ENERGY WORKBOOK FOR

PARKS

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ENERGY INTERPRETATION

In 1975 and 1976 the National Park Service sent one of its veteran interpreters on a 70-park tour to determine the potential for energy interpretation programs. The traveller, William Lewis, head of seasonal interpreter training at Yellowstone and professor of communication at the University of Vermont, concluded that parks are an ideal place for energy education. He urged the Park Service to promote it and offered some tips based on his evaluation of programs he saw.

"Use a reasoned approach," he suggests, "instead of a doomsday message." Try presenting a problem and its alternatives rather than conclusions about what society is doing wrong. Let people tell you what they think will happen if we choose various alternatives. Ask questions. Anticipate potential antagonism and alter your approach accordingly.

Above all, Lewis says, be creative. Try to find new ideas to capture visitor imagination like the interpreter "who lighted a candle instead of a campfire" for an evening program.

ENERGY WORKBOOK FOR PARKS

was written by the Park Project on Energy Interpretation, National Recreation and Park Association (NRPA), 1601 N. Kent Street, Arlington, Va., 22209, (703) 525-0606. Funds for the publication and the Project were provided by the Federal Energy Administration. The Park Project on Energy Interpretation works in 24 major park systems, at approximately 100 specific locations, to encourage the use of information on energy conservation in park interpretive programs. Park systems which participate in the Project and which helped to shape this book are:

California State Parks
Washington State Parks
Oklahoma State Parks
Delaware State Parks
Georgia State Parks
Vermont State Parks
Pennsylvania State Parks
Minnesota State Parks
Golden Gate National Recreation Area
Everglades National Park
Gateway National Recreation Area
Great Smokey Mountains National Park
Cape Cod National Seashore
Yellowstone National Park
Padre Island National Seashore
Rocky Mountain National Park
East Bay Regional Parks
Huron-Clinton Metro Authority
Lincoln Metropolitan Parks
Fairfax County Park Authority
Schuylkill Valley Nature Center
Cleveland Metroparks
Columbus Metropolitan Park District
Lima Environmental Education Center

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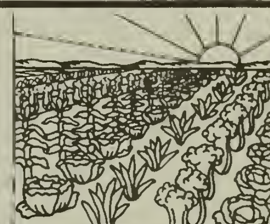

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WHAT IS THIS BOOK ABOUT?

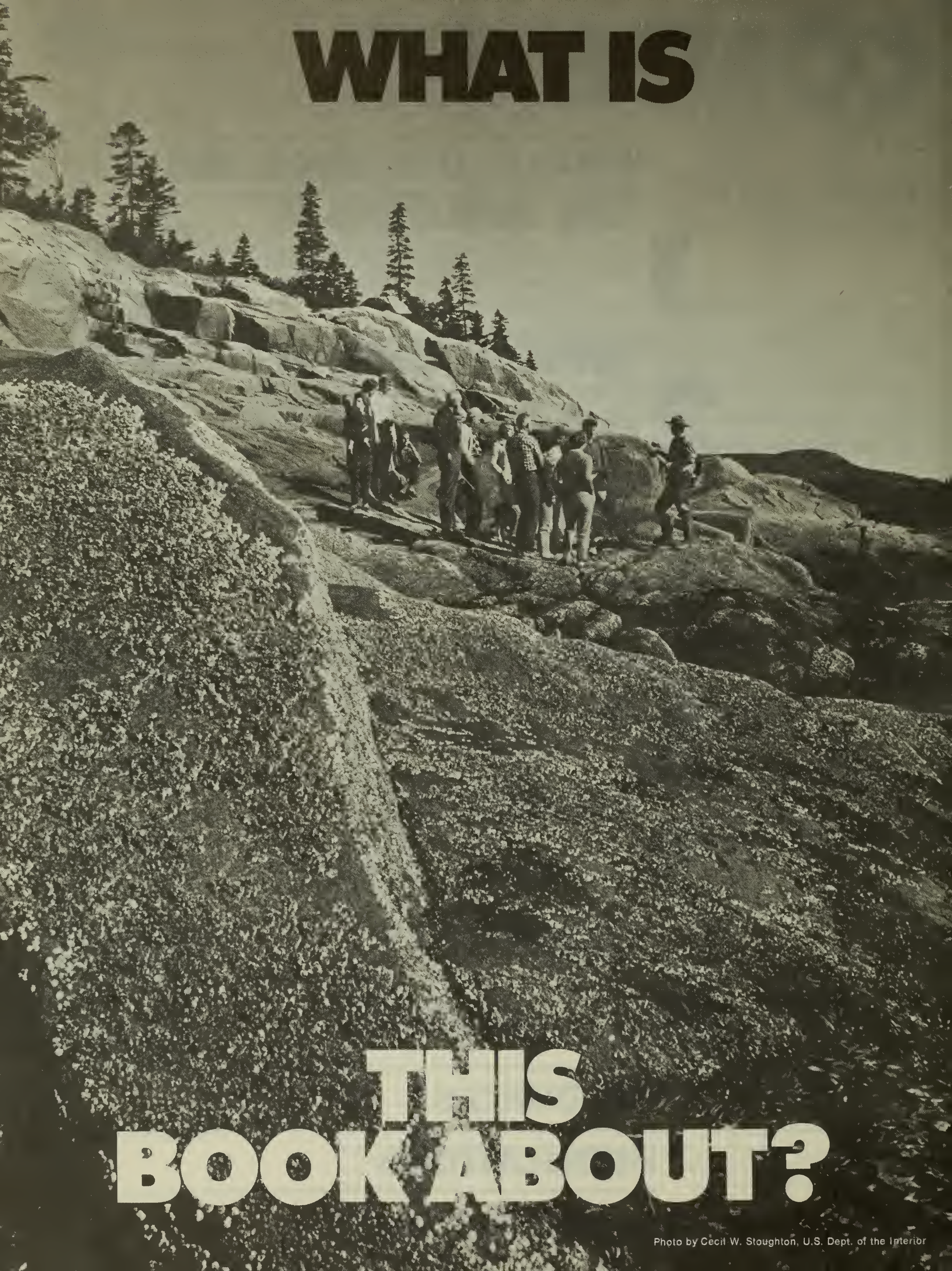


Photo by Cecil W. Stoughton, U.S. Dept. of the Interior

This is a workbook about energy for naturalists, interpreters, teachers, and anyone else interested in helping others understand how energy works and its importance to our society. It has been written especially for naturalists and interpreters in parks and nature centers. Several hundred of them helped us shape this book and several dozen contributed to these pages—either directly by writing something which appears here or indirectly by helping us plan activities, reviewing our manuscript, or just contributing ideas.

The book is the result of two years of work by the Park Project on Energy Interpretation to promote the idea of giving more attention to energy education in parks. We called, wrote, and visited interpreters in many park systems and nature centers. At the same time that we gave our pitch for more energy emphasis we also asked what information they needed to do good programs and we tried to supply it.

Most of them told us they especially needed examples of how energy works in nature and activity ideas to help them get started. This *Energy Workbook For Parks* is an attempt to provide that information. The book brings together most of the energy teaching tools we have discovered. It is an effort to share information, trials, errors, and successes. We hope it reflects the enthusiasm and great artistry of many of the interpreters with whom we've worked.

This workbook is also a companion to the *Energy Manual for Parks,* a 200-page basic reference book we published in 1976, designed to save interpreters the time and trouble of searching for factual information. Its chapters explore how energy is used in nature, how it is used by people, and possible alternatives to our current energy problems. The *Manual* is available from the National Recreation and Park Association, the organization which sponsored our program using funds provided by a grant from the Federal Energy Administration.

Why Energy in Parks?

We believe energy is an important focus of interpretation and environmental education not only because people all over the world are gravely threatened by a dwindling supply of fuel, but because energy is a thread which ties our world together. All living things, including the plants and animals in your park and the visitors who come to see them, are dependent on energy to sustain life. Without energy, life ends.

Energy has not been a major focus of park interpretation and environmental education in the past. This workbook does not advocate that it should suddenly become the central focus for all interpretation. However, it is a fascinating and important lens through which everything that happens in our world can be viewed. An understanding of energy helps people perceive how nature works and helps to prepare them for the difficult energy decisions our society faces in the coming years.

This is an age when it's easy for people to think that food originates in grocery stores, electricity is the magic that happens when you turn a switch, and oil is something manufactured by companies. The many ways industrial society uses energy are difficult to grasp. The processes seem larger than life. The way energy is used in natural systems isn't ultimately any simpler, but it works on a scale that people can understand. Sunlight feeds plants and plants feed animals. The directness of the processes is a refreshing and interesting change from the giant, complex systems which supply energy for our homes, factories, cars, and manufactured goods. Nature provides an appealing and logical context in which we can learn about energy.

Most importantly, nature's use of energy helps us to see some alternatives now that our supply of fossil fuels is no longer sufficient for all of the things we want to do. We live on a finite planet and the supply of energy, like all of our other resources, is limited. We must find ways, as nature does, to live within these inescapable limits. Parks are ideal settings for this message.

Programs on this topic need not be gloomy, tense, doom-dripping lectures on the uncertain fate of humanity. Rather, they can be joyous, invigorating exchanges from which people find new ways to understand the complexity of modern life.

How to Use This Book

We have designed this workbook with interpreters and naturalists in mind. We've left space in each chapter for your ideas and notes. We hope these spaces will overflow with new ideas and ways to strengthen the energy message. We've given the book a sturdy binding and paper stock so it can stand a lot of "thumbing" and outdoor use.

The background sections which begin each chapter provide some basic information about how energy works. They tell you more than you need to know to present most of the activities in this book, but they tell you things that will help you design other programs and help you answer questions from visitors. Source materials for each chapter, as well as recommendations for additional reading, are listed under "Resources" in the back of the book.

Each chapter includes fully developed programs as well as brief suggestions which we call "kernels." We originated some of these programs, but most came from interpreters and naturalists who participated in our workshops. A few came from people not directly involved with our project. Each chapter also includes activity descriptions or short articles written by interpreters and naturalists. These are identified as "An Idea From."

The activities are stated simply and there is lots of room for embellishment on your part. Relating them to your park is one of the keys to making exciting programs. Add information with an energy twist about the plants, animals, geology, and history of your setting, as well as the relationship to nearby cities and towns.

A consistent format is used for each activity. A short introduction tells you what the activity is about and why we like it. The LOGISTICS section tells you what kind of place and what materials are needed, as well as information about group size or type. THE GO OF IT tells how the activity might be done, sometimes including a sample script.

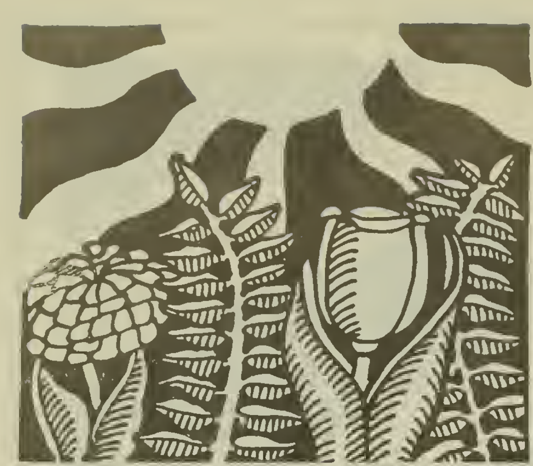
Many of the activities illustrate a number of concepts and could appear in any one of several chapters. Our grouping is somewhat arbitrary and we hope you will see many different uses for each activity. The games and ideas can also be combined to form larger programs. We offer some suggestions for such groupings.

The ideas and games in this book are general introductions to concepts, the first step in understanding. We use sensory experiences because they are fun to lead, fun to do, and allow all ages to work together. Learning comes easily from these experiences, and we hope your visitors will return for more. Good luck!

Nancy Strader and Lee Stephenson

THE SUN DOES IT

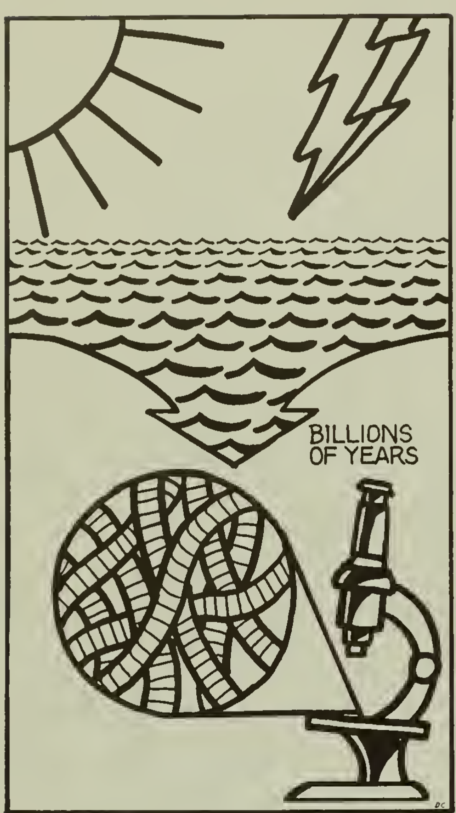
1



How life evolved on Earth is uncertain, but we do know that living things have certain needs for survival. One of those is energy. Nearly all of the energy to power the Earth's intricate processes and to feed its creatures comes from our sun.

"The sun is the chief's canoe."
—Bella Coola Indian saying

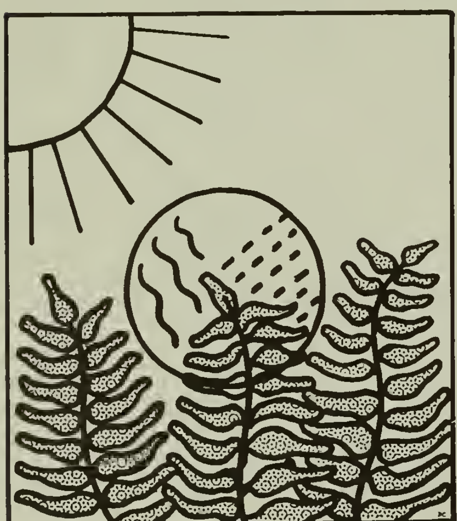
BACKGROUND



Scientists are still speculating about how the Earth was created and how life here began. However, based on what is known, they generally agree that the first primitive forms of life probably arose from non-living matter and were the basis for the evolution of all advanced forms.

Energy played a key role in the process. According to current theories, sunlight, lightning, or some other form of energy provided the "spark" necessary to synthesize the elements of the Earth's early atmosphere to form the first living things, small organic particles. This spontaneous generation of life may seem unlikely. But, given the ample supply of energy, chemical building blocks, and time (several billion years) for trial and error, it was probably inevitable.

Eventually, organisms evolved which were capable of converting solar energy into organic compounds. They produced oxygen as a by-product of the conversion and the oxygen began to accumulate in the atmosphere. As the composition of the atmosphere changed, it screened out increasing amounts of the harmful ultraviolet radiation in the sun's rays, permitting the eventual migration of organisms to land. Slowly, the land was colonized by successive evolutions of plants and animals which were adapted in many forms to fill available living spaces.

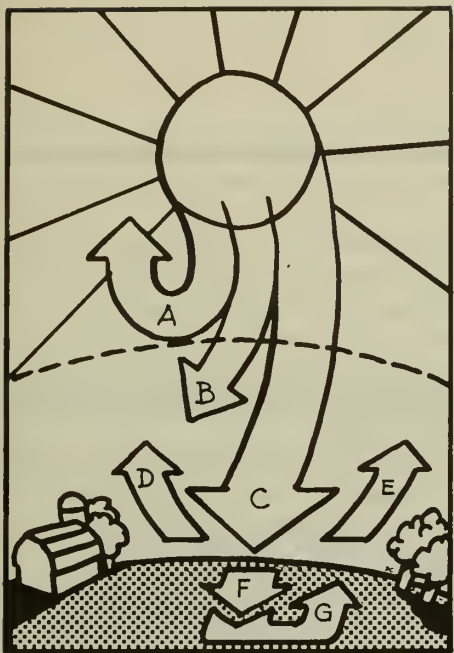


Thirty to 40 of the more than 90 chemical elements known to exist in nature are needed for life. Water is also necessary to the functioning of all living cells and is the largest component of all organisms. Living things also need a certain minimum of physical space and most require oxygen. And energy, the subject of this workbook, is a crucial ingredient—the fuel which makes things work. It is "the go of things."

Sunlight is the major power behind life on Earth. We have other sources—heat from the interior of the planet and tides caused by the gravitational interplay of the sun, Earth, and moon—but solar energy, including that stored millions of years ago in fossil fuels, comprises over 99 percent of the energy available on the surface of our planet.

The sun's rays make the 93 million mile trip to Earth in about eight minutes. The energy is released in a reaction scientists dream of controlling to produce energy for us on Earth: nuclear fusion. Triggered by gravity, which pulls all of the matter comprising the sun toward its core and creates intense heat, the reaction fuses molecules of hydrogen (the major ingredient of our sun and other stars) to form helium and releases a tremendous quantity of energy.

"Life may be unique to the planet Earth. But few scientists engaged in exploring the origin of organisms think so; most are convinced that life has probably arisen many times in many places . . . Given the immense size of the universe, they argue, it would actually be unreasonable to think that life is restricted to one small planet in one minor solar system."
— William Keeton, *Biological Science*



A. Reflected from the atmosphere 30%
B. Absorbed by the atmosphere 10-15%
C. Solar radiation entering atmosphere
D. Reflected from ground 5-10%
E. Evaporation 20%
F. Supplied to ground and reradiated 30%
G. Photosynthesis, winds, ocean currents, etc. 1%

Our sun is actually burning itself up, consuming an estimated four to 4.5 million tons of its mass every second at extremely high temperatures—an average of 11,000 degrees Fahrenheit on the surface and 20 million degrees or more in its core. The Earth is delicately positioned in an orbit close enough to the sun to reap its energy harvest, yet far enough away to avoid burning with it. The result is a planet teeming with life. When the sun's chain reaction stops, life on Earth will probably also stop. But the sun is just entering middle age and is expected to continue to provide energy for another five billion years.

The sun radiates energy in every direction in the form of electromagnetic waves which gradually lose power as the distance increases. This electromagnetic radiation has various intensities which are called wavelengths and about half of those reaching our atmosphere are the visible wavelengths we call sunlight.

Only a tiny fraction—an estimated one/two-billionths—of the sun's energy waves are intercepted by the Earth's atmosphere. But even this small percentage has tremendous power which has been estimated to be a continuous 2.5 billion billion horsepower—the equivalent over a year's time of 35,000 times the energy used in all human processes. This continuous and relatively stable solar input is called the solar constant.

Some of the incoming energy, about 30 percent, is reflected by clouds, gases, or the Earth's surface and is scattered back into space. The remainder provides the energy to power the "great engine of Earth." The atmosphere is heated, creating wind, ocean waves, and varying weather. Billions of tons of water are evaporated, lifted into the sky to form clouds, and then released again as rain. Materials move through the cycles which circulate chemical elements from the environment to organisms and back again. And even the landscape is altered by erosion, the sun's energy in the form of moving water and wind.

Less than one percent of the incoming solar energy becomes food for nearly all of the Earth's creatures. Plants are the go-between in this exchange, converting light energy into chemical energy in a process called photosynthesis. Virtually all of the planet's other living things are then sustained by eating plants or eating animals which have eaten plants.

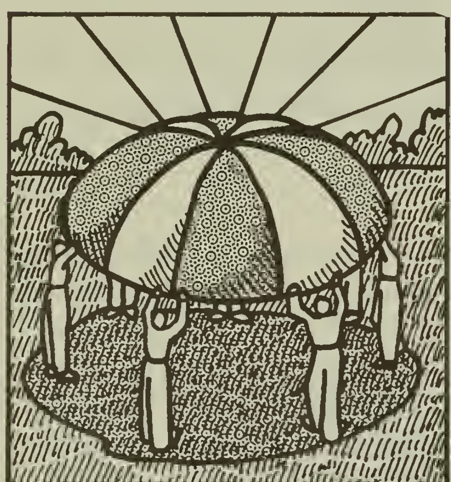
ACTIVITY
SUN CHUTE

This activity focuses on the ways that life on Earth is touched by the sun.

The parachute becomes a symbol for the sun and is used throughout the three parts of the activity. As the chute is decorated, discussion centers on where the materials come from and what sun symbols from other countries represent. The chute serves as a prop for The Air Conditioner Game, with its theme of the sun's effect on the environment. Finally, the chute becomes a backdrop and the focus of a ceremony that recognizes the interrelationships of all living things, including people.

WHAT YOU NEED

■ Supplies for the three parts of the activity: dye materials, natural or purchased, recycled five-gallon cans, magic markers or paint, a large parachute (available from Army and Navy surplus stores), pre-cut ropes, a ladder, pins, needles and thread, string, and tape.



THE GO OF IT

DECORATING THE CHUTE

■ It's fun to make dyes from plants if time allows. If the chute is large consider dipping only portions of it in the dye bath. It takes many onionskins to produce a rich, gold color. Use an outside fire to heat the dye. Nylon usually resists coloration, but silk chutes are harder to find. Try dyeing an old bed sheet cut in a circle and sewing it on the nylon chute.

■ Discuss the use of sun symbols in other cultures, such as those used in Navaho sand paintings, the decoration of early English churches, and Aztec temples. The group may want to design their own symbols. Suggest that they do research by observing the sunrise or sunset. If time allows, take a field trip to a museum to look for artists' images of the sun.

THE AIR CONDITIONER GAME

■ This game is a good warm-up and friend-maker and works well with all ages. After the chute has been decorated, find a large flat space—a field or an empty hall or gym. Ask the players to remove their shoes and socks. Spread the chute out smoothly and find a place to stand around the edge of it. Practice slowly raising and lowering the parachute until the players are working together smoothly.

■ "The sun gives us heat." Ask everyone to raise the chute high above their heads. All move under it and lower the edges, encompassing the group in its folds. They are all under the sun.

■ "The sun cools us." Divide the group in half (perhaps by the warm or cold seasons during which they were born). All the spring-summer people can cool off by lying on the ground under the chute while the winter-fall people turn on the sun's air conditioner (the winds). They do this by holding the chute at waist-level, raising and lowering it so that a rippling effect is created.

THE SUN RAISING CEREMONY

■ Choose a place in advance to hang the chute. It could be flat on a wall, strung vertically between two trees, or horizontally placed as a tent shelter. Try to select a spot that can serve as a central gathering spot for the group (do it at dawn if possible). Attach the ropes to the chute and "raise the sun" into position. A little live music such as a recorder would add special magic to the ceremony. (You might also do the yoga exercise here.)

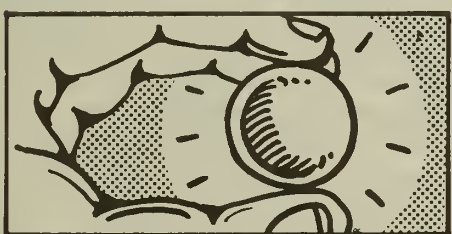
■ The Sun Chute is now a special place and can be made more so by attaching things to it that are found. "Dead and down" objects, rather than picked or alive ones are the rule; but arts and crafts items, poems and stories, may also be hung. The chute can be a temporary gallery, shelter, or a backdrop for a play. It can be folded up each evening at sunset and hung again on the following morning as a ritual. Review all the things collected to see how everything that lives on Earth is touched by the sun. Discuss how they relate to one another and to the group.

ACTIVITY
MAGIC SUN

This simple activity can be played by everyone. Choose the props carefully for maximum effect. A grab bag is a sure thing and the variety of suns represents both the many forms of energy and the many ways people use and think of the sun. This is a good way to build on information the group already has and to reinforce some of the energy concepts you will be discussing.

WHAT YOU NEED

■ This activity can be done indoors or outside. Have a "cosmic" bag of magic suns



(perhaps a dark blue cotton bag with silver stars pinned on). Have as many suns as people in the group. Use your imagination for the sun symbols, such as a gold disk from a key chain, a coin, a Christmas ornament or ball, a yellow painted ping-pong ball, a wad of gold foil (recycled), or a small flashlight.

THE GO OF IT

■ "This magic sun gives us special powers when we hold it. Let the sun shine on it, heat it, reflect the light around us. As you take possession of the magic sun, you can speak for it. Touching it releases ideas about all that the sun does for us on Earth." Reach into the cosmic bag and hold the sun you've chosen up to the light.
■ Begin a statement, "I'm the magic sun, I can ______." Each person finishes the statement and returns their sun to the bag, which is then passed around the circle. Some samples of things the sun does: feeds plants, melts glaciers, tans our skin, runs the water cycle, makes the wind blow. When the cosmic bag comes back to you say something simple like "THE SUN DOES IT," "LIFE ON EARTH BEGINS WITH THE SUN," "LET THE SUN SHINE ON," or add your own phrase.

AND THEN

■ Make a list of all that the sun does. If you have a group of children, they can draw pictures or cut out photos from magazines to illustrate. Or see how many sun functions can be included in a group poem. Or write the ideas as spokes or rays coming from around the sun. This list can be a teaching tool if the teacher groups the forms of energy (chemical, physical, stored, moving, direct, indirect). It also could be the basis for a slide show.

"THE SUN DOES IT!"

This is a program idea for children. Read a couple of short creation myths or legends of the Indian tribes or settlers of the region. Allow some time to let the flavor of the phrasing and language sink in. Show a short slide show of Indian or settler life (fairly good quality slides can be made from magazine photos or drawings). Discuss the basic things that the first people in that area needed to sustain life. Focus on the sun and write a list of things that the sun does: it shines, splits rocks, makes plants grow, creates winds, lights the Earth, and so on. In a parallel column, list a cast of characters who could do the things the sun does: weather-cooker, soil-maker, water-cycler, moon-lighter, earth-heater, and others. Ask the children to select their roles and to break into groups: stage hands, cast, prop-finders, script writers, scenery painters. Give each child a role.
The curtain rises; the play begins!

