a thorough examination, people do not see or understand many of the special things that are taking place right below their eyes, ears, and noses.

PROCEDURE:

PRE-VISIT ACTIVITY

1. Write to the U.S. EPA Water Quality Branch in your region for posters and other educational materials on wetlands in your state.

2. To help develop observation skills, have students make scopes out of empty toilet paper tubes and yarn. They can be decorated or kept simple. Wrap them in black paper and keep the ends open to make them look more like telescopes. The scopes are for viewing objects up close. When your students use them, their attention will be more focused. Carry them on regular walks around the school and school grounds to help students become practiced at looking at specific objects on walls, statues, trees, and anything along the route. Encourage them to look on top, along the sides, and underneath.

3. Since many students have never visited a pond, plan your visit and review the following guidelines before visiting the pond: Walk slowly; do not run. Stay with the group. Be quiet except during group discussions and then talk softly. Respect all living and non-living things. Become involved. Do what is asked of you. Don't pick plants unless told to do so.

ON-SITE ACTIVITY:

1. Before approaching the pond have students sit down and discuss the senses they will use to explore the pond. While sitting have them feel natural materials around them. Ask them to rub some of them in their hands. After a few minutes, ask them to describe their experiences. If possible, take the objects apart to look inside. Ask:

-How did it feel, how did it smell, and how did it look?

2. Walk slowly toward the pond and ask students to plug their ears so they cannot hear for one minute. When the time is up ask:

-What did you smell? What did you see?

3. Ask them to sit again, close their eyes, and listen carefully until they hear five sounds. Each time they hear a new sound have them lift a finger until their hands are open. Clap when they can open their eyes. Ask:

-What sounds did you hear? What do you think made these sounds?

4. Begin following a trail to the pond. Instead of looking at the trail, walk slowly, looking up at the sky. Search for different patterns, colors, and shapes and encourage students to use their scopes. Stop at a point when everyone seems to be engaged and have each person locate a favorite pattern, color, or shape. Have them quietly describe the object to the people closest to their left arms. Repeat this process following the trail, but this time have them look at the ground around their feet as they walk. Stop to describe it. Continue the walk to the pond and have them observe for a third favorite shape, color, or pattern without focusing through the scope.

5. At the water's edge, have everyone find a special spot where they can see you easily. They should not be in the water or on wet soil, but they need to be on the edge of the pond. Explore the pond using their senses again. Extend their arms and hold their hands on the surface of the water, but not in it. Then have students place their hands in it. Ask:

-How did it feel on the surface and how did it feel in the water?

6. Have students down into the muck and pull up a handful from the bottom. Have them

the feel and smell of the muck and look closely into the muck for insects or signs of other animals. Pick up rocks from the pond's bottom and the sides and turn the rocks over to look under them. Explain that small, jello-like shapes on the rocks are eggs of animals and insects from the pond.

7. Ask for predictions of the life that may be at the pond. Look into the water very closely for signs of movement or other life. Ask:

-What kinds of life can you see? Do you think that plants are a form of life? When have you seen a dead plant? How did you know it was dead?

-What signs do you see of animals and insects eating plants in the pond? Be sure to look on and under plants.

8. Walk slowly around the pond and look for signs of animals and people. Find and discuss signs for three different animals at the pond. (There may be a lot of duplication, especially if this is in the city.)

9. Discuss what helps the animal live in water or near the water. Adaptations are special parts of an animal's body that make it possible to live in one place and not another. If there are ducks or geese, look carefully at their feet and discuss adaptations. When observing animals remember to look into the air above the pond, on the surface of the pond, under the water, and along the shore. Look in the plants along the pond for nests and look for tracks of animal's feet in the soft soil around the pond. Share with each other your finds. (If the students work in groups of three or four, they should share with other groups.)

10. Before leaving, compare your observations. Using several large notebooks, have the students list or draw what they have seen. They can later record their findings on a long sheet of craft paper in the classroom. Use the small handbook, *Pond Life* (a Golden Guide) or a similar guide to identify some of the unusual pond dwellers.

IN THE CLASSROOM:

1. Compare what everyone saw at the pond. List ten pond characteristics, including smell, sounds, sights, and textures. Search for similar characteristics around the school. Ask:

-Why or why aren't these found at the school? Would the animals found at the pond be happy at the school?

2. Discuss why a pond is important. Using a tape recorder or a camerecorder, have the students record a letter to the governor of your state about the importance of ponds.

ASSESSMENT:

Ask students to:

1. List five important characteristics of a pond that makes it different from the schoolyard.

2. Draw a picture of a foot of an animal that lives in a pond.

3. Describe the sounds of the pond and record them using a tape recorder.

EXTENSIONS:

1. Bring a bucket of pond water and several inches of "muck" from the floor of the pond back to the classroom to observe. Empty this into a large, clear one-gallon jar. If possible, hook up an aquarium aerator and run a hose into the jar. Place it close to a window, and watch for activity. Keep an observations list close to the jar and whenever anyone sees something moving inside the jar, record it (in writing or drawing) on the list. Once a week pull out a small tube of the pond water, look at it through a large magnifying glass in front of a lightbulb and watch for movement. Discuss how some animals have many lifecycles. For example, frogs change from eggs to tadpoles to frogs. Look for changes in the jar, too.

2. Read *Beaver at Long Pond* or *Between Cattails* and identify the residents of the pond. Describe the area surrounding these ponds. Create a 3-D class mural of a pond using drawings on foamcore board to add new dimensions to the mural. For example, a dragonfly or hawk can be on the board and glued to an "I-shaped" cardboard to lift off the mural.

3. "Circle Ponds" is an activity to be done at the pond. (Have a parent volunteer place large hoops (hoola hoops work well) in lush spots along a path leading back to the bus or school--a route different from the one taken to the pond.) Ask your students to use their excellent observation skills along the way. In their journals have them fill ten pages with one large circle per page and draw an observation of one living item found in each hoop. Compare and discus the contents of these ten circles.

