



Thank you to the Sierra Nevada Recreation Corporation: Moaning Cavern, Black Chasm Cavern and California Cavern for permission to use their classroom lesson plan material.

Cavern Life

Lesson 1: Living Conditions

OBJECTIVES

Students will learn to:

- Describe elements and conditions that can effect cavern life.
- Explain the three zones of a cavern system and the differences of each zone that can effect cavern life.

BACKGROUND INFORMATION

Animal and plant species must adapt to live in different conditions. Some animals and plant life are unable to adapt to certain conditions and are, therefore, unable to sustain life in environments with those conditions. For instance, deserts with their harsh heat and dry conditions are not hospitable to penguins, yet the ice cold, humid conditions of the Polar Regions are ideal for penguins.

There are many ecosystems above ground. A cavern system has its own ecosystem that is different from any above ground environment. Because it is sheltered, outside conditions have very little effect on a cavern's environment. While above ground ecosystems are affected throughout the year by the seasons, most of the time a cavern is not. Therefore, caverns have a unique, constant environment.

In addition to the lack of environmental changes, there are other aspects that effect the living conditions in a cavern system. Because caverns are between the surface and the water table, they are in the direct path of water that filters from the surface down to the water table. Since the water cannot evaporate out of the cavern, it tends to stay humid.

Probably the most prominent feature of a cavern is the darkness. This plays a very important role in the way animals live in caverns and how they adapt to the environment. A cavern system, if large enough, will have three "zones" based on the level of light it receives. The first is called the "Entrance Zone." This is the area at the immediate cavern opening. Next is the "Twilight Zone," the area that starts at the end of the entrance zone and goes until all traces of light are gone. The last zone is the "Dark Zone." This is the rest of the cavern beyond the twilight zone, where no amount of light ever penetrates. Each cavern will have a different distance for each zone, depending on how large the entrance is and the contours of the cavern. Some caverns may not be big enough to have a dark zone.

Different animals live in different areas of the cavern depending on how well they have adapted to the living conditions. Because the entrance zone is so close to the surface, it is effected by the outside elements. Since it gets direct sunlight and rain, both plants and animals can easily live here. This area of the cavern is used mostly for shelter. The twilight zone, which may not get direct sunlight, is less hospitable. It is close enough to the surface that it is still affected by the outside elements, but provides more shelter and a cooler environment than the entrance zone. Some plant life may still grow here. The animals that live in this zone prefer the cooler, moister conditions. Animals that are found in these two zones are not necessarily cavern inhabitants. They are

more like visitors who can also live outside the cavern. However, some may choose to live their whole life in a cavern.

The dark zone is the area of the cavern that requires the greatest degree of special adaptation in order to live there. It gets absolutely no light, is not effected by outside elements and has a constant temperature and fairly constant humidity. Through evolution, the animals that live in this area of the cavern have adapted in order to survive. Due to the lack of sunlight, many of these animals have little or no pigment. Many of them also have no eyes or are blind. To make up for the lack of sight, cavern animals have developed other ways to find their way around and to find food. Some have extra long antennae to feel with; others have acute senses of smell and/or hearing.

All of the Sierra Nevada Recreation Corporation caverns go back or down far enough that they have all three zones. The living conditions are similar in each, yet each cavern has some unique qualities.

Boyden Cavern is a horizontal cavern with a large opening allowing easy access. There is a seasonal stream that flows through it which helps keep the environment cool and moist.

Moaning Cavern is a large vertical chamber with two narrow, vertical entrances that make access to the cavern difficult. Water enters the cavern from surface rain but does not collect inside. However, due to the lack of cross-ventilation that horizontal caverns have, Moaning Cavern stays humid year round.

California Cavern is a horizontal cavern with several small, accessible entrances. It is still close to the water table, so it floods every winter. Even during the driest time of year several chambers remain flooded forming underground lakes. The numerous entrances and water create an ideal environment for cavern life.

Experiments & Activities

Grades K – 4 "Explore The Senses"

Pair off students and blindfold one of each pair. Spend at least 15 minutes doing an activity that involves using one of the four senses listed below, then switch. At the end of the experiment, ask the students questions about what they did to show them how their other senses were heightened during the experiment and explain that this is what happens to animals in the dark zone.

