

Using the *Bitter Water, Bottomless Lakes* Curriculum Guide

This section features:

- A brief description of the Outdoor Classroom Program offered through New Mexico State Parks
- A brief overview of planning and scheduling a field trip to Bottomless Lakes State Park; and
- An overview of the activities in this guide and how to navigate your way through them.
- A background article and glossary describing the natural and cultural history of the BLSP area



Taking Learning Outside

The Outdoor Classroom Program (OCP) is a joint venture in outdoor, standards-based learning between the New Mexico State Parks Division (NMSP) and the NM Public Education Department (PED). Begun in 2007, the OCP has provided transportation grants, curricula, and training for teachers and other educators to help get students into outdoor learning environments. With continued support from teachers and the New Mexico Legislature, the OCP will be able to support outdoor learning in every corner of the state. Please visit the teachers section of the State Parks website (www.nmparks.com) for more information and updates.

A Tool for Teachers

Teachers along the lower Pecos River in New Mexico have an outdoor classroom at Bottomless Lakes State Park. Situated near the Pecos River, the park features a number of sinkhole lakes and unique habitats that makes this area an important biological hotspot. This curriculum, specifically targeting 4th and 5th grade science standards, includes several activities for field (FT) and/or classroom (CR). The following page lists these activities and briefly describes them.

The following pages will also detail the layout of each activity as well as provide a potential approach for the integration of these activities into your classroom lesson plans. Once you have decided on a plan of action, please contact the staff at Bottomless Lakes State Park to schedule your field trip. Be sure to inform them which activities you plan to do before, during, and after your field trip.

Bottomless Lakes State Park – (575) 624-6058 / (575) 624-6029 (fax)
www.nmparks.com

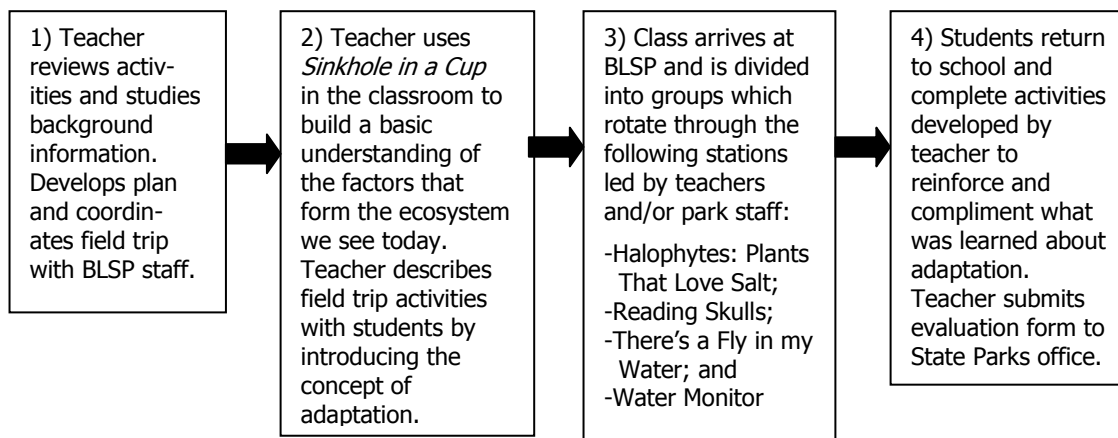
Please note that while this curriculum has been designed and developed by State Parks staff for use at Bottomless Lakes State Park, nearby Bitter Lakes National Wildlife Refuge is also a viable field trip destination. Please contact the refuge for further information at (575) 625-4009.

Activities

Bitter Water, Bottomless Lakes features nine standards-based activities grouped into five categories identified by a specific icon:

I. Geology Rocks 	Field	Activity A)	<i>Sinkhole in a Cup</i> – understanding how “bottomless lakes” are formed
	Class	Activity B)	<i>Scratching the Surface</i> – identifying rocks and minerals
II. Water Ways 	Field	Activity A)	<i>There's a Fly in My Water</i> – aquatic invertebrates and water quality
	Field	Activity B)	<i>Water Monitor</i> – measuring water chemistry and quality
III. Habitats on the Edge 	Field	Activity A)	<i>Can You See the Signs?</i> – discovering local wildlife through tracks and scat
	Field	Activity B)	<i>Habitats in a Hoop</i> – biodiversity survey within the area of a single hula hoop
IV. Amazing Adaptations 	Field	Activity A)	<i>Reading Skulls</i> – skulls reveal much about an animal
	Class	Activity B)	<i>Halophytes: Plants That Love Salt</i> – these plants thrive in soils that kill others.
V. Know Your Place 	Field		<i>Pecos River Bingo</i> – discovering biodiversity and strengthening observation skills

