Mojave Desert Discovery

An Educator's Guide to the Cultural and Natural History of

Death Valley
National Park

Mojave
National
Preserve

Joshua Tree
National Park

Lake Mead
National
Recreation
Area

Red Rock
Canyon
National
Conservation
Area

Revised 1998, 2004

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FOREWORD

The Mojave Desert is an excellent example of the diversity of many desert environments. Originally, many scientists placed what is now called the Mojave Desert into a more transitional environment, between the Great Basin Desert to the north and the Sonoran Desert to the south. Because of the many distinctive species of plants that live in the Mojave Desert, it is now considered a separate desert.

Although this unique desert can give the impression of being indestructible, it is actually quite fragile. Because of its fragility, it is very susceptible to impact from people. Many of the threats facing the Mojave Desert today are related to how people choose to use the resources of this land. Everyone who travels through or lives in this environment makes decisions every day affecting the desert around them. In many cases, these choices are made without people even realizing that they are making a decision about their environment. Every time a lawn is watered, an archeological site is disturbed, or an exotic species is introduced, a decision is made about management of the desert. And these are just a few of the many threats facing this environment today.

The future of the Mojave Desert revolves around the education of its users. This guide has been designed to assist educators in developing a stewardship ethic toward the Mojave Desert in today's youth. Educating children about the area will provide them with the information they need to make good decisions about managing the resources of the desert in the future.

This guide has been developed from a wide variety of educational activities that have been used by educators in this and many other desert areas. Each unit has been designed to stand alone as an educational device or to be used in conjunction with other units. The information contained in this guide is invaluable in developing a respect for the Mojave Desert, and it has been designed to be as easy to use as possible while still challenging students.

The Mojave Desert is a unique and magnificent environment. It is an area that, if treated with respect and care, will be a source of inspiration for many generations. This respect and care can only come from educating the area's future managers and users.

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INTRODUCTION TO USING THIS GUIDE

This activity guide is designed for use by teachers and other educators who live in the desert, as well as by those who may have never seen a desert area. Some activities are designed for the classroom; some are more effective if they are conducted outside. Many of them can be done on the school playground. These activities can be used in environments other than the desert, although a few would require adaptation.

The activities are written for upper elementary grades, but many can be modified for other grade levels. The background information provided in each unit is primarily for use by teachers in order to help with the activities.

We encourage you to use these activities with your students and to visit a wild desert region with them if at all possible. We also welcome any comments you have about this guide.

THE OBJECTIVES OF THIS GUIDE ARE TO:

1. Provide teachers and other educators with a resource guide about the Mojave Desert ecosystem.

2. Acquaint students with the desert environment through hands-on activities.

3. Develop within the students an understanding of the value of the Mojave Desert.

4. Develop within the students an appreciation for the total environment.

5. Direct students toward actions they can take in order to protect desert ecosystems.

An interdisciplinary approach was taken when creating the materials for this guide, so that activities can easily be integrated into varied subject and skill areas. The three-ring binder enables you to add and remove materials in order to make it more useful.

OVERVIEW OF UNITS

This guide is organized into twelve units, each about a specific subject area. Many units are easily integrated into other categories and teachers are encouraged to be flexible when using the materials.

Most units open with background introductory material for teacher use. Following are ideas for hands-on activities with students. Reproducible pages, called Discovery Activity Pages, are at the end of most units. Most units include Fun Facts boxes and glossaries. Glossary words appear in *italics*. Other entries in italics include scientific names and foreign words.

UNIT I — **The Parks** gives specific information about each park highlighted in this guide.

UNIT II — **Deserts** contains activities that introduce students to desert ecosystems. Students become familiar with what a desert is and where deserts are located around the world. Activities explore the natural forces creating deserts and what makes the Mojave Desert a unique environment.

UNIT III —Activities in **Safety** teach students about desert survival and safety issues to consider before visiting a desert region. Students also learn about poisonous plants and animals and what precautions to take when hiking in the desert.

UNIT IV— In **Water** students will explore where this resource comes from and how to use it wisely. Students learn about competing uses for water and how its consumption affects plants and animals living in the desert.

UNIT V — **Geology** contains activities exploring some basic geological processes, such as dune formation and erosion. Students create a relative time line to compare modern events with the beginning of the Earth.

UNIT VI —**Plants** identifies some common Mojave desert plants and discusses several ways plants survive in the desert environment.

UNIT VII — **Animals** contains activities that explore basic survival needs animals have and ways they have adapted to the desert, both physically and behaviorally.

UNIT VIII — **Endangered Species** focuses on the endangered plants and animals of the Mojave Desert and reasons for their decline. Students learn about the importance of preserving all species, as well as those living in desert habitats.

UNIT IX — **Desert People** discusses Native American inhabitants of the Mojave Desert and how their lifestyle compared with our modern lifestyle. Information about ways they used plants and animals is also included.

UNIT X — **Westward Expansion** includes information and activities on early explorers, miners, cattlemen, and homesteaders.

UNIT XI — **Making a Difference** contains some simple actions that students can take to protect desert ecosystems, both in the classroom and outdoors.

UNIT XII — **Resources** offers a bibliographic listing of sources for more information, including children's books.

Organization of Individual Activities

Each activity begins with a section providing the objective(s) of the activity, the materials needed, the subjects the activity covers, and the skills it involves. A method section contains step-by-step directions to conduct the lesson. As a facilitator, you are encouraged to maximize student critical thinking and creativity in each activity. An Extending the Experience section is included at the end of each activity to encourage students to investigate the information in greater detail.

THE PARKS

The National Park Service (NPS) and the Bureau of Land Management (BLM) manage large sections of land within the Mojave Desert. Both agencies are under the Department of the Interior, but each has a different management policy.

THE PARKS

National Park Service (NPS)

The National Park Service follows guidelines set by the Organic Act, which was passed by Congress on August 25, 1916. The act states: "The Service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations... which purpose is to conserve the scenery and the natural historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." In other words, the NPS focuses its management to conserve the various units under its jurisdiction while still allowing use and enjoyment of them.

Bureau Of Land Management (BLM)

The mission of the Bureau of Land Management is based on the principles of multiple use and sustained yield. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. The resources that the BLM manages in the Mojave Desert include recreation; rangelands; minerals; watershed; fish and wildlife; wilderness; air; and scenic, scientific, and cultural values. The BLM has jurisdiction over the largest portion of federally-owned land in the Mojave Desert. Therefore, a majority of the desert is managed under this philosophy.

It may seem redundant to have more than one land management agency, but it really is not. Each agency must focus its management style on the resources it has been given by the American people to manage. In this way, it is possible to provide the best management possible for the vast resources of the Mojave Desert.

NPS Units

DEATH VALLEY NATIONAL PARK

INFORMATION
Write: Superintendent, Death Valley National Park, Death Valley, CA 92328
Email: DEVA_information@nps.gov
Call: 760-786-3200
www.nps.gov/deva on the Internet

IN AN EMERGENCY
Call: 911 or 760-786-2330

HOW TO GET THERE
Death Valley is located on the California/Nevada border, 140 miles west of Las Vegas, Nevada, and 240 miles northeast of Los Angeles. Access through the park is most easily gained along California 190 from the east or west. The largest community within Death Valley is Furnace Creek, which is also the location of the visitor center. Scotty's Castle is located in the northern portion of the park. Access to the castle is gained heading north off California 190 or entering from the north on Nevada 267.

PARK OVERVIEW
Death Valley National Monument was established by Presidential Proclamation in 1933. In 1994, Death Valley National Monument was redesignated Death Valley National Park with the passage of the California Desert Protection Act. Death Valley NP now encompasses over 3.3 million acres, making it the largest National Park Service area in the contiguous 48 states. Although Death Valley is a long distance from most metropolitan areas, school groups are encouraged to visit. The unique scientific features located in and near Death Valley make it a fantastic place to learn about the desert. There are many locations within the park that can provide for a wonderful outdoor education experience.

Death Valley contains the lowest point on the North American continent — a portion of the Badwater Salt Pan lies 282 feet below sea level. The highest point in the park is Telescope Peak, in the Panamint Mountains, at 11,049 feet above sea level. The geological record is remarkably complete, if confusing. Although there is still much disagreement among geologists regarding the mechanism for the valley's formation, all of the major divisions of geologic time are represented.

Plant and animal life is abundant. Over nine hundred species of plants (twenty-one of which are found nowhere else in the world) and numerous species of mammals, reptiles, and birds are found from the lowest elevations to the highest. Desert pupfish, relics from the Pleistocene Epoch, survive in small, isolated pools of water. Desert bighorn sheep inhabit the rocky slopes and gorges of the high country. Predators include coyotes, kit foxes, bobcats, and an occasional mountain lion.

The record of human occupation dates back nine thousand years. Although approximately two thousand archeological sites in Death Valley have been recorded, the inventory is not complete. Less than five percent of the park has been sampled. Only by seeking a shortcut to the California gold fields did a small group of pioneers stumble upon the valley and give it its name.

Myths, legends, and rumors of possible mineral riches spread through the west, and expeditions into Death Valley ensued. Despite the flurry of gold and silver mining, Death Valley's real riches proved to be borate and talc deposits and the tourism generated by the valley's growing mystique.

SAFETY
Always carry plenty of water, whether planning to hike or just driving through. The park contains hundreds of abandoned mines and associated structures that are potentially dangerous. Stay out and stay alive! Be alert for flash floods when it looks stormy. Do not ford low places when water is running. Watch where you put your hands and feet, especially in warm weather when snakes are most active. Drink and carry plenty of water. Summer temperatures regularly exceed 110°F. Even in spring, when it is cooler, it is important to guard against dehydration.

VISITOR ACTIVITIES
Hiking, camping, backpacking, and photography are all popular activities. Ranger-conducted programs are available daily during the winter and spring. Check at the visitor center and entrance stations for the current schedule.

VISITOR SERVICES AND ACCOMMODATIONS
Groups are responsible for making their own camping or lodging reservations. Camping can be reserved in advance, October through April, by contacting Spherics at 800-365-CAMP. For motel reservations you can contact the Furnace Creek Ranch, P.O. Box 1, Death Valley, CA 92328, or call 760-786-2345. Rooms are also available at Stovepipe Wells, twenty-seven miles north of Furnace Creek on California 190. For reservations call 760-786-2387.

FEES
General entrance is $10 per car for seven days. Bus visitors pay $5 per person for non-commercial trips. Camping fees range from $8 to $40 per site. Educational groups from accredited institutions may qualify for fee waivers for entrance and camping fees. Contact the fee collections supervisor at the park address.

HOURS OF OPERATION
The park is open twenty-four hours a day. The visitor center is open 8:00 a.m. to 5:00 p.m. Scotty's Castle is open 8:00 a.m. to 5:00 p.m.

HOW TO SCHEDULE A FIELD TRIP
Education programs are available for groups who want to learn firsthand about the area through National Park Service interpreters who are very familiar with the park. These programs are available on a reservation basis. To book a program contact the assistant chief district interpreter at the park address or call 760-786-3200. Scotty's Castle is a wonderful place to introduce children to a fun way to learn history. Tours through the castle are offered in the form of living history. Your guide is dressed as if from the 1930s time period and will contact your group as if they are visitors from that era. The tours need to be booked in advance by contacting the Scotty's Castle district interpreter at the park address or call 760-786-2392.

JOSHUA TREE NATIONAL PARK

INFORMATION
Write: Superintendent, Joshua Tree National Park, 74485 National Park Drive, Twentynine Palms, CA 92277-3597.
Email: JOTR_info @ nps.gov
Call: 760-367-5500.
www.nps.gov/jotr on the Internet.

IN AN EMERGENCY
Call: 911 or (909) 383-5651 collect.

HOW TO GET THERE
The park lies 140 miles east of Los Angeles. You can approach it from the west via Interstate 10 and California 62 to entrances in the towns of Joshua Tree and Twentynine Palms. The south entrance at Cottonwood Spring, which lies twenty-five miles east of Indio, can be approached from the east or west, also via Interstate 10.

PARK OVERVIEW
The park was established by Presidential Proclamation in 1936. Two deserts, the Mojave and the Colorado (a subsection of the Sonoran), come together at Joshua Tree National Park. These are two large ecosystems primarily determined by elevation. Few areas more vividly illustrate the contrast between the two deserts.

The higher and slightly cooler Mojave Desert is the home of the Joshua tree, extensive stands of which dominate the park's western half. The trees can reach nearly thirty-five feet in height, and age estimates of old trees approach eight hundred years. The Colorado Desert occupies the eastern half of the park. Creosote bush, ocotillo, and cholla cactus are characteristic plants of these elevations below three thousand feet.

The park's variety of protected habitats supports wildlife of many kinds. Animals which can be found here include reptiles and amphibians (desert tortoises, snakes, lizards), more than two hundred species of birds, invertebrates, and more than forty species of mammals (bats, mice, ground squirrels, jackrabbits, coyotes, raccoons, foxes, bobcats, mule deer, bighorn sheep).

The park encompasses some of the most outstanding geologic displays to be found in the California desert — the results of repeated uplifts, lava flows, and continuous erosion. The western part of the park embraces several mountain masses with peaks rising over five thousand feet, interlaced with

THE PARKS

medium-elevation plateaus and valleys. To the east, plateaus drop off into the immense, elliptical-shaped Pinto Basin. The colossal outcrops of the Wonderland of Rocks area offer some of the most spectacular scenery in the park. Throughout the region are many clues to a geography shaped — past, present, and future — by earthquakes.

Complementing the fascinating natural history is a rich cultural history of Native Americans, miners, cattlemen, and homesteaders. The first humans inhabited the area perhaps ten thousand years ago and enjoyed a more favorable climate. Throughout the park are reminders of these earlier inhabitants — Native American rock art, mine shafts and associated buildings, homesteader cabins, and handmade dams.

SAFETY
Always carry plenty of water, whether planning to hike or just driving through. Avoid drainage areas after thunderstorms or severe weather because of flash floods. Do not enter mine shafts or associated buildings. They are extremely dangerous. Set strict guidelines with your group for rock scrambling and climbing; even short falls can be fatal. Watch where you put your hands and feet, especially in warm weather when snakes are most active.

VISITOR ACTIVITIES
Hiking, climbing, camping, backpacking, and photography are all popular activities. Ranger-conducted programs are available on weekends in the spring and fall. Check at visitor centers, at entrance stations, or on park bulletin boards for the current schedule.

VISITOR SERVICES AND ACCOMMODATIONS
No services are available in the park. Motels, stores, restaurants, and auto services are located in nearby towns. Camping reservations are available for group sites and two family campgrounds. Contact Spherics at 800-365-CAMP. Fees are charged for camping.

FEES
General entrance is $10 per car for seven days. Bus visitors pay $5 per person for non-commercial trips. Camping fees range from $5 to $35 per site. Educational groups from accredited institutions may qualify for fee waivers for entrance fees. Write: Education Office, 9800 Black Rock Canyon Road, Yucca Valley, CA 92284, Email: JOTR_Education@nps.gov, or call: 760-367-3011.

HOURS OF OPERATION
The park is open twenty-four hours a day. The Oasis Visitor Center in Twentynine Palms is open 8:00 a.m. to 5:00 p.m. daily. The Cottonwood Visitor Center is open 8:00 a.m. to 4:00 p.m. Black Rock Nature Center is open 8:00 a.m. to 4:00 p.m., September through May.

HOW TO SCHEDULE A FIELD TRIP
Write: Education Office, Joshua Tree National Park, 9800 Black Rock Canyon Road, Yucca Valley, CA 92284, or call: 760-367-3011. Ranger-led programs are available on both natural and cultural history topics.

Many groups visit the park on their own. Fee waivers may be available (see Fees section). The park has many self-guided nature trails with either interpretive signing or brochures. Other short or longer trails may be appropriate for your group. Picnic areas are available. Water is only available at a few locations; plan to bring your own. Be sure your group is prepared with appropriate clothing and sturdy walking shoes.

LAKE MEAD NATIONAL RECREATION AREA

INFORMATION
Write: Superintendent, Lake Mead National Recreation Area, 601 Nevada Highway, Boulder City, NV 89005.
Email: LAME_information@nps.gov
Call: 702-293-8990
www.nps.gov/lame on the Internet

IN AN EMERGENCY
Call: 911, 702-293-8932, or 800-680-5851.

HOW TO GET THERE
The Lake Mead Alan Bible Visitor Center is located near the west end of Lake Mead, on U.S. Route 93, four miles east of Boulder City, thirty miles south of Las Vegas. Katherine's Landing is on the south end of Lake Mohave, on the Arizona side, three miles above Davis Dam. It is thirty-three miles from Kingman, Arizona, and seven miles from Bullhead City, Arizona.

PARK OVERVIEW
The park was established by Congress in 1964 as the nation's first national recreation area. Lake Mead, formed by Hoover Dam, and Lake Mohave, formed by Davis Dam, dominate the park. The park contains a wide diversity of resources and constitutes extensive and superlative examples of the plants, animals, and physical geography. From an elevation of approximately 517 feet at Davis Dam, the land rises to a height of 7,072 feet on the Shivwits Plateau.

While the park's name conjures up an image of water, the land-based resources comprise eighty-seven percent of the park's surface area and offer an exciting wealth of natural and cultural resources enhancing the attraction of the Colorado River and Lakes Mead and Mohave.

Exposed within the park boundaries are geological deposits spanning 1.7 billion years. They represent the Basin and Range and the Colorado Plateau provinces, the boundary between which may be seen at the Grand Wash Cliffs. Not so readily discernible are paleontological resources. Petrified wood and fossilized shells are found at various locations, and mammoth remains over ten thousand years old have been found at Overton Arm.

Complementing this geological

diversity is the fact that Lake Mead NRA lies within the northeastern portion of the Mojave Desert, on the southern edge of the Great Basin Desert, and just north of the Sonoran Desert. As a result of this location and the interface of these deserts, the park contains a surprising variety of plants and animals, such as the gila monster, ocotillo, palo verde, and smoke tree. These species are considered to be at the far reaches of their northern distributional range.

While at first glance, the region may seem to be a hostile land, humans have known the secrets of this area for longer than might be imagined. So far, the oldest evidence of early habitation has been dated at 3,000 B.C. There are over nine hundred identified archeological sites above the water lines of Lakes Mead and Mojave.

SAFETY
For protection against sunshine, wear a hat and sunglasses. Summer temperatures can reach 120°F. Never swim alone. Air mattresses and other beach toys can quickly blow away, leaving you stranded far from shore. Always check the weather forecast. Spring and summer days can be very windy; summer storms can arise abruptly. Call 702-736-3854 for a current forecast from the National Weather Service. Be alert for flash floods in stormy weather.

VISITOR ACTIVITIES
Visitors enjoy swimming, fishing, boating, and backcountry hiking in spring and fall and camping year round. Ranger-guided programs are available for the general public. Check with the visitor center for the current schedule.

VISITOR SERVICES AND ACCOMMODATIONS
Food and drinks are available at all marinas. Motels, stores, restaurants, and auto services are found in nearby towns. Campgrounds are located at various areas of the park.

FEES
General entrance is $5 per car for five days. Campsites are $10 per night and no reservations are available. Contact the park for information on fee waivers for educational groups.

HOURS OF OPERATION
The park is open twenty-four hours a day. The visitor center is open 8:30 a.m. to 4:30 p.m. daily except Thanksgiving, Christmas, and New Years Day.

HOW TO SCHEDULE A FIELD TRIP
Because of the high demand for these programs and limited park staff, ranger-led field trips in the Mead area are only conducted for teachers who have attended the National Park Service workshop: *My Home is the Mojave.* Some field trips are scheduled through a lottery system. Programs in the Kathreine's Landing (Mohave) area are scheduled on a limited basis. For more information on the programs, call the education office at 702-293-8716 or 8957, or visit our website at www.nps.gov/lame/classindex.htm.

You are welcome to take your group on your own anywhere in the park. Several trails exist near each visitor facility. Shaded picnic areas are also located near each campground. Shade is sparse, so it is best to visit in the fall or early spring. Bring water and wear sturdy walking shoes. Thin shoes or sandals will not provide protection against cactus.

MOJAVE NATIONAL PRESERVE

INFORMATION
Write: Superintendent, Mojave National Preserve, 222 East Main Street, Suite 202, Barstow, CA 92311
Email: moja_info@nps.gov
Call: 760-255-8836
www.nps.gov/moja on the Internet

IN AN EMERGENCY
Call: 911 or 909-383-5651.

HOW TO GET THERE
Mojave National Preserve is located 180 miles northeast of Los Angeles and 50 miles southwest of Las Vegas. Access is from I-15 at Baker, Cima Road, and Nipton Road and from I-40 at Kelbaker Road, Essex Road, and Fenner. There are no gas stations, stores, or other services inside the park, so come prepared.

PARK OVERVIEW
Mojave National Preserve was established through the California Desert Protection Act of 1994. Rose-colored sand dunes, volcanic cinder cones, Joshua tree forests, and mile-high mountains are all part of the scene. The preserve encompasses 1.6 million acres of mountains, jumble rocks, desert washes, and dry lakes; outdoor enthusiasts appreciate the opportunity for solitude here not easily found at other southern California parks.

Plant and animal life varies by elevation. Desert tortoises burrow in creosote bush flats, while the black and yellow Scott's oriole nests in Joshua trees higher up the slopes. Mule deer and bighorn sheep roam among pinyon pine and juniper in the preserve's many mountain ranges.

Mojave Desert experiences change with the seasons. Infrequent winter snows sparkle on the mountains. With enough moisture, spring wildflowers carpet the desert with vivid colors. Summers are hot: hikers and campers explore the higher elevations such as Mid-Hills and the New York Mountains. The cooler temperatures of fall mark hunting season. A network of dirt roads offer year-round opportunities to explore by 4-wheel-drive vehicle.

SAFETY
Always carry plenty of water in your car and especially when hiking. A hat and sun screen are essential for hiking. Be

careful around abandoned mines; do not enter mine shafts for any reason. To avoid rattlesnakes, watch where you put your hands and feet.

VISITOR ACTIVITIES
Hiking, climbing, camping, backpacking, and exploring dirt roads are all popular activities.

VISITOR SERVICES AND ACCOMMODATIONS
No services are available in the park. Gas stations with convenience stores are located at Baker, Halloran Summit, Cima Road, and Primm on I-15 and at Ludlow and Fenner along I-40. Motels and restaurants are located at Baker, Nipton, and Ludlow. Reservations are not accepted at family campgrounds, but campgrounds rarely fill. Groups can reserve the Black Canyon Group and Equestrian Campground by calling 760-928-2572.

FEES
There are no entrance fees. Camping is $12 per night, per site. Group camping is $25 per night.

HOURS OF OPERATION
The park is open all the time. The Baker information center is open 8:00 a.m. to 5:00 p.m. daily except Christmas. The Hole-in-the-Wall information center is open Friday, Saturday, and Sunday, 9:00 a.m. to 4:00 p.m.

HOW TO SCHEDULE A FIELD TRIP
Call park rangers at 760-255-8836 to inquire about educational programs.

BLM Unit

RED ROCK CANYON NATIONAL CONSERVATION AREA

INFORMATION
Write: Red Rock Canyon National Conservation Area, HRC 33, Box 5500, Las Vegas, NV 89124
Call: 702-363-1921
www.redrockcanyon.blm.gov/ on the Internet

IN AN EMERGENCY
Call: 911 or 702-293-8998 collect.

HOW TO GET THERE
The park is located twenty miles west of Las Vegas, Nevada via Nevada 159 (West Charleston Boulevard) or Nevada 160.

PARK OVERVIEW
The park was established in 1967. In 1990 special legislation supported by the Nevada congressional delegation, changed the status of the recreation lands to a national conservation area, the seventh to be designated nationally. The unique geologic features, plants, and animals of Red Rock Canyon represent some of the best examples in the Mojave Desert.

The most significant geologic feature of Red Rock Canyon is the Keystone Thrust Fault. About sixty-five million years ago, it is believed that two of the earth's crustal plates collided with such force that part of one plate of grey limestone was thrust up and over the younger red sandstone. The Keystone Thrust Fault extends from the Cottonwood Fault (along Highway 160), thirteen miles northward to the vicinity of La Madre Mountain where it is obscured by more complex faulting.

SAFETY
Always carry plenty of water, whether planning to hike or just driving through. Set strict guidelines with your group for rock scrambling and climbing; even short falls can be fatal. Watch where you put your hands and feet, especially in warm weather when snakes are most active.

VISITOR ACTIVITIES
More than one million visitors each year enjoy spectacular desert landscapes, climbing and hiking opportunities, and interpretive programs. This 83,100-acre area provides a thirteen-mile scenic drive, more than twenty miles of hiking trails, picnic areas, and a visitor center.

VISITOR SERVICES AND ACCOMMODATIONS
The visitor center has water, telephones, and restrooms. There is one primitive campground that is first come, first served. No water is available. Ask at the visitor center for directions. Other visitor services are available in nearby towns.

FEES
There is a $5 entrance fee per vehicle.

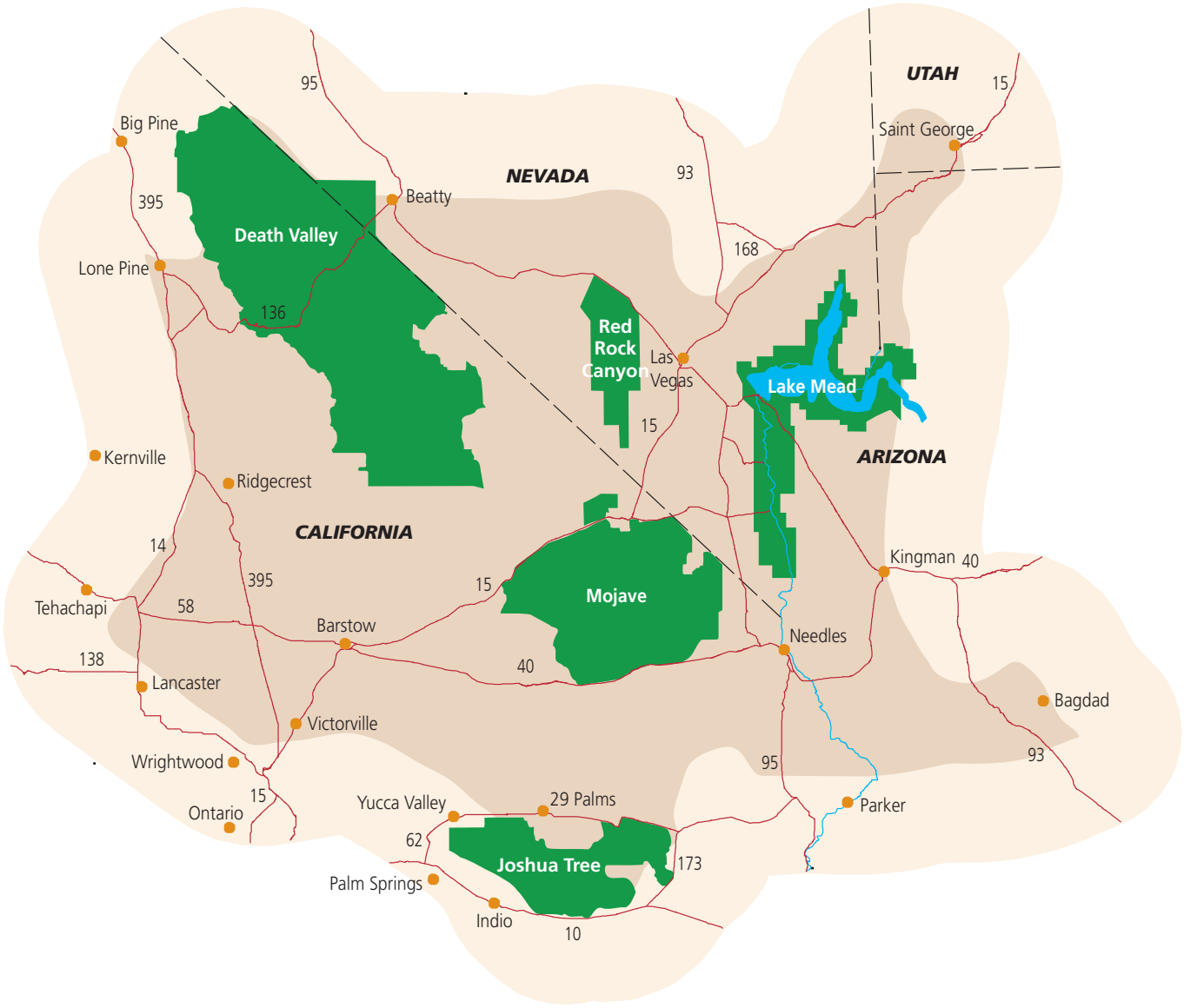
HOURS OF OPERATION
The thirteen-mile scenic drive is open 7:00 a.m. to dusk. The visitor center is open 8:30 a.m. to 4:30 p.m.

HOW TO SCHEDULE A FIELD TRIP
Red Rock Canyon offers numerous locations for field trips. Reservations are required for stops at the visitor center and the Children's Discovery Trail. This trail is located at Lost Creek Canyon and is less than one-mile round trip. A free booklet that accompanies the marked trail is available to visiting school groups. The booklet, which is geared to elementary age children, discusses flash floods, plants, animals, riparian zones, and cultural resources. Arrangements

to receive the booklets are made at the time of making reservations. A pre-visit packet and video will be sent before the visit date.

