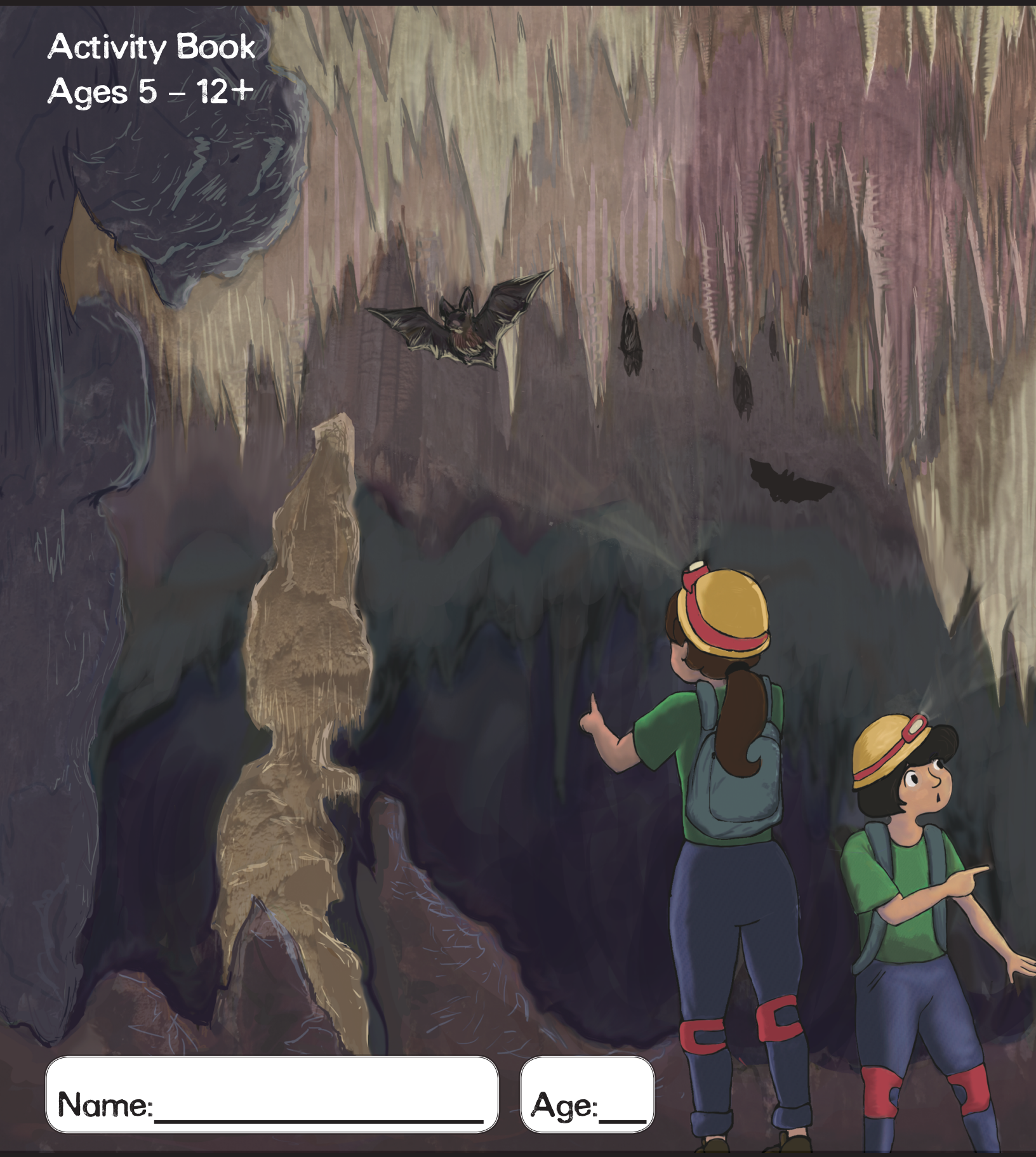
Junior Cave Scientist

National Park Service
U.S. Department of the Interior

Geologic Resources Division
Cave and Karst Program

Activity Book
Ages 5 – 12+



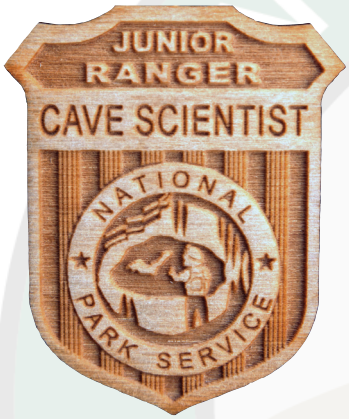
Name:_____ Age:___

Explore • Learn • Protect

Become a Junior Cave Scientist

The National Park Service manages more than 150 areas that have caves or karst landscapes. This includes over 4,900 caves! In fact, four of the seven longest caves in the world are located in our national parks.

In this book, you will explore a fascinating and fragile underground world, learn about national parks that contain caves or karst, and complete fun educational activities.



Explore
magnificent and beautiful caves. You will find an amazing underground world just beneath your feet!

Learn
about caves and karst systems and the work that cave scientists do.

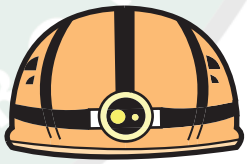
Protect
our national parks and the things that make caves and karst areas special.

To earn your badge, complete at least _____ activities.
(Your Age)

Activities in this book are marked with an age indicator. Look for the symbols below:

Flashlight
Ages 5 - 7

Lantern
Ages 8 – 11



Helmet and Headlamp
Ages 12 and Older

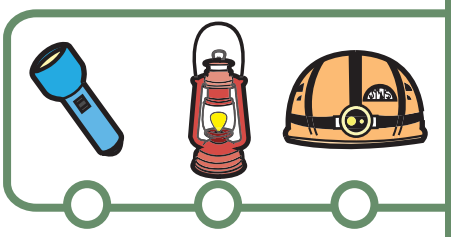
Put a check ✓ next to your age indicator on each page that you complete.

I received this book from:_____

After completing the activities, there are two ways to receive your Junior Cave Scientist badge:

1) Return the completed book to a ranger at a participating park, or
2) Visit go.nps.gov/jrcavesci

What are Caves and Karst?

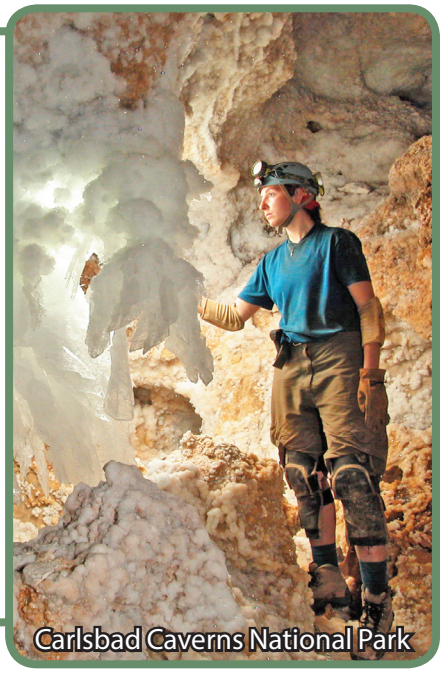


Caves are naturally occurring voids, cavities, interconnected passageways, or alcoves in the earth. Caves preserve fossils, minerals, ecosystems, and records of past climates. Specially adapted animals live in extreme conditions within caves. Caves are beautiful to look at and provide great places to explore and learn.

Karst is a type of landscape that forms when rocks are dissolved by weak acids. Acidic groundwater slowly dissolves the rock creating large passages and channels. Karst landscapes usually have caves, sinkholes, sinking streams, and springs.