All activities are suited for use on a field trip, but consider using one or more as a pre-field trip activity in your classroom. A possible approach with an adaptations focus for a group of 80 students would be as follows:



This is, of course, just one possible scenario. All activities could be conducted at the park, and in any particular arrangement that best suits your teaching goals. Park staff are well versed with these activities and can offer helpful suggestions for your consideration. Keep in mind that park staff are not always available to lead activities at the park. Please come prepared to lead. Activities are adaptable to other grades and subject areas.

Walking Through a BWBL Activity

Each activity in the curriculum follows a consistent format for ease of use and navigation.

Cover page features the nuts and bolts of each activity.

Subject area/category heading and activity title.

Central theme of the lesson/activity, including time frame and venue suggestions (i.e., classroom or field trip).

Standards and benchmarks alignments designated by grade and keywords. All are science standards unless noted otherwise.

Logistical information and materials.

Background information on the subject (variable length depending on the particular activity).

Procedure instructions and information. All of these pages will feature full bar headers with activity titles and the category icon. Variable length depending on the particular activity.

Bolded terms are defined in the Vocabulary section at the end of each activity.

A teacher evaluation form is the last page of each activity. Not pictured here, this form asks for your feedback on the activity, particularly how it could be improved to better serve as a learning tool. Return it to State Parks upon completion.

Student activity pages are colored for clear photocopying. The clipboard icon and space for team or student's name helps specify it as an activity sheet.

IV. AMAZING ADAPTATIONS
Halophytes: Plants That Love Salt
Halophytes have found a niche at Bottomless Lakes State Park and Bitter Water National Wildlife Refuge by adapting to salty soils. (Field Trip / 45-60 minutes)

Standard/Benchmark	Grade	Keywords
Life Science	4	Adaptation, differences
Science	4	Adaptation, differences
Science	4	Adaptation, differences

Goal: Students will identify halophytes, salt-loving plants and learn how these plants have adapted to this environment.

Objectives:

- Identify salt cedar, salt grass, iodine bush, four-wing salt bush and Peccan surflover.
- Record data and observations about these halophytes.
- Use an electrical conductivity meter to measure the salt in the soil around each plant.

Materials:

- Clipboard
- Pencil
- Data observation sheets
- Plant identification cards
- Quart size, zip-top plastic storage bags
- Small garden trowels
- Permanent markers
- Electrical conductivity meter
- Plastic cups
- Distilled water

Background: Are there certain foods that you just have to eat? Maybe French fries or popcorn? Salt is essential to life, and we all need some every day. There are some plants that need salt too. They are called halophytes (HAL-uh-fytes), or salt-loving plants. They have adapted over time to living in soils that have much higher amounts of salt than other soils, absorbing the salt through their roots. Some plants have learned to live in places and conditions where other plants can't. Several of these salt-loving plants grow at Bottomless Lakes State Park. You'll find them growing in the salt marshes. These plants have adapted to living in salty soil. They have learned to absorb the salt through their roots and store it in their leaves. When the water evaporates, the salt is left behind, leaving behind a white crust. This white crust helps to create a special niche for local plants like salt cedar, four-wing salt bush, salt grass, iodine bush and even the endangered Peccan surflover.

Pass the Salt! Similar to people, these halophytes "need" not even salt through salt glands called salt glands. The excess salt is accumulated and excreted through pores in the plants' leaves. The salt is then re-deposited back into the soil and the cycle starts all over again. Some plants, like the salt cedar, actually change the soil composition with the salt they add, giving them a competitive edge over other plants.

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Amazing Adaptations
Halophytes: Plants That Love Salt

Procedure I: A Dash of Salt

- Have students divide into teams of 3-4 per group.
- Hand-out clipboards, pencils, plant ID cards, keys and data observation sheets - one per group.
- Using the ID cards and keys, students will locate the five different halophytes.
- Once a halophyte is identified, teams will answer questions and list observations about each plant.
- After teams find all five plants and return to the starting point, groups will share and compare their results with each other.