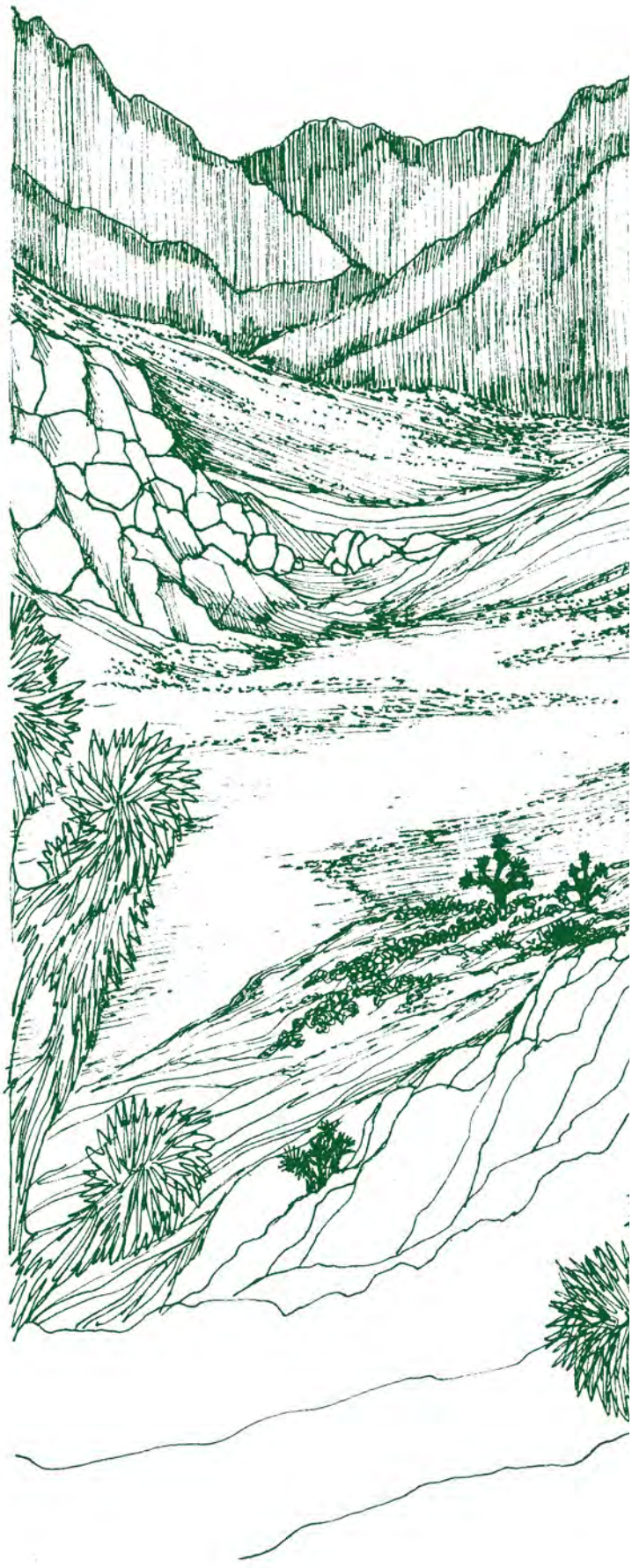
If you have any questions or wish to schedule a field trip, contact the environmental education coordinator at the visitor center at 702-363-1921 between 8:30 a.m. and 4:00 p.m. Spring dates fill quickly so reserve early.

Mojave Desert Parks

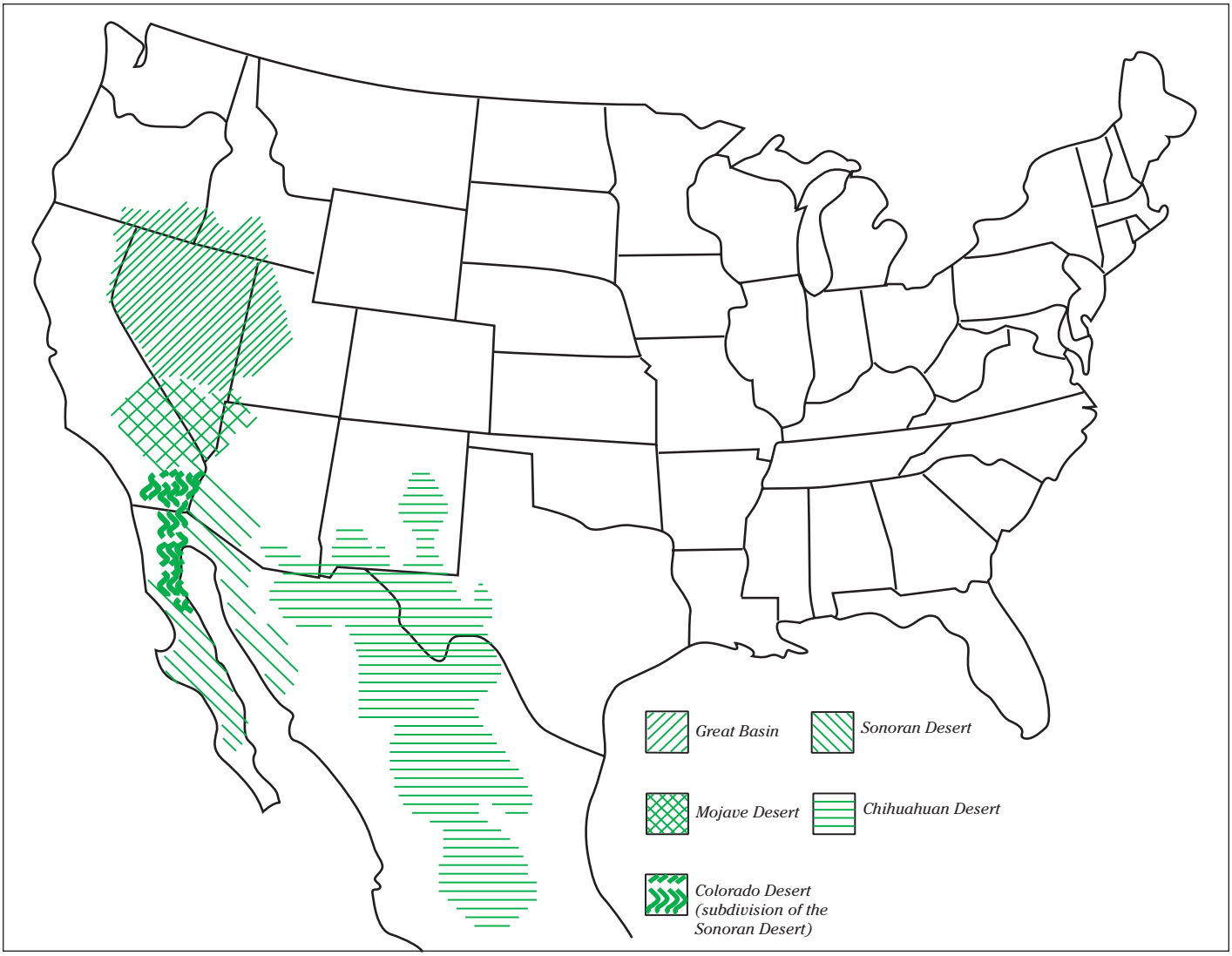


DESERTS

Never-ending sand dunes. Scorching temperatures. Vultures circling over the remains of an unlucky traveler. These are images the word “desert” brings to mind for many people. December and January trigger phone calls to desert parks from potential visitors hoping to escape the chill of winter. They are amazed to hear of nighttime temperatures below freezing. Snow in the desert is an impossibility to them. Isn’t the desert always hot and dry?



DESERTS



What Is A Desert Anyway?

Check five sources and you will probably find five, slightly different definitions. Some sources define a desert as an area receiving no more than ten inches of precipitation annually. However, many areas receiving this amount of *precipitation* are not deserts. This simple definition is not complete.

Both the timing and type of precipitation determine the environment established. In a desert, rain isn't evenly distributed throughout the year. Weather patterns often create short, violent downpours. Flash floods, characteristic of some desert areas, are produced. Much of the water runs off before it can soak into the soil.

A lot of moisture is also lost to evaporation. Many deserts lie in areas of high pressure systems where there is little cloud cover. At least 90% of the sun's rays reach Earth, producing seasonal hot temperatures. (For comparison, the surface of more humid lands, covered with more vegetation, receives only 40% of possible solar radiation.) The hot, dry air causes any available water to evaporate quickly. When temperatures are extremely hot, rain can evaporate before it reaches Earth.

The conditions producing high daytime temperatures reverse the process after sundown. Approximately 90% of the day's accumulated heat radiates back toward the sky. In moister climates only about 50% of this heat is lost. These conditions produce the wide range of daily temperatures

characteristic of deserts. This range is often fifty degrees or more.

The rapid heating and cooling of air create another characteristic of most deserts — strong winds. These winds, circulating air which is often hot and dry, increase the already high rate of evaporation. Evaporation in American deserts ranges from 70″ – 160″ per year.

A desert then is not so easily defined. All these characteristics — seasonal, high temperatures; low, sporadic rainfall; a high rate of evaporation; wide temperature ranges; strong winds — are part of the definition.

Where Are The Deserts?

Draw a line around the world, starting mid-center between Joshua Tree and Death Valley, and you will touch or come close to many of the world's great deserts — Mojave, Great Basin, Sahara, Arabian, Iranian, Gobi. Most deserts occur between the latitudes of 15° – 40° on either side of the equator. They are found around the world on every continent, covering approximately 20% of the Earth's land area.

Sand dunes cover only about 10% of this area. Some deserts are very mountainous. Most are hot, with warm daytime temperatures much of the year, but others are cold, getting over half their moisture from snow.

Why Are Deserts Where They Are?

Deserts can be divided into four types — subtropical, coastal, interior, rain shadow — depending on the conditions creating them.

Subtropical deserts lie along the Tropic of Cancer (23°N latitude) and the Tropic of Capricorn (23°S latitude). Near the equator hot, moist air rises. It cools, dropping heavy rains on tropical areas. The resulting cooler, drier air then descends, creating zones of high atmospheric pressure as it moves away from the equator. The descending air hinders cloud formation and precipitation. It also warms up, absorbing any available moisture. The Sahara, the world's largest hot desert, is a subtropical desert about the size of the United States.

Coastal deserts are also in areas of high pressure. Damp, chilly fog forms when air, chilled by water contact as it blows toward shore, meets warm air over land. Although humidity is high, atmospheric disturbances that can cause rainfall are not present. Two coastal deserts, the Atacama of Chile and the Namib in southern Africa, are among the driest places in the world.

Interior deserts, like the Gobi, exist because they are too far from moisture-laden, ocean winds. By the time these winds reach the center of a large landmass, the air is very dry.

Rain shadow deserts are created when mountain ranges lie parallel to moist, coastal areas. Prevailing winds moving inland cool as air is forced to rise over the mountains. Carried moisture falls on slopes facing the winds. When the winds move over the crest and down the far side, they are very dry. Descending air also makes it hard for additional clouds and precipitation to form. Without another source of moisture, rain shadow deserts are formed on the far side of these mountain ranges (see Discovery Activity Page #1).

The Mojave Desert

The Mojave Desert is a rain shadow desert. It is defined by a combination of latitude, elevation, geology, and indicator plants. It is situated between the Great Basin Desert to the north and the Sonoran to the south (mainly between 34° – 38°N latitudes). Elevations are generally between three and six thousand feet, although Death Valley National Park includes both 11,049-foot Telescope Peak and the lowest point in the United States, at Badwater, 282 feet below sea level.

Temperatures are a function of both latitude and altitude. Although the Mojave Desert has the lowest absolute

GLOSSARY

endemic — belonging exclusively or confined to a particular place.

environment — all those factors, both living and non-living, which make up the surroundings of an organism.

evaporation — the process by which water changes into vapor.

flash flood — a sudden, rising flood caused by heavy rainfall.

gneiss — a *metamorphic* rock where intense pressures and temperatures have caused minerals to segregate giving the rock a banded appearance.

groundwater — water stored beneath the surface of the ground, coming from *precipitation* and surface water that has percolated down.

metamorphic — changed by great pressure, stress, and/or chemical changes, usually at depth in the crust, from pre-existing rocks.

native — a plant or animal that evolved or was transported to an area through natural means.

Precambrian — all geologic time prior to the Paleozoic Era (prior to 570 million years ago).

precipitation — water received on the Earth directly from clouds as rain, hail, sleet, or snow.

elevation and the highest maximum temperature (134°F in Death Valley), it is north of the Sonoran Desert and its average elevations are higher. As a result, its average temperatures are lower than those of the Sonoran.

The Mojave Desert is in what some geographers call the Basin and Range Province, a landscape of alternating mountain ranges and their adjacent basins. Common rock substrates include *Precambrian gneisses* and granites. Slopes are often composed of *metamorphic rocks*, such as gneisses.

Mojave Desert vegetation is dominated by low, widely spaced shrubs. Vegetation in the desert's northern half closely resembles that of the Great Basin Desert, as that in the southern half does the Sonoran. However, nearly one quarter of all Mojave Desert plants are *endemics*. Synonymous with the Mojave Desert is the Joshua tree. Other endemics are Parry saltbush and Mojave sage. A more widely distributed plant, the creosote bush, dominates much of the land surface, often in close association with species of bur-sage.

Creating Desert Wastelands

Deserts are growing by an estimated fifteen million acres a year. But this desert growth is not reason for desert lovers to celebrate. These desert lands are being created through desertification, the process in which land supporting life is transformed into land supporting very little or no life at all.

Probably the main cause of desertification in the United States is overgrazing. Unlike *native* desert animals, livestock can strip land of most of its cover. Before natural vegetation can grow back, soils erode, leaving the area unable to support most of the life that once lived there.

As technology has improved, making more water available for irrigation, farming in desert areas has increased. This, along with human population growth and its water demands, has depleted *groundwater* supplies faster than they can replenish themselves. In some cases, desert plant and animal communities can no longer be supported.

As the popularity of driving off-road vehicles across the desert increases, so does the damage done to plants and fragile desert soils. Deserts are mined for copper, silver, gold, and other minerals, leaving tremendous scars on the land.

Many people seem to have a desert wasteland mentality. They view deserts as lifeless, valueless areas. Resource destruction, that might concern them if done elsewhere, may not bother them when desert areas are the victims. Desert education is necessary to increase appreciation of these biologically and aesthetically rich lands.

Activity 1
Desert Puzzler

OBJECTIVES: Explain the creation of a rain shadow desert. Name one desert created this way.

MATERIALS: Discovery Activity Page #1, graph paper, poster board, puzzle made from an enlargement of Discovery Activity Page #1.

SUBJECT: Science.

SKILLS: Analysis, problem solving.

METHOD: Atmospheric and geophysical conditions work together to create deserts where they are. Understanding the rain shadow effect will help explain to your group how the Mojave Desert was formed. To the west of the Mojave Desert lie the San Gabriel, San Bernardino, and San Jacinto mountain ranges, running parallel to the Pacific Coast. These mountain ranges create the rain shadow effect described in the introduction to this unit.

1. Enlarge the rain shadow diagram on the activity page on a piece of poster board. Cut it into pieces to create a puzzle. If you have a large group, you may want to make more than one puzzle. Laminating or covering the pieces with clear contact paper will extend their life.

2. Give a copy of the activity page to each student. Use the diagram to explain rain shadow deserts.

3. Leaving their activity pages behind, have students stand in a circle, surrounding the area where the puzzle will be assembled. Give puzzle pieces to members in your group. Ask participants to step in one at a time. Each may either attempt to place the puzzle piece in the right location or move a piece already placed. After the puzzle is completed, have a volunteer explain how the rain shadow effect creates dry areas.

EXTENDING THE EXPERIENCE: Contact areas on both sides of the mountain ranges and in the mountains to collect rainfall totals for the past three years (such as Los Angeles, Big Bear, and Joshua Tree and Death Valley national parks in California; and Las Vegas and Lake Mead National Recreation Area in Nevada). Graph the data and discuss.

Activity 2
Sun And Water

OBJECTIVES: On a monthly basis, compare average maximum temperatures and rainfall of a desert park with those of a park in a different climate. Plot given data to make graphs.

MATERIALS: Discovery Activity Pages #2 and #3, map of the United States, pencils and colored pencils or crayons.

SKILLS: Comparison, computation, inference.

SUBJECTS: Math, science.

METHOD: Graphs are a way of making data come alive visually. Your group can learn more about desert climates by using graphs to compare temperatures and rainfall in desert parks with those of parks in other areas.

1. Pass out copies of the activity pages. Discuss what is meant by "average high temperature" and "average monthly rainfall." Find each park's location on a United States map. If anyone has been to one of the parks ask for a brief description. Try to find pictures of each park in books or other reference materials.

2. Have students select one Mojave Desert park and one non-desert park for the graphing activities. Using the grid for Average Daily High Temperatures and a colored pencil or crayon, write in the name of the desert park chosen and plot its temperature data. Mark each month's average high with a dot, and then connect the dots with a red line. Using black, do the same for the non-desert park.

3. Do the same for average monthly rainfalls, using a bar graph format on the grids provided. Fill in the name of the park chosen on each grid.

4. When the graphs are completed, ask the following questions: In which month is there the greatest difference in average daily high temperatures between the two parks chosen? During which months does the group think most people visit the two parks? Explain the choices. What is the average total yearly rainfall for the parks? How can it be helpful to have records of average temperatures and rainfall?

EXTENDING THE EXPERIENCE: Check for temperature and rainfall averages for your own area. Local newspapers can be a good source of information. How does your area compare with those listed? Get these statistics for other desert areas of the world. A good source of information is a reference book found in many libraries — *The Weather Almanac*, edited by James A. Ruffner and Frank E. Bair.

Activity 3
Where And What Are Deserts?

OBJECTIVES: Name two deserts in the world. Describe how they are alike and/or different.

MATERIALS: Discovery Activity Pages #4 and #5, desert pictures or postcards, file cards, map of the world, scissors, yarn.

SUBJECTS: Language arts, science, social studies.

SKILLS: Comparison, description, discussion, drawing, listing, mapping, writing.

METHOD: Deserts exist all over the world. Although most share some characteristics, they also have some surprising differences. In this activity, your group will locate the deserts of the world and discuss their characteristics.

1. Brainstorm to create a list of words your group associates with deserts. Pass out copies of the activity pages. Referring to a map of the world posted on a bulletin board, locate the deserts. Place file cards with the deserts' names around the map's perimeter. Identify each with a piece of yarn running from its map location to the card listing its name.

2. Collect pictures of as many deserts as possible. Postcards are a good source. Put them next to the deserts' names. If a photo is found that cannot be cut out to display, have a student make a drawing of it.

3. Discuss the facts given about each desert. Help the group come up with three adjectives describing each desert, using "hot" or "cold" plus two more words. List these on file cards under each desert's name.

4. Go back to the words the group first listed. See how many of these match the adjectives under each desert's name. You can use this as a discussion starter for the activity about people's desert perceptions found in the Extending the Experience section.

5. Based on what the group now knows, come up with a list of characteristics most deserts share. Post this as part of your bulletin board display.

6. Two deserts are numbered on the deserts map, but are not on the deserts chart. Challenge your students to find these deserts' names and facts about them. Have them write this information on the back of Discovery Activity Page #4. (20: Monte, 21: Thar)

EXTENDING THE EXPERIENCE: Following this activity are quotes about deserts from a variety of sources. Read these quotes to your students, discussing the range of feelings displayed. If your group does not live in a desert area, ask them about their desert perceptions. If you do live in the desert, ask non-natives of the area if they remember any perceptions they once had about deserts. If available, read *Gila Monsters Meet You at the Airport* (see listing in the resources unit).

Try to find a class in a different climate area with whom to correspond. Ask members of this class to describe their ideas of what deserts are like. If some of their perceptions are wrong, share correct desert information with them. At the same time, ask your group

to share perceptions of the other class' geographic area.

Activity 4
Roadrunners And Lizards

OBJECTIVES: List two true statements about deserts.

MATERIALS: Playing field.

SUBJECTS: Language arts, physical education.

SKILLS: Listening, psychomotor skills.

METHOD:

1. Write statements about deserts, some true and some false.

2. Divide your group into two equal teams, the Roadrunners and the Lizards.

3. Line up the two teams facing each other, about two feet apart.

4. About fifteen feet behind each team, draw a home base line.

5. Read a statement. If the statement is true, the Roadrunners chase the Lizards, trying to tag them before they reach their home base line. If the statement is false, the Lizards chase the Roadrunners. Anyone caught must join the other team.

6. Continue playing until all statements are read.

Fun Facts — DESERT QUOTES

"It remained as a symbol of thirst and death, infested with horror, repelling all who viewed it from afar on the surrounding mountains. At a casual glance, nothing seemed to live here except the few plants which had clawed deep into the earth, defying wind and heat alike, . . . to store up some vestige of sustenance for their long vigils in the midst of almost total aridity. But this was deceptive. The desert nurtured a whole world of living things of its own."

Edward Maddin Ainsworth
Beckoning Desert, 1962

"The pale moon, occasionally overshadowed by clouds, threw a ghostly light over the desert, and skeletons of animals glistening in her beams, strewed the way, adding horror to the scene."

Gwinn Harris Heap
Journal of the Expedition of E.F. Beale, from Missouri to California, in 1853

"The popular conception is that a desert is all sand, — barren, desolate, unfruitful, shifting sands, where the heat is frightful and where nothing can live save horrid toads, lizards, snakes, chuckwallas, and gila monsters.

"To most people the . . . desert is not only a place devoid of interest, but absolutely to be shunned, feared, dreaded. If they must journey across it, they do so as hastily as possible in the fastest train, surrounded by all the luxuries modern travel can give; the blinds of the car drawn down if the journey is made by day, and with a sigh of relief and thankfulness if it is made by night.

"But in the material sense the . . . desert is a place of fascination and surprises.
On every hand are strange, wonderful, and beautiful things, — things that are unknown to cities and to the unobservant anywhere."

George Wharton James
The Wonders of the Colorado Desert, Vol. I, 1906

"The desert is the opposite of all that we naturally find pleasing. Yet I believe that its hold upon those who have once fallen under its spell is deeper and more enduring than is the charm of forest or sea or mountain."

J. Smeaton Chase
California Desert Trails, 1919

"This is the most beautiful place on Earth."

Edward Abbey
Desert Solitaire, 1968

Fun Facts — DESERT QUOTES

"We are struck by the appearance of Yucca trees (Joshua trees), which give a strange and southern character to the country and suited well with the dry and desert region we were approaching. Associated with the idea of barren sands, their stiff and ungraceful forms make them to the traveller the most repulsive tree in the vegetable kingdom."

Captain John Fremont
A Report on the Exploring Expedition to Oregon and North California, in the Years 1843–44

"The most conspicuous form of plant life on the Mojave Desert is a yucca known as the Joshua tree, a weird, fantastic form growing to a height of about twenty feet, with long stiff bristling green daggers all over its limbs in lieu of leaves, and with its branches bent and twisted into strange shapes. In patches of the desert this plant grows in sufficient profusion to form one of those paradoxes in which the region abounds — a desert forest, and a dreary, unearthly forest it is."

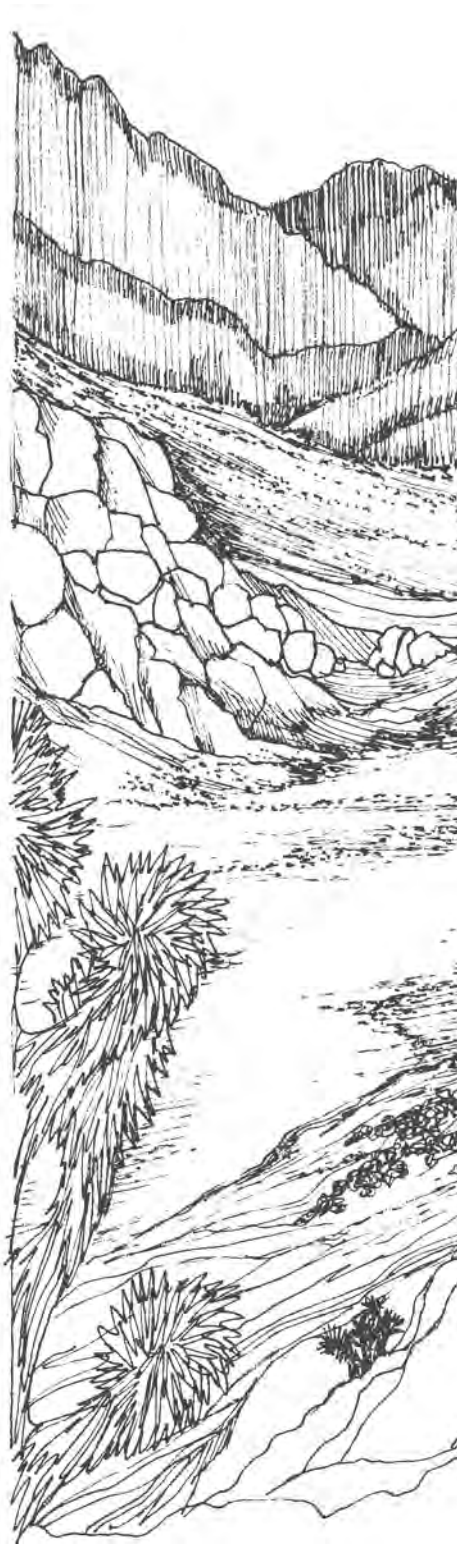
Charles Keeler
Southern California, 1899

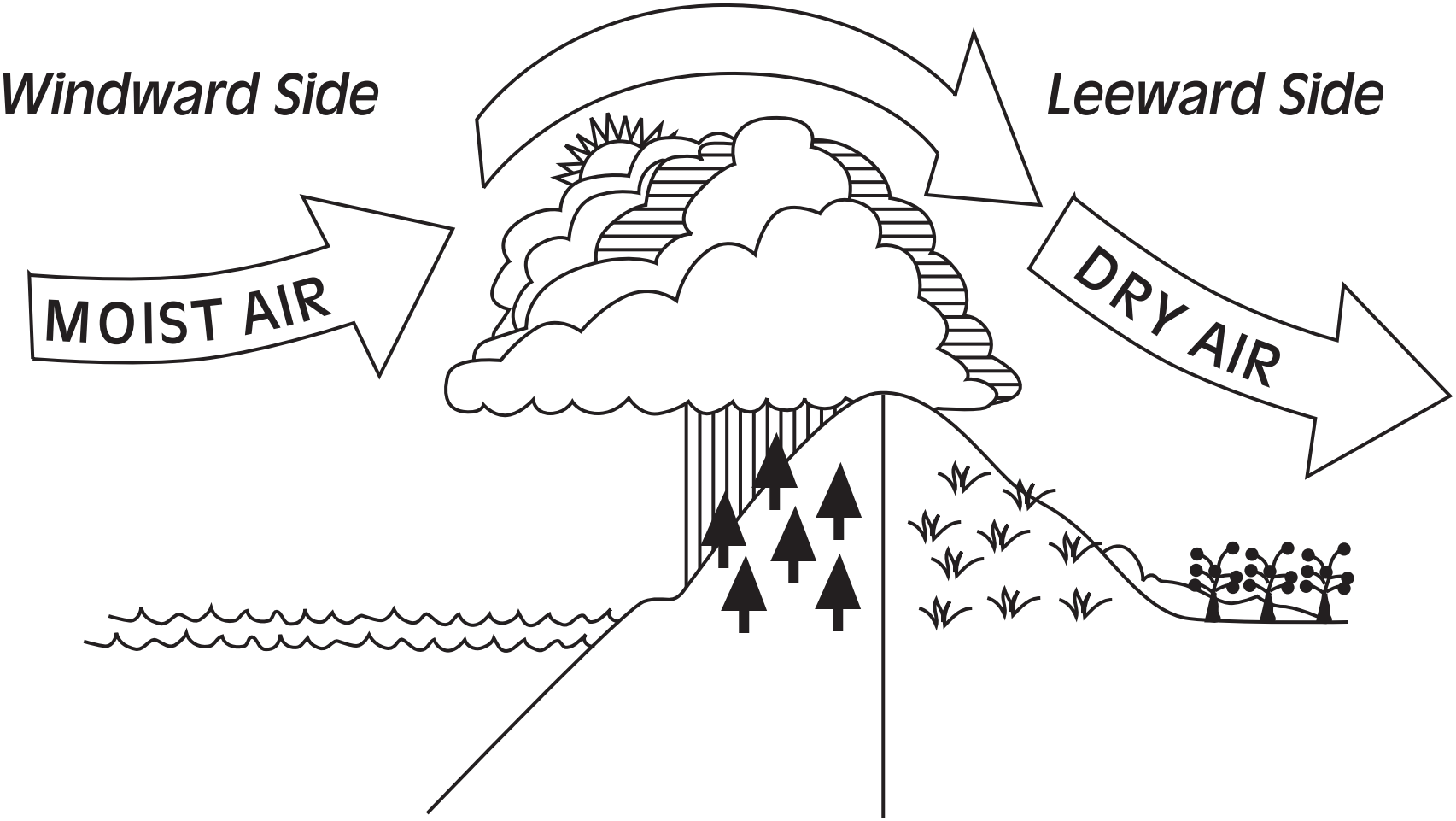
"It is stern, harsh, and at first repellent. But what tongue shall tell the majesty of it, the eternal strength of it, the poetry of its widespread chaos, the sublimity of its lonely desolation? And who shall paint the splendor of its light; and from the rising up of the sun to the going down of the moon over the Iron Mountains, the glory of its wondrous coloring?"

John C. Van Dyke
The Desert, 1901

"From time immemorial the desert has been cast in the role of a sinister adversary. Brooding in parched silence, the desert has been pictured as a furnace trap which lures its victims to their deaths. We hear stories of stranded motorists who, with sun-cracked skins and blackened tongues, stagger feebly to a highway and are rescued, or else fall in heat-induced delirium and leave their bleached bones for subsequent travelers to find."

Erle Stanley Gardner
The Desert is Yours, 1963





Rain Shadow Deserts

Rain shadow deserts are created when mountain ranges lie parallel to moist, coastal areas. Winds moving inland cool as air is forced to rise over the mountains. Clouds form and carried moisture falls on slopes facing the winds. When the winds move over the crest and down the far side, they are very dry. Descending air also makes it hard for additional clouds and precipitation to form. Without another source of moisture, rain shadow deserts are formed on the far side of these mountain ranges.