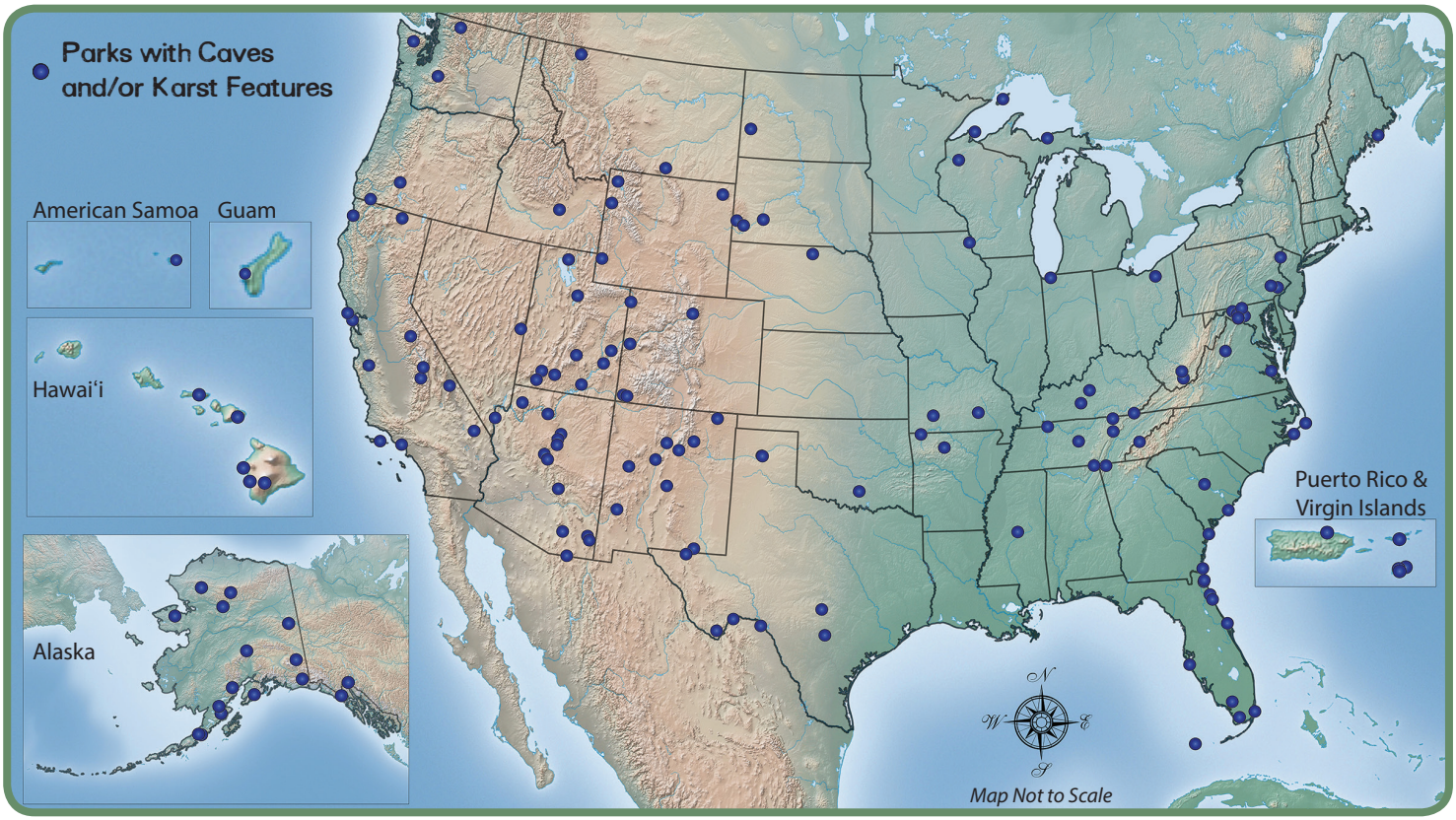
Cave scientists, also known as **speleologists (spē-lē-ŏl-ō-gists)**, explore, and map caves, and study animals, water, rocks, fossils, and other aspects of caves and karst systems.

Learn more about caves and karst systems at:
www.nature.nps.gov/geology/caves/index.cfm



Carlsbad Caverns National Park

National Park Areas with Caves and/or Karst Features



Put an X on the map in the location of your home, or the park you are visiting.

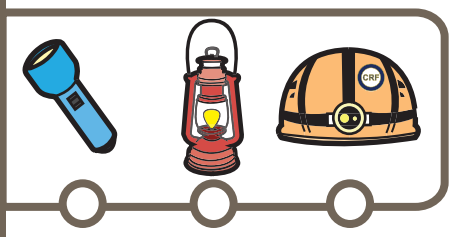
Are there any National Park caves or karst features in your state?

☐ Yes ☐ No

Speleo-Fact: Mammoth Cave is the longest cave in the world with over 400 miles (644 km) of connected passageways.

Be Cave Safe!

A Quick Guide for Cavers Big or Small



As a Junior Cave Scientist, it is your job to make sure that you are prepared and safe during your caving trip. Make sure to ask for permission before entering a cave. **Learn what to take and the "rules of three" to be cave safe.**

What Should You Take for a Safe Adventure?

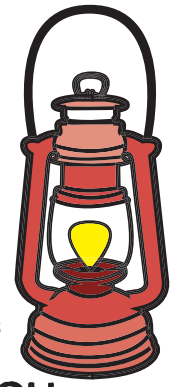
Decide what items are necessary for a safe cave adventure but avoid carrying too much! **On this wild trip you can only bring 13 items. Which will you choose?**

_____Headlamp	_____Helmet	_____Trash bag
_____Water bottle	_____Umbrella	_____Snacks
_____Ice cream	_____Flashlight	_____Bicycle
_____First aid kit	_____Batteries	_____Knee pads
_____Glow sticks	_____Sunglasses	_____Gloves
_____Map of the cave	_____Elbow pads	_____Basketball

Never go into a cave without a responsible adult. Bring all of the appropriate gear and always travel with at least a group of **three**. To be cave safe, travel with someone who is familiar with the cave you are exploring.

Three Sources of Light

When going into a cave, be sure to carry at least **three** sources of reliable light. Being cave safe will keep you from getting stuck in the dark!



Getting Ready to Leave

To make your cave adventure safe, be sure to always let **three** people know where you are going. **Who will you tell that you are going into a cave?**

1._____

2._____

3._____

Now That You are Ready, What do You Hope to See in the Cave?

_____

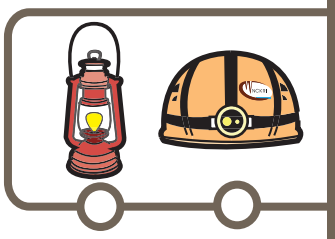
_____

_____

Do Not Overdo It!

Know your limit and do not over exert yourself. Always let the slowest caver set the pace of the group. Teamwork means helping each other, communicating frequently, and being aware of your surroundings. Save enough energy to make it out of the cave!

How to be a Careful Caver



Cave Etiquette

It is very important for Junior Cave Scientists to practice proper cave **etiquette**, or manners. This means that everybody has to do their part to take care of these special places. **Unscramble the phrases to learn how to be a careful caver.**

1. wildlife not do disturb

_____

2. damaging features avoid cave

_____

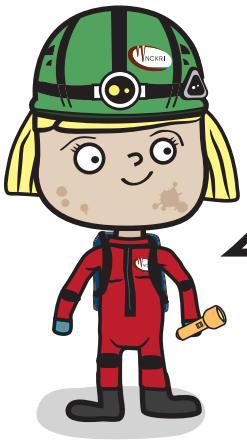
3. step careful be you where

_____

4. in, it pack pack out it

_____

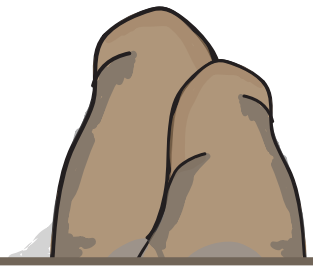
Carlsbad Caverns National Park



Careful What You Touch!

Cave formations are fragile and the oils from your hands can cause discoloration and stop their growth.

Wear clean gloves to protect your hands and the cave.



Challenge: Fill in the blanks for this well known conservation saying

Leave nothing but_____ _____footprints,

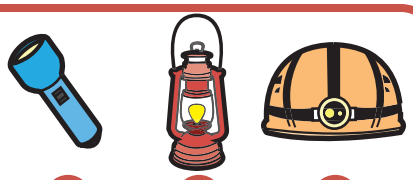
take nothing but_____, kill nothing but_____.

Word Bank:

pictures carefully time placed

Speleo-Fact: Some parks host "Lint Camps", where volunteers remove unsightly and destructive lint from caves.

Name That Cave



One of the topics **speleologists** study is **speleogenesis**—how caves form. **Use clues and pictures to help you choose the cave type**. Be careful, not all of the names in the word bank are real types of caves!

I form along rocky shorelines. The impact of waves creates me.

I am a _____

I form when water dissolves bedrock. My walls are made of limestone, dolomite, marble, or gypsum. I am the most common type of cave.

I am a _____

I get my shape from molten lava. When the lava cools, my ceiling and walls are created. After the lava stops flowing, I become an empty tube.

I am a _____

I form between piles of rocks and debris from rockslides and rockfalls. I am found at the base of cliffs or steep slopes, and in narrow canyons.