RESOURCES:

Beaver at Long Pond, William T. George and Lindsay Barrett George, illustrated by Lindsay Barrett George, Greenwillow Books, New York, 1988. ISBN 0-688-07106-6.

Between Cattails, Terry Tempest Williams, illustrated by Peter Parnall, Charles Scribner's Sons, New York. ISBN 0-684-18309-9.

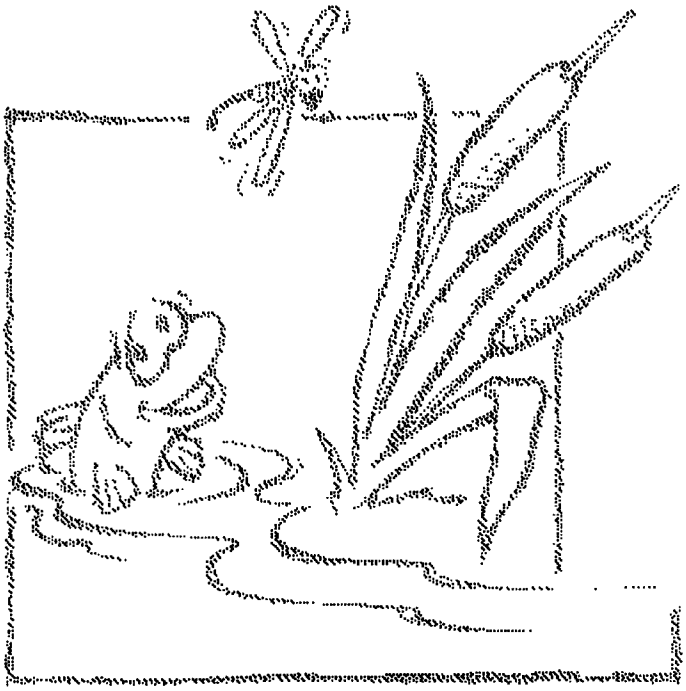
Pond Life, by George K. Reid, Ph.D., Golden Press, New York, 1987. ISBN 0-307-24017-7.

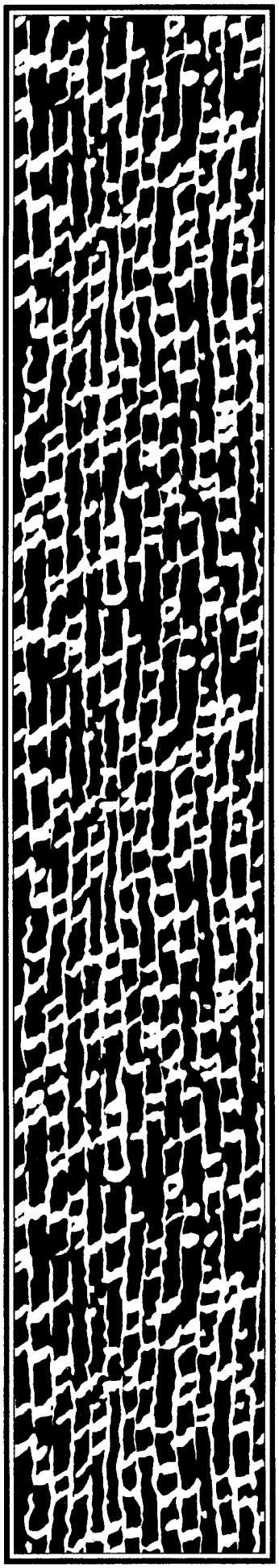
EPA Water Quality Branch, Water Management Division Region:

CO, MT, ND, SD, UT, WY
VIII, 999 18th Street, Suite 500, Denver, CO 80202-2405

CA, NV, AZ, NM, HI
IX, 75 Hawthorne Street, San Francisco, CA 94105

WA, OR, ID, AK
X, 1200 Sixth Avenue, Seattle, WA 998101





ECOSYSTEM MATTERS GLOSSARY

abiotic- *a non-living factor in an ecosystem (e.g., air, sunlight, water).*

acorn- *the nut (fruit) of an oak tree; typically set in a caplike base.*

adaptation- *the process by which animals or plants can change to live in a particular ecosystem; or, the trait in an animal or plant that makes it especially well-suited to live a particular ecosystem.*

aesthetics- *refers to the value placed on beauty.*

alpine- *refers to the high mountain area above timberline.*

amphibian- *an animal that lives in moist, wet areas. In its larval stage it lives underwater and breathes using gills. Through metamorphosis, it becomes and adult and breathes through lungs and moist skin (e.g., salamander, frog).*

anadromous- *usually refers to fish that spend most of their adult lives in oceans but migrate up fresh water streams to spawn (e.g., salmon).*

archaeologist- *a scientist who studies the life and culture of past peoples through the excavation and examination of their material remains.*

archaeology- *the study of past human lives and cultures through the examination of their material remains.*

artifact- *typically a simple tool or ornament produced by past human workmanship.*

aquatic- *refers to plants and animals that live, grow, or are regularly found in water.*

aquatic insects- *insects that spend part of their lifecycles in fresh water (e.g., mosquitos, mayflies).*

bat grate- *typically a framework of parallel or latticed metal bars that allow bats access to a mine or cave, while excluding humans and many other animals.*

bedding grounds- *a particular area where animals (typically herding animals) rest or sleep.*