Discovery Activity Page #2

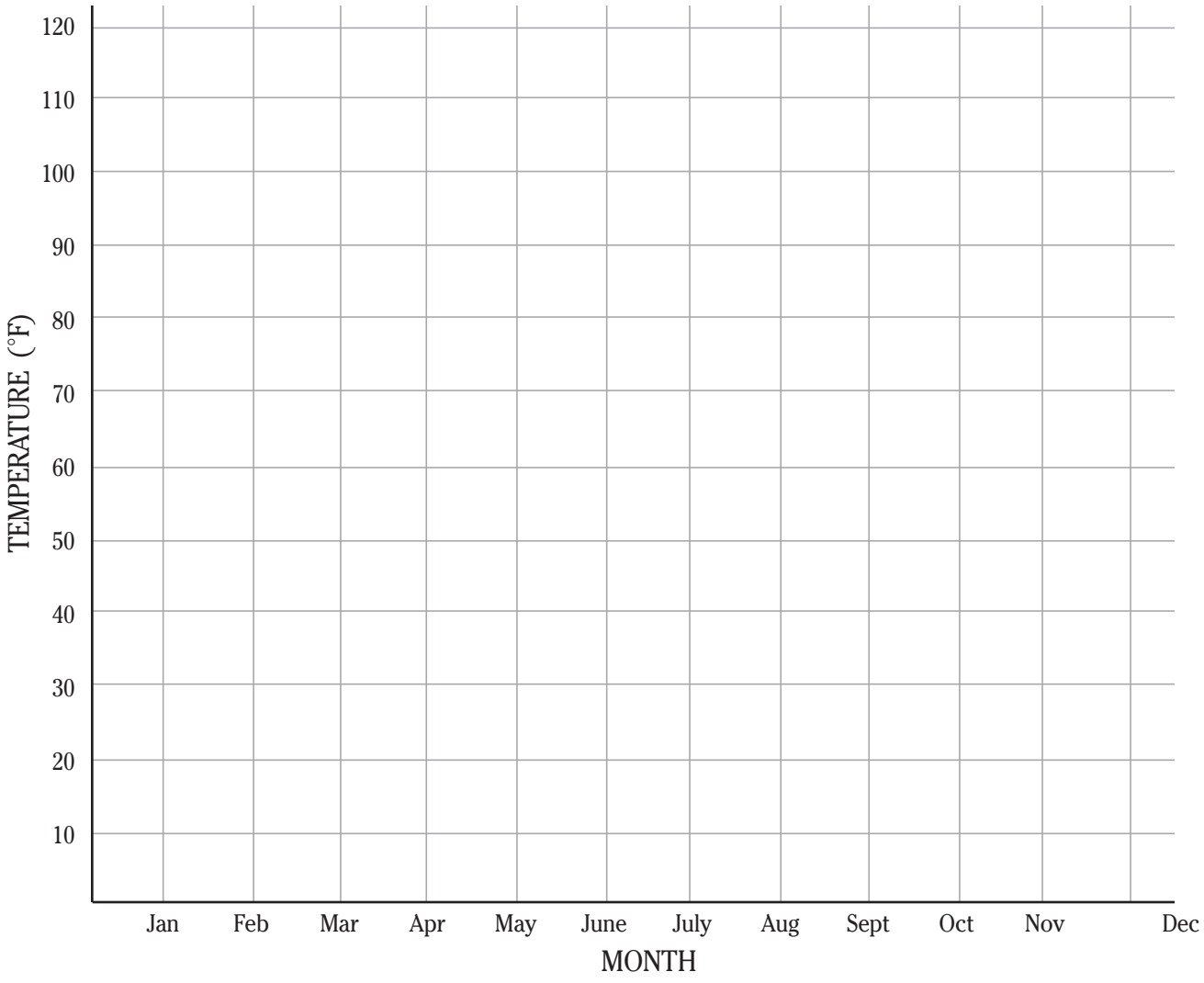
Average Daily High Temperature

(IN ° FAHRENHEIT)

MOJAVE DESERT PARKS	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Death Valley (California)	65	72	80	87	99	109	115	113	106	92	76	65
Joshua Tree (California)	63	68	75	83	90	101	105	103	94	86	72	62
Lake Mead (Nevada, Arizona)	54	60	67	76	85	96	102	99	93	80	65	56

NON-DESERT PARKS	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Acadia (Maine)	31	32	39	50	61	70	76	74	66	57	46	35
Great Smoky Mountains (Tennessee)	48	51	60	70	76	82	84	84	78	70	59	51
Yosemite (California)	47	55	59	66	73	82	90	90	85	74	58	46

Red Line=
Black Line=



Discovery Activity Page #3

Average Monthly Rainfall

(IN INCHES)

MOJAVE DESERT PARKS

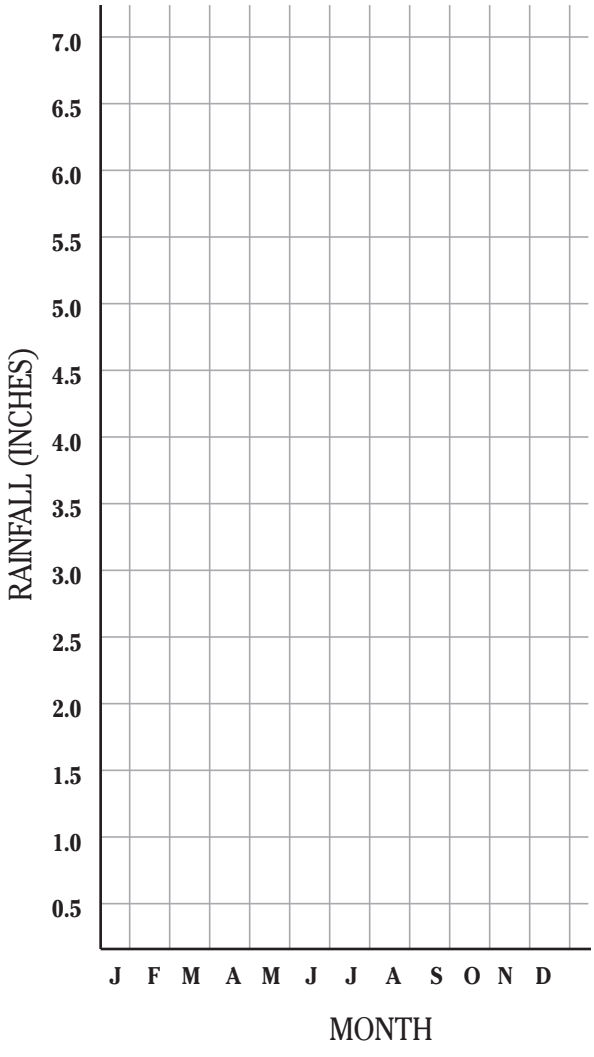
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Death Valley (California)	.2	.3	.2	.1	.1	.1	.1	.1	.1	.1	.2	.2
Joshua Tree (California)	.4	.4	.3	.1	.1	.1	.5	.7	.3	.3	.3	.5
Lake Mead (Nevada, Arizona)	.6	.5	.7	.4	.2	.1	.5	.8	.5	.4	.5	.4

NON-DESERT PARKS

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Acadia (Maine)	4.4	4.14	3.8	3.8	3.9	2.9	3.0	3.0	3.8	4.2	5.5	5.2
Great Smoky Mountains (Tennessee)	4.5	4.2	5.6	4.5	4.4	4.6	5.1	4.5	3.7	3.0	3.7	4.2
Yosemite (California)	6.6	5.0	4.6	3.5	1.5	0.6	0.4	0.3	0.7	1.4	4.7	6.9

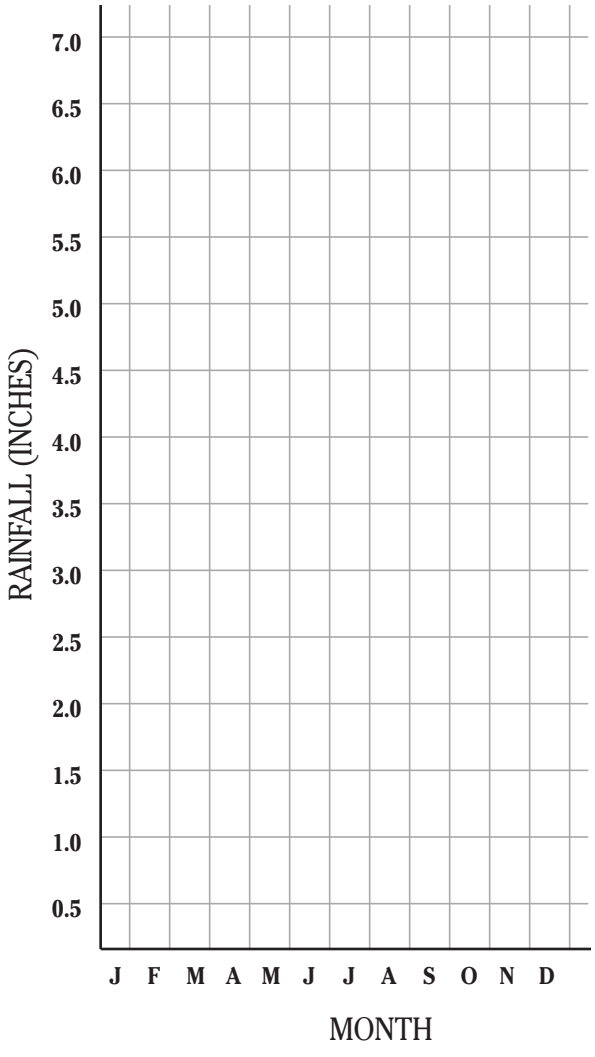
Average Monthly Rainfall

At_____



Average Monthly Rainfall

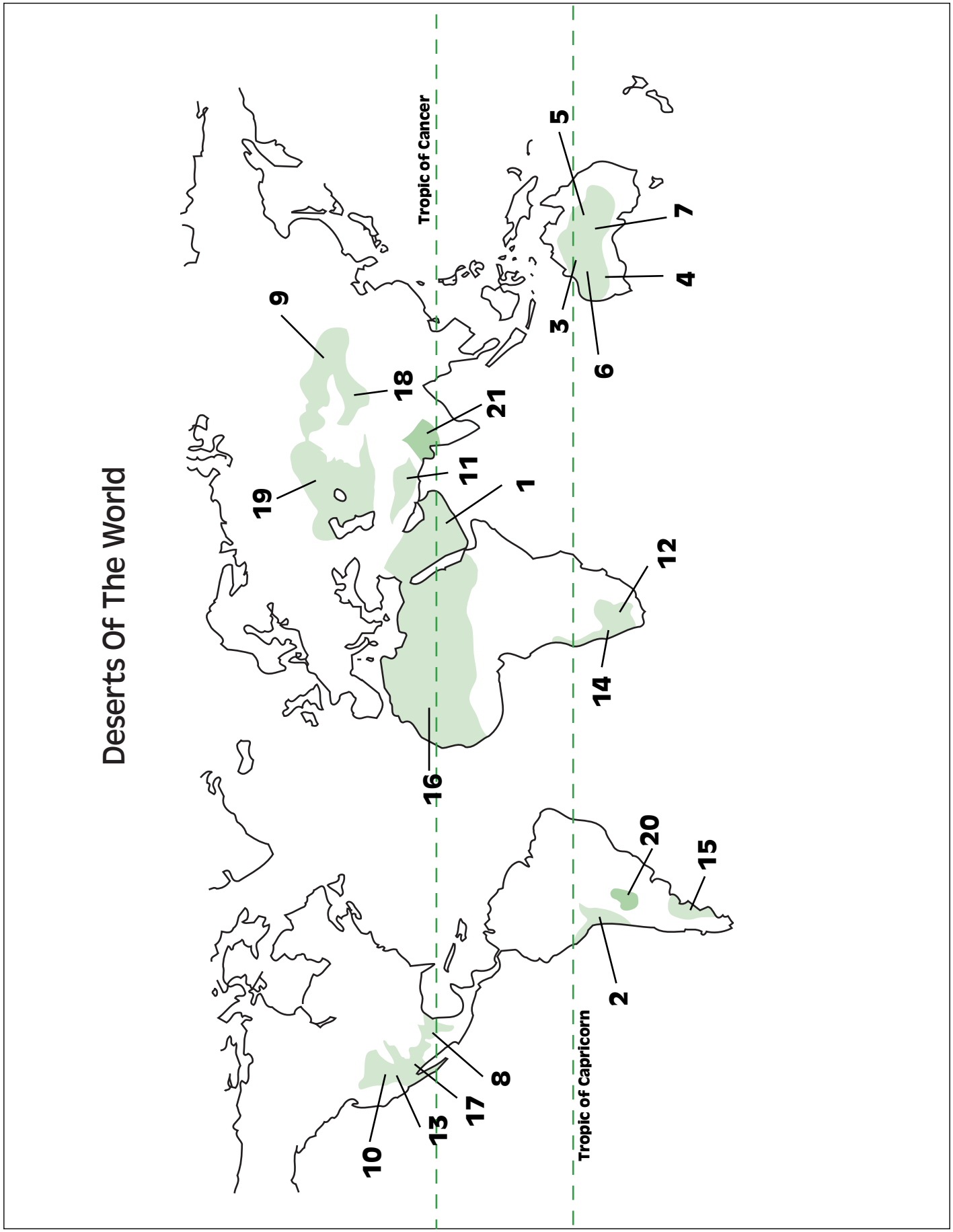
At_____



Deserts Of The World

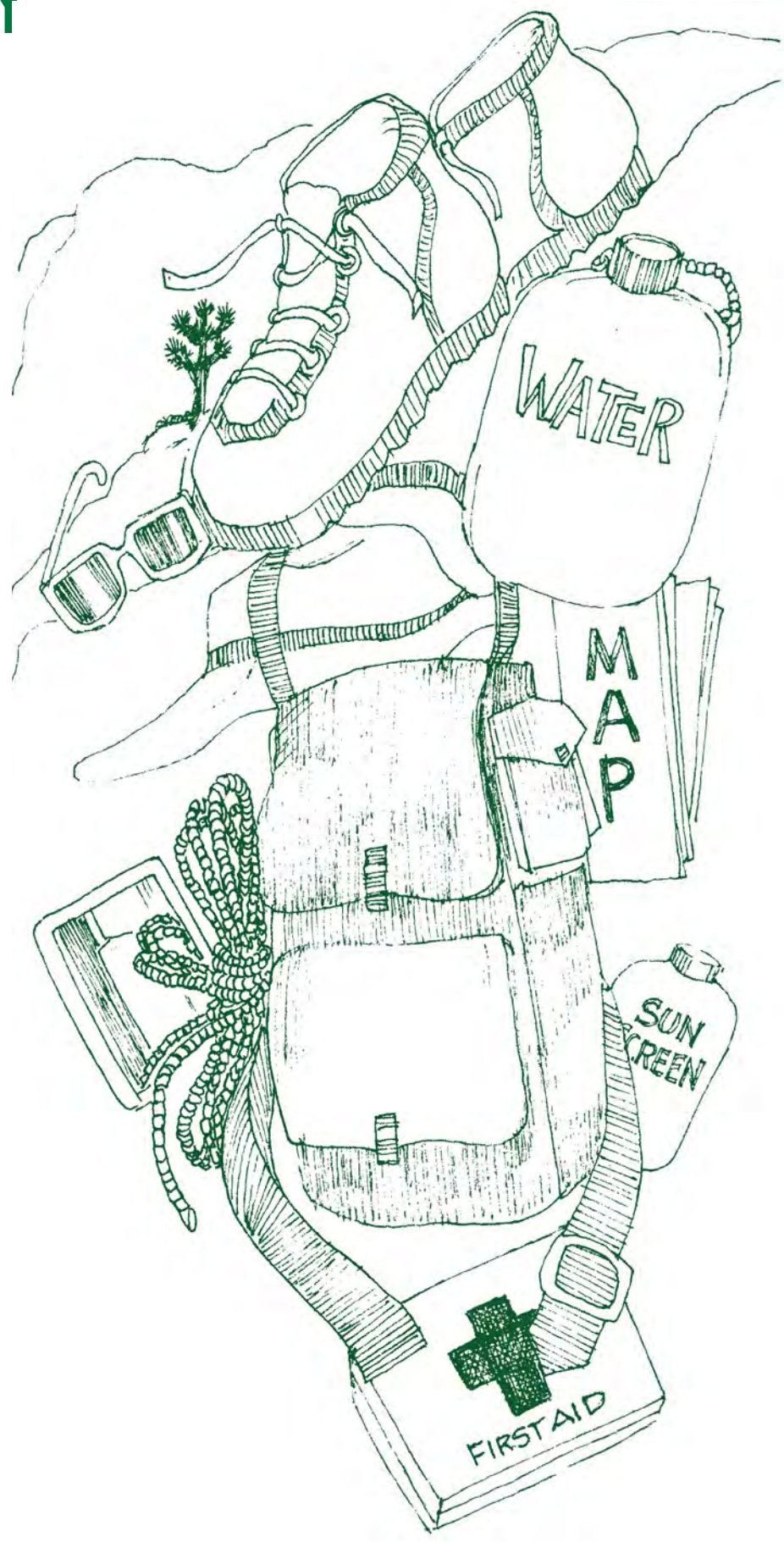
	Name	Type	Size	Hot or Cold Desert	Physical Features	Examples of Plants, Animals
1.	Arabian	Subtropical	900,000 sq. mi.	Hot	Covered almost entirely by sand	• Acacia, Oleander, Saltbush • Camel, Gazelle, Oryz
2.	Atacama	Coastal	54,000 sq. mi.	Cold (usually covered by a cool fog)	Covered by sand dunes and pebbles; one of the driest areas on Earth	• Bunchgrass, Cordon Cactus • Lizards
3 - 7.	Australian (Great Sandy, Victoria, Simpson, Gibson, Sturt)	Interior Subtropical Rain Shadow	890,000 sq. mi.	Hot	Three areas are sandy; two are stony	• Acacia, Eucalyptus • Dingo, Kangaroo, Bandicoot
8.	Chihuahuan	Subtropical	175,000 sq. mi.	Hot	High plateau covered by stony areas and sandy soil	• Cacti, Creosote, Mesquite • Coyote, Rattlesnake, Javelina
9.	Gobi	Interior	450,000 sq. mi.	Cold	Covered by sandy soil and areas of small stones called “gobi”	• Grasses • Camel, Gazelle, Gerbil
10.	Great Basin	Rain Shadow	158,000 sq. mi.	Cold	Covered by sand, gravel, and clay; contains many mountain ranges and basins	• Sagebrush, Saltbush • Bighorn Sheep, Pronghorn Antelope, Jackrabbit
11.	Iranian	Subtropical	150,000 sq. mi.	Cold	Covered by coarse gray soil, stony pavement, and salt flats	• Grasses, Pistachio Tree • Monitor Lizard, Oryz, Scorpion
12.	Kalahari	Subtropical	200,000 sq. mi.	Hot	Covered by sand dunes and gravel plains	•Acacia, Baobab Tree, Aloe • Gazelle, Hyena, Jackal
13.	Mojave	Rain Shadow	25,000 sq. mi.	Hot	Covered by sandy soil, gravelly pavement, and salt flats	• Creosote Bush, Joshua Tree • Bighorn Sheep, Chuckwalla, Jackrabbit
14.	Namib	Coastal	52,000 sq. mi.	Cold (usually covered by a cool fog)	Covered by sand dunes along the coast and gravel farther inland	• Aloe, Bunchgrass, Lichen • Darkling Beetle, Jackal, Web-footed Gecko
15.	Patagonian	Rain Shadow	153,000 sq. mi.	Cold	Covered by stony and sandy areas	• Cacti, Grasses • Puma, Rhea, Patagonian Fox
16.	Sahara	Subtropical	3.5 million sq. mi.	Hot	Covered by mountains, rocky areas, gravel plains, and sand dunes. Some areas have no rain for years.	• Acacia, Grasses • Addax, Antelope, Fennec Fox, Jackal
17.	Sonoran	Rain Shadow	120,000 sq. mi.	Hot	Covered by sand, soil, and gravelly pavement	• Agave, Ocotillo, Saguaro • Coati, Gila Monster, Javelina
18.	Takla Makan	Interior	600,000 sq. mi.	Cold	Covered by sand dunes and rocky soil	• Grasses • Camel, Jerboa, Gazelle
19.	Turkestan	Interior	215,000 sq. mi.	Cold	Mostly covered by sand dunes	• Saxaul Tree, Sedges • Gazelle, Gerbil, Saiga Antelope

Discovery Activity Page #5



SAFETY

Each year people are lost, injured, and sometimes killed while visiting desert areas. Many of these accidents could have been avoided if some simple safety precautions had been taken. The following safety and survival information could not only help you if you're ever in an emergency, but, better yet, might also prevent an emergency from occurring.



SAFETY

Equipment

1. Always carry plenty of water, in your backpack and in your car. Take periodic drinks whether you are thirsty or not. The usual recommendation is one gallon per person per day and up to two gallons during strenuous activity in the summer.

2. Essential equipment includes sturdy walking shoes and proper clothing. Long sleeves and long pants are suggested for protection from rocks and cacti. A hat, sunscreen, and sunglasses are recommended. Carry a day pack to hold such items as water, lunch, first aid kit, jacket, and flashlight.

3. Equipment to always carry in your car includes at least two gallons of water, for yourself and for the car radiator; a sheet to make shade; a blanket for warmth; extra food that won't spoil; and a flashlight. Never attempt to walk for help if you become stranded by the roadside. Stay with your vehicle, make a shelter, and drink plenty of water. Wait for help to come to you.

4. Be prepared for variable weather conditions. Temperature ranges throughout the day can be extreme. Occasionally, heavy thunderstorms produce flash floods. During stormy weather avoid dry creek beds and other possible flash flood areas. Do not try to drive or walk across a flooded area.

5. Carry a map of the area. Learn how to use a compass and bring it along.

6. Always tell someone your plans — where you are going, what route you will take, when you will return. If your plans change during your trip, update with a telephone call. If no phone is available, leave a note in an obvious place along your original trail. This will help searchers find you faster in the event of an emergency.

7. Carry matches to start a fire during an emergency. A fire will not only provide warmth, but also a feeling of safety.

8. Bring string, a tarp, and a knife for making shelter. It is important to make shade if none is available, to prevent hyperthermia and dehydration in the hot sun.

9. Carry a first aid kit.

10. Carry a signaling mirror or other signaling device, such as a whistle. When in an emergency situation, there will most likely be people looking for you. You must act as part of the rescue team by helping them find you.

11. Bring food for energy while out in the field. Packaged foods like granola bars, crackers, or dried fruit are convenient to carry in a backpack, and they do not require preparation.

12. Hiking in the desert often means traveling over rough, steep terrain with frequent elevation changes. Try to pick a route that best suits your abilities. Distances are often deceiving. Hike during cooler times of the year or in the early morning.

Dangerous Situations

Hyperthermia occurs when the body's natural cooling mechanisms, like perspiration, fail. The most dangerous form of hyperthermia is heatstroke. Symptoms include a high body temperature (above 106°F); dry, red skin; a rapid pulse; and unconsciousness. A victim of heatstroke should be cooled as rapidly as possible by sponging the skin with cool water or a cold pack. Seek professional help immediately.

Symptoms of heat exhaustion, a less serious condition, include normal body temperature, pale and clammy skin, heavy perspiration, headache, nausea, and dizziness. Move to a cool, shaded area and drink water.

Hypothermia is the lowering of the body's core temperature. Deserts are not always hot; temperatures may go below freezing. Some desert areas, like Lake Mead National Recreation Area, have artificial lakes that have cool temperatures year round. Be ready to insulate yourself and stay dry. Try to stay active, build a fire, and eat food.

Remember, prevention is the best cure. Set your priorities in a survival situation to prevent hyperthermia, dehydration, and hypothermia since these conditions are hard to reverse without medical attention.

Dehydration occurs with the loss of water and thus usually accompanies hyperthermia. Totally cease activity, sit in the shade, and drink water.

Hazardous Plants And Animals — Which Really Are?

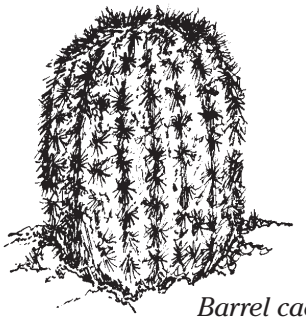
The deserts of the southwest United States support a wide variety of plant and animal life with interesting adaptations which allow them to live in the sometimes harsh desert environment. Due to years of television programs, films, and novels accentuating the poisonous plants and animals of the desert, many people fear these creatures rather than admiring them and their amazing adaptations.

Most desert dangers come from man-made hazards (like barbed wire fences, open mine shafts, and wells), not plants and animals. The exaggeration surrounding desert creatures has caused unwarranted fears among people and, as a result, the killing of many harmless species. In order to prevent this misinformation from causing extinctions, it is important to learn which plants and animals are actually poisonous. Here are

the most commonly asked about species; some are harmful, some are not.

Plants:

Cacti — Cacti are interesting plants to look at, but all have spines of varying sizes. The spines of some species, like the teddy-bear cholla, have microscopic barbs which are very painful if they



Barrel cactus

become imbedded in the skin. Pliers or tweezers are often required to remove the spine. Keep a safe distance from cacti on trails. Watch for loose clothing that might snag on the plant as you walk by.

Datura or **Jimson weed** — Flowers are funnel-shaped and white with a purplish tinge in the throat. This plant is hazardous to touch and can be lethal if any part is eaten. Datura, like any other wildflower, should not be picked.

Datura

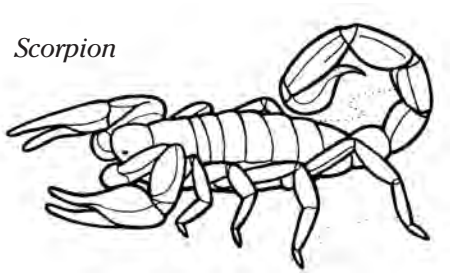
Animals:

Tarantula — This large hairy spider is not harmful to humans; rather it is beneficial because it feeds on many insects. It is most active in the fall when males are hunting for mates.

Hospitals recommend that bite or sting victims of the following should seek professional help as soon as possible:

Scorpion — While more than twenty species are known to exist in the

Scorpion



Southwest, only one is deadly — the sculptured scorpion (found only in Arizona and New Mexico). This straw-colored, slender-tailed scorpion is only two inches in length. A scorpion's stinger is located at the extremity of the "tail." Poison is injected beneath the skin, making surface treatments ineffective.

Black widow spider — This is a common spider found as frequently in homes as in desert wilderness. A black widow's venom is more potent than that of a rattlesnake, and it acts quickly on the nervous system of humans. The black widow is usually found in shady and protected areas like rock and wood piles and seats of pit toilets.

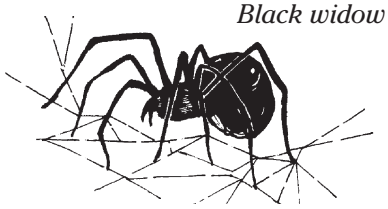
Brown recluse spider — Earlier in this century, the black widow was considered the only United States spider dangerous to man. But now, the brown recluse has joined ranks. Its bite can go unnoticed for two to eight hours. The first symptom is usually the deterioration of the flesh around the bite. Sometimes called the fiddleback spider because of the violin-shaped spot on its "head," it is found in open fields, rocky bluffs, outhouses, garages, and piles of sacking or clothing.

Rattlesnake — One feature to most easily identify a rattlesnake is its triangular head, which appears distinct from the rest of its body. Those found in the Mojave Desert include: Mojave Desert sidewinder, Mojave green, red diamond, southern Pacific, speckled, and western diamondback.

If bitten, seek professional help immediately. Stay calm, restrict movement and, if possible, keep the bite site below the level of the heart. As with other forms of poison, the physical condition and size of a person affects how serious a bite will be. For this reason, children are more susceptible. Wear clothing that will protect from a bite while hiking or walking in the desert. Watch where you put your hands and feet. The best prevention against snakebite is giving the snake a wide circumference.

A rattlesnake will try to remain hidden from a human rather than strike. Snakes hibernate during the winter. During the summer, they search for food at night (lizards, young rabbits, rodents) and coil up in shady spots during the day. If you do see a rattlesnake consider yourself lucky!

Black widow



SAFETY

Activity 1
Is This Hiker Ready?

OBJECTIVES: Name the necessary items to take on a desert hike. Explain why each item is necessary.

MATERIALS: Backpack, clothes to layer, first aid kit, hat, map, packaged food, sturdy shoes, sunblock, sunglasses, unnecessary items (such as a radio, toys, bikini, gum, etc.), water bottle, Discovery Activity Page #1, crayons or colored markers.

SUBJECTS: Art, health, language arts.

SKILLS: Analysis, discussion, drawing, listening, listing, public speaking, writing.

METHOD: In this activity, your group will prepare one hiker for a day in the desert by gathering the necessary items for safety.

1. Choose one student from your group to be the "hiker." With all the materials set out on a table (both necessary and unnecessary), call on one volunteer at a time to give an item to the hiker and tell why they think it is necessary. The volunteer can help dress the hiker with the piece of clothing, rub on sunscreen, or pack the item in the hiker's backpack.

2. When the group feels the hiker is prepared, talk about the items left on the table and why they are unnecessary. What other things might be unnecessary? Has the hiker forgotten anything?

VARIATION: As you start a discussion on desert safety, arrange to have a hiker wander into the classroom. This hiker is obviously unprepared — sandals, shorts, tank top, a tiny fanny pack with only a small water container. Ask the students if the hiker looks prepared. The answer should be a resounding "No!" As students name items they think the hiker needs, bring them out from a hidden location and "prepare" the hiker. Discuss why each item is necessary. Some fun can be added by producing oversized sunglasses or a giant sombrero.