Procedure II: Worth Its Weight in Salt

- Give each team a quart-size zip-top plastic storage bag and one small trowel.
- Assign each team one of the halophytes to be tested. Have them write the name of their plant on outside of bag with permanent marker.
- Tell students they will be discovering which plant has the saltiest soil by testing the amount of salt in the ground near their plant. Ask students to guess which one they think it will be.
- Once teams locate their plant, they will dig a small hole near the plant, approximately 6 inches deep. Students will put one scoop of soil from bottom of hole into the plastic storage bag.
- After returning to the starting point, each team will test their soil sample for salt (saline) using the electrical conductivity (EC) meter. Teachers/staff will assist students in using the EC meter.
- Students will share results and discover which plant grows in the saltiest soil.

Peccan surflover **Iodine bush** **Saltgrass**

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AMAZING ADAPTATIONS
Halophytes: Plants That Love Salt Worksheet

Team/Name: _____ Date: _____

Using the flash cards or field guides, find and identify salt cedar, salt grass, iodine bush, four-wing salt bush and Peccan surflover. Once you have identified these salt-loving halophytes, write down your observations about each one:

Halophyte #1

- Are there leaves? If so, describe them (color, shape, texture): _____
- What do you observe about the stems? _____
- Are there flowers? If so, describe them: _____
- What do you notice about the area surrounding this plant. Are there other plants growing nearby? _____
- What plant is this halophyte? _____

Halophyte #2

- Are there leaves? If so, describe them (color, shape, texture): _____
- What do you observe about the stems? _____
- Are there flowers? If so, describe them: _____
- What do you notice about the area surrounding this plant. Are there other plants growing nearby? _____
- What plant is this halophyte? _____

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Bitter Water & Bottomless Lakes: The Pecos River Basin in Southeastern New Mexico

By John Read & Rob Yaksich, New Mexico State Parks

“Let Nature be your teacher.” ~ William Wordsworth (English Poet, 1770-1850)

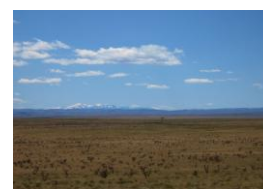
In 1866, the Bottomless Lakes area became a stopover for cowboys herding cattle through New Mexico territory from Texas to Colorado on the Goodnight-Loving Trail. While they weren't the first humans to live in or traverse the area, they may have been among the first to discover the unusual nature of these unique pools. Tying their lariats together, the cowboys tried unsuccessfully to find the bottom of the lakes. Giving up in frustration, they dubbed the lakes “bottomless,” a name which sticks to this day. In truth, the deepest of these lakes is only 90 feet, but the unique country of the Pecos River Basin in southeastern New Mexico continues to inspire curiosity, wonder and amazement.

Bottomless Lakes State Park was established as New Mexico's first State Park in 1933 as a project of the Civilian Conservation Corps. Covering a land area of 1400 acres, Bottomless Lakes contains several small sinkhole lakes bordered by high red bluffs. Lea Lake is the largest of these at about 15 surface acres. The park is located 12 miles southeast of Roswell and offers a variety of activities including hiking, swimming, fishing, and something you wouldn't expect in the arid Southwest - scuba diving. Rare **protected species**, including the Pecos pupfish and Mexican tetra, live alongside more common wildlife, like ducks, mule deer, and rabbits.

Bitter Lake National Wildlife Refuge is located a few miles east of Roswell where the Chihuahuan Desert meets the southern Great Plains. One of the more biologically significant **wetland** areas of the Southwest, Bitter Lake is home to more species of dragonflies than the Florida Everglades! Established in 1937 to provide a wintering habitat for **migratory** birds, this refuge plays a crucial role in the conservation of wetlands in the Southwest.

The Pecos River Basin in Southeastern New Mexico

The Basin from Bitter Lake National Wildlife Refuge to Bottomless Lakes State Park provides an unusual geologic landscape and **habitat** for a wide variety of plants and animals, and is also home to several thousand human residents. Here, the Chihuahuan Desert, short grass prairie, Pecos River, and the Roswell Artesian Basin come together, offering the careful observer the chance to witness some rather unusual biological interactions of wetland and desert creatures. For instance, you may find roadrunners hunting for garter snakes in a willow thicket, while dragonflies may cruise over desert flats or cultivated farmland seeking small, flying insects.