I am a _____

Word Bank:

Sea Cave
Bat Cave
Solution Cave
Talus Cave
Man Cave
Volcanic Cave

Make Your Own Cave at Home

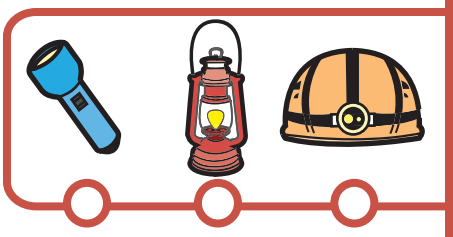
Making your own cave at home is really simple! Grab a few chairs and arrange them in a circle. Drape a sheet or blanket on top of all the chairs to form the cave. Be creative, how dark can you make the inside of your cave? Don't forget your flashlight!

Name Your Cave

_____

Icing on the Cave

Cave decorations, also known as **speleothems**, are mineral deposits in caves. As water flows or drips into a cave, it leaves behind different minerals creating speleothems. **Draw a line from the speleothem description to its matching picture.**



Cave Popcorn

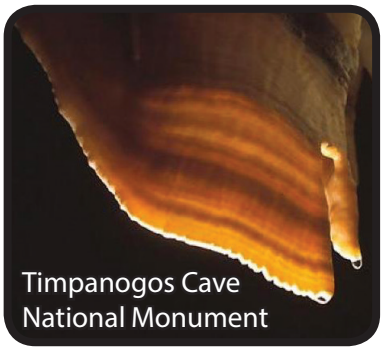
Cave popcorn is a fun name for a type of coralloid, which are small balls of the minerals calcite, aragonite, or gypsum.

Cave Bacon

Cave bacon hangs from a slanted or sloped cave ceiling. They are sometimes called draperies, curtains, or ribbons because of their shape.

Soda Straws

Soda straws are thin-walled mineral tubes. Sometimes the tube gets clogged forcing water flow to the outside of the straw forming a stalactite.

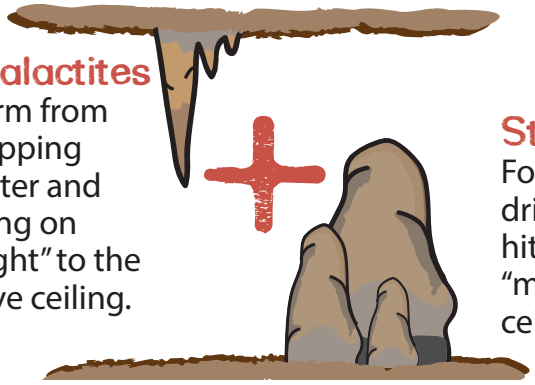


Timpanogos Cave National Monument

Sequoia National Park

Wind Cave National Park

Speleothem Math



Stalactites
Form from dripping water and hang on "tight" to the cave ceiling.

+

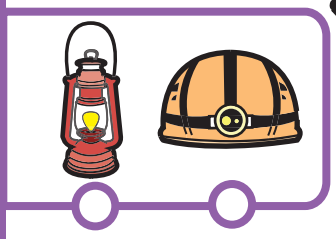
Stalagmites
Form where dripping water hits the floor. They "might" reach the ceiling someday.

=

Draw a Cave Column
Columns form when stalagmites and stalactites meet.

Speleo-Fact: Scientists use speleothems to study climates of the past.

Troglofauna Trio



Troglofauna refers to animals that live in a cave. Many animals that live in caves have special adaptations to their dark surroundings. **Find all of the underlined words in the word search.**

Trogloxene: The Cave Guest

Trogloxene comes from the Greek words *troglo* (cave) and *xenos* (guest). These guests spend much of their time outside returning to the cave for **shelter**, hibernation, or roosting. They usually leave the cave in search of **food**. Examples include bats, cave salamanders, birds, and pack rats.

Timpanogos Cave National Monument

Carlsbad Caverns National Park

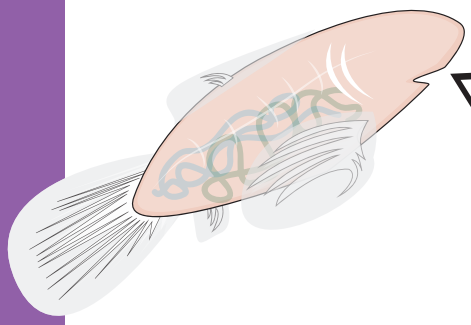
Troglophile: The Cave Lover

Troglophile comes from the Greek words *troglo* (cave) and *phileo* (love). These **cave** lovers can spend their whole life in the cave but can also live above ground. Some troglophiles have special adaptations, or **traits**, for living in caves. Examples include beetles, earthworms, and cave crickets.

Hays County, Texas

Troglobite: The Cave Local

Troglobite comes from the Greek words *troglo* (cave) and *bios* (life). These animals spend their entire life inside the cave. They are specially **adapted** to survive in extreme environments. Most of these animals lack color **pigment** and have small or no eyes! Examples include cave crayfish, blind cave fish, cave millipedes, and blind salamanders.



What troglofauna type would you like to be? Why?

_____

_____

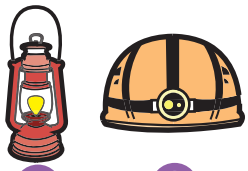
_____

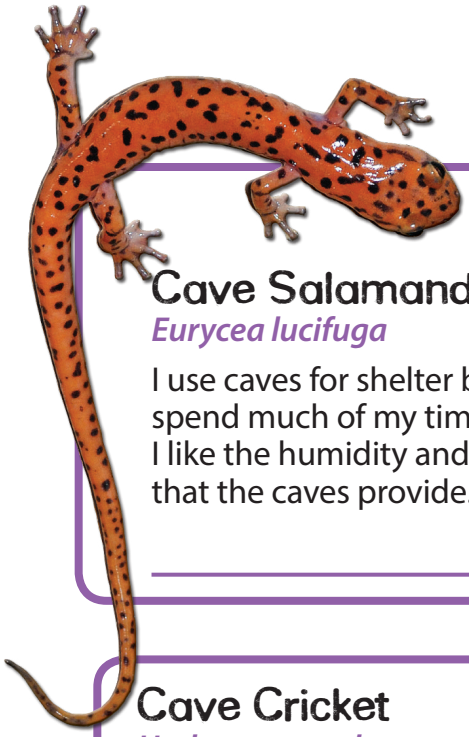
_____

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

Reveal the Mysteries of THE CAVE DWELLERS

Mysterious animals live inside caves! **Identify which troglofauna category each dweller belongs to**. Use the previous page for help if you get stuck. **Draw a star ☆ next to your favorite cave dweller.**





Cave Salamander

Eurycea lucifuga

I use caves for shelter but I spend much of my time outside. I like the humidity and safety that the caves provide.

_____

Cave Millipede

Trichopetalum whitei

I live deep inside caves. I have no eyes and have lost all of my pigment. I live completely in the dark all the time.

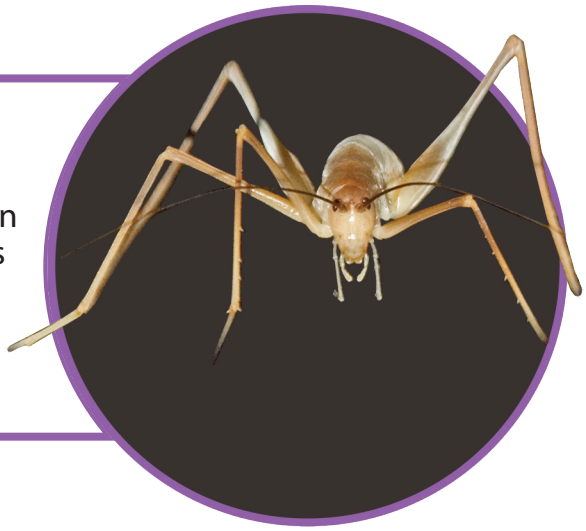
_____

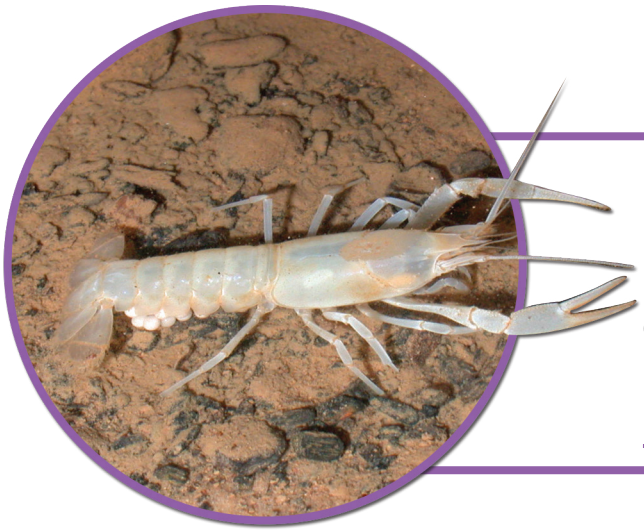
Cave Cricket

Hadenoecus subterraneous

I live throughout caves and usually leave them when it is time for dinner. I have very minimal adaptations for living in caves. If you go in a cave, you will most likely see me!