bedrock- *the solid rock that underlies the earth's surface.*

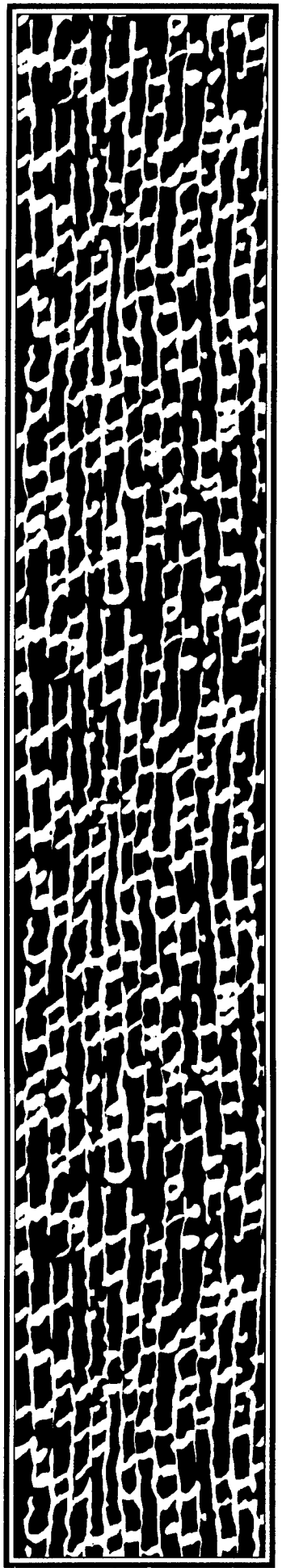
behavior- *the actions of an animal to certain circumstances.*

biodiversity (biological diversity)- *the variety, distribution and abundance of life forms and ecological processes in an ecosystem.*

biome- *an ecological formation with distinctive plant and animal communities that are produced and maintained by certain climatic conditions.*

biosphere- *the life-supporting land, water and atmosphere of the earth's surface; the entire earth's ecosystem.*

biotic- *a living factor in an ecosystem.*



biotic community- *living things in a community (as compared to the non-living things).*

bobcat- *a wild cat of North American named because of its short tail; also characterized by its tufted ears and freckled fur.*

body mass- *usually refers to the size and weight of an animal's body.*

bottlenecks- *a hindrance to production or progress.*

browse- *shrubs eaten by deer, elk, sheep or cattle; to eat the twigs of leaves of shrubs.*

carnivores- *animals that kill and eat other animals.*

carrying capacity- *the maximum number of individuals in a species that a particular ecosystem can support at an given time.*

cave- *a natural opening into the earth, often on a cliff or hill.*

cavity nester- *a wildlife species (typically birds) that requires holes in trees for nesting and reproduction.*

clay- *fine particles of earth with high water holding capacity; hard when dry, plastic or sticky when wet.*

clutch- *the number of eggs produced and incubated at one time.*

colony- *a group of animals or plants of the same species, living or growing together.*

competition- *when two or more organisms vie for the same resource. Competition can occur between two different species (interspecific) or between two individuals of the same species (intraspecific).*

consensus- *a general agreement or collective opinion.*

consumer- *an organism that eats other organisms or their remains; or, a person or other entity that uses items or services.*

controlled burn- *see prescribed fire.*

corridor- *a linear tract of land that a species must travel or migrate through in order to reach habitat suitable for a particular life-sustaining need.*

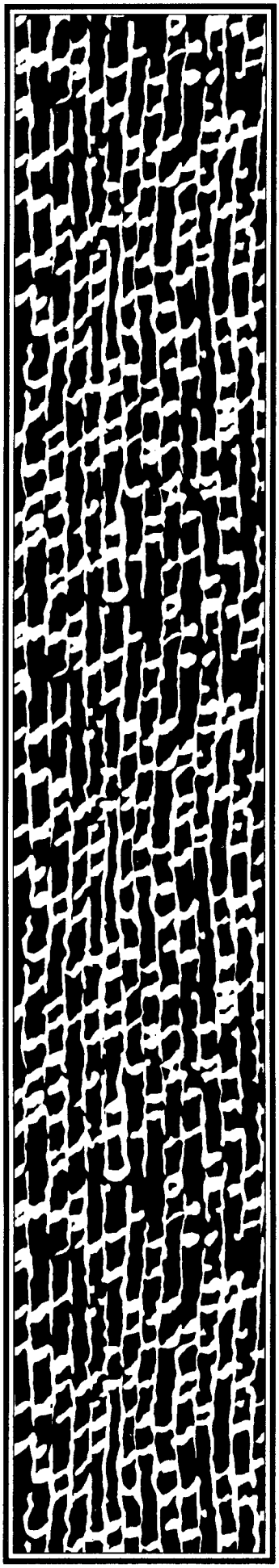
crystals- *are solids with faces that come together in may ways and have regular shapes that identify the crystal. For example, salt crystals are always shaped like cubes. Crystals that are forming are said to be "growing" and their shapes and sizes will be different.*

decay- *to rot or decompose*

decomposer- *organisms that which decay dead plants and animals.*

deforestation- *the permanent replacement of forests by other land types or uses.*

dense, density- *the number of individuals in a specified unit of space; usually expressed as the density of a population.*



desalting plant- *a facility that removes salt from salt water to produce fresh water.*

desert- *an ecosystem with little available precipitation and little vegetation.*

diamond- *extremely hard and beautiful crystals often used in jewelry.*

disturbance- *an event such as fire, flood, wind, earthquake, disease that causes profound change to an ecosystem.*

diversity- *(see biodiversity)*

duff- *the layer of partially decomposed, organic matter underneath the litter layer of a forest floor.*

ecologist- *a scientist who studies living things and their relationships with their environment.*

ecoregion- *geographic area in which the combination of climate, topography, and geology, determine what types of plants and animals that live there. All the earth's ecoregions form one large ecosystem. See biome.*

ecosystem- *a system formed by the interaction of groups of organisms with each other and their environment; the physical environment and the ecological processes that connect them. Ecosystems may be large or small.*

ecosystem management- *the strategy of using ecological, economic, social and business principles to manage an ecosystem to produce, restore, or sustain its integrity over the long term (as opposed to the strategy of focusing on only one principle, resource use, or species).*

ecotone- *a mixing zone where two ecosystems and their accompanying plant and animal species overlap.*

edge effect- *the tendency of wildlife to use ecotones; or, in forest management, the altered environmental conditions along the edges of forest plots that are directly adjacent to recently harvested forest lands.*

environment- *the total of all the external conditions and influences that affect the existence of an organism.*

environmental impact- *the effect of an action upon the environment; may be negative or positive.*

environmentalist- *a person who protects the environment from pollution, wasteful uses of natural resources, and undue human intrusion.*

erosion- *a process by which wind and water removes earthy or rock material from the land surface.*