This stretch of abundant water has nurtured life—both human and wild—for centuries. The combination of fresh and saline (salty) water habitats promotes a unique diversity of flora and fauna that makes this area biologically important. While it's simple enough to understand how river water gets here, the story of the lakes that dot this landscape begins a long time ago and lies literally under our feet.



The Pecos River begins its long journey to the Gulf of Mexico in the high country of northern New Mexico's Sangre de Cristo range, the southernmost chain of the Rocky Mountains. Flowing more than 200 miles before reaching Chaves County, it travels another 700 miles before merging with the Rio Grande at Amistad Reservoir northwest of Del Rio, TX. Along its route, the Pecos River supports countless numbers of plants and wildlife, as well as farms, ranches, towns, and cities.

Photo of Pecos River near Terrero, NM, by Buck Bradford

Of Earth and Water

The Geology

The unique **geologic** features of the Pecos River Basin range from high red bluffs to low **artesian** springs. The processes that created these features began during what geologists term the **Permian Period** (286–248 million years ago {mya}). During the mid-Permian (255 mya), much of present day southeastern New Mexico and west Texas was near the equator and covered



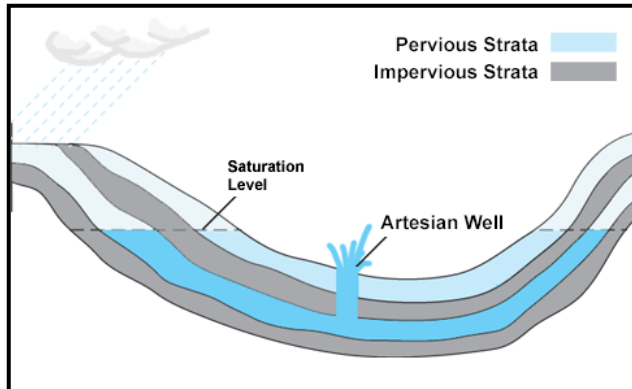
by a vast, shallow sea. As plate tectonics drove this area northward, periods of global cooling locked up countless billions of gallons of water in **glaciers**. Ocean levels fell and the sea in this area became cut off from the main body of the ocean by a now-extinct coral reef known as the **Capitan reef escarpment**. Trapped seawater in the basin gradually evaporated, leaving behind layers of the mineral **gypsum**. When the climate warmed, wind and rivers carried red silt into the basin from eroding mountains to the north

and west. Seasonal dry and wet periods contributed further to the strata building processes over millennia, adding alternating layers of white gypsum rock and **red siltstone** (*left*) seen at Bottomless Lakes and Bitter Lake today. In time, these beds and deep underlying rocks were tilted up in the area around the Sacramento Mountains by tectonic uplifting. This process created the gradual downward slope of these rock formations to the Pecos River Basin.

The Hydrology

Surprisingly, much of the water here in the Basin comes from these mountains sixty miles to the west via an aquifer running through a relatively thin layer of **porous** limestone. Rain and snow that falls on the **Capitan** and **Sacramento** mountain ranges **percolates** into this underlying rock, known to geologists as the **San Andres limestone** layer, and slowly travels underground down the long, gentle slope of the Basin towards the Pecos River. A layer of solid rock caps this huge volume of slowly moving water. Since it can't escape to the surface, pressure builds as water from upslope continues to percolate down toward the Basin. When this water eventually reaches

the eastern Basin, the impermeable rock cap is replaced by softer gypsum rock, which the highly pressurized water can infiltrate and dissolve, forming the springs and sinkholes at the surface we see today. In fact, many steep-walled, water-filled **sinkholes**, called **cenotes** in Spanish [se NO tes], are located in both Bottomless Lakes and Bitter Lake.



'Impervious strata' refers to the solid rock layer through which water cannot penetrate, leaving it trapped underground. Pervious strata are the soft, porous rock layer (gypsum in the case of the Pecos River Basin) that water can penetrate and dissolve. An artesian well forms when water under tremendous built-up pressure finally permeates the soft rock and bubbles to the surface.