RA, THE SUN GOD

One of the most ancient and primitive creation stories comes from Egypt. Ra, the sun god, emerged from the primeval ocean and found he had no place to stand. So he created a bit of dry earth, the first hillock represented by the hieroglyph  **or**  **. It was the sign for the word that meant to shine forth. From this little hill of mud came all of life and the elements that life depends on.**

How did this myth come to be? "Every year the Nile flooded its banks and spread across the land, and as the waters subsided, little hillocks of slimy mud rose up, teeming with miniscular life in the hot sun. Here was the source of life. The power of the sun to generate life is something every man can see with his own eyes, as the sun warms and quickens seed and germ in the Earth . . . It was all the same life force . . ."—from *The Beginning*, by Maria Leach

An Idea From Roy Cerny and Karl Samp

Upper Sioux Agency State Park, Granite Falls, Mn.

INTERPRETING WITH THE SUN

Here at Upper Sioux Agency State Park we have had an energy interpretive program on a small scale for several years. At the park we have three solar devices (cooker, oven, and water heater), all of which cause the visitors to ask "what's that?" They are crude, inexpensive, but effective devices for collecting and using the rays of the sun to perform tasks. We have baked cakes, roasted hot dogs, and heated water before often-amazed visitors. We offer a standing invitation to our solar energy displays—we will cook any meal for any visitor who comes to see our program.

The devices we use to demonstrate sun power are made from aluminum foil, black paint, plywood, cardboard, tape, glass, and an old picnic cooler. The mold used to shape the reflector cooker is a permanent installation here at the park. Visitors may come to the park with their materials and use the mold to make their own parabolic reflector. The mold is out on the patio, under a bench that protects it from weathering, and is an attractive and useful addition to the park.

Anyone who can open a can of beans can put a cooker together in a short time. We have found that the oven seems to work best for demonstrations. The cooking process is slowed down a great deal by cloudiness or foil which is dirty or badly wrinkled. We highly recommend adding these devices to your educational interpretive programs. Get busy and start cooking!

A LEGEND

Viracocha was the name given by the early pre-Inca people to their creator, the Sun. He was the Uncreated Creator, the Ancient Foundation, the Teacher of the World. No one ever saw him—only his works. The legends tell of a wondrous House of the Sun built in the city of Cuzco, 12,000 feet above the sea. The Sun himself sent the gift of fire by shining down on a fluff of cotton wool on a polished concave plate that was placed in an opening of the house. The wool burst into flame and fire was bestowed upon the people of Earth.

"O Viracocha, Creator of the world,
Where art thou?
Fainting we long for thee.
Maker of men and women,
Giver of life, giver of valor,
Listen from the sky—or from the sea—
Wherever thou art.
Comfort our weariness,
Let us not die."

—Poem and introduction (paraphrased) from *The Beginning*, by Maria Leach

TAKE A RAY OF SUNSHINE AND ADD YOURSELF

Here are suggestions of things to do with the sun.

1. Carry a prism on your walk. Let each person carry it. When you show it to the group ask these questions: What is sunlight? What can we see in the prism and what does it do to the sun's rays? Where do rainbows come from?

2. Buy a small radiometer for your classroom or visitor center. This instrument shows the intensity of radiant energy. Place it on a windowsill and watch what happens when the sunshine strikes it. Which way do the fins turn? Why do they turn? How is this device like blacktop pavement on a sunny day?

3. An experiment: place two identical clear glass pans in the direct sunlight. Put one on a white sheet of paper, the other on black. Take the temperature of the water in both pans.

4. Make an evap-o-bag. Fill one-third of a large clear plastic bag with water. Place it in the sunlight. Watch condensation take place. Or tell the story of the water cycle with a terrarium.

5. Grow several coleus plants in your room. Turn one regularly, but leave the others in the same relationship to the sun. Or place one plant in a very southern exposure close to the window and leave other plants further away from the light source, or in a northern window. What are the differences in their respective growth patterns? Why?

6. Why can't we look directly at the sun?

ACTIVITY
A CAMPFIRE PROGRAM

An evening campfire is a special occasion, a time for ghost stories and toasting marshmallows. There is something magical about sitting quietly surrounded by the noises of the night, watching the flames and embers burning in the darkness. The fire itself is usually considered a prop, but in this activity it is used as a symbol for the sun's power and the energy people can tap.

WHAT YOU NEED

■ Ask everyone planning to attend to come with a candle. (Have a few boxes of large birthday candles for extras.)

■ Have a candle lantern with a spare candle and matches ready.
■ Select the site for the program and logs for the fire in advance, being sure that you have enough dry kindling. You will want a short, bright fire that will burn for about half an hour.

A NATURE WALK

Go for a nature walk in your park or city. Look for examples of the ways the sun affects the environment: heat- and cold-induced cracks in a sidewalk, flowers bending toward the sun, leaves turning color in the fall, varieties of plants everywhere, moss on the north side of trees, dew or fog, dried leaves or branches on the ground. Why are there spaces between the metal parts of fire escapes and the concrete slabs in highways and bridges? Why does snow often melt faster around the trunk of a tree or around a dark object?

Prepare a tour or ask your maintenance worker to lead a tour of your visitor's center or school to see how the building is heated. Start at the incoming pipe for oil or gas (or the incoming wire if the system runs on electricity). Then go from the furnace room to your meeting room, following pipes, heating ducts, and radiators.

THE GO OF IT

■ Time the program so that it begins at dark. Have the group assemble a short distance from the campfire site. Explain that the walk will be a silent one. Light your lantern and ask everyone to line up in single file, placing a hand on the shoulder of the person in front of them. Hold your lantern high to light the path. Lead the group slowly.

■ At the site, place the lantern in the center, next to the dry wood, and wait until everyone is seated. If you have a clear night, ask the group to look up at the stars as you turn off the lantern. Point out that our sun is a star similar to those twinkling above and that our sun is still shining even though it isn't visible—it's shining on the other side of the Earth.

■ Then light the fire, explaining that since our sun is not visible, the fire will be used to symbolize it. Point out that the sun's energy is stored in the wood. Ask the group to look closely at the flames and think of the fire power within that great ball of gases 93 million miles away.

■ Lead a group sharing game. Those sitting around the circle may each contribute a thought about what the sun does; "The sun gives us ___________." Try sharing positive feelings about sunlight, early memories of the sun, or an experience that came about because of the sun. If the group is an imaginative bunch, try telling a round-robin story, with each person contributing a line. The theme could be how the first people who lived in the area discovered and used fire or felt during a solar eclipse.

■ The sun is constantly handing out energy and never gets anything back! Energy flows along a one-way street. Since only a very small portion of the sun's energy comes to the Earth, how can that piece be used more efficiently? Go around the circle for ideas. If the park or community has a solar or alternative energy installation, suggest that they visit it and talk about its purpose.

■ If the fire hasn't died of its own accord, help it along. Ask everyone to light their candles so they may carry away "a piece of the sun."

■ Light the candle lantern, put out the fire, and lead the group back to the starting point.

Notes

ACTIVITY

GREETING TO THE RISING SUN

This activity is based on a traditional yoga exercise. The movement sequence stretches muscles and warms the body. The sun's rays warm the Earth and bring light and heat to the new day. This is a celebration that can be done alone or with a group. Try it in silence so that everyone can concentrate fully. It is a good exercise to begin the new day.

The yogis practice the greeting at sunrise when, in their belief, the air is filled with "prana," the combined energy of the sun and air. It is an example of rituals practiced by many other cultures to show respect and reverence for the sun's importance and power.

WHAT YOU NEED

■ Try out the movement sequence yourself in advance. Choose a quiet site with an eastern exposure, overlooking water or a special view. Request that the group come dressed in loose-fitting comfortable clothing. The activity is for young and/or limber people.

THE GO OF IT

■ Assemble at dawn and walk at a brisk pace to the site. Briefly explain the purpose of the Greeting, emphasizing that this is a special time to share the sunrise with feelings and movements.
■ Have the group arrange themselves so they have enough space, but can still see and hear you.
■ Ask them to rehearse the parts of the Greeting by following you. Lead the movements slowly and seriously, concentrating on breathing.
■ Run through the whole Greeting in its complete form. Explain that they are now ready to silently greet the rising sun. Face the eastern sky.
■ Do the Greeting together. If the group would like, try it again.

A. Stand with your feet parallel and a few inches apart. Raise your arms above your head, stretching to the fingertips. **Inhale.**

B. Bend down slowly, letting your hands fall to your sides, with fingers reaching for the floor. Press your head gently toward your knees. **Exhale.**

C. Extend a leg behind you so that you are kneeling on one knee. Have your foot outstretched with toes pointed. **Continue to exhale.**

D. Extend the other leg, feet now together, with both legs flat on floor. Lift your head and curve your back. **Continue to exhale.**

E. Turn toes under and raise your body until it is at an angle to the floor. Keep your body stiff and your arms fully stretched. **Inhale.**

F. Keeping your body stiff, bend your elbows. **Exhale.**

G. Shift your weight forward onto straightened arms, with your toes pointed and legs flat on floor. **Inhale.**

H. Raise the buttocks so your body makes a triangle with the floor; keep feet flat on floor and close together. **Exhale.**

I. Repeat C. **Inhale.**

J. Repeat B. **Continue to inhale.**

K. Repeat A. **Exhale.**

An Idea From Dan Sealy

Oklahoma State Parks, Oklahoma City, Okla.

STRING ALONG WITH THE SUN

This game should be played in a relaxed way. It's a good closing activity that offers everyone the chance to show off something they've learned during the day's program.

Choose a dry spot to sit outside or a quiet indoor space. Have a ball of sun-colored, thick yarn. (Variegated yellow, orange, white and red would be appropriate.)

Seat everyone in a circle. The leader holds the yarn out toward the center. "Let's take a minute to think of how everything on Earth is affected by the sun." (Pause for 30 seconds.) "First we will identify ourselves as something touched by the sun today. As we pass the ball around the circle, each of us will have a chance to tell how the sun affects us. We'll keep passing the ball until the circle is complete."

Place the ball on the ground in front of you and take the first turn. For example, "I am a raindrop in the cloud above us. The sun brought me here by carrying me on a breath of warm air up high into the sky." After you have spoken, hold the end of the yarn in your hand and pass the ball to the next person. Each person holds the yarn as it unwinds. You might say, "Please string along with the sun," as you pass the ball.

SUN COMMERCIAL

Since we all have our own favorite ideas about the sun and how important it is, how about writing commercials to express these feelings to other people? All you need is a willing group and writing materials for everyone.

Divide the group into smaller teams of three to six people and have each team brainstorm for ideas about the sun. For each idea the teams will determine whether the message will be in the form of a song, jingle, drawing, or slogan. They should also decide where their message would appear—TV, radio, cereal boxes, or billboards. Allow approximately 30 minutes for the preparation of the commercials, then gather together for a group presentation.

The finished commercials can be shared at a campfire or classroom program or displayed in the park, school, or nature center.

HOW TO BRAINSTORM

Brainstorming is a fine example of sharing human energy to produce new ideas. It is a technique that is used in many places for many purposes. A group should consist of six to 10 people with one person acting as the recorder. (The recorder does not participate.) Use several large sheets of paper to jot down ideas. You want to be able to read them from across the room and hang them up around you.

The group sits in a circle. The recorder explains the rules and gives the topic. The rules are:

- This is not a time for heavy thinking. Brainstorming is a free-flowing process. It should be fun; fantasies are welcomed.
- Keep your idea brief—just a few words.
- There are only right answers, and even if an idea seems ridiculous it can trigger valuable ideas for someone else. Don't comment positively or negatively on others' ideas.
- You may "pass" if you can't think of a contribution.

Go around the circle twice in the order that people are seated. After that, it's a free-for-all and can last until it seems finished. You will notice that the pace changes often—the flow of human energy and ideas peaks and ebbs. Be patient and try to wait out the dry periods.

Once you have a list of ideas, reprocess them. Review, deciding if you want to cluster ideas, put them in categories, or assign them to small teams of your brainstormers to work up into a fuller statement or program.

Try it!

ACTIVITY
SUNLIGHT AND SHADOW PLAY

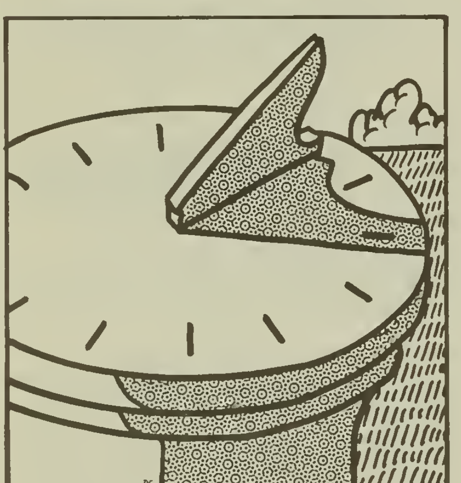
Thanks to Helen Ross Russell

This activity is for children and is a lot of fun while providing an awareness of the sun. It uses light because it is the easiest kind of energy to see, but you might also try similar games with other energy forms.

WHAT YOU NEED

■ Try this with school groups. An outdoor setting is required, but an urban park or playground will do nicely. This is a good activity to follow a sun talk. It requires a sunny day and a spot that has a sense of place, away from loud traffic sounds and diversions if possible.

THE GO OF IT



■ "Today we're looking for something special. We've talked before about the sun and how life depends on it. We've all watched the sun rise and set, have felt the sun's heat on our bodies and on the sidewalk, and watched it make plants grow. The sun does lots of things on Earth. One of the most important things it does is to give us light. We tell time by the sun and watch the seasons pass. In our part of the world the days get shorter during December and much longer by the time July comes around. But when an eclipse happens it turns day into night. Once in a while during daylight hours the moon passes between the sun and the Earth and leaves us in the dark. We talk about the shadow of the moon and scientists have special instruments to watch this happen. But it hurts our eyes to look at the sun or could cause damage even when the moon's protecting us from its light. We can be like the moon and cast a shadow on the Earth."

■ Form a circle and sit. Ask the players to look at the soles of their feet. "Do you see anything special there? Is anything connected to either of your feet?" Shake one of your feet and then the other. Ask the group to try it. "Let's all take a minute to look for our shadow. When you find yours come back to the circle." Let everyone take a turn to tell about their own shadow. "Let's sit where we are but move our heads and eyes to look for another shadow here in this place. Compare the amount of light blocked to the size of the object. Can you sit right here and make your shadow touch your hand? Swap a shadow with a friend. Can you do it? How? Let's all try to change the size of our shadows. Do you think the sun knows we're fooling around with the light it makes? Can you cover a building's shadow? Where did yours go? Have you ever looked for shadows on a cloudy day? What happened? What are the clouds doing?" Play a game of tag in which "It" has to step on one of the players' shadows to close the activity.

SUN DIAL PROJECT

This may be a temporary or permanent structure in your park. You can improvise by using a flagpole surrounded by gravel, a tall dead tree, or a stake anchored firmly in the ground for the gnomon (pointer). The shadow cast by the pole changes through the day and varies from day to day as the earth-sun relationship runs its cycle.

Set up an observation schedule over a period of time so that visitors and students can see the shadows that change direction and size with the Earth's movement. How does this show that the Earth really moves around the sun? The sundial can be a worthwhile project because the retrieved information about the daily source of light can be applied to the use of solar driers and ovens.

If your park or school has the space and money, a permanent sundial would be an attractive addition to the site. Many turn-of-the-century formal gardens incorporated sundials in the landscaping plans. Tell time by the sun—who needs a watch?


ENERGY

WHAT IS ENERGY? 2

Energy is not a substance, but a capacity—the ability to bring about change. It can take different forms and often changes from one form to another, but when this occurs, the loss of one kind of energy is balanced by the gain of another kind; it is never "used up." Some forms of energy are more concentrated and can do more work than other forms.

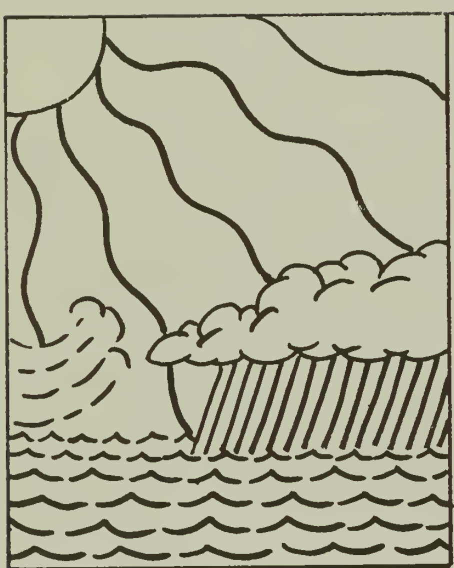
"We dance round in a ring
and suppose
But the Secret sit in the middle
and knows."—Robert Frost


N93085

BACKGROUND

Energy is unique and unlike any of the other ingredients which make life possible. It is less a substance than a capacity. This capacity can take many forms.

Something in motion, like water flowing in a river, is said to have KINETIC energy. If something has the capacity to do work because of its location, such as a rock balanced at the top of a hill, it is said to have POTENTIAL energy. HEAT is the energy of molecular motion, LIGHT the motion of photons, and ELECTRICITY the motion of electrons. The bonds which hold things together—your body, the chair you sit on, the pages of this book—are CHEMICAL energy. GRAVITATIONAL energy is possessed by all matter in the universe. And matter itself can sometimes become what we call NUCLEAR energy.



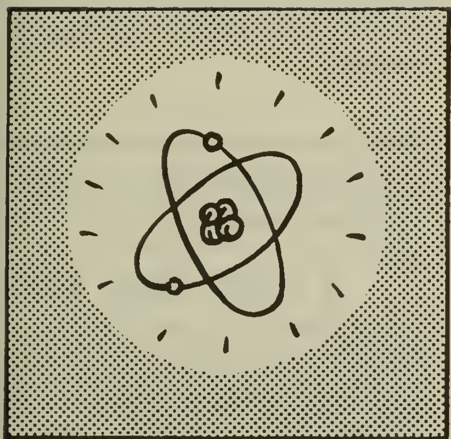
These forms are not rigid and permanent. Energy often changes from one form to another. For example, the energy in hydrogen fuels our sun's fusion reaction and then is transformed into electromagnetic energy which travels through space to Earth. Upon reaching our atmosphere some of this energy is converted into heat, some to wind, some to potential energy stored in the water in clouds, some to ocean waves and currents, and so forth. Some is transformed by plants in the process of photosynthesis into chemical energy, which may then be food to an animal and become a different kind of chemical energy in its flesh. The animal may, in turn, provide food to other animals or to you. When any creature dies, it is eaten by decomposer organisms which convert the energy in the dead organic matter into their own chemical energy.

An important observation scientists have made about these transformations is that the loss of one kind of energy is balanced by the gain of another kind. This is so basic to the nature of energy that it is called the First Law of Thermodynamics, or the Law of Conservation of Energy. It may seem in many transformations that some energy is used up, but this is not the case. When wood is burned, for example, the stored energy in the wood is converted primarily into heat, smoke, and ashes. After the fire has burned out, it may appear that the wood's energy has been used up, but the same quantity still exists in the surrounding environment. The energy has merely been dispersed into other forms.

Our fire example also illustrates that some forms of energy have more capacity to do work than other forms; that is, energy has a qualitative as well as quantitative aspect. The chemical energy in the wood before it is ignited has more capacity to do work than the chemical energy transformed into heat, smoke, and ashes after the

"We feel intuitively that energy is something defineable, yet it resists definition. We must be content with the explanation that energy is a capacity, the capacity to do work or to bring about change." — Carol and John Steinhart, *Energy: Sources, Use, and Role in Human Affairs*

fire has burned out. Thus, energy is more concentrated in some things than others.



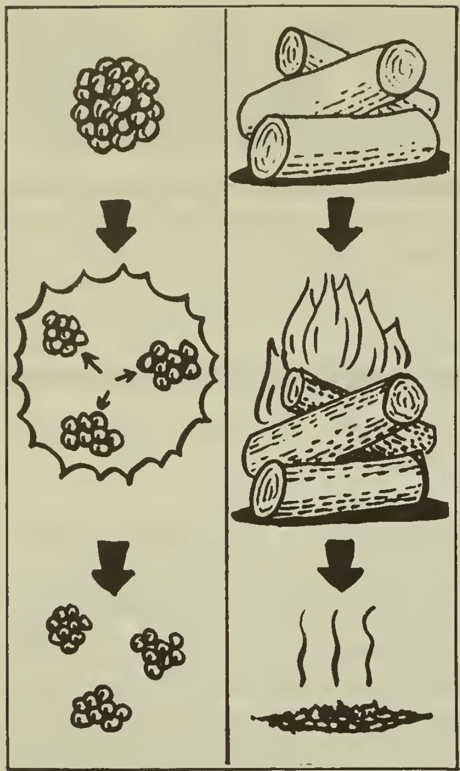
The relationship of matter to energy is one of the keys to understanding what is known about energy. Matter is anything which occupies space and has mass—a molecule of oxygen, a particle of soil, a raindrop, a microscopic insect, an apple, a leaf, a bird, and your body all are matter. Atoms, the basic units of matter, can be bound together chemically to form substances. As we can see from the great variety of "things" in our world, atoms can be combined into many forms. The bonds which hold the atoms of "things" together are stored chemical energy.

Some kinds of matter have more chemical energy than others and some release it more readily than others. Probably the process most familiar to you when you think of releasing energy is burning. We combust gasoline to make cars move, oil or natural gas to heat our homes, and coal to make electricity in power plants. Our bodies "burn" fuel, too, when they break down the food we eat to release its chemical energy.

Modern industrial society gets most of the energy it uses to run machinery by burning stored sunlight—dead plants and animals compressed underground over millions of years into the fossil fuels: oil, natural gas, and coal. Since we are using these fossil fuels much faster than they are being formed, they are essentially a nonrenewable form of energy. In many less developed areas of the world, on the other hand, people obtain most of their energy by burning renewable forms of stored solar energy in wood and animal dung.

All of these substances are valuable to people because they contain highly-concentrated energy which can be easily released to do work. In many cases these "fuels" give up their chemical energy so easily that they will burn freely if ignited by a match. The energy in many other things is more difficult to liberate. For example, the chemical energy in a diamond can be released by burning, but diamonds will not combust until heated to 1200 degrees Fahrenheit.

Chemical reactions are rearrangements of atoms without changing the structure of the atoms themselves. But matter can also undergo



more fundamental changes in atomic structure which release far more energy than that available in chemical reactions. These are called nuclear reactions.

Scientists have designed "reactors" to trigger and control the release of large quantities of nuclear energy in a process called fission. These reactors are being used in some places to generate electricity. Nuclear fusion, the process which provides energy from the sun, has not been successfully harnessed by scientists. Even after more than 20 years of research, formidable and perhaps unsolvable technical obstacles may block its development.

The conversion of even a small portion of the mass of a substance releases tremendous quantities of energy. But starting and controlling these reactions also takes a lot of energy; the amount produced may be largely offset by the amount invested.

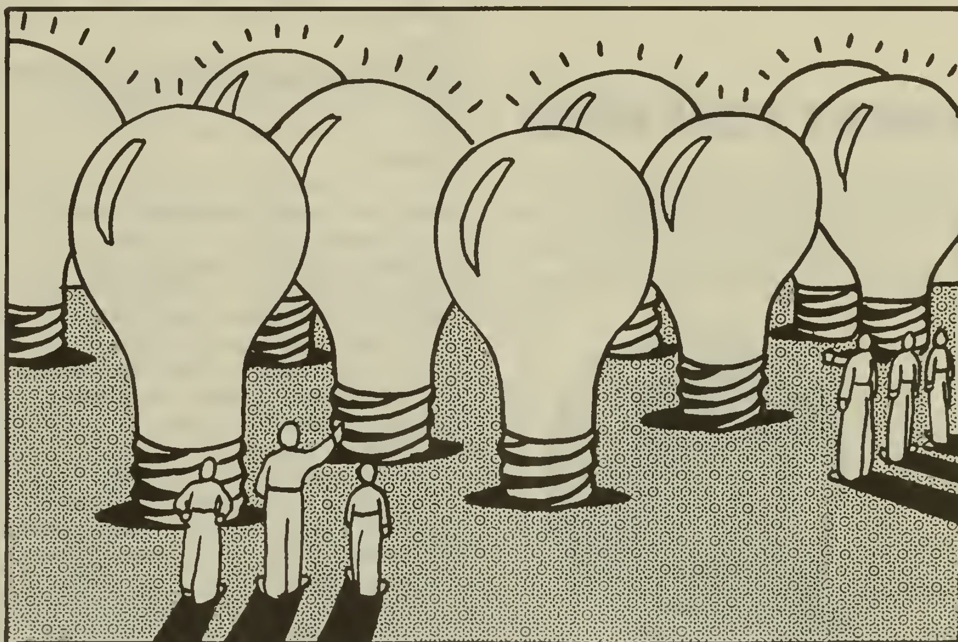
The usable energy left after any transformation in excess of that invested to accomplish the process is called the net energy yield. This is a useful concept which can help us evaluate alternative ways of using energy. Applying this kind of analysis to human energy systems is difficult due to the complexity of measuring the energy used to accomplish a process—for example, amounts consumed in exploring for an energy resource, mining or drilling, processing, transporting, and ultimately transforming the energy into some form of work.

