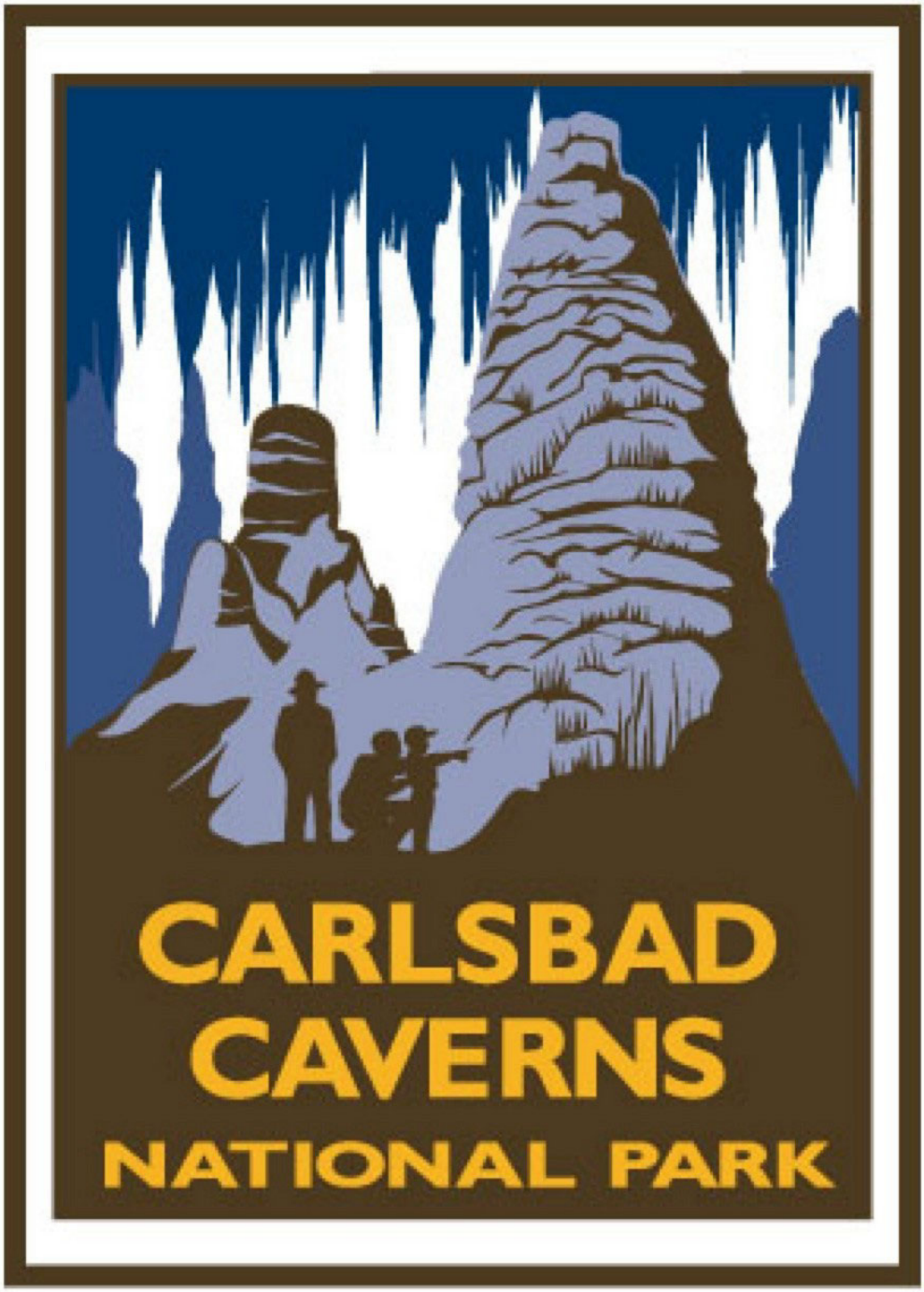
Life Science

A curriculum and activity guide for Carlsbad Caverns National Park

Middle School Ecology



Biosphere

Biosphere is defined as the system of living things and their environment. Within a biosphere we have ecosystems, which focus on the habitat and the interrelationships between the plants and animals. In this unit students will participate in a game designed to allow them to see the plan of nature in order to help them understand the need to protect Earth's resources. Students will learn to distinguish the identifying characteristics of ecosystems, habitats, and niches of living things. In the lesson, ***What's Cookin'?***, students will learn the basics of food chains and food webs.

In this unit six biomes (a large region on the Earth that has a certain climate and certain kinds of organisms) will be identified. If you were to travel along the surface of the Earth from one latitude to another, you would also move from one biome to another. Each biome is described in terms of its climate and its living things. The plants and animals that survive in a biome are adapted to the conditions in that biome.

Particular attention will be paid to the characteristics of the Desert biome. Deserts cover roughly one-third of the Earth's land surface. Yet deserts aren't all dryness and desolation. This unit will provide activities that allow students to create various desert formations and participate in the development of microhabitats. Students will also identify the great deserts of the world and design brochures that will identify the distinguishing characteristics of each desert.

Oh Deer!

How does our world affect us?

Summary: This lesson is designed to introduce students to the basic needs of survival and how changes in an ecosystem can affect animal life.
Duration: 1 class period
Setting: Outside
Vocabulary: limiting factors, habitat, drought, fire, deforestation, uncontrolled hunting, population
Standards/Benchmarks Addressed: SC1-E1, SC1-E2, SC2-E1, SC3-E1, SC4-E1, SC4-E2, SC4-E5, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC11-E2, SC11-E3, SC11-E4, SC11-E5, SC11-E6, SC11-E7, SC11-E8, SC14-E1, SC15-E2, SC16-E1, SC16-E2, SC16-E3

Objectives
Students will:

- identify and describe food, water, and shelter as the three essential components of habitat.
- define limiting factors and give examples.
- recognize that fluctuations in wildlife populations are natural as ecosystems constantly change.
- create a line graph depicting the population cycles as the Oh Deer game is played.

Background
There are many factors that influence the number of plants and animals in a habitat. Climate is an extremely important variable that influences both the diversity of species and the number of plants and animals an area can support. Another important variable is limiting factors. Limiting factors are resources, such as food, water, shelter, and nesting sites, that are in short supply and restrict the population sizes of living organisms. These factors serve to balance the number of plants and animals that can survive in an area at one time.

Other limiting factors like disease, predation, and competition for resources can also impact populations. If any of the limiting factors change the plant and animal populations change as well. Some changes may cause the population to increase while others may cause the population to decrease.

For example, if there are more plants than usual in an area, populations of animals that eat that plant may increase. If one animal's population increases, the population of animals that eat that animal might also increase. Increases in population are not always good. A population could grow too large for the environment to support. Other changes in limiting factors can cause a population to decrease. If a population becomes diseased, the population may decrease and the population of animals that eat the diseased animal will also decrease. In nature, populations usually balance themselves.

Predator and prey relationships also play an important role in animal populations. If the balance between predator and prey is changed, populations are changed. The deer population in some areas has grown too large because there are very few natural predators. Mountain lions and

wolves are the natural predators of deer. Wolf and mountain lion populations have decreased due to over-hunting and habitat loss. This loss of a natural predator for the deer, along with other factors, has led to overpopulation of deer in some areas.

Materials
None

Prep
Have two parallel lines on the playground or classroom floor 10 to 20 yards apart.

Procedure
Warm up: Ask the students what living organisms need in order to survive. List their ideas and discuss the basic needs: food, water, shelter, and space. What kinds of things limit the population growth of animals? List ideas and discuss these limiting factors: drought, fires, deforestation, and uncontrolled hunting. Now we are going to play a game to see how these needs and limiting factors affect the wildlife in the environment.

Activity

1. Divide class into groups by counting off by fours. All the students who share a number meet at a different location in the room (best if played outdoors because of the space needed).
2. Have two parallel lines marked off on the playground or floor about 10 to 20 yards apart.
3. Have all the Ones meet at one of the parallel lines. The Ones represent deer. The other students will stand on the opposite line and represent the components of the habitat: food, water, shelter, and space. The deer will go out and search for one of the components of habitat.
4. Explain the signals needed for the game. Here are the signals for the deer and the habitat components (they will be the same for both).
    a. Food – clamp your hands over your stomach
    b. Water – put your hands over your mouth
    c. Shelter – hold your hands together over your head
    d. Space – hold your arms straight out at your sides

    Have the students stand on the appropriate lines facing away from each other and decide which component they will represent (or be looking for). Students cannot change what they are or what they are looking for during the round; they may change before beginning the next round. If the deer finds the habitat component it is looking for it takes the student back to the deer line. This represents that the deer has survived and reproduced. If the deer fails to find the component it is seeking it dies and becomes part of the habitat side. (As the game is played keep track of the number of deer after each round- this will be used to make a line graph showing population trends corresponding to environmental factors.) Continue this process for a total of fifteen rounds.
5. After the fifteen rounds discuss the activity and what the students concluded about the environment's impact on animal populations. Discuss that increases and decreases in the animal population are natural. In the beginning the herd grows, then some must die as the habitat is depleted.
6. Review with students what limiting factors are: drought, fire, deforestation, uncontrolled hunting. Play the game again including some of the possible limiting factors. (Be sure to keep count of the number of deer and the conditions that were involved in each round,

so the students can see the relationship between the limiting factors and their effect on the population.)

a. If there is a drought no student on the habitat side can choose water as their symbol.
b. If there is a fire no student on the habitat side can choose food or shelter as their symbol.
c. If there is deforestation no student on the habitat side can choose shelter as their symbol.
d. If there is uncontrolled hunting have 4 or 5 students become hunters (determine an appropriate hand signal to use).

Discuss the results of the game with the use of limiting factors and their results on the wildlife population. Be sure that the students understand that humans can be a limiting factor on population growth.

Wrap Up: Have the students describe what they learned from the game. They should also construct two line graphs depicting the population cycle of both games and describe why the populations increased and decreased during the games.

Assessment
Teacher observation, participation, line graphs and explanations.

Where Do I Belong?

What is an ecosystem?

Summary: This lesson introduces students to ecosystems, habitats, niches, and interactions among living things.
Duration: 1 class period
Setting: Classroom
Vocabulary: ecology, habitat, niche, ecosystem, abiotic factors, biotic factors, biome, predation, population, community, predator, prey, competition, parasitism, mutualism, commensalism, producer, consumer, decomposer
Standards/Benchmarks Addressed: SC1-E1, SC1-E2, SC2-E1, SC3-E1, SC4-E1, SC4-E2, SC4-E5, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC9-E1, SC10-E2, SC11-E1, SC11-E2, SC11-E3, SC11-E4, SC11-E5, SC11-E7, SC12-E2, SC14-E1, SC16-E1

Objectives
Students will:

- define ecology and relate ecosystems, communities, populations, habitats, and niches to one another.
- define producer, consumer and decomposer.
- describe a food chain, food web, and energy pyramid.
- compare competition, predation, commensalism, mutualism and parasitism.