escape terrain- *part of an animal's habitat where it can quickly go to elude predators.*

ethic- *a moral code based on the principle of good conduct.*

ewe- *an adult female sheep.*

factory- *a place where people work to change natural resources, like minerals, into something new.*

fat load- *the increase in calories, stored as fat, to prepare for an extended period of high energy demand, like migration, or an extended period of fasting, like hibernation.*

fault- *a fracture or zone of fractures in layers of rock or the earth; the rock movement that occurs along such cracks.*

fetus- *an unborn mammal in which the development of its major body organs is complete.*

fledging- *the process by which a young bird prepares for flight.*

flyway- *bird migration routes linking breeding habitat in the north to wintering habitat in the south.*

food chain- *the transfer of food energy from plants through a progression of animals. For example, a green plant is eaten by an insect, which is eaten by a frog, which is eaten by a snake.*

food web- *the complex and interlocking series of food chains.*

forage- *the process where herbivorous animals search for and eat vegetation; or, the plant material eaten by herbivorous animals.*

forbs- *low growing herbaceous plants (e.g., weeds, herbs, not grasses).*

forest fragmentation- *the change from vast and continuous forests to a mosaic of forest patches caused by tree harvesting, suburban sprawl, highways, etc.*

forest floor- *the ground of the forest.*

fuel loading- *the accumulation of combustible material like underbrush, grass, sticks, and trees in an area.*

game, game animal- *designated wildlife which may be legally hunted only under regulation.*

global- *refers to the whole earth.*

grass- *an herbaceous plant with long thin slender leaves and very small flowers.*

grassland- *a plant community composed primarily of grasses.*

grazer- *an herbivorous animal that eats grasses.*

guano- *bat droppings, usually refers to buildup of droppings.*

habitat- *an area that has the minimum required arrangement of food, water, shelter and space for a particular species.*

harvest- *the gathering of plants, animals or other renewable natural resource for use.*

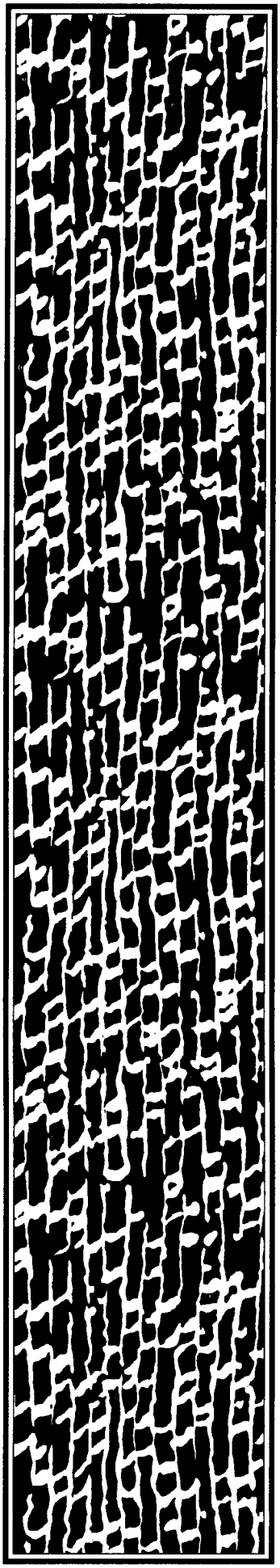
hibernation- *a period of extremely low metabolic activity during the winter.*

humus- *decayed organic matter in soil.*

hydrology- *the study of the waters of the earth, their distribution on the surface and underground, and the hydrologic cycle involving evaporation, precipitation, etc.*

immunity- *a condition of being able or having the capacity to resist a particular disease.*

inbreeding- *the mating of genetically similar individuals in a species.*



indicator species- *a particular plant or animal species used as a general measure of the health of an ecosystem.*

insecticide- *a chemical used to kill insects.*

interface- *a common boundary between abutting areas.*

inventory- *process of identifying and counting plants or animals.*

invertebrate- *an animal without a backbone.*

irrigation ditch- *a canal used to divert water from a stream to an agricultural field.*

lamb- *a young sheep less than one year old.*

landowners- *are people or companies who own land and have responsibility for the land.*

larva, larval stage- *the immature stage of many invertebrates followed by metamorphosis and the adult stage.*

life cycle- *the course of an organism's development through a series of stages or phases.*

limiting factor- *the environmental influences that limit the size of a population (e.g., predation, disease, food, water).*

limnology- *the study of fresh water ecosystems including marshes, ponds, and rivers.*

litter- *the layer of dead but not decomposed, fallen plant material that covers the forest floor; the layer above duff.*

lumber mill- *a factory where raw logs are cut into lumber (e.g., boards and planks).*

mammal- *warm-blooded, vertebrate animals characterized by having fur or hair; females nurse their young (e.g., mouse, bear, cow, human).*

management- *the practice or act of controlling the harvest, protection, or restoration, or other use of resources.*

managers- *people who make decisions about how resources will be used.*

marine- *refers to the sea (salt water).*

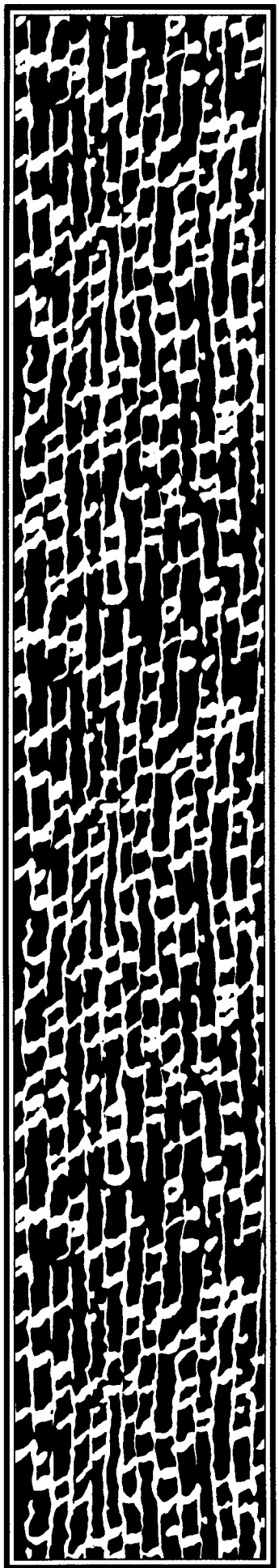
microscopic- *too small to be seen with the unaided eye; requires a microscope to observe.*