_____





Cave Crayfish

Orconectes australis

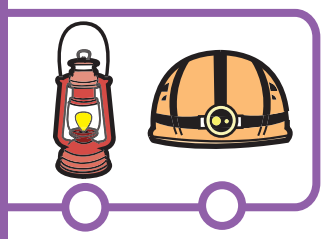
I have no eyes, lack color pigment, and have other adaptations to live in total darkness. I mostly live underwater.

_____

All photos from Mammoth Cave National Park

Speleo-Fact: There are at least 41 cave-adapted species found at Mammoth Cave National Park.

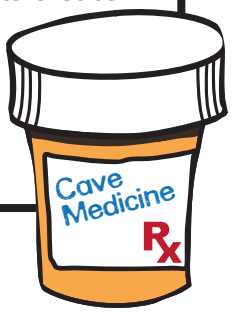
Cave Microbiology



Microscopic organisms (**microbes**) such as bacteria thrive in caves. Some microbes get energy from organic material brought into caves by animals or water. Others get energy from **carbon dioxide** and **nitrogen** from the air. Some even get energy from minerals in cave walls.

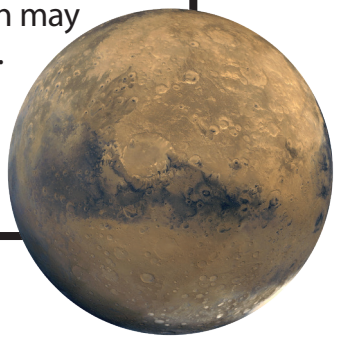
Medicine from Caves

Many cave microbes make compounds that could be used as medicine for people. These microbes may help scientists create antibiotics to fight drug-resistant "superbugs" and to understand how drug resistance in bacteria works. Caves are natural laboratories for scientists!



Life on Mars?

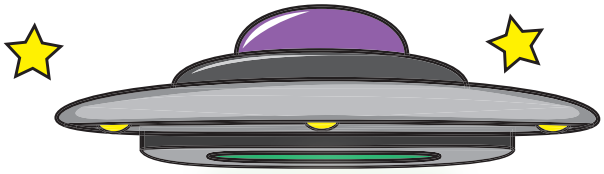
Cave scientists search for microbes in the extreme environments of caves. Like Earth, Mars has many caves which may have the potential to support life. The fact that microbes on Earth survive in extreme conditions suggests there could be life on Mars.



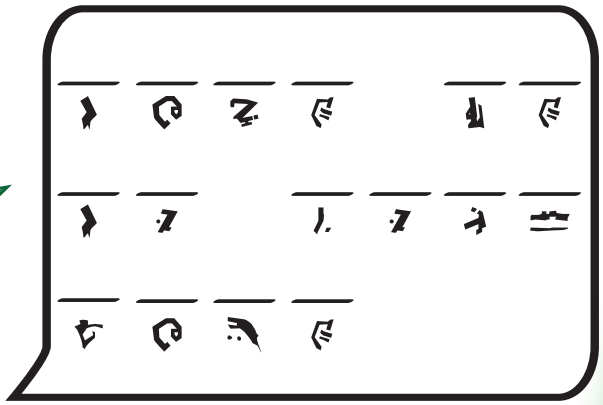
Snotty Snottites

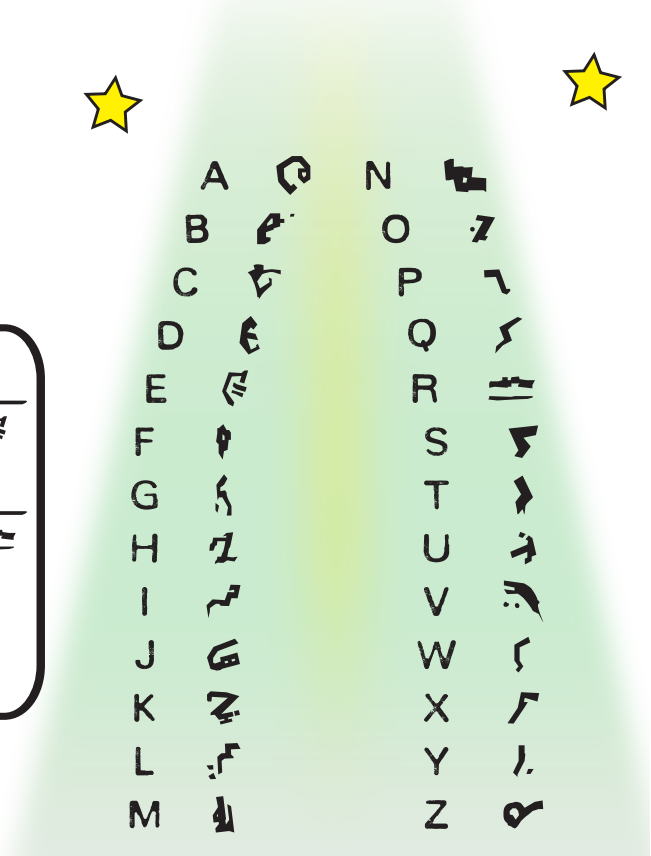
Cueva de las Sardinas, Tabasco, Mexico

Imagine seeing walls covered with snot-like film! **Snottites** are rare groups of sulfur-eating bacteria that hang from walls and ceilings of caves and have the consistency of snot. Snottites drip, just like your runny nose. They produce **sulfuric acid**, which can burn skin like battery acid! Snottites are very rare.

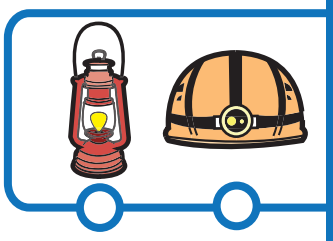


Decode the Secret Martian Message





Flying Mammals



Bats are the only true flying mammals. There are 45 known species of bats in the United States. Many bats live in caves and mines. **Learn about four bat species and complete the activity at the bottom of the page.**

Mexican Free-tailed Bat

Tadaria brasiliensis

Habitat: We live in caves, mines, under bridges, and in buildings. We migrate to Central America during the winter months.

Eats: moths, beetles, flies, wasps, ants

The official state bat of Texas and Oklahoma!

Gray Bat

ENDANGERED

Myotis grisescens

Habitat: We live in caves all year long. We usually live in one cave during the summer and a different cave during the winter.

Eats: beetles, flies, moths, mosquitoes

95% hibernate in the same eight caves!

Indiana Bat

ENDANGERED

Myotis sodalis

Habitat: We usually hibernate in groups of thousands from October to April. We can travel long distances to find the right cave.

Eats: moths, beetles, hard-bodied insects

First discovered in Indiana!

Tri-colored Bat

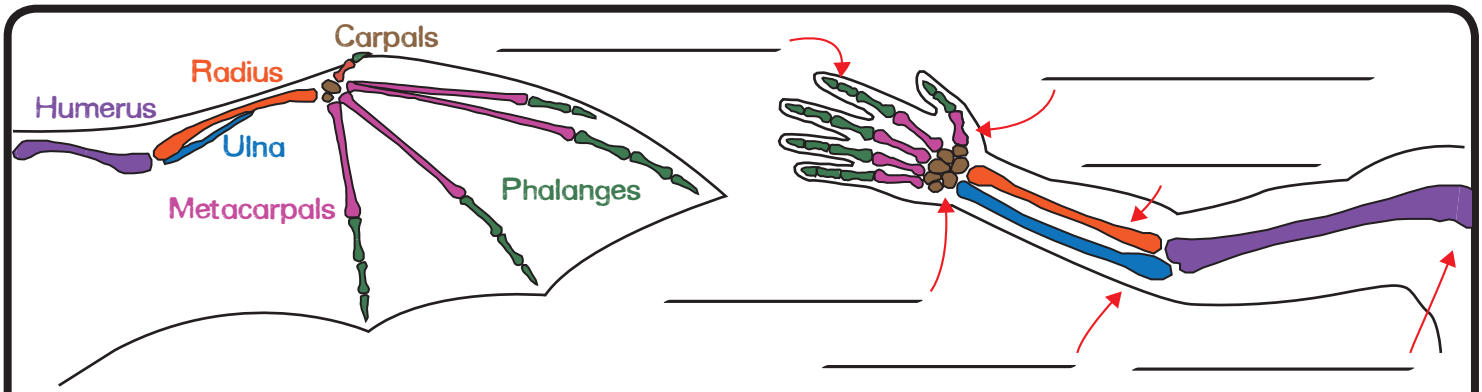
Perimyotis subflavus

Habitat: We like to live on the edge of forests. We retreat to caves and mines during winter to avoid the cold.