Background
The biosphere is the part of the Earth that contains all living things. Each ecosystem that we study is part of the biosphere. A system is a group of things that interact with one another. The organisms that make up the living part of an ecosystem are called biotic factors. An organism depends on other biotic factors for food, shelter, protection, and reproduction. Nonliving things that we find in an ecosystem are called abiotic factors. Abiotic factors have an effect on the type and number of organisms living in an ecosystem. Some abiotic factors include soil, water, temperature, and sunlight.

All populations living in an area make up a community. A population is a group of individuals belonging to the same species whereas a community is made up of all the populations of living things in a given area. A community cannot be considered apart from their physical environment. Communities are made up of species that are intimately linked through feeding relationships. Food chains and webs of desert species, for example, emphasize the remarkable adaptations of desert organisms and the interdependence of species. Animals in every habitat must solve two important problems: 1) finding enough food for themselves and 2) making sure they don't become food for others.

Communities and their physical environment are called ecosystems. An ecosystem is a community of interlocking parts, which act upon each other in life's grand plan. It contains a balanced mix of living things and non-living materials that interact in order to form a self-contained ecological unit. In an ecosystem there is a one-way flow of energy through living things and a cycling of nonliving materials. Plants and animals are parts of most ecosystems and so are other living things called microbes. Plants use the sun's energy to produce food

which, in turn, animals consume to get their energy. Most ecosystems also have three nonliving parts: soil, water, and air.

By studying an ecosystem we can see how communities are influenced by their physical surroundings. A stream, for example, depends on supplies of carbon, phosphorus, nitrogen, water, and energy. At the same time, populations alter their physical environment. Stream animals reshape the stream by digging into its banks. Even by dying, a stream animal changes the characteristics of its environment by contributing organic matter to the streambed.

Within each large ecosystem, smaller ecosystems can be found, for example, a decaying tree in a forest. As the tree decays, it returns to the soil and recycles minerals in a series of processes. Fungi and lichens or decomposers permeate and then soften the bark. Insects, such as termites or beetles, attack the heartwood. In turn, animals feed on the insects. Waste materials from the animals are deposited on the ground providing a rich fertilizer for the soil.

Limiting factors control animal population sizes in a given area of habitat. Limiting factors are resources, such as food, water, shelter, and nesting sites, that are in short supply and restrict the population sizes of living organisms. These factors serve to balance the number of plants and animals that can survive in an area at one time. As a result, a balance is maintained with the environment. Only a certain number of animals and plants can thrive in a limited space – when there are too many animals the resources are depleted and the animals and environment suffer. Climate is another extremely important variable that influences both the diversity of species and the number of plants and animals an area can support. Interactions between organisms on different levels of the food chains also influence the number of plants and animals found in an area. Thus, the populations of predator and prey species are closely linked. Predators provide an important check on the population size of their prey and reduce the risk that the prey population will increase to the point that it will exceed the available food.

Materials
Science magazines
Science textbook

Procedure
Warm up: Draw a connections web on the board. Start by writing an animal's name on the board and circling it. Ask the students to name things that are connected to the animal (interactions with other organisms, food, shelter…). Draw lines to the other factors until the web is very complex. Point out that the web has abiotic and biotic factors. Explain that this web on the board is not even a fraction of the interactions happening in a natural ecosystem. Define ecosystem, abiotic factors, and biotic factors.

Activity

1. Habitat vs. Niche- ask students to define the terms habitat and niche. What do you think your habitat or niche is. Explain the main differences and similarities of the two terms. Stress that a niche is much like an occupation, or the organism's role, while the habitat is its home.
2. Describe an Animal's Habitat and Niche—hand out several science magazines. Tell the students to pick out any organism from the magazine (it can be a plant, animal, insect, reptile…). What do you think this animal's habitat is? Its niche? Do you think it has any relationships with other organisms? If so, what kinds?

3. Introduce the Five Specific Interactions- List the five types of interactions on the board and give an example of each (predation, competition, parasitism, mutualism, and commensalism).
4. Students will now write a paragraph involving a predator (mountain lion, coyote, fox, snake, etc…) through the eyes of its prey (mouse, insect, deer, etc…). Discuss what each student wrote.

Wrap Up: Have the students create an animal that does not already exist. Draw a picture of the animal and define its habitat and its niche. They must also describe two specific interactions it has with another living organism (predation, commensalism, mutualism, or competition).

Assessment
Collect the students' pictures. Did the students define the animal's habitat and niche? Did the students describe two interactions the animal has with another organism?

Extensions

Materials needed: 2-liter bottle, sand, aquatic plants, gravel, scissors, ruler, water, fish (1 goldfish or guppy per student), fish food

1. As a class, brainstorm and discuss factors needed for an ecosystem. Inform the students they are going to be creating an ecosystem in a 2-liter bottle. Each student will be given a 2-liter bottle, sand, gravel, aquatic plants, water, and eventually one fish to add to their ecosystem.
2. Have students draw a plan for their ecosystem and get it approved by you before they begin constructing their ecosystem. Students must be sure that the ecosystem is safe for the fish.
3. After the plan has been approved the students can start constructing their ecosystems. Students should be able to explain how the fish will be able to survive in the ecosystem, and what they (students) must provide in order for the fish to survive.

Materials needed: 5 cm soil, jar, water, aquatic plant, 1 cup mixed bird seed

Have students observe and describe succession (the series of changes that naturally take place in a community over time) by conducting the following experiment using soils, water, seeds, a plant, and a jar. First, place 5cm of soil in a jar and fill with water to a depth of 7.5 cm. Place the uncovered jar on a windowsill, allowing the contents to settle overnight. Plant an aquatic plant in the jar. As time passes, do not replace the water that evaporates from the jar. Once or twice a week, have students add three or four seeds (use mixed birdseed) to the jar. As long as water remains in the jar, the seeds should germinate and then die. Continue adding seeds even after the water evaporates; this evaporation is a metaphor for a warming, drying climate. As the water evaporates, the aquatic plant will die, but the birdseed may find the environment suitable for growth. When seedlings begin to sprout start adding water to represent rainfall. Have students illustrate what they saw happen to their pond. What did they learn about environmental change?

Parts to a Whole

How does it all fit together?

Summary: Student will be creating a visual representation that distinguishes the relationship between an individual of a species, its interactions with others (living and non-living) around them, and the role of limiting factors.
Duration: 1 week
Setting: Classroom
Vocabulary: population, community, ecosystem, limiting factors, competition, drought
Standards/Benchmarks Addressed: SC1-E1, SC1-E2, SC2-E1, SC2-E3, SC3-E1, SC4-E1, SC4-E2, SC4-E5, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC9-E1, SC10-E2, SC11-E1, SC11-E2, SC11-E3, SC11-E4, SC11-E5, SC11-E6, SC11-E7

Objectives
Students will:

- be able to distinguish between the characteristics that make up an individual, a population, a community, and an ecosystem.
- define the terms population, community, ecosystems, and limiting factors.
- predict the effect of drought on populations of plants and animals in a habitat.

Background
All populations living in an area make up a community. A population is a group of individuals belonging to the same species whereas a community is made up of all the populations of living things in a given area. A community cannot be considered apart from its physical environment. Communities are made up of species that are intimately linked through feeding relationships. Food chains and webs of desert species, for example, emphasize the remarkable adaptations of desert organisms and the interdependence of species. Animals in every habitat must solve two important problems: 1) finding enough food for themselves and 2) making sure they don't become food for others.

Communities and their physical environment are called ecosystems. An ecosystem is a community of interlocking parts, which act upon each other in life's grand plan. It contains a balanced mix of living things and non-living materials that interact in order to form a self-contained ecological unit. In an ecosystem there is a one-way flow of energy through living things and a cycling of nonliving materials. Plants and animals are parts of most ecosystems as well as other living things called microbes. Plants use the sun's energy to produce food which, in turn, animals consume to get their energy. Most ecosystems also have three nonliving parts: soil, water, and air.

By studying an ecosystem we can see how communities are influenced by their physical surroundings. A stream, for example, depends on supplies of carbon, phosphorus, nitrogen, water, and energy. At the same time, populations alter their physical environment. Stream animals reshape the stream by digging into its banks. Even by dying, a stream animal changes the characteristics of its environment by contributing organic matter to the streambed.

Within each large ecosystem, smaller ecosystems can be found, for example, a decaying tree in a forest. As the tree decays, it returns to the soil and recycles minerals in a series of processes.

Fungi and lichens or decomposers permeate and then soften the bark. Insects, such as termites or beetles, attack the heartwood. In turn, animals feed on the insects. Waste materials from the animals are deposited on the ground providing a rich fertilizer for the soil.

Limiting factors control animal population sizes in a given area of habitat. Limiting factors are resources, such as food, water, shelter, and nesting sites, that are in short supply and restrict the population sizes of living organisms. These factors serve to balance the number of plants and animals that can survive in an area at one time. As a result, a balance is maintained with the environment. Only a certain number of animals and plants can thrive in a limited space—when there are too many animals the resources are depleted and the animals and environment suffer. Climate is another extremely important variable that influences both the diversity of species and the number of plants and animals an area can support. Interactions between organisms on different levels of the food chains also influence the number of plants and animals found in an area. Thus, the populations of predator and prey species are closely linked. Predators provide an important check on the population size of their prey and reduce the risk that the prey population will increase to the point that it will exceed the available food.

Can human population be a limiting factor? The size of the human population affects virtually every environmental condition facing our planet. As human population grows, demands for resources increase; pollution and waste grow as well resulting in millions of plants and animals facing the threat of extinction. Consequently, it is evident that human population takes its toll.

Materials
Poster board
Colored pencils
Markers

Procedure
Warm up: On the chalkboard make four columns with the headings: Individual, Population, Community, and Ecosystem. Define each of these. Explain to the students that individuals make up populations, which in turn make up communities, which in turn make up ecosystems.

(Review background information as necessary)

Imagine the plant and animal populations in the Chihuahuan Desert. Ask students if they think that the area could support an unlimited number of species. Also ask them to consider what might limit the number of individual animals and the number of species (drought, fire, heat, and predators). Students should consider what happens to all the populations of plants and animals during the drought (the numbers of all decrease). Discuss why limiting factors are important to a habitat (It controls animal populations, thus balance is maintained with the environment. Only a certain number can thrive in a limited space. Too many animals will deplete the resources.).

Activity: Explain to the students that there are several ecosystems. Ask students to name some that could be found in the Chihuahuan Desert or more specifically Carlsbad Caverns National Park (riparian area, cave ecosystems (which can include the twilight zone, varied temperature zone, and the constant temperature zone), desert, and forest).

Discuss the concept of an energy pyramid. Explain that it depicts the species of a habitat in their appropriate hierarchical levels (producer, consumer, etc.). The pyramidal shape is formed because the energy decreases as you move up the levels. This happens because each time an animal eats another animal or plant, 90 percent of the energy contained in the food source is lost due to the digestion process. Therefore, only about 10 percent of the energy is actually transferred to the next level of the food chain.

Explain to the students that they will be working in groups to create an Energy Pyramid. Each group must choose an ecosystem located in our area. They will then identify an individual species they'd like to follow through the relationships of individual, population, community, and end with the ecosystem.