Net energy analysis is also a valuable tool in the study of nature. Plants and animals also invest energy to obtain the food, water, space, and shelter they need. Their success, as individuals and populations, in achieving a net yield of energy sufficient to accomplish growth and reproduction is one of the key determinants in survival.

"Perhaps the best way to start is to admit that we have only the faintest idea of what we are talking about. 'Energy' as a concept—like 'life' and 'love' and 'time' and 'mind'—is as slippery as an anaconda in a lard factory."—Don Fabun, *Dimensions of Change*

ACTIVITY
TURN ON THE ENERGY SWITCH

This simple technique shows that energy is present wherever life exists.



WHAT YOU NEED

- The prop is a flexible stick, picked up along the trail. Or use a manufactured electrical switch that can be carried in a pocket.
- To prepare for the activity, walk along a trail in a natural area. Look for signs of life and choose the stopping points. Think about the energy processes that are taking place there and the various forms of energy that reveal themselves.

THE GO OF IT

- On the walk, ask for a volunteer to be in charge of the switch at each stopping point. That person will look around for life signs and gently touch what is found with the switch. Ask the group to tell what happens when the switch is turned on. What is helping this ____ to live today? How can visitors help? If the switch-person is the sun, what forms of energy would be flowing?
- To vary the activity, use the switch at every other stopping point. Pass the switch to someone different every time you use it.

Notes

AN ENERGY PACKAGE HUNT

Take your group on an energy package hunt along a trail, in the schoolyard or field. Look for things that represent energy in a concentrated form. Enjoy looking at the patterns and designs of the containers and encourage those in the group to observe and suggest why the containers that hold energy are fashioned in those ways.

TAKE THE WRAP

Ask the group to bring sample packages for food and other items to your next get-together. If possible, take a trip to the grocery or hardware store to help show the packaging and merchandising involved in human systems. How does nature attract buyers? Do we really need the array of packaging that currently envelops our society? What about putting one item in a paper bag? What other ways can we conserve energy through wiser use of packaging?

ENERGY IS THE MESSAGE

This is a short and sweet question-answer exercise that can stimulate discussion and lead to other activities. It also gives an indication of the audience's understanding. Try it at the beginning and end of the energy program. The questions should be posed in an informal, relaxed way; the object is to gather impressions, not facts. Try recording the answers. All ages can participate.

Ask the group to contribute something they've heard or read about energy within the last month. Are there some modern myths about energy? Would it have been the topic of so much conversation 10 years ago? One hundred years ago?

At the conclusion of the program, ask another question. What did you discover about energy today? These responses can be recorded, too. The questions can be asked in an off-the-cuff manner, or in a sharing circle for a more intense experience.

ACTIVITY
MINI-PARKS

Thanks to Steve Van Matre

This activity examines the ways in which energy flows, is stored and used within the park. By focusing on a very small portion of the park, the job is made easier. The mini-park also offers models of the ways that people use energy.

WHAT YOU NEED

■ Select an area of the park that is rich in varieties of plant and animal life; for example, along the banks of a stream, between meadow and forest, in a tidal estuary. Each group needs a 15-foot length of string (durable white twine is best) and inexpensive hand lenses for everyone (if your budget allows).

THE GO OF IT

■ The activity breaks down into three parts: exploration of the mini-park site, planning a tour, and a tour of the mini-parks.

■ Divide the group into teams of threes (or fours if children are involved). Lay out the general boundaries of where they may go within the area. It's easier to keep the groups within earshot of the leader, but at sufficient distance to avoid disturbing each other.

■ "You have 20 minutes to plan your park and presentation. Select a spot that interests you and agree with your teammates on the location of your mini-park. Lay out your string to form the park's boundaries."

■ "Take your lenses and explore the park. Look for varieties of living things and see what is happening there (ant trails, mushrooms sprouting, logs decomposing). What energy flows are represented here among the plants and animals, in the different levels of vegetation, in the sky above and underground? Try to include as many forms of energy as you can (kinetic, potential, chemical, heat, light, nuclear, gravitational). Think of the support systems involved in the life processes here, and how living things relate to each other. Share your findings with your team members. Now begin to alter the relative scale of the things you find here. That ant can be a buffalo, the fallen log, an example of suburban sprawl. Use your collective imaginative powers and fantasy. When people come to your park, how do they get the energy they need to survive? Do they bring it with them? What should the park provide? Give your park a reason for being, a name and location, entrances and exits, special features (scenic and otherwise), facilities and visitors maintenance, flora and fauna, and seasonal variations."

■ "Now begin to plan your three minute presentation for the tour. You will explain to the visitors the role of energy in the life of your park. Remember plants, animals, and people all need energy to live. Divide up the presentation so that all the team members have an opportunity to talk to the visitors."

■ The leader should wander among the groups to keep them on the right track. Then gather the group together to take a tour, visiting each of the mini-parks. As each group finishes its presentation, lead applause. The group should be prepared to answer questions about their mini-park.

■ Mini-parks is an example of an environmental awareness game that has been modified in order to build an energy theme into an interpretive program. This activity has been used many times as a training tool for park personnel, but it also works with some adjustments for groups of teachers and children. Try it your way and test its versatility even further.

HEAT EXCHANGE

Much has been written about heat released into the atmosphere by buildings or through the burning of fuels. This is a list of some possible ways that our bodies affect our own environment, and it affects us. Can you add to the list?

Heat Gains
Heat is produced in our bodies by:
- **basal processes such as respiration, circulation, and cellular maintenance**
- **activity**
- **digestive processes**
- **muscle tensing and shivering in response to cold**

We absorb radiant energy from:
- **the sun, directly or reflected**
- **glowing radiators**
- **non-glowing hot objects**

Heat is conducted toward our bodies:
- **from air temperature above skin temperature**
- **by contact with hotter objects**
- **by the condensation of atmospheric moisture creating heat**

Heat Losses
Heat is lost through outward radiation:
- **to the sky**
- **to colder surroundings**

Heat is conducted away from the body:
- **to the air below skin temperature**
- **by contact with cold objects**

Bodies lose heat through evaporation:
- **from the respiratory tract**
- **from the skin**

—from ***The Energy Primer,*** **Portola Institute**

An Idea From Pat Momich

Shenandoah National Park, Va.

PETAL POWER

Before you print my energy program I'd better tell you a few things—primarily that I have scratched the whole approach that I told you about. Why? Because I had one program that completely bombed. Unfortunately it was also the night that my supervisor was auditing the program. UGH! I had one of those crummy, totally unresponsive audiences that apparently only wanted to be entertained. They wouldn't answer even the simplest question. They certainly didn't want to think! Well, without offering thought or interchange, I can understand how a program like mine would be somewhat dull and I lost about one-third of my audience (15 out of 45 people). Needless to say, I was pretty upset—that's never happened to me before. It brought on a tirade of questions about the goals of interpretation and its worth if people wouldn't even listen to things that are most important.

Anyway, I needed to change the approach since I refused to give up the project. I needed a gimmick—a cute way to present the energy idea so that it would be more entertaining without losing the importance of the matter—and I needed some kind of a visual aid to capture people's attention. I found both the gimmick and the visual aid in the form of a little flower—Achillea—or more correctly, Achillea millefolium, sometimes called Yarrow. Of course, any flower or plant would work. This is what I do:

I introduce my friend and his family background. (You know Achillea came from a very distinguished branch of the family because they're into medicine! Why, their skill was even recognized back at the time of the Trojan Wars. That's how they got their name—after Achilles, the Greek war hero!)

How does Achillea live in this high-elevation, short growing-season place? (He has a "fur" coat, is shorter at higher elevations, and has a tough, sturdy stem, etc.)

Okay, Achillea is pretty to look at, but really what good is he? (If you're not careful you'll probably mistake him for a weed! He exhales O_2, stops erosion, stores food for others.)

But how does he eat without a mouth? (Essentially he eats sunshine, and he uses only one-sixth of the sunshine for himself, so five-sixths of it is stored for others—food chain.)

How do *we* fit into the food chain? What do we eat? How do we get our food? (Our food generally comes from the store, by machines that eat fossilized sunshine.)

So, sunshine is pretty important, both to Achillea and his relatives, and to us. The sun makes our weather, gives us light and heat, makes the winds blow, and the waters flow, and some other even more amazing things. In several places the sunshine became concentrated and fossilized. Think about it. How did we get to the park? How was the car made? How do we keep warm? Is there anything that does not use fossil-sunshine?

But we have a problem. It takes 400 million years for sunshine to fossilize to the point where it can do any work for us. What would happen if we ran out of fossil-sunshine? Is there anything we could do about it?

Maybe Achillea has a few secrets he could share. His family has probably been around for millions of years before man appeared. How do they do it?

- cooperate with all other life
- keep close to the earth
- maintain a simple life—few needs
- use all sunlight efficiently and don't waste any

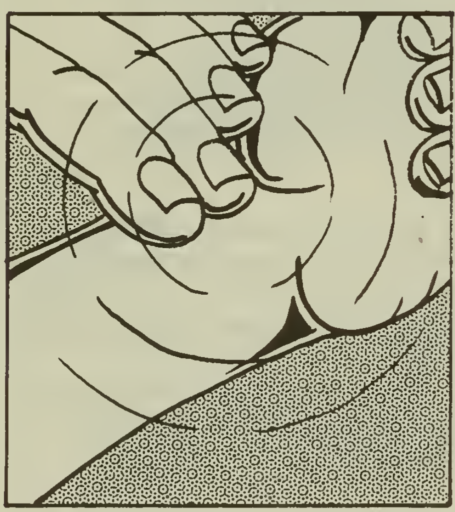
As you travel through the park, watch for Achillea along the roadsides. If you're quiet and observant, maybe he'll have a thing or two more to tell you.

ACTIVITY
FINDING THE PULSE OF THE PLACE

This activity aims at the starting point of learning, the senses. The players try to feel energy, rather than to label it or intellectualize about it.

WHAT YOU NEED

■ Everyone will need writing equipment. Choose a natural area, including a central gathering spot. Allow an hour and limit the group to 10-15 people. This activity works particularly well with adults.



THE GO OF IT

■ "Energy flows through this place, giving it life. Plants, animals, and people all depend on energy to survive. Energy is often in flux, yet we know that energy powers and sustains life and our universe." Ask the group to sit down together in a circle. "Imagine that energy is flowing here with us today with a rhythm, a pulse that we can pick up. First we'll describe that pulse with words and observations, then we'll try to communicate our feelings about it to others with language, sounds, movements. We begin with ourselves, our own bodies. As we sit here in a circle in the sunshine, let's find our own pulse, listen to our heartbeat, and think of the way we use the sounds of our pulse to detect life."

■ Ask participants to count the number of pulsebeats during 15 seconds timed by the leader. Multiply by four to get the pulse rate. Ask people to jot it down. "By sitting very still perhaps we can sense, without touching, our pulse throbbing in other parts of our bodies." You may want to ask them to touch their temples, armpits, wrists, to find the strongest pulse, or place a hand over their heart.

SEEING EXERCISES

■ The group stays within hearing range of your voice for this. "Now let's take this sense of sight that we depend on so regularly and extend it." (The seeing exercises used are by Steve Van Matre. Directions for using them are found in his books, **Acclimatization** and **Acclimatizing.**)

■ "Let's each go choose a viewing spot. Settle into this place, concentrate on the smells, the sounds, the plants and insects nearby. Adjust your body so that you can relax and just be still, but observant. Take a few minutes to use the seeing exercises. Then record a few of your impressions about what you see and return to the circle."

■ Try similar exercises for the senses of taste, smell, and hearing.

TOUCHING THE EARTH

■ Ask the group to lie on their backs within the sound of your voice. "Use your sense of touch by placing the palms of your hands down flat on the ground beside you. Press them upon the surface, the skin of the Earth. Touch the soil, the grass, with your fingertips, and the backs of your hands. Touching tells us something secret and special, something just for us that sometimes has no words. Let your hands relax, joining the rest of your body. Think of your skin as wrapping you, keeping you warm while drawing you together into a single organism. You don't have to do anything special to feel what's around you with your skin. It just happens. The sun warms you from above, and the soil you lie on continues to pass on the heat from the sun to your body. Can you feel a pulse in this place?"

■ Pause for a few moments. "Get up slowly, brushing off the person beside you carefully. Write down your feelings."

CREATIVE WRITING

■ "We will work in groups of threes. Put your collective words together to please yourselves. Let your creative energies flow and mingle. The pulse of this place, this spot in the park that you now know so well can give you new ideas and thoughts. Share them with each other. Place your word lists together so that you can look at them all at once. We will have 15 minutes to plan and about three minutes to present."

■ "Perhaps your group may express its joint feelings in a poem, a paragraph, a series of movements, a concerto of sounds, a mime."

■ Lead the applause at the end of each presentation. "Thank you for sharing your ideas and feelings about the pulse of life in this place."

A KERNEL

"What is Life? It is the flash of a firefly in the night. It is the breath of a buffalo in the winter time. It is the little shadow which runs across the grass and loses itself in the sunset."—Crowfoot, Chief of the Blackfoot Nation, 1890

An Idea From The Environmental Education Center

The Brandywine Conservancy, Lima, Pa.

ENERGY—IT IS OUR SUNSHINE

These energy awareness games and activities work well with elementary school age children.

In **HEART THROB,** the children take their pulses and discuss the reasons for a pulse. Thoughts turn to how we—or any animals—obtain energy for our bodies, and to the problem of getting rid of waste. This is followed by a "shopping" expedition to find sources of energy for animals: leaves, nuts, berries, and even other animals. We point out that there are costs involved. As food is found, the group determines the "expense account" of animals as they obtain their food: flying, digging, pecking, running, breathing, pumping blood, digesting previous meals, and so forth. Other "expense account" thinking includes energy conservation techniques: hibernating, storing berries, sleeping, and even migrating in winter to locate more abundant food supplies.

SUN TRAPS is an imitative game with the children pretending they are trees. They hold their arms into the air, stretching out their branches as far as they can. Their hands and fingers are the leaves, fluttering to capture enough sun to make food for the entire tree. They press the soles of their feet against the soil, seeking more space beneath the Earth's surface in which to spread their root system. They choose a favorite tree and try to take its pulse, too.

We have worked a great deal developing ways that children can use their bodies to measure energy. This is done by checking eye pupil dilation in sun and shade, touching things with hands to compare temperatures, listening for or feeling wind, and comparing water flow in pond and stream simply by the force against our hands. Students can think of specialized instruments which humans use to extend their ability to measure certain kinds of energy.

The closing activity ties the whole program together. The class forms a sharing circle. The teacher-naturalist names an activity such as bird soaring, car running, a fire in a fireplace, or a child drinking a glass of milk. The students respond by citing sources of energy for the activity going all the way back to the sun.

ACTIVITY
"QUALITY IS OUR MOST IMPORTANT PRODUCT"

This activity encourages some thinking about the fuel for our fires, not only the varieties of types of fuels, but the concentration of energy within that fuel. Heat is one result of fire. How can it be captured and used?

WHAT YOU NEED

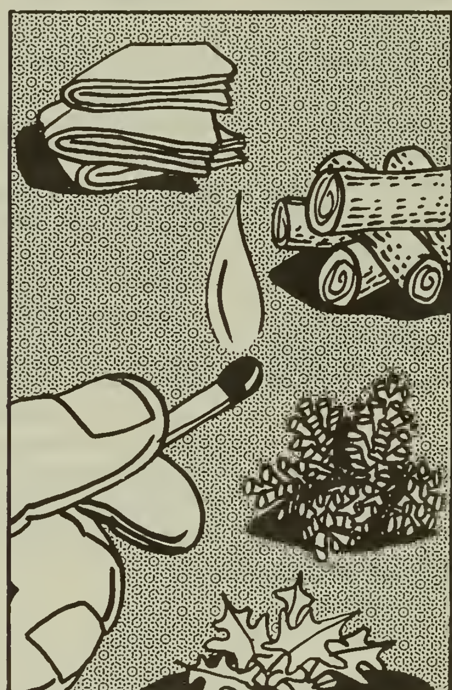
■ Have piles of fuels, such as newspaper, grass, leaves, coal, several types of wood, or pinecones, placed in a central point in a picnic area. Be sure there are enough fireplaces for the size of your group. Several buckets of water should be available for emergencies, and a magnifying glass for each team.

THE GO OF IT

■ Divide the group into teams of four. They are a team of scientists working for ERDA in a brand new testing facility. They can choose their roles as lighter, recorder, thermometer holder. Ask them to determine testing procedure and safety precautions.

■ They test and compare the different ways that the fuel burned. Brainstorm for a list of factors. Examples: the fuel that was the quickest and easiest to light, that burned hottest or longest, or that created the most light. Remember to consider how much smoke is given off and the remaining amounts of ashes and coals.

■ Lead a discussion based on their findings. Talk about other sources of the energy we use: oil, natural gas, nuclear reactors. Be sure to take care of the burning embers from your fires.



AN ENERGY RIDDLE

Question:
Guess why wood wins the prize for being a high energy fuel source?

■ **Answer:**
Because it provides heat in four ways: once, when you expend energy to chop, haul, stack, store, and carry it; next, when it burns and warms you and your home; again, by heating the food and drink that fuel your body; and, finally, when the words on the printed page kindle an idea or two in your brain!

Notes

An Idea From Ron Snuggs

Unicoi State Park, Helen, Ga.

A MOONSHINE WALK

The walk follows a half-mile trail to Anna Ruby Falls that parallels and crosses a swiftly flowing creek. The stream is littered with huge boulders and the forest rises abruptly on both sides. The mid-summer sounds of water and wind in the trees are interrupted only by a passing car winding up the hilly road nearby. The group gathers after sundown on a moonlit night.

"We are taking a special kind of walk tonight, a stroll through the woods to Anna Ruby Falls by moonlight. As I switch off my flashlight, I hope you will begin to explore the ways that nature uses energy in this place. We guarantee that there are no hidden power lines, no special effects crews imported from Hollywood, but just living things going about their business as usual.

"The soil is the stuff of life that supports you right now on its surface. Millions of microscopic insects and organisms, some of which never see the light of day, call the soil their home. If you remove your shoes you can wiggle your toes down into the softer layer of top soil. Feel the moisture and temperature there. What would it be like to live there? We share the Earth with all these creatures and when they die and decompose, the minerals and elements in their bodies become part of the soil. This is one kind of energy flow. How do we all benefit from it?

"We all know that the sun is the source of life here on Earth. As we pass along the trail, reach out and touch the rocks. Can you trace the path of sunlight with your sense of touch? Try it again when we cross the bridge—the sun may have shone last on that side. Warmth is given back to us, even as the Earth turns its back to the source of light and life. But look at the shadows playing among the trees above and on the hard-packed trail ahead of us! What gives us second-hand light at night? And why is it silver instead of golden?

"A moonshine walk has a special meaning in these parts. Moonshiners traveled at night to fire their stills hidden deep in these forest-covered hillsides. Special wood was chosen to release the least amount of smoke possible. Backwoodsmen still practice this ancient form of alchemy. Camouflage covered all the apparatus that was needed to turn corn into the hardest, fastest liquor ever—white lightning. Another form of energy?

"Let's take a minute and sit here on the bridge suspended above the stream and watch the water from the two falls converge. Let those muscles relax that we've used and abused on our climb. The water is flowing under us, coursing around the boulders and fallen trees that litter the stream bed. Think of the erosion that changes the face of the Earth, other kinds of moving things, the potential power of a single grain of sand. It's all happening here. Listen for the sounds of energy in a single droplet of water. Compare that with the potential powerof the tons of water free-falling through space just ahead of us." (Pause)

"As we turn our backs on Anna Ruby Falls and prepare to return to our starting point, let the exposed surfaces of our skin tell us something about the moisture carried in the air all around this special spot. Touch your hair—can you feel it there? Even the plants, the evergreens and grasses bordering the trail have an extra measure of dampness to bathe in. The change in temperature in this place is so sudden, that perhaps you can feel the heat radiating out into space from someone standing near you. since the trees are giving off oxygen as you pass through this place, breathe in and exhale and share a bit of the breath of Anna Ruby Falls.

"There are a few stars lighting our way tonight. See if you can catch a glimpse of them as they rise higher in the sky. All around us, saturating the mud embankments that line the trail is a kind of creature which makes its own light. Perhaps that is how the stars of our galaxy appear to a neighboring galaxy. These insects are relatives of another night-brightener, the firefly. Can you touch one of them?"

When the group returns to the starting point they gather to share their impressions of the walk to the Falls. Each person contributes an idea, an image, or an association they might have.

FLOW AND CYCLE

3

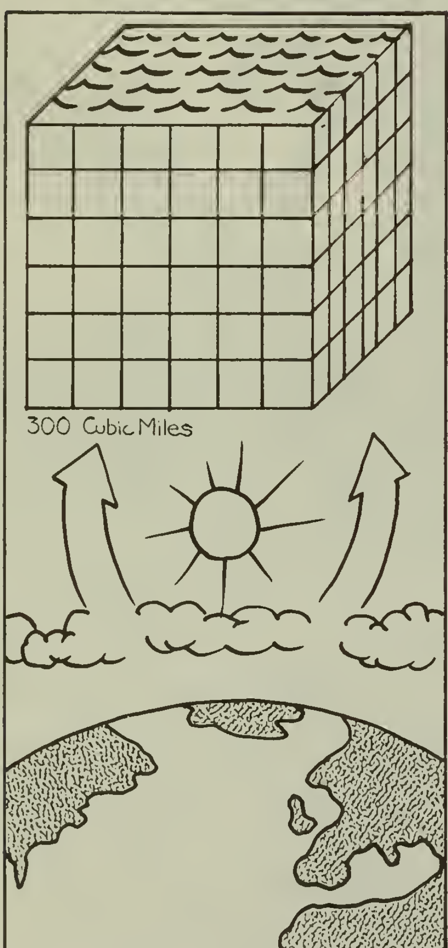
Energy flows and matter cycles. This is a crucial distinction because energy is contained only temporarily by our biosphere and then continues its flow through the universe, while matter exists in finite quantities on Earth and must be used again and again.

BACKGROUND

The "things" of Earth are constantly being built and disassembled in cycles which move our finite supply of chemical elements through the biosphere. But energy is different. It does not cycle and is contained on Earth only temporarily. The behavior of energy can best be described as a one-way flow.

Solar energy does not return to the sun. Rather, it travels through space on a straight path and a small portion is intercepted by Earth. Some is reflected, some does work in the atmosphere, and some is temporarily stored in different forms in the Earth's systems. But eventually, all of this stored energy dissipates back into space, usually in the form of heat, and continues its voyage through the universe.

It takes energy to change matter from one form to another. The continual round trip of chemical elements which make up matter is paid for by the one-way trip of energy.



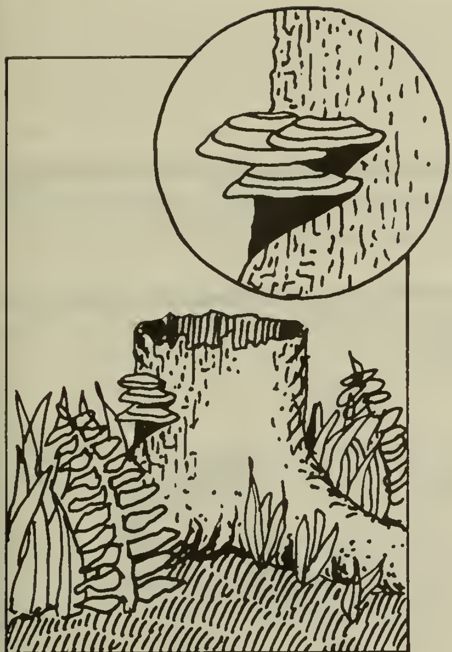
Each chemical element has a specific cycle and some take more time to complete their loop than others do; some take as much as several million years. The movement of chemical elements is referred to collectively as matter cycling.

Most chemical elements move in so-called sedimentary (earth-related) cycles in which erosion, sedimentation, mountain-building, volcanic activity, and transport by organisms are the major components. However, most people are probably more familiar with a cycle that is not sedimentary—the water cycle. The sun vaporizes about 300 cubic miles of water each day from the Earth's lakes, rivers, oceans, and land. The vapor is lifted into the sky and then is gradually released as precipitation which falls back to the surface. This rain runs over the ground in streams and rivers or is absorbed into the soil.

You can see nature's cycles at work nearly anywhere you look. The water cycle is at work when clothes are drying on a line, when steam forms on a window from plant transpiration, and when fog and dew are created. The rust on automobiles is evidence of nature's efforts to break down the metal by oxidation. You can see rocks breaking into smaller pieces which will eventually become soil, and a dead tree or animal decomposing and releasing mineral nutrients.

The movement of energy, chemical nutrients, and water provides subsidies to some ecosystems while draining resources from others. Mountain ecosystems, for example, lose nutrients through erosion to other areas such as estuaries. These rich inputs of energy and minerals often result in greatly expanded life-supporting potential for the receiving system.

Organisms play a crucial role in energy flow and matter cycling. Plants, the producers, transform light energy into chemical energy and capture chemical elements from the soil, air, and water. All of these are stored in plant structure. Other organisms obtain energy and chemical nutrients by eating plants or by eating animals which have eaten plants. Even though only 30 to 40 of the more than 90 chemical elements are necessary for life, organisms are an important part of nearly all matter cycles.