3. To review information several days later, pass out copies of the activity page. Have your students draw items they need for a hike inside the outline of the backpack.

4. When everyone is finished, allow volunteers to bring their backpacks to the front of the class and discuss what they have drawn. After doing this with several students, decide if anyone has forgotten anything.

EXTENDING THE EXPERIENCE: Ask students to bring in newspaper articles about actual desert rescues and/or emergencies. Local newspaper offices and libraries might be good sources of clippings. What went wrong? What might have been done to prevent the situation from occurring or to cause a different outcome?

Activity 2
A Hike In The Desert

OBJECTIVES: List two natural history facts about the desert.

MATERIALS: Any props used, index cards, necessary items for hiking.

SUBJECTS: Language arts, physical education, science.

SKILLS: Discussion, listening, observation, public speaking, reading, research.

METHOD: As you study deserts with your class, you should take your students and venture out into the field for hands-on research, experiments, and activities. This can be an enjoyable and rewarding experience for everyone, if you understand the basics of desert safety explained thus far and take a few simple precautions.

Discuss desert safety with your students and allow them to participate and be responsible for preparing themselves to go out. Perhaps each student can carry a small backpack with some necessary items. This will make each student aware of necessary safety items and give them a feeling of responsibility for themselves. If you choose this approach, be sure to examine each bag before you leave school, checking for the necessities and removing superfluous items that simply add weight to the student's pack. If you want the students to be unencumbered by packs, you must be responsible for bringing enough water for everyone, usually one gallon per person per day.

You, as the teacher, must also make preparations that the students cannot help with, such as packing a first aid kit and leaving exact instructions with someone (probably the school office) about where you are going, what route you are taking, and when you plan to be back. Also, arrange to have enough chaperones accompany you on the trip. You know best the personality of your students and how they are likely to respond to the activity, but generally one adult per six to eight students is adequate. Plan to visit the area yourself ahead of time to familiarize yourself with the area and plan your hike.

Everyone needs to be aware of harmful plants and animals. If your students will be scrambling up and along rocks, warn them to always look before placing a hand, foot, or seat. Many critters, including snakes, frequent

rocky areas and should be avoided as a courtesy to the animal and as a safety precaution for yourself. Also, talk to the students about the dangers of cacti and other prickly plants. Cacti are fun to look at but not fun to touch.

Whatever preparations you make, be sure to discuss them with the students so they can benefit from the information too. The goal is to teach students responsible desert preparedness without instilling an unnecessary paranoia.

1. Begin with a discussion of the above information. Working with your students, select a location for a desert outing. This could even be a walk in an area close to school.

2. Get together the necessary items for each student to carry. It would be good to do Activity 1 with your class first.

3. Decide if your hike will just be walking with little or no information or if you will have information stops at predetermined locations. A good way to involve students in this is to plan a "Pass Along Hike."

Pass Along Hike: Determine locations of interest ahead of time and collect brief information about each site. This could be identification of plants, animals, or animal signs; pointing out interesting geology; or safety reminders, such as the possible presence of snakes in and around rock piles. Write this information on index cards. Walk in a single file until you reach your first stop. The corresponding information card is given to the first student in line, who quickly reads the card and shares the information with each student who passes. The information giver then joins the end of the line. This process is repeated at each stop. Review at the end of the hike to see what is remembered about each stop. This is also a good time to add additional information.

EXTENDING THE EXPERIENCE: Plan a walk in an area near the school. Select students to be "experts" at each stop. Have students research information for their stops. Invite other classes to take your class' nature walk. If an appropriate outdoor area is not available near the school, this activity can be done in the classroom. Pictures and objects, such as a tortoise shell or rock, can be used. Remember, these objects cannot be removed from National Park Service areas.

Activity 3
Animals People Love To Hate

OBJECTIVES: Name two animals generally feared by people. Name positive attributes of these animals.

MATERIALS: *How Poison Came Into the World* (on page 6); pictures of poisonous, feared animals; scissors; three twelve-inch black or brown pipecleaners per student.

SUBJECTS: Art, language arts, science.

SKILLS: Analysis, discussion, evaluation, listening, research, writing.

METHOD:

1. Pass out pictures of poisonous animals or animals people fear face down. Have students flip cards over and share first words/reactions.

2. Discuss and list which animals your students dislike or are afraid of. Why have they developed these feelings?

3. Then say the animals on their cards have just died. Each student must write a eulogy, saying as many good things as possible. Encourage students to research information for their eulogies.

4. Humans have made stereotypical assumptions about some animals that are not always accurate. The appearance and behavior of animals did not evolve to appeal to humans. They came about to ensure survival.

It is important to respect all animals

Fun Facts — QUICK FIRST AID REFERENCE

Scorpion, black widow spider, and brown recluse spider bites — Seek professional help. Individual reactions vary.

Rattlesnake bites — Seek professional help immediately. Keep victim calm and restrict movement. Keep bite site below level of heart.

Heatstroke — Symptoms: red, flushed victim; hot, dry skin; extremely high body temperature. **Life-threatening**. Cool victim quickly. Seek professional help immediately.

Heat exhaustion — Symptoms: pale, clammy skin; profuse perspiration, extreme weakness. Give water. Have victim rest. Medical help is needed for severe cases.

Hypothermia — Symptoms: staggering, slurred speech, uncontrolled shivering. Replace wet or cold garments with dry, warm clothing. Wrap victim with persons who are warm in blankets or a sleeping bag. Give hot liquids to conscious victim.

and to know which may harm us if we get too close. Native Americans incorporated these animals into myths and legends to help explain them. Read *How Poison Came Into the World* to your students.

How does each animal in the story intend to use its poison? Why do animals have painful bites, stings, and other defenses? What would happen to them if they didn't have these defenses?

EXTENDING THE EXPERIENCE: Using pipecleaners, have each student construct a tarantula. Cut two pipecleaners in half. To make four pairs of legs, bend each short piece of pipecleaner into a letter **M**. To make feet, bend the ends of each **M** outward. Stack the four pairs of legs so that the four middles are together. Wrap the long pipecleaner around and around the middles to make the body. Spread the legs so the spider can stand on them. From a tarantula's viewpoint, have the students write stories about an encounter with a human.

How Poison Came Into the World

(Choctaw Indians-Southeast)

Back when the world was new, there was a certain plant that grew in the shallow water of the bayous. It grew in the places where the Choctaw people would come to bathe or swim. This vine was very poisonous, and whenever the people touched this vine, they would become very sick and die.

This vine liked the Choctaw people and felt sorry for them. It did not want to cause them so much suffering. It could not show itself to them, because it was its nature to grow beneath the surface. So it decided to give its poison away. It called together the chiefs of the small people of the swamps — the bees, wasps, and snakes. It told them that it wished to give up its poison.

These small creatures held council together about the vine's offer. Until then, they had no poison, and they were often stepped on by others. They agreed that they would share the poison.

Wasp spoke first. "I will take a small part of your poison," it said. "Then I will be able to defend my nest. But I will warn the people by buzzing close to them before I poison them. I will keep the poison in my tail."

Bee was next. "I, too, will take a small part of your poison," it said. "I will use it to defend my hive. I will warn the people away before I poison them, and even if I should have to use my poison, it will kill me to use it, so I will use it carefully."

Water Moccasin spoke. "I will take some of your poison. I will only use it if people step on me. I will hold it in my mouth, and when I open my mouth people will see how white it is and know that they should avoid me."

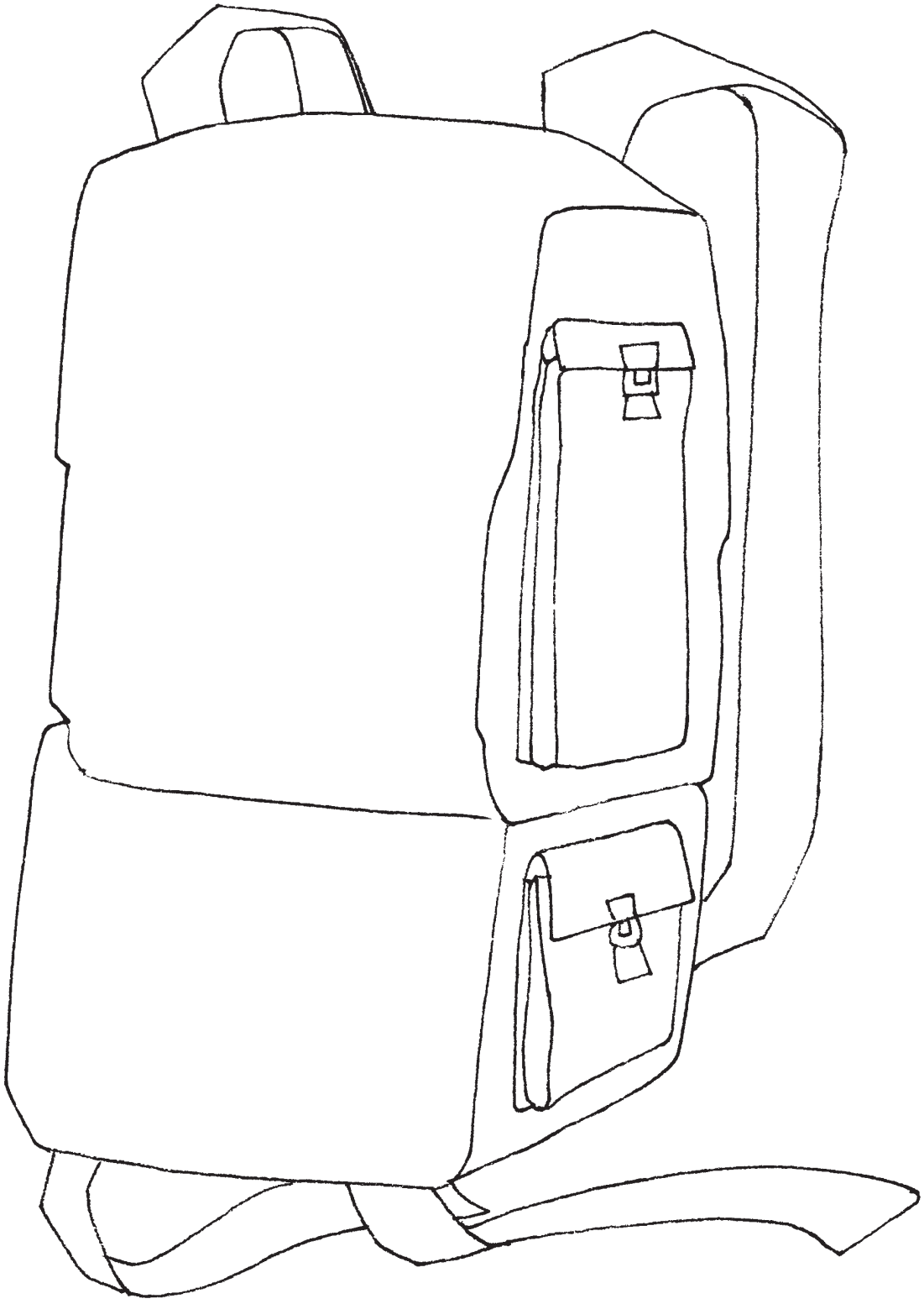
Last of all, Rattlesnake spoke. "I will take a good measure of your poison," he said. "I will take all that remains. I will hold it in my mouth, too. Before I strike anyone, I will use my tail to warn them. *Intesha, intesha, intesha, intesha.* That is the sound I will make to let them know they are too close."

So it was done. The vine gave up its poison to the bee and the wasp, the water moccasin and the rattlesnake. Now the shallow waters of the bayous were safe for the Choctaw people, and where once that vine had poison, now it had flowers. From then on, only those who were foolish and did not heed the warnings of the small ones who took the vine's poison were hurt.

Discovery Activity Page #1

Is This Hiker Ready?

What would you put in the backpack?



WATER

Residents of the Mojave Desert live in an area that normally receives less than ten inches of rain a year, usually less than six. Some places in Death Valley receive less than two inches a year. In contrast, many areas in the northeastern United States receive more than sixty inches of rain annually. Before construction of dams along the Colorado River and development of an elaborate water delivery system, only a few thousand people lived in this region as there was no dependable water supply. Today over twenty million residents prosper here because of this system.

WATER

The Colorado River

From space the Colorado River is seen as an undulating blue line that extends 1,450 miles from the Rocky Mountains of Colorado to the Gulf of California. Plummeting from an elevation of fourteen thousand feet, the river descends through some of the most rugged and remote territory in the United States. Much of its course passes through the hottest, driest region in the country, where rainfall averages four to six inches a year and the temperature often rises to 120°F. Each year it carries nine million tons of salt and 136 million tons of silt to the sea, eroding rock over 1.7 billion years old and carving mile-deep canyons. The river and its major tributaries traverse through seven states, draining an area of 242,000 square miles.

This once-wild river has played a central role in human society for nearly two thousand years. Native American groups, such as the Anasazi, Mohave, Hualapai, and Paiute indians farmed its

fertile flood plains for centuries. Native fish, such as the Colorado squawfish and the humpback sucker, provided an important food source.

Early peoples had many different names for the Colorado. The Mohaves, who lived along its banks, called the river *Ahamcave* (along the water). The Paiutes of southern Utah called the Grand Canyon section of the Colorado *Pahaweep* (water down deep in the earth). Named the Tison or Firebrand River by white explorers of the 1500s, the river did not receive its present title until 1776 when a Spanish missionary traveled to the edge of the Grand Canyon and described what he saw as *El Rio Colorado* (the red river).

Rivers historically have been used as major routes of travel, often through land that was otherwise inaccessible. The Colorado, however, until tamed by Hoover Dam, remained an almost impenetrable obstacle to navigation. One of those who tried was Lt. J.C. Ives, sent by the United States Army in 1858 to travel up the Colorado by boat as far as possible from the Gulf of California. He piloted his steamboat five miles upstream from where Hoover Dam now stands and remarked:

> "The region is altogether valueless. Ours was the first, and will doubtless be the last, party of whites to visit this profitless locality. It seems intended by Nature that the Colorado River shall be forever unvisited and undisturbed."

It was not until 1869, when Maj. John Wesley Powell, a Civil War veteran, completed his historic journey down the river from Green River, Wyoming, that the Colorado was finally mapped in its entirety.

Today over twenty million people rely on the Colorado River as their primary water supply, including people living in Las Vegas, Nevada; Palm Springs, San Diego, and Los Angeles, California; and Phoenix and Tucson, Arizona. Two million acres of farmland are irrigated by the river, and ten major dams have been built along its course in an attempt to control its unpredictable behavior.

So important is this river to residents

GLOSSARY

adaptation — special tools for survival; physical or behavioral characteristics that make an organism more suited to its environment.

aquifer — rock or sediment through which groundwater moves easily.

atmosphere — the gaseous mass surrounding Earth to a height of 500 miles and held in place by Earth's gravity; provides the gases essential to life: oxygen, carbon dioxide, nitrogen, and water vapor. Water is stored in the atmosphere as clouds.

cloud — a visible body of fine droplets of water. May exist up to several miles above Earth's surface.

condensation — the process by which water changes from the vapor state to the liquid or solid state. Water vapor stored in clouds condenses to form rain.

conservation — the careful use of a specific resource such as water.

ecosystem — the interaction of the biological community (all living things) and the physical environment (water, air, minerals).

evaporation — the process by which water changes into a vapor.

glacier — a thick mass of ice originating on land from the compacting and recrystallization of snow that shows evidence of past or present flow.

groundwater — water stored beneath the surface of the ground, coming from *precipitation* and surface water that has percolated down. Water that supplies wells and *springs*.

habitat — the place where a plant or animal lives, an organism's home. Provides food, water, shelter, and space in a *suitable arrangement*.

icecap — a covering of ice and snow permanently overlying an extensive tract of land and moving in all directions from a center.

oasis — a fertile or green spot with water in a desert. Palms, mesquite, willows, and cottonwood trees may grow there.

Pleistocene Epoch — an epoch beginning about 2.5 million years ago and ending about 10,000 years ago. Best known as a time of extensive continental glaciation.

precipitation — water received directly from clouds as rain, hail, sleet, or snow.

riparian — located or living along or near a stream, river, or body of water.

spring — a natural flow of *groundwater* that reaches the surface.

suitable arrangement — when those things necessary for survival (food, water, shelter, space) are adequate in quantity, accessible, and in keeping with the biological lifestyle of a species.

transpiration — a process by which plants evaporate moisture through the surfaces of their leaves.

of the Southwest that some have called it "the most legislated, litigated, and debated river in the world." All the water in the Colorado River was legally allocated among the seven contiguous states with the signing of the Colorado River Compact in 1922. Through this compact, 16.9 million acre-feet were given away, two million acre-feet more than existed in the entire system (one acre-foot of water equals 325,000 gallons or the amount an average family of four uses in one year). An additional 1.5 million acre-feet were promised to Mexico annually with the signing of a 1944 agreement. Today, because of an extended drought, it is estimated that less than nine million acre-feet flow down the river each year. Of that, only a trickle finally finds it way to the Gulf of California.

The river has also been described as "a finite resource with an infinite demand." Most years it never reaches the ocean. Because of this demand, in 1991 the Colorado River was declared the most endangered river in the United States by American Rivers, a conservation society.

What Good Is A Fish?

Much of the native life that exists in or along the Colorado River is endangered. Construction of dams forever changed the character of the river. Once warm, silty, swift, and shallow, the river is now cold, clear, deep, and virtually stagnant along much of its route.

Fish, in particular, cannot tolerate these changes. Seventy percent of the fish population of the Colorado River exists nowhere else in the world. Four species of fish native to the river are endangered — the razorback (or humpback) sucker, the humpback chub, the bonytail chub, and the Colorado squawfish. All have developed specific structures to survive the extreme environmental conditions of their turbulent, silty habitat, the most common adaptation being a large hump behind the head. This hump allows the fish to stay on the bottom of the stream where currents are not so strong.

These fish depend upon tributary canyons that provide shallow spawning areas and protected back bays for juveniles. Most of the traditional spawning areas have been flooded with the rising waters of human-made lakes. While rivers change almost overnight with the completion of dams, native life adapts much more slowly, if at all.

Up to sixty thousand razorback suckers still exist in Lake Mohave, a remnant population that was there before the construction of Davis Dam. Most of these fish are twenty-five to sixty years old and are not reproducing successfully. If no effort is made to assist them, it is likely they will become extinct within the next ten years. A recovery effort is now underway in Lake Mohave. A back bay has been separated by a barrier from the main river channel in order to provide a spawning area for eighty adult fish. The young will be protected there until they are at least ten inches long and better able to compete with predatory fish such as carp and largemouth bass. If this project is successful, similar attempts may be made to reestablish the bonytail chub and the Colorado squawfish.

Nevada has eighty-two known native species of fish. Of these, seventeen are listed as endangered and four are listed as threatened. Thirty-one species are being considered for listing. Thirteen species have become extinct. The primary reason for this decline is *groundwater* pumping for irrigation and other water needs, drying many of the natural *springs* where native fish thrive.

The Devil's Hole pupfish was declared an endangered species in 1967 and its survival is still uncertain. This two-inch fish is one of five species of pupfish that are found in Death Valley springs. Its entire population is restricted to one small pool. Pupfish have survived from the *Pleistocene Epoch* when large inland seas covered much of the Southwest. As climates changed and the waters receded, the fish gradually adapted to smaller pools that have large concentrations of salts and other minerals toxic to most fish. Their ability to tolerate these saline conditions could one day be very valuable in researching human kidney diseases.

Southern Nevada's needs for new sources of water could have a direct impact on the fishes of Death Valley National Park. The Las Vegas Valley Water District has applied for permits to withdraw water from the groundwater supply underlying central Nevada, the same *aquifer* that feeds many springs in Death Valley as well as springs throughout Nevada.

Much attention has been paid to conserving "likeable" species such as the desert tortoise and the bighorn sheep. Insects, fishes, and other smaller organisms are often ignored. The National Park Service is legally obligated to protect all species found in national parks, both for the enjoyment of future generations and for the irreplaceable roles species play in the ecology of our planet. However, the National Park Service cannot defend wildlife, from shrimp to lizards to bats to bears, without the cooperation and commitment of all Americans. The survival of the human species depends upon our ability to protect the ecology of our planet, including the fish.

Water Conservation

At first glance the water supply seems limitless. Lakes Mead and Mohave have over seven hundred miles of shoreline. Lake Mohave extends sixty-seven miles upstream from Davis Dam, and Lake Mead backs up 110 miles behind Hoover Dam, before it meets the Grand Canyon. When completely full, Lake Mead could supply every person in the world with 2,200 gallons of water or enough water to cover the state of New York to a depth of one foot. Lake Powell, formed by Glen Canyon Dam in 1963, has over 1900 miles of shoreline. Lake Mead, with its capacity of 28.5 million acre-feet, and Lake Powell, with its capacity of twenty-seven million acre-feet, can each hold over two year's worth of runoff from the Colorado River.

Why should we be concerned about conserving this vast resource? Construction of human-made reservoirs has given us a false sense of security. Inaccurate measurements led us to believe more water was available than existed. The large lakes allow tremendous amounts of water to evaporate — two million acre-feet evaporate from these surfaces each year, thirty million gallons of water evaporate from Lake Mead every hour. In fact, more water evaporates off the surface of Lake Mead every day than is used by the entire state of Nevada.

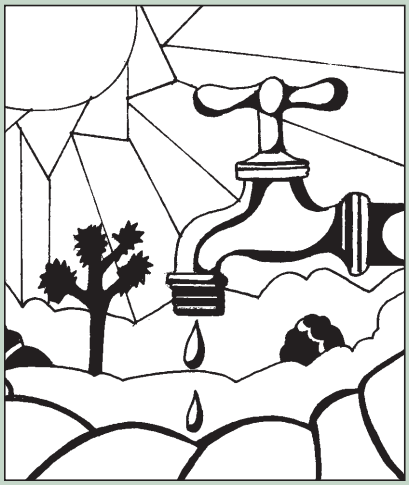
Much of the remaining water is used unwisely. More than sixty percent is sprayed over household lawns and gardens or used to irrigate farmlands in the valleys of Southern California, often with inefficient systems. So much water is used that the mighty Colorado rarely reaches the ocean anymore.

As the river approaches its destination, what water there is has such a high concentration of salts, pesticides, and fertilizers from agricultural lands that it is unsafe to drink. Water delivered to Mexico must first go through a desalination plant in Yuma, but desalination plants are expensive to build and expensive to use. Water produced at a desalination plant built in Santa Barbara, California, may cost up to $1,900 an acre-foot, or more than nine times the normal cost. How much will we be willing to pay for water in the future?

The Colorado River system continues to work only because some states are using less than their allocated share. Nevada will soon be consuming all of its allotment and will need to come to terms with the fact that there is no more water. As populations expand and demands continue to rise, something will have to change. Conservation must play a vital role in adapting to modern-day use of water in the desert.

Fun Facts — WATER WONDERS

- Nearly 80% of Earth's surface is covered with water. This is the same amount of water that was here billions of years ago. Water cannot be created or destroyed.
- 97% of all the water on Earth is salt water.
- 3% of Earth's water is fresh water.
- 2% of Earth's water is glacial ice at the North and South poles.
- Only 1% of the world's water is fresh water available for us to use.
- The Great Lakes contain 20% of the world's fresh water.
- A person's body is about 70% water.
- A person can live only two to three days without water.



- An average person in the United States uses 77 gallons of water per day.
- Groundwater supplies 50% of the drinking water in the United States.
- About half of the fresh water used in the United States is for irrigation.
- 60% of domestic water is used to water gardens and lawns.
- A gallon of water weighs 8.34 pounds.
- It takes about 120 gallons of water to produce an egg. This includes water to raise the grain to feed the chicken. It takes 100 times more water to produce a pound of meat than a pound of wheat.

Activity 1

Creature Feature

OBJECTIVE: Create a creature with *adaptations* for living in a *riparian* area.

MATERIALS: Crayons, drawing paper.

SUBJECTS: Art, language arts, science.

SKILLS: Analysis, classification, drawing, problem solving, public speaking, reporting, small group work.

METHOD:

1. Introduce students to the term riparian zone. This is an area that includes not only the water, but the vegetation associated with the water. Riparian zones are areas that surround fresh water springs and that line riverbanks and lakeshores. Many animals living in this area could not survive without the special conditions that the riparian zone provides. Riparian areas often provide different and more abundant vegetation than surrounding areas, a higher percentage of shade, trees for nesting or shelter, higher humidity, and more diverse plant and animal life. Riparian areas are easily affected by natural and man-made changes.

2. Have each student design a creature adapted to living in a riparian area. This activity can be done individually or in small groups. While they are designing the creature, have them consider the following questions. Put the questions on a chalkboard or chart paper for easy reference. How are its feet adapted to the environment? What kind of body covering does it have that makes it well suited for living in an aquatic area (scales, feathers, shell)? Where are its eyes? How can it see what's above, what's below? How does it move (swim, fly, carried on current)? What does it eat? How is its mouth adapted to this kind of food? What kind of limbs does it have (arms, legs, flippers, gills, wings, tail)? Did you invent anything special which will help it adapt to living in a desert region (surviving flash floods, drought)? An example of an invented creature is below.

3. Have students (or groups) share their creatures with the class, discussing ways each animal has adapted to an aquatic *habitat*.

EXTENDING THE EXPERIENCE:
Talk about threats to aquatic habitats, such as construction of dams along the Colorado River or draining a spring for irrigation. How would this creature adapt to these and other man-made changes? Would this creature disappear or would it adapt?

What could be done to protect this animal and still satisfy our water needs?

EXAMPLE:
DOUBLE-CRESTED CREVICE CREEPER

WHAT DOES IT LOOK LIKE? — This is a scaly-fleshed, bird-like creature. It has no feathers. The scales and flesh on its head, body, and legs have a rosy, golden hue. The creeper is the size of a sparrow.

WHERE DOES IT LIVE? — It lives near rocky stream bottoms, along muddy banks, and in areas of calm, deep pools for diving. This creature is mainly a wader, but it can submerge for up to three minutes in search of food. It is a non-migratory bird that lives in the southern part of the United States where the climate is mild all year long.

WHAT DOES IT EAT? — It feeds on insects, worms, animal carcasses, and discarded human food.

WHO EATS IT? — The creeper can be attacked by snakes and raccoons. It uses its long, pointed beak in defense against predators, goring them and then feeding on their carcasses. It shares the carcasses with other water and land animals, using the carcasses as bait to prey upon any insect, small creature, or fish that looks delectable.

WHAT ARE ITS ADAPTATIONS? —

1. It has a long bill for finding food in cracks and crevices of rocks and in mud. The creeper also uses its bill for snatching curious insects out of the air and small fish that may get too close.
2. Double crested, it has two colorful (red with yellow spots) bony ridges on top of its head. In and out of water, it has the look of a small blossom, helping to attract insects.
3. Its eyes have top and bottom lids for protection from darting prey and sun.
4. The coiled tail twists for propulsion under water.
5. Its webbed feet are for balance and propulsion through water.
6. Webbed, bat-like wings allow for low, short distance flight and underwater movement.

Activity 2
Water, Water Everywhere

OBJECTIVES: Explain why water is a limited resource. Name at least three ways you can conserve water in your daily life. Recite some simple statistics regarding water consumption in a typical household.

MATERIALS: Drinking glass with water, eye dropper, five gallons of water, five-gallon aquarium or clear plastic container, four jars of equal size (at least 2 ½ cups), map of the world, measuring cup, paper, salt, tape.

SUBJECTS: Language arts, math, science, social studies.

SKILLS: Application, computation, discussion, observation, research.

METHOD: There is a limited amount of usable water in the world. Therefore, it is important for people to conserve water in their daily lives. This activity demonstrates that our water resources are limited, shows how much water can be wasted by a typical family, and presents ways students and their families can save water. This is a two-part activity, consisting of a class discussion followed by a demonstration.

DISCUSSION:

1. Begin activity with a discussion of the ways we use water each day, including how we use water to make the foods we eat.

2. Ask: "How many of you think there is a lot of water in the world? How many of you think there is not a lot of water in the world?" Explain: "You are all correct. There is a lot of water in the world, however there is not a lot of water we can actually use."

3. Display a world map. Have students read names of oceans from the world map. Ask: "Are our oceans salt water or fresh water?" Point out that there is a lot more salt water than fresh water in the world. Ask students to locate *icecaps* and *glaciers*.

4. Is salt water available to us to drink? Place a tablespoon of salt in a cup of water and have a student take a sip. Explain that if we drink too much salt water we lose water in our body. Salts draw water from body tissues, preventing the body from functioning normally.

5. Explain that fresh water is our main source of water for household uses and for drinking.

Water Use Chart

- Brushing teeth — 5 gallons per minute (running water)
- Dripping faucet — 10 to 20 gallons per day
- Flushing the toilet — 5 to 7 gallons per flush
- Taking a bath — 30 to 40 gallons
- Taking a shower — 5 to 7 gallons per minute
- Using a dishwasher — 15 to 25 gallons per load
- Washing a car — 30 to 40 gallons
- Washing laundry — 20 to 40 gallons per loa
- Watering the lawn — 5 to 10 gallons per minute

DEMONSTRATION:

1. Fill an aquarium with five gallons of water. Tell students this will represent the total amount of water in our *ecosystem*. Label this container "total water on the Earth."

2. Remove 2 ¼ cups of water from the large container. Tell students this represents the total supply of fresh water in the system. Put this into one of the jars next to the aquarium. Label this jar "total fresh water on Earth." The remaining water in the aquarium represents salt water.

3. Ask students to define/describe a glacier. Ask the students to predict the amount of fresh water locked up in glaciers on our planet. Take 1 ½ cups from the "total fresh water" jar. Put this in another jar and label "fresh water in polar icecaps and glaciers." Advise the class that this water is not available for use.