Each team will receive poster board, colored pencils, and/or markers. Pictures from magazines to use for the pyramid could also be an option.

Wrap Up: Groups will present their Energy Pyramid to the class in a ten-minute presentation.

Assessment
Pyramid rubric

Extensions
Each student should select a specific species and conduct library research about how change in their local climate might affect their selected animal.

Parts to a Whole

Energy Pyramid	Self Evaluation	Teacher Evaluation	Comments
Visual:		**/12**	
Includes an energy pyramid colored and labeled (consider quality and appeal).			
Energy Pyramid is visually attractive (fills the page, colorful, neat).			
Illustrations distinguish the relationships between the individual, population, community and ecosystem.			
Written:		**/8**	
Information is accurate.			
Proper grammar, spelling, etc.			
Presentation:		**/8**	
Presenters followed appropriate speaking rules (eye contact, voice, enthusiasm).			
Presentation quality, organization, information, and appeal.			
Teamwork:		**/4**	
Are the efforts of each team member clearly demonstrated, or did it appear to be the work of one or two?			
Responsibility:		**/4**	
Turned in on due date and presented in class with visual aids.			

4 - no mistakes 3 - few mistakes 2 - many mistakes 1 - incomplete (however is present) 0 - not evident or not included

Percentages: Visual _____ Written _____ Presentation _____ Teamwork _____ Responsibility _____ Overall_____

Move Over Please!

What happens when a plant population is too dense?

Summary: This project explores the effects of plant population density.
Duration: 2 weeks
Setting: Classroom/lab
Vocabulary: population, overcrowding
Standards/Benchmarks Addressed: SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC2-E3, SC3-E1, SC4-E1, SC4-E3, SC4-E4, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC11-E2, SC11-E3, SC11-E4, SC11-E5, SC11-E7, SC12-E2, SC14-E1

Objectives
Students will:

- work with the scientific method in order to see what happens when a plant population gets too dense.
- make a chart to record the growth of plants.

Background
Nature is an amazing thing. It has the ability to regulate itself in order to promote a healthy habitat for all living things. In order to maintain a healthy environment nature has a natural cycle of population increases and decreases.

If a population becomes too crowded the plants or animals must compete for the resources (food, water, shelter, and space) available. This creates an unhealthy environment, which causes the plants and/or animals to suffer.

Plants are modular and do not move around. As a consequence, plants can get larger so both biomass and the numbers of plants are indicators of plant population size. As the population increases (in numbers or biomass) either survival or reproduction will be reduced by the limits imposed by resources, competition, predation, or by space limits. Competition is high because of the fixed nature of their location and the fixed nature of resource availability. Competition is mitigated by other factors such as predation, disease, and mutualistic interactions.

The degree of intra- and inter-specific competition is described by the self-thinning rule (also called Yoda's rule or the 3/2 power rule). This rule states that as plant population density increases plant size decreases due to resource limitations.

Materials
2 small milk cartons
Potting soil
Water
Radish seeds
Metric ruler
Marker
Pie pan
Measuring cups

Procedure

Warm up

Ask the following questions:

- What do you think will happen if the plants are too close together?
- Will there be enough food, water, and sunlight?
- What else might be in short supply?

Have students write their answers in a science journal.

Activity

1. Do the experiment using the following directions.
    a. Cut off the top of each carton and punch three holes into the bottom of each of the cartons.
    b. Label the cartons A and B.
    c. Fill each carton ¾ full with potting soil.
    d. In carton A, plant three radish seeds about one centimeter apart. In carton B, plant 20 radish seeds about ½ centimeter apart.
    e. Place both cartons in a pie pan. Water each carton with about ¼ cup of water. Water each carton every 3-4 days. Keep the soil damp.
    f. Observe and measure all the plants in each carton after one week and then again a week later. Keep a record of plant growth in a journal.
2. Make a chart comparing the plant growth in both cartons A and B. Answer the follow-up questions:
    a. In which carton were the plants taller?
    b. In which carton were the plants fuller?
    c. In which carton were the plants more crowded?
    d. What might have caused the difference in the way the plants grew?
    e. What might happen to the soil when the plant population becomes too dense?
    f. Do you think that overcrowding might cause similar problems in other populations such as animals and humans?

Wrap Up: Students must explain what they learned through this activity and answer the initial question: What do you think will happen if the plants are too close together? Will there be enough food, water, and sunlight? What else might be in short supply?

Assessment

Collect the students' journals. Did they answer the initial questions and keep a running log on plant growth? Did the students answer the follow-up questions? Did the students summarize what they learned from the activity?

What's Cookin'?

How are living things linked in the Ecosystem?

Summary: This lesson will help students understand how energy flows within an undisturbed habitat. Students will learn about the flow and about the interdependence of organisms.
Duration: 1 week
Setting: Classroom
Vocabulary: primary consumers, secondary consumers, tertiary consumers, scavengers, detritivores, predators, herbivores, carnivores, primary producers, photosynthesis, thermodynamics
Standards/Benchmarks Addressed: SC1-E1, SC2-E1, SC2-E2, SC2-E3, SC3-E1, SC4-E2, SC4-E5, SC5-E2, SC5-E3, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC9-E1, SC11-E1, SC11-E2, SC11-E3, SC11-E4, SC11-E5

Objectives
Students will:

- Recognize the food web and the living things that are a part of it.
- Discuss the elements of a food web and their impacts on the world.
- Have a better understanding of the interdependency of all living things in an ecological system.

Background*: A Close Look at Energy*

There are two important laws of thermodynamics that are fundamental to understanding how energy behaves in living systems. The First Law states: *Energy can be changed from one form to another, but it can never be created or destroyed*. Energy transformation occurs all the time in living systems: photosynthesis converts light energy into chemical energy, mammals convert the chemical energy in their food into the heat needed to keep their bodies warm. The First Law also tells us that in any energy conversion, the energy that exists after the conversion is exactly equal to the energy that existed before, however, the quality doesn't remain the same. The first law may lead us to believe that there will always be enough energy, yet anyone who has attempted to start a car with no gas can attest to the fact that though there once was gas (chemical energy) in the vehicle it was converted to energy of movement and now is no longer there.

The Second Law states: *In all energy exchanges and conversions, the potential energy of the final state is always less than the potential energy of the initial state*. In other words, every time energy changes form, there is less *useful* energy after the change than before. Almost every time energy changes form, some of the energy turns into "low quality" heat that is "lost" to the surrounding environment. The energy still exists, but is no longer easily used. Ecologists express the energy quantities in an energy pyramid. The pyramid shows how many producers(plants) are needed to feed the primary consumers (mice) that are needed to feed the secondary consumers (snakes) that are needed to feed the top predator (a coyote). Understanding the Laws of Thermodynamics and applying them to the food pyramid allows one to see why there needs to be more mice than coyotes in a desert.

Let us follow the energy flow. Energy of life starts in the sun. It is passed along from one organism to another; from plants to plant eaters, on to the animals that eat them and so on. An animal's use of the sun's radiant energy begins with the "capture" of that energy by photosynthetic plants (and certain microorganisms) that convert light energy to chemical energy in the form of carbohydrates. Each organism is described by its position in the energy flow, and because plants capture the sun's energy and make their own food, they are called primary producers. What makes humans, and every other non-photosynthetic species (all animals), possible is that all other organisms can utilize the plant's stored energy. Animals (or the plants themselves) can break down the glucose and other food molecules produced by plants into water and carbon dioxide in a process called respiration. Respiration is photosynthesis in reverse. During respiration, the stored chemical energy captured originally by the plant is released for use by the plant-eater. Primary consumers are the herbivores, or plant-eating animals, that feed almost exclusively on photosynthetic plants; also called primary consumers. Other animals called secondary consumers prey on primary consumers. Secondary consumers are the carnivores. Tertiary consumers are the carnivores that feed on secondary consumers. Detritivores are organisms that feed on small bits of dead material and waste from each level. As each of these organisms dies, its components are broken down by digestion or by various decomposers, such as bacteria and fungi. There is also another type of consumer. Scavengers, which include earthworms and vultures, are animals that eat dead animals. They play a crucial role in the recycling of nutrients for further use in the ecosystem. In the real world many animals eat more than one kind of animal. Also, most prey animals are eaten by more than one kind of predator. This producer-consumer-decomposer sequence in a food chain represents a flow of both energy and matter. Thus the depiction of a simple chain turns into a complex web.

Consider this. Each individual from each species is concerned most basically with obtaining energy—energy to keep going, energy to grow, and energy to reproduce—in sum, energy for survival. Ultimately, all that energy comes from the sun through plants and the medium of photosynthesis. It ultimately returns to the universe as waste heat from cellular respiration.

Materials
Owl pellets*
Paper towels
Bone diagram
Tweezers or toothpicks

Procedure
Warm up: Write the words shrews, grazing insects, sun, owl, grass. Ask students why they think these five words would be placed together and what they have in common. Students should answer that they are all in a food chain. Explain that the students will be completing an activity that will enable them to see evidence of connections within a food chain. Review key terms such as primary producer, primary carnivore, and herbivore.

Activity: Students will pair up. Each pair should receive an owl pellet. Have students begin taking apart the pellet. Students should examine the various bones they find. Have them compare these bones to a bone chart. After identifying the various types of bones found discuss what we can conclude from these findings. Refer back to the original words on the board and ask students to draw an illustration showing the food chain represented in this activity.

Explain to the students that the class will be making a food web mural. Students will choose any ecosystem, for example the Chihuahuan Desert. Once they've identified an ecosystem the student will pick a plant or animal that lives there and through research, determine its place in the web. Once students have determined its place they should also identify its predators and

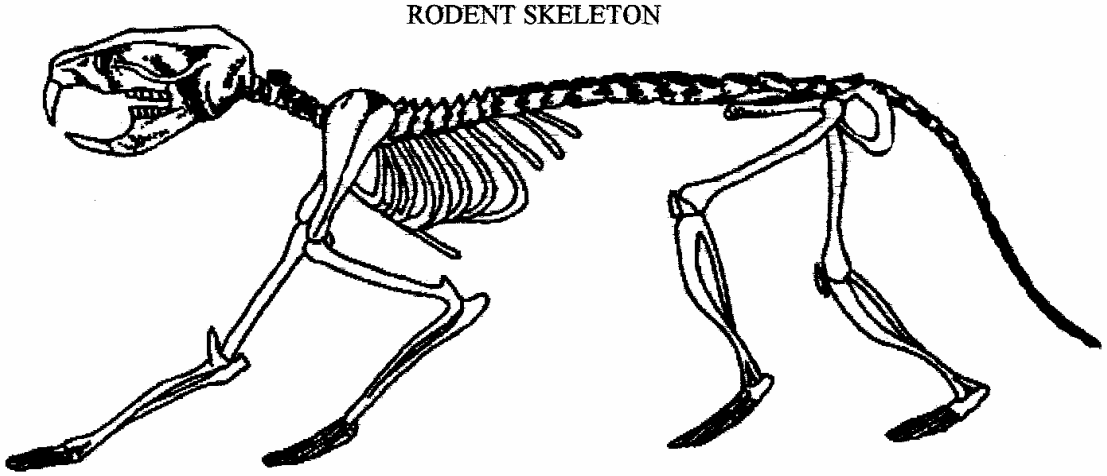
prey. When students have completed their findings they will place their information on the class food web model.