Considering how these cenotes are formed, it's no surprise that the water found in them contains significant amounts of dissolved minerals. For instance, as gypsum dissolves, calcium sulfate is released into the water. This particular salt gives water in the cenotes a bitter taste, and often makes the water too salty to drink. In fact, conditions in some of the lakes become so salty at times that only the most salt-adapted species can survive. This can be a headache for Park management and Game & Fish staff who want to create public fishing opportunities but can't because the water may be too salty. Be sure to see the Water Lab exhibit in the Visitor Center, especially to see how water in the Pecos River compares to that found in the lakes.

Flora & Fauna

Where water is abundant, plants and animals abound. At least 350 species of birds have been observed in the area, including thousands of wintering ducks, geese, and sandhill cranes. Mammals, from tiny mice to bobcats, deer, and porcupines, make their homes here, as do more than 50 species of reptiles and amphibians. Twenty-four species of fish are found here, including some that are uniquely adapted to living in the higher saline conditions of the lakes.



Many species of wildlife are found in and around the Pecos River Basin from Bitter Lake NWR to Bottomless Lakes SP, including (L to R) several members of the skimmer family of dragonflies, roadrunners, the Pecos sunflower, box turtles, and black-tailed jackrabbits.

In ancient times, herds of mammoth and prehistoric bison roamed what is now southeastern New Mexico. Preyed upon by dire wolves, saber-toothed cats, and **Paleo-Indian** hunters, they all eventually became extinct. Flash forward to the 18th and 19th centuries, where prairie wolves and the Comanche and Apache hunted vast herds of bison and pronghorn. As the western frontier gradually faded into history, so did the great herds and hunters of the plains. But remnants of those bygone days still exist, and you can encounter a surprising array of wildlife in the Basin.

Where habitats come together, wildlife diversity is often high. Riverside, or **riparian**, thickets of willow, salt cedar (an invasive plant species), and mesquite harbor many species of birds, mammals, and insects, including mule deer, Cooper's hawks, and bullsnakes. In rockier areas, wood rats (pack rats), lizards, rattlesnakes, and rock wrens find numerous hiding and nesting places. Once out on the open grasslands, speedy pronghorns and black-tailed jackrabbits scan the horizon for hungry coyotes and human hunters. Many species, like coyotes and mule deer, are quite adaptable and may be found in a variety of habitats, even living within towns and cities. Such species are considered to be **cosmopolitan**, meaning that they are usually widespread and abundant across different ranges and habitats and are usually in little danger of extinction.

There are other animals and plants here whose habitat requirements are much more specialized. These species have adapted to life in a particular **niche**, including those that thrive only in the saltier conditions found in the lakes and some soils. A few of these niche specialists are found nowhere else in the world, making them **endemic** (unique) to this area. Endemic species tend to have particular adaptations and restricted ranges, which makes them highly vulnerable to extinction. In fact, some local endemic species are listed as threatened or endangered. Bottomless Lakes State Park and Bitter Lake National Wildlife Refuge are havens for some of these protected species, including the Pecos sunflower, Wright's marsh thistle, Pecos pupfish, Mexican tetra, least shrew, barking frog, arid land ribbon snake, and the Pecos River muskrat.



Endemic species found in the area of Bottomless Lakes State Park and Bitter Lake National Wildlife Refuge include (starting clockwise from the snake: arid land ribbon snake, barking frog, Pecos River muskrat, and Wright's marsh thistle. These species are found nowhere else in the world except for this portion of the southwestern US.

Humans: Part of the Equation

The earliest human inhabitants of this region were **Paleo-Indian** hunters and gatherers. The best known of these peoples were part of the **Clovis and Folsom cultures**, named after the types of spear points found at Clovis and Folsom, New Mexico.

In the area of the Basin near Roswell, permanent, large-scale habitation sites have not been

located, but a variety of temporary prehistoric campsites have been found. These people made their homes here as early as 12,000 years ago. Archeological excavations show that their diet consisted of meat from mammoths and giant bison, as well as plant seeds, roots, nuts, and berries.