One of the essential tasks organisms perform is decomposition. Without it, all of the chemical elements on earth would soon be locked up in dead animal bodies and plant structure and life would cease. Decomposition is carried out primarily by organisms such as bacteria and fungi which feed on dead organic matter. Abiotic processes such as fire or water erosion also contribute. Decomposition, in effect, reverses the process of photosynthesis by reducing organic (living) matter to inorganic (non-living) chemical compounds.

There is a significant amount of seasonal variation in energy flow and chemical cycling. For example, nutrient input in plants is greatest during the spring and summer but leaves are dropped mainly in the fall. This litter is decomposed throughout the year but at an accelerated pace in summer. The chemical makeup of leaves also varies by season and many of these nutrients are withdrawn from the leaves and stored in sap over the winter.

Although energy flows and chemical elements cycle, they have one important thing in common—both can be stored. Energy is stored in all of the things you see around you. In Chapter Two we discussed the way energy is stored in atoms and in the bonds which join atoms together to make things. Chemical elements are also stored in matter. The flow of energy and the cycling of matter are both characterized by periods of movement and storage. The difference is that energy can only be transformed and stored a few times before it has all escaped and resumed its flow through the universe; the chemical elements that make up matter never leave the planet, but rather cycle again and again.

Since all of the chemical elements in the biosphere are continually reused, there is no such thing in nature as "waste" or "throwing away." Everything is eventually re-processed in the material cycles. On the other hand, people in industrial societies fabricate linear processes which perpetuate the myth that things can be "thrown away." We overburden the chemical cycles by releasing natural substances such as nitrogen, sulfur, mercury, and lead in large quantities. And, worse, we introduce new and often toxic substances, such as chlorinated hydrocarbons and plutonium without knowing how they will affect natural cycles.

ACTIVITY
I WAS, I AM, I WILL BE

All living things change, but at different speeds. Energy makes change possible. This activity tries to dramatize the long and short of cycles in different things.

THE GO OF IT

■ The players are asked to find something "dead and down" that they especially like while taking a hike or a walk. Make a circle and take a few minutes to let people think about the life cycle of their objects. The leader shares a story, like "Who Ate Roger Williams?" The players identify themselves with the found object and state its past and future forms. For example, "I am a feather. Once I was a part of an eagle's wing. Someday I shall become specks of soil."

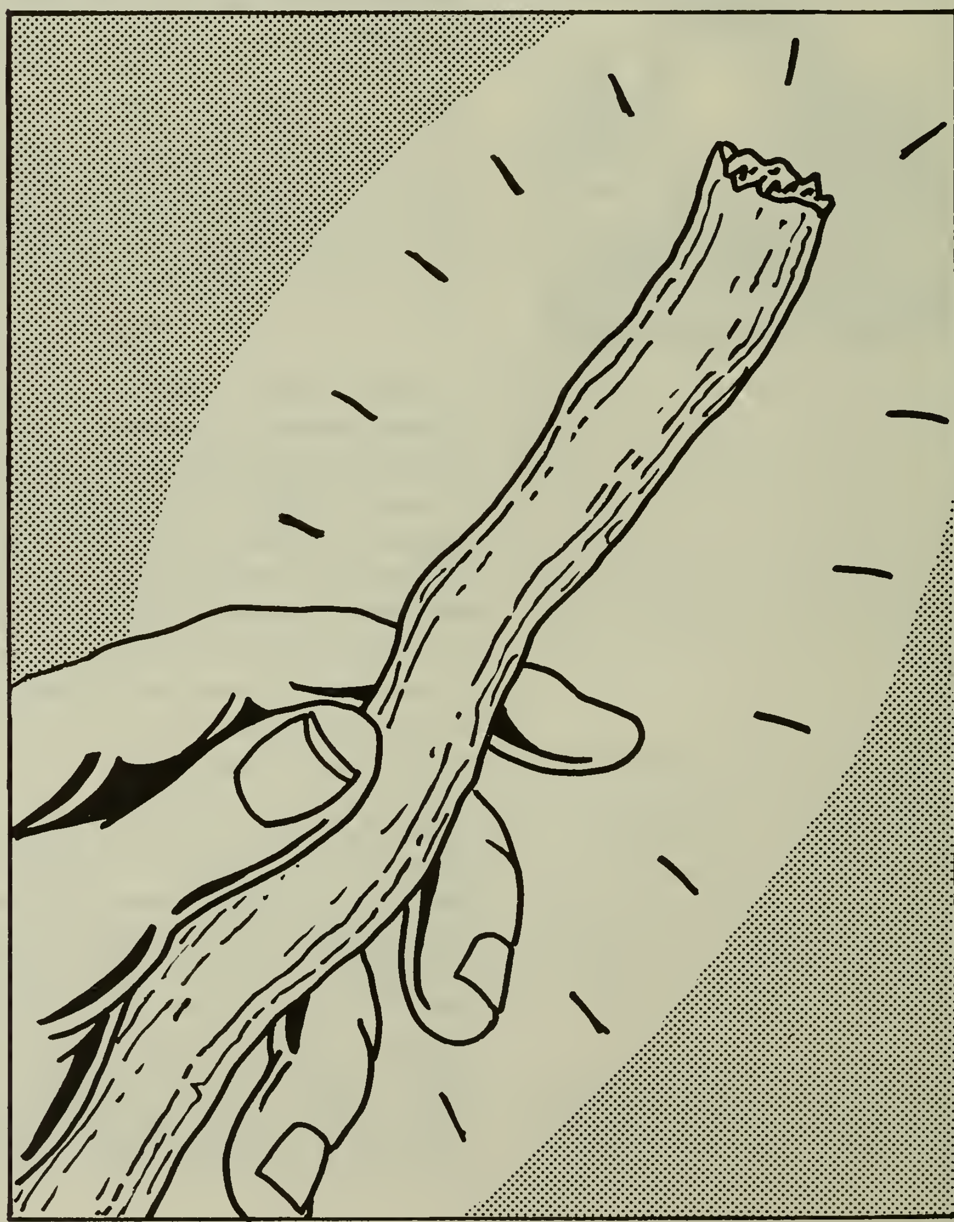
■ After everyone has contributed, the leader reminds them that everything is becoming something else and that energy powers the cycles of matter.

AN OPTION

■ Toward the end of the walk, the leader picks up a small stick. Later, as the group gathers for the closing words, the leader places the stick on the ground and invites everyone to sit around it. The leader takes the stick and holds it in both hands.

■ "This is not an ordinary, humble stick, for it has magic powers. As we hold it in both our hands, we can speak for it right now, at this very minute: I am a stick, here at ____. As I pass it to my left hand, I have the power to see into an imaginary crystal ball and view the past. I once was a tiny maple seedling, whirling through space. Now as I pass the stick to my right hand, it carries me into the future. I will become a mushroom growing on the forest floor in the Great Smokies!"

■ Each person speaks for the magic stick until it is returned to the leader. The leader tosses the stick over his or her shoulder saying, "Let the stick go on about its business."



An Idea From Bruce McHenry

North East Regional Office, National Park Service, Boston, Mass.

THE COILED SPRING

How does energy flow change in different seasons? Winter is a time of storage, hibernation, and dormancy, but spring is a time when energy processes burst into life-giving activities. The park or playground can serve as a study area for observing and learning about these processes. Or take slides of your park that show the sequence of seasons and use them to provoke questions and comments on the differences.

The energy flow and storage theme is a natural one for a series of environmental education programs. Try scheduling several consecutive visits before, during, and after the arrival of spring.

Choose stations along the trail or in the school playground. Here are some ideas for studies:

Measure the thickness of ice in a stream as it melts. Take water temperature and depth measurements. Note when the banks defrost, if floods occur, and when insects hatch.

Use a sundial to measure the changes in the sun's shadow and record each visit. How has the relationship of the earth to the sun changed?

Photograph the same twig on a tree each time you visit. What changes are occuring? Check the bark, buds, insect life, sap oozing.

Look for animal homes and tracks, signs of movement, nesting, food gathering, cocoons bursting.

Have a creative writing exercise in which the children prepare advertisements designed around the phrase, "This year spring will be brought to you courtesy of ______." The ads should be a paragraph in length and will be read aloud, acted out, or mimed. Some might prefer to draw an illustration or cartoon to go with an ad.

By the time spring has sprung, the children will have a clearer understanding of how energy creates changes in the living things around us.

A good resource is **Ten-Minute Field Trips,** by Helen Ross Russell.

WHO ATE ROGER WILLIAMS?

This story suggests that energy moves matter in strange and wonderous ways. Also recommended is Aldo Leopold's "Story of X."

"The truth that matter passes from the animal back to the vegetable, and from the vegetable to the animal kingdom again, received a curious illustration not long ago. For the purpose of creating a suitable monument in memory of Roger Williams (1603?-1683), the founder of Rhode Island, his property was searched for his grave and that of his wife. It was found that their remains had passed into oblivion. The shape of the coffins could only be traced by a black line of carbonaceous matter. The rusted hinges and nails, and a round wooden knot alone remained in one grave; while a single lock of braided hair was found in the other.

"Near the graves stood an apple tree. It had sent down two main roots into the very presence of the coffined dead. The larger root, pushing its way to the precise spot occupied by the skull of Roger Williams, had made a turn as if passing around it, and following the direction of the backbone to the hips. Here, it divided into two branches, sending one along each leg to the heel, when both turned upward to the trees.

"One of these roots formed a slight crook at the knee, which made that portion of root system bear a striking resemblance to the human form. There were the graves, but their occupants had disappeared, the bones even had vanished. There stood the thief, the guilty apple tree, caught in the very act of robbery. The transformation was complete.

"The organic matter, the flesh, the bones of Roger Williams, had passed into an apple tree. The elements had been absorbed by the roots, transmuted into woody fibre, which could now be burned as fuel, or carved into ornaments; had bloomed into fragrant blossoms, which had delighted the eye of passers-by, and scattered the sweet perfume of spring; more than that had been converted into luscious fruit, which, from year to year, had been gathered and eaten. How pertinent, then, is the question, "Who ate Roger Williams?"

from *The American Biology Teacher,* March 1973 (contributed by Paul Stetzer, Schuylkill Valley Nature Center, Philadelphia, Pa.)

ACTIVITY
THE STUFF OF NATURE

Adapted from the *Manitoga Program Plan,* Attic & Cellar Studios, Washington, D.C.

This exercise can be added to a nature walk. It is a good way to coax visitors up a steep hill and to teach them about the effects of energy flow and matter cycling on the land.

WHAT YOU NEED

■ Select a gathering point at the foot of a hill along the trail. Keep a stash of small rocks and loose clumps of soil nearby. The walk will be silent, the explanation brief.

THE GO OF IT

■ Ask the group to sit and rest before climbing the hill. Talk for a few minutes about the natural history of this place, how people have used it, and how the trail came to be there.

■ Also talk briefly about the visible signs around you of matter cycling: rocks disintegrating, leaves decomposing, water flowing, gravity pulling loose things downhill, and so on.

■ As the walk begins, stand at the foot of the hill. As the people pass by, give each a small stone or a bit of soil, as if it were a talisman. As the stone or soil is given, try saying something like this:

■ "This is the stuff of nature. These things may once have been at the top of this hill. But wind and water erosion carved away at the hill over time. Gravity pulls the loosened materials down. As we go up the trail now in silence we will return our rocks and soil to the top of the hill. It takes energy to move matter, and we can share in that process today."

■ Add a reference to the energy of your body working against the Earth's gravity as you climb. Feel perspiration form and evaporate, cooling you as you exert yourself.

■ At the top of the hill you might want to discuss changes in the land which have been caused by people and the role people can play in replenishing it.

THE LIVELY CYCLE OF A TREE

Check your trails for examples of all the life phases of one particular kind of tree that is common in the region. Find examples of your "pet" tree as a seedling, a sapling, a mature tree, dead but standing (a home for animals), fallen and decomposing (being turned into soil by decomposers). Look for the seeds, nuts, leaves, flowers, or fruits of your tree so that you can tell its whole life cycle. Think about the flow of energy which made each of these steps occur.

Compare the tree's life cycle to a soda can's from creation to decomposition. Some questions to ask:

- **Who starts the compost heap in the forest?**
- **Who rakes the forest floor?**
- **How did the tree's seeds travel?**
- **What resources did the tree draw upon to grow?**
- **What happened to the energy the tree used?**

— Suggested by Tom Fox, Gateway National Recreation Area, New York

An Idea From Terry Stevenson

Cape Cod National Seashore, Mass.

THE WAVE GAME

Take a walk along the beach at low tide to look at the distance from the low to high tide lines. What kinds of shells, rocks, and debris can you find at the high tide mark? How did they get there?

Try a relay race to dramatize this energy message. Distribute coffee cans to all the children. Line them up (barefoot) at the water's edge. At the "go" signal they fill their buckets with water, carry to the high tide mark, dump. Return to the shoreline, repeat. Encourage the children to do this until they're too tired to go on.

Here are some questions to ask them afterward:
- How do you feel? Was this work?
- How much work do you think the waves do?
- What kinds of energy did you use?
- Where does your energy come from? Where does the waves' energy come from?
- Do people try to fight the energy of the ocean? Have they succeeded?
- What happens to the shoreline in storms?
- What happens to a town in a storm?

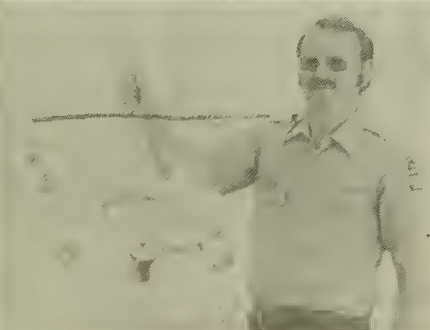
EXTRAS:

This activity can also be done without the buckets, by carrying the water (or sand) in your hands.

Compare maps of the shoreline of today with those of 50 years ago.

Have the children rub shells and rocks from the beach together to break them down. Hold up the ground-up substances and ask them if they would like to eat this for dinner. Explain that the nutrients in the rocks and shells are now available to plants in the water and that animals (like the fish you eat for dinner) get the nutrients by eating the plants.

Remember—there are children who think we have sandy beaches because men with big trucks come along and dump sand there!



An Idea From Rich Koopman

Prado Visitor Center, California State Parks, Norco, Ca.

A THROW-AWAY

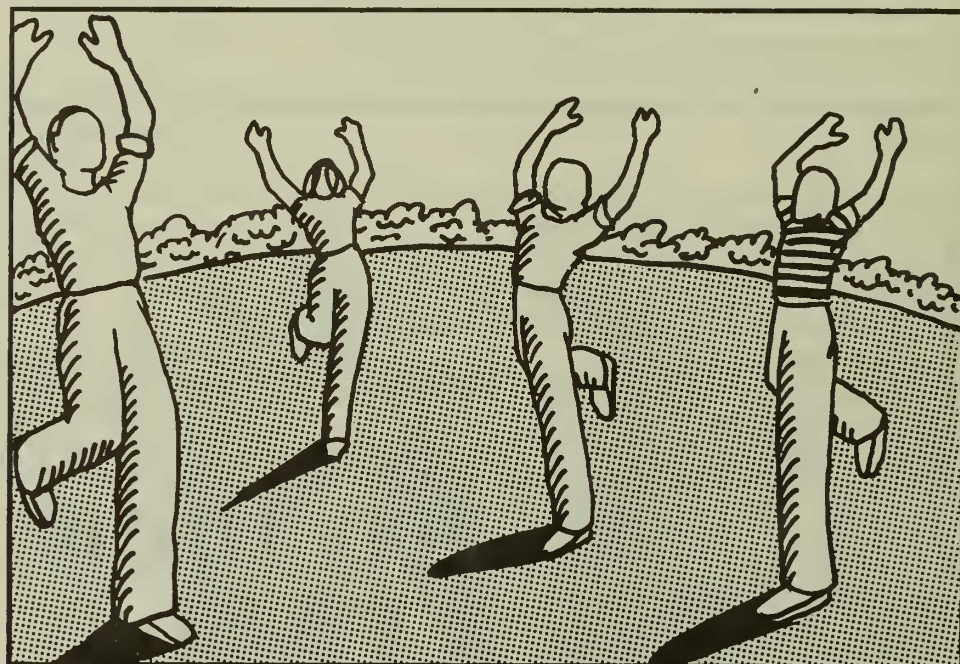
You may be interested in an exhibit which has drawn considerable interest in my center lately. It is a simple, handmade mobile appropriately named, "Trash-mobile." Construction costs are extremely cheap—a walk along most any nature trail will provide an enormous selection of trash. Additional construction materials include a spool of fishing line and some twigs or wire from recycled coat hangers for the horizontal supports.

The "Trash-mobile" works well as a message and conversation piece which is noticeably out of place and perhaps a bit ugly among professionally prepared museum exhibits. With a tool like this, one can launch into discussions with visitors about the litter problem and all its social, political, and economic ramifications as well as talk about the enormous amount of energy required to produce both the container and product for our one-time use.

The mobile can be left unlabeled or one can devise various "catchy slogans" and hang them separately in sequences similar to the old Burma Shave ads which formerly occupied the country roadsides. Perhaps if we all had these "modern art" mobiles in our homes, the nation's nature trails would get cleaned up.

ACTIVITY
PASS THE MOTION

This is a fast-paced game used to get bodies and ideas moving. You may want to try it before leading any of the movement-based activities in this workbook. This activity does not have a strong energy message but gets people thinking about energy flow.



WHAT YOU NEED

■ This game works well indoors and out. If you do this with children, try clapping a beat (rehearse it before starting). You can also use a drum made of an empty three-pound coffee can, or any percussion instrument. These add a little excitement and provide a good system for *stopping* the movement. (Freeze when the drum goes "bang"!)

THE GO OF IT

■ Form a circle and ask the children to warm up a bit. Have them shake out all the stiffness in their feet; first one, then the other. Next shake the hands, arms, and head. Now, stretching for the ceiling or sky, have them reach as far up as possible. Then all collapse, sinking down to the ground. If the leader does this in a slightly exaggerated way, the group will follow.
■ Now hold hands to reform the circle. Choose the instrumentalist or rehearse clapping the beat.
■ The leader begins by acting out a motion—jumping up and down, swinging arms in circles, twisting into a human pretzel and unwinding.
■ The instrumentalist picks a beat, the leader repeats the motion, and the whole group does it along with the leader.
■ "We are passing energy around as you share my motion with me. Now the person on my right will take my movement and make it theirs by adding to it and changing it."
■ The motion is passed around the circle, with each player altering it as it comes along. If one child takes too long, the instrumentalist clues in the next player with an extra "bang."
■ When the motion gets back to the leader, see if everyone can remember the original motion. As you sit down to rest, talk about how you are all feeling. As you use energy, heat is released.

HAIKU

In this chapter are many possible ways of discovering energy flows and storage in nature. They create changes that are full of beauty in form, function, and usefulness. By using language we can store our ideas on paper and capture the images around us. The words of poems often have a special rhythm and flow to them. Haiku is a form of Japanese poetry that is fun to work with in a group. Divide your group into teams of threes. Give a few examples of Haiku. The poem form is simple; three lines containing five, seven, and five syllables respectively, written about one of the seasons. Haiku are fun to read aloud.

Summer dying in
drying grasses, one last sun
so slowly setting.

Ann Atwood, Haiku: The Mood of the Earth

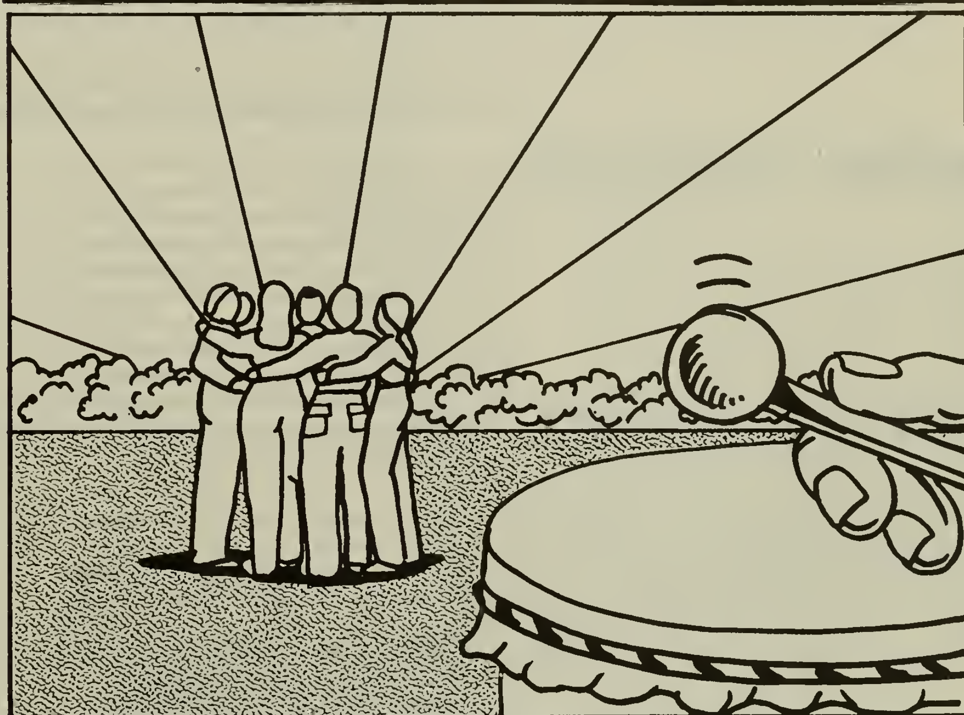
Falling spring raindrop
joins sun on leaf, to power
photosynthesis.

Jean Matthews
(unpublished)

ACTIVITY
SUN HUDDLE

Thanks to Nancy Scribner,
Montgomery County Schools,
Chevy Chase, Md.

This activity follows the themes of some of the games in Chapter One. We've talked about energy flow. Now let's follow it from the source—the sun—to see where and how it moves, and the forms it can take as it arrives on Earth.



WHAT YOU NEED

■ Start by doing a warmup activity like "Pass the Motion." Use a percussion instrument for a background beat. Try this with a group of adults and children. Find a sunny meadow or field for a special effect or it can be done indoors. Gather the group together in a tight cluster. Project your voice in a loud whisper.

THE GO OF IT

■ "Let's all pull in close together and be like the sun. Feel how warm we are from moving. Our bodies are releasing heat because of the energy flowing within us. Feel how strong and powerful we are. The sun can send out rays of heat and light energy for millions of miles until they touch Earth. But the sun does more than just powerful things like melting glaciers, making wind, causing waves, and making people squint when they look at it. The sun does special things like making food in each leaf it touches, and pulling water up into the sky."

■ "Choose something a sun ray could do. At the sound of the beat, each of us will travel to the Earth and change into something that makes life. As we change, we will keep the motion going until our energy runs out. Some of us will change quickly, some slowly, and when you get tired, freeze. Remain silent until everyone has finished." Beat a drum in varying and interesting rhythms as an accompaniment.

■ Gather together in a circle for discussion. Go around the circle asking each person to identify what they were and show the group their movement again, if they'd like.

■ "How did your energy change? Did you feel as strong as you did when we were all together on the surface of the sun? What kinds of life did you bring to Earth?"

The winds dwell in the mountains,
and when the Changeable Wind blows,
the animals wake from their winter's sleep.
When the Blue Wind blows, the leaves come out.
When the Yellow Wind blows, the animals leave their dens
and the earth is covered with green, growing things.
When the Dark Wind blows, the snakes and the lizards
shed their winter-dry skins and put on fresh skins.
—Navaho Indian Saying

"Behold my brothers,
The spring has come,
The earth has received the embraces of the sun and
we shall soon see the results of that love!"
—Sitting Bull, Sioux Chief

ACTIVITY
THE SOUNDS OF ENERGY

Adapted from the *Manitoga Program Plan,* Attic & Cellar Studios, Washington, D.C.

This exercise is a relaxation game. It is designed to draw people together in a non-verbal way by playing with the sounds that they make. By adding our hums and ahs to the noises and songs made by the living things around us we can share a special kind of experience and create a mood for other kinds of learning and feeling. This is not specifically an energy activity but can be a strong finish to your energy program.

WHAT YOU NEED

■ This activity works well as an end-of-the-day experience for a small group (five to 15). Try it with all ages. Look for a flat open area surrounded by trees. A nice addition would be a swiftly running stream. Choose your spot before you are to lead your program. Go there alone and spend time relaxing there, letting your thoughts and feelings explore the place. Jot down a few ideas and word-images that occur to you. They can be included in your script.

■ This is a special experience, and it helps if you are feeling calm and relaxed. Take a minute before you begin talking to breathe deeply and get comfortable. The group will wait for you and the pause will help to set the mood you want.

THE GO OF IT

■ "We can listen, learn, and share in the Sounds of Energy. Let's lie down on our backs with our heads together. Our feet extend in a starburst radiating out from the central point. We relax, closing our eyes, blending our bodies into the ground beneath us, feeling our heat sinking into the ground. The spinal column is the focus of our awareness—press it more deeply into the earth, then relax and soften the muscles and tissues of your body; relax your shoulders, waist, calves, hips.

■ "Listen to the sounds around us: the leaves rustling, the noises of the forest."

■ Pause. "Breathe in slowly, in a sustained flow, and exhale, releasing air from your lungs. Now you have shared air with the plants here in this spot, and they will return it to us. Imagine that your spine is a hollow tube, a wind instrument, designed for this special day. As you breathe in through your nose and lips, think of yourself as a musician playing with a wind ensemble. Listen to the breathing of those around you, and complement them."

■ Pause and stay with this for several minutes. "Next, close your lips, add a humming sound, and share your song with others in the circle."