***Wrap Up*:** Discuss the completed food web.

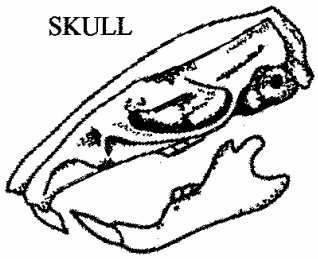
Assessment
Research on their animal or plant.

*Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215
1-800-334-5551

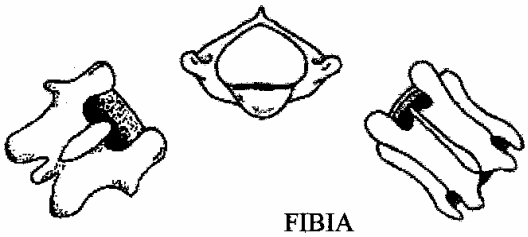
BONES FOUND IN OWL PELLETS
RODENT SKELETON



SKULL



VERTEBRAE



PELVIS

ULNA & RADIUS

RIBS

FIBIA & TIBIA

HUMERUS

SHOULDER BLADE

FEMUR

What's Cookin'?
Research Format

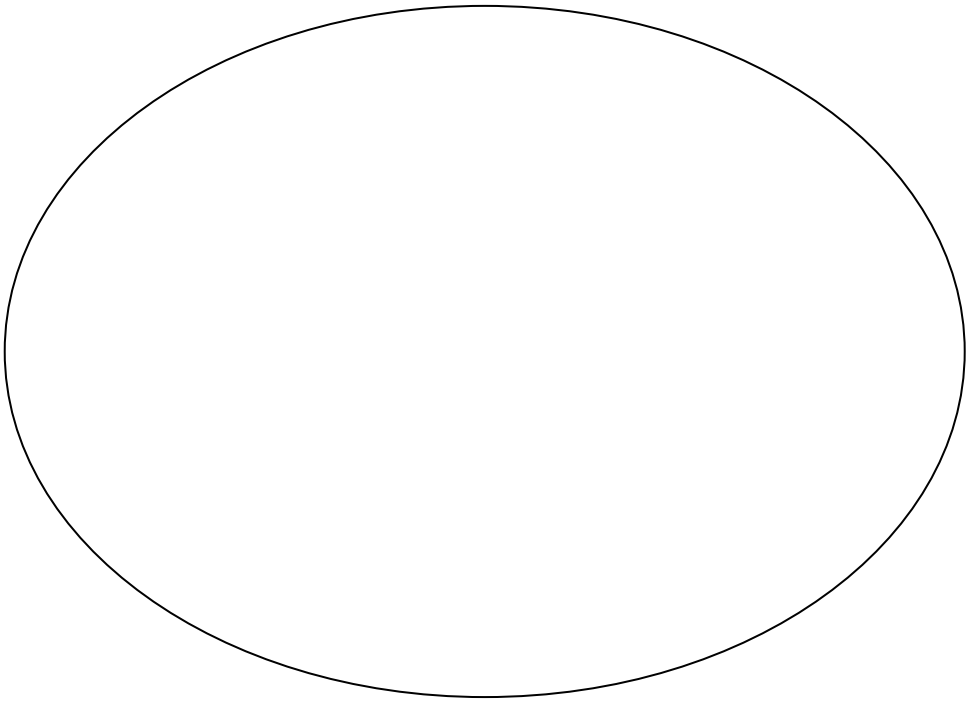
Name:_____

One way ecologists show a community's energy flow is through food chains and food webs. A food chain shows what one type of animal eats and what its prey eats in turn. A food web goes a step further, showing the relationships among many animals in a community. It shows who eats what and who eats whom within a community. A web that includes all the animals and plants in a small patch of the Chihuahuan Desert, for instance, would have hundreds of strands.

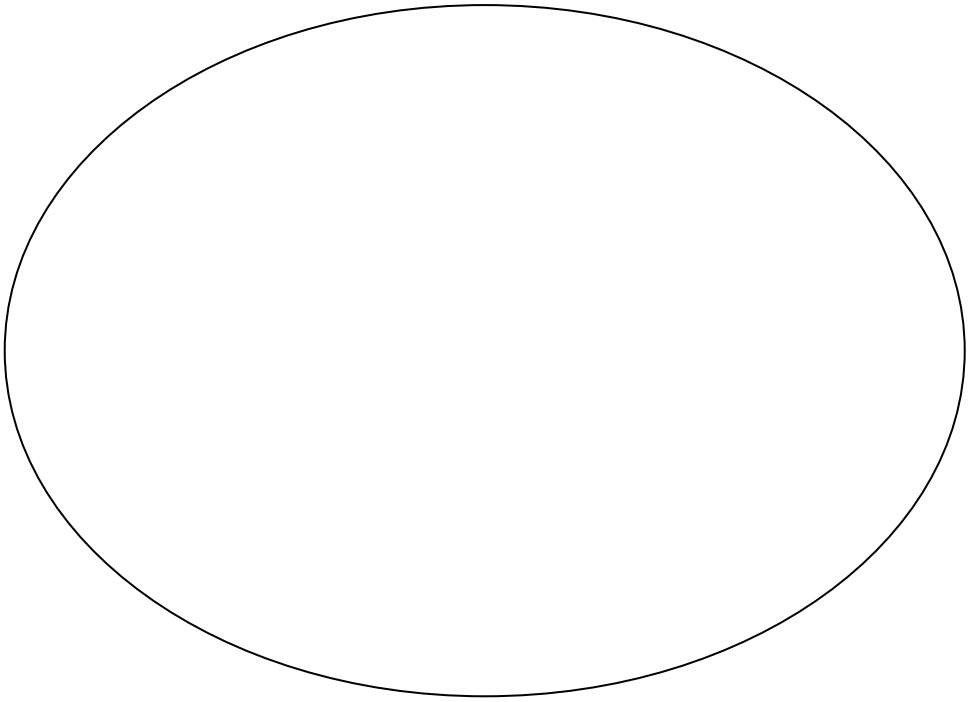
Use this information for review as you complete your research.

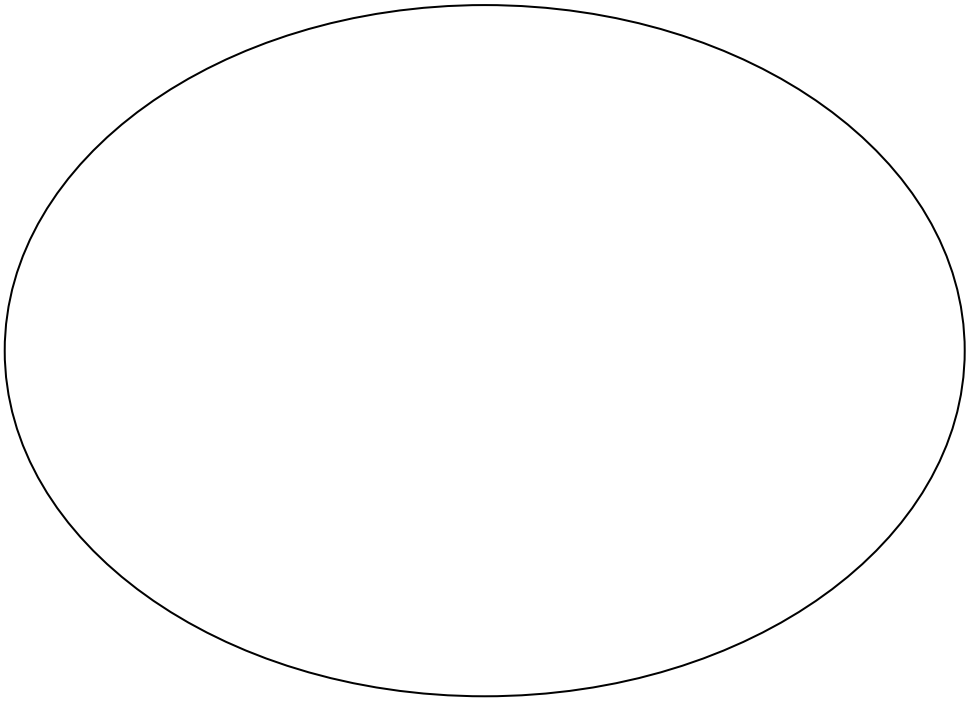
An animal's use of the sun's radiant energy begins with the "capture" of that energy by photosynthetic plants. Because plants capture the sun's energy, they are called primary producers. A primary consumer is a plant-eating animal, or herbivore. Primary consumers are preyed on by other animals, the secondary consumers, and so on, in what is termed the food chain. As each organism dies, its components are broken down by digestion or by various decomposers, such as bacteria and fungi. This producer-consumer-decomposer sequence in a food chain represents the flow of both energy and matter.

Use the shape below to label and illustrate the plants and animals in your chain (use one for each illustration).