Eats: gnats, beetles, moths, flies

Can each catch an insect every two seconds!

Bat Anatomy



Bats are mammals, just like you! Look at the bones inside a bat wing and the bones inside a human arm. The bone structure is very similar. Can you find these similarities? **Fill in the blanks to name all of the bones.**

Hint: Use the colors as clues

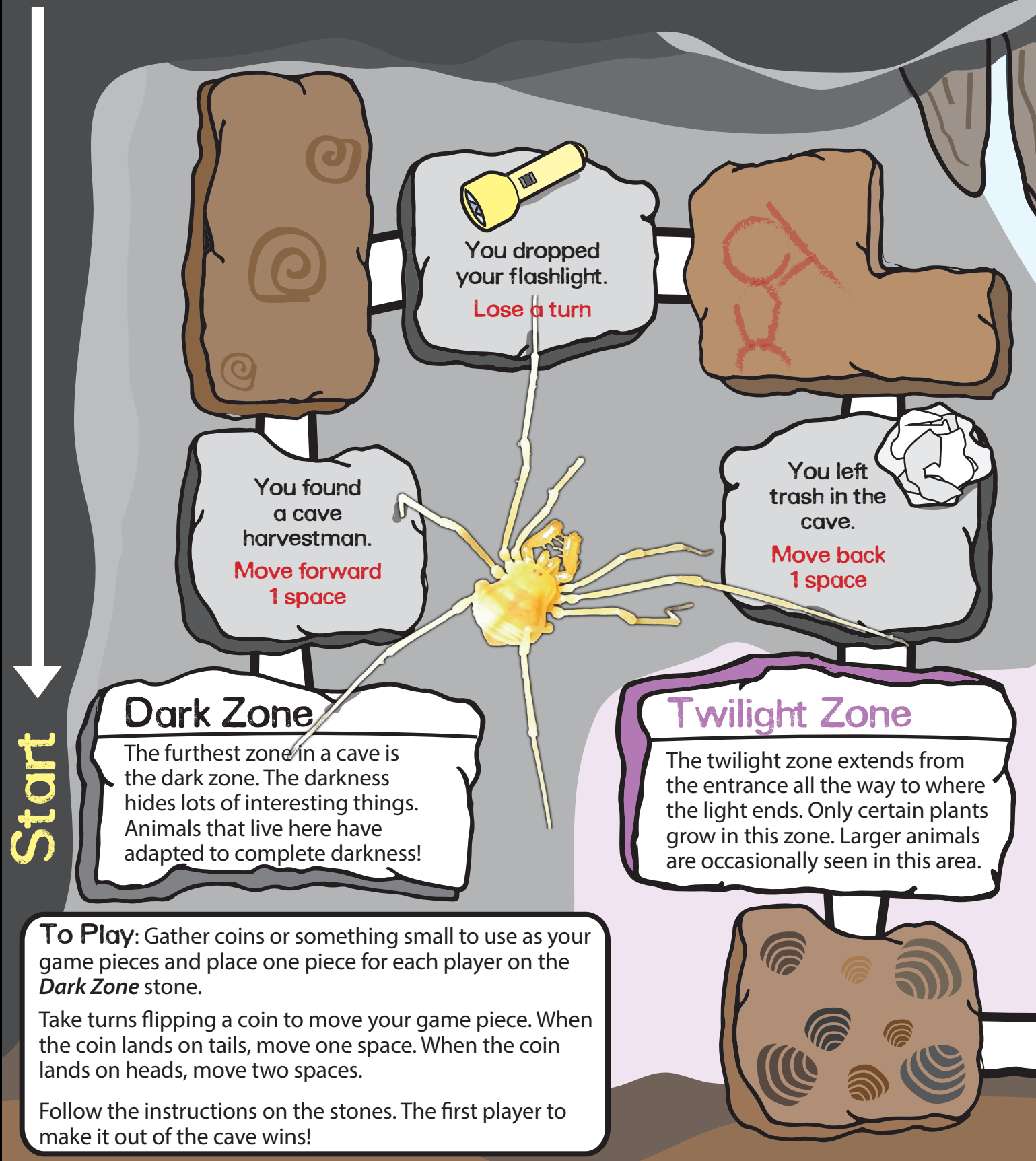
Myotis sodalis and *Myotis grisescens* photos © Merlin D. Tuttle, Bat Conservation International. Used with permission.

Speleo-Fact: Currently, there are 10 bats listed as threatened or endangered in the United States.

Zones of a Cave

The deeper you go into a cave, the less light there is. Caves are separated into three zones depending on how much light the zone receives. In this activity, start from the deepest part of the cave, the dark zone, and pass through the twilight and entrance zones to make it out of the cave.

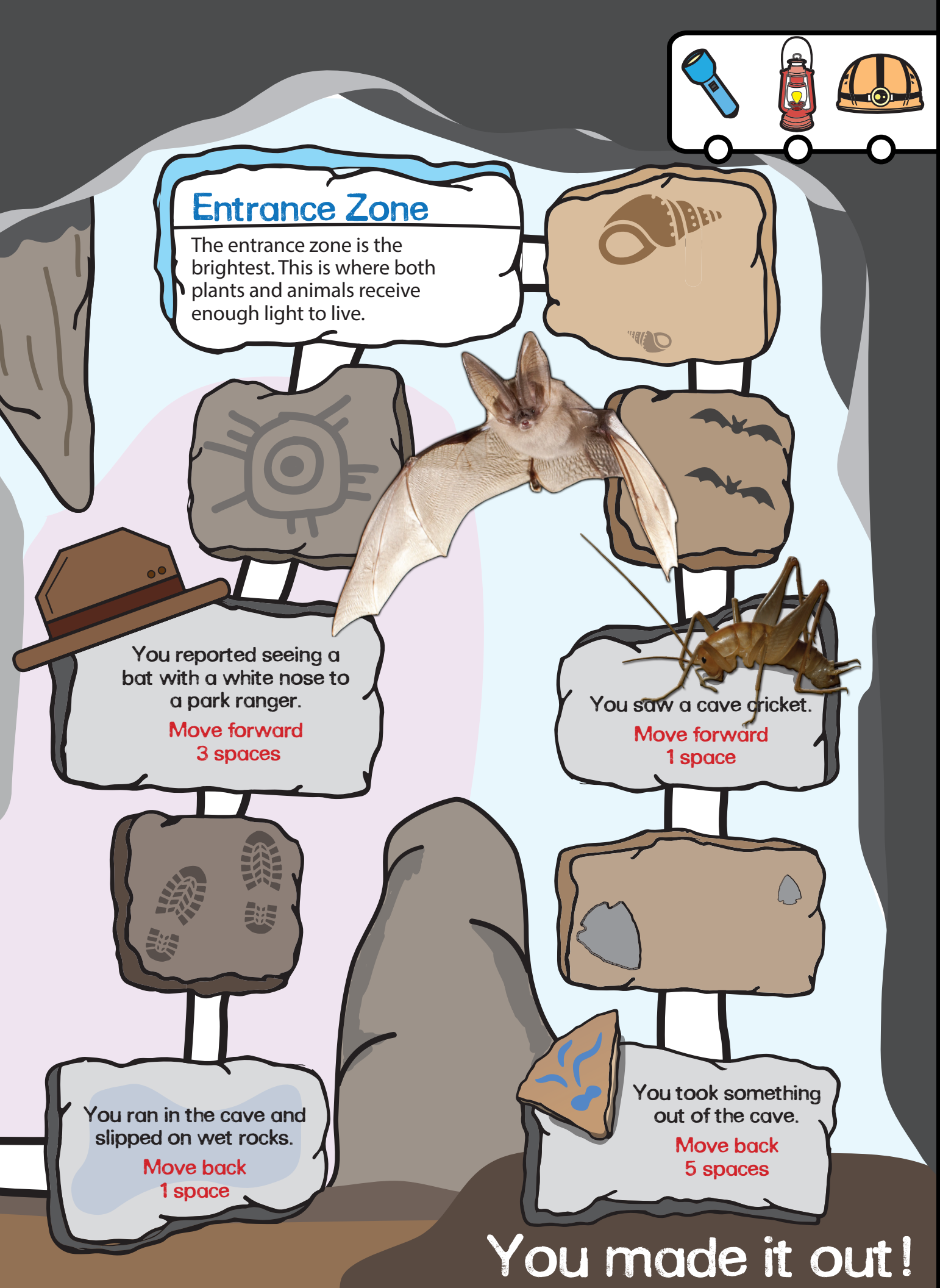
Follow the stones and make it out of the cave!