■ The leader starts a soft hum. "Try to keep a continuous sound alive, ebbing and flowing with your need for breath, for life. Now open your lips and let the song ring out with an 'ahh'."

■ Lead the song. "Try trills and harmonies, slow and fast speeds, soft and loud volumes, high and low notes. Discords are music too; enjoy them. Our song is orchestrated with nature; the inhabitants of the woods are amazed by us. We offer our sounds of life to the plants and animals who live here."

■ After the song begins offer a dialogue: "Let our song wind around us, drifting like a column upward from the center of the circle. It travels through the woods, along the trails, between the trees, filtering through the rocks and spaces. Our song explores these special places we walked today. It comes back to us, back to our circle, and shall follow us when we leave filled with the memories and feelings of this special place.

■ "Gently, gradually, we decrease the energies we've created, changing the 'ahh' to a hum and then to breathing again. Rest our instruments. Return the air from our lungs to the atmosphere. Listen again to the sounds of nature, allowing them to creep back in, to meet the echoes of our sound."

■ As your voice fades away, wait for a few minutes, thank everyone for sharing their sounds and giving you such a pleasant ending to the walk. Ask the group to open their eyes and rise, brushing the leaves off others next to them.

ACTIVITY
ENERGY EGG HUNT

Thanks to Jack de Golia, Grand Teton National Park, Wy. and Lucy Seaver and Judy Thomson, Fort Snelling State Park, St. Paul, Minn.

This is a good basic activity to learn about energy flows and matter cycles in natural and built environments.

WHAT YOU NEED

■ Find a natural area with an interesting variety of plant life close to a quiet indoor room you can use.

THE GO OF IT

■ Before taking the group outdoors, divide it into teams of three. (If there are children, be sure to have an adult in each group.)

■ The game is based on the idea of an Easter egg hunt, but this particular hunt is for energy "eggs."

■ Ask each team to find one object—the energy egg—that is pleasing to them all.

■ They are to determine three ways that energy flows through the egg and has effected or will effect a change. They have five minutes for this part of the activity. Tell them to leave the egg where it is.

■ Then the entire group visits each egg and each team gives the group a three-minute presentation about the energy that flows through or is stored in the egg. Encourage speculation about what the thing has been and what it is becoming. Contributions of ideas from the audience are welcomed.

■ Repeat the activity indoors, asking the teams to select something pleasing that was made by people. Ask the teams to identify the things that make up the indoor egg. Present to the whole group.

■ Each team is to imagine what would happen to the natural outdoor egg if it were brought inside and placed beside the indoor object. Would this change the energy flow of the outside thing? What would happen to it? If your egg is a living thing, what would it take to keep it alive?

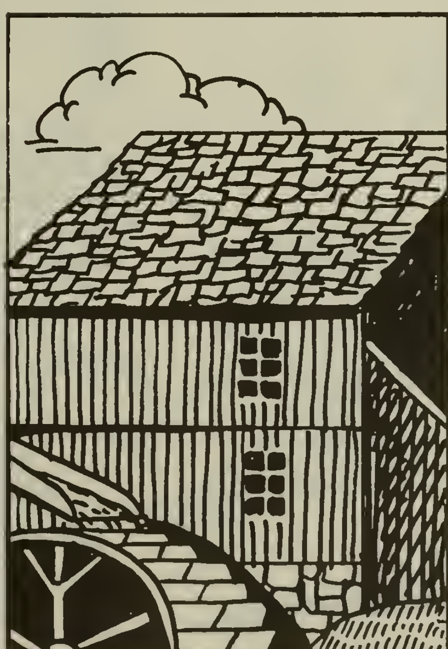
■ Then suppose the opposite: that the indoor egg is placed outside. What changes would occur? Compare the materials and energy expended to form both the indoor and outdoor eggs.

A WATER WHEEL

If you are lucky enough to have a water wheel in your park or nearby, try describing how the wheel works in terms of energy storage and flow. The river, creek, or pond which runs the wheel is a natural storage of energy. By directing the water to run against and turn the paddle wheel, mechanical energy is harnessed. You could use the wheel as an analogy for matter cycles being driven by energy flow.

Check any available historical material to discover the environmental considerations taken into account by the millwright.

What happens in the spring when the flow and volume of water in the river increases? What ways are used to control the force and amount of water? What work did the original mill do? What forms of energy power mills and factories today? Try grinding grain with a hand grinder. What kind of energy does that take?



THE BEAN SCENE

A lima bean is really a storage compartment for a living plant. If we look inside we can see the tiny bean plant that is already growing there.

Soak one-half pound of dried large limas in water overnight. Pass a bean to everyone in your group. Peel off the outer skin. Examine the structure of the seed. Look for the "eye" on the inverted curve. Gently split the bean by inserting both your thumbnails in the seam opposite the "eye." Notice the large energy storage system, two lobes of the seed, that nourishes the baby plant. Look at the structure of the baby plant; its leaves, stem and root.

You may want to plant the other seeds in recycled cups. They will sprout in a few days. Study the plant's needs: sun, air, soil, water.

by Mary Anderson, National Park Service, National Capital Parks, Washington, D.C.

ACTIVITY
A FEEL TRIP

This game is often used as a sensory exercise. Here it is used as a condensed form of "The Pulse of the Place" activity that can be done in 20 minutes or so, depending on the amount of discussion it provokes. In the first round, with our eyes closed, we explore the object briefly and describe our impressions. Then with eyes open, we see the object and, with similar expressive language, describe the ways that energy has affected the object.

WHAT YOU NEED

- This may be played in a quiet spot, inside or outside. Have a paper bag ready with several "dead and down" objects. Divide the group into teams of four or five. Ask them to sit together in a tight circle. Explain the rules.

THE GO OF IT

ROUND ONE

- Begin with closed eyes. Explain that each team will be given an object from the bag to pass around the circle with everyone describing it to the team in a few words. Use all of the other senses—touch, taste, hearing, smell. The purpose is to refresh our language skills through the use of all our perceptions and to listen to those of others in the team. For a stone, one response might be: "This stone has a grainy texture, both smooth and rough." Someone could say this about a pine cone: "It has a sweet, pungent odor."
- The object is passed around once. The person who started the object places it in the middle of the circle. With eyes still closed, pass around two other objects. When all three objects are in the center of the circle, ask the team to open their eyes.

ROUND TWO

- Eyes open, pass each of the objects around the circle, one at a time. On this round everyone has a turn describing how energy forces have formed or altered the object and how it will continue to be changed in the future. Ask the group to consider how energy has been moving the chemical elements which make up this piece of matter. They may build on their impressions in Round One.
- Sample comments: "The rough spots on the rock will be worn smooth by the force of the river." Or, "The pine cone seeds will be scattered as the cone becomes brittle and dry."
- Place the objects back in the bag and carry it along on your nature walk. Deposit each of the objects in a logical place so that they can continue their life cycles.

A KERNEL

The Audubon Center in Greenwich, Connecticut has another approach with a message. The staff has placed two recycling bins; one marked for trash and litter, the other for compost materials. The two bins speak for themselves—no interpreters needed.

An Idea From Ane Merriam

Dept. of Natural Resources, Tallahassee, Fla.

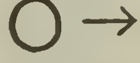
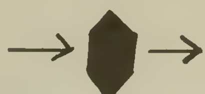
THE ENERGY ECOLOGY FLOW GAME

Energy flows operate and define the system of nature and human society. For example, consider sun energy flowing into leaves, being trapped as plant matter. The plants are consumed by animals and the wastes of this consumption are recycled to become nutrients for more plants.

There are similar flows in human society. Fossil fuel energy (from natural systems long ago) is changed into electricity which runs a city. Industries in the city (like a paper company) use (consume) this energy to make products (paper) which are used by others (more consumers). After the product is used it is "thrown away." However, there really is no "away." Everything gets recycled, sometimes by us humans, most often by nature. Pollution may be seen as stuff that doesn't get recycled fast enough.

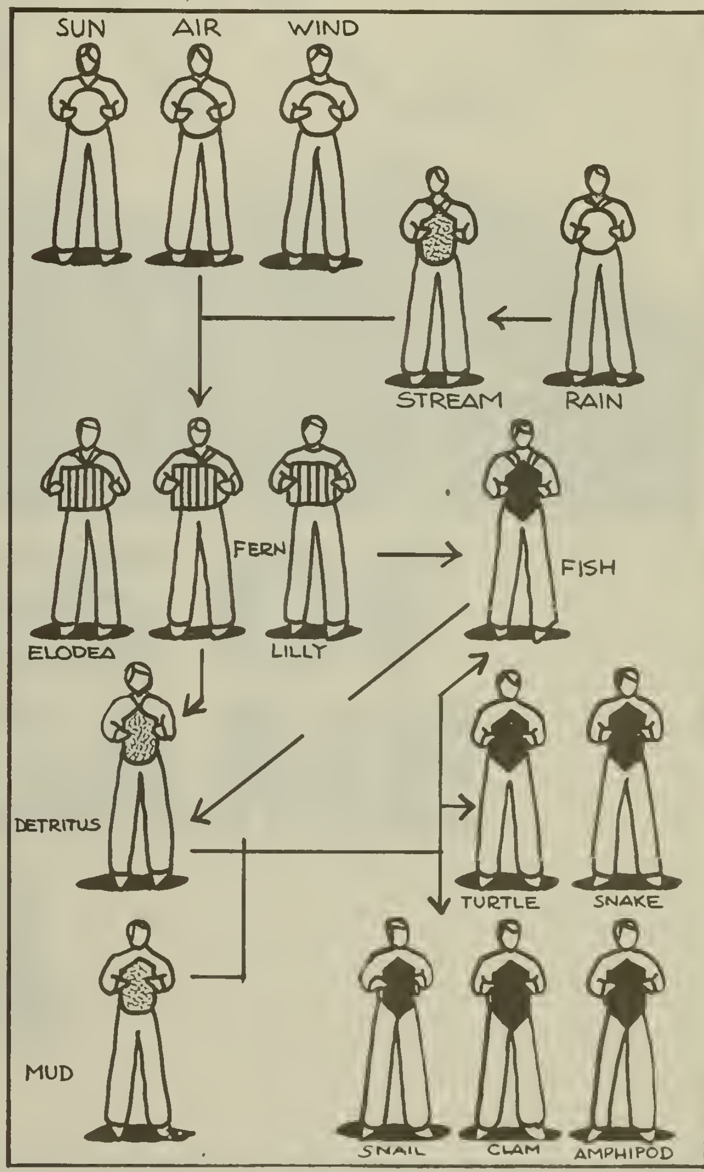
The "Flow" game enables the student to identify the parts of any system we use or know about through the use of symbols. The system studied may be a forest or a city. The children become familiar with four symbols representing producers, consumers, stored energy, and outside energy sources.

Examples are given for each symbol. An outside energy source could be the sun, rain, or fossil fuel. Examples of storage might include trees, soil, animals, batteries or power plants. Producers are green plants for natural areas and perhaps a factory in a city. A consumer could be represented by a person, an animal, etc.

- outside energy source symbol: 
- storage symbol: 
- producer symbol: 
- consumer symbol: 

Then the children go on a follow-up field trip to a natural or man-made place. At the end of the trip they act out the energy ecology flow that they've observed that day, holding cardboard cut-out symbols and arranging themselves to show how energy is passed from one energy player to another.

A help may be the book, *Energy Basis for Man and Nature* by Howard T. and Elisabeth C. Odum, McGraw-Hill, 1976.



RULES OF THE GAME

4

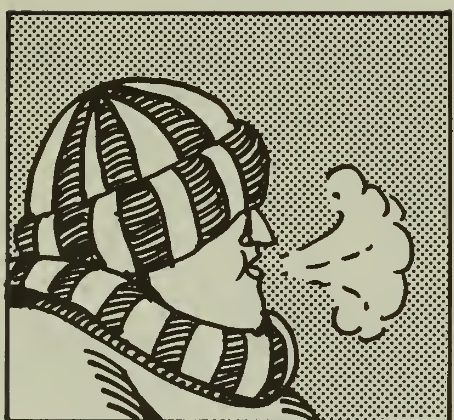
Even though it has amazing power and flexibility, there are limits to what can be done with energy. We can't create or destroy it. And each time it changes from one form to another its ability to do work decreases.

"Energy is an equation, and it won't do at all to consider only one side of it."—Jean Matthews

BACKGROUND

In spite of the many amazing Earth processes which are powered by energy, there are some definite limits to what energy can do. We have already briefly discussed one of the basic laws of energy, the First Law of Thermodynamics, which summarizes scientists' observation that we never use up any energy. The loss of one kind is balanced by the gain of another kind. This means that we can neither destroy energy nor create it. As far as we know, the total quantity of energy in the universe is constant.*

We have also seen that different forms of energy have different capacities for doing work; that is, energy is more concentrated in some forms than in others. Scientists have their own term to describe and measure differences in energy concentration. They call it entropy. However, there is an important difference between the two terms. Entropy is the inverse of concentration; something with high concentration of energy is said to have low entropy, and vice versa. For example, fossil fuels have low entropy, but the dispersed heat which escapes when we burn them has high entropy.



Scientists have observed that each time energy is transformed its ability to do work or to cause change decreases. This is one way of stating the Second Law of Thermodynamics. No natural or human-contrived process is 100 percent efficient. Thus some of the energy which is "used" in the process is not converted into useful work. This runaway energy escapes—usually in the form of heat—and is radiated back into space. Heat energy can be seen escaping from many energy processes. Think of the heat waves you see rising from the hoods of automobiles and the exhaled breath from people that is visible in cold weather.

This aspect of the Second Law is well stated by the popular phrase, "there's no such thing as a free lunch." It means that, although a given quantity of energy may be transformed many times, no chain of energy transformations can continue indefinitely. Because some is lost at each step, sooner or later there's no usable energy left. This is why there are fewer animals at the end of a food chain and why it takes so much energy to make and use electricity (burning coal or oil to heat water to run turbines in power plants, to generate electricity to be sent through wires, to be converted to light or mechanical energy in homes or factories).

The electricity example also shows that some energy transforma-

*We should point out a subtlety here in case you get a question from someone who is versed in nuclear physics. Since matter can be converted into energy in nuclear reactions (see Chapter Two), the First Law of Thermodynamics, in order to be strictly applicable to *all* energy transformations, is best described by this statement: Energy/matter can neither be created nor destroyed.

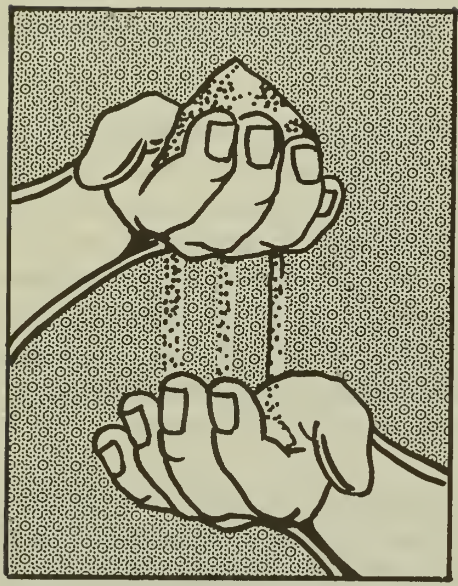
tions can result in the conversion of some energy into a more concentrated form. Electricity is a more highly concentrated, lower entropy form of energy than coal or oil. Similarly, the chemical energy in the structure of a plant leaf is more concentrated than the sunlight striking the leaf; the leaf accumulates and stores the sun's energy.

These increases in concentration are possible only through the increased entropy of the total amount of energy that went into the process. However, this does not mean that the degraded portion of the energy is entirely useless in its new forms. Returning to our fire example, the dispersed heat, smoke, and ashes which remain after the fire has burned out have less potential for doing work than did the wood. But the smoke may do work in a smokehouse, the ashes may be used for fertilizer, and the heat dispersing into the surrounding environment may warm a fern, a snake, or a camper.

The Second Law is also frequently expressed in terms of order and disorder. Scientists have observed that all things in nature move toward random arrangements unless energy is invested to impose or maintain order. Concentrations of things—odors, smoke, a pile of leaves, and groups of park visitors on nature walks—tend to disperse unless energy is expended to keep them together. Trees in a natural forest never grow in straight rows. Structure also tends to fall into disarray—ice melts, rocks break up, wood rots, weeds overtake lawns, furniture comes apart, machines stop working.

The complex and highly ordered systems which make up living plants and animals may seem to contradict the Second Law. But a living cell is an unstable and improbable compilation which can be maintained only by inputs of energy. Organisms, ecosystems, and the biosphere at large create and maintain a high state of internal order by continual degradation of high-utility energy such as light or food to low-utility energy such as dispersed heat.

There are some other important limits on what we can do with energy because the heat and chemical elements released in many energy processes can become serious pollution problems. Every living organism produces heat. Each of the Earth's more than four billion people generates body heat equivalent to at least a 100-watt light bulb and the many machines used by people in industrial nations create far greater quantities of heat. The combination of these sources represents only a small fraction of the heating of our atmosphere by the sun. However, some scientists warn that this is a delicate balance and that continued increases of human heat production could cause serious climatic disruptions.



In addition to heat, other kinds of pollution often result directly from human energy use. When oil and especially coal are burned they release a number of substances which are harmful in large quantities. These include carbon monoxide, sulfur oxides, and nitrogen oxides. Nuclear reactors emit radioactivity and create a number of toxic by-products. And noise pollution from all of the machines we run with energy has been found to cause physical and mental disorders in people exposed to high levels for extended periods of time.

One particularly important factor in considering pollution from controlled energy processes is that the amount of heat and other pollutants we create is the same whether a given quantity of energy is used productively or wastefully. Thus, by using our machines only when necessary, by eliminating those which do unnecessary work, and by maximizing the efficiency of those which do important work we can receive the same benefits, conserve energy, and reduce pollution levels. Most experts agree that we could save from 20 to 50 percent of the energy we now use without significantly altering the comfort and productivity of our lives.

ACTIVITY
LEAF RELAY RACE

This game is a race designed to show that each time there is an energy transfer, some energy is lost for our use.

WHAT YOU NEED

■ You will need an open, fairly flat area covered with dry leaves. Sand or pine needles may be substituted. All ages may play.

THE GO OF IT

■ As the group approaches the site, ask each person to gather an armful of leaves or whatever you are using. Deposit them in a heap at one end of the site.
■ Have the group count off by twos or threes and form teams. Ask the teams to line up in parallel lines. The first five players remain standing, the rest are loyal rooters. The players should spread out their lines so that they are separated by several yards.
■ Beginning at one end of the lines, assign a role to four of the five team members: human, carnivore, herbivore, and plant. All players should mark their starting spots.
■ Ask the fifth person from each line to stand behind the leaf pile. Explain that these people represent the sun and will hold today's energy supply for each team in their arms.
■ The sun people scoop up an enormous pile of leaves. At the "go" signal, the "suns" race to the "plants," who nonviolently grab as much of the sun's energy as they can. The plants turn (they do not run) and the herbivores run up to grab the armfuls. The carnivores and humans do the same. The humans run back to their starting spot and raise the remaining leaves high above their heads to signal that they are through. (Warning: the running cannot begin until the last exchange has been completed.)
■ Look around on the ground to see how much energy was lost in each transfer compared to the amount held by the last person at the finish point.

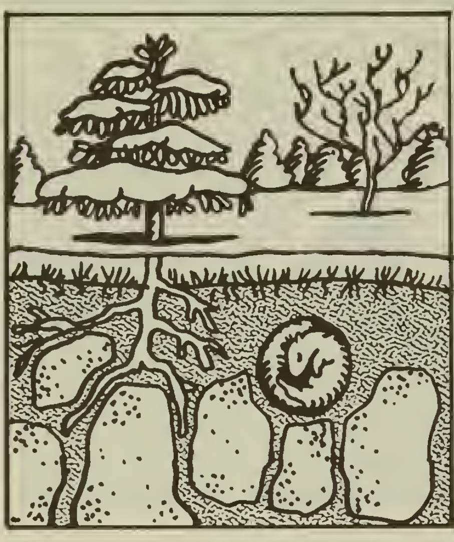
Notes

ACTIVITY
ENERGY BARGAINS

Energy bargains in the natural world are things which have high concentrations of energy and which are useful. The less energy invested in the use of something, the greater the bargain. We can't beat the Second Law of Thermodynamics, but we can learn more about how energy works in nature. Some of the bargains we can observe in nature may provide ideas for more sensible, efficient ways for people to use energy.

WHAT YOU NEED

■ Review "Energy Packages," "Take the Wrap," and the Second Law of Thermodynamics definition. You may combine these activities to make a full program.



■ Choose a trail you are familiar with and look for the ways that plants, animals, and people use the park. Consider the changes with the seasons.
■ Distribute hand lenses, paper, and pencils to everyone.

THE GO OF IT

■ Explain to the group that they will be acting as a team of bargain-hunters and efficiency experts while on the trail today. They will be looking for bargains among the forms of life and uses of energy around the park. Give them clues and connections as to how they may find similar bargains in their own homes or schoolyards.

■ Some examples: A thick blanket of snow provides insulation to the soil, seeds, and even animals below it. An apple tree has food energy in its fruit for birds, animals and people. Its wood is excellent for burning in fires and emits a pleasing odor. When the tree dies, it becomes a home for insects and decomposers. A compost heap is made up of "leftovers." Table-scraps from dinner, grass clippings, and raked leaves can be combined to make an excellent soil conditioner.
■ Take your regular walk, but allow people to find their own examples of bargains.

AND THEN

■ Use this as a follow-up to the "Energy Bargains" activity. You may want to reread the background information in Chapter Three on energy flow. Let's see what happens to our bargains with time.

■ Have chalk and chalkboard in an indoor room.

■ Ask the group to share their bargains and to look at the process of how energy changes matter from an orderly state to a disorderly state. Draw three vertical columns on the chalkboard, the first for the bargain item (leaf), the second for the energy force (sunlight for photosynthesis), the third for the end result (a discarded autumn leaf).

■ Divide the group into teams of fours. Each team picks out an example of the Second Law of Thermodynamics in action.

■ The team takes 10 minutes to plan a charade that acts out the changes made by energy transforming matter. The rest of the group guesses.

THE SECOND LAW

Energy has amazing power and flexibility but there are limits to what can be done with it. Each time energy is transformed, its ability to do work or cause change decreases. Although a given quantity of energy may be transformed many times, no chain of energy transformations can continue indefinitely. Because some is lost at each step, sooner or later there's no useable energy left.

MY ROOM IS RULED BY THE SECOND LAW

If you are looking for a way to explain how the Second Law of Thermodynamics works, try these ideas. Have children think about their bedrooms or their toy shelves. Adults can consider file cabinets, kitchen cupboards, car interiors, tool rooms, attics, brief cases.

Even though most people who use these things try to keep them neat, they often become messy. That's because there is a natural tendency towards disorder. The most committed housecleaner, the most compulsive tidier-upper still is frustrated by dust, rust, breakage, or the cat upsetting the motor oil. It takes human energy to keep up with the work and to resist the powerful urge to nag others about the disorder they are making or ignoring. The Second Law rules supreme. If you still doubt it, check the contents of your suitcase when you return from your vacation!

An Idea From Jack de Golia

Grand Teton National Park, Wy.

"THERE'S NO FREE LUNCH"

This excerpt from a slide show script is one interpreter's way of presenting the First and Second Laws of Thermodynamics.

"Energy, we say, 'comes' from our sun. Yet it's not really created there. Energy can neither be created nor destroyed. It can only be changed from one form to another. This is the First Law of Thermodynamics. A second law says energy tends toward its most random, diffused state. Everything hot cools off. Every use of energy costs some energy. There's no free lunch!

"Energy governs all living organisms, as rigidly as the stars and planets. Energy cannot be created nor destroyed, only changed. When it is changed, some energy escapes. For living things these two laws demand constant activity or growth, a constant search for energy. That search, of course, requires energy—a kind of Catch-22 if it weren't for living things cooperating by passing around the energy.

"Plants are able to capture a fraction of incoming solar energy. They pass on to animals that eat them a fraction of the energy they captured. Some of the energy a plant catches powers plant growth and day-to-day maintenance, and some gets stored. In all these uses, energy is lost to the plant (and the animal) as the plant changes light energy into chemical energy and heat energy. All living things give off heat—that's the price for using energy—and the heat radiates out, lost in space, as far as the plant is concerned. And so it goes with the animal that eats the plant and the animal that eats the animal that eats the plant, and so on down the line. Less and less energy remains available, more and more is lost for those waiting in the lunch line as chemical energy is used to power life and as heat energy is lost because of that use. There's no free lunch.

"For most of human time our energy needs for food, shelter, transportation, and warmth were simply met. Then, just a short while ago, humans discovered a source of stored solar energy that literally has exploded in our faces.

"We use this energy voraciously because it makes life easier. Coal, natural gas, and oil, the fossil remains of plants and animals which also sought energy to make life easier, now fuel new kinds of fires. The more we found, the faster we used it, until now we can look ahead 25 years to the possible end of the oil age, assuming we continue using it like it's going out of style. Nearly every part of human life is now dependent on fossil fuels. These fuels power our transportation and communication systems, and run complex networks of machinery in businesses and factories. They give us heat and light indoors and out, allowing us to stretch our working and playing hours well beyond sundown. Our world is filled with products and processes that have come about through our increasing knowledge of how to make energy do work for us. How often do we consider that it's made, moved, and packaged courtesy of a bunch of fossils who once ate sunshine?