migration- *usually refers to the seasonal movement of animals from one region to another, however, migrations may cover very short distances for some species.*

mineral- *a naturally occurring, non-living object found in the Earth's crust; generally thought to be a metal or rock, but not always.*

mines- *are human-made holes in the earth from which minerals are removed. Some mines go far into the ground while some are on the surface. Mining is the act of removing minerals from the ground.*

mortality- *death; usually refers to death rate.*



natural resources- *raw materials provided by the Earth and usually processed into useful products. Some natural resources are renewable, like trees, crops and wildlife. Other natural resources are nonrenewable, like oil, coal and metals.*

neotropical birds- *are birds that breed in North America during the summer and spend the winter south of the Tropic of Cancer.*

nest parasitism- *when a bird lays an egg in another bird's nest, leaving the host bird to hatch its egg and raise its young. This is a natural way for cowbirds to reproduce.*

niche- *an organism's function or role in an ecosystem.*

nutrients- *in forestry, it refers to minerals in the soil that help provide food for plants to grow. The are taken into the tree through roots.*

nymph- *the immature stage of many insects that undergo incomplete metamorphosis; this immature insect typically looks like a smaller, flightless, adult.*

old growth- *forests of trees hundreds or thousands of years old, characterized by large trees, abundant snags, broken tree tops, and accumulations of decaying wood.*

omnivore- *an animal that eats both plants and animals.*

organic matter- *generally, all matter made by the processes of living things and containing the element carbon.*

organism- *any living thing.*

parasite- *an organism living in or on another organism (the host) from which it obtains its nutrients. Parasites usually harm their hosts to some degree.*

parent material- *is formed by the weathering of rocks and minerals that begins the process of soil formation.*

pesticide- *a chemical used to kill plant or animals considered to be pests.*

pine tree- *(from the genus **pinus**) an evergreen tree that has bundles of needle-like leaves instead of large leaves; seeds are contained in cones.*

placenta- *the uterine tissue of mammals that helps to exchange material between the mother and fetus.*

pneumonia- *a respiratory disease characterized by fluid in the lungs.*

pollutants- *unhealthy substances released to the air, water or land, that makes a resource less valuable or unfit for a specific purpose.*

population- *the number of a particular species in defined area.*

potholes, prairie potholes- *ponds and wetlands in west-central North America formed by retreating glaciers; important for migrating waterfowl.*

prairie- *a vast land area covered with grass and free of trees.*

precipitation- *any form of water falling from the sky (e.g., rain, snow, hail).*

predation- *the act of capturing another animal to eat.*

predator- *an animal that hunts, kills and eats other animals.*

prescribed burn- *a resource management technique where a fire is deliberately set in, and controlled to a specific area to meet certain management objectives.*

producer- *typically, a green plant that produces organic matter from inorganic matter by the process of photosynthesis.*

public land- *land that is owned by citizens and managed by government natural resource agencies.*

ram- *an adult male sheep.*

reptile- *a vertebrate animal characterized by scaly, waterproof skin and a reproductive strategy that produces a shelled egg (e.g., snake, turtle)*

resources- *are the collective wealth of a region that comes from the land, or from the people of the land. See also, natural resources.*

riparian- *refers to land areas adjacent to aquatic ecosystems.*

rodent- *mammals such as mice, rats, squirrels, or beavers characterized by large teeth used for gnawing.*

roost- *a place where flying animals can rest; the act of resting on a perch.*

salt- *a cube-shaped crystal mineral found where there has been sea water. It is used in food preparation, soap manufacturing, and de-icing airplanes.*

sand- *small, rough particles of quartz with low water-holding capacity.*

scat- *droppings of a wild animal, fecal material.*

scouring- *an action to clean a river or channel of sediment by flushing with water.*

senses- *any of an animal's functions of taste, touch, smell, hearing, and sight that allow it to examine its environment.*

shorebird- *birds characterized by long legs and long bills, that feed along the shores of coastal or inland waters.*

silt- *small, powdery particles of water-transported earth deposited as sediment.*

snag- *a dead tree that is still standing; characterized by a broken top and/or branches, and a hollow interior; important for some wildlife species.*

soil- *the top covering of the Earth's crust suitable for plant growth. Includes the living things living in it.*

spawning- *the reproductive strategy for fish whereby eggs are produced, deposited and/or fertilized.*

species- *a population whose members resemble each other and are able to breed to produce fertile offspring; the most narrowly defined taxonomic level.*

stand- *a group of trees in a specific area uniform in age and condition so as to be distinguishable from the adjoining forest.*

streambank- *the edge of a stream.*

stump- *the remains of a tree after it's top has been cut off.*

substrate- *an underlying layer; in rivers, it refers to the bottom of the river or stream.*

survivorship- *the number or percentage of newborn individuals in a population that are alive after a given period of time.*

tanks, desert tanks- *eroded depressions in the rock which fill up with water. They are very important to desert wildlife.*

terrestrial- *refers to the ground (as opposed to aquatic).*

territory- *an geographic area used for breeding, feeding, or both, which is defended by and animal against others of the same species.*

thermal- *refers to temperature.*

ton- *2,000 pounds.*

topography- *the description of a particular place or region; a map. The "lay of the land."*

tropical forest- *the highly biodiverse forest biome of the warm, humid equatorial region of the earth.*

tundra- *a cold, dry biome characterized by barren terrain with low-growing plant life.*

umbrella species- *see indicator species.*

understory- *the smaller trees and shrubs growing underneath the taller forest canopy.*

wasteland- *a discriptor used by people who believe that a particular place has little or no value or use. Some wildlife species may require this habitat.*