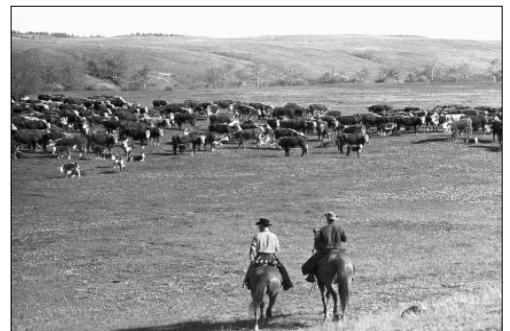
(Historical Society of New Mexico)

Paleo-Indians were present at the end of the last Ice Age, but shortly thereafter became extinct for unknown reasons. Mammoths, giant bison, and many other species also became extinct around this time. Research suggests that other cultures in New Mexico after the Ice Age may have merged, moved away, or disbanded.

After the extinction of the Paleo-Indians, the Jornada-Mogollon culture migrated to the Basin area but was replaced by their descendants called the Jumano. These people were agriculturalists. The Jumano culture was probably replaced by competition for resources by the Mescalero Apaches and Comanches shortly before 1700. The nomadic bands of Mescalero Apache and Comanche people depended on a seasonal bounty from an array of places to survive, but left little evidence of their passing.

The first documented European visitor to the area was the Spanish explore Don Antonio de Espejo, who explored the Pecos Valley for Spain in a fruitless quest for wealth in 1583. A small amount of trade persisted in the Basin over many years between Native Americans and Spanish and Mexican traders and explorers, but European presence in the Roswell area was mostly transitory due to a lack of resources, no discovery of gold or other riches, and occasional raids by the Apaches or Comanches. Eventually the Apaches were driven south by the Comanche to the Guadalupe Mountain region of Texas and Mexico in the late 1700s.

In 1867, Roswell's first settlement of a few adobe shacks was built along the **Goodnight-Loving Trail** by homesteaders from the Midwest who came to Roswell and Chaves County to start the ranching industry. In the 1870s, Comanches launched attacks against settlers, buffalo hunters, and cattle herders. These raids brought down a retaliatory U.S. Army campaign that broke the Comanche power once and for all. The Comanche were forced to surrender and begin the painful transition to reservation life. Their tribal government today operates near Lawton, Oklahoma.



(Historical Society of New Mexico)

In about 1890, with the discovery of artesian water, agriculture then became the main industry in Chaves County. With the extension of the railroad to Roswell in the mid-1890s, a population boom lasted for nearly four decades until the Great Depression struck in the 1930s.

The Great Depression Creates a Park

When Bottomless Lakes State Park was established as New Mexico's first State Park in 1933, the US was in the grips of the Great Depression. Unemployment and poverty were rampant

across the nation, and Chaves County was no exception. In an effort to provide relief, President Franklin D. Roosevelt established the Civilian Conservation Corps, the CCC. The Corps, part of Roosevelt's New Deal, would establish and revitalize national, state, and local parks across the country, and would ultimately mobilize and employ more than three million young men.



Here in New Mexico, a CCC crew of about 200 men from all corners of the country constructed the rock pavilion and water tower (*left*) near Lea Lake shortly after the park was established. Before the start of World War II, CCC crews would build roads and picnic shelters throughout Bottomless Lakes. The CCC also constructed buildings and roads at other New Mexico State Parks, as well as National Park and Forest Service sites. After the Japanese attack on Pearl Harbor in 1941, national attention shifted away from

domestic issues in favor of the war effort. Rather than formally disbanding the CCC, the 77th Congress ceased funding it, causing it to end operations in 1942. Many of their structures and parks remain today, testimony to the workmanship of the CCC, representing a visionary period in US conservation history.

Here Today, Here Tomorrow

Today's students are the resource managers of the future. Bottomless Lakes State Park, Bitter Lake National Wildlife Refuge, and other local, state and federal locations along the Pecos River in New Mexico, provide public access to natural resources that were more common at one time. Today, these public facilities provide a place of refuge for wildlife and a living laboratory for the education and inspiration of our youth and the public as a whole. Through the Outdoor Classroom Program, we hope to continue to engage and inspire future generations of New Mexicans.



Fifth graders from Berrendo Elementary School in Roswell gather around Bottomless Lakes State Park Superintendent Steve Patterson as he shows off a sample of aquatic insects they have just gathered from Lea Lake. Surprisingly, this was the first trip to the lake for some of these students even though they live only 20 minutes away. Through the Outdoor Classroom Program, State Parks hopes to get students reconnected once again to their natural back yard.