To Play: Gather coins or something small to use as your game pieces and place one piece for each player on the ***Dark Zone*** stone.

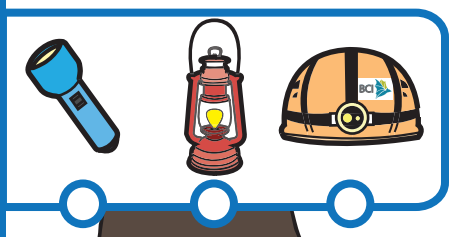
Take turns flipping a coin to move your game piece. When the coin lands on tails, move one space. When the coin lands on heads, move two spaces.

Follow the instructions on the stones. The first player to make it out of the cave wins!

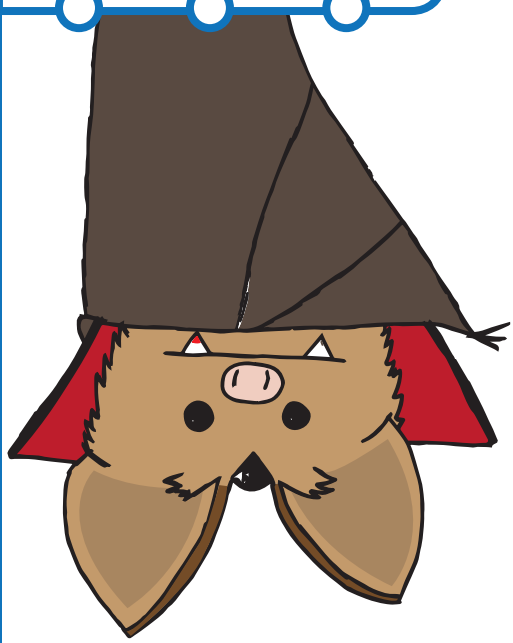


Speleo-Fact: Kazumura Cave in Hawai'i (lava tube) is the deepest cave in the United States at 3,614 ft. (1,101 m).

Dispelling Batty Myths

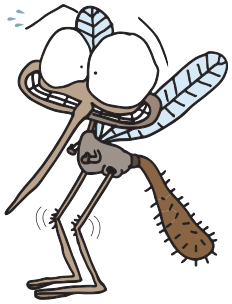


Bats are blind! Bats are vampires! There are many myths about bats and it is your job to debunk these myths. **Fill in a bat fact and complete the activity at the bottom of the page with friends and family.**



I Want to Suck Your *Blood*

Not all bats feast on blood. There are only three species of bats that lick the blood of their prey after making a small bite. Vampire bats do not live in the United States. Bats in the United States mainly eat insects. One bat can eat over 1,000 mosquito-sized insects in one hour!

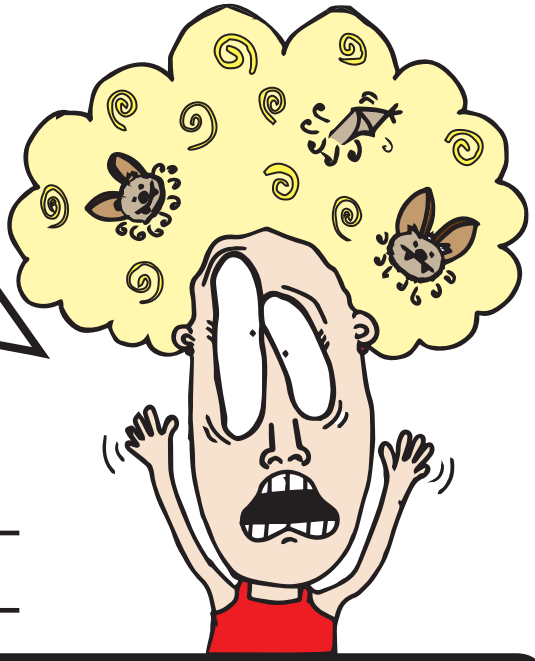


Blind as a Bat

Bats use sound waves that bounce off objects such as flying insects to "see", in a process called **echolocation**. They use echolocation to find food and navigate through the darkness. Some bats also use their eyes to hunt prey due to echolocation's short range.

Help! They're in My Hair!

Bats do not want to land in your hair! Bats are found in many places. They live in caves, trees, or in structures such as barns. Thousands of bats live under bridges across the United States. Even on a bad hair day, your head is not a place for a bat.



Bat Fact

Write down your favorite fact about bats.

_____

_____

Bat and Moth Activity

Group of 3 or more

Let's see what it is like to be a bat by using echolocation!

Objective: The "bats" try to tag all the "moths", while the moths try to avoid the bats! Once all the moths have been tagged, switch teams.

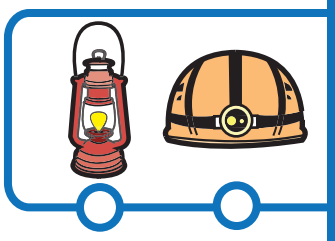
Rules:

- Split into two teams; the bats and the moths.
- Blindfold the bats or have them close their eyes for the entire activity.
- Whenever a bat says "bat", the moths must respond by saying "moth".

Uncover the Mystery of

The Bat Killer

Something is killing our bats! We are in need of a Junior Cave Scientist to help uncover what is causing all this destruction. **Use the clues to identify the deadly disease by filling in the blanks.**



Clue 1

Some people say that I am a really "fun guy" (fungi) and I cause the disease. I thrive in places that are cool and damp. Caves are some of my favorite's places to grow.

Clue 2

Since 2006, I have killed millions of bats. I grow on their noses, wings, and bodies and wake them up during hibernation. I cause them to leave the cave during the harshness of winter.

Clue 3

From a single cave in New York, I have spread to caves and mines across the eastern United States and Canada. Soon I may be in every cave in North America. I bring devastation and death to bats wherever I go.

Is your state infected?

☐ Yes ☐ No

Healthy

INFECTED

All photos from Mammoth Cave National Park

Clue 4

Before entering a cave, humans decontaminate their gear, clothing, and boots to make sure they don't spread me to other places. In places like Mammoth Cave, visitors walk over special mats to disinfect their shoes. I am a real threat to farmers who rely on bats to eat pesky bugs.

I am...

_ _ _ _ _ - _ _ _ _

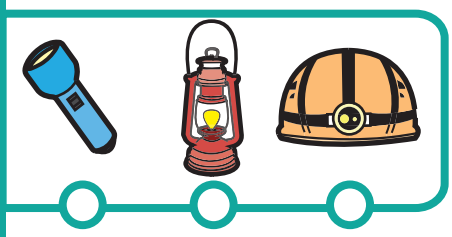
_ _ _ _ _ _ _ _

Need a hint? Use the blue letters in the clues above.

Visit nature.nps.gov/biology/wns to find out more.

Speleo-Fact: This disease kills between 90-100% of infected bats.

Finding Fossils in Caves



Paleontologists study the remains of ancient life. Caves are ideal places to preserve fossil remains for thousands or even millions of years. Fossil remains can range from tiny shells to skeletons of bears! There are two categories of cave fossils: fossils preserved in walls and bedrock, and fossils that accumulate in caves.

Fossils in the Walls

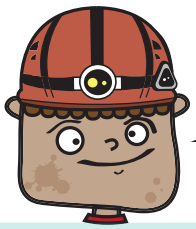
Most caves form in **carbonate rocks** such as limestone, dolomite, and gypsum. These are **sedimentary rocks** that may contain fossils. Fossils in cave walls are often marine invertebrates (ocean animals without a backbone) which help us learn about ancient environments.

Wind Cave National Park

Oregon Caves National Monument

Special Delivery: Fossils in Caves

There are different ways fossils end up in caves. These include fossils from animals that die in caves, animals that fall into caves, or the remains of animals brought in by predators.



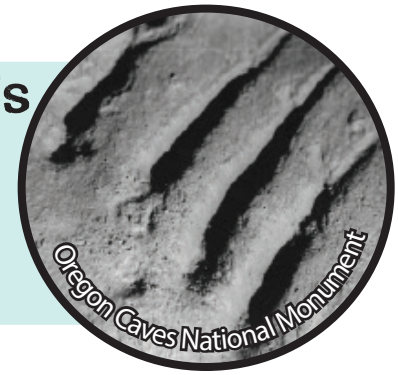
Never disturb fossils you find while on a caving adventure.

Carlsbad Caverns National Park

Body Fossils or Trace Fossils

Body fossils are any type of body parts including shells, bones, teeth, and plants.