What's Cookin'?
Research Format





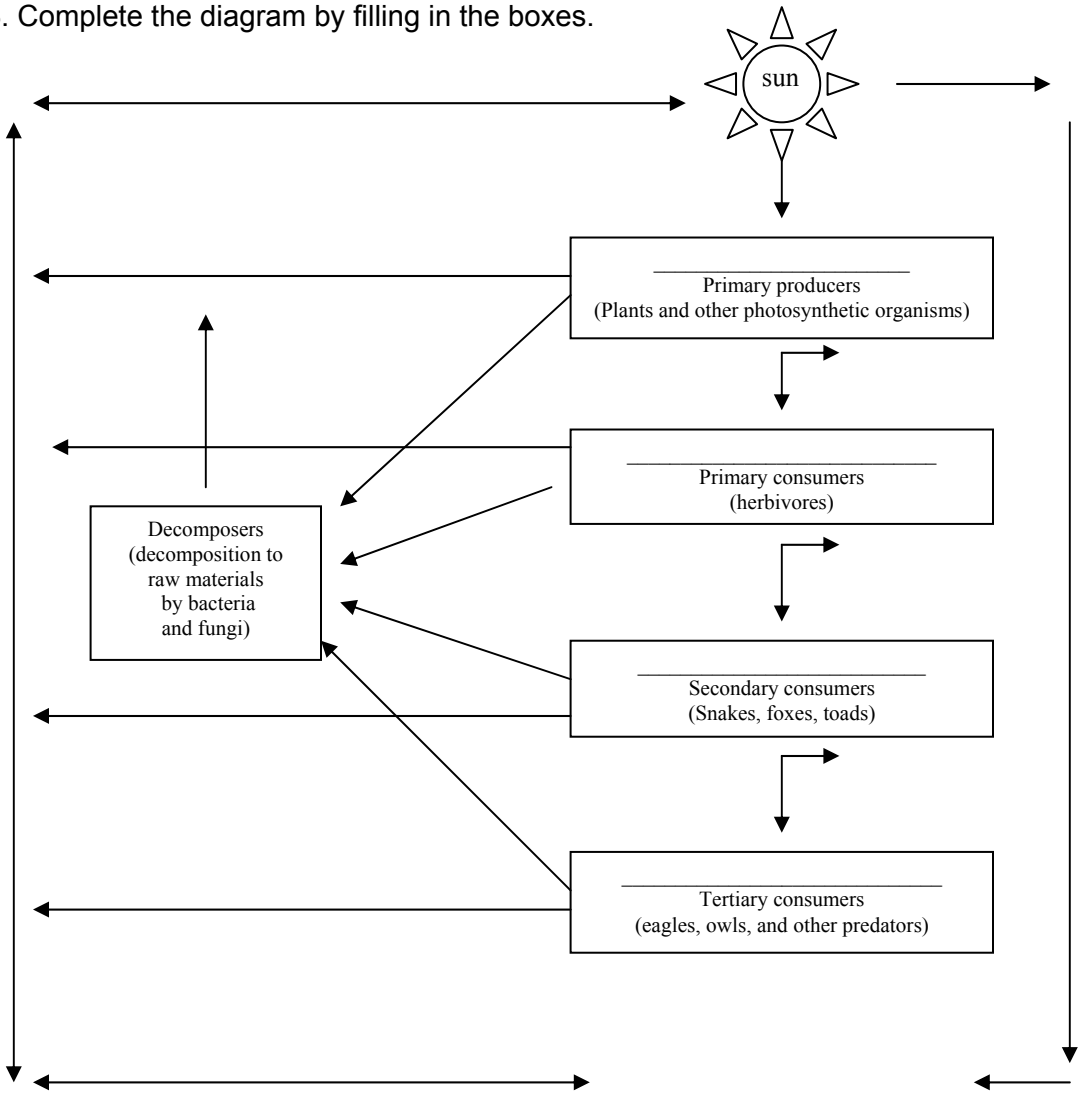
What's Cookin'?
Research Format

Name:_____

1. Identify your plant or animal. _____

2. Determine where your plant or animal fits in the diagram and write its name in the box.

3. Complete the diagram by filling in the boxes.



Biomes!

What are the seven biomes?

Summary: This lesson introduces the students to characteristics of the seven biomes (grassland, ocean, forest, desert, rainforest, taiga, and tundra).
Duration: 1-2 class periods
Setting: Classroom
Vocabulary: biome, grassland, ocean, desert, forest, rainforest, taiga, tundra
Standards/Benchmarks Addressed: SC1-E1, SC2-E3, SC3-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC11-E2, SC11-E3, SC11-E4, SC11-E7

Objectives
Students will:

- comprehend the distinct differences in the characteristics of the seven biomes.
- create a poster depicting the characteristics of the seven biomes.

Background
Each environment has different kinds of organisms. One factor that influences where organisms live is climate. Climate is the average weather of a region over a long period of time. Two basic factors influence both climate and weather. These factors are precipitation and temperature. Weather is the result of the day-to-day changes in these factors. Climate is the average of these factors over a long period of time.

A biome is a region characterized by certain kinds of plant life, animal life, and climate. The plants and animals that survive in a biome are adapted to the conditions of that biome. Each biome is described in terms of its climate and its living things. The plants and animals that survive in a biome are adapted to the conditions in that biome.

Some researchers say there are six land biomes on the Earth, however we included the ocean as a separate biome. That brings us to a total of seven biomes on the Earth. These biomes include the desert, grassland, forest, rainforest, taiga, tundra, and the ocean.

The tundra is a biome that is cold and receives little precipitation. Winters in the tundra are long, dark, and very windy. Summers in the tundra are very short. There are only about eight weeks of the year when conditions are right for plants to grow. Most of the soil in the tundra is frozen all year. This frozen soil is called permafrost. Few plants can survive in the tundra, because the growing season is so short. The plants that do grow are adapted to grow very quickly. The most common plants are grasses, mosses, and lichens. The animals that live in the tundra have special adaptations that allow them to survive in the very cold environment. These animals include: caribou, lemmings, arctic foxes, snowy owls, and wolves.

The taiga is a biome in which the main type of plant life is evergreen trees. This biome has long, hard winters and constant snow cover. However, there is no permafrost in the taiga. The most common plants in the taiga are conifers. Because conifers keep their leaves all year, little sunlight reaches the forest floor. The only plants that can survive with very little sunlight are ferns and mosses. The animals that reside in the taiga have adapted to living in these conifer forests. These animals include: porcupines, crossbill, and moose.

The deciduous forest is a biome named for the broad-leaved trees found there. The climate is temperate. Temperate means that it is not very hot or very cold. The plants of the deciduous forest include deciduous trees (maple, oak, and beech) and many wildflowers along the forest floor. The animal life in the deciduous forest is very diverse. It includes: squirrels, deer, rabbits, black bears, hawks, foxes, insects, worms, birds, frogs, slugs, and snakes.

The tropical rain forest is a biome that has high temperatures and a large amount of rainfall. Tropical rain forests are found only near the equator. The tropical rain forest changes very little from season to season. There are more living things in the tropical rain forest than in all other biomes combined. It has been estimated that 50% of all living things live in the rain forest. However, this biome only covers 2% of the Earth's land mass. Some of the plants in the rain forest include hanging vines and sandbox trees. The animals of the rain forest are adapted to live only in one level of the rain forest. Few animals move from one level to the next. There is so much diversity in the rain forest it is hard to identify all the plants and animals that live there. Some of the animals that live in the rain forests include: hummingbirds, sloths, monkeys, toucans, and parrots.

The grassland in temperate regions is a biome that has cold winters, warm summers, and uneven precipitation. As you might guess, grasses are the main kinds of plant life in the grasslands. Many insects live in the grassland. They include: ants, locusts, and grasshoppers. The grass also provides the appropriate habitat for many other animals. These animals include: prairie dogs, burrowing owls, hawks, coyotes, and wolves.

The desert is a biome that receives less than 10 inches of rainfall each year. Most people think that the desert is always hot. That is not true. A desert can also be very cold. Desert plants have adapted to living with very little water. Some of these plants include: cacti, creosote bush, and other small-leaved plants. Desert animals have also adapted to prevent water loss. These animals include: snakes, lizards, and kangaroo rats.

An ocean is a large body of salt water. There are four major oceans on the Earth: Pacific, Atlantic, Arctic, and Indian. Since these oceans are all connected water can flow from one ocean into another. The same is true with animal and plant life. The ocean is alive with a great deal of plants and animals. Seaweeds, sea snakes, whales, whelks, penguins, porpoises, tuna, and tunicates are just a few of the many organisms that live in the ocean.

Materials
Butcher paper
Drawing materials
World map
Science textbook

Procedure
Warm up: Ask the students if they have ever heard the term biome. Explain what a biome is. Ask the students to brainstorm possible biomes and discuss the seven biomes: grassland, ocean, desert, forest, rainforest, taiga, tundra

Activity

1. Look at the world map with the class and discuss where some of the biome regions can be found. Divide the class into groups of 2 to 4.
2. Each group will be given a large piece of butcher paper. The students will then divide that piece of paper into seven different sections, one for each of the biomes discussed.

3. Students are to research and fill up as much space as possible in each of the biome sections with pictures and facts about plants, animals, and weather characteristics for each particular biome. The groups should discuss between themselves what should go into each biome section and why it belongs there.

Wrap Up: Students will present their work and explain some things that make each biome distinct: a particular plant, animal, and weather characteristic.

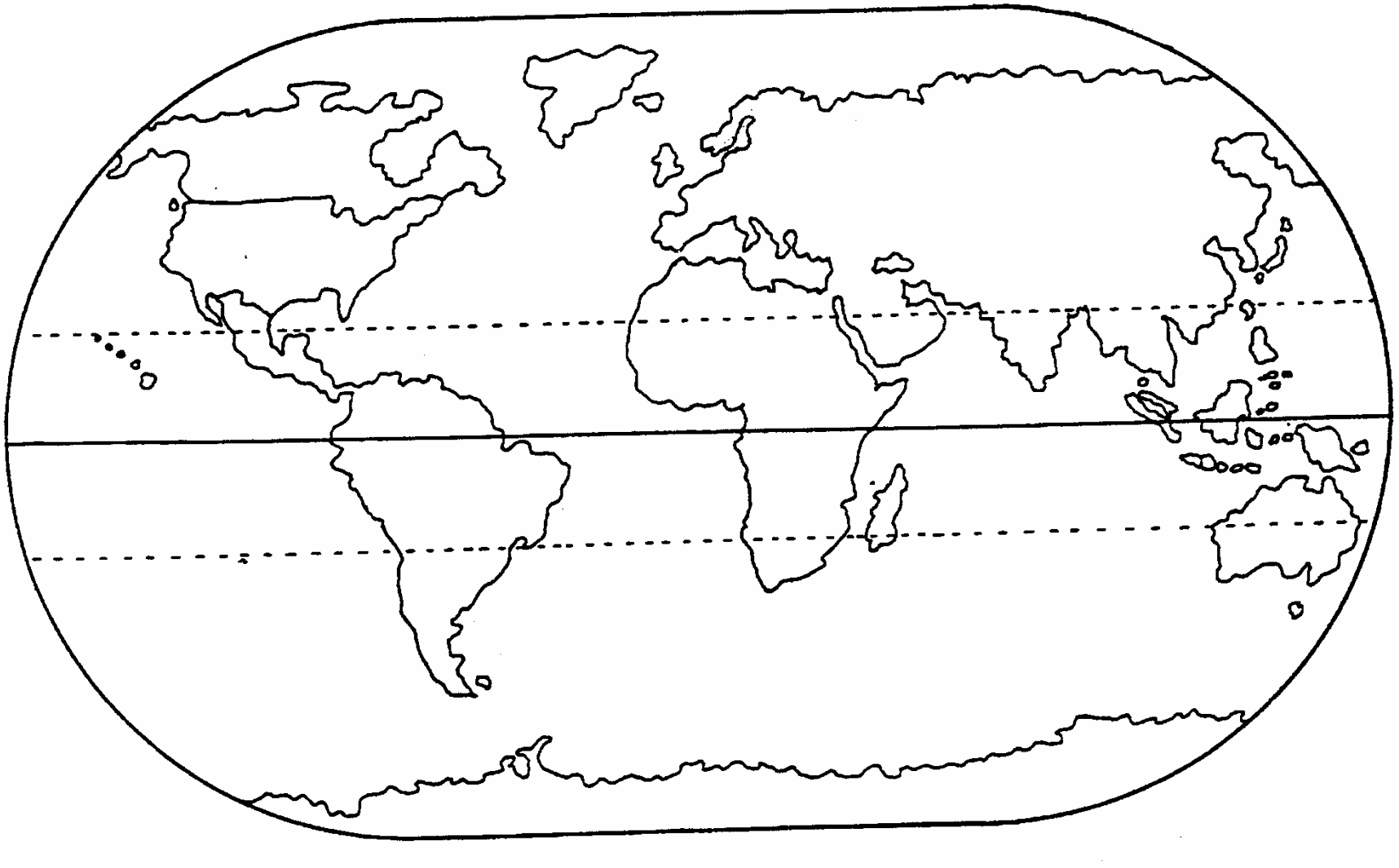
Assessment

Students should be able to answer the following questions (teacher may use any format: game, written, discussion):

1. *What is a biome?*
2. What is the climate like in the desert? How does it compare with the climate in the tundra?
3. What is the climate like in the rainforest? How often does it rain?
4. In what biome would you find a cactus?
5. In what biome(s) would you find a wolf?
6. If you find a wolf in more than one biome, how is it possible?
7. Because of the harsh hot and dry conditions of the desert, what characteristics would a plant (and animal) have in order to survive there?
8. What might the waxy coating and spines on the plants in the desert tell us about the weather there? How might this relate to the plant life in Carlsbad Caverns National Park?
9. How do animals of the forest, grassland, tundra, taiga, desert, and rainforest differ form the animals of the ocean?
10. What biome-like region is Carlsbad Caverns National Park located in?