Glossary

Artesian spring or well: A source of water that occurs when the water table is higher than the surrounding topography. An artesian spring or well occurs when water is trapped in an aquifer under a layer of impervious material like rock or clay with no way to the surface. Typically, the water in the aquifer is under pressure because it flows from a high elevation to a low elevation. When the water comes in contact with softer material like gypsum, that pressure allows the flow of water upwards and out of a spring or well without the need for pumping. Refer to the artesian well diagram at the bottom of page 3.

Capitan Mountains: A mountain range in Lincoln County, south-central New Mexico. The range is about 20 miles long from east to west and about 6 miles wide. The highest point in the range is an unnamed peak that reaches 10,201 feet, 118 feet higher than Capitan Peak. The Spanish used this mountain range as a landmark on their way to and from Santa Fe.

Capitan reef escarpment: The remnant of an ancient reef (*below*) which formed approximately 250 million years ago from calcareous sponges and algae, other lime-secreting marine organisms, and vast quantities of lime that precipitated directly from the seawater forming a 400-mile-long reef. Eventually the sea evaporated, the reef subsided, and a thick blanket of sediments and mineral salts buried the reef. The reef was entombed for millions of years until a mountain-building uplift in this region exposed a part of the fossil reef in the Guadalupe Mountains about 26 million years ago. Faulting lifted the present day Guadalupe Mountains nearly two miles upward. After this uplifting, the wind and rain wore away the softer sediments, exposing the more resistant reef material.

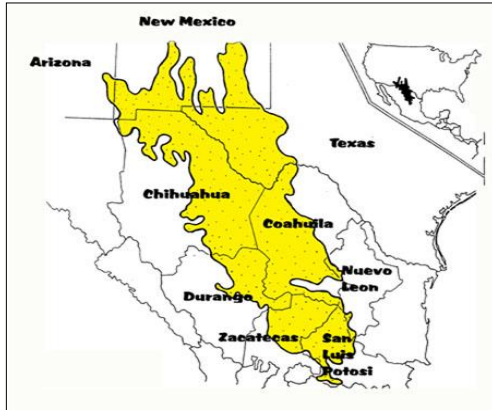


Cenote: Pronounced [se NO teh] in Spanish, it is a type of steep-walled, water-filled sinkhole. In many cases, cenotes are caused by the collapse of rock roof-sections over an underlying cave system. Also called a doline [doh LEEN].



The view from above Cottonwood Lake at Bottomless Lakes State Park. The trail from the lake leads back to the park's visitor center, which is in the background just to the right of the circular road.

Chihuahuan Desert: The second largest of the four North American deserts (after the Great Basin desert), the Chihuahuan Desert is approximately 800 miles long and 250 miles wide and lies in the rainshadow of the Sierra Madre Oriental and the Sierra Madre Occidental mountain ranges in Mexico.



The northern Chihuahuan Desert in New Mexico and west Texas is typified by relatively cold winters, with most winter nights below freezing, and hot summers with daytime highs that regularly exceed 100°F. Most of this desert's yearly moisture falls from mid-summer to early fall. The Chihuahuan Desert contains extensive grassland and shrub habitats, often dominated by creosote bush (*Larrea tridentata*).

Cosmopolitan species: Species that have a very broad distribution and can be found almost world-wide, like the common housefly.

Ecosystem: A natural unit consisting of all living organisms (*biota*) in an area functioning together with all the non-living (*abiota*) physical factors of the environment.

Endemic species: Species that are often very rare because they are only found in a small geographical region. A local example would be the Pecos pupfish, which is found nowhere else but along a small portion of the Pecos River in New Mexico and Texas. A more commonly known example would be the giant panda, found only in a few mountain ranges in central China.

Fauna: All of the animal life of any particular region or time.

Flora: All of the plant life occurring in an area or time period, especially the naturally occurring or indigenous plant life.

Geography: The study of the Earth and its features, inhabitants, and phenomena.

Geology: The science and study of the solid matter that constitutes the Earth, encompassing such things as rocks, soil, and gemstones. Geologists study the composition, structure, physical properties, history, and the processes that shape Earth.

Glaciers/Glaciation: The process by which glaciers spread over the land.