weaned- *to be withheld from mother's milk.*

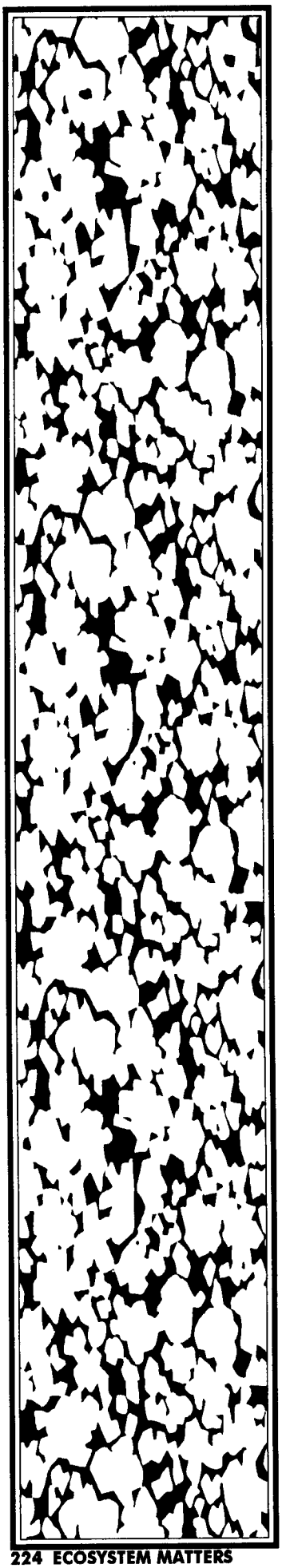
wetlands- *areas that are frequently inundated with water and are characterized by vegetation that requires saturated or seasonally saturated soils.*

wildfire- *any fire occurring on wild land that is not controlled or prescribed.*

wild land/urban interface- *areas where houses and other urban structures are built in close proximity to wildland areas where natural disasters, such as fire, are likely to occur.*

wildlife- *large or small animals that are not domesticated.*

woodland- *a partially wooded area in which the trees are often small and do not form a closed canopy.*



ALPHABETICAL INDEX

BIOGRAPHIES

PATTYANNE CORSENTINO *EDUCATOR/EDITOR WRITER/DENVER, CO*

Pattyanne Corsentino holds a B.S. in both Biological Science and Industrial Education from the University of Northern Colorado, and has 51 additional graduate hours in environmental education. She has taught in Denver public schools for twelve years.

Pattyanne has eight years as a educational consultant and workshop facilitator. She is presently a Homework Hotline Teacher, and is in her fourth year as a children's instructor at the Denver Botanic Gardens. She also serves on the National Steering Committee for the Leopold Education Project.

Pattyanne joined the U.S. Forest Service as an Environmental Education Specialist in the Rocky Mountain Region in 1992. Assigned through the Intergovernmental Personnel Act, she designs, implements, and enhances environmental education efforts for the Forest Service.

Pattyanne was named the National Conservation Teacher of the Year 1991. She has been recognized as the Colorado Outdoor Educator of the Year 1990 by the Colorado Wildlife Federation, the MeadowLark Award for Project WILD Facilitator of the Year 1989, received the Outstanding Youth Leader Award from the Denver Mayor's Office, The Blue Bird Award from National Public Radio, and the US Environmental Protection Agencies National Achievement Award for Outstanding Environmental Education Program 1990 and 1991.

MARY F. ADAMS *EDUCATOR/EDITOR/WRITER/GREELEY,CO*

Mary Adams earned her M.A. in Science Education from University Northern Colorado with a specialization in Health, Science, and Environmental Education. Mary is a veteran teacher with nineteen years of public school experience in science and health, grades K-12, and one year of community college education. Her education consulting experience (Lifelong Learning) includes conducting comprehensive health (Growing Healthy, Healthy Environment/Me) and science education workshops (Project WILD, Project Learning Tree, Earth Systems Education, Science Cluster), writing curriculum (Science of Alcohol Curriculum for the American Indian) and grants.

Mary's awards include the Greeley Audubon Society Outstanding Educator Award, Hewlett/Packard Award of Excellence, the Keep Colorado Beautiful Award, and the Colorado Project WILD Tenth Anniversary Commemorative Award (1994) for excellence in leadership.

ROXANNE BRICKELL *EDUCATOR/EDITOR/WRITER/DENVER, CO*

Roxanne Brickell holds a B.A. in Elementary Education from Metropolitan State College and a M.A. in Environmental Education. She has taught sixth grade for ten years in the elementary and middle school settings.

Roxanne has 14 years of experience as an educational consultant and workshop facilitator including Project WILD and Project Learning Tree. She was a contributing author for the "Rivers at Risk Activity Booklet," U.S. Fish and Wildlife. She presently directs Project Food, Land & People as their the national education consultant.

Roxanne was named National Conservation Teacher of the Year 1986. She's also received awards from the Colorado Division of Wildlife, Colorado Association of Science Teachers, Colorado Educator of the Year 1986 by the ColoradoWildlife Federation, the Meadowlark Award for Project WILD Facilitator of the Year 1986 and Colorado Department of Education for teaching excellence.

WENDY HANOPHY *EDUCATOR/EDITOR/WRITER/ARVADA, CO*

Wendy Hanophy holds a M.A. in Secondary Education and a B.S. in Wildlife Biology, and has worked in both the teaching and natural resource professions.

Wendy is nationally recognized for her contributions to environmental education. She has written curriculum materials for environmental educators since 1981, including Project WILD, Municipal Solid Waste Management, South Platte: Learning and Teaching the Essentials, American Studies Program, and Educator's Guide to Denver's Urban Wildlife Refuges (in process). *Wendy has been training other educators to integrate environmental education into their programs since 1980.*

Wendy's numerous state and national awards include Tandy Technology Scholars Outstanding Teacher Award 1989-90, Governor's "Celebrate Colorado!" Environmental Award 1989, U.S. West Outstanding Teacher for Colorado 1990, Take Pride in America Semi-Finalist 1990, Nature Educator of the Year Noteworthy Program 1991, Who's Who Among America's Teachers 1992, and U.S. Environmental Protection Agency Pollution Prevention Award 1992.