Name: _____

Directions: Outline, color, and label your specific desert on the world map.



Why's it so Hot?

What are the distinguishing features of a desert and how are they formed?

Summary: Students will explore the various factors that contribute to the formation of a desert.
Duration: 1 class period
Setting: Classroom and outside
Vocabulary: arid, desert, evaporation, precipitation, desertification, rain shadow
Standards/Benchmarks Addressed: SC1-E1, SC2-E1, SC3-E1, SC4-E1, SC4-E5, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC11-E1, SC11-E4, SC11-E5

Objectives
Students will:

- understand the physical characteristics of a desert biome.
- be able to identify four major reasons why deserts are formed.

Background
Imagine a place with only a few drops of water to drink all year long; a place where the sun can be so hot that rocks are too hot to touch. A desert is an area that receives less than 10 inches of precipitation per year *and* has a high rate of evaporation (if the annual evaporation rate of an area is higher than the annual amount of rainfall, the area is considered a desert). Deserts cover roughly one-third of the Earth's land surface. There are about 20 major deserts in the world, spread out on five continents. Many people may think that deserts are all the same. In fact, deserts are among the most varied and interesting landscapes on earth. Their barren appearance is misleading because an amazing variety of wildlife and plants have evolved adaptations enabling them to survive the harsh environment. Some deserts have rolling dunes while others have a flat surface of smooth stones. Deserts also vary in terms of the altitude in which they are found.

It is important to recognize the relationship between the Earth's geography and its climate. There are four major reasons why deserts form. Deserts occur as a result of more than one of these factors: latitude, ocean currents, rains shadows, and central location on a continent.

Rain shadow deserts are created by prevailing winds that reach a mountain range. As they rise quickly and cool, they lose most of their moisture as rain. By the time the winds cross over the mountains and move down the far side, they are very dry. The dry winds will create a "rain shadow" desert if the area on the far side of the mountain does not receive moisture in some other way.

Inland deserts are formed because they are just too far from moisture-filled ocean winds. Air that picks up its moisture over the oceans has already dropped that moisture as rain by the time it reaches these mid-continental regions.

Latitude deserts are found along one of two lines of latitude, 30 degrees north or 30 degrees south. Many deserts form because they lie in zones of high atmospheric pressure, where dry air is descending. As the descending dry air warms up, it absorbs much of the moisture in the area.

Cold current deserts are created when moisture-laden air traveling east over the ocean cools as it crosses cold ocean currents (along the western coasts of Africa, South America, and North America). Since cool air holds less moisture than warm air, the cooling air masses drop most of their moisture over these cold currents. By the time the air reaches the west coast of the continent, it is very dry.

Materials
Map of the United States
Colored pencils
Two buckets of water
Sponges
Ruler
2 shallow pans
Salt
Stopwatch
Chalkboard

Procedure
Warm up: Ask students to brainstorm what they think they know about deserts, their characteristics, and how they are formed. Write responses on the board. Give students the definition of a desert. Explain that they will be performing an activity that will allow them to observe how evaporation affects living things in the desert. Using a map of the United States, ask students to locate the four deserts in the North American continent.

Activity: In these activities, students will get a chance to find out how evaporation affects living things in the desert and how it helps shape the way many desert areas look.

1. Show students how water evaporates by wiping a damp sponge across a chalkboard. Explain that the water evaporated or changed from a liquid to an invisible gas called water vapor.
2. Next, ask students how heat affects evaporation. To show how heat affects the evaporation rate, complete these two demonstrations.
3. Place one pan in a sunny, open area and the other in a shady area. Fill each pan with exactly two inches of water. Leave the pans in place several hours, then measure the amount of water in each pan. Does one pan now have less water?
4. The second demonstration shows how quickly rainfall evaporates off the hot desert ground with a sidewalk graffiti demonstration. Take a bucket of water, some sponges, and a stopwatch to an outside area. Locate a shady sidewalk area and a sunny one. Have the students write their initials on the sunny sidewalk with a damp sponge. With the stopwatch time how long it takes for their letters to evaporate completely. In which area did the water evaporate more quickly?

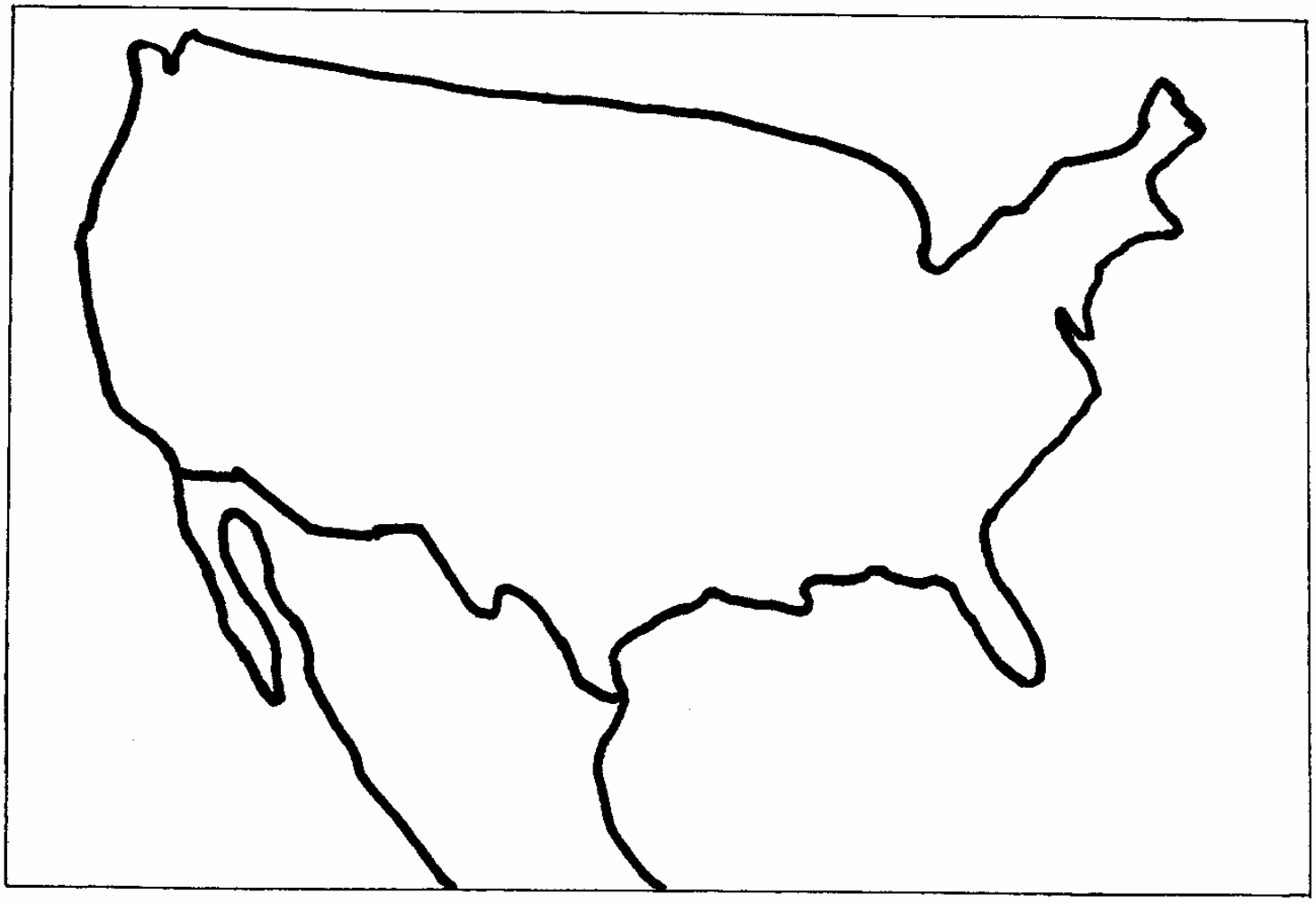
Explain to the students that they will be researching the four deserts located on the North American continent. Divide students into four groups. Assign each group a desert to study. Each group should complete research on their assigned desert. Include the name, type, size and location, how the desert was formed (rain shadow, high pressure, inland, latitude, or cold current), physical features, examples of plants and animals (what are their indicator species), and special facts. Pass out a map of North America to each group. Each group will provide a physical outline of their assigned desert.

***Wrap Up*:** Groups will present their information to the class.

Assessment
See research rubric.

Name: _____

Directions: Use the following map to color and label the physical outline of your assigned desert.



North American Desert Research

Research on North American Deserts	Self Evaluation	Teacher Evaluation	Comments
Visual:		**/4**	
Includes North American map with location outlined, colored, and labeled (consider quality and appeal).			
Written Report:		**/20**	
Includes content about animal life (identifies indicator species).			
Includes content about plant life (identifies indicator species).			
Includes location or geography.			
Written in complete sentences (neat, proper grammar, spelling, etc.)			
Cites 3 references (*at least one internet site).*			
Presentation:		**/4**	
Organization of information, quality, etc.			
Teamwork:		**/4**	
Are the efforts of each team member clearly demonstrated, or did it appear to be the work of one or two?			
Responsibility:		**/4**	
Turned in on due date and presented in class with visual aids.			

4 - no mistakes 3 - few mistakes 2 - many mistakes 1 - incomplete (however is present) 0 - not evident or not included

Percentages: Visual ____ Written Report ____ Presentation ____ Teamwork ____ Responsibility ____ Overall ____

Scenic Sculpture

How are these desert landscapes created?

Summary: Through a hands-on activity, students will explore the factors contributing to desert formations and construct 3-D models.
Duration: 2 class periods
Setting: Classroom
Vocabulary: alluvial fan, arroyo, butte, dune, erosion, mesa, wadi, arch, playa, canyon, columns, weathering
Standards/Benchmarks Addressed: SC1-E1, SC2-E1, SC2-E3, SC3-E1, SC4-E1, SC4-E5, SC6-E2, SC6-E3, SC6-E5, SC6-E6, SC12-E1, SC12-E3, SC12-E7

Objectives
Students will:

- identify various desert landforms.
- identify causes of desert landforms.
- construct a 3-D model to illustrate the features seen in a desert.