"Our scale of energy use is unprecedented. And those two laws of thermodynamics are taking a heavy toll. The fossils are running out because the sun only made a few. What's the solution? No one knows for sure. It seems that we might stretch out our fossils a while if we use them more efficiently for the things they do best instead of for everything."

ACTIVITY
THE LAP GAME

From *The New Games Book,*
edited by Andrew Fluegelman

Here is a game from the masters of game design, The New Games people in California. You may want to rename it "Group Thermodynamics."

The Second Law of Thermodynamics can be expressed in terms of order and disorder. Scientists have observed that orderly arrangements of matter are less probable than random arrangements. Thus a natural tendency exists toward randomness unless energy is expended to create or maintain order. Concentrations of things tend to disperse unless we work to keep them together

Use a short statement such as the preceeding one before you play this game. After the game and a brief recovery period, ask the players to share their discoveries about how human energies work.

WHAT YOU NEED

■ This is for a large group and hundreds have played at a sitting. A cleared open grassy field, good weather, and an absence of mud are musts.

THE GO OF IT

■ Choose a few co-leaders and ask them to help you organize the group in a circle. Everyone stands in the circle, shoulder-to-shoulder. Now turn to the right. Then, very gently, everybody sits down on the knees or lap of the person behind them.

■ There are two ways to get into this position. The "slow and easy" method is to have one person lie on his or her back wth knees bent. The next person sits down, forming a nice chair for the next person to sit on, and on and on until the whole circle is seated. The crucial moment comes when the person on the ground is hoisted up onto the lap of the last person in the circle. And there you have it, a sitting circle.

■ The "fast and reckless" method is for the players to sit on their neighbor's lap at precisely the same moment. This is very impressive when it works and a spectacular flop when it doesn't.

■ Once comfortably seated, players may wave their arms, give the person in front of them a back rub, or even try a caterpillar merry-go-round. Next to tickling, that last suggestion is the surest way to end the game.

■ The "New Games" staff says that this game was originally called "Empress Eugenie's Circle," after the Austrian Empress's account of how her soldiers kept dry while resting in a wet field!

THE LIGHT AT THE END OF THE CAVE

At Carlsbad Caverns National Park in New Mexico, many visitors ask why there isn't more light in the cave. The reasons are an interpreter's dream. The use of more lights would not only require more energy, but the additional heat created could upset the delicate balance of life in the cave, allowing new organisms to move in. This very simple example can be used to illustrate that all energy use creates heat and other pollutants; using less reduces the impact. The number of people in the cave also makes a difference in the temperature.

—adapted from the "Lewis Report" to the National Park Service on energy interpretation, by Bill Lewis, Yellowstone National Park, Wy.

RECOMMENDED READING

Try a little light reading for yourself or a children's group. Dr. Seuss may not have intended it as such, but his book, *The Cat in the Hat Comes Back,* gives an imaginative rendering of the Second Law at work and at play.

An Idea From Patrick Smith

Cape Cod National Seashore, Mass.

PICK "UP" A CARD, ANY CARD

This activity has been used many times as part of the environmental education program at the Cape Cod National Seashore. By modifying the old practical joke of "52-pickup," children are exposed to the concept that it takes time and energy to create order.

You will need a paper bag, three-by-five cards numbered from one to 30 (a card for each player), a watch with a second hand. This can be played indoors or outside.

Show the group that the cards are in order by number. Remove the rubber band holding the cards together and replace them carefully in the bag. Choose a timekeeper and ask for a volunteer to play "Pick Up A Card, Any Card." Ask the volunteer to reach into the bag at the signal and toss the cards into the air, with the timekeeper recording how long it takes from the signal until the last card falls to the ground. Have someone act as a radio interviewer to ask the volunteer how he or she is feeling. What physiological signs does he or she show?

Ask the volunteer to pick up the cards and return them to their original order. Time this effort and interview again. Compare the amount of time it took to create disorder and to make order.

To continue working with this concept, divide the group into four teams and the cards into four packets, consecutively numbered. Suggest that there are many ways to do work and solve problems, using in this case brains and bodies.

Ask each team to spend five minutes planning the most efficient way to create order from chaos. Scatter the cards again without timing and then see how quickly they can be reassembled in the correct order. The entire team works together to discover a more efficient way of doing the task. Compare results and methods and decide if it was worth the effort and energy expended.

HOT STUFF—A COMPOST HEAP

Start and maintain a compost heap in a spot that's visible and accessible to visitors. Use it as a teaching tool to encourage them to learn about matter cycles, the components of rich, fertile soil, a gardening project, and for "Hot Stuff" production.

On a cold winter's day, turn your heap with a pitchfork as an extra part of your regular walk or talk. Notice the steam rising from this mass of organic material. Ask visitors to place their hands above the pile or use a thermometer. Why is the compost heap giving off heat? Where does it come from?

The process that is occurring is hard to observe. Try poking around in the heap with a stick and using a hand lens to view a few of the immense numbers of organisms at work there. By consuming and digesting the rich organic matter in the heap, the organisms release heat as a by-product. We can't feel the heat produced by one of these busy workers, but multiply that quantity by as many as 100 billion organisms per square foot and you've got hot stuff!

The compost pile can be used as a year-round interpretive tool. You might use it to nourish a small park garden. How about a "lunch" garden for park employees, planted with lettuce, tomatoes, carrots, etc.? Or if you work at a park with an historic theme, consider starting an historically accurate small herb or kitchen garden. Remember house plants like composted soil, too.

"Hot Stuff" can be a demonstration of how soil came to be. Have a few children rub rocks together and examine the results. Others can gather armfuls of leaves or hunt for ants, earthworms, etc. Toss lightly with compost and a bit of sand. Let the children put on their own earth-making demonstration to parents and visitors, using posters, musical accompaniment, drama. Happy digging!

ACTIVITY
THE FIRE-MAKER

This activity is for a campfire program. Portions of it could be used when you light a fire (for an evening program or in the stove or fireplace of the visitors center). Take the theme of a fire and emphasize the flow and dispersal of energy involved, giving it as broad an interpretation as you can. Embellish the program by building on your own interests: cultural anthropology, Indian legends, forestry.

WHAT YOU NEED

■ Have on hand the materials needed to light, fuel, and extinguish a fire.

THE GO OF IT

■ Begin the program with a commentary like this one:

■ "The ceremony of the campfire connects us to all peoples and the flow of time has a special relevance tonight. We are linked to survivors of a more primitive time by our appreciation and respect for fire. Left unattended, it can sweep through forests and cities, leaving destruction and death in its wake. Come too close and feel the sharp pain. We learn "hot, don't touch" as babies, yet fires draw us together. Early tribes used the fire area as a gathering place, to celebrate the seasons, the fertility of fields, the hunt, and changes in weather. This was the place for the making and sharing of myths and legends or the passing on from generation to generation of the oral history of a people, a heritage. By aspiring to understand the happenings in the natural world, people were drawn together for survival."

■ Here are some sample topics and activities that can be added to the program.

■ What is fire and what happens in the burning process? Use this question as you lay the fire. Pass around coals from the last campfire and samples of several kinds of wood.

■ Add some facts about the BTU-value for different kinds of wood, methods of forestry, drying and stacking wood, the problems of burning wood in densely settled areas (such as campgrounds), and air quality considerations.

■ There is carbon in all living tissue, in our bodies, in the flesh of the tree. By burning the wood we release chemical elements and the sun's stored energy. As the wood burns, the by-products emerge: heat, coals, ashes, and smoke.

■ Anthropologists have discovered the traces of charred wood in the remains of early communities. Can you imagine how fire was first used? What were the differences in the lives of cave men with the advent of fire? (Children in the group can role play these changes.)

■ Describe a time line to show the chain of productivity based on the use of fuels and fire. What are the links in the chain from the first flintstone to nuclear reactors?

■ In our own country, Indian tribes used fire to flush out game. The early settlers used wood as fuel until the mid-1800's, when U.S. forests became depleted in many regions. With the lack of available wood, we turned to peat, coal, and eventually oil, natural gas, and nuclear power. Ask actors to do quick skits (with a three-minute rehearsal) showing how these fuels are made available to us.

■ These different fuels have different value to us because their energy concentration and the pollution they produce vary. Just because we can heat ourselves by a wood fire with a minimum of effort and cost here in the park, does it mean we should heat our city homes with wood?

"This is the fire that will help the generations to come, if they use it in a sacred manner. But if they do not use it well, the fire will have the power to do them great harm."
—Sioux Indian saying

By the mystery of his intellect, itself a form of energy, man has created and learned to manipulate a world of machines whose heat, motion and light he can command at will by a switch, a lever, or a button. Yet he can do so without any understanding of the process involved.
—William H. Eddy, Jr., *Consider the Process of Living*

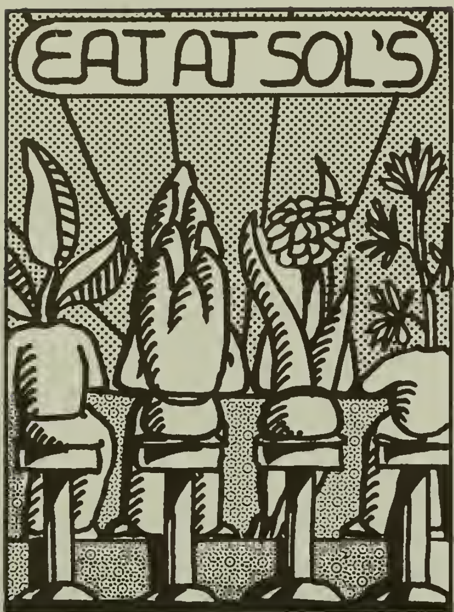
We have failed to see ourselves as part of a large and indivisible whole. We have failed to understand that the Earth does not belong to us, but we to the Earth.
—Rolph Edberg, *On the Shred of a Cloud*

EAT AT SOL'S 5

Plants convert the sun's energy into food which feeds virtually all of the Earth's creatures. The abundance of plants (and therefore animals) varies widely at different places on the Earth due to variation in sunlight and other environmental factors. People in industrial societies have learned to produce food in vast agricultural networks, but we are still dependent on plants to convert the sun's light energy into chemical energy in the things we eat.

"A living body is not a fixed thing, but a flowing event, like a flame or a whirlpool: the shape alone is stable for the substance is a stream of energy going in at one end and out at the other."
—Alan Watts, *Does It Matter*

BACKGROUND



Virtually all creatures on Earth eat at the sun's lunch counter.* The sun's partners, green plants, repackage some solar energy in the form of food. Through this process of photosynthesis, plants transform sunlight into sugar, a highly concentrated form of chemical energy.

The key to this transformation is chlorophyll, the pigment which makes plants green. All of the green parts of plants capture sunlight, but in plants that have leaves, most photosynthesis occurs there.

Photosynthesis involves a long and complex series of chemical reactions. Basically, plant chlorophyll uses the sun's energy to make sugar by combining water with carbon dioxide. A by-product of the process is oxygen, which is released into the air or water surrounding the plant. Thus, plants not only provide the food for nearly all other organisms but also contribute to their oxygen supply.

About one-half of the sunlight reaching the Earth's surface is in wavelengths which can be captured and transformed by plants. But only a portion of this amount actually strikes plant surfaces, and only five percent or less of that portion is converted into sugar. The plants use an average of 20 to 50 percent of the chemical energy for their own respiration and maintenance and they store the remainder. The amount stored is rarely more than one or two percent of the energy they originally receive.

This converted sunlight stored in the structure of plants is then available as food to plant-eating animals. When they eat plants their metabolic processes absorb the energy, using some of it for respiration and maintenance and storing some in new organic compounds in their flesh. This stored energy may later be food for meat-eating animals.

It is important to keep the Second Law of Thermodynamics in mind when considering food chains because some energy is always lost with each step in the chain; no energy transformation is 100 percent efficient. By the time these costs have taken their toll and the consumer organism has used some of the energy for its own respiration and maintenance, 80 to 90 percent of the energy has been released as heat. Thus, energy can be transferred in food chains a maximum of three or four times before its loss is complete.

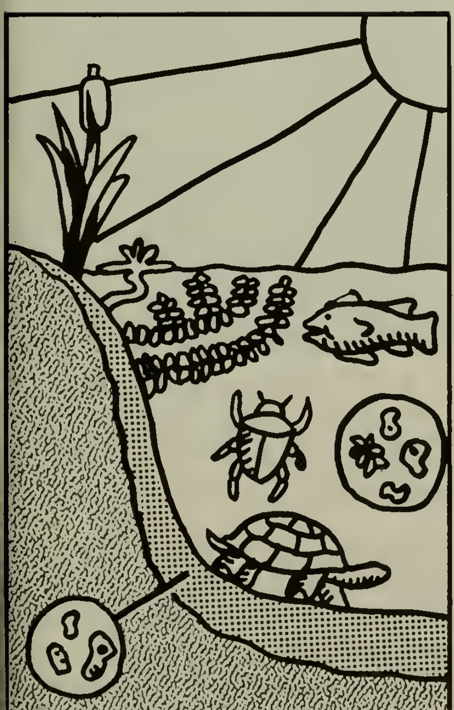
The number of plants and their productivity determine the quantity of energy (food) available to animals and, therefore, the number of

*There is an interesting exception. A few kinds of bacteria thrive solely on energy they release by oxidizing inorganic material. These so-called chemosynthetic bacteria are not dependent on the sun's energy for food.

"If all several hundred thousand leaves of a mature sugar maple could be spread out on a flat surface they would probably cover half an acre. During the course of a summer day a square yard of leaf surface manufactures somewhere in the neighborhood of one gram of sugar an hour, or a total of a pound and a half per month during June, July, and August, when the sun is at its brightest. That means that the mature sugar maple is capable of producing more than 3600 pounds of food—nearly two tons—in one summer season through the action of its leaves."—Richard Ketchum, *The Secret Life of the Forest*

animals which can exist. There is a dramatic difference in the capacity to support life among the Earth's many different kinds of ecosystems. The amount of sunlight reaching a given location depends on the angle of exposure to the sun (the tropics get more sunlight than the poles), geological features such as mountains which shade many areas, and climatic conditions such as the number of cloudy days. Life supporting capacity is also affected by variation in soil composition, temperature, rainfall, and other environmental conditions.

In general, the diversity of plants and animals is greatest in the tropics and decreases progressively in ecosystems toward the poles. Species of nesting birds have been estimated at 1395 in Colombia, with only 1100 in Panama, 143 in Florida, 118 in Newfoundland, and 56 in Greenland. The same decrease is observed in the diversity of mammals, fish, and trees.



But within this tropics-to-polar gradient many factors affect the diversity of plants and animals. The more physically and geographically varied an ecosystem, no matter where it is, the more species are likely to exist simply because there are more habitats. Life is also exceptionally abundant in ecosystems which receive regular energy and nutrient subsidies from other areas such as deltas, estuaries, upwelling zones in oceans, and tropical rain forests.

Water covers about 75 percent of the Earth's surface and the plants of the Earth's oceans, lakes, and other bodies of water account for most of the photosynthesis on the planet. Most water plants are tiny free-floating forms of algae which have no leaves, roots, or stems. Rooted plants play a minor role because light does not reach the bottom of most aquatic ecosystems.

Food factories on land are both more complex and more varied than aquatic food systems. This is due to differences in climate, soil composition, water supply, and the modifying effects of the organisms themselves.

About 350,000 different kinds of plants fill the nooks and crannies of the Earth's widely varying land and aquatic environments. The energy stored by these plants feeds the millions of species of animals, each of which has evolved to play a specific role in ecosystems. Each plant and animal has a job which includes a specific area to occupy and a way to obtain energy. Ecologists call this the organism's niche. Some have a broad job description such as some herbivores which eat many different kinds of plants or omnivores, which eat both meat and plants. Some are specialists and therefore much more vulnerable to disruptions in food supply.

> "Nature is, above all, profligate. Don't believe them when they tell you how economical and thrifty nature is, whose leaves return to the soil. Wouldn't it be cheaper to leave them on the tree in the first place? . . . Nature will try anything once. This is what the sign of the insects says. No form is too gruesome, no behavior too grotesque. If you're dealing with organic compounds, then let them combine. If it works, if it quickens, set it clacking in the grass; there's always room for one more; you ain't so handsome yourself."—Annie Dillard, *Pilgrim at Tinker Creek*

Sometimes two different organisms develop in different ecosystems to do essentially the same job. And often many different species do similar work in the same ecosystem but get their energy and nutrients in slightly different ways. However, no two species can permanently occupy precisely the same niche.

The ways in which people have modified their environment have drastically altered their niche on Earth. Pre-agricultural people survived by hunting for meat and gathering fruits and nuts, as well as the seeds of wild wheat, barley, rye grass, flax, and legumes. A nomadic lifestyle resulted from the need to follow game herds.

It is estimated that people first learned to cultivate plants and animals about 10,000 years ago—probably after someone observed that discarded seeds grew in areas where bare soil had been exposed. In order to obtain higher crop yields farmers learned to grow rows of a single crop. Methods were developed to drive off or kill other organisms which competed for the food.

These changes required increasing inputs of energy which came first in the form of human labor, later in the form of animal power, and finally, with large-scale use of fossil fuels, in the forms of machinery, pesticides, and fertilizers. Although altering natural cycles has meant higher agricultural productivity, these processes have also caused serious ecological disruption. The Second Law of Thermodynamics reminds us that the use of more energy inevitably increases the disorder in the system at large.

Perhaps the most important effect of agricultural advances in industrial societies has been to allow many people to forget their ties to natural ecosystems. Now that we can obtain all of our food at grocery stores which are supplied by vast centralized production, processing, packaging, and transportation systems, it's easy for people to forget that all of our food comes from the sun with help from plants.

An Idea From Josh Barkin

East Bay Regional Park, Oakland, Ca.

A BELLYFUL OF SUNSHINE

Josh Barkin, a veteran and master interpreter, includes energy "messages" in his programs because, says Josh, "energy causes nature to be beautiful, soft and delicate—always purposeful. No nature story would be complete without mention of energy. It is vital to how our world works and it is in everything I do and talk about."

Josh captivates visitors using a special combination of humor, personal knowledge of how things in nature work, and a touch of elfish magic. When he talks about nature, his eyes twinkle. He's also fond of mimicking the sounds of birds, bees, and the wind in trees.

"Our world of grasses, grains, flesh and flowers comes straight from the sun. The Ding-Dongs and Twinkies we eat come in a round-about way from the sun." Josh rubs a child's stomach while he talks about food and says, "you have a belly full of sunlight—Eat at Sol's."

He works with hand puppets, designed and sewn by his wife, Pearl, whom he describes as "the head on my shoulders." The puppets speak for themselves, telling the audience something about energy at work and relating energy concepts to conservation methods that we all can practice.

Thank you for this chapter title, Josh.

An Idea From Shelley Tyre

Schuylkill Valley Nature Center, Philadelphia, Pa.

"THE GREEN SEEN"

The "Green Seen" can be done as a demonstration or in small groups. Seeing may help the disbelievers, and this experiment is fun and informative.

You can have a closer look at chlorophyll. Take a handful of grass and put it in a small bowl. Add about five ounces of alcohol. Mash up the grass with a mortar and pestle or a small rock. (The alcohol will change the grass to a bright green paste.) Cut a strip of paper towel or filter paper and hold it upright so that one end is in the alcohol mixture. After a short time the moisture will "climb" the paper. Now you should be able to see two kinds of chlorophyll: one blue-green, the other yellow-green. You may also see another pigment from the grass, the orange carotenoids. Relate the pigment in the grass to that found in our skin.

What you see is chlorophyll, the link between the sun and life on Earth. With sunlight, the cells that contain chlorophyll change carbon dioxide and chemicals into sugars, the food stuffs necessary for plant growth, and give off oxygen.

ACTIVITY
THE BIG SQUEEZE

Thanks to Nancy Scribner,
Montgomery County Schools,
Chevy Chase, Md.

This is a movement game for children from pre-school through sixth grade. It is designed especially to heighten the children's awareness of the vast quantities of energy required to produce food with large-scale agricultural-marketing practices. By "being" or acting out some of the processes, the children can begin to get a sense of the concept of net energy.

WHAT YOU NEED

■ Choose an inside space large enough for the group to move around freely. Use the list of energy steps from "The Fuel-Food Web," in this chapter and a chalkboard. Gather together some materials—paste, a large sheet of butcher paper, a small drum or tambourine, and a collection of old magazines with pictures.

THE GO OF IT

■ Help yourselves to a tomato for inspiration. Eat it with your eyes closed. Write as many descriptive words on the chalkboard as you can. How does the tomato look, smell, feel, taste? Take the list of energy steps from "The Fuel-Food Web" and review them, brainstorming with the group for action words or clues that describe how the tomato is changed.

■ Have a rehearsal, acting out the steps with the whole group. In a circle, ask what would be a good motion for planting the seeds. Everyone should try it. Ask what sounds could go with the motion and try them, one at a time. After all steps have been acted out by everyone, choose a person for each step and one to be the tomato.

■ Use the percussion instrument to signal the beginning of the process. Rehearse four soft, slow beats for each step, so that the children can plan and pace their movements. Remind the group that tomatoes bruise easily. The tomato person passes around the circle from person to person, process-step to process-step, until the last person gives the tomato a *Big Squeeze*!

■ For a closing (and quieting down) activity, have the children draw or cut pictures from magazines that show something about the step they represented. Put the drawings together in a collage, arranged and glued onto a large sheet of backing paper cut in the shape of a tomato. This can be done in a free-form manner or sequentially.

■ Or take a trip to a catsup (juice, etc.) factory to observe the processing, cooking, and packaging of the tomatoes.

■ Make catsup in the classroom and taste it.

An Idea From Paul Stetzer

Schuylkill Valley Nature Center, Philadelphia, Pa.

THERE'S NO SUCH THING AS A FREE LUNCH

This activity has been used in a program for teachers of all grade levels who participated in a one-week three-credit graduate course, as well as with students from fifth grade up. The site was a relatively open area.

Each person gets a card. All but three have "Green Plant" written on them; two cards read "Moose" and the last card says "Wolf." The green plants sit in a circle, and each is given 10 energy units (10 peanuts, sunflower seeds, or candies). This group brainstorms ways the plants use energy, such as growth, maintenance, repair, reproduction, and manufacture of hormones, enzymes, and proteins as they eat nine of their units. The "Green Plants" hold the last unit in their hand at shoulder level. The two "Moose" now compete, running around the outside of the circle and grabbing as many of these energy units as possible. Everyone helps the moose think of ways they use energy, and then each moose eats all the goodies except one. The person whose card says "Wolf" catches the moose in a game of tag, and captures the last two energy units. The brainstorming is repeated, and the wolf feasts on the plunder. With about 25 participants, the arithmetic works out like this: 220 energy units to the green plants, 22 units to the moose, and two units to the wolf. This activity illustrates that approximately 90 percent of the energy is lost at each step from lower to higher trophic level.

Here are some questions to explore: As the wolf is eating the last two goodies, ask the wolf and moose how they feel. Are they huffing and puffing? Was it worth the effort? Compare the amounts of work they did and the units of energy they received with the plants.

There's no free lunch!

PROTEIN FACTORIES

"Cattle and other meat-producing animals once served a valuable function for people. Because they can convert plant materials which human beings cannot eat (grasses, corn stalks, garbage) into protein which people can eat (meat), they were valuable "protein factories." Today however, cattle, hogs, and chickens eat corn, soybeans (over 90 percent of the U.S. soybean crop is fed to animals) and other grains. These animals no longer graze or rummage around the farmyard for food. Instead, they are kept in huge enclosures and are fed until they reach marketing weight. According to Frances Moore Lappé, author of *Diet For a Small Planet,* only about one-tenth of this plant energy they eat is returned to humans in the form of edible protein.

—Catherine Lerza *Energy Ideas for Parks,* Issue #5, Park Project on Energy Interpretation

AN INDUSTRIAL PARK

During a workshop at Huron-Clinton Park, Tom Smith reported that an "industrial park" was operating at full production directly inside the boundary of the metropark itself.

The park was a small tree which revealed its industrial character with but a small stretch of the imagination. Growing beside the nature trail, the "industrial park" was busily producing carbohydrate fuel to power itself and feed others and emitting oxygen to support consumer groups operating in, around, and near the park. The tree's leaves were its production machinery, converting sunlight to starches; its veins and cells, the transportation network. Tom explained that the industrial plant had a highly evolved assembly line and employed many workers, all of whom had specialized functions and tasks. Tom invited us to return in the fall to taste some of the "plant's" products, which would then be available for distribution and marketing. Winter is a slow season for the operation of this particular industrial park, so many employees seek work elsewhere and the "plant" is maintained by a skeleton staff. The park was funded by an investment firm, Sun, Air, Water, and Soil, Inc., with seed money deposited and squirreled away by a furry anonymous friend.

FOOD FOR THOUGHT

Imagine a science fiction situation where all life on Earth is destroyed except for one group of organisms. Ask which group could survive the longest without the support of any other living things.

What would happen if all plants derived the energy to produce their food from some non-renewable material on Earth other than the sun?

— By Helen Ross Russell

An Idea From Sandi Whitehead

Everglades National Park, Fla.

ENERGY RIDDLES

Sandi plays the following game with school-aged children after a walk in the Everglades!

Prepare 16 energy riddles. Allow four to six students to a team. The teams compete to see who can answer the riddles the fastest and who can get the greatest number of correct answers. Each team is given a deck of cards (reproduce the riddles and cut on lines to make cards).

The deck includes the 16 riddles and the 16 answers to the riddles. Give the signal and the students attempt to match the riddle with the answer. The team which finishes first gets two points. A team then gets one point for each riddle answered correctly. Each team must be checked and the points tallied. The team with the greatest number of points wins.