Touch - using different objects (feather, pen, etc) touch the student on the arm and have them describe the sensations and try to identify the object

Hearing - with students located in different areas of the class, have each one take a turn creating a day-to-day sound (closing a drawer, zipping a jacket, etc), then have the blindfolded people indicate where the sound is coming from and what it is.

Taste - have small pieces of fruit, bread, candy, etc for blindfolded people to eat and identify. It should be fed to them so they can't identify it by touch.

Smell - have containers of strong smelling food that are opened one at a time for blindfolded students to identify.

Grades 5 – 8 "Examine Environmental Conditions"

Using the included "Living Conditions" worksheet, list the environmental conditions that effect the living conditions and how animals adapt to each of the ecosystems listed.

Grades 5 - 8 "Examine Humidity"

Materials

- two equal-sized clear bowls
- plastic wrap
- straight pin
- measuring cup
- measuring spoons
- water

PROCEDURE

Place bowls side-by-side in an area away from direct sunlight. Fill each with the same amount of water using the measuring cup.

Make note of the amount of water used. Mark the waterline on each bowl.

Cover one bowl tightly with plastic wrap then using a straight pin, puncture 4 small holes in the top. This bowl will represent the enclosed nature of a cavern. The second, uncovered bowl will represent water on the surface.

Throughout one week, have students observe the bowls and note any changes on the included "Humidity & Evaporation Worksheet."

On day 5 pour the water from one bowl into the measuring cup and make note of the amount. For added emphasis, students can use measuring spoons of water to add to the water in the cup until it is back to the original amount used, and record how much water they added.

Repeat process with second bowl.

Explain the process of evaporation and why the covered bowl did not evaporate as much as the uncovered bowl. Compare the covered bowl to a cavern environment and the uncovered bowl to the surface environment.

Grades 9 – 12 "Special Adaptation"

Study research on different animals that have special abilities and why they have them. Example, bat/echo location, cavern cricket/antennae, etc.

Cavern Life

Lesson 2: Cavern Inhabitants

Objective

Students will learn to:

- Describe the different categories of cavern life and identify the types of animals for each category
- Explain how the category of an animal's cavern use is directly related to where it lives in a cavern.

Background Information

Many species of animals live in caverns or use them for shelter. There are three categories of cavern inhabitants based on the level of their use of a cavern:

Trogloxenes (derived from the Greek words – troglos meaning cavern and xenos meaning guest)

These are animals who normally live outside, but use a cavern for temporary shelter.

Troglophiles (derived from the Greek words – troglos meaning cavern and phileo meaning love)

These are animals that can and often do live outside in a similar environment (cool, dark and moist) but can also live in a cavern if they choose. Some of these animals may choose to spend their whole life inside a cavern.

Troglobites (derived from the Greek words – troglos meaning cavern and bios meaning life)

These are animals that live exclusively in the dark zone of caverns. These animals evolved through the millennia from troglophiles who first entered the cavern and either chose to stay or were trapped and managed to adapt. Through evolution these troglophiles changed their physical attributes to better adapt to the environment. These are the animals which have little or no skin pigment, no eyes and which exhibit other special adaptations.

Zonation is the term used to identify which animals live in which zone.

Cavern inhabitants are also identified by the surface area they occupy in a cavern, whether it be on the ceiling, walls or floor. Different animals inhabit different areas. This is known as stratification.

Identifying animals by stratisphere and zone is known as segregation. This segregation creates small communities of animals throughout a cavern system. A chart is helpful to compare how animals are divided according to stratification and zonation to form a community. An example chart is shown below.

	ENTRANCE	TWILIGHT	DARK
CEILING	mosquitoes moths	flies spiders	bats cavern crickets
WALLS	centipedes birds	salamanders millipedes	harvestment millipedes
FLOOR	rats bears	flatworms snails	beetles fish

All of the Sierra Nevada Recreation Corporation caverns exhibit some cavern life. However, none of them are heavily populated, and what life there is, is rarely seen. Because of their horizontal entrances, Boyden and California Cavern get occasional visits from bats. However, there are no bat colonies that make these caverns their home. All three caverns have frogs that find their way in from time-to-time. Insect life, though infrequent is the main variety of cave life to be found at the three caverns.