Trace fossils include tracks, burrows, and coprolite's (fossilized poop).


Oregon Caves National Monument

Label each picture as a trace or body fossil

Skeleton

Sloth Dung

Vertebra

Tracks

_____ _____ _____ _____

Evidence of Ancient Animals

Mammoth Cave National Park

Packrat Middens

Packrats make nests and glue them together with their urine! Fossilized rodent urine is called **amberat**. Pack rats gather materials from all over which creates a lot of debris. The piles of debris are called **middens**. Scientists use ancient plant material from middens found inside caves to learn about past climates.

Save the California condor

Could you imagine a bird with a 10 foot (3 meter) wingspan flying right above you? The California condor, one of North America's largest birds, became extinct in the wild in 1987 due to exposure to lead, habitat loss, poaching, and pesticides. After the successful actions taken by government agencies, American Indian tribes, zoos, and environmental groups, there are now more than 160 of these birds living in the wild. Condors lay their eggs in caves, rock crevasses, and large trees. 12,500-year old condor bones have been found in caves, proving they have been part of the ecosystem for a long time!

Grand Canyon National Park

How does protecting caves also help save the California condor?

What information do caves provide about the California condor?

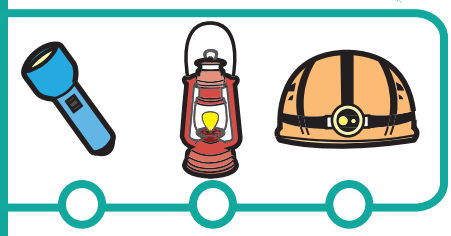
What are three factors that contributed to the decrease in the California condor population?

Why do you think it is important to try to save the California condor from going extinct?

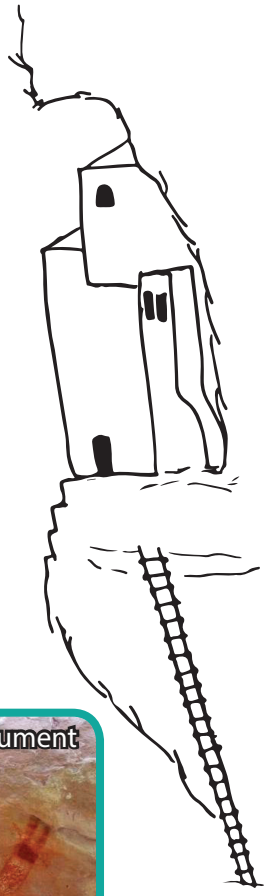
Visit www.nps.gov/grca/naturescience/california-condors.htm to find out more about California condors.

Speleo-Fact: In 1976, a fire in Rampart Cave (Grand Canyon NP) destroyed 70% of an extensive fossilized sloth dung deposit.

Travel Back in Time with Cave Archeology

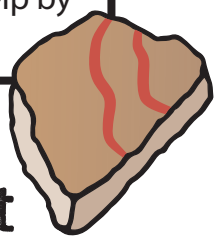


Caves in the United States have provided shelter for humans for more than 10,000 years. **Artifacts** left in caves provide information about the daily lives of American Indians. These artifacts include items such as pottery, arrowheads, and baskets.



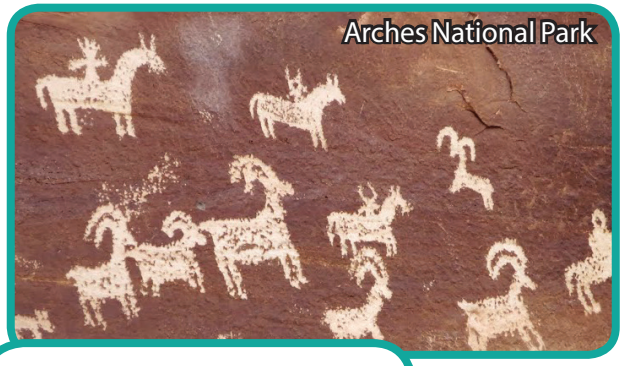
It is not "Finders-Keepers"

Pieces of broken pottery are called **sherds**. These artifacts are culturally significant and also provide archeologists with clues about the past. As a Junior Cave Scientist, it is your job to protect artifacts in caves. Help by reminding others not to pick up, touch, or take home any artifacts.



Pictures are Portals to the Past

Cave drawings provide a glimpse into the lives of people who lived long ago. **Pictographs** were made by painting on cave walls or rocks, while **petroglyphs** were created by carving, chipping, or cutting into the rock.



_____ Label these two as either a pictograph or a petroglyph. _____

We never leave drawings or signatures in any cave. Instead, create your own cave art in this box.

Karst is All Around You

Karst describes a landscape that forms when weak acids (**carbonic** and/or **sulfuric acid**) in groundwater dissolve bedrock. Karst can range in size from small caves to entire landscapes.

Sinking Streams

Russell Cave National Monument

Sinking streams are streams that drain into the ground at **swallets** or **swallow holes**. Water that goes into sinking streams may eventually come out at a karst spring.

Karst Springs

Ozark National Scenic Riverways

Water flowing through karst systems emerges from a cave or other openings as a **karst spring**.

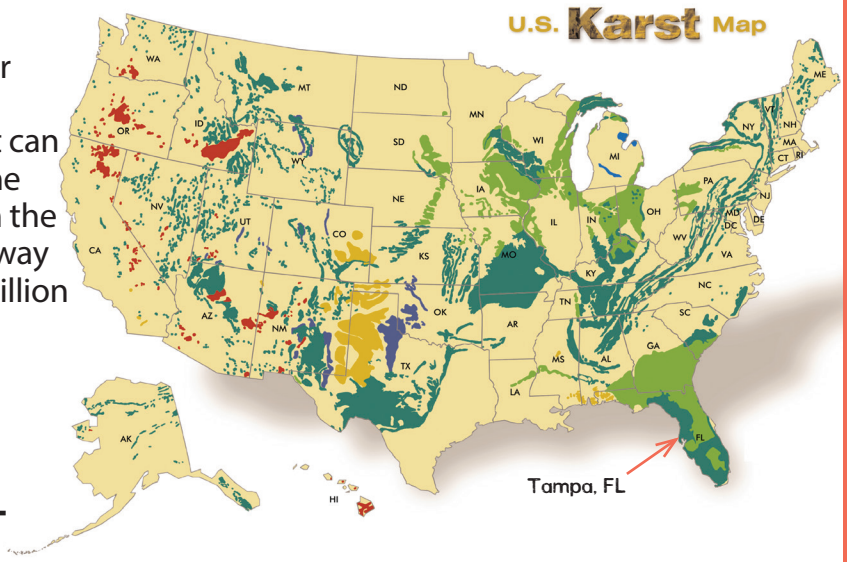
Underground Water

In the United States, 40% of the groundwater that we drink comes from **karst aquifers**. A karst aquifer is a body of carbonate rock that can store and transfer large amounts of water. The Floridan Aquifer—the largest karst aquifer in the United States—extends from Florida all the way to South Carolina! It yields more than 250 million gallons (946 million liters) of water per day.

What rock type do you live on if your home is in Tampa, Florida?

_____

_____



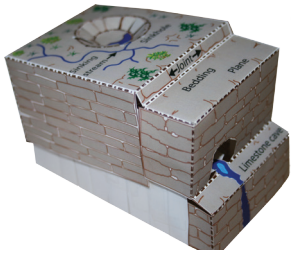
Rock Type

Carbonate Rocks (limestone, dolomite, marble)	Exposed
	Buried under 10 to 200 ft. (3 to 60 m) of non-carbonates
Evaporite Rocks (gypsum, halite)	Exposed
	Buried under 10 to 20 ft. (3 to 60 m) of non-evaporites
Pseudokarst	Volcanic
	Unconsolidated material

From Veni et al. (2001) © American Geological Institute. All rights reserved.

Karst Topography Model

Build this 3-D model to see how water travels down a sinkhole and out of a karst spring.



Visit go.nps.gov/learnkarst for a printable model and instructions.

Speleo-Fact: The land surface of the United States is 20% karst.

Living with Karst

Karst systems are complex and always changing. We need to plan carefully when living in karst areas and be aware of potential problems. **Learn more about living with karst and answer the questions.**

Do Not Trash Sinkholes!

Sinkholes are holes in the ground formed when water has dissolved away the bedrock. Throwing trash or other contaminants into sinkholes threatens groundwater systems, the water you drink, and the surrounding environment.