Goodnight-Loving Trail: Used in the cattle drives of the late 1860s for the large-scale movement of cattle northward from the open range country of west Texas and New Mexico to the railroads in Colorado. The trail is named after two prominent cattlemen, Charles Goodnight and Oliver Loving.

Gypsum: A common mineral (calcium sulfate) with thick and extensive **evaporite** beds in association with **sedimentary rocks** like limestone and siltstone. The largest deposits occur in **strata** from the **Permian** age. Gypsum deposits can also occur when high concentrations in ocean or lake water precipitate onto the Basin floor.

Habitat: the natural environment in which an organism lives.

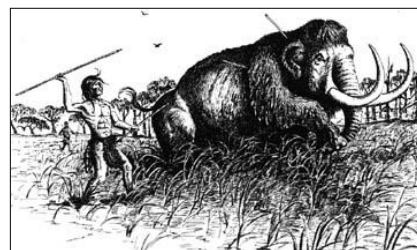
Hydrology: The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Invasive species: Generally considered to be non-native plants or animals that cause adverse economic and/or ecologic effects in the habitats into which they are introduced.

Migratory birds: Birds that take regular seasonal journeys of varied distances made in response to changes in food availability, habitat or weather.

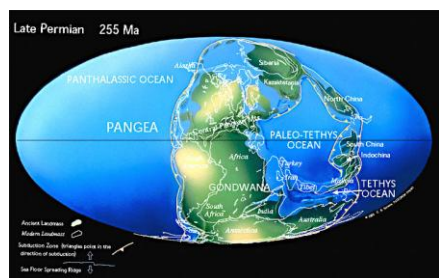
Niche: The position or function of an organism in a community of plants and animals; (i.e., a red-tailed hawk is a predator of small mammals).

Paleo-Indians: Native Americans living in New Mexico around 12,000 years ago who hunted now-extinct mammoths (*right*) and bison and made distinctive Clovis and Folsom spear points.



Percolation: The slow movement of water through the pores in soil or permeable rock.

Permian Period: The geologic period that extends from about 299 million years ago to 248 million years ago. At this point in Earth's history, landmasses were joined together to form the super-continent Pangea. Massive oceans teemed with life, and vast swamps were home to a rich array of dinosaur precursors. The end of the Permian is marked by the largest extinction event in Earth's history, in which 70% of land organisms and up to 95% of marine organisms died off.



Porous rock: Rock that has numerous connected passageways through which liquids can flow permeate and travel (analogous to a sponge).

Protected species: Those plants or animals protected by state and/or federal law. For instance, those species in sufficient danger of extinction may be deemed threatened or endangered by state and/or federal law and will receive protection under the law, which prohibits or limits hunting or other removal or destruction of their habitat.

Riparian: The interface between land and a flowing surface water body.

Red siltstone: A sedimentary rock rich in iron oxide, which has a composition intermediate in grain size between the coarser sandstones and the finer mudstones and shales.

Sacramento Mountains: A mountain range in south-central New Mexico lying between Roswell and Alamogordo extending 85 miles north to south and 42 miles east to west.

San Andres limestone: A layer of limestone that crops out in a broad band along the flanks of the Sacramento Mountains and underlies all of the Roswell Basin east of that outcrop. More than 1,000 feet thick, this limestone layer forms the artesian aquifer in the Roswell area that produces water for irrigation.

Sinkhole: A natural depression or hole in the surface topography caused by the subsurface removal of **soil** or bedrock, often both, by water. Sinkholes may vary in size from less than a meter to several hundred meters both in diameter and depth, and vary in form from soil-lined bowls to bedrock-edged chasms. They may be formed gradually or suddenly, and are found worldwide. Mechanisms of formation may include the gradual removal of slightly soluble bedrock (such as **limestone**) by percolating water, the **collapse** of a **cave** roof, or a lowering of the **water table**.

Wetland: An area that is permanently or periodically inundated or saturated at the soil surface for a period of time during the year. The presence (or absence) of water is not necessarily a good method for identifying wetlands because the amount of water generally fluctuates depending on such things as rainfall patterns, snow melt, dry seasons, and longer droughts. Generally, wetlands are located within topographic features that are lower in elevation than the surrounding landscape such as depressions, valleys, and flat areas.



References

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Photos provided by the New Mexico State Parks archives except where noted otherwise.