Or, ask the teams to make up their own riddles and limericks after showing them some examples. The teams can pair up to guess the answers, with a time limit to heighten the competition.

From the sun I get energy
To grow and live;
From the sun I make food
My gift to give.
What am I?
[green plants]

Mosquito eats plants,
Little fish eats mosquito,
Big fish eats little fish,
Bird eats big fish,
Alligator eats bird,
Vulture eats dead alligator,
Mushroom turns it back to earth,
And a plant is given birth.
What am I?
[food chain]

Notes

ACTIVITY
DIVERSITY IS THE SPICE OF LIFE

This activity is simply an observation experience. You can use it as an introduction to many concepts, such as interdependency, the presence of energy in our surrounding, and niches. Build on it by adding creative arts projects, science fiction ideas, or further study of insects and plants that energize your park.

■ The following story comes from *The Living Earth,* by Peter Farb, published by Harper-Colophon, a book full of excitement about the life cycles of the soil.

■ "One of the first modern naturalists to be intrigued by soil life was Dr. William Beebe of the New York Zoological Society

... While he was on a bird-collecting expedition to Belem, Brazil, over 40 years ago, it occurred to Dr. Beebe that the soil he had tramped on every day, while his eyes were aimed at the treetops, might also hold something of interest. So, just before heading downstream to board his steamer, he dumped handfuls of jungle earth, mold, and decaying leaves into an old bag.

■ "A few days later, on the high seas en route back to New York, he began examining with a magnifying glass this thin veneer from the jungle floor. What he thought would be a shipboard diversion became a mighty labor. For the jungle soil was indeed alive, with ants, termites, beetles, scorpions and false scorpions, worms of every sort, springtails—all visible to the naked eye. With his magnifying lens, he discovered more organisms, each one hugging its grain of soil. Day after day he pored through the litter, drawn into its secret world:

■ *'Contracting the field of vision to this world where leaves were fields and fungi loomed as forests; competition, the tragedies, the mystery lessen not at all. Minute seeds mimicked small beetles in shape and in exquisite tracery of patterns; small beetles curled up and to the eye became minute seeds of beautiful design. Bits of bark simulated insects, a patch of fungus seemed a worm, and in their turn insects and worms became transmitted optically into immobile vegetation ... When we had worked with the lens for many minutes, all relative comparisons with the surrounding world were lost. Instead of looking down from on high, a being apart, with titanic brush of bristles ready to capture the fiercest of these jungle creatures, I, like Alice in Wonderland, felt myself growing smaller, becoming an onlooker, perhaps hiding behind a tiny leaf or twig.'*—From *Zoologica,* 1916

■ "When his vessel reached New York City, Dr. Beebe had not yet completed his examination of the jungle soil. From this section of the tropics, four square feet in area, he had collected over 500 specimens, and calculated that at least twice that number remained. In fact, Dr. Beebe concluded, at least 1000 organisms visible to the naked eye were sheltered in this bit of jungle earth."

WHAT YOU NEED

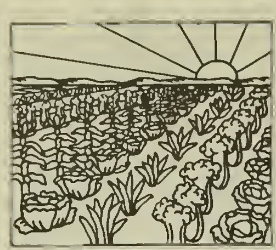
■ Pass out hand lenses, paper, and pencils to everyone. Give each person a five-foot length of string. Distribute the story, xeroxed, folded in half, and taped, and explain it's not to be opened until the signal is given.

THE GO OF IT

■ The players choose a spot that interests them. They will have 20 minutes to study the "spice of life." They lay out the string in a line or a circle and get comfortably positioned. At the signal, they read the story. The players use the hand lenses to explore the spice of life in this place. They count, categorize, sketch, observe, or just enjoy watching the plants and animals living there. Ask them to see if they can discover any of the links in the decomposer food chains. They may also look for ways that materials are being cycled.

Diversity represents stability and strength in nature, but monoculture means vulnerability. Here is an example:

A city in the midwest recently discovered that most of the elm trees lining the city streets and shading park lands had become infested with Dutch Elm Disease. A massive tree removal program took place in the fall and replanting began the following spring. Beside each stump the city park department planted a new tree, but they repeated the same mistake—they planted all sweet gums!

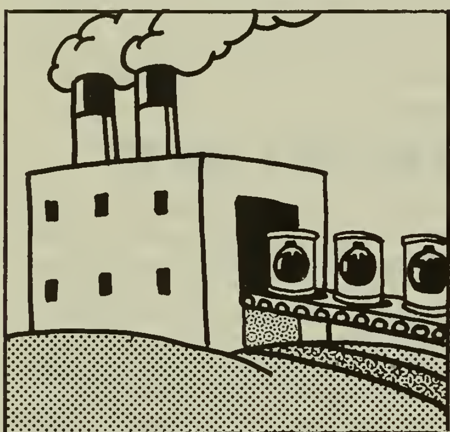


ACTIVITY
FUEL-FOOD WEB

This activity compares the energy expenditure of home gardening to that of large-scale commercial farming.

WHAT YOU NEED

■ This sequence of ideas is designed for an environmental education program or for a classroom.



■ Play the game with a small group or divide a larger group into competing teams. Keep the time limited so that the players will complete the steps quickly—10 to 15 minutes. Each team can select a recorder who will present the results to the whole group. Have a large enough space for teams to work without interrupting each other. Supply pencils and paper, copies of the resource sheet, a chalkboard or a large sheet of paper, cherry tomatoes, seeds, recycled cups, water, and soil.

THE GO OF IT

■ "The sun helps make the tomato. If we stoop over and pluck the ripe fruit, we come close to the life-giving energy of the sun. Instead, someone else grows the tomato, speeding along the growth process with fossil fuel fertilizer. Then a machine, which uses fossils, too, harvests the tomato. Then another machine carries the tomato to storage, which costs more energy. By the time the tomato gets to market, packaged and hauled by the fossils, more energy has gone into getting the tomato to our mouths than we get by eating it. The *net energy* is less than zero."—"There's No Free Lunch," a slide show by Jack de Golia

PART I

■ Ask the teams to brainstorm and list all the steps involved in taking a tomato from seed to table, from your own garden, and from large-scale produce farming. Compare the results with the resource sheet. Visit a vegetable canning plant or frozen foods company to witness some of the steps.

PART II

■ Review all these steps for both ways of growing tomatoes using brainstorming techniques and small group discussion. Look for numbers of people and machines involved and for the types of fuel that might be used at each step, such as transportation, refrigeration, etc. Be sure you give sun, air, soil, human energy, and water full credit! Compare the two lists.

■ Serve a snack of cherry tomatoes and plant a seed or two. (See the "Container Gardens" activity in this chapter.)

PART III

■ How can we eliminate some of the steps? If you have a pick-your-own farm nearby, organize a field trip to visit it. What happens to your list of steps when the potential buyer goes to the field to "pluck the ripe fruit?" How far did you have to drive round-trip to the farm?

PART IV

■ For an ambitious group project, try preserving the tomatoes. Keep track of the amount of time that the stove is working; the cost of lids, jars, and ingredients; money spent; and your hours of labor. At what price would you be willing to sell your tomatoes? Would you save and store your tomatoes for later on, or would you try to sell them, or give them away?

■ "The Big Squeeze " in this chapter, is a good follow-up activity to any of these.

ENERGY STEPS RESOURCE SHEET

Most people now eat frozen or canned vegetables instead of fresh ones, even in the summer. Here is a list of the energy steps involved when we obtain and prepare frozen vegetables. How many steps can you save by eating fresh vegetables?

1. **someone else grows a vegetable**
2. **it is transported to a processing plant**
3. **it is sliced by machine**
4. **it is packaged**
5. **it is frozen**
6. **a refrigerated truck takes it to market**
7. **market keeps it frozen**
8. **you drive to market to buy it**
9. **you take it home and put it in freezer**
10. **you thaw it and cook it**
11. **you throw away package**
12. **you eat it**

ACTIVITY
A NUTRITION WORKSHOP

We eat to sustain ourselves and to get the energy to do work. Many people are interested in improving their diet, not just to lose weight or save money, but to get the most nutritional value from food. The reward is often healthier bodies as well as the satisfaction of knowing we are using a smaller slice of the world's natural resources.

WHAT YOU NEED

- Locate a dietician or doctor who is willing to co-lead or plan the session. Try your medical center, school, or hospital or check with your local Cooperative Extension Service.
- Start your own annotated bibliography (see our bibliography for ideas). You can use it as a workshop handout and add to it later as you use more cookbooks and references.
- Send out invitations or announcements giving a general outline of activities and suggested readings, a list of what to bring, and appropriate clothing.
- This schedule is for a half-day workshop and more activities can be added.

THE GO OF IT

- Have handout materials and relevant posters on display. Start the session in a circle with group introductions and brief statements from everyone about what they hope to learn from the day's activities.
- Encourage your guest co-leader to use a slide show, movie, or some other visual way to introduce the topics to be covered. Some small group discussion can follow. Prepare an outline of the materials you want to cover so the groups all end up in approximately the same place.
- Go outside for a brisk walk along the trail to look at the sun's lunch counter. Look for photosynthesis at work, signs of food chains, and producer-consumer-decomposer groupings. You might also do a short version of "The Sun Worship Ceremony" from Chapter One as a closing activity before going indoors.
- The group can also play a food chain game such as "There's No Such Thing as a Free Lunch," in this chapter, or design an activity with your resource person about the nutritional components of basic foodstuffs. Consider natural packaging and processing and review "Take the Wrap" from Chapter Two.
- Now is the time for a real lunch. George Tokiedas, a science teacher in the New York City Schools, suggests this menu: Mix your own salad of par-boiled green beans, tuna, diced cheese, green peppers, tomatoes, and sprouts with lemon juice and salad oil. Fill pockets of Syrian bread with salad (no plates needed). Serve with cider and tea. For dessert try a snack of peanut butter, honey, raisins, and dry milk, from *Diet For A Small Planet,* by Frances Lappé.
- Return to the circle to digest lunch and to talk over the morning's activities. Encourage the group to plan a follow-up session or some other means of communicating, such as a round-robin letter to collect tried and true recipes; a potluck dinner one month later; or plans for leading similar sessions for church, community, or school groups, with the park and staff acting as hosts and resource people.

CONTAINER GARDENS

It's possible to grow your own food in an urban setting in areas with restricted use without having a big yard and rich top soil. Use recycled containers, potting soil and compost, specially-bred seeds, and your own planning and energy. Containers can be made from barrels, rubber tires, oil drums, scrap wood, and even plastic bleach bottles. Four to six hours of direct sunlight, proper watering and drainage, and protection from winds are the basic ingredients you need. You can have the pleasure of watching things grow, helping that process—and you get the fresh taste of home-grown vegetables. Container gardens are practical for use in parks and are good vehicles for agricultural interpretation in urban settings. Put them on casters and you can roll them indoors at night or they can be left out on a balcony or porch. Use compost from your composting heap made from lunch leftovers, grass clippings, raked leaves, etc. It takes energy to get energy, so roll up your sleeves and happy gardening!

Franziska Hecht from National Capital Parks, National Park Service, in Washington, D.C., has prepared a list of good books and articles for learning about container and other kinds of gardening.(See Resources for recommended reading.)

An Idea From Page Hartley and Bill Edgar

Schuylkill Valley Nature Center,
Philadelphia, Pa.

ENERGY FLOWS DOWN ON THE FARM

The Manatawna Farm of the Schuylkill Valley Nature Center offers visitors a chance to discover the natural world of a working farm. Children are encouraged to look beyond the animals and machines to see the farm as a complete unit; a network of interplay between the plants, animals, and people there.

As soon as the children arrive, they are invited to pick an ear of corn (when the season allows) or dip into the corn crib. Some of them grind the corn by hand using muscle energy and feed the grain to the chickens. If any hens have been productive that day the children can take a look at the fresh eggs. They are asked to think about the last time they ate fried chicken, where it came from, and how much energy went into the steps from the egg to the table. Where do the wastes from the meal go? The Schuylkill River flows by the farm and there is a landfill project to visit on the outskirts of the city. Energy flows only one way, dispersing as it goes.

The children see a non-stop cycle at work as they focus on how materials travel, moved by energy. After feeding corn to the chickens, they shovel chicken manure onto the corn for fertilizer and discuss what the soil is composed of and how the manure adds richness and nutrients so that the corn will continue to produce. On the field trip they are encouraged to ask and discover the answers to these questions:

How are the basic needs of the crops growing at the farm met? How does the farmer supplement nature's efforts? What foods do the animals eat? If we draw a food chain, how many links are necessary to connect the animal to the plant source?

What kinds of fuels are required to run and maintain the machinery? Where do those fuels come from and how? (Trace their connections to the sun.)

What kinds of human and fossil fuel energy are required to run and maintain the shelters and storage units for food stuffs, animals, and people living here?

What products are possible from crops, animals, machinery, the farm staff?

What forms do they take? Are they sold for cash, or exchanged in a bartering system? Where do the products go? (Out to the public or used again on the farm?)

The plants, animals, and people of Manatawna Farm Eat At Sol's.

Your park may be able to arrange visits to a local farm for occasional field trips.

ENERGY PUPPETS

An adaptation from the script of an energy puppet show given at Hidden Oaks Nature Center, Fairfax County Park, Va. by Susan Allen.

Kernel Corn and Energy Ant provide an opportunity to question our heavily subsidized fossil-fuel agriculture.

Kernel: "The Indians taught the Pilgrims to grow and make good use of this special and tasty energy package; me! I had much smaller kernels in those days because I wasn't as fancy as I am today."

Energy Ant: "And now you're so important that we grow acres and acres of nothing *but* corn. Corn—as far as the eye can see!"

Kernel: "The folks in this country sure have made changes since the old pioneer days."

Energy Ant: "Did you ever think, Kernel, that in nature there is no such thing as a single plant growing in such abundance?"

Kernel: "Well, I do know that when grown in that manner folks have to put out plenty of energy to protect me from natural predators. Phew! Fertilizers, herbicides, pesticides; you name it. And then there's fuel for tractors and harvesters and I don't know what all. They've got those big machines running all over the place! I don't have enough energy myself to pay for all the fuel bills!"

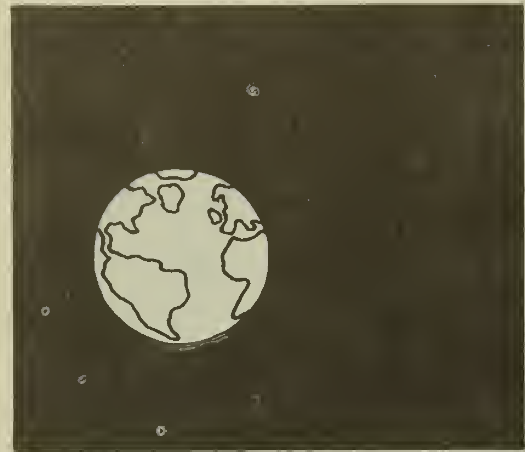
Energy Ant: "That's a thought, who *does* pay the bills?"

Curtain. A discussion follows.


25¢
75¢

LIMITS

6



Because the Earth has a finite supply of energy and other resources necessary for life, there is a limit to the number of living things it can support. The mechanisms which control resource use and population size in nature are not fully understood. One factor which enables many species to adjust to limited resources and changing environmental conditions is the ability to modify their behavior or physiology over successive generations.

"The forest community may provide a certain amount of coal, or lumber, or natural water storage or a hundred-hundred other commodities, but man can only take so much before endangering the source of that supply itself. (How simple the conclusion; how imperceptive the players.)"
—Steve Van Matre, *Acclimatizing*


15¢
LB

BACKGROUND

Each living creature on this planet requires energy, chemical nutrients, and water to survive. Since the quantity of all of these things is finite, there is a definite limit to the number of organisms which can be supported. This is called the carrying capacity of an ecosystem. There is no escaping these limits, even for people.

The concept of "limiting factors" was first described by the German chemist Justus Liebig in 1840. He found that the growth of plants was often limited by insufficient supply of a single essential chemical element. Subsequent discoveries revealed that receiving too much of the things needed for an organism's growth, as well as too little, can be a limiting factor. Plants and animals can live and reproduce only within a certain range of tolerance, which varies from species to species.

But how, with so many different species living in ecosystems, are energy and nutrients distributed? Why don't the bigger and stronger species take everything? Little is known about the things which affect relationships between species in ecosystems. It is one of the dark corners of ecological science because it is so difficult to study the complicated webs in which the millions of different species interact with one another and their environment.

Since all organisms compete for limited resources and virtually all, except plants, eat other organisms to obtain energy, many different kinds of living things interact with one another. But there is also a remarkable degree of separation.

Communities tend to be highly stratified and zoned, with different species living, eating, and breeding in specific locations. These spacing and grouping mechanisms are directly related to the supply of energy, chemical nutrients, moisture, shelter, and other needs.

For example, a forest community is often stratified into an herb level close to the ground, a shrub level a few feet higher, a layer of young trees in the middle, and a canopy of large trees above. Different insects and animals live at each level and may interact little although they live in close proximity. Even among similar species, rigid stratification is often found. In New England evergreen forests, three different but very similar species of warblers feed at three distinct levels in the same trees and rarely enter one another's territories.

Other factors such as varying activity patterns make it possible for more than one species to occupy the same space. Owls, for example, are the nighttime equivalent of hawks, filling the same niche and using similar sources of energy.

> "So important is man's role becoming as 'a mighty geological agent' that Vernadsky has suggested that we think of the 'noosphere' (from Greek noos, mind), or the world dominated by the mind of man, as gradually replacing the biosphere, the naturally evolving world which has existed for billions of years. This is dangerous philosophy because it is based on the assumption that mankind is now not only wise enough to understand the results of all his actions but is also capable of surviving in a completely artificial environment."
> —Eugene Odum, *Fundamentals of Ecology*

But no matter how thoroughly nature fills the spaces in ecosystems and utilizes the available energy supply, controls on populations are necessary. All species tend to expand their numbers and use of space, given the opportunity. Competition results and the most successful competitors are the most likely to survive.

Many ecologists now believe that internal mechanisms are also a factor in controlling populations. Experiments have shown that high population density can cause reduced resistance to parasites and that stress from overcrowding can reduce births and cause premature deaths.

Many species, especially higher animals, tend to stabilize their numbers at a level below the carrying capacity of an ecosystem. Their density fluctuates but tends to remain near the equilibrium point until environmental conditions change. By maintaining their numbers near this equilibrium level, species are more protected from drastic population booms and busts due to environmental fluctuations.

Is this the way nature would do it?

The average American baby born in 1973 will require:
26 million gallons of water
52 tons of iron and steel
1,200 barrels of petroleum
13,000 pounds of paper
21,000 gallons of gasoline
50 tons of food
10,000 pounds of fertilizer

and will discard in his or her lifetime:
10,000 no-return bottles
17,500 cans
27,000 bottle caps
2.3 automobiles
126 tons of garbage
9.8 tons of particulate air pollution

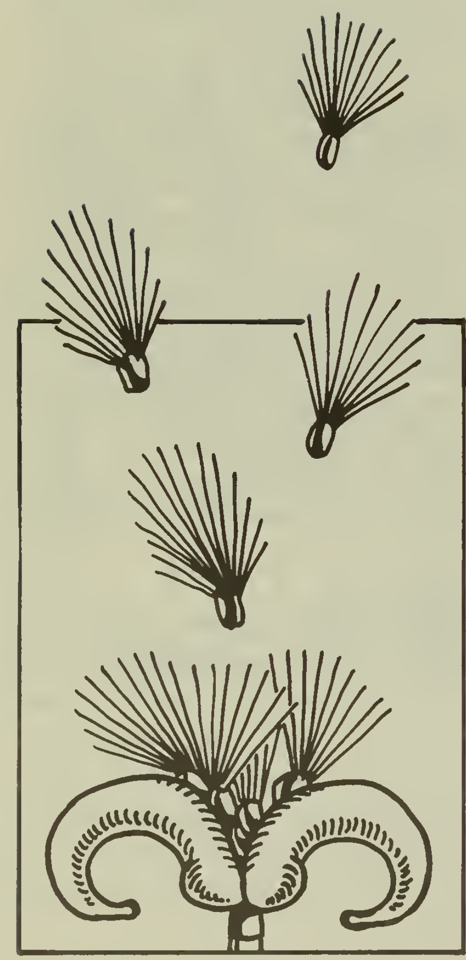
—G. Tyler Miller Jr., *Living in the Environment*

When a population control mechanism is related to the number of individuals of a species, it is called density-dependent. Although the subject is a controversial one, a majority of experts now believes that such density-dependent factors as competition, predation, and self-regulating mechanisms are the primary limiting factors for most species. However, among less-advanced, short-lived species such as microorganisms, many single-celled plants, and many insects, density-independent factors such as temperature and moisture may be the dominant factors.

While competition for energy and other needs is the rule among species and among individuals in the same species, cooperation is also common in nature. Some insects and many higher animals colonize or join together in family groups or larger packs. Such social units often impose a social order on the relationships among individuals which is significant from an energy standpoint. This social order minimizes the time and energy used in fighting with one another for food, space, shelter, dominance, and mating privileges.

Living things are not entirely helpless when subjected to changes in energy flow and environmental conditions. They are often capable of adapting their behavior and physiology in successive generations to better cope with new circumstances.

> "We did not think of the great open plains, the beautiful rolling hills, and winding streams with tangled growth, as 'wild.' Only to the white man was nature a 'wilderness' and only to him was the land 'infested' with 'wild' animals and 'savage' people. To us it was tame. Earth was bountiful and we were surrounded with the blessings of the Great Mystery. Not until the hairy man from the east came and with brutal frenzy heaped injustices upon us and the families we loved was it 'wild' for us. When the very animals of the forest began fleeing from his approach, then it was that for us the 'Wild West' began."
> —Chief Luther Standing Bear of the Oglala band of Sioux



Physiological adaptations occur through the evolution of the species over many successive generations. A species' lifespan and the duration of its reproductive cycle are important determinants of how fast these adaptations can occur. Fast reproducers like bacteria may adapt to environmental changes in a few hours or days. But longer-living creatures like people may take millions of years to make major changes.

Organisms not only adapt to physical conditions, but also modify their environment—often to make it more suitable to their needs. For example, one type of desert chaparal shrub invests some energy to produce a germination inhibitor which stunts or eliminates the growth of nearby herbs which would compete with the chaparal for water. A mature forest whose canopy screens out nearly all sunlight is a dramatic example of organisms changing their environment.

Communities and ecosystems grow and evolve in ways similar in many respects to the development of organisms. Ecosystems grow and age in stages called succession. These changes occur continuously in nature and cause fundamental changes in the amount of energy the community can harness and how the energy is used.

In the early stages of succession, growth is rapid. Food webs are simple, involving relatively few plants and animals with broad niches. Change comes quickly compared to older communities. Later stages of succession are characterized by the slower growth of the accumulating biomass. A higher degree of stratification and zonation in the community creates many microclimates and a much greater diversity of species. Complicated food webs are formed by the many highly-specialized species. This diversity makes the community much more stable than one with the same number of individuals in fewer species because it is less vulnerable to disease and disruptions in food supply.

Each succeeding community tends to modify the environment in ways which prepare it for the next, more complicated community. Eventually the environment is better suited to the successors, which gradually take over.

These changes have a purpose; ecosystems naturally evolve in a succession of communities until a relative equilibrium with the physical environment is achieved. This equilibrium affords the ecosystem maximum protection from fluctuating supplies of energy and nutrients by maximizing their storage in the ecosystem.

As succession proceeds, a basic change gradually occurs in energy flow because less of the available energy can be used for growth; the increasing biomass of the community requires that more and more energy be used to maintain the structure. Eventually, nearly all of the available energy may be devoted to maintenance, resulting in a relatively stable community which may be self-perpetuating for hundreds of years. However, disruption from natural causes or human activities usually prevents such long-term stability.

These concepts are of great significance to people. It is easy to forget that the urban ecosystems, where most people in our society live, are also part of the biosphere. Even though machines and global transportation networks make our communities much less subject to local limits, our population and use of resources are still limited by the finite carrying capacity of the Earth. And these limits are increasingly evident. The era of cheap and abundant supplies of fossil fuels and most metals has ended. Food and water are also in increasingly short supply.

The economic systems of our industrial society are now dependent on growth, which cannot continue indefinitely. Our continuing success as a species depends on our ability to perceive the limited supply of energy and other resources on Earth and to modify our behavior accordingly.

"... As Rene Dubos reminds us, 'trend is not destiny.' We can say no! Biological evolution takes millions of years, but cultural change can occur rapidly . . . Possible futures based on extrapolation of present trends will probably occur only if we give up in despair and assume they are inevitable."—G. Tyler Miller, Jr., *Living in the Environment*

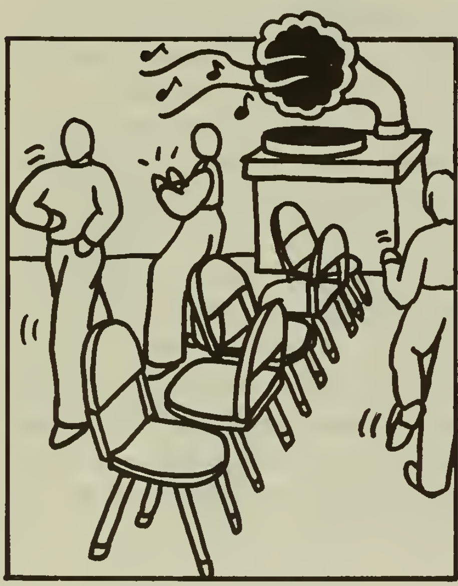
ACTIVITY
MUSICAL CHAIRS

Adapted by Lee Stephenson

An old faithful, this game has been revised to illustrate how limited resources affect us. Using a familiar format like this gets a group warmed up quickly and saves time and energy that otherwise would be used to explain the rules.