Mammoth Cave National Park

National Corvette Museum

Putting the "Cars" in Karst

Many people live near or directly on karst where the collapse of cave passages and formation of sinkholes are normal processes. Building near, or on top of, karst can be dangerous. One of the best strategies for living with karst is to learn more about our surroundings and what is beneath our feet. In February 2014, a giant sinkhole formed beneath the National Corvette Museum in Kentucky swallowing several classic cars.

How many cars do you see? _____

What is the term for where a stream goes underground?

_____

What acids are responsible for dissolving bedrock in karst systems?

_____

What are three factors that can contribute to groundwater pollution?

_____

_____

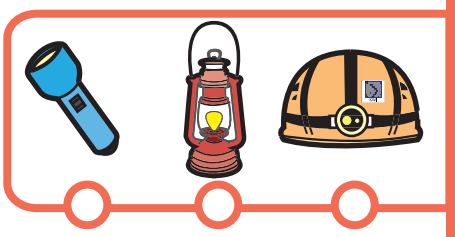
What do you think is the coolest fact about karst?

_____

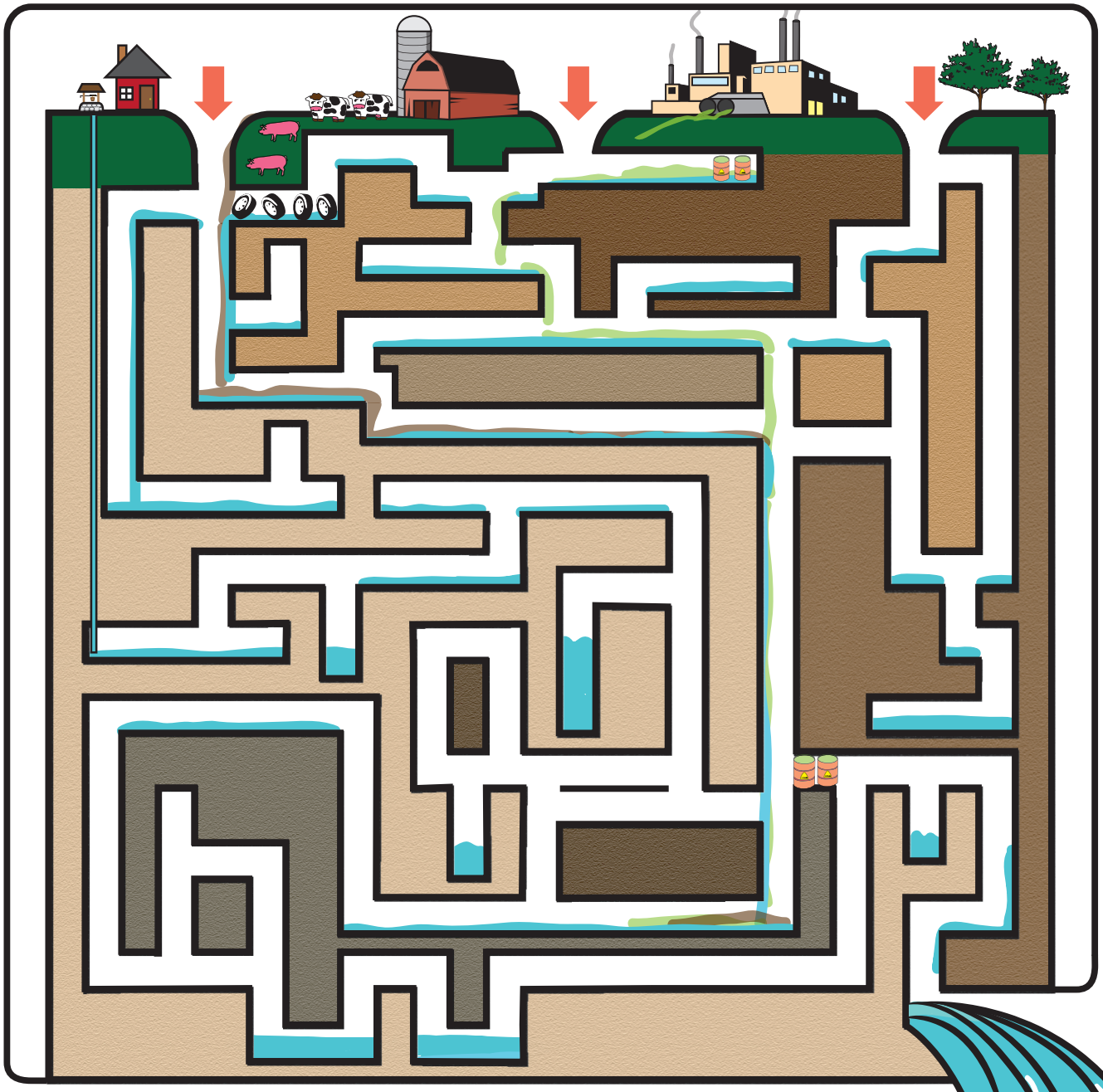
_____

Look at pages 19–21 to help answer these questions.

Find a Solution to the Pollution



Karst systems can be damaged by things that happen at the surface. **Pollution** by trash, sewage runoff, industrial chemicals, pesticides, herbicides, and fertilizers can harm karst environments. Some of the water we drink travels through karst. It is your job to minimize pollution. **Solve the maze**. **Enter through any of the three sinkholes and avoid as much pollution as possible.**



How do actions at the surface affect what happens below the surface?

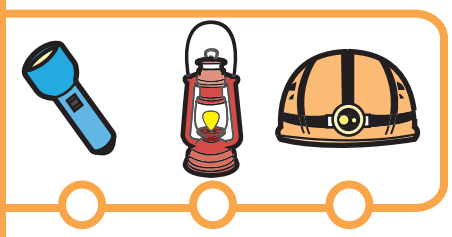
_____

How can you help keep groundwater clean?

_____

Speleo-Fact: San Antonio, Texas gets all of its water from the Edwards Aquifer, a karst aquifer.

Caves Need Care



Caves and karst landforms are fragile resources and can be harmed or damaged by humans. It is your job as a Junior Cave Scientist to **conserve** these resources and enjoy caves for the adventures they have to offer. Caves take hundreds of thousands of years to form. We must ensure they are still here for future generations.

Write a poem about caves. Start each line with the letters in the word "cave".

C

A

V

E

Draw your favorite thing about caves or other karst landforms.

Mammoth Cave National Park

Historic Graffiti

Many caves in the National Park System have old signatures from early visitors. These historic signatures hold cultural significance but are very destructive to the cave. Visitors are no longer allowed to write their names in caves. This helps **preserve** the cave's natural beauty for everyone to enjoy.

Why will you try your best to preserve caves and karst landforms for future generations?

Carlsbad Caverns National Park

Junior Cave Scientist Pledge

As a Junior Cave Scientist, I promise to:

EXPLORE

magnificent and beautiful caves;

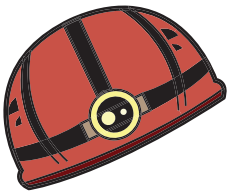
LEARN

about caves and karst systems and the work that speleologists do; and

PROTECT

our national parks and the things that make caves and karst areas special.

I promise to enjoy the national parks and share what I learn with my friends and family.



Signed by _____

Junior Cave Scientist

Certificate of Achievement

_____

has successfully completed the requirements to be an official National Park Service Junior Cave Scientist

_____ Educator/Ranger Signature

_____ Date

National Park Service
U.S. Department of the Interior

Geologic Resources Division
Cave and Karst Program

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Paul G. Johnson - Pinnacles National Park, p.6
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Kenneth Ingham – Cueva de las Sardinas, p. 10
Michael Durham – Townsend's big eared bat – pp. 13, 23
National Corvette Museum – Corvettes in sinkhole, p. 20
Gavin Newman – Lechuguilla Cave, Carlsbad Caverns NP, p. 22
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John Burghardt	Paula Bauer	Ellen Rohn	Barbara Tallman	Cami McKinney
Bill O'Donnell	Tim Connors	Jacquelynn Hilton	Dianne Joop	The Kids of GRD

Bats in Crisis

White-nose syndrome (WNS) has killed more than **6.7 million** bats in the United States and Canada. WNS can spread from bat-to-bat, or soil-to-bat. It may also be spread by humans carrying spores of the fungus *Pseudogymnoascus destructans*, or "PD", on their clothing or equipment.

Your Help is Needed!

- Stay out of caves and mines where bats are hibernating.
- Honor cave closures. Check with your state and federal agencies for the status of caves and caving in your area.
- Report bats showing signs of WNS, and bats that are dead, dying, or appear diseased, to your state wildlife agency.
- Help spread the word about WNS and the value of our bats.

For more information on bats and WNS, visit:

www.nature.nps.gov/biology/wns • www.whitenosesyndrome.org • www.batcon.org

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