4. Discuss briefly that the *atmosphere* also contains moisture, which we can sometimes see in the form of clouds and which can fall to earth as rain, snow, etc. Ask students to describe what happens to rain after it reaches the ground. Remind students that water runs into streams, lakes, ponds, and oceans; is used by plants and animals; and evaporates back into the atmosphere. Be sure to discuss the fact that some water falls onto soil and soaks in to become *groundwater*. Ask students to predict how much of the remaining fresh water is atmospheric or groundwater. Take ¼ cup from the "total fresh water" jar. Put this in a jar and label "atmospheric and ground water." Discuss why most of this fresh water is not available for use — because it is in the clouds or under a thick rock layer.

5. There should be ½ cup water remaining in the "total fresh water" jar. Take five drops out with an eyedropper. These five drops represent the amount of fresh water available to humans. The ½ cup, less five drops, represents surface and groundwater that is either technologically or economically unfeasible to make available for human use — including polluted water. Put the five drops in a jar and label "fresh water available to humans." You may wish to place a few drops of food coloring in this jar so that students can see it easier. Relabel the "total fresh water" jar "polluted or too costly to use."

6. Conclude this activity by discussing how we can ensure that this limited amount of fresh water is not polluted or lost in some way. What are some ways to conserve water?

EXTENDING THE EXPERIENCE: Reproduce the water use chart in a larger format. Have students keep track for one week of how much water they use. Multiply this by the number of people in the family. Add the amount of water used for watering the lawn and garden, washing the car, etc. How could some of this water be conserved?

Activity 3
Water Words

OBJECTIVES: Describe the water cycle. Describe one feeling they have about water.

MATERIALS: Bulletin board, crayons, Discovery Activity Pages #1 and #2, paint brushes, magazines, paper, pencils, scissors, watercolors.

SUBJECTS: Art, language arts, science.

SKILLS: Analysis, discussion, listing, mapping, research, writing.

METHOD:

1. Ask students to cut photographs from magazines showing water. Display these on a classroom bulletin board.

2. Ask students to list words connected to water, including ways they feel about the water in the photographs and its importance to plants and animals.

3. Pass out copies of the two activity pages. Referring to the list at the end of this activity, write the word search vocabulary on the board. Introduce the words and use some of them to describe the water cycle. Have the students try to use these words in sentences. Have students complete the word search.

4. Brainstorm adjectives for water, actions for water, words that describe feelings about water, and synonyms for water.

5. Have students write short poems to describe their feelings about water or have them paint a water scene. One possible poetic form to use is this version of a cinquain. This is a five-line poem that contains the following format: The first line consists of one word, the subject of the poem. The second line consists of two words, adjectives describing the subject. The third line contains three words which express the subject's action (past, present, or future). On the fourth line the author writes four words describing his/her feelings about the subject. The final line is a synonym for the subject.

EXAMPLE:

Ocean
Gray, rough
Smashing, crashing, roaring
I'm half afraid, you
Sea

After the cinquains are complete, they can be shared by reading them aloud or displaying them with art.

EXTENDING THE EXPERIENCE: Research where your water comes from. Does your water come from a well or from a central delivery system? Visit your local water treatment plant and learn step-by-step how water gets to your area. Using a map of your local water system trace the water to its source.

Word search vocabulary

atmosphere
bighorn
cactus
cloud
condensation
conservation
creosote
cycle
desert
drink
drip
evaporation
fish
groundwater
lake
mesquite
oasis
palm
precipitation
rain
riparian
river
spring
transpiration
water
willow

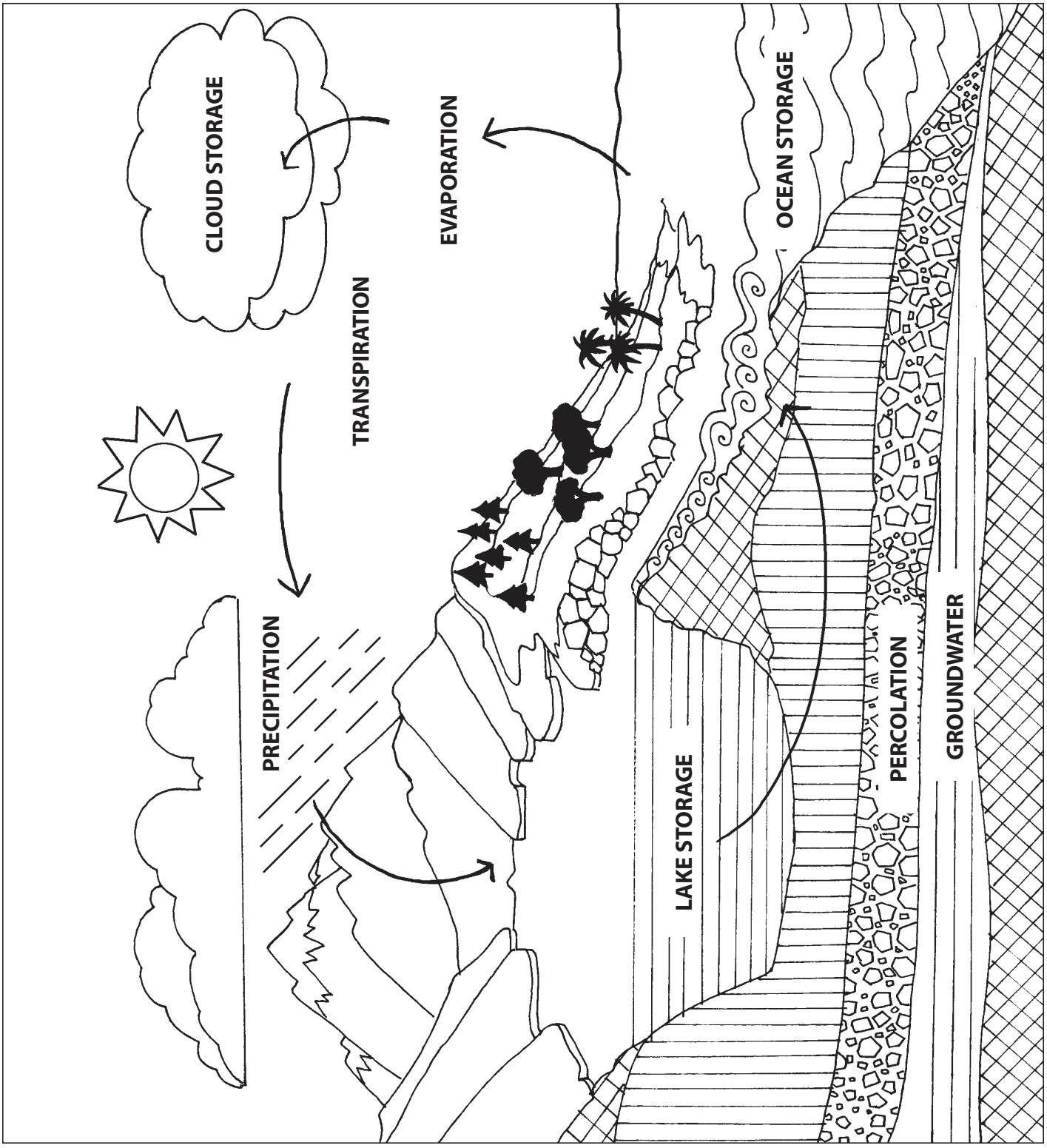
Discovery Activity Page #1

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

Discovery Activity Page #2

The Water Cycle

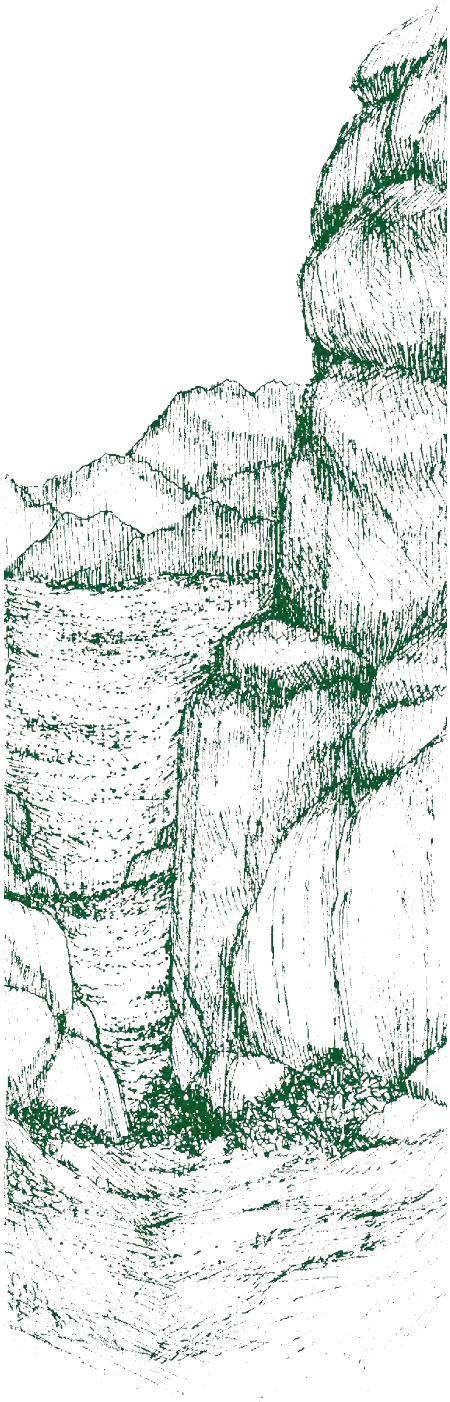
All the water that exists on the Earth today was created billions of years ago. The amount remains exactly the same. Water changes form from solid to liquid to gas (vapor), but it can never be destroyed. As water changes form it travels through a never ending cycle — from rainfall to rivers, lakes, and oceans, then stored as groundwater or returned to the atmosphere by evaporation or transpiration. This cycle connects the world's water as one body, but only 1% of it is available as fresh water for humans to use. We must be careful to protect the quality of this water as it can become contaminated easily. All life depends upon water in order to survive.



GEOLOGY

Far from being static, the geology of Earth is dynamic, in constant motion and change. The crust is a puzzle made up of *tectonic plates*, shifting against one another over a molten layer of *magma*. During the changing relationship of the plates, Earth's crust has undergone compression and stretching, creating vast breaks in the surface known as *faults*. Periods of mountain building uplifted the great mountain chains of the world. Since the Precambrian Era, the Mojave Desert has experienced many different phases over almost incomprehensible time periods.

(See the Fun Facts chart in this unit)



GEOLOGY

All three families of rock are evident in the Mojave Desert — *igneous*, *sedimentary*, and *metamorphic*. The earliest rock, related to the metamorphic *gneiss* and *schist* at the bottom of the Grand Canyon, has little exposure in the Mojave, but can be seen at Saddle Island in Lake Mead National Recreation Area (NRA) and parts of Death Valley National Park (NP). Changed from pre-existing rock by immense temperature and/or pressure (without melting), this metamorphic rock is ancient — from the Precambrian Era, formed about 1.6 to 1.8 billion years ago.

Once Upon A Time

It is hard to imagine that during the Paleozoic Era (570 – 225 million years ago) much of the American Southwest was covered by shallow seas. However, fossil impressions of marine creatures in limestone and dolomite reveal the ancient beginnings of many sedimentary rocks. Throughout this period, fluctuating seas deposited thousands of feet of sediment, then retreated, exposing these layers to erosion. Different layers of marine deposits can be seen in banded mountains throughout the desert.

During the Mesozoic Era (225 – 65 million years ago) mountains were uplifted, revealing the Paleozoic layers. Evaporating bodies of water left behind salt (halite), calcium (gypsum), and many other evaporates that have been mined by humans for hundreds of years for industrial and domestic use. Rivers and transient streams carried great amounts of eroded material into the lowlands.

The climate became even more arid than it is today, expanding great belts of sand dunes. Jurassic winds carried the sand, creating the *cross-bedding patterns* still evident in the Aztec sandstone found in Red Rock Canyon National Conservation Area (NCA), Valley of Fire State Park, and Lake Mead NRA. It continues into Arizona and Utah where it is called Navajo sandstone. Red, beige, and even white, this sandstone has a propensity for fanciful erosion by wind and water. Spectacular arches can be formed. Beehives, goblins, and castles appear to the human imagination in other rock formations.

The beginning of the Cenozoic Era (65 million years ago – present) heralded another tectonically active period. Several different types of faulting deformed the layers of sediment and the metamorphic rock beneath. Normal faults produced vertical lifting and dropping, while strike-slip faults shifted blocks laterally. Thrust faults folded older layers over younger deposits, producing miles of horizontal displacement. This topsy-turvy construction can be seen at the Keystone Thrust Fault at Red Rock Canyon NCA and in the Muddy Mountains of Lake Mead NRA.

Magma On The Move

Along with the faulting, volcanic activity increased across the landscape. Igneous rock is derived from molten layers of magma beneath the Earth's crust. Under great pressure, the magma rises towards the surface through weak points such as faults.

If the molten rock solidifies before reaching the surface, it is intrusive, forming *tabular sills*, *dikes*, and large bodies called *plutons*. These rocks are large-grained from slow cooling. Erosion of less resistant surface rock exposes the plutonic formations. Plutonic rock can be seen all over the Mojave Desert, and Joshua Tree National Park has especially fantastic examples.

Extrusive igneous rock is magma that reaches the surface, in the form of lava and explosive material. Ash, cinder, *lapilli*, and *volcanic bombs* are violently expelled by volcanoes and vents when lava is very thick and filled with gas. *Cinder cones*, *calderas*, and *stratovolcanoes* are formed in this way. *Shield volcanoes* are formed by less viscous lava. Extrusive igneous rock is usually fine-grained from cooling quickly on the surface.

The most recent period of volcanic activity in the Mojave Desert occurred only three thousand years ago and was centered at the Ubehebe Crater in Death Valley NP. The hot springs in Black Canyon at Lake Mead NRA and the cinder cones and lava flows found in the Mojave National Preserve (NPres) are reminders of this active period.

Shake, Rattle, And Roll

For Mojave Desert residents earthquakes are active reminders of the Earth's dynamic nature. An earthquake is a shaking of the Earth caused by the release of energy as rock suddenly breaks or shifts under stress. Although earthquakes can happen anywhere, most occur along tectonic plate margins and are associated with faults.

The Mojave Desert lies near the boundary between the Pacific and North American plates. As these plates slide past each other stress is created, forcing rocks to break along faults. A magnitude 7.6 earthquake, centered in the western Mojave Desert, rattled a wide area on June 28, 1992. It was the largest to strike California in forty years and was also the world's largest earthquake for 1992. Aftershocks from this quake were felt for many years.

Whittling The Earth

In this arid region of little precipitation and sparse vegetation, *erosion* is a major process shaping the desert. Water can seep into the smallest crack and percolate between grains of stone. Acids, minerals, and gases are carried in solution to react with the rock, causing chemical alterations such as *oxidation* of iron and manganese which produces many hues of red and purple.

The rain that does come is often in torrential thunderstorms that carry large amounts of debris through washes, forming *alluvial fans* below the mountains and filling in the desert basins. Wind also distributes material, molding sand dunes, such as those found at the Kelso Dunes in the Mojave NP, and abrading landforms into sculptural shapes, like the arches at Valley of Fire. Gravity continually draws material downward, forming aprons of *talus* debris along the skirts of the mountains.

Erosion is not always a natural process. Human activities, such as overgrazing, deforestation, construction, and water diversion, are recorded on the land. Bicycles, off-road vehicles, and indiscriminate blazing of new trails destroy the protective layer of *desert pavement* and promote erosion of fragile desert soils. Removal of even seemingly unimportant rocks spoils the experience for others and is illegal in National Park Service areas.

The fascinating rock formations of the Mojave Desert are inviting, but be careful when climbing. Many people are injured or killed in climbing accidents every year. Explore and enjoy the desert safely and sanely.

GLOSSARY

alluvial fan — a fan-shaped deposit formed where streams issue from the mountains onto the lowlands.

caldera — a large depression typically caused by collapse or ejection of the summit area of a volcano.

cinder cone — a small volcano built primarily of rock fragments ejected from a single vent.

cross-bedding pattern — layers inclined at a steep angle to the horizontal, characteristic of sand dunes and river deltas.

desert pavement — a surface of pebbles and cobbles exposed by winds and sheet wash that protects the finer material beneath, a desert crust.

dike — a long, narrow, cross-cutting mass of *igneous rock* intruded a fissure in older rock. Dikes are often oriented vertically.

erosion — processes that fragment, dissolve, and remove rock and related material: wind, water, gravity.

fault — a fracture or fracture zone in Earth's crust along which there has been movement of the sides relative to one another.

gneiss — a *metamorphic rock* where intense pressures and temperatures have caused minerals to segregate giving the rock a banded appearance.

hoodoo — a pillar of rock left by *erosion*.

igneous rock — a rock formed by the crystallization of molten *magma*.

lapilli — small, stony particles ejected from a volcano.

lava — molten rock that makes it to Earth's surface.

magma — naturally occurring molten rock containing water and gases, found beneath Earth's crust.

Maar volcano — volcano formed by a steam explosion caused when groudwater meets magma

metamorphic rock — a rock changed by great temperature, pressure, stress, and/or chemical changes, usually at depth in the crust, from pre-existing rocks (either *igneous* or *sedimentary*).

oxidation — the process of combining chemically with oxygen, producing an oxide.

pluton — a structure resulting from the crystallization of *magma* beneath Earth's surface.

schist — a *metamorphic rock* that readily splits into parallel layers and has a platy or scaly appearance.

sedimentary rock — a rock formed of sediments deposited by wind, water (conglomerates, sandstone, shale), or precipitation (limestone, gypsum, salt).

shield volcano — a broad, gently sloping volcano built from fluid lavas.

stratovolcano — a volcano with steep sides, built up by different layers of explosive cinder and ash, with occasional lava flows.

tabular sill — an *igneous* body intruded parallel to the layering of pre-existing rock. Most sills are horizontal.

talus — an accumulation of rock debris, usually at the base of a cliff.

tectonic plate — one of the geological structures making up Earth's crust. Related to the deformation of the crust by faulting and folding.

volcanic bomb — a streamlined rock fragment ejected from a volcano while molten.

Activity 1

Deep Time

OBJECTIVE: Demonstrate the relative distance of events in time.

MATERIALS: Adding machine paper tape (at least forty feet), crayons, Span of Time chart on page 5.

SUBJECTS: Art, math, science.

SKILLS: Application, computation, drawing.

METHOD:

1. Find a space about forty feet in length.

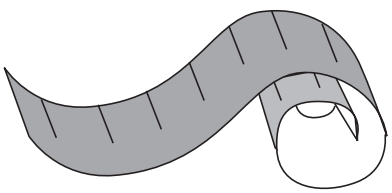
2. Assign one person to represent the beginning of the Earth and have them pull out the paper tape. Lay the tape on the ground.

3. Assign each person an event on the Span of Time chart and have them pace out the distance to their assigned event.

4. Starting with the beginning of the Earth, have each student call out their event and how long ago it occurred.

5. Have students draw a picture to represent their assigned event at the length of tape that represents that date in time. *(Note that modern events have occurred in such a tiny part of recent history compared with the rest of time that it would be difficult to include all the events on this tape.)*

EXTENDING THE EXPERIENCE: Try a larger format outside, using twine instead of tape. Using the same format, make a time line for human history.



Activity 2

Dunes And Hoodoos

OBJECTIVES: List different ways rock can be eroded. Describe the *erosion* that occurs from these processes.

MATERIALS: Blow dryer, empty ice tray, flat plate, rain or a sprinkler, sand, small block the same height as the tray, three quarters.

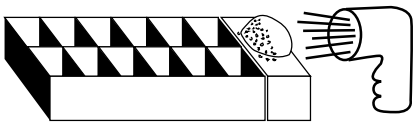
SUBJECTS: Art, language arts, science.

SKILLS: Analysis, comparing, description, evaluation, predicting, oral and written communication.

METHOD: Students can predict what they think will happen in each experiment. They can write and draw what happens after each experiment and compare the results to their predictions.

WIND:

1. At the end of an empty ice tray, place a block that is the same height as the tray.



2. Mound approximately ½ cup of sand on the block.

3. Use a blow dryer to blow the sand across the ice tray.

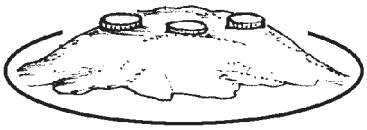
4. Note the shape the pile takes as the sand blows away.

5. Note the different sizes of sand grains in the tray. What size made it the farthest?

WHAT HAPPENED AND WHY?
Wind transports and deposits sand. Because of their lighter weight, small grains will go the farthest. The different shapes that sand dunes take depend on the speed and direction of the wind. A cresent with its horns pointing downwind is a barchan dune, common in all deserts.

WATER:

1. Make a mound of sand (two inches deep in the center) on a flat plate.

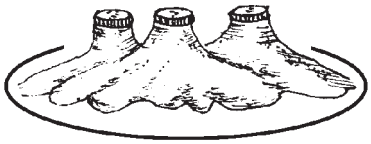


2. Place three quarters on top, about one inch apart.

3. Place out in the rain or make your own with a sprinkler from above.

4. Note what happens to the sand.

WHAT HAPPENED AND WHY?



The quarters act like very hard rocks on less resistant stone. A cap rock protects the layers beneath from erosion so that *hoodoos*, pinnacles, and other strange shapes are made.

EXTENDING THE EXPERIENCE: Ask students to look for evidence of erosion in their neighborhoods. It can involve an entire mountain or just a square inch.

THE SPAN OF TIME

(INDOOR) LENGTH FROM PRESENT	(OUTDOOR) LENGTH FROM PRESENT	YEARS AGO	EVENTS
38 feet	254 yards	4.57 billion	Earth begins
29 feet	194 yards	3.5 billion	Life on Earth begins
25 feet are abundant	167 yards	3 billion	First fossils form; algae, fungi, and bacteria
4.5 feet	31 yards	550 million	Jellyfish, sponges, and worms are abundant
3.75 feet	25 yards	450 million	First primitive fish
40 inches	22 yards	400 million	Earliest land plants (ferns and mosses)
35 inches	19 yards	350 million	Earliest land animals (amphibians)
31 inches	17 yards	310 million	First reptiles
27 inches	15 yards	270 million	Reptiles abundant and well developed
24.5 inches	14 yards	245 million	Age of Dinosaurs begins
18 inches	10 yards	180 million	Flowering plants develop
16 inches	9 yards	160 million	Birds evolve; dinosaurs abound
7 inches	4 yards	70 million	Modern birds develop
6 inches	11 feet	65 million	Dinosaurs extinct; Age of Mammals begins
5 inches	8 feet	50 million	Mammals and birds abundant
4 inches	7 feet	40 million	First elephants
.5 inches	10 inches	5 million	First humans
.15 inches	3 inches	1.5 million	Beginning of Pleistocene and Ice ages
.001 inch	.02 inch	10,000	End of the most recent Ice Age
.0002 inch	.004 inch	1,915*	Mt. Vesuvius erupts in Pompeii
.0001 inch	.0015 inch	779*	Magna Carta signed in 1215
.00002 inch	.0004 inch	218*	Declaration of Independence signed in 1776

Indoor Scale: .1 inch = 1 million years
Outdoor Scale: 2 inches = 1 million years

* Years ago calculated from 1994

Activity 3

Mystery Minerals

OBJECTIVES: List four tests used in geology to identify rocks and minerals. Identify limestone by using a test.

MATERIALS: Magnifying glasses, pennies, rock and mineral samples (limestone, dolomite, graphite, hematite, pyrite, gypsum, quartz, etc.), steel files or scissors, unglazed white porcelain tiles, vinegar.

SUBJECTS: Language arts, science.

SKILLS: Analysis, classification, comparison, computation, observation, writing.

METHOD:

1. Have students keep a log, recording results and observations. For each sample, perform these tests:

Test One: Observe the color of the mystery sample. Color is important in identification.

Test Two: Observe how the sample reflects light. This is called its luster. Is it dull, metallic, resinous, glassy, pearly, silky, or diamond-like?

Test Three: Add a few drops of vinegar to the sample. Observe through a magnifying glass. Does it fizz? If it does, it is a carbonate rock such as limestone or dolomite. The acidic vinegar is reacting with the rock to produce carbon dioxide gas.

Test Four: Streak the rock on a tile. What color is the streak mark? Is it the same as the rock? Example: pyrite is a brassy yellow, but its streak is greenish black.

Test Five: Try to scratch the surface of the rock with your fingernail, a penny, and a steel file or scissors. This demonstrates the relative hardness for each sample. Compare with the scale below. The Mohs scale of hardness runs from 1 (softest) to 10 (hardest):

1	TALC
2	GYPSUM
2.5	FINGERNAIL
3	CALCITE
3.5	PENNY
4	FLUORITE
5	APATITE
6	FELDSPAR
6.5	STEEL FILE OR SCISSORS
7	QUARTZ
8	TOPAZ
9	CORUNDUM
10	DIAMOND

2. Have students tabulate their results and compare the different samples. Although they might not be able to identify each sample exactly, these tests help classify various rocks.

EXTENDING THE EXPERIENCE: Have students compare their results with those in a geology text.

Activity 4

Oxidation

OBJECTIVES: Describe the changes of a metal during *oxidation*. List what chemicals can speed up oxidation.

MATERIALS: Four iron or steel nails, four shallow dishes, distilled water, salt, vinegar, (optional: four pennies).

SUBJECTS: Art, language arts, science.

SKILLS: Analysis, application, comparison, drawing, evaluation, observation, prediction, writing.

METHOD:

1. Place an iron or steel nail in each of four shallow dishes. Students can predict what they think is going to happen to each nail.

2. Pour two tablespoons of distilled water each over three of the nails. Leave the fourth one dry.

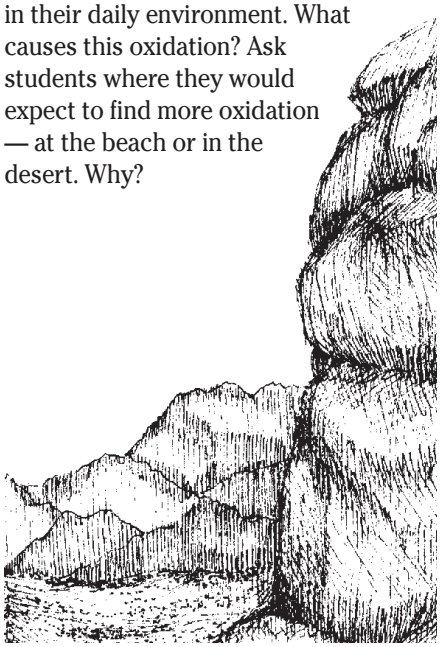
3. Sprinkle a tablespoon of salt each over two of the wet nails.

4. Pour a tablespoon of vinegar over one of the salty, wet nails.

5. Have students keep a log predicting what they think will happen to each nail. Record observations in writings and drawings. Observe and compare the nails every day for a week. Optional: Repeat 1-5, but use pennies instead of nails.

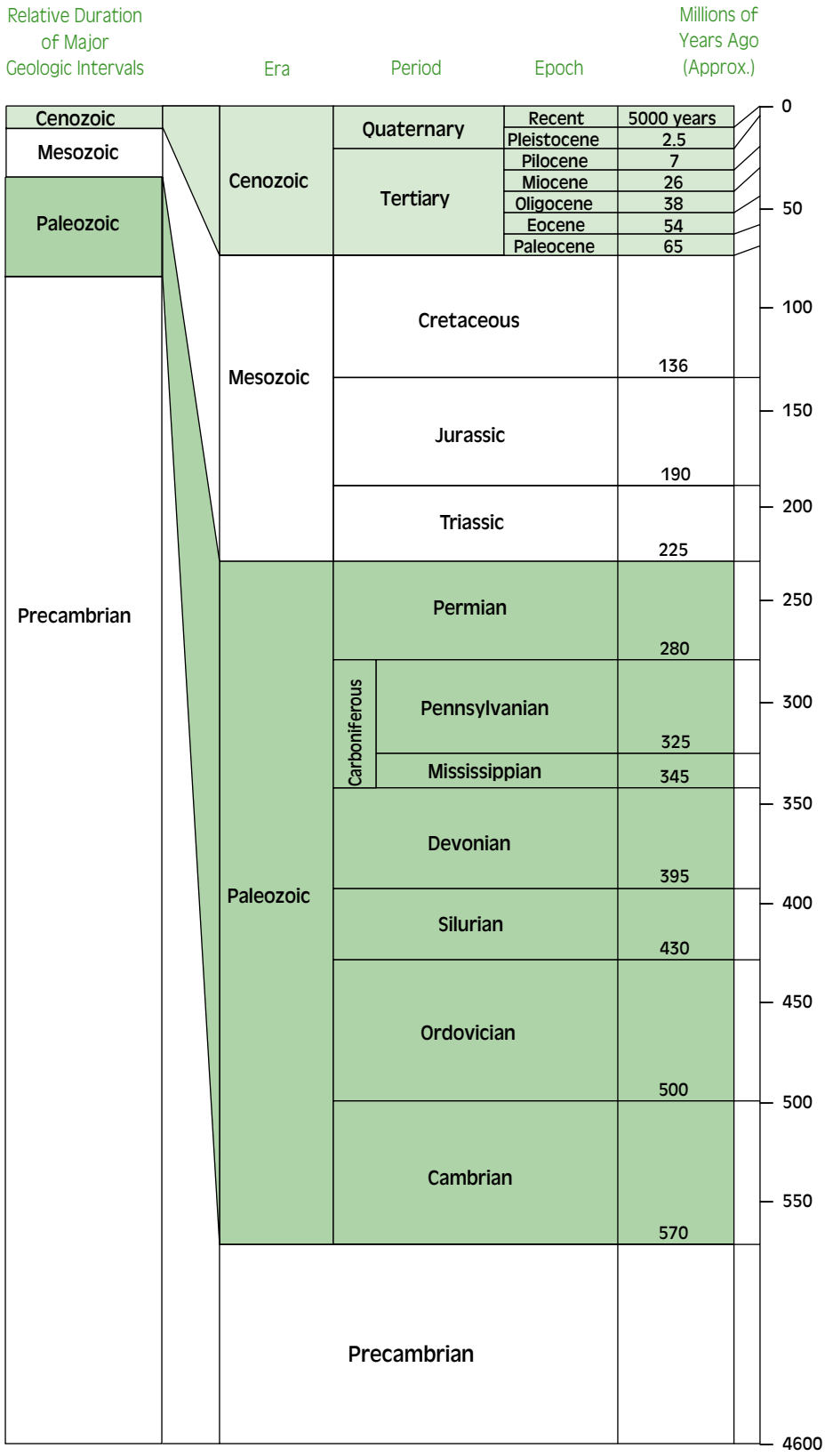
WHAT HAPPENED AND WHY? When left in contact with the air, metals can bind with oxygen. Oxidation, or rusting, creates the many bright colors that can be seen in desert rocks and soils. Salts, water, and acids help speed up the process. Oxygen combines with iron to form a reddish-brown iron oxide called hematite or, in more extreme cases, a yellowish-colored rust called limonite. The salt will react with copper to produce copper chloride.