WHAT YOU NEED

You will need sturdy chairs, a record player, music (try Tom Glazer's Energy Songs), an extension cord, shirt cardboards or recycled file folders (9 by 12 approximately)—one for each chair, enough file cards for everyone, magic markers, and packages of lifesavers.



THE GO OF IT

PART I

■ All players carry a chair to form a line with the chairs facing opposite directions in the middle of the room.

■ To rehearse your group, start by listening to the music, clapping to the beat. Everyone walks around the line of chairs, keeping time with the music.

■ The record player is at the end of the line. As the leader stops the music, everyone sits down. The leader asks the group if there were enough chairs for everyone. "It *seems* as though there is enough to go around—enough energy, enough natural resources, enough places for everyone. How is it *really*?" Not waiting for a response, the leader begins playing the music, removing an end chair and sitting on it. The game continues with one person left out each time.

PART II

■ Give the game a new twist by passing out file cards labeled with the name of a kind of plant, animal, or person. The players keep their new identities secret. The leader places a large card over the back of each chair. On each card is an example of limiting factors such as floods, forest fires, parasites, etc. The game is played again, and as the players are eliminated they briefly reveal their identities and tell what happened to them. They remove a chair and form a rhythm section or audience. The last survivor gets a package of lifesavers and a round of applause. The winner may share them, save them, or eat them all, but there should be enough for everyone.

PART III

■ Ask each person to take a card from a chair. Brainstorm for the names of things they think people *need* to live. Have the players copy one of these needs on the blank side of their card and hang it around their necks, with the new word showing. Reassemble the chairs in a row (reminding the group that it takes energy to make energy). Play the game again. With the exclusion of each person (or need) ask the group to vote yes or no to determine whether they as a group or community can live without that "need." If the majority says no, ask them to swap, to trade places with a less vital need. It may be a short game!

ENVIRONMENTAL LIVING—A PROGRAM OF THE NATIONAL PARK SERVICE

The Environmental Living Program is an exciting way to develop children's awareness of how people lived during other periods of history in the United States. By using living and working spaces within existing historic sites and buildings, the children, teachers, and park staff gain a deeper appreciation of times gone by. There is a lot of planning and pre-visit thinking involved for everyone, but the results are worth it.

The school children are first visited by a park interpreter or historian loaded down with a "bag of tricks"—an assortment of props chosen to arouse the children's curiosity about the place, the period of history, and the program. If the site is a Civil War fort, the bag might hold personal belongings of a typical soldier of that era: clothing, tools, coins, etc. Much of the response to the program depends on the teacher, who works closely with the park staff and receives advanced training in an on-site workshop. The one day, overnight, or weekend visit is planned to correlate with existing classroom studies in social sciences, math, literature, and creative arts.

The program offers an excellent vantage point for a closer look at the way people have used natural resources for energy production. The change-over from one fossil fuel use to another in the face of limited supplies and increased demands can be graphically pointed out.

The Environmental Living Program can offer an excellent opportunity for studying the use of energy then and now. The windmill of yesterday's farm can become a symbol of a potential "new" source of energy for the future.

An Idea From Claire Bishop

Ginkgo Petrified Forest State Park, Vantage, Wash.

THE CHAMPIONS— HOW DO THEY SURVIVE?

This summer I used energy as a theme in my campfire program "The Champions: How Do They Survive?" Judging from visitor comments after the slide-talk, many people left the program with a new energy awareness.

"Champions" is about the plants and animals that thrive in our park—an arid sagebrush environment. I used energy themes to illustrate the interrelationships between these individual plants and animals. The sun was introduced as the mainstay for all life in our area, as well as the whole Earth. It is the sun passing along its energy to green plants that enables them to grow and survive—to become champions. The plants with their stored solar energy become food for herbivores such as mule deer, yellow-bellied marmots, and rabbits. These animals then pass on their plant-derived energy (albeit reluctantly) by becoming a meal for carnivorous predators like the scorpion, owl, and bobcat. Predator leftovers are quickly claimed by decomposers, which ultimately return any residue to the earth, to be energized once again by the sun.

The omnivorous animals close the program with an inspirational illustration of how humans fit into the sagebrush ecosystem. Rather than being lauded as champions of the area, the unique ability of humans to manipulate the environment is demonstrated. People, instead of living within the natural conditions of this area, have instituted energy-intensive changes that make life easier for Homo sapiens, but at the same time make survival difficult for other animals and plants of the area.

I felt a bit radical in pointing the accusing finger at people for disrupting the sagebrush environment. Surprisingly though, park visitors were willing to accept the accusation that human decisions often adversely affect other members of an area's ecosystem. In fact, not only were visitors not offended by this touch, many lingered after the program to talk and ask questions. Some of the energy-related questions were fairly sophisticated and lively dialogue followed.

"Champions" was something of a challenge to its viewers, confronting many with truths they were unaware of previously. Few rejected the challenge; the majority reached a new energy awareness. Hopefully, those who attended the program are now more aware of the energy implications of their actions and will in the future be more open to energy alternatives.

ANIMAL SPACES, PEOPLE PLACES

A popular theme for a walk and talk is the how, what, where, why, and when of animal homes. Educators attending an energy workshop at Fort Snelling State Park in St. Paul, Minnesota offered some ideas on how to emphasize energy.

Design a discovery unit to answer the following questions:

How do the various animals in your park provide heat for their homes? What building materials do they use? How does the search for and transportation of the materials change the environment and use up energy? Do animals know about insulation? What animal homes are solar heated? What animals "cool it" for the winter, or how do they adapt to low temperatures? Can you think of some animal mobile homes? Take the same list of questions and apply them to people.

Do some reading about architecture and design or invite an architect or building engineer who likes to teach to come along. Other related materials to consider: how local native American tribes built their homes and how the materials and design style were adapted to the seasons and to available resources. Compare that with our housing construction today and how energy systems are used to deal with climate and resources. What kinds of experimental or "new" technological developments are happening in housing (earth architecture, domes, mobile homes, even styles of tents)?

ACTIVITY
THERE'S NO PLACE LIKE HOME

Lead your group through "Mini-Parks" (Chapter Two) or "Animal Spaces, People Places" (this chapter) before trying this activity, which explores the concept of ecosystem niches and the limiting factors that define them. It involves role playing and imagination and enables players to discover the concept of limits.

WHAT YOU NEED

■ Have on hand pencils and paper, cards, and mailing tags. At the gathering point, divide the group into four teams with no more than four people per team (you may want to comment on the "limit" you're imposing on team size). Each team is given a card with a category and the name of a living thing native to your park. Here are some samples you might use:
Plant—pine tree
Animal—earthworms
People (past)—Iroquois Indian family
People (present)—park interpreters (let visitors discover your role in the park)

THE GO OF IT

■ Each team brainstorms for the things the particular plant, animal, or group of people needs to live: energy, oxygen, soil, water, food, shelter, clothing, etc. Then brainstorm about their role or job—their niche. Choose a place within sight of the gathering point. Review the needs and the roles listed in brainstorming. Does the place chosen provide the plant, animal, or people on each team's card with the things they need? Is this the right place to do their job?
■ Select a note taker. Tell each team to become a search party to find a more suitable space for the organism on their card. Give each search party 10 minutes and then have each give a short explanation of why the space they selected is a better niche for their plant or animal.

"The bottom line case for parks isn't their capability to carry visitors: it's their capacity to carry the planet. Parks are energizers. They are safe, dependable, incredibly complex and valuable power plants. They DO the job, and they EXEMPLIFY the job. Eventually we must learn to understand and emulate the job they do. Within the structure of today's changing energy patterns, parks no longer just invite our interest, they demand our attention. The wisdom they contain needs many translators. We need artists and musicians, scientists and architects, poets and interpreters; the parks are one of our greatest national resources in an energy-nervous time."—Jean Matthews, National Park Service.

■ The presentation may be given in several ways. Encourage the groups to role play, mime, narrate a story, write a poem as a summary. Begin the presentations with the whole group visiting the plant space niche, then the animal, then past and present people, being sure that each group (except the plant) relates to the one that's gone before it. Encourage questions after each presentation and don't pass up the opportunity to ask questions which make an energy link, such as "how does your plant, animal, or person get food?" or "how does it help others get the energy they need?" Applaud at the end of each presentation. Try to sum up the findings, and thank everyone for participating. Award each person a mailing tag reading I'VE FOUND MY NICHE!

Notes

ACTIVITY
TOWER OF POWER

By Nancy Strader

This activity was designed on-site, at the spur of the moment for a teachers' energy workshop a at state park in St.Paul, Minn. The visitors' center is "blessed" with utility lines and a row of towers running right through the front yard. We chose to use the towers as props instead of trying to ignore their presence.

WHAT YOU NEED

■ Try this activity with a large group of children or adults. It's a tongue-in-cheek exercise that sets the tone for the day's program. Use your own touches and humor and enjoy it.

THE GO OF IT

■ Gather the group around the tower. Explain briefly that they are all here to share ideas and knowledge about how energy works in nature and how people use energy. In order to get "charged up" for the day's activities, invite them to "tap" the energy resources around them. Form a circle around the tower, holding hands.

THE ENERGY TAP

■ Ask the players to place the palms of their hands on the palms of the people standing beside them. The leader begins a "tap," tapping the tower base and then the person. The tap is passed around the circle (or circuit) until it comes back to the leader. For the second round, the leader speeds up the action by passing a series of taps on to the next person without waiting to complete the circuit. The results? Everyone is tapping hands and sharing in the energy flow. Then the leader abruptly raises a hand into the air and breaks the circuit. The group goes off on an energy walk thoroughly charged for action.

NEW-OLD LOGGING AT GROTON STATE FOREST, VERMONT

Paul and Sandal Cate, seasonal interpreters, have found a way to interpret net energy to the children they work with. A horse provides the power to haul harvested trees in the forest. The park staff determined that it costs less to feed, stable, and care for the horse than to invest in a machine, fuel it, and keep it running. Only a narrow path is necessary for the horse to pass in and out of the forest, so there is a minimum of disruption. The logging is done during the winter when a protective covering of snow prevents damage to plant growth. A less obvious benefit is the noise level—just a few whinnies and snorts instead of the sounds of a diesel engine droning away. The children are shown the scars of the roadways required for previous logging operations. They can compare them with the horse paths and also notice the remnants of the horse's contribution to forest replenishment.

EVOLUTION

"It took 200,000,000 years to organize this meeting. Out of near eternity, one common minute to stand upon a common ground—it, the snapping turtle: carapaced, and lumping toward a water hole, perhaps for egg-laying; me, fledged into automobile, flying too fast for reaction. Just time to spot the turtle between the wheels. I stop, turn around, come back. It stays midroad. Another car blasts over. What strange guards these are that patrol this open gauntlet. Did the turtle sense some great predators approaching? No, how could a beast make sense of noises made out of metal. I step out with an iron bar in hand to get it away from danger. But now my steps have made a difference. It recognizes. It claws to scratch its way around and face me. Its eyes glaze cataract white, but it can see. Jaws begin to open. I might as well be a dinosaur stalking out from trees of ferns and horsetails. The jaws clank hard over my good intentions, but I win the encounter and flip it in the grass. Dim-witted anachronisms . . . they cannot run our roads. But no need to patronize. They move slowly, but perhaps with more certainty. Compared to their ancestry, we have just been born. They have seniority. We have built some ways to prop a throne upon the mound of evolution. But let's wait and see. Let's wait another 200,000,000 years and see whose road the turtle crosses."

— By Charles Johnson, Vermont State Parks, Montpelier, Vt.

An Idea From Gina Moriarty

George Washington Birthplace National Monument, Va.

COLONIAL WORKING FARM

George Washington Birthplace National Monument, administered by the National Park Service, operates a colonial working farm. In demonstrating 18th century farming methods and observing colonial customs, the conservation of energy is a natural occurrence. Here are some examples.

Gardens are maintained by the use of oxen and hoes, rather than using modern farm machinery. Compost, rather than chemical fertilizers, is used to replenish the soil. Marigolds, praying mantises, and ladybugs are used as natural enemies of pests, rather than using chemical pesticides. Tools are made by hand, rather than by modern methods. Candles are used to light the farm workshop and the kitchen. The fireplace is used for cooking colonial meals and for heat and light. Oxen are used for hauling compost and wood and other needed items on the farm.

An Idea From Bill Lewis

Yellowstone National Park, Wy.

VIEW FROM THE FUTURE WALK

This is to be done with tongue in cheek, except when you are talking, of course. Take a walk around your park, choosing a trail which passes a number of things made by people, such as picnic benches, trash cans, "don't" signs, a visitor center, power lines, rusting beer cans, parking lots, a boat launch, storm drainage ditch, fences around fields, and the trail itself.

Select some of these for use as focal points for a view from the future. Explain to the visitors that: "We are going on a special walk today. Let's all take a minute to step into an imaginary time machine and project ourselves to the year 2077." (This is a good spot for a little dramatic interpretation and a pause.)

"As citizens of the world in the year 2077, we will today be visiting an historic preservation site, a park that has been maintained intact for the last hundred years. Only nature has made changes on the land itself. I invite you to follow this trail in the hope of getting a sense of what life was like in those good old days of the 1970's and how the quaint folks living then recreated and used their parks. Perhaps we can also get a feeling for their values and views of the future."

Stop at each pre-selected site, asking for a volunteer visitor to speak as the interpreter so that everyone has a chance to make his or her own comments.

ACTIVITY
PLANNING A BACKPACKING TRIP

Offer an introduction-to-backpacking workshop for novices who don't know how to get started. Here is a sample format you might follow for a one-day workshop to be held at a time when your park is not being used intensively. You can use this time to help people to plan economically and efficiently for their trip. Backpacking requires a sound understanding of what the basic needs are for human survival with a minimum of physical comforts. Some planning strategy is required to estimate the distance to be traveled, the weight you can carry, and the supplies needed. The group will be conserving the natural resources of the park by carrying their own supplies.

WHAT YOU NEED

- Locate a seasoned hiker, an interested doctor, and a nutritionist to attend as resource people and participants. Assemble nutritional and caloric information from your library. Locate a large room and prepare a slide show of scenes of the park.

THE GO OF IT

- Gather for introductions to each other and the day's schedule.
- Present a slide show about the trails and camping areas the group will be using in the park. This gives a sense of the pleasures and problems of "packing in," and teaches something about how our bodies use energy.
- Have a question and answer period with resource people. Meet with them as a group beforehand to review the concepts behind your program and to emphasize the importance of your energy theme so that they'll be on your wavelength.
- Try an awareness game: work in twos or threes. Take each other's temperature and pulse, record, then run in place for a few minutes and repeat. Ask for differences. What does this mean for us when doing physical exercise and carrying extra weight? Where does the increased heat go? (If you have a room thermometer, check it before and after. Where did the energy come from?)
- Mix up enough granola for everyone to have a snack. As you add each ingredient, ask where it came from, how it was picked, processed, and brought here.
- Take a break for energy snacks and milk. Use this time to replace the energy lost during the morning's calisthenics. Reassemble for a walk along a trail, looking at ways that nature conserves and uses energy. (You might try other games and ideas included in the workbook.) This is an important dry run for the overnight. Use it as a time to get to know the park and each other.
- Lunch time. If you have a movie you like about backpacking, show it now.
- Divide the group into sub-groups. A planning session could cover such topics as: where to go, what routes to take, distances to travel, kinds of foodstuffs to use, the weight of your pack, encampment areas, maps, lists of items needed (do we really need 25 jackknives and propane camping stoves?), evening activities, and ways to minimize the damage done to the park environment. Don't omit discussion of the amount of energy expended in the planning for the trip. What are the advantages?
- The groups gather to present and compare their ideas (five- to 10-minute presentations). Again, you may specify what you hope to get out of this session. Happy trails!

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time
—T. S. Eliot
Four Quartets

An Idea From Gary Mozel

Washington State Parks, Olympia, Wash.

"INVADERS" ON THE TRAIL

(Many park interpreters and naturalists find it difficult to talk about energy conservation and energy efficiency to campers who arrive in recreation vehicles. Gary Mozel, naturalist with the Washington State Park System, has developed several ways of dealing with this sensitive situation.)

How do you talk about energy and conservation to a campground full of people who came to your park in rigs that get six miles per gallon? Can you maintain both integrity and health in this situation?

It's easy, of course, to just avoid making pointed references to rec vehicles or any motor vehicles during a program. My energy conscience bothers me when I do this, though. Tells me my grandchildren aren't going to have the miracle drugs they need because I didn't push energy conservation enough. So I've developed a number of gimmicks that allow me to point out the energy-guzzling nature of big RV's in relatively inoffensive ways. I never use more than one or two per program; any more and my energy radicalism would become too obvious and I'd be run out of the campground.

The Family Vacation as Energy Saver Approach. *Consumer Research* magazine, in its March 1975 issue, summarized the results of a study that asked the question "Can an American family reduce their net energy consumption by abandoning home and going camping?" The answer is a solid "If." Vacationers can save energy *if* they shut down everything at home and *if* they don't drive clear across the country and *if* this and *if* that. I like to mention this study when I do a program since it points out folks can have fun *and* conserve energy. It's also a good lead-in for a quick comment on RV's, since one of the crucial factors in saving energy while camping is a vehicle that gets lots of miles per gallon.

The Comparison with Nature Approach
Consider the average snail. It can carry its shell around because the thing isn't very heavy compared to the snail's body weight. Now consider the shells we carry around. Have we improved on nature or become less efficient? A back pack tent weighs five pounds. A motor home weighs in at 7000 plus pounds.

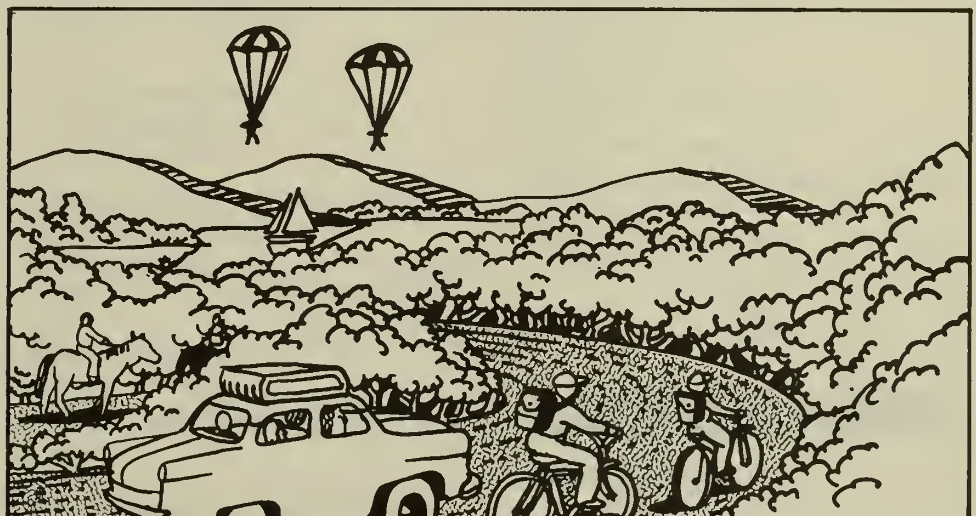
The Small Potatoes Approach
Suggest that those who arrived in big rigs leave them parked during their stay. Walk or bicycle to the grocery store instead of driving. For an afternoon's entertainment, hike one of the park's many trails instead of driving to town.

The True Confessions Approach
It's hard to argue with a personal story of recognized wrongdoing and reclaimed righteousness. Tell about how you came to sell your '73 Cadillac and buy a subcompact. Tell about your Uncle Ferd and why he junked his camper and took up backpacking. These are stories of individual attitudes and experiences; once again, nothing need be said against energy-wastrel RV's, but, once again, the message is obvious for those willing to pick it up.

The Look At Us Approach
We now use very compact pickup trucks in many of our parks to collect fees, haul equipment around, etc. In addition, we've cut down on the number of miles we drive in a given period. Point these things out to the visitors, extolling the virtues of small, energy-efficient vehicles. Nothing need be said about gargantuan RV's, but the implications are obvious.

ACTIVITY
A PARK FREE-FOR-ALL

There are many descriptions of parks, what their purposes ought to be, and how they should be used. As our population grows and becomes ever more mobile, visitation will continue to increase and debate on the proper use of parks is certain to grow. We hear a lot about the rights of individuals and groups to use park land, but what about our obligation to protect the land itself? This game illustrates the complexities of defining a role for parks and the pressures they may encounter in an energy-short era.



WHAT YOU NEED

■ This activity is for a large group of adults. Have several blown-up maps of the park, large pads of paper, magic markers, and cards available. Choose a comfortable indoor space.

THE GO OF IT

■ Pass out cards with a role assignment to everyone. Explain that this meeting is to discuss planning for the operation of the park for the next five years.

CAST OF CHARACTERS

People who want to use the park for:

■ ski mobiling
■ trail biking
■ power boating
■ canoeing
■ horseback riding
■ backpacking
■ car-camping
■ rock climbing
■ off-road vehicles
■ a conference center

People employed as:

■ a park administrative officer
■ a local newspaper reporter
■ environmentalists
■ a local power company publicist
■ concerned citizens
■ state, federal, and local officials
■ a local airport official
■ a park concessions operator
■ a rock group promoter
■ a local TV station investigative team
■ the park police chief
■ a park planner
■ the park maintenance supervisor
■ the park superintendent
■ a park interpreter
■ an endangered species advocate
■ the ecology department head from local college
■ a local historian
■ an energy company executive
■ a construction union president

THE PLAY'S THE THING

■ The players take quick notes about what they (in the context of their roles) would want for the park, their visions of what the park should be. They display their cards and move around the room to look for others who might share common interests in park programming and development. Each interest group has 45 minutes to plan its strategy. They may use the maps and pads of paper to organize a three-minute pitch. The park superintendent, the park administrative officer, and the park planner sit at a table; the rest around the room, acting as the audience. The meeting is convened, the presentations are made, and the panel leaves the room in order to meet privately to decide who gets what. Meanwhile, the members of the audience vote for their top three favorite uses for the park and count their ballots.

■ For further entertainment, the TV commentator and camera man give their version of the meeting (the eyes and ears of the news). Then the newspaper reporter offers a second account. The panel returns and announces its decision, including a budget and a two-year development plan. The meeting is adjourned.

RESOURCES

The following books were used as source material for all chapters and are highly recommended for your reading.

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W.W. Norton & Co., New York, 1972

Energy: Sources, Use, and Role in Human Affairs
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Ecology and Field Biology
Robert Leo Smith
Harper and Row, New York, 1974

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Eugene Odum
W.B. Saunders Co., Philadelphia, 1971

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Wadsworth Publishing Co., Belmont, Cal., 1975

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Robert E. Ricklefs
Chiron Press, Portland, Ore., 1973

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Robert Rouse and Robert Smith
Macmillan Publishing Co., New York, 1975

Natural Ecosystems
W.B. Clapham, Jr.
Macmillan Publishing Co., New York, 1973

***Recommended Reading**

***Energy and Power**
"The Energy Resources of the Earth"
M. King Hubbert

"The Flow of Energy in the Biosphere"
David M. Gates

"Energy and the Universe"
Freeman J. Dyson
W.H. Freeman & Co., San Francisco, 1971

Energy Primer
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Four free catalogs:
Sundials
New Ipswich, N.H. 03071

Edmund Scientific
1006 Edscorp Bldg.
Barrington, N.J. 08007

A-Z Solar Products
200 E. 26th St.
Minneapolis, Minn. 55404

Ears Energy Catalog #6
Environmental Action Reprint Service
2239 East Colfax
Denver, Col. 80206

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***The International Book of Trees**
Hugh Johnson
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Dr. Seuss
Random House, New York, 1958

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Bill Lewis
National Park Service, Washington, D.C., 1976

***Energy Activity Guide**
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*The City People's Book of Raising Food
Helga and Bill Olkowski
Rodale Press, Emmaus, Pa., 1975

Gardening Shortcuts
Chevron Chemical Co., San Francisco, 1974

"Farming in a Flower Pot"
Family Circle, March, 1973

"Balcony Farming"
Apartment Life, July, 1974

For information about specific gardening problems, write to the U.S. Department of Agriculture, Washington, D.C. 20250, or the Institute for Local Self-Reliance, 1717 18th Street, N.W., Washington, D.C. 20009.

For booklists of published material about gardening write to Garden Way Publishing, Charlotte, Vermont 05445 or Rodale Press, Inc., Book Division, Emmaus, Pennsylvania 18049.

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New York Zoological Society, New York, 1916

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PARK PROJECT ON ENERGY INTERPRETATION

National Recreation and Park Association
1601 North Kent Street
Arlington, Va. 22209

Please enclose payment with order.

Energy—Who's Doing What?

A list of approximately 200 U.S. citizens groups, companies, and non-profit agencies involved in some type of energy work; all organizations listed are willing to answer questions. Free.

Energy Activity Guide

A 24-page collection of colorfully illustrated articles and activities, containing information on all aspects of energy. Written for general audiences and often given to visitors at park sites. Free.

Energy Manual for Parks

A handbook for interpreters and naturalists, containing up-to-date information on energy use in nature and by people. Provides the basic facts from which interpretive programs may be created. It is also useful for general audiences. $3.

Lee Stephenson
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NOTES

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