Experiments & Activities

Grades K – 4 "Who Lives Where"

Ahead of time, find suitable rocks outside that can be easily overturned.

Divide the students into small groups. Taking them outside, have each group turn over a rock and be prepared to immediately watch what types of bugs scurry away and where they go. Also note what else is found under the rock. After studying the animal life, have the students think about why the bugs live under the rock (dark, cool, moist) and compare these to living conditions to those in a cavern. Explain that many of the bugs they have been watching (and others of their species) can and do live quite comfortably in a cavern.

Grades 5 - 8 "Who Lives Where, Activity 1"

List the communities of a cavern system and describe physical characteristics of the animals that live in each one.

Grades 5 - 8 "Who Lives Where, Activity 2"

Match animals to the appropriate area of the cavern system they live in using the "Inhabitants" worksheet included.

Grades 5 - 8 "Who Lives Where, Activity 3"

Divide the class into three groups. Each group will study a different zone and the animals found there. When research is complete, have each group share their findings.

Grades 9 - 12 "Study of Animal Biological Clocks"

Do further study on cavern life concentrating on how cavern animals respond to biological clocks that correspond with outside animals, even though they do not have sunlight or weather conditions to guide them.

Cavern Life

Lesson 3: The Food Web

Objectives

Students will learn to:

- Understand the importance of each element in a food web.
- Realize that without light there can be no life.

Background Information

Due to the isolated nature of a cavern system, food sources are limited. Animals who live in the entrance zone are not permanent inhabitants and leave the cavern to acquire food. Those living in the twilight zone may leave the cavern as well, or they may rely on food sources within the cavern. The animals living in the dark zone must rely completely on food sources already in the cavern, or on those brought in.

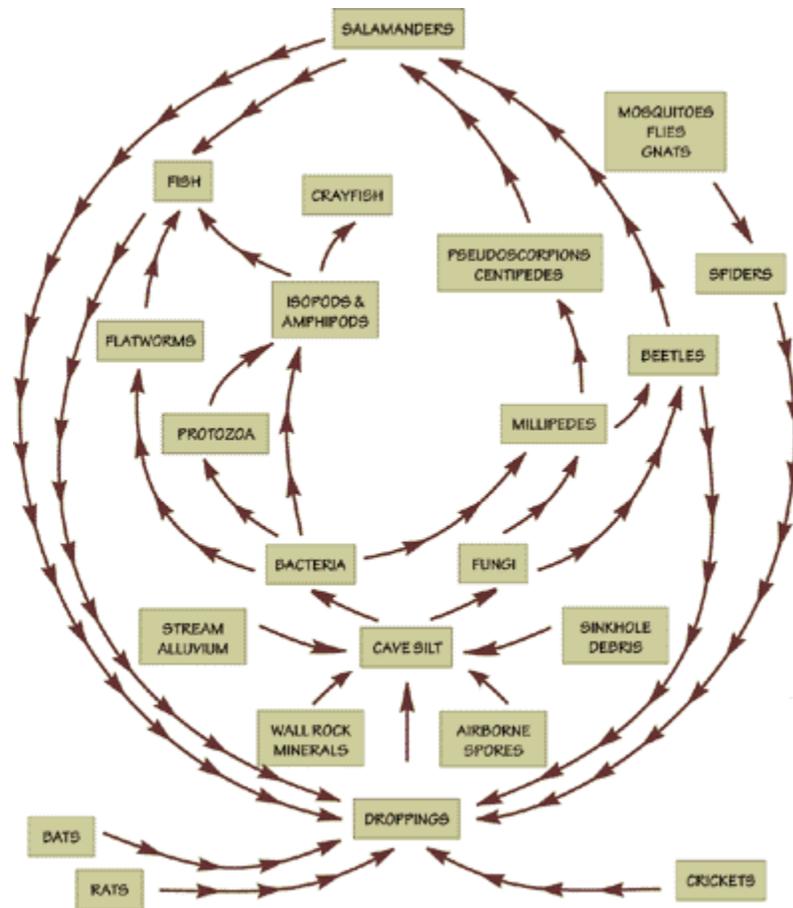
Due to lack of light in the dark zone, no plant life can grow. However, bacteria, mold and fungus may grow from organic material. The web begins with small organic materials that may be washed in through underground streams, come from the surface through sinkholes, travel by air currents, or fall off troglodites. Another source of organic material is from animal droppings and dead animals. Bat guano is an important contributing food source.