EXTENDING THE EXPERIENCE: Have students look for examples of oxidation in their daily environment. What causes this oxidation? Ask students where they would expect to find more oxidation — at the beach or in the desert. Why?



Fun Facts — THE GEOLOGIC CALENDAR

Absolute dates were added quite recently, long after the calendar had been established using relative dating techniques. The Precambrian accounts for more than eighty-five percent of geologic time.



PLANTS

Many people think of the desert as vast expanses of sand dunes without many plants. Yet, the desert actually has an impressive diversity of plants. For example, Lake Mead National Recreation Area has over eight hundred different kinds, some of which are found nowhere else in the world.

PLANTS

Harsh desert conditions, such as high temperatures, scarcity of water, constant winds, and lack of soil nutrients, make it difficult for many plants to exist. Plants have an additional problem in that they cannot retreat or escape from the sun as animals can. They have adapted to these problems in a variety of ways and with amazing success.

Desert plants can be divided according to how they meet the conditions of surviving high temperatures and uncertain precipitation: drought escapers, drought evaders, and drought resisters.

Here Today, Gone Tomorrow

The drought escapers are also known as *ephemerals*. They are abundant and showy *annuals*. These are especially noticeable during the spring wildflower season. Water is not a problem for these plants, as the seeds do not germinate if there has not been adequate rainfall. The seeds lie dormant until specific conditions are met. The seed coats contain a germination inhibitor that dissolves with adequate rainfall and specific temperatures.

Life for these plants is brief. The growing season is short. Taking advantage of the two rainy seasons (summer storms and winter showers), they grow quickly, flower, and produce seeds for a new generation. These lie dormant in soil the rest of the year escaping heat and drought. When the seeds have been produced, the plant withers and dies. The seeds fall to the ground, then are carried by wind, rain, or animals. They may wait years for the right conditions to germinate.

Looks Can Be Deceiving

The drought evaders are *perennial* plants that live for many years. They face high temperatures and drought by maintaining life only. They flower in the spring then shed their leaves when summer temperatures arrive. The plants enter a state of dormancy until conditions improve. These plants may look dead much of the year. The ocotillo is a good example.

Spines Are Fine

The drought resisters include a variety of shrubs and other woody or fibrous plants. They can take the worst the desert has to offer. *Cacti* store moisture in their spongy stems or root tissues during periods of rain, then use it sparingly during times of drought. Leaves have been reduced to *spines* and the green cortex (stem) functions as the leaves, carrying out the process of *photosynthesis*. Other plants, such as the catclaw acacia and the mesquite, have deep and widespread root systems to capture all available moisture.

Many drought resisters, such as the creosote bush, have tiny leaves and/or coat their leaves with a waxy, resinous substance to reduce moisture loss. Fine, grey, downy hairs on leaves and stems of plants, such as the brittlebush, reflect the sun's rays. These hairs also function

like the spines on cacti to provide shade. Drought resisters survive throughout the year and grow as conditions allow.

Exotic Aliens

Some plants found in the desert today, such as tamarisk (salt cedar) and tumbleweed (Russian thistle), do not belong there. They were introduced from other countries and are called exotic, alien, or non-native *species*. The tamarisk was planted as a shade tree and to control wind and erosion. It came originally from the Mediterranean area and can tolerate salty soils. It grows well in sandy, moist soils and has invaded riverbanks and natural springs, competing with *native species* for precious water sources.

Activity 1
Join The Club

OBJECTIVE: Identify three common plants of the Mojave Desert. List three adaptations plants have developed in order to survive in the desert.

MATERIALS: Clipboards, map of the United States, paper, pencils, props: canteen, several white shirts, several wide-brimmed hats or sun-visors, suntan lotion.

SUBJECTS: Art, science.

SKILLS: Comparison, drawing, observation, public speaking, small group work.

METHOD:

1. Find an outside area near your school that has several different kinds of desert plants. This could also be done on a field trip to a wild desert area.

2. Discuss with students briefly what a desert is. (A region that is hot, dry, windy, has rocky soils, etc.) Display a map of the United States, and show students where the Mojave Desert is located. Ask them if they live in the desert? What would they need to take if they were going to walk through the desert for a day. This would include light-colored clothing with long sleeves and long pants to protect them from the sun and cacti. Other items would be suntan lotion, sunglasses, water, and lunch. Discuss other ideas the children may have.

We can leave the desert when the day is over. When it's hot we go to our air-conditioned homes. Plants can't leave, so they have developed survival tools. Did you know that plants make their own shade? Plants make their own suntan lotion. Plants can store water and reflect the sun's heat.

3. Divide students into four groups. Give each group a clipboard, paper, and a pencil. Assign a "secretary" for each group.

4. Distribute one prop (see list of materials) to each group that represents a particular adaptation. Students will search to find members of their "club."

Suntan Lotion Lovers — Many plants limit what moisture they can lose through evaporation by covering their leaves or pads with a waxy coating. This works much the same as suntan lotion in protecting us from "drying out" in the sun. Desert plants also have very small or no leaves (may have spines instead) in order to reduce surfaces exposed to the sun. Give students in this group a bottle of suntan lotion.

GLOSSARY

adaptation — special tool for survival, physical or behavioral characteristic that makes an organism more suited to its environment.

annual — a plant which completes its life cycle from seedling to mature plant in a single growing season and then dies.

cactus — a plant with fleshy stems and branches and with scales or spines instead of leaves.

community — the plants, animals, and other living things that live in an area and are dependent upon one another.

ephemeral — lasting a very short time, short-lived.

exotic species — non-native, something that did not exist in the area before humans brought it from another place.

mortar — a bowl-shaped receptacle in which substances are pounded to a powder or paste.

mucilaginous — pertaining to or secreting any of various gummy or gelatinous substances.

native species — a plant or animal that evolved or was transported to the area through natural means.

perennial — a plant which persists in whole or in part from year to year and flowers in more than one year.

photosynthesis — the process by which green plants convert carbon dioxide and water into simple sugar. Chlorophyll and sunlight are essential to the series of complex chemical reactions involved.

species — a genetically and adaptively unique plant or animal able to reproduce itself and to evolve.

spine — a pointed, more or less rigid, deep-seated emergence from a plant. A spine is a modified leaf. A thorn differs in having vascular tissue, like a branch.

wash — the bed of an intermittent stream.

PLANTS

White Shirt Specials — Since light colors work to reflect the sun's rays, some plants "wear" light colors to keep cool and, in doing so, retain more moisture. Many desert plants have white leaves or hairy surfaces that work just as a white shirt to reflect the sun's rays. Give students in this group white shirts to wear.

Make-Your-Own-Shade Club — If a plant can be kept cool, it will lose less water through evaporation. Many plants are able to keep themselves somewhat cooler than the surrounding air temperature by "making their own shade." Spines on *cacti* and leaves on trees create shade for those plants. Large plants are able to shade the ground over their root system, which allows for more moisture to be held within the ground and to be used by the roots. Give children in this group sun-visors or hats to wear.

Canteen Kids — Some plants are able to store large amounts of water in their thick leaves or stems. Members of this group are called succulents. Cacti are a good example of this group. After water is taken up by the roots (which are generally short in order to quickly absorb surface water after a shower), it is then chemically changed by the cactus into a *mucilaginous* substance. It does not evaporate as quickly as the watery sap found in large-leafed plants. This moisture is stored in the stem. Give this group a canteen.

5. Ask the students to search for the next fifteen or twenty minutes. Use clipboards and pencils to record findings. Students can draw a simple sketch of the plant. Each group should try to find at least six members of their "club."

6. Gather the groups together and go on a "tour" to look at the best example from each group. (Have the students choose this plant.) Discuss ways we need that plant — for food, water, medicine, shelter, oxygen, etc. Also include ways animals need that plant — food, shelter, moisture.

7. Ask students ways they can help protect plants — not littering, not picking, not stepping on or driving over. Consider creating a desert garden on the school grounds. Sometimes desert plants can be obtained from areas that are planned for development with permission from the landowner.

EXTENDING THE EXPERIENCE:
Ask each student to choose a plant that they think is interesting and do a research project to find out more about it. Topics to research might include ways that plant survives in the desert; what particular *community* it lives in (desert *wash*, cliff, spring); human uses of it for food, medicine, clothing, etc.; and ways other animals use it. The information on plant uses following this activity can be shared with students. Display pictures of each plant with a description about it on a classroom bulletin board.

Uses Of Plants

Beavertail cactus — The young pads and fruits are still used as a food source. Pads are gathered in the spring when most tender and boiled for twenty minutes. The outer skin with all the spines is removed. Pads are cut into strips and stored in water. Fruits are used to make jam.

Brittlebush — Early Catholic priests burned the dried leaves for incense. Native Americans chewed the gum exuded from the stems and heated the gum to smear it on their bodies to relieve pain.

Creosote bush — Over thirteen different kinds of insects make this bush their home, including several species of grasshoppers and crickets that live only on this plant. Native Americans used the plant to treat a wide range of ailments from rheumatism to wounds and burns. A tea was made from the leaves to cure colds and infections. Lac, the resinous incrustation on the branches, was used by Native Americans to mend pottery and attach arrow points to shafts.

Joshua tree — Birds, lizards, packrats, and other animals use the Joshua tree for food, shelter, and nest-building materials. Native Americans used the smallest roots (red) for patterns in their baskets.

Mesquite — Native Americans used the seed pods as an important food source. The seeds were ground into flour and made into gruel or bread. The trunk was used to make mortars and furniture. The sap was used as a snack, for glue, and as an ointment for wounds.

Mojave yucca — Leaves were pounded in water to release the fiber and worked into cordage for ropes, nets, hats, and shoes. Thousand-year-old sandals made of yucca strands have been found in primitive dwellings. Seeds were ground into flour. Roots were cleaned and pounded into a soup called "amole."

Activity 2
My Favorite Plant

OBJECTIVE: Use creative expression in describing the environment.

MATERIALS: Clipboards, index cards, paper, pencils.

SUBJECTS: Art, language arts, science.

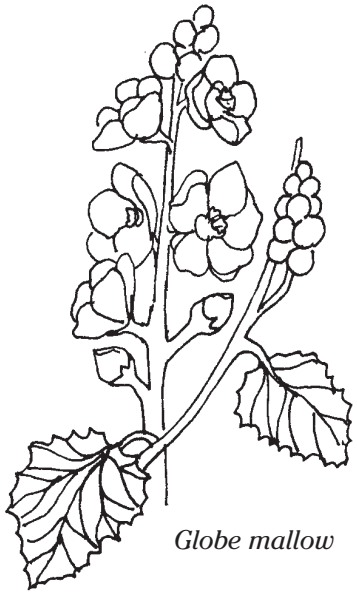
SKILLS: Description, discussion, listening, observation, public speaking, reading, writing.

METHOD:

1. Go outside to a desert area and have each student or group of two or three students sit by a plant that they think is interesting. Each student should examine the plant closely, describe it on paper, and think of a name for the plant based on its description. True names are not important. Especially note any unusual characteristics the plant may have. Look also for signs of ways animals use that plant — holes around roots, insects that live on it, etc. Have students look for ways their plant is adapted to the desert. When everyone is finished, have each student or group "introduce" their plant to the rest of the class and tell what they have discovered about it.

2. Have each student or group write a poem about their plant. A simple form to use is this version of a cinquain, a five-lined stanza. On the first line name your plant. On the second line write two descriptive words about it. On the third line write three action words about it. On the fourth line describe its relationship to the environment in four or five words. On the fifth line sum up your feelings about the plant in one word.

EXTENDING THE EXPERIENCE: Do research on each plant to find out its common and scientific names. Are either of these names based on a description of the plant? Have each group write the common and scientific names of their plant on an index card. On a second card have them write three or four descriptive sentences about their plant. Go back outside and attach the name cards to each plant. Give a description card to each group and have them try to find the matching plant. Switch cards between groups and repeat. These cards could also be used in the classroom to play a game of "concentration." Spread cards on a flat surface face down. Turn over two at a time to try to match the description with the name.



Globe mallow

Activity 3
Be A Botanist

OBJECTIVE: Identify three common plants of the Mojave Desert.

MATERIALS: Clipboards, crayons, Discovery Activity Page #1, plant field guides, slide projector, slides or pictures of desert plants.

SUBJECTS: Art, language arts, science.

SKILLS: Comparison, drawing, observation, small group work, writing.

METHOD:

1. Find slides or pictures of many of the plants listed in the Fun Facts box. Divide them according to size — belly flowers, below your knees, etc. Share the slides or pictures with your students.

2. Find an outside area near your school that has several kinds of desert plants. This could also be done on a field trip.

3. Split the class into small groups. In addition to each student having a clipboard and copy of the activity page, give each group a plant field guide. Have them look at the field guides, and explain how they can be used to identify plants.

4. Using the activity page (and the field guides, if possible), challenge the students to identify as many plants as they can. Remind them of the size categories as an aid in identification.

5. After getting the group back together, list all the plants found. Did they find plants that are not on the activity page?

6. In what size categories are most desert plants? Compare desert plant sizes with those of a different area, such as a dense forest. Are the sizes different? Why?

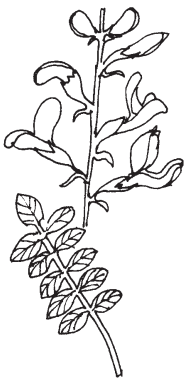
EXTENDING THE EXPERIENCE: Choose plants from the Fun Facts box to list on the board. Have each student pick a plant to draw and describe, similar to what is done in a field guide. Using the size categories in the Fun Facts box, arrange the pictures and descriptions into a plant field guide. Loan your book to other classes to help them identify desert plants near the school.

Fun Facts — SOME PLANTS OF THE MOJAVE DESERT

Note: Some of the desert plants listed below are in the drawing on the opposite page. Locations are given below.

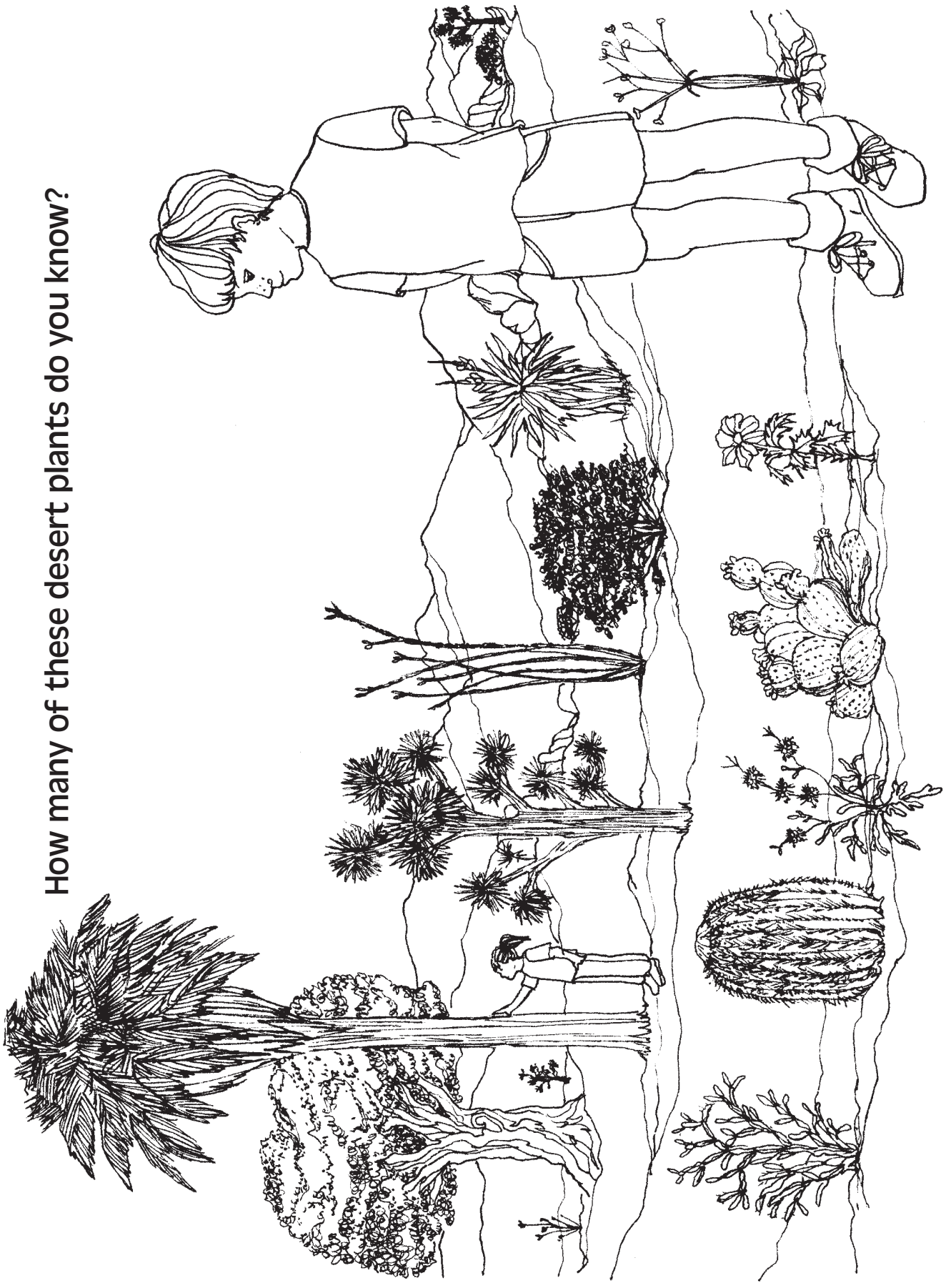
COMMON NAME	SCIENTIFIC NAME
BELLY FLOWERS	
Desert star	*Monoptilon belliodes*
Desert heron's bill (Filaree)	*Erodium texanum*
Monkeyflower	*Mimulus* spp.
Purple mat	*Nama demissum*
BELOW YOUR KNEES	
Chia *(bottom row, 3rd from left)*	*Salvia columbariae*
Desert dandelion *(bottom row, 5th from left)*	*Malacothrix californica*
Desert five-spot	*Eremalche rotundifolia*
Desert gold poppy	*Eschscholzia glyptosperma*
Desert mallow	*Sphaeralcea ambigua*
Desert paintbrush	*Castilleja angustifolia*
Forget-me-not	*Cryptantha* spp.
Gilia	*Gilia* spp.
Pincushion	*Chaenactis* spp.
Prickly poppy (Cowboy's fried egg)	*Argemone munita*
Sun cup	*Camissonia brevipes*
BELOW YOUR WAIST	
Bladderpod	*Isomeris arborea*
Brittlebush	*Encelia farinosa*
Burrobush	*Ambrosia dumosa*
Cheesebush	*Hymenoclea salsola*
Desert Trumpet *(bottom row, 6th from left)*	*Eriogonum inflatum*
Nevada ephedra (Mormon tea)	*Ephedra nevadensis*
Paper-bag bush	*Salazaria mexicana*
Rabbitbrush	*Chrysothamnus* spp.
Sweetbush (Chuckwalla's delight)	*Bebbia juncea*

COMMON NAME	SCIENTIFIC NAME
OVER YOUR HEAD	
Blue palo verde	*Cericidium floridum*
California fan palm *(top row, 2nd from left)*	*Washingtonia filifera*
Catclaw acacia	*Acacia greggii*
Cottonwood *(top row, 1st from left)*	*Populus fremontii*
Creosote bush *(top row, 5th from left)*	*Larrea tridentata*
Desert willow	*Chilopsis linearis*
Joshua tree *(top row, 3rd from left)*	*Yucca brevifolia*
Mesquite	*Prosopis glandulosa*
Mojave yucca *(top row, 6th from left)*	*Yucca schidigera*
Ocotillo *(top row, 4th from left)*	*Fouquieria splendens*
CACTI	
Barrel *(bottom row, 2nd from left)*	*Ferocactus cylindraceus lecontei*
Beavertail *(bottom row, 4th from left)*	*Opuntia basilaris*
Fish-hook	*Mammillaria tetrancistra*
Golden cholla (Silver cholla)	*Opuntia echinocarpa*
Mohave mound	*Echinocereus triglochidiatus-*
Mojave prickly pear	*Opuntia phaeacantha*
Pencil cholla *(bottom row, 1st from left)*	*Opuntia ramosissima*
Teddy-bear cholla	*Opuntia bigelovii*



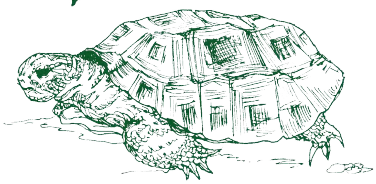
Discovery Activity Page #1

How many of these desert plants do you know?



ANIMALS

Although at first glance the desert seems to have little in the way of wildlife, it actually contains large, diverse populations. The desert environment may seem an unlikely place for animals to thrive or even exist. However, desert animals have *adapted* to their environment, and each fills an important *niche* in the desert *ecosystem*.



ANIMALS

Beating The Heat

Desert animals have developed a variety of strategies for thriving in a land of extremes. One of the most common is to be active only at night, when the desert is coolest. Animals mostly active after dark are called nocturnal. Foraging for food and water at night also allows animals to use the dark for protection from predators. Since many desert animals are nocturnal, the desert may seem empty to those of us who travel through during the day — all we see of many desert dwellers are the tracks they leave behind.

Some desert animals are active only in the early morning and at twilight. Lizards, snakes, rodents, and insects seek shelter in cool, humid burrows or shade themselves under rocks and bushes. Owls survive by being nocturnal, eagles by soaring high above the earth where temperatures are much cooler. Phainopeplas (a bird) use a different method of dealing with the summer heat; they migrate to cooler climates when it starts to warm up.

Because of their large ears, jackrabbits and mule deer have the ability to radiate heat. Blood vessels in their ears are located just under the skin, and air flowing around them cools the blood. This cooled blood circulates through the rest of the body, picking up more heat to carry to the ears for "disposal." Ants, beetles, and lizards reduce the amount of heat they absorb by straightening out their legs as they walk across the hot desert terrain.

Drinking What You Eat

No animal can survive for long without water. Wood rats get their water by eating juicy cacti and other plants that contain moisture. Snakes get the moisture they need from the mice and other small animals they eat.

Kangaroo rats and pocket mice get much of the moisture they need from their diet of dry seeds. Seeds stored in their humid burrows absorb moisture from the air. Animals utilize this moisture when the seeds are eaten. Kangaroo rats also chemically manufacture water (called metabolic water) from dry seeds as they are being digested.

Desert bighorn sheep get some of the moisture they need from what they eat, but they also have to drink water. In the desert, water is usually found in springs or rivers and occasionally in ponds and rock pools after a rain. Because these animals rely on this water, their territory is limited. They can't wander too far from reliable water sources.

Sleeping Through It

Another method used by some desert animals to avoid drought and heat is to sleep through it, just as some cold-climate animals hibernate through the winter. This dry, hot weather sleep is called estivation.

One well-known desert estivator is the spadefoot toad. Spadefoot toads can survive in underground burrows for months or even years, covered with a jelly-like substance that keeps them moist. They come out of estivation when heavy raindrops cause vibrations in the earth that wake them. They will then dig to the surface, find a mate, and lay eggs in the pools created by the rains. The toads then burrow back into the ground and estivate until it rains again. The tadpoles that hatch from the eggs must grow quickly, before the pools dry up. Only a few survive to adulthood.

Some animals estivate not only because of heat and dryness, but because of a shortage of food. Plants and other sources of food tend to die back in the hottest and driest part of the year. Some desert rodents, spiders, and snails estivate to avoid this scarcity of food.

The activities in this section have been designed to teach children about the animals of the Mojave Desert. All animals except one have developed techniques for dealing with the often harsh desert environment. Humans, instead of adapting to the environment, often try to adapt the environment to meet their needs. These activities will give students ideas of what they can do to help protect the fragile desert ecosystem and an understanding of why it is important to do so.

Activity 1

Camouflaged Critters

OBJECTIVES: List two ways animals use *camouflage* to their benefit. Describe the difficulty predators have when searching for food (camouflaged animals). Name two common Mojave Desert animals that use camouflage as an *adaptation* for survival.

MATERIALS: Flagging tape, modeling clay, pictures of camouflaged animals (especially those native to the Mojave Desert).

SUBJECTS: Art, language arts, science.

SKILLS: Application, comparison, description, invention, observation, writing.

METHOD: Students will compare pictures of insects, animals, and birds. They will observe the benefits of shape and protective coloring. They will then create a camouflaged critter.

Animals are adapted to their environment in order to survive. For instance, a horned lizard is usually the same color as the ground it lives on, a desert side-blotched lizard is colored to look like the plants it lives on, and many

snakes use their coloring as camouflage when they rest in the shade of bushes. Often, animals adapt to changes in their *habitats* by using camouflage to avoid predators. Camouflage gives the organism the ability to blend with its surroundings.

1. Introduce or review the concept of adaptation. Show students pictures of desert animals that use camouflage as an adaptation for survival. Have students brainstorm types of camouflage and the benefits of this adaptation.

2. Mark off two different areas outside with flagging tape. Make the two areas a short distance apart. Separate the class into two groups and assign each group an area.

3. Pass out a small ball of clay to each student. Instruct the students to go to their area and create camouflaged critters with their balls of clay by using fallen sticks, leaves, or bits of gravel. Instruct the students to create critters that blend with their environment. Give them about fifteen minutes to work.

4. Have group one place their critters in area one. Make sure to tell them they cannot hide the critters. They must be camouflaged in their surroundings. Give them about five minutes to place their critters. At the same time, have group two place their critters in area two. Be sure to emphasize that neither group can watch where the other group is placing its critters.

5. Ask both groups to step away from their area. Inform the students that they have magically turned into birds and must now find food. Ask them to hold one cupped hand on their stomach (to hold their food). Two fingers on their other hand become their beak. Group one will now have to find food (the camouflaged critters) in area two, group two in area one. Count to three for the food search to begin.

GLOSSARY

adapt — to fit in, to be suited for getting the things needed for survival.

adaptation — special tools for survival, physical or behavioral characteristics that make an organism more suited to its *environment*.

biological community — all of the living things, both plants and animals, living in a particular *environment*, working together to fulfill their individual needs.

camouflage — an adaptation which enables an organism to blend with its environment.

ecosystem — the interaction of the *biological community* (all living things) and the physical *environment* (water, air, minerals).

environment — all those factors, both living and non-living, which make up the surroundings of an organism.

habitat — the place where a plant or animal lives, an organism's home. Provides food, water, shelter, and space in a *suitable arrangement*.

mimicry — a form of protective coloration, or acting, in which an animal closely resembles another kind of animal or object in its *environment*. The animal being mimicked usually has toxin which causes predators to avoid it. By imitating the toxic animal, the other animal may avoid getting eaten.

niche — an organism's special function within its *environment*.

predation — the natural act of animals that kill other animals for food.

predator — any animal which hunts live animals for its food.

suitable arrangement — when those things necessary for survival (food, water, shelter, space) are accessible, adequate in quantity, and in keeping with the biological lifestyle of a species.

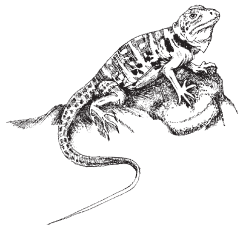
territoriality — a behavior pattern in animals consisting of the occupation and defense of a living space.

6. Call time after ten minutes and have both groups display their food in a designated area. Hold a viewing party, asking students to see if their clay critter was found.

7. Travel in a group to the undiscovered critters. Discuss with students why some critters were found and others were not. What special trait or habitat helped camouflage the critters? What animals in the Mojave Desert use camouflage as an adaptation for survival? Can you think of any other types of adaptations?

8. Remove sticks or rocks from the clay and return those items to their natural setting.

EXTENDING THE EXPERIENCE:
Students can write about the experience and what they learned about camouflage.



Activity 2
The Comforts Of Home

OBJECTIVES: Examine and list the minimum requirements for human life. Compare these requirements with those of desert animals.

MATERIALS: Crayons, paper.

SUBJECTS: Art, science, social studies.

SKILLS: Analysis, application, discussion, drawing, inference, listing, observation.

METHOD:

1. Ask students to draw pictures of their own homes. Have them think about and draw pictures of the four most important things in their homes.

2. Make a list of what the students feel are important. Differentiate between needs and wants. Challenge children to think about what is essential for survival. Make sure this includes food, water, shelter, and space. Explain that these must also be available in a *suitable arrangement*. Whenever one of these basic needs is threatened or removed the animal may not be able to survive.

3. Show students pictures of desert animals and ask them to draw one of these in its *habitat*. Make sure this drawing includes where the animal gets food, water, shelter, and space.