STEVIE QUATE *EDUCATOR/WRITER/STUDENT/DENVER, CO*

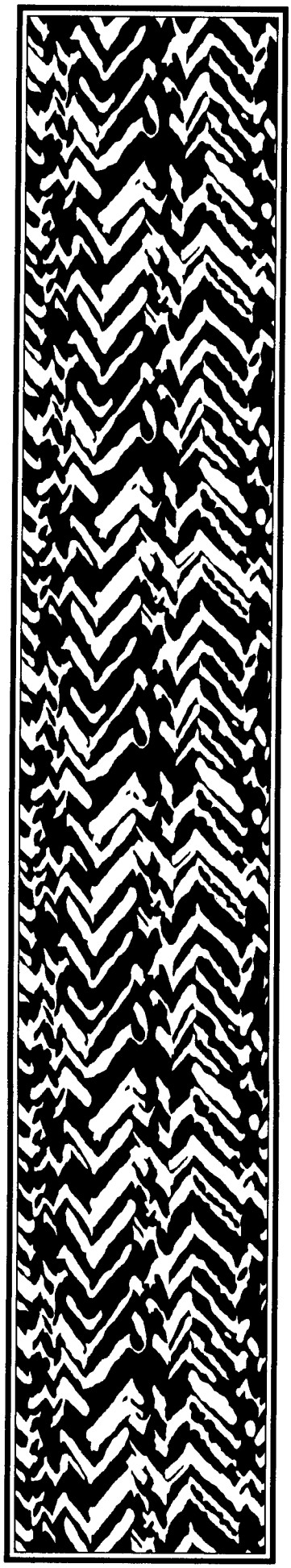
Stevie Quate has taught high school English just north of Denver for the past 22 years. Occasionally she tackles a short story or submits an article to an educational journal. During the summer, she directs Colorado Writing Project as well as leads various workshops for teachers. She is currently working on her doctorate at the University of Colorado.

JANICE M. HOPPE *EDUCATOR/WRITER/ST PAUL, MN*

Janice Hoppe has a B.S. in Elementary Education and Music from the University of Wisconsin, River Falls.

Jan has ten years of teaching experience and is a former senior editor and market research supervisor for TREND Enterprises, Inc., a national educational publishing firm. Her curriculum development and writing experience includes developing model learner outcome documents for the Minnesota Departments of Education and Agriculture and curriculum design for University of Minnesota. She is the lead writer for Minnesota Ag in the Classroom's Ag Mag and has written Minnesota's Arbor Day teaching materials for several years. She is also a curriculum consultant/editor for Project Food, Land & People.

Jan's awards include being listed in Outstanding Educators in America, 1974.



CHARLES W. CLARK *EDUCATOR/WRITER/ARVADA, CO*

Chuck Clark received his B.A. in Biology from Western State College and is a graduate candidate at Denver University in Environmental Policies and Management.

Chuck presently teaches sixth grade, but has fifteen years of experience teaching fourth - ninth grade. He is a former Project WILD assistant for the Colorado Division of Wildlife, Production Coordinator for "Water Wonders" curriculum, and facilitator for "No Time to Waste" Teachers Resource Guide. Chuck has been a Project WILD/Project Learning Tree facilitator since 1985. He was Advisory Committee Member for the Arkansas Headwater Recreation Area (1988-1990) and is presently a Citizens Advisory Board Member for Rocky Flats.

Chuck's awards include Colorado Conservation Teacher of the Year 1987, EPA President's Environmental Youth Award (sponsor) 1987, Take Pride in America Award 1988, and Buena Vista Citizen of the Year award 1989.

SUE DOYLE *EDUCATOR/WRITER/LAKEWOOD, CO*

Sue Doyle received a BA from National-Lewis University, a Bilingual endorsement. She has 15 years teaching experience in the Denver Public School. Her consulting experience includes Colorado Geographic, Alliance, curriculum committees, and Growing Healthy Consultant.

Sue's professional awards include the Golden Apple Award and Excellence Award from Foothills Parks and Recreation.

BONNIE JOY *EDUCATOR/IDAHO SPRINGS, CO*

Bonnie Joy has a B.A. in Education from Metropolitan State College, Denver, Colorado and a M.A. in Education in Computer Education from Lesley College, Cambridge, Massachusetts. She has 70 college hours beyond her masters with emphasis on environmental education.

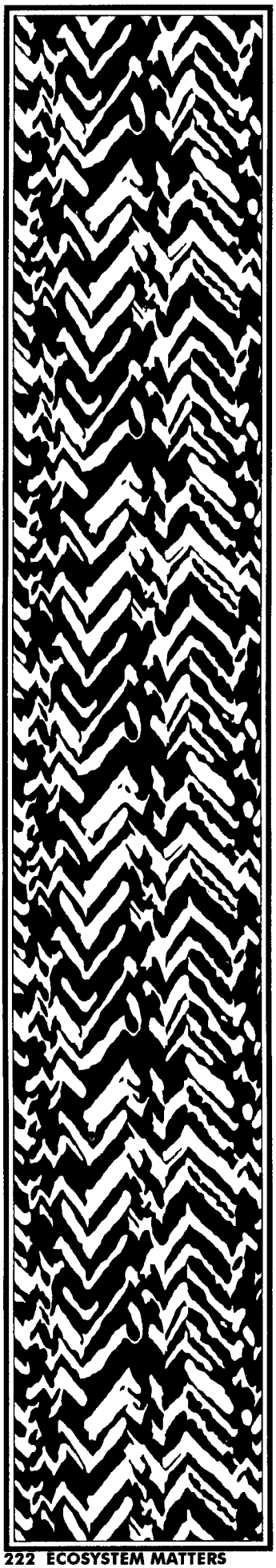
Bonnie has taught second, third, fourth, and fifth grades in Adams County School District #12 for eight years. She also taught gifted education in Shaker Heights, Ohio. In the last six years, she has facilitated Project WILD and Project Learning Tree workshops.