It is important to understand that even though light does not reach the dark zone, life would not be able to exist there without food sources that began with light. The organic material that makes its way into the dark zone originated on the surface where there is light. Without light plant life cannot grow. Plants break down to organic material that is brought into the cavern. Animal droppings also are produced from organic material, so again, without light there would be no animal droppings. Without any of these food sources that originate on the surface with light, life in the dark zone (or anywhere else on earth) would not be possible.

In the dark zone, small insects and protozoa feed off the bacteria and fungi that grow from the organic material. Small, water-dwelling animals may eat organic material floating on the water surface. Larger animals then eat the smaller animals. Their droppings provide the nutrients for more bacteria & fungi to grow and the web is then complete.

Since the food supply is limited and does not have much variety, the animals that can sustain life in a cavern are also limited. The balance of nature in the cavern food chain is very fragile, as are the animals that live there. If one element in the web is effected, it causes a chain reaction that eventually effects every living thing in the cavern.

A sample cavern system FOOD WEB is shown here:



Experiments & Activities

Grades K – 4 "Without Light There is No Life"

Materials

- two medium-sized jars
- potting soil
- two bean seeds
- medium-sized box

Procedure

Plant a seed in each jar (use the same kind for each). Put one near a window and cover the other with a box that will not allow light in. Water them both at the same time on a regular basis. Over time, see how the seed receiving light grows into a plant and the one under the box does not. Maybe the one under the box will become moldy. This is what happens in a cavern.

Grades K – 4 "Food Web Game"

The game listed under Grades 5 – 8 can also be used for younger grades. It may be useful to explain a simple food chain first using familiar elements such as:

- light – grass – cow (hamburger) – person

When doing the cavern food web game, using pictures instead of the names may be more appropriate for younger students.

Grades 5 – 8 "Food Web Game"

Materials

- large card (3" x 6") for each student
- ball of yarn

Procedure

Write the name of an element of the food web on each card. If you have used up all the names and have cards left over, either repeat some names, or if enough are left over, create a second set and divide students into two groups.

Have students form a circle (or two) and give each a card. (Do not put cards in a logical order.) Starting with an organic material person, have them hold the beginning of the yarn then pass it to the next element of the food web until everyone is included.

Let them see how they are all interconnected to form a "web."

Choose an element to eliminate from the web. Have that person drop their section of the yarn and step back. The people who had hold of the other sides now have a slack string on one side. They then drop their section and step back. This continues until the last person drops the yarn. This shows how all the elements are dependant on all the others even if not directly, and the importance of maintaining a healthy food web.

You may want to try it several times, each time choosing a different element to eliminate, to show that it doesn't matter where the problem starts, everyone is still effected.

Grades 9 - 12

Choose a specific cavern animal and do a report listing such information as the category in which it fits, the area of the cavern it is located, the zone it stays in, what it eats, and how it contributes to the cavern community.