4. Compare the needs of humans with those of other animals.

EXTENDING THE EXPERIENCE: Have students go outside and look for animal homes. When a home (crack, burrow, nest, etc.), is found, discuss what might live there and why it chose this location. Are all of the essentials needed for survival found nearby?

Activity 3
Desert Homes Bingo

OBJECTIVES: Identify three different types of animal homes and who might live there. State two ways animal homes are inadvertently destroyed by humans.

MATERIALS: Discovery Activity Page #1, pencils or wax markers. (You may wish to consider laminating the bingo cards so they can be used several times and marked with wax pencils.)

SUBJECTS: Art, language arts, physical education, science.

SKILLS: Description, discussion, drawing, listing, observation.

METHOD: All animals need a home of some sort. This home will usually provide them with shelter and protection from predators. Different animals have different needs and, therefore, have different types of homes.

1. Ask students to describe their homes. Identify the type of animal homes found in the area (nest, burrow, hole, water, crack, etc.).

2. Give each student a bingo card and marker. Take them on a short walk through the desert. Have students find an animal home and name an animal that might live there. Place an X on the appropriate square. Play continues until everyone gets bingo.

3. Conclude with a sharing circle. Ask students to describe the most interesting and unusual homes that were found. Can they name any homes that probably exist in the area but were not found? Ask each student what his/her favorite desert animal is and where it lives? Would that animal be harmed if its home were destroyed? Where might it find a new home?

EXTENDING THE EXPERIENCE: Have students create posters or bumper stickers that support preservation of desert animals' homes. Have students choose a natural area in or near the schoolyard to adopt and improve as a *habitat* for animals. Improvement of habitat can include litter pick-up, fencing against trampling, planting native vegetation, and constructing anti-erosion devices.

Activity 4
Night Sounds

OBJECTIVES: Define the concepts of animal communication, *predation*, *territoriality*, mate-seeking, *adaptation*, and *mimicry*. Provide examples of how these physical and behavioral adaptations allow animals to survive in their environment.

MATERIALS: Blindfolds, noisemakers. (You will need a pair of identical noisemakers for each pair of students. Examples of noisemakers: shakers and maracas, film canisters containing pebbles, rubber bands that can be twanged, whistles, bells, blocks of wood that can be clapped together.)

SUBJECTS: Language arts, math, science, social studies.

SKILLS: Application, computation, discussion, evaluation, listening.

METHOD: This game is designed to demonstrate the importance of sound in such animal behaviors as communication, predation, territoriality, mate-seeking, adaptation, and mimicry.

1. Spend some time familiarizing students with the terms listed in the objectives.

2. Explain the procedures of the activity to the students.

3. Blindfold students and have them stand in two parallel lines at least forty feet apart. The students should be standing back to back, with their hands behind their backs.

4. Walk behind each line placing one noisemaker in each student's hands. For the first round, everyone gets something. Have the participants all practice making noise with their devices. Remind students they will not only be making a noise, but must listen closely for the sound of their partner.

5. The leader gives a signal to begin. The participants attempt to find their "mate" by using the noisemakers. When they find their "mate," they should halt, stop making noise, stand quietly together, and wait for the other pairs to find each other.

6. It will be easy for the last two animals to find each other, since they will be the only two making any sound! After all the "mates" have been found, take off the blindfolds, return to a circle, and discuss the activity.

POSSIBLE RESULTS:

1:1 ratio
critter finds its mate
2:1 ratio
two critters find the same mate
1:0 ratio
no mate available or mate not found

7. Are some animals able to find mates more easily than others? Why? If the concept of *predation* does not arise in the discussion, inject it briefly before playing a second round.

8. Have students face outward in the lines again to play a second round. This time, one or two persons will not get a noisemaker. They will be the *predators*. Predators can capture (touch) prey only after the prey makes noise. Play again.

9. After playing a second time, discuss some limitations that may be placed on predators. Examples include: must capture animal within three seconds after noise has been made; can only capture one or two animals per game. Play the game again.

10. After playing a third round, discuss how the new rules affected predators. What factors in nature limit a predator's success? Conclude by having students name the most important factors in the survival of animals, as presented in this game. Do skills in using senses help animals survive in their environment? How?

EXTENDING THE EXPERIENCE: Introduce the idea of predators imitating (mimicking) the noise sources in some way. This will help students to see how predators adapt, making it easier for them to capture prey. The game may then be played again. Discuss this new option (mimicry). Did it affect the game? Are predators the only living things that use mimicry? Although gopher snakes are not poisonous, they have very similar coloration to rattlesnakes, they coil up like rattlesnakes, and they have been observed whipping their tails in dry weeds, producing a rattle-like sound. Why?

Fun Facts — SOME ANIMALS OF THE MOJAVE DESERT

BIRDS

Common raven	*Corvus corax*
Gambel's quail	*Callipepla gambelii*
Greater roadrunner	*Geococcyx californianus*
Red-tailed hawk	*Buteo jamaicensis*
Turkey vulture	*Cathartes aura*

FISH

Bonytail chub	*Gila elegans*
Colorado squawfish	*Ptychocheilus lucius*
Desert pupfish	*Cyprinodon* spp.
Humpback chub	*Gila cypha*
Razorback sucker	*Xyrauchen texanus*

INSECTS AND ARACHNIDS

Broad-necked darkling beetle	*Coelocnemis californicus*
Giant desert hairy scorpion	*Hadrurus arizonensis*
Desert tarantula	*Aphonopelma chalcodes*

MAMMALS

Black-tailed jackrabbit	*Lepus californicus*
Coyote	*Canis latrans*
Desert cottontail rabbit	*Sylvilagus audubonii*
Desert kangaroo rat	*Dipodomys deserti*
Desert bighorn sheep	*Ovis canadensis nelsoni*
Desert wood rat	*Neotoma lepida*
Townsend's big-eared bat	*Plecotus townsendii*
White-tailed antelope squirrel	*Ammospermophilus leucurus*

REPTILES AND AMPHIBIANS

Desert tortoise	*Gopherus agassizii*
Red-spotted toad	*Bufo punctatus*
Collared lizard	*Crotaphytus insularis*
Chuckwalla	*Sauromalus obesus*
Rosy boa	*Lichanura trivirgata*
Sidewinder	*Crotalus cerastes*

Activity 5
Birds And Lizards

OBJECTIVES: List two ways animals use camouflage to their benefit. Describe the difficulty predators have when searching for food (camouflaged animals). Name two common Mojave Desert animals that use camouflage as an adaptation for survival.

MATERIALS: Pictures of Mojave Desert lizards and birds, such as roadrunners, loggerhead shrikes, and American kestrels; rope to designate starting line; quart-size plastic bags; pipecleaners cut into two-inch strips (two or more strips for each participant). Note: The pipecleaners need to be at least three different colors. One color should blend readily into the environment — for example, light tan for dry leaves and weeds. One color should blend a little less well, and one color should not blend at all. Tan, green, and hot pink are good choices.

SUBJECTS: Physical education, science.

SKILLS: Observation, psychomotor development.

METHOD: This is a simple game, easily adaptable to a variety of animals and environments. The game is played out-of-doors (although it can work indoors on a multi-colored carpet). It works best if played in an area with some ground vegetation as opposed to a bare surface. The game is a relay and a hunt combined into one.

Loggerhead shrikes (a bird) eat large insects, small birds, mice, and lizards. When hunting is good, it stores excess food by impaling it on thorns, cactus needles, or barbed wire. Roadrunners feed on insects, scorpions, lizards, and snakes. They usually run after their prey rather than fly. American kestrels are small hawks and include lizards in their diet.

1. Before the game begins, prepare the field by scattering pipecleaners in an area approximately fifteen feet square. Some of the pipecleaners should be easily seen, and some should hide a bit. The pipecleaners represent camouflaged and non-camouflaged lizards. Don't allow the students to observe your placing of the "lizards." With a rope or by drawing a line, designate a starting line approximately forty feet from the "lizards."

2. Share the pictures of birds and lizards with the students. These birds hunt and eat lizards (and they eat other things as well.) Discuss the physical and behavioral adaptations that each animal (lizard or bird) uses to survive. For what kind of habitat might each lizard be best suited, judging from its coloration?

3. Divide the group into two or three equal teams, each bearing the name of a lizard-eating bird. Have students line up behind the starting line. Allow plenty of space between teams. The first person in line in each team receives a plastic bag, which represents the bird's stomach.

4. Students will quickly walk, not run, from the starting line to the lizard area, pick up the first lizard they see (they may only retrieve one lizard at a time), place it in the "stomach," and quickly walk back to the starting line, where they hand the "stomach" to the next teammember. The leader goes to the back of the line. If you choose to make this a competitive game, the winning team is the one that goes through the entire line first.

5. After playing one round, have the groups examine the contents of their plastic bags. Which color lizard was "eaten" the most, the second-most, and the least? The brightly colored, non-camouflaged lizard should be the most abundant.

6. Play another round or two of the activity. The time it takes for a team to complete a round will grow longer as it becomes more difficult to hunt for the lizards. After the game is over, have students scour the area to search for lizards that still might be hiding. The students will be surprised at how many lizards they missed!

EXTENDING THE EXPERIENCE: Have students research how camouflage is used by other animals world-wide. Challenge them to find pictures of the best camouflaged and the most strangely camouflaged animals. Have them find pictures of brightly colored animals. How can they survive when they are so easily seen? Are there ever any advantages to being brightly colored?

Activity 6
Keeping Cool

OBJECTIVES: Demonstrate the concept of thermo-regulation and how exothermic (see definition in Method section) animals must work to keep their body temperature regulated. Name two strategies employed by exothermic animals for regulating body temperature. Name two common exothermic animals of the Mojave Desert.

MATERIALS: Fahrenheit thermometers (each team of two needs one), sets of cardboard insects (seven insects in each set), masking tape, scratch paper and pencil, watch for activity leader.

Note: Make insects out of colored cardboard. Attach thermometers to colored cardboard. Each team needs a thermometer and insects with matching colors.

SUBJECTS: Language arts, math, science.

SKILLS: Analysis, application, discussion, inference, problem solving, prediction, small group work.

METHOD: Students will use a thermometer to simulate a lizard. The thermometer "lizard" will have to travel to find food, while maintaining a pre-determined average temperature.

All animals must maintain body temperatures within certain ranges to stay active and alive. Animals can be divided into two general groups according to the way they maintain their body temperatures — endotherms (inside heat) and exotherms (outside heat). Mammals and birds are endotherms and produce heat

within their bodies, allowing them to maintain a fairly constant body temperature, regardless of outside temperatures.

All other animals (amphibians, fish, reptiles) obtain most of their heat from the environment. Many exotherms regulate their body temperatures by moving into warmer or cooler spots in their environment. Lizards and snakes, for example, alternate between basking in the sun and resting in the shade to keep their body temperatures within the range that permits them to stay active and alive. Exotherms can also regulate their body temperature by burrowing and by varying the angle of their exposure to the sun.

PREPARATION: This game is to be played outdoors and works best on a sunny, warm day. Find an area where two lines can be drawn about fifty feet apart. If possible, choose a location containing shrubs or rocks that provide shade spots and some full sunlight areas.

ACTIVITY:

1. Let the children pair up, and give one thermometer to each team. Explain how to read the thermometer, then challenge each team to find the highest and the lowest temperatures in the activity site.

2. After about five minutes, call the group together. Add the highest temperature found by the group to the lowest temperature and divide by two to find the average temperature.

3. Instruct the teams to place one piece of masking tape on their thermometer two degrees above the average temperature and another piece of tape two degrees below the average.

4. Ask if anyone in the group has ever had a fever. Explain that humans and other mammals produce heat inside their bodies and have a steady temperature regardless of outside temperatures. If our body temperatures go up or down even a few degrees from 98.6°F, we can get sick or even die.

5. Explain that unlike humans, animals such as lizards, snakes, and frogs get most of their body heat from their surroundings. On hot days, a lizard's body temperature goes up; on cold days, the lizard's body temperature goes down. Introduce the terms endotherm and exotherm to the group.

6. Tell the students that they are going to play a game in which they pretend their thermometers are a special kind of lizard. Give a set of insects to each team. The set's color should match the color of their "lizard."

7. Explain the procedures of the game:

(A) Each team will place its lizard's food (the insects) in various places within the activity area. Be sure some are placed in sun, some in shade, and some in partial shade.

(B) Teams have about fifteen minutes to move their lizards around as they look for food. The lizard can eat only one insect every two minutes. Each team watches the thermometer window at all times to be sure the lizard does not get too hot or too cold. The top of the mercury column should always be visible in the window.

(C) If the temperature is going too low, the lizard must warm up in the sun. If it is going too high, the lizard must cool down in the shade. Perhaps a partially shaded area will be just right as the lizard digests its insect and waits for the next one. The students may not use their own bodies as shade for the lizards.

(D) When the leader calls out "insect," the teams move their lizards along the ground to the first insect. The insect is gathered up, and each team decides where the lizard will rest as it digests its food. The lizard may move during this time if the temperature is going too high or too low.

(E) After two minutes the leader calls out "insect" again, and the process is repeated.

(F) After all insects have been "eaten," the students will gather together and discuss their lizards' search for food.

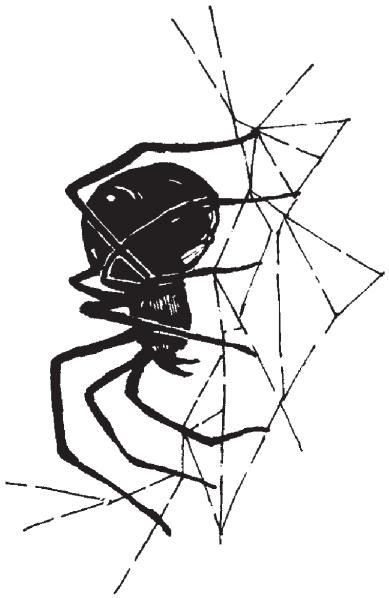
8. Allow the teams a few minutes to place their insects around the area and begin the game.

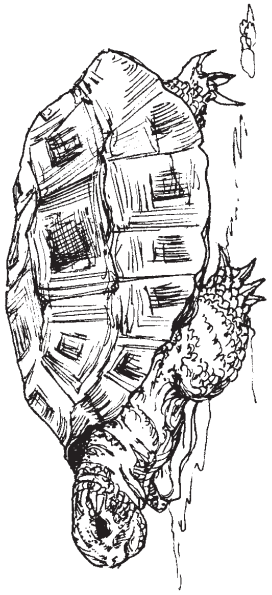
9. Discussion questions at the end of the activity might be: Were you able to keep your lizard within the safe range? Did any lizard heat up or cool down too much? If so, what might have happened to your lizard? Did your lizard have to do a lot of scurrying around to survive?

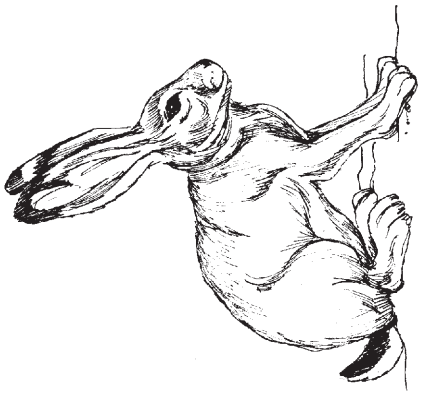
What might happen to a desert lizard if you took it home for a pet? How can lizards cool off or heat up other than by moving to the shade or sunlight? How do you cool off when you get too hot? What do you do now that you could not do if your body temperature responded to surrounding temperatures in the same way as your lizard?

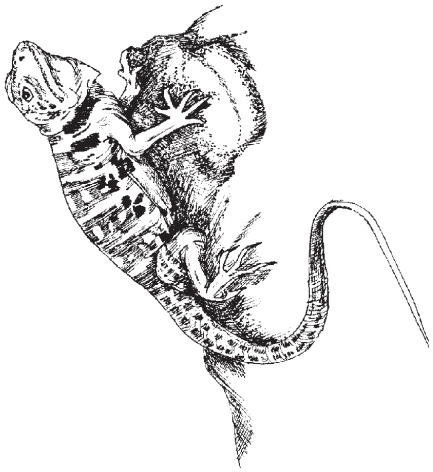
EXTENDING THE EXPERIENCE: Real lizards commonly burrow into the ground to escape hot and cold temperatures. Let the teams play another game in which they can bury their lizards in order to maintain the lizards' temperatures at a safe level.

Discovery Activity Page #1









ENDANGERED SPECIES

What is an *endangered species*? An endangered *species* is a plant or animal in danger of becoming *extinct* throughout all or a significant portion of its range. The United States Fish and Wildlife Service manages this nation's endangered species program, including developing and maintaining the federal list of endangered and *threatened species*.

ENDANGERED SPECIES

Extinction Is Forever

Extinction is a natural process. For millions of years different types of plants and animals have lived and then have become extinct. We don't always know why a species has become extinct, but we do know that extinction can be caused by natural occurrences. Many times extinction is caused by more than one natural event, including climate change, disease, overpopulation, or competition for food.

When a species becomes extinct because of a natural process, it usually means its environment has changed, and more than likely the species will be replaced by a new, emerging one. It can be disturbing when a species becomes extinct, but we can more readily accept that loss when it comes naturally. However, most of the extinction and near extinction that is occurring today is not natural. And there has been a great increase in the rate of extinction. This increase is primarily caused by the activities of humans.

Tarantulas Are Terrific

One of the most difficult tasks educators face is teaching children about the intrinsic value of each species on the face of the Earth. Presently, in the environmental field, there is a strong push to educate about the non-monetary value of each species. This is being accomplished through the teaching of environmental ethics.

One leader in the environmental ethics field, Hugh W. Nibley, states: "We have taught our children by precept and example that every living thing exists to be converted into cash, and that whatever would not yield a return should be quickly exterminated to make way for creatures that do." Teaching environmental ethics with its emphasis on the intrinsic value of all species will have the positive effect of helping people understand the benefits of the endangered species program.

These benefits may be summarized as follows:

1. Endangered species generally serve as indicators of larger environmental problems and, when detected, allow analysis and correction of more involved problems during the pursuit of a preservation program.

2. The "Era of Endangered Species" has initiated a process of maturation within fish and wildlife agencies as they begin to consider **all species** in their program planning, not simply those with an obvious economic value.

3. By preventing the unnatural extinction of life forms, we automatically preserve any benefits to humans which they may possess, but which research may not yet have revealed.

4. Perhaps the most important reason for preserving endangered species is the realization that all life is connected and interdependent.

No Place To Go

Because of its variety of habitats, the Mojave Desert is home to a tremendous diversity of plants and animals. Some of these habitats are being destroyed or altered by humans. *Groundwater* pumping, construction of roads, agricultural pollutants, construction of large residential tracts, grazing of domestic stock, and many other factors affect the desert *ecosystem* and the plants and animals living there. As these habitats are destroyed, the danger of extinction increases. Today the Mojave Desert is home to many threatened and endangered species.

This unit is designed to enable students to become aware of endangered species, the causes and threats leading to their extinction, and the reasons why their preservation is important to each of us. Students will realize that they, as individuals, are empowered to foster change. They will be able to take actions contributing to the removal of threats to the well-being of species.

Activity 1

Living On The Edge

OBJECTIVES: List two reasons some plants and animals in the Mojave Desert are endangered. Describe two ways you can help protect *endangered species*.

MATERIALS: Discovery Activity Page #1.

SUBJECTS: Language arts, science.

SKILLS: Analysis, comparison, discussion, inference, observation, synthesis, prediction, reading.

METHOD:

1. Hand out the activity page.

2. Explain to students that some plants and animals have limitations as to where and how they can live. The more limitations they have, the more likely they are to become endangered. Provide clear examples, such as polar bears or fish.

3. Have the children look at the paired pictures on the activity page and circle the one in each pair which is most at risk.

4. After the children have made their choices, review their selections. Ask them why they made the choices they did.

5. After you have gone over all the answers, ask the children which of the plants and animals they would want

to be? Why would they want to be that plant or animal? Which plant or animal would they not want to be? Why? Which plants and animals are most likely to become endangered? Why? What actions can students take to help organisms most at risk?

EXTENDING THE EXPERIENCE: Create an entire desert *ecosystem* in an area of the school, from floor to ceiling, with wildlife peeping out from all corners. Include life hiding below the soil and life soaring in the sky. Illustrate positive actions humans can take to protect and preserve desert ecosystems.

Activity 2

And Then There Were None

OBJECTIVES: Define, compare, and contrast the terms *endangered* and *extinct*. Analyze the impact of human social, economic, and political activities on other living things. Name two endangered plant or animal species living in the Mojave Desert.

MATERIALS: Six small tokens (or slips of paper) for each student, tape, index cards.

SUBJECTS: Language arts, science, social studies.

SKILLS: Analysis, comparison, inference, observation, prediction, public speaking, reporting, research.

METHOD: The students will do an activity which demonstrates how natural populations are effected by human interference.

1. Referring to the Fun Facts list in this unit, write the names of the plants or animals on index cards. Make one for each student.

GLOSSARY

biological community — all of the living things, both plants and animals, living in a particular environment, working together to fulfill their individual needs.

ecosystem — the interaction of the *biological community* (all living things) and the physical environment (water, air, minerals).

endangered species — a species of plant or animal in danger of extinction throughout a significant portion of its range.

exotic — not *native*, something that did not exist in the area before humans brought it from another place.

extinct species — a species which has vanished from existence.

groundwater — water that is stored beneath the surface of the ground, coming from precipitation and surface water that has percolated down. Water that supplies wells and springs.

habitat — the place where a plant or animal lives, an organism's home. Provides food, water, shelter, and space in a *suitable arrangement*.

native species — a plant or animal that evolved or was transported to an area through natural means.

species — a genetically and adaptively unique plant or animal able to reproduce itself and to evolve.

suitable arrangement — when those things necessary for survival (food, water, shelter, space) are accessible, adequate in quantity, and in keeping with the biological lifestyle of a species.

threatened species — a species present in its range but in danger because of a decline in numbers.

2. Have students stand in a large circle. Tape a card with the name of an animal or plant to each student's shirt.

3. Distribute six tokens to each student. Tell them the tokens represent all the individuals of their species found in a specific area. Tell them each token may represent more than one individual.

4. Read these instructions: I am going to read some survival factors for your organism (taken from the survival factors list on page 4). Each time I read a statement that limits or reduces your chances of survival, put one token on the floor in front of you. Whenever I say, "Human Population Growth," everyone puts down a token. When you have only two left, sit down on the floor and say, "I'm in big trouble."

5. Continue to play until everyone is sitting. Discuss the results of the activity by asking questions such as these: How many of you have tokens left? How many have none? Why? Is this realistic? Why or why not? What are the important ideas about animal populations in this activity?

6. Write the words extinct and endangered on the chalkboard. Tell students their populations became endangered when they became small in number. Endangered refers to any population of plants or animals in danger of extinction. There are still some left. Extinction is final. The plant or animal is gone forever.

7. What factors influence the survival of populations of plants and animals in the Mojave Desert? Can students think of some factors this activity did not consider?

ENDANGERED SPECIES

SURVIVAL FACTORS

- People have released *exotic* fish into your *habitat* and they are over populating.
- A long-term drought has affected the water level in your habitat.
- Because you are rare and beautiful, you have been gathered or stolen by collectors.
- Human population growth
- The exotic tamarisk tree has invaded your habitat, using up the water you depend on.
- A poacher has shot you illegally.
- The thickets of willows and other shrubs you live in are being trampled by domestic livestock and feral burros.
- Spreading urban cities are reducing the habitat you live in.
- Dams have been built upstream from you causing water temperatures to decline and the water to be too clear.
- Illegal off-road vehicle use has caused damage to your burrow.
- A major road is built across your habitat dramatically increasing traffic.
- Wetlands that you need to survive are drying up due to *groundwater* pumping.
- Human population growth
- Illegal use of off-road vehicles is destroying vegetation you use for food and shelter.
- Introduced exotic species of fish are competing with you for your food supply.
- A strip mine is operating on the slope you live on.
- Agricultural fertilizers have washed into the marsh you live in.
- Pesticides have polluted the spring you live in.
- The pesticide DDT sprayed in Central and South America is carried to you through the migratory birds you prey on, causing your eggshells to be too weak to survive.
- You are a predator thought to be a threat to domestic livestock.
- Willow and cottonwood trees you need for nesting have been destroyed because of diversion and overuse of water upstream.
- Someone enters the cave you are hibernating in causing you to wake in the middle of winter when it is too cold for you to survive.
- Past hunting practices have significantly reduced your population.
- The edge of the small spring you live in is being trampled by humans and livestock, causing salt and mud to cloud the water, depleting your oxygen supply.
- Human population growth

EXTENDING THE EXPERIENCE: Have each student select an endangered or threatened species to research. Have them present short reports, giving each species' current status and highlighting any programs under way to protect the plant or animal. Find out what regulations regarding endangered species affect development in your community. Research situations where the presence of an endangered species has halted or threatened to halt a development. What have been the local reactions?

Activity 3

What Endangered Or Threatened Species Am I?

OBJECTIVES: Compare and contrast the terms *endangered* and *threatened*. Name two endangered plants or animals found in the Mojave Desert.

MATERIALS: Masking tape, index cards.

SUBJECT: Language arts, science.

SKILLS: Application, discussion, listening, problem solving.

METHOD:

1. Referring to the Fun Facts list in this unit, write the names of plants and animals on index cards. Repeat species so there are three or four of each.

2. Select three or four students to come to the front and turn so their backs are facing the rest of the group. Tape the cards for one species on the students' backs.

3. Have these students ask questions about their species that can be answered "Yes" or "No" by the rest of the group.

For example, "Do I fly?"

4. After the students have successfully guessed their identity, take some time to add interesting information about the species, including its status as threatened or endangered and some threats to its survival. If the students cannot guess their identity, have the rest of the group help by describing some of the species' characteristics.

5. Repeat for the other species.

EXTENDING THE EXPERIENCE:
Why all the fuss about endangered species? How can we prevent organisms from becoming endangered or extinct? Do we have any responsibilities when organisms become endangered? What is one action you can take to prevent an organism from becoming endangered?

Activity 4
Who Lives Here?

OBJECTIVES: Name two things that happen to a community of plants and animals when *habitat* is destroyed. List some of the human activities which change the desert. Discuss what happens to the plants and animals that live in a habitat when it has been disturbed.

MATERIALS: Chairs, crayons, drawing paper, record or tape player, recording of the song "Home on the Range."

SUBJECTS: Art, language arts, music, science, math.

SKILLS: Analysis, comparison, discussion, drawing, inference, listening.

METHOD: One of the greatest threats to plants and animals today is habitat depletion. What happens to these plants and animals when their habitats are disturbed? In this activity children will play a game of musical chairs with the chairs representing habitats.

1. Have students draw a picture of a Mojave Desert plant or animal and label it. Have them also draw a picture of its habitat.

2. Tape a picture of a plant or animal on each student. Tape a picture of a habitat on each chair.

3. Place chairs in a row, alternately facing left and right. Students stand in a circle around the chairs. There should be one less chair than there are students. When the music starts, indicate the direction students are to start walking. When the music stops, they are to find a seat. Remove a chair after each round. Explain that this habitat has been removed because of a human impact, such as bulldozing for a housing site or collecting *native species* of plants. Play until just one species is left, the survivor.

4. Play several rounds of the game, varying each set by introducing additional factors, such as imaginary roads or fences species can't cross or natural disasters which eliminate additional habitat.

5. Summarize this activity with a discussion. How many different desert plants or animals did we begin with? How many different habitats? What happened to the habitats? What are some reasons for human activities which are changing the desert (need for more homes, increased roads, increased demand for recreation, desire to make the desert like another habitat by introducing *exotic* species)? What happens to the plants and animals when an area is disturbed?

EXTENDING THE EXPERIENCE:
Have students research descriptions, accounts, and photographs of their local area as it was seen by early pioneers and explorers. Compare and contrast the area today with the past. Are there more or fewer native species of plants and animals? What are native plants and animals which have become threatened, endangered, or extinct? What exotic plants and animals now live in this area? Locate natural springs and other natural water sources. Are these water sources still accessible to wildlife? What actions can students take to protect desert plants and animals near their homes?