Bonnie was on the PLT State Advisory Board from 1985-1987, and held the PLT Workshop of the Year in 1986.

JEFF KEIDEL *EDUCATOR/WRITER/BUENA VISTA, CO*

Jeff Keidel earned his B.S. in Conservation Education from Colorado State University, School of Forestry and Natural Resources. He has taught fifth and sixth grade science for three years and high school science for nine years.

Jeff was the Conservation Teacher of the Year 1984 , Conservation Teacher of the Year 1983 Colorado Wildlife Federation, and received the Meadowlark Award for Project WILD Facilitation 1988 Colorado Division of Wildlife. A summer of counting bighorn sheep in Colorado's Collegiate Park range inspired the development of his Murder Ewe Wrote activity for Ecosystem Matters.



CAROLYN KIRK *EDUCATOR/WRITER/CONIFER, CO*

Carolyn Kirk holds a B.S. from Western State College with a major in Elementary Education and minors in Biology and Health Education. She has since completed over 50 hours of graduate coursework, with an emphasis on environmental education. She has taught for 15 years, and is currently a middle school math teacher. Carolyn is involved with environmental education on the state level, serving as a Project WILD facilitator for seven years and Project Learning Tree facilitator for four years. She's supervised environmental studies sessions for youth on behalf of Colorado State Cooperative Extension. She's also been involved with piloting and presenting many new curricular programs.

Carolyn's awards include Park/Teller Soil Conservation District Teacher of the Year 1991 and the Meadowlark Award for Project WILD Facilitator of the Year 1993. She served on the Colorado Department of Education Environmental Education Advisory Committee from 1990 to present and has received recognition from the Nature Conservancy for $10,000 fund-raising with students for wetland purchase.

CAROLYN KNAPP *EDUCATOR/WRITER/DENVER, CO*

Carolyn Knapp holds a B.S. in Renewable Natural Resources, Forestry/Watershed Management from the University of Arizona, Tucson and an Elementary Education Certificate Program from Metropolitan State College, Denver. Her teaching experience includes multi-grade levels (Preschool-6th grade) at Denver Botanic Gardens, Denver Museum of Natural History, and Gove Community School. Carolyn was involved in curriculum development at Thorne Ecological Institute, Denver Botanic Gardens, U.S. Forest Service, and Denver Urban Forest/U.S. Forest Service Tree Trunks. Classroom teaching experience includes Denver Public Schools Bryant Webster Elementary School (1st grade); Jefferson County Public Schools Governor's Ranch Elementary and Stony Creek Elementary.

Carolyn is a trained Project Learning Tree and Project WILD facilitator and has been involved in Grow Lab, Fast Plant and Bottle Biology, and Earth Keepers workshops. She helped develop Tree Trunk Kit for Denver Urban Forest and U.S. Forest Service; co-developed Rainforest Kit for Denver Museum of Natural History; and conducted teacher training workshops for Colorado School of Mines, Adams County School District, and Denver Urban Forest. She attended Cultural and Ecological Institute on Water Regional Conference, Cultural Diversity Training Workshop, Western Wetlands Riparian Areas Wordshop, and Ecosystem Management Workshop at Fort Collins.

BARBARA POULIN *EDUCATOR/WRITER/STEAMBOAT SPRINGS, CO*

Barb Poulin earned her B.A. in Elementary Education from University of Northern Colorado and her M.A. in Elementary Education from Adams State College. She has been a teacher for 16 years in grades 1-5. Barb has worked on curriculum development, the six state CAEE Committee, and the Keystone School Advisory Council. She's been an EPA facilitator/West Slope, and a contributing author writer for the " River at Risk Activity Booklet," U.S. Fish and Wildlife Service.

Barb is an environmental education consultant, Project Learning Tree and Project WILD facilitator. She was awarded the Meadowlark Award forProject WILD Facilitator of the Year 1992.

MICKAELA S. EARLE *GRAPHIC ARTIST/WESTMINISTER, CO*

Mickaela Earle is a Graphic Arts graduate from the Denver Institute of Technology (Phi Beta Kappa). Her experience includes graphic and fine arts, work in the advertising, printing, and horticulture industries, and eight years in the nursery industry.

Mickaela's commissioned illustrative works have been published locally and internationally. She is a member of the Advisory Board for the Colorado Mountain College Graphic Arts Program and has received recognition in the Rocky Mountain News and The Denver Post for charitable art work donations.

SCOTT L. SHAFER *COMPUTER LAYOUT AND GRAPHIC DESIGNER/LAFAYETTE, CO*

Scott Shafer is a graduate of the Denver Institute of Technology with a degree in Graphic Communications and Design. His computer graphics experience consists of a wide variety of areas with an extensive knowledge of IBM, Macintosh and prepress. This includes computer concept and output for four-color process, desktop publishing and visual communications.

Scott has worked on projects for individuals and businesses for five years.

LISA R. CASEBEER *WORD PROCESSOR/MONTROSE, CO*

Lisa Casebeer graduated from Lake of the Woods High School, Baudette, Minnesota May 1984.

Lisa has eight years of clerical/secretarial experience. She worked as secretary/typist with the Department of Social Services and the Division of Wildlife for five years and also was employed in the Legal Department of Tri-State Generation and Transmission, Inc. Lisa has been an active word processor for Project Food, Land & People for three years.

Lisa operates her own word processing business, Mustang Horse Ranch Word Processing Services. She enjoys working with her many horses and competes in Combined Training with them all summer long.

NORM KITTEN *ILLUSTRATOR/GRAPHIC ARTIST/FORT COLLINS, CO*

Norm Kitten is a graduate of the Colorado Institute of Art with a degree in Graphic Communications.

For the past thirteen years he has worked in various facets of the graphics industry, from production design to art director, fine art illustration to cartooning

Norm resides in Fort Collins, CO . He is currently writing and illustrating a book inspired by his son, as well as working a full time job as a computer artist.