Cavern Life

Glossary

adapt: to adjust to new or changed conditions

adaptation: the process of making adjustments to new conditions

bacteria: the plural term for bacterium meaning one-celled microorganisms

community: in ecology – a group of animal and plant species living together and having close interactions, especially through food relationships.

condition: anything that modifies or restricts the nature, existence, or occurrence of something else.

ecosystem: a system made up of a community of animals, plants, and bacteria and its interrelated physical and chemical environment.

elements: the natural environment consisting of earth, air, fire and water.

environment: the result of all the elements that influence living things in a given area

evaporate: to change into a vapor gas

evolve: to gradually change over time

evolution: the process of evolving

food web: a group of plant and animal life whose nutritional needs are provided by one another

fungus: any plant life that does not have flowers, leaves or chlorophyll (what makes plants green). Most common examples are mushrooms, mold and mildew

guano: the waste from bats and birds

humid: moist, damp conditions

humidity: environmental condition when there is a lot of water vapor in the air

inhabitants: the living things that live in a given area

isolate: to be by oneself; separated from others

living conditions: the combination of elements that govern the way living things exist in a given area

mold: a form of fungus

nutrients: things that give nutrition, such as food

organic material: any basic living material, anything from bacteria to fungus and up

pigment: a substance that gives color to animal or plant tissues

protozoa: parasitic, single-celled, microscopic organisms

segregation: separating similar things from others according to a given form of measurement (type of life form, color, etc.)

species: a group of plants or animals that are of the same type or origin

stratisphere: the area occupied by a certain segregated group

stratification: the process of separating into segregated groups and areas

troglobites: animals that permanently live inside caves

troglophiles: animals that can live either in or outside of a cave if similar environment

trogloxenes: animals that visit caves, often using it for shelter, but live outside.

zone: a designated area of which the boundaries are chosen for a given reason

zonation: to create zones based on a given reason

Cavern Life

Recommended Reading

Caves & Caverns – an activity book

by Kate Coder, Audrey Taylor, and Ann Molosky
Lincoln Caverns, Inc. ©1990
pages 2-5, 29

Caves

by Stephen Kramer
Carolrhoda books, Inc. ©95
pages 8-28

Our Planet – Caves

by Susan Rigby
Troll Associates ©94
pages 4-17

Looking Inside Caves & Caverns – X-Ray Vision series

By Ron Schultz
John Muir Publications, ©93
pages 4-10, 20-38

Caves – The Wonders of our World series

By Neil Morris
Crabtree Publishing Co. ©96
pages 4-15

Speleology - Caves and the Cave Environment

by George W Moore and Nicholas Sullivan
Cave Books, 64,78,97
pages 7-78

Cavern Life

Quiz

The _____ zone is at the beginning of the cavern.

The _____ zone receives partial light.

The _____ zone is the part of the cavern that never receives any light.

The dark zone is unaffected by the outside environment because it has a constant _____.

Since the water in a cave is unable to evaporate out, the cavern environment stays _____.

Due to the lack of light, animals that live in the dark zone tend not to have _____ or _____.

The animals that live in caves prefer the _____ and _____ living conditions.

The animals that normally live outside but use a cave for shelter are called _____.

The animals that prefer the cool, moist conditions of the twilight zone and can comfortably live in a similar environment outside are _____.

Animals that live exclusively in a cave are known as _____.

Cave animals can be classified by which zone they live in as well as the three surface areas of the cavern. These areas are: _____, _____, _____.

A blind cave fish would be found in the _____ zone and on the _____.

Because of the lack of _____ in the dark zone, plants are not able to grow.

Organic material that makes its way into the cavern provides a source for _____ and _____ to grow from.

WORD LIST (some words may be used more than once)					
entrance	eyes	trogloxenes	ceiling	fungus	twilight
troglophiles	cool	dark	pigment	temperature	floor
troglobites	walls	light	humid	bacteria	moist