ENDANGERED SPECIES

Fun Facts — SOME THREATENED AND ENDANGERED SPECIES OF THE MOJAVE DESERT

COMMON NAME	SCIENTIFIC NAME	FEDERAL STATUS
Plants		
Bear-paw poppy	*Arctomecon californica*	C
Foxtail cactus	*Escobaria vivipara* var. *alversonii*	C
Eureka Valley Evening Primrose	*Oenothera arita eurekensis*	E
Panamint daisy	*Enceliopsis covillei*	C
Sticky buckwheat	*Eriogonum viscidulum*	C
Mammals		
Amargosa southern pocket gopher	*Thomomys umbrinus amargosae*	C
Desert bighorn sheep	*Ovis canadensis nelsoni*	S
Mountain lion	*Felis concolor*	C
Townsend's big-eared bat	*Plecotus townsendii*	C
Birds		
Bald eagle	*Haliaeetus leucocephalus*	T
California brown pelican	*Pelecanus occidentalis californicus*	E
Least Bell's vireo	*Vireo bellii pusillus*	E
Mexican spotted owl	*Strix occidentalis lucida*	T
Yuma clapper rail	*Rallus longirostris yumanensis*	E
Reptiles		
Coachella Valley fringe-toed lizard	*Uma inornata*	T
Desert tortoise	*Gopherus agassizii*	T
Amphibians		
Lowland leopard frog	*Rana yavapaiensis*	C
Fish		
Bonytail chub	*Gila elegans*	E
Colorado squawfish	*Ptychocheilus lucius*	E
Devil's Hole pupfish	*Cyprinodon diabolis*	E
Mohave tui chub	*Gila bicolor mohavensis*	E
Humpback chub	*Gila cypha*	E
Razorback sucker	*Xyrauchen texanus*	E
Insects and Snails		
Badwater snail	*Assiminea infima*	C
Devil's Hole warm springs riffle beetle	*Stenelmis calida calida*	C

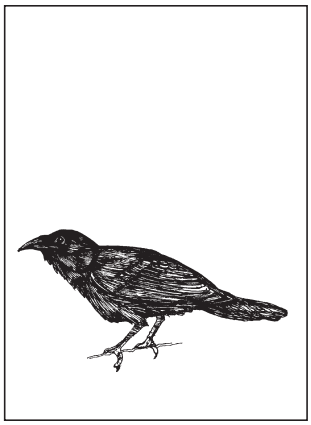
KEY TO FEDERAL STATUS:

E — Endangered T — Threatened C — Candidate S — Sensitive

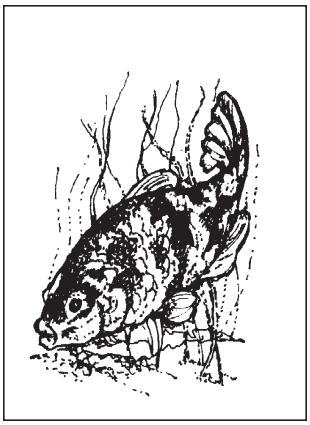
Discovery Activity Page #1

DESERT DYNAMICS

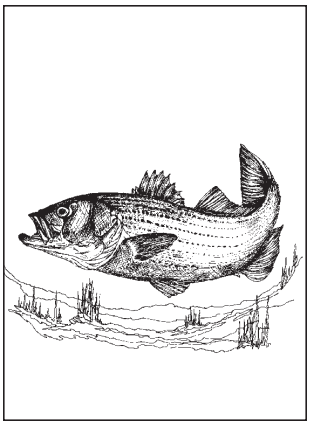
The peregrine falcon eats other birds that migrate from countries where dangerous pesticides are still used.



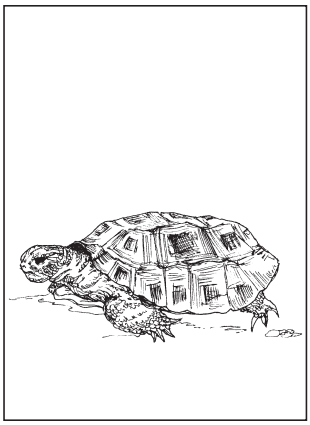
The raven eats a variety of food and lives in many different environments.



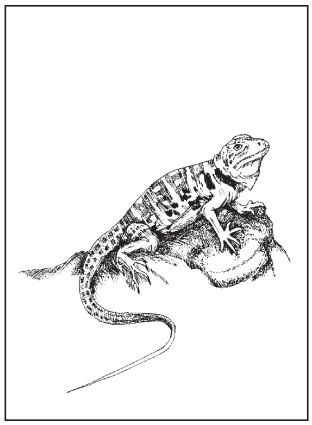
The desert pupfish lives in small pools of water that can dry up if too many wells pump out the water.



The striped bass lives in both fresh water and salt water.

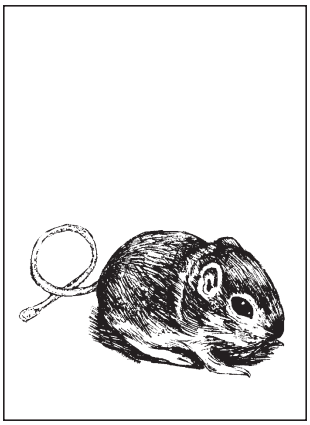


The desert tortoise lives mostly in the Mojave Desert and moves too slowly to get out of the path of off-road vehicles.

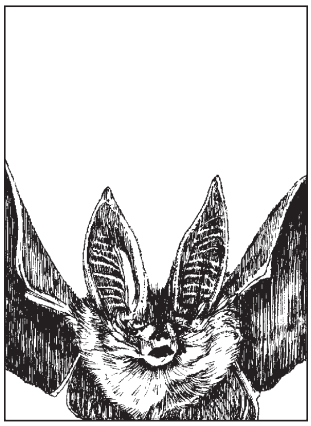


The collared lizard lives throughout the Southwest and can move very quickly.

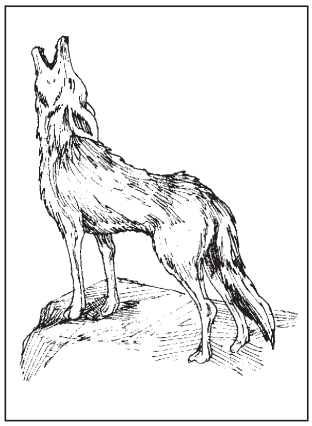
The desert bighorn sheep must live near springs in order to get the water it needs to survive.



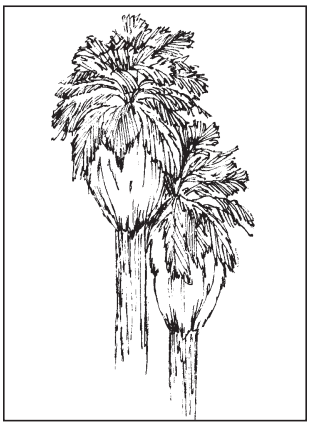
The kangaroo rat doesn't drink water; it makes all the water it needs in its digestive system.



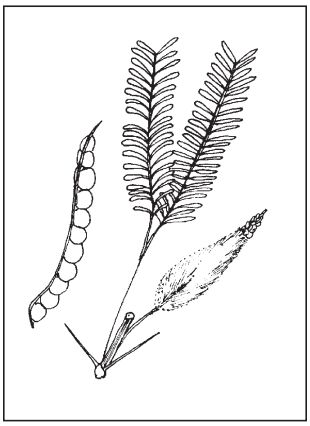
The Townsend's long-eared bat lives in very isolated caves.



The coyote lives in many locations throughout the country.



The fan palm tree lives near seeps and springs and relies on this water to survive.



The mesquite is a common plant and gets the little water it needs from occasional rain.

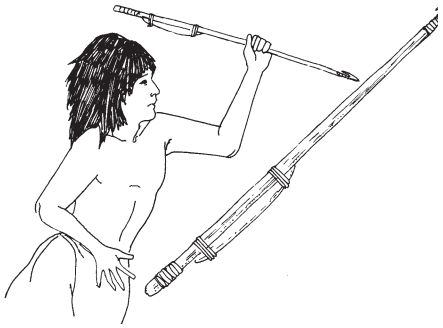
DESERT PEOPLE

Glaciers periodicaly blanketed much of the world during the Pleistocene Epoch, approximately 2.5 million to ten thousand years ago. The rivers of ice gradually receded as the epoch ended. As conditions improved, early hunters pursued herds of large animals. The land and climate differed dramatically from today. It was cooler. Lakes and swamps existed where no water remains now. Lush grasslands covered the plains, supporting mammoths, mastodons, horses, camels, and, in some areas, bison.

DESERT PEOPLE

These early people, called "Paleo Indians," are known mainly from their stone tools. One distinctive style of stone tool is called the Clovis Point. This leaf-shaped point measures four to five inches in length and was attached to a wooden spear shaft.

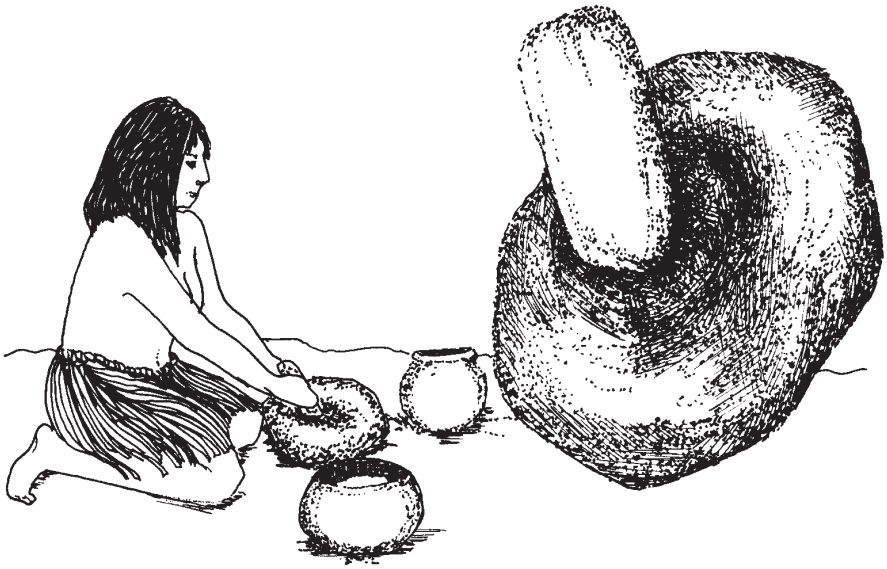
Hunters used a spear thrower, or atlatl, to propel the spear. Most atlatls were little more than a wooden shaft with a hooked end. The weapon's hollow tip fitted over the hook. A quick snap of the arm launched the spear. This revolutionary tool increased the force and speed of the spear. While improved weapons and hunting techniques possibly reduced some animal populations, erratic climatic changes probably had greater impact. Sixty animal species disappeared by the end of the Pleistocene Epoch.



Changing Lifeways

Starting ten thousand years ago, the climate in the Mojave Desert region gradually became more arid. This change meant only desert-adapted plants and animals survived. As the world changed so did the people.

Between nine and ten thousand years ago, a Desert Archaic culture began to emerge. These hunter-gatherers lived in small groups, moving from place to place as food became available — agave in the spring, cactus and mesquite beans in the summer, acorns and pinyon pine nuts in the fall. They lived in caves, rock shelters, and shelters constructed of poles and brush.



Plants dominated the diet and provided numerous medicines. Wooden digging sticks were used to dig roots and tubers. Coiled baskets held seeds and nuts. Flour was ground from seeds by rubbing a *mano* against a flat milling stone (*metate*). The flour could be cooked fresh or stored in cache pits. Cooking was done in ceramic vessels called ollas (ô'yäs) or by heating rocks in a fire and then placing them in baskets filled with liquids.

Meat supplemented the diet. Game was obtained by netting, trapping, snaring, or hunting. Almost any animal was taken — birds, bighorn sheep, jack rabbits, chuckwallas, even insects. Drying and smoking preserved the meat for later use.

The desert also provided clothing. Rabbit skins were woven into capes and blankets. Densely woven sandals of yucca fibers protected feet. Shells from the Pacific Ocean and the Gulf of California were obtained in trade and used for necklaces and other adornments.

The desert's rhythm governed all aspects of life. This seasonal search for food and resources continued for some groups until the introduction of domesticated foods encouraged a more sedentary lifestyle. For others, the hunting-gathering way of life continued until historic times.

Gardening In The Desert

Domesticated corn, beans, and squash arrived in the desert southwest some five thousand years ago. However, people did not come to depend on cultivation until as late as A.D. 800. At first, farming was casual. Seeds tossed

on partially cleared fields received little attention while the groups continued to exploit native resources. In the fall, they harvested the domesticated plants along with native seeds and nuts. Later, farming practices intensified.

As farming gained importance, groups built scattered villages on river terraces. The Anasazi living in Nevada initially built pit houses — structures partially dug into the ground and then roofed with timbers and mud. Later they built mortar and stone blockhouses known as pueblos. Other groups fashioned structures with mud and sticks, or continued to build brush shelters.

Storing The Harvest

Depending on available materials, baskets or ceramic vessels were used. Initially, Desert Indians made plain utilitarian vessels for cooking and storage. Later, some groups fashioned highly decorative wares. Stylized pottery often reflected group identity and changing time periods. Today, archeologists use the different styles of pottery as guides to understanding the people who made them.

GLOSSARY

atlatl — a throwing device, from the Aztec word meaning "spear-thrower."
mano — a stone used for grinding food by hand on a *metate*.
metate — a stone with an indented upper surface for grinding food.
petroglyph — a picture or design that is carved, pecked, or etched onto a rock surface.
pictograph — a picture or design painted onto a rock surface.
shaman — a medicine person who communicates with spirits to gain power or to cure illnesses.

DESERT PEOPLE

Changing Times

Farming produced a steady source of food. But more food meant more people. Village sizes increased, and social organization became more complex. Groups like the Anasazi flourished briefly, but farming in the desert was risky. Croplands became exhausted. Prolonged droughts brought further hardships. Social tensions may have intensified. The picture remains unclear, but we do know that groups like the Anasazi abandoned the Mojave Desert by A.D. 1150, retreating eastward.

The groups that remained —Cahuilla, Chemehuevi, Hualapai, Mohave, Serrano, Southern Paiute, Shoshone, and others —continued their traditional lifestyle until the Spanish arrived in the sixteenth century. These peoples, and the nameless ones that preceded them, left a rich legacy in human adaptation to one of the world's harshest environments — a legacy that offers important lessons to contemporary inhabitants of these lands.

Traditional Territories

Traditional territories of contemporary and prehistoric Mojave Desert inhabitants overlap the boundaries of numerous federal parks and recreation areas. These associations are summarized below:

- Death Valley National Park — Cahuilla, Chemehuevi, Serrano, Southern Paiute
- Mojave National Preserve — Kawaiisu, Serrano, Shoshone, Southern Paiute
- Joshua Tree National Park — Cahuilla, Chemehuevi, Pinto*, Serrano
- Lake Mead National Recreation Area — Anasazi*, Chemehuevi, Havasupai, Hualapai, Mohave, Southern Paiute, Yavapai
- Red Rock Canyon National Conservation Area — Anasazi*, Chemehuevi, Desert Archaic*, Mohave, Southern Paiute

* Prehistoric groups

Activity 1
Communication

OBJECTIVES: List methods by which information can be transferred from culture to culture. Name at least three reasons why preserving the knowledge of past cultures is important to modern cultures.

MATERIALS: Pictures of *pictographs* and/or *petroglyphs* from your local area, a myth or legend from a local tribe, a visit to an archeological site.

SUBJECTS: Art, language arts, social studies.

SKILLS: Analysis, communication, discussion, drawing, listening, observation, reading, reporting, research, small group work, writing.

METHOD:

1. Begin with an introduction of how we have learned valuable information about the uses of certain plants and animals from other cultures. (Example: In the Tehuacan Valley of central Mexico, tiny cobs of an early variety of corn have been unearthed from dry caves. This corn, dated approximately 5,000 B.C. is believed to have evolved from teosinte, a wild grass found in many areas of Mexico. The plant and knowledge of its propagation gradually passed from group to group up through northern Mexico and eventually into the Southwest.)

2. Ask the students to help identify some of the methods by which information might have been transferred from one culture to another. Talk about the following methods — petroglyphs, pictographs, songs, stories, archeological evidence, conversations.

3. Illustrate the transfer of knowledge by telling the following Mohave myth or another myth or legend from a local tribe.

Mastambo was standing with his arms folded. He took two steps toward the west, thinking about food. He went north two steps still thinking, then he went south two steps and stood. Now he made a little hole and spat white saliva into it. Soon something small grew from the hole. Then Mastambo said, "Listen to me. This is corn. This is squash. This is melon. This is beans." The Mohave began to plant these along the river bottom and no longer wandered through the desert.

4. Discuss the fact that if one of these methods is lost or destroyed, such as archeological evidence, we lose the ability to unlock some of the secrets of the world around us.

5. Have the students recall an important event or experience in their lives. Have them create a story about that event using pictographs or petroglyphs to record it. Have students share their stories with the class.

EXTENDING THE EXPERIENCE:
Make a list of our most commonly used food crops (corn, squash, beans, grains, potatoes). Research the origins of these crops and which native people originally used them. Create a bulletin board with pictures of modern crops and their predecessors from the wild, as well as the people who eat them today and the native people who cultivated them in the past.

Activity 2
Desert Pharmacy

OBJECTIVES: Name medicinal uses of two desert plants.

MATERIALS: Discovery Activity Page #1, natural plant parts (i.e. mesquite seeds, leaves, acorns).

SUBJECTS: Language arts, science, social studies.

SKILLS: Analysis, application, communication, discussion, observation, problem solving, reporting, research, writing.

METHOD:

1. Read or tell a story about a *shaman* or medicine person and the role he or she played in the lives of desert people.

2. Choose one student to be a traditional doctor (medicine person) and another to be a modern doctor. Have the remaining students form a circle, placing their hands behind their backs. Each student in the circle represents a different kind of plant growing in the Mojave Desert. Place the modern doctor in the center of the circle and the medicine person outside the circle.

3. Ask the modern doctor to close his/her eyes. Give the medicine person a small natural object found in the area. This object symbolizes folk medicine. (Be sure to select an object such as a fruit, nut, or seed that would not damage a plant if it were picked. Remember, these cannot be collected in National Park Service areas.)

4. As the medicine person walks around the circle, he or she says, "I know a plant which modern medicine seeks. Can the good doctor find it in my medicine chest?" After the medicine person has secretly left the folk medicine in the hands of one of the "plants," he or she stops. The modern doctor must then guess which of the plants has the medicine.

5. The doctor gets one guess. If correct, he or she becomes the next medicine person, the former medicine person becomes a plant, and the plant with the folk medicine becomes the modern doctor. If the doctor is incorrect, he or she becomes a plant, the plant with the folk medicine becomes the doctor, and the original medicine person hides the folk medicine again. If the medicine person successfully hides the folk medicine from the doctor three times, he or she becomes a plant, and a new medicine person is chosen.

6. Using the activity page, summarize this activity by describing the uses of plants by desert people to cure injuries or illnesses. How would this information be passed down from one generation to another? How would remedies be discovered?

7. More than three thousand plants are used by tribal people throughout the world. Many of these medicines were used long before modern application. Use the following examples:

• Quinine comes from the bark of various kinds of cinchona trees which grow in South America and was used by South American Indians to cure malaria. When Spaniards arrived in the Americas in the 1600s they learned its value from Native Americans. United States troops used large quantities in World War II and Viet Nam. Today quinine is used to regulate heartbeats.

• May apple (American mandrake) is a plant growing in eastern North America, bearing a single white flower and an oval yellow fruit. It was used by Penobscot Indians to treat cancer. Study of this plant led to the discovery of a useful anticancer drug from a related plant in India.

8. Conclude the activity by discussing the importance of preserving native plant communities that may be used for curing illnesses and diseases.

EXTENDING THE EXPERIENCE: Have students research a plant specific to the Mojave Desert and write a story about its medicinal uses. If possible, have a local herbalist or pharmacist visit the class to discuss modern uses of ancient medicines. Compile all the information into a medicinal plants book.

Activity 3
Native American Pottery

OBJECTIVES: State two major functions of pottery. Develop one pottery piece. Name four ways to decorate pottery.

MATERIALS: Discovery Activity Page #2, one piece of modeling clay for each student, various natural tools for making pottery designs (sticks, fiber, seashells, pine cones, feathers).

SUBJECTS: Art, social studies.

SKILLS: Classification, comparison, description, discussion, invention, small group work.

METHOD:

1. Discuss with students the former lifestyles of Native Americans living in the Mojave Desert. Discuss the type of tools the hunter-gatherers used. Then discuss how agriculture allowed a more sedentary lifestyle and how pottery provided a more durable storage container for these agri-gatherers. (Pottery was also used by hunter-gatherers.)

2. Ask students to make a list of vessels in their own homes that are strictly utilitarian (pots and pans) and those that are decorative (flower vases or pieces of sculpture). Discuss the two types of pottery (utilitarian and decorative) and the different uses of each type. **Utilitarian**: storage, cooking, and drinking vessels. **Decorative**: ceremonial objects and decorative art.

3. Discuss how the size, shape, and design of a pottery vessel might vary depending on its use. How does the design and shape of ancient pottery compare with the design and shape of objects we use today?

4. Using a piece of modeling clay, demonstrate how a pottery vessel might have been made. Where would the potter have found clay? Knead the clay and, using coils, form a vessel. Smooth out the coils using your hand or a wooden paddle. What happened to the vessel after it was formed?

5. Using the illustrations on the activity page, discuss the various techniques used to decorate a vessel and the pattern created. Why decorate the vessel?

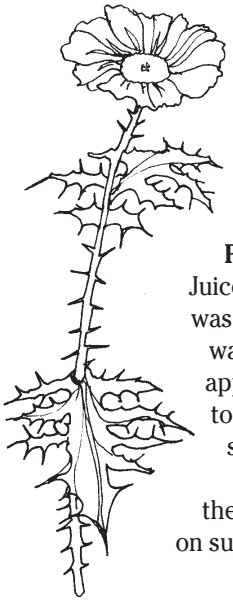
6. Divide the students into groups of four. Give each student a piece of modeling clay, and provide each group with tools for decorating their pottery vessels. Encourage students to try ancient or imaginative shapes.

EXTENDING THE EXPERIENCE: Visit a museum displaying pottery made by Native Americans. Ask an artisan to visit the class and demonstrate clay art.

Discovery Activity Page #1

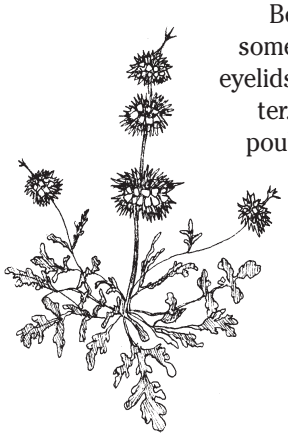
A Desert Pharmacy

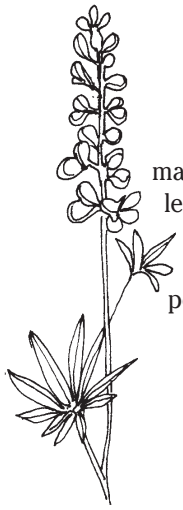
Many cultures still use some of these remedies. Remember, plants cannot be collected in National Park Service areas.
It is not advisable to use any of these remedies yourself.



PRICKLY POPPY
Juice of a fresh plant was used to burn off warts. The tea was applied to sunburn to relieve pain and swelling. An ointment made from the seeds was used on sunburn and other minor burns.

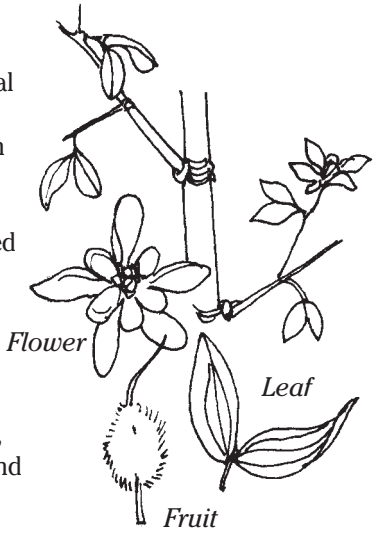
CHIA
Chia was one of the most important seed plants for the Native Americans. Seeds were harvested by beating ripe seed heads over flat, tightly woven baskets. The seeds swell when placed in water. Because of this they were sometimes placed under the eyelids to remove foreign matter. They were also used in poultices for infections. Hot mush was wrapped in a cloth and applied to the infected area. Powdered seeds were added to water to make a nutritious drink or gruel.



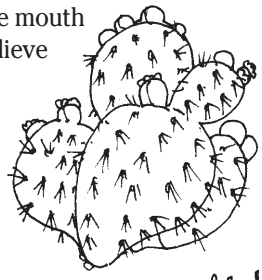


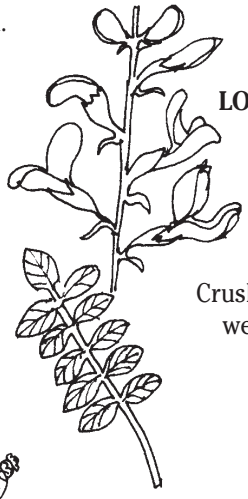
LUPINE
A lotion made of the leaves was used to treat poison ivy blisters.

CREOSOTE BUSH
Creosote bush was used in the treatment for many ailments and diseases, including colds, chest infections, intestinal discomfort, cancer, nausea, wounds, poisoning, and swollen limbs due to poor circulation. Sprigs of twigs and leaves were boiled as a tea and drunk, placed over fire to create steam that was inhaled in a sweat house, or pounded into a powder and pressed into a poultice on wounds. In the case of a snake or spider bite or scorpion sting, creosote leaves were chewed and placed on the swelling.

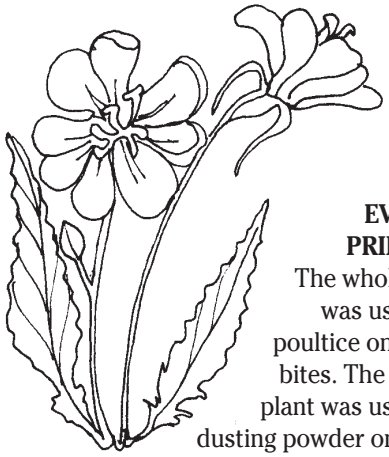


PRICKLY PEAR
Skinned pads were used as a poultice for infections and cuts. They were placed against the injured area for several hours to absorb fluids. Pieces were held in the mouth to relieve gum pain.



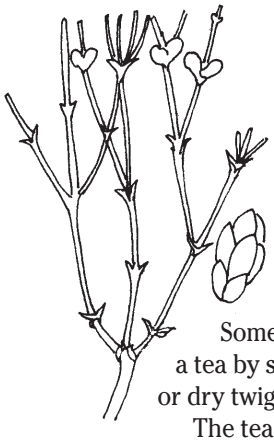


LOCO WEED
This plant was used to treat stomach disorders. Crushed leaves were used to soothe a bad back.



EVENING PRIMROSE
The whole plant was used as a poultice on spider bites. The ground plant was used as a dusting powder on sores.

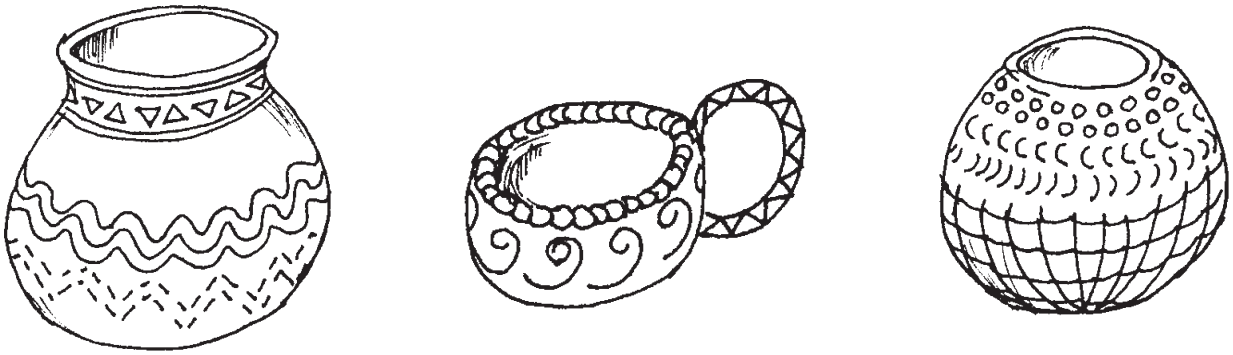
FILAREE
Filaree was used to treat excessive bleeding and animal bites.

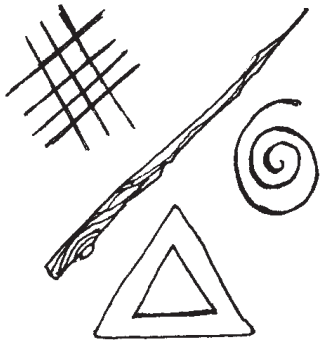


MORMON TEA
Some people still brew a tea by steeping the green or dry twigs in boiling water. The tea was used to treat kidney ailments and stomach disorders, as well as to purify the blood.

Discovery Activity Page #2

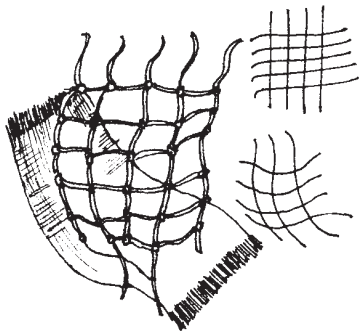
Decorated Pottery



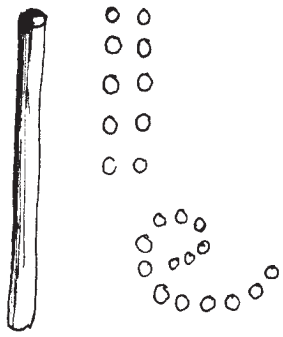


Incising Using a Pointed Stick

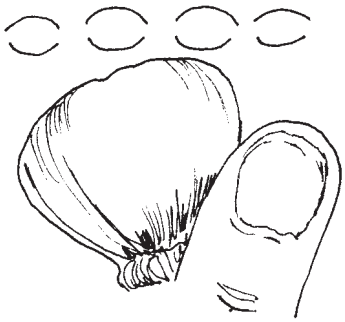
Cord Impressions



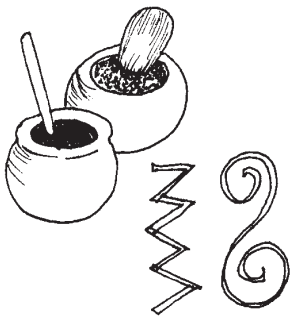
Net and Fabric Impressions



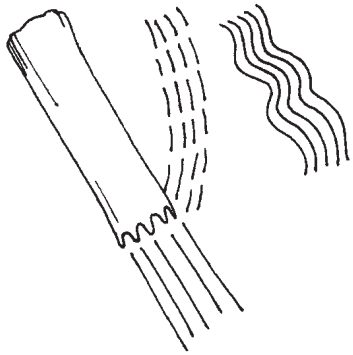
Using a Dowel



Shell or Fingernail



Painting Designs



Combining with a Notched Stick

WESTWARD EXPANSION

In addition to Native American habitation, explorers, miners, cattle ranchers, and