Background
Deserts landscapes have been described in terms ranging from breathtaking to barren. Although you see no autumn foliage or lush deep greens of summer the desert landscapes are distinct and varied. Cracked salt flats, deep rock canyons, golden arches, and towering sand dunes are all part of desert landscapes, along with arroyos, playas, buttes, and other landforms. In order to determine how the formations are created it is necessary to take a look at the various factors that create a desert.

It is important to start by defining a desert because it is here that we first begin to see the process. Deserts are defined as an area that receives less than 10 inches of precipitation per year and has a high evaporation rate. Evaporation rates can be from seven to fifty times high as the rate of precipitation. The dry air of the desert allows 90 percent of the incoming solar radiation to strike the Earth's surface as compared to 40 percent in humid climates. It is no wonder then that deserts truly are the hottest places on earth. The same dry air that allows the radiation to penetrate during the day also allows the accumulated heat to be radiated back to the sky at night. Therefore, deserts are also known for their extremes in day and nighttime temperatures.

If you were to look closely at a map of the Earth you would see that deserts aren't randomly scattered. In fact, it is important to recognize the relationship between the Earth's geography and its climate. Deserts are located where they are because of four main factors: latitude, rain shadows, cold currents, and central location on a continent.

Most deserts are found along the lines of latitude: 30 degrees north or 30 degrees south. This occurs because of the way air circulates in the tropics. Rain shadow deserts form when a mountain cuts off a low-lying area's rain supply. As moisture-laden winds travel over mountains they rise and cool thus dropping their moisture on the western side of the mountain. Cold

currents are caused by ocean winds being cooled as they blow across very cold currents near shore. This cold, dry air holds little to no moisture and therefore, as it blows inland, a desert is created. The many deserts are found in a central location on a continent. Any air that picked up moisture over the oceans has already dropped it as rain before it reaches the mid-continent region.

What does the dryness have to do with desert formations? For one thing, forces of wind, water, and weathering are given more power by the high evaporation rate. Wind is one of the primary factors in sculpting the desert. A sandblasting effect occurs when dry sand, pebbles, and dirt are picked up and blown with great force. Because of the dry surfaces and sparse soil-anchoring vegetation, we see sand particles blown into high dunes.

Water is an even more powerful erosive force than wind. Rainfall and riverflow are infrequent in desert areas. And yet, it is not uncommon to experience flash flooding. When rain does come to a desert, it often falls heavily, washing away soil, transporting rocks and sand, and cutting deep gashes in the surface. When streams and riverbeds fill with water, sediment is eroded and carried with enormous power. This mud, sand, and water slurry scours everything in its path. An example of this is the Colorado River creating the Grand Canyon. Flood waters running down a mountain drop their load of sediment, forming alluvial fans.

Weathering is how exposure to the elements breaks down rocks. One form occurs when the rapid heating and cooling of the desert causes rocks to expand and contract, building up strain. This strain can build up until a rock cracks. It's a slower process, and a more subtle contributor to desert formations than wind and water, but just as important. In many deserts sand helps shape the way desert landscapes look. Although water can erode rock surfaces without sand, sand increases the amount of erosion that takes place.

Materials
Water
Flour
Salt
Measuring cups
Sandpaper
Cardboard (at least 14"x18")
Small plastic bowls
Paints
Bowls
Chalk

Procedure
Warm up: Pass out a small sheet of sandpaper to each student. Ask them if they know what sandpaper is used for (it helps grind and smooth rough surfaces on wood and other materials). Explain that water or wind-carried sand can also grind, just as sandpaper does. For example, during a sandstorm in the desert, the wind may blow hundreds of pounds of sand around at speeds of over 10 miles per hour for several days. As the grains constantly bounce and grind they begin to wear rock surfaces down. Hand each student a piece of chalk and allow them to experience the abrasiveness of the sandpaper by rubbing it against the chalk. Remind the students that this same effect can be caused by water too.

Refer to the background information that stated how the Colorado River was made.

Activity: Students will make salt dough clay and then create a desert scene that depicts a variety of landforms found in a desert.

Step 1 – Have students combine ½ cup of salt and 1 cup of flour in a bowl. Students will then slowly add water and stir until the dough is the consistency of bread dough.

Step 3 – The teacher will name a landform and then give the definition. Students will be expected to write down all definitions, and then based on the description only, form their interpretation of that landform. Once finished, teachers will show pictures of each landform named. Students will assess their formation and make the necessary changes.

Step 4 – Each student will be given a piece of cardboard and will be instructed to create a desert landscape that would include seven of the eleven types of landforms defined. Students should label each landform.

Step 5 – Students may be allowed to paint their formations. Keep in mind the colorings of the various formations are often due to the different minerals found as opposed to vegetation.

Wrap Up: As a review play a quick game of “What am I?” Students will be given a definition or a picture and asked to provide the name. This can be played for fun or for bonus points.

Assessment
Topographical desert formations made of salt dough, quiz.

Scenic Sculpture
Landforms Quiz

Name: _____

Students should draw a picture of each type of landform listed:

1. arroyo	**2. butte**
3. wadi	**4. alluvial fan**
5. dune	**6. canyon**
6. playa	**7. arch**

Desert Formation Model

Desert Formations	*Self Evaluation*	Teacher Evaluation	Comments
Visual:		**/12**	
7 of 11 types of landforms discussed are depicted.			
Formations are accurate.			
Painted formations represent realistic coloring.			
Written:		**/8**	
Provides a definition for each landform.			
Identifies an area in which each landform can be found.			
Presentation:		**/4**	
Organization of information, quality, etc.			
Responsibility:		**/4**	
Turned in on due date and presented in class with visual aid.			

4 - no mistakes 3 - few mistakes 2 - many mistakes 1 - incomplete (however is present) 0 - not evident or not included

Percentages: Visual _____ Written _____ Presentation _____ Responsibility _____ Overall_____

How Do They Survive?

What is a microhabitat and how does it help plants and animals survive?

Summary: Students will describe the various ways in which plants and animals of the desert adapt by participating in an activity that examines microhabitats as one type of adaptation.
Duration: 1 class period
Setting: Classroom
Vocabulary: burrow, microhabitat, adaptation
Standards/Benchmarks Addressed: SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC2-E3, SC6-E2, SC6-E3, SC4-E4, SC4-E5, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E5, SC6-E6, SC11-E2, SC11-E3, SC11-E5

Objectives
Students will:

- interpret the results of their experiment in order to determine if their hypothesis was supported.
- explain how animals and plants use microhabitats as a means of survival.
- explain what a microhabitat is.
- understand how life cycles of plants and animals help them cope with desert conditions.

Background
A variety of organisms live in almost any habitat you could name. The desert, for example, is a challenging habitat for the plants and animals that live there. Yet for thousands of years plant and animal species have adapted and thrived in these arid lands. How? Because each organism has its own way of life which often requires a different environment from that of other organisms, plants and animals inhabit specific microhabitats within the environment of a general habitat. This microhabitat allows them to accommodate their needs and survive the harshness of the desert. A microhabitat is simply a small, distinctly specialized habitat.

For some animals their respite is the cool interior of a burrow. Rattlesnakes, kit foxes, and kangaroo rats spend most of the day resting in underground burrows. They choose the night for their active period to avoid the intense dehydrating heat of the daytime sun. During the day, the cool microclimate of their burrows helps protect them. How cool is it? While the soil surface up top may be 165 degrees Fahrenheit, their underground dens may be a livable 80 degrees Fahrenheit. In their cozy microhabitat, these animals can conserve their energy for nighttime hunting or seed gathering expeditions. Astonishingly, over half of all vertebrate animals, including those that live in caves and the soil, are nocturnal.

During the dry times, animals such as the spadefoot toad, an amphibian that lives in the American Southwest, can be found in a burrow dug with its spade-shaped back feet. It will continue to lie dormant until the sound of raindrops hitting the surface awakens the toad. At that point the race is on. Within approximately 8-10 days the cycle of finding a mate to laying the eggs to becoming a toad will be complete.

Some plants use combined strategies of dormancy and an accelerated life cycle. The seeds of the sand verbena will remain dormant (sometimes for years) until there is enough rain. When there is sufficient rain, they grow quickly, making their flowers and seeds and then dying all within a period of a few weeks. Some plants bloom at night in order to minimize water loss.

An arroyo, a ditch carved by water in desert regions, makes for the perfect microhabitat for javelinas. When the steep banks erode, shallow cavities are created that provide warmth in the winter and cool in the summer.

Cave entrances can provide a microhabitat for a variety of plant and animal species and provide growing conditions similar to a forest. It is not uncommon to find a fringe of green around the entrances to caves. Upon closer examination, evidence of animals such as birds, snakes, skunks, or mice living in the mouth of the cave can be found.

A variety of microhabitats can be found in any environment. Plants and animals find “their place” in logs, under boulders, in cacti, or even under a refuse can. Places such as a shady area under a tree or shrub are microhabitats because they provide a home for shade loving plants or respite for the desert lizards.

The above mentioned areas are only a few of the vast array of microhabitats found in an environment. The challenge is to locate some in your area. A hike is a great way to discover your world. When hiking an area such as the desert here are a few things to look for:

- Cuplike nests tucked in cholla cacti, where cactus wrens raise their young;
- Mounds where kangaroo rats live;
- Lizards basking on rocks;
- Young cacti growing under “nurse” trees or plants;
- Shallow pits in the ground where javelinas have been digging for roots;
- Cavities in cacti, where woodpeckers or owls nest

Materials
3-5 gallon terrarium
Sand (enough to fill the bottom 5 inches)
1 large, flat, dark-colored rock
12-inch scientific thermometer
Desk lamp with 100 watt bulb
Paper towel tube
Full sheet of paper
1 craft stick
Scissors
Graph paper

Procedure
Explain to the students that there are a variety of ways in which plants and animals adapt in order to survive. Today’s focus will be on the use of microhabitats as a means of survival.

Warm up: Write the word microhabitat on the board. Ask students for a definition. Explain that a microhabitat is a small area within a habitat that provides special conditions. These special conditions can include shelter, moisture, darkness, etc.

Activity: Students will create a microhabitat in order to determine how animals find small cooler climates amid the harsh conditions of the desert.

- Let the sand sit in the classroom overnight so that it will be room temperature. Place the paper towel tube lengthwise in the bottom of the terrarium (cutting if necessary). Cut a hole approximately ¾ inch in diameter on the topside of the tube. Roll up a sheet of paper and insert it into the hole in the paper towel tube. Fill the terrarium with sand (5 inches deep). Place the rock on the top of the sand. Clear an area on one side in order to create a shady overhang. Position the heat source so that it is 5-6 inches above the terrarium. Mark the center of the terrarium with a craft stick. This is the place where the temperature readings will be taken. Mark an X on the rock with a permanent marker to show where that temperature will be measured. Do not turn on the lamp until you are ready to begin the experiment.

Students will be divided into 6 groups. Each group will form a hypothesis regarding the temperatures within the microhabitat. Students will also tell why they made their hypothesis. Students will record temperatures in four locations, four times a day. A temperature reading will be taken in the burrow, under the rock, on the surface of the rock, and on the surface of the sand. The temperatures will be taken at times to be determined. After one day of taking temperatures a pattern should emerge. You may continue to take readings for another day in order to determine consistency in the pattern.