Cavern Life

Humidity & Evaporation Worksheet

BOWL A = covered with plastic wrap. BOWL B = uncovered bowl

Amount of water originally put in bowls

Daily Observations

	BOWL A	BOWL B
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

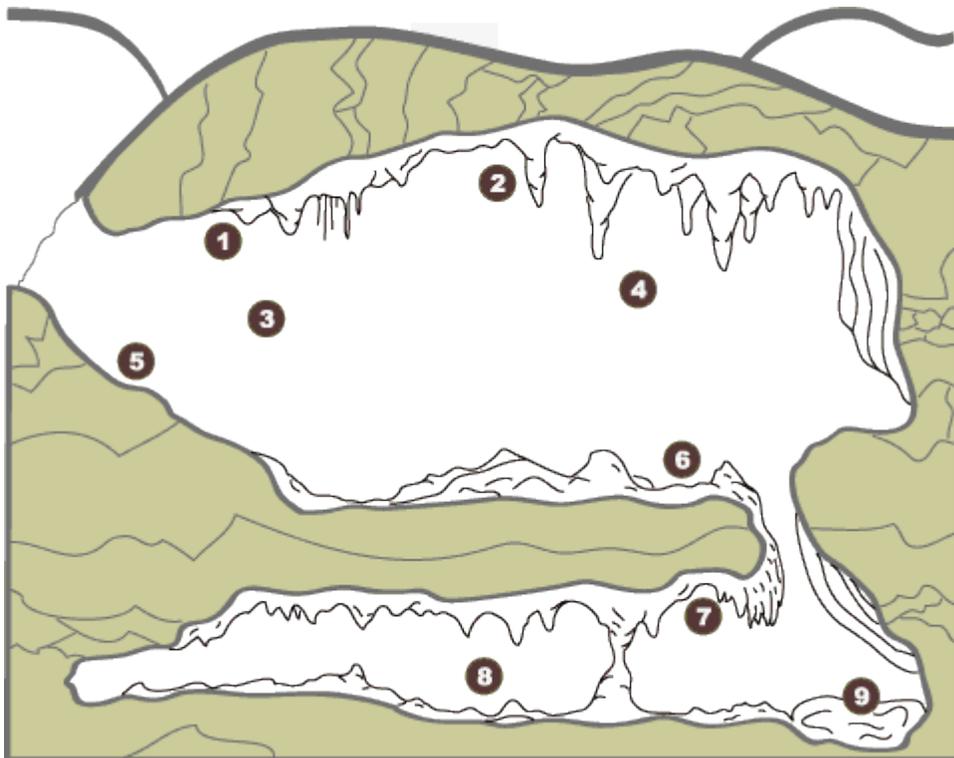
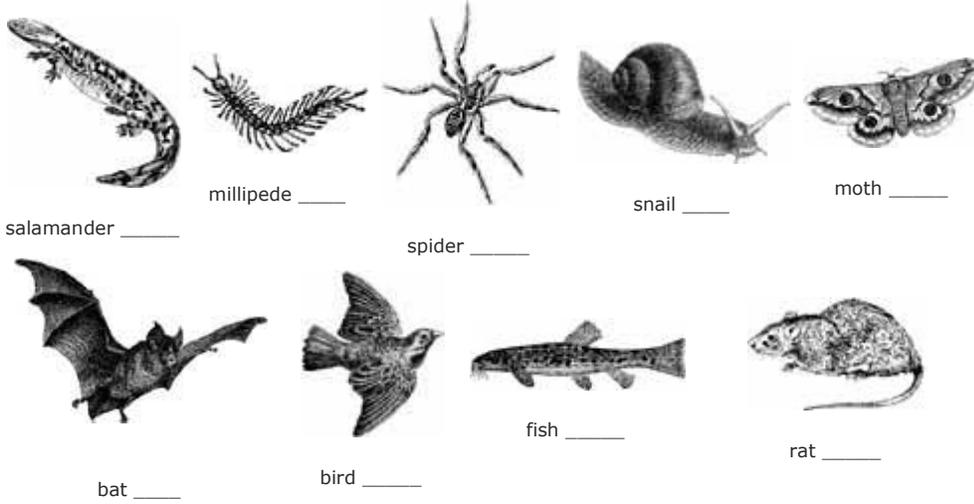
End Results

	BOWL A	BOWL B
Original amount of water		
Amount left on day 5		
Amount evaporated		

Cavern Life

Inhabitants

Match the animal to its home in the cave.



Cavern Life

Living Conditions

Surface Ecosystems	Environmental Conditions	Adaptations Needed
Tropical Rainforest 		
Desert 		
Polar Region 		

Cavern Ecosystems	Environmental Conditions	Adaptations Needed
Entrance Zone 		
Twilight Zone 		
Dark Zone 		

Cavern Life

Go Batty!

Help the bat find its way into the cavern.