Wrap Up: Explain to the students that the five areas in the terrarium were used to simulate microhabitats found in the desert. Conduct a follow-up discussion based on the results of the experiment. Students should attempt to explain why or why not their hypothesis was valid.

Assessment
Students should create a graph to depict the results of the experiment and give a written response on what caused the variety of temperatures to exist within the terrarium.

Students will research various types of microhabitats that plants and animals utilize.

Extension
Students could go on their own microhabitat search and locate the variety of microhabitats found in their area.

How Do They Survive?
Microhabitat Research

Microhabitats	*Self Evaluation*	Teacher Evaluation	Comments
Visual:		**/12**	
4-fold with illustrations should depict microhabitats.			
Illustrations should be colorful, detailed, and fill the page.			
Graph should be included (look for accuracy).			
Written:		**/16**	
Provides a paragraph in response to the graph analysis. (What caused the variety of temperatures.)			
Provides a definition of microhabitat.			
Identifies the type of plant/animal that uses the microhabitat.			
Identifies an area in which each of these animals and their microhabitats can be found.			
Responsibility:		**/4**	
Turned in on due date and presented in class with visual aid.			

4 - no mistakes 3 - few mistakes 2 - many mistakes 1 - incomplete (however is present) 0 - not evident or not included

Percentages: Visual _____ Written _____ Presentation _____ Responsibility _____ Overall_____

Great Deserts of the World

Are they all alike?

Summary: In this activity students will study the various aspects of the Chihuahuan Desert and by comparing it to other deserts of the world come to appreciate its uniqueness.
Duration: 1 class period
Setting: Classroom
Vocabulary: desert, arid, humidity, flash flood
Standards/Benchmarks Addressed: SC3-E1, SC4-E5, SC5-E2, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC12-E1, SC12-E3

Objevtives
Students will:

- locate some of the great deserts of the world on a map.
- research information about specific deserts of the world.
- create a travel brochure that includes specific information about their desert.

Background
Whether it is Death Valley or Takla Makan (translated, the place from which there is no return), these deserts are deserving of their name. Dry and often desolate, the desert can be a tough environment for humans. Sand dunes, solid rock, or pebbled ground can stretch for hundreds of miles, without a glimpse of shade in sight. People traveling with enough water to survive the daytime heat may freeze on cool nights or become lost in dust or sandstorms. Yet, deserts aren't all dryness, dunes, and desolation. They can have an array of colorful cacti, interesting creatures, flash floods, bizarre rock formations, tree-sized cacti, salty lakes, and high mountains.

The desert is a biome, a geographic area that supports a certain kind of climate and certain community of plants and animals. In the Sonoran Desert you'll find cacti of many shapes and sizes. The Australian Desert supports an abundance of lizards, from the geckos measuring in at 2 inches to the monitor that can grow to be 7 feet long. The Sahara Desert is home to 3.5 million square miles of hot, windy vastness. You'll find little wildlife along its rock and sand-filled floor. As you can tell, exactly what you'll see in a desert depends on which one you visit.

How are deserts formed? There are four major reasons why deserts form. Deserts occur as a result of more than one of these factors: latitude, ocean currents, rains shadows, and central location on a continent.

Rain shadow deserts are created by prevailing winds that reach a mountain range. As the winds rise quickly and cool, they lose most of their moisture as rain. By the time the winds cross over the mountains and move down the far side, they are very dry. The dry winds will create a "rain shadow" desert if the area on the far side of the mountain does not receive moisture in some other way.

Inland deserts are formed because they are just too far from moisture-filled ocean winds. Air that picks up its moisture over the oceans has already dropped that moisture as rain by the time it reaches these mid-continental regions.

Latitude deserts are found along one of two lines of latitude, 30 degrees north or 30 degrees south. Many deserts form because they lie in zones of high atmospheric pressure, where dry air is descending. As the descending dry air warms up, it absorbs much of the moisture in the area.

Cold current deserts are created when moisture-laden air traveling east over the ocean cools as it crosses cold ocean currents (along the western coasts of Africa, South America, and North America). Since cool air holds less moisture than warm air, the cooling air masses drop most of their moisture over these cold currents. By the time the air reaches the West Coast of the continent, it is very dry.

There are about 20 major deserts in the world, spread out on five continents. Despite their differences, deserts have two things in common: their dryness and high rate of evaporation. The desert is the hottest biome on earth. Most other biomes are insulated by their humidity (water vapor in the air). While a forested area may have 80-90 percent humidity, the desert will have only 10-20 percent. The humidity in the air reflects and absorbs the sun's energy, therefore lack of humidity results in more of the sun's energy reaching the ground.

There are two main types of deserts: hot and cold. Most of the world's deserts are hot deserts. That means they have hot daytime temperatures during most of the year. Cold deserts have daytime temperatures that during certain times of the year plunge below freezing. Many cold deserts get over half of their moisture from snow. In most deserts, air temperature falls quickly at night and rises quickly during the day.

Deserts may get little rain on average. But they often get huge amounts all at once. Storms may be strong and flash floods are not uncommon. Places like the Sahara may get rain only once in 20 years. When it does rain, they can receive a decade's worth in just a few hours.

Some deserts experience dust or wind storms. Dust storms are stirred up by the wind. These dust clouds, thousands of feet high, can block out the sun. Soil from the Sahara can be carried all the way to Paris. These storms can make it difficult to breathe and can quickly dehydrate an animal. Particles of sand rubbing against one another during a sandstorm can create such static electricity in the air that people suffer from headaches.

The soils vary from sandy, salty, crumbly, or very rocky. Soil may be rich in minerals, but often lacks organic matter (decayed plants and animals). This is because there are fewer plants and animals in the desert to start with.

Common plants can include cacti, yucca, salt bush, creosote bush, and a variety of annuals. Desert plants have adapted a variety of methods to reduce water loss and increase water storage.

Some deserts have abundant wildlife that include a large number of lizards and small mammal species. Desert animals have some impressive ways of handling the challenges of desert life.

(See fact sheet for additional desert information).

Materials
World map
Paper
Brochures

Procedure
Warm up: Bring in travel brochures from a variety of places (from all biomes). These can be obtained from a local travel agency. Ask students what types of trips they have been on before.

Have students examine the brochures and discuss the advertising techniques they see applied. Explain to the students that they will be creating travel brochures for the great deserts of the world. Discuss the background information with the class.

Activity: Explain to the students that they will be working in groups to create a brochure of their assigned desert. Students will research specific information about each desert (location, size, temperature, rainfall, interesting fact), and then use this information to create a travel brochure.

Students will be placed into nine groups in order to research the following deserts:

- Arabian
- Australian
- Chihuahuan
- Gobi
- Kalahari
- Mojave
- Patagonia
- Sahara
- Sonoran

Wrap Up: Groups will present their brochures to the class.

Assessment

Desert Travel Brochure

Evaluate maps for accuracy.

Great Deserts of the World

Desert Name	*Type*	Location and Size	Formed By	Physical Features	Examples of Plants and Animals
Arabian	Hot	Arabian Peninsula Covers 900,000 sq. mi.	High pressure	Covered almost entirely by sand, has some of the most extensive sand dunes in the world	Acacia, oleander, saltbush Desert locust, dromedary camel, gazelle, jackal, lizards, oryx
Australian	Hot	Australia Covers 890,000 sq. mi.	High pressure Rain shadow	Sandy, stony	Acacia, casurarina tree, eucalyptus, saltbrush, spinifex grass Blue-tongued lizard, dingo, fat-tailed mouse, kangaroo, rabbit-eared bandicoot, hopping mouse, thorny devil
Chihuahuan	Hot	North Central Mexico and SW US (AZ, NM, TX) Covers 175,000 sq. mi.	High pressure	High plateau covered by stony areas and sandy soil Many mountains and mesas	Cacti, Chihuahuan flax, creosote bush, lechuguilla, mesquite, Mexican gold poppy Coyote, diamondback rattlesnake, javelina, kangaroo rat, roadrunner
Gobi	Cold	Northern China and Southern Mongolia Covers 450,000 sq. mi.	Rain shadow Inland	Covered by sandy soil and areas of small stones called Gobi	Camel's thorn, grasses Bactrain camel, gazelle, gerbil, herboa, lizards, onager, wolf
Kalahari	Hot	Southwestern Africa Covers 200,000 sq. mi.	High pressure	Covered by sand dunes and gravel plains	Acacia, aloe, baobab tree, tamarisk tree Gazelle, gerbil, ground squirrel, hyena, jackal, sandgrouse, springbok
Mojave	Hot	Southwestern US (AZ, CA, NV) covers 25,000 sq. mi.	Rain shadow High pressure	Covered by sandy soil, pavement, and salt flats	Creosote bush, desert sand verbena, Joshua tree, mesquite Bighorn sheep, chuckwalla, coyote, jackrabbit, sidewinder, zebra-tailed lizard
Patagonia	Cold	Argentina Covers 153,000 sq. mi.	Rain shadow	Covered by stony and sandy areas	Cacti, grasses, shrubs Patagonia fox, Patagonia hare, puma, rhea
Sahara	Hot	Northern Africa Covers 3.5 million sq. mi.	High pressure	Covered by mountains, rocky areas, gravel plains, slat flats, huge areas of dunes	Acacia, grasses, tamarisks Addax antelope, dorcas gazelle, fennec, fox, Horned viper, jackal, herboa, sandgrouse, spiny tailed lizard
Sonoran	Hot	Southwestern US (CA) Parts of Mexico (Baja) Covers 120,000 sq. mi.	High pressure Rain shadow	Covered by sand, soil, and gravelly pavement Gets more rain than any other N. Am. desert	Agave, Coulter's globemallow, creosote bush, desert Mariposa lily, mesquite, ocotillo, paloverde, saguaro Coati, elf owl, gila monster, kangaroo rat, pack rat, roadrunner, sidewinder, tarantula

Great Deserts of the World

Brochure Rubric

Desert Brochure	Self Evaluation	Teacher Evaluation	Comments
Visual:		**/12**	
Includes a world map with location outlined, colored, and labeled (consider quality and appeal)			
Brochure is visually attractive (fills the page, colorful, neat)			
Brochure contains points of interest of the given desert (these may include plants, animals, locations specific to that desert)			
Written:		**/12**	
Information is accurate.			
Proper grammar, spelling, etc.			
Advertising techniques are evident (desert presented as a top attraction)			
Presentation:		**/4**	
Organization of information, quality, etc.			
Teamwork:		**/4**	
Are the efforts of each team member clearly demonstrated, or did it appear to be the work of one or two?			
Responsibility:		**/4**	
Turned in on due date and presented in class with visual aids.			

4 - no mistakes 3 - few mistakes 2 - many mistakes 1 - incomplete (however is present) 0 - not evident or not included

Percentages: Visual ____ Written ____ Presentation ____ Teamwork ____ Responsibility ____ Overall ____

Name _____

Directions: Outline, color, and label your specific desert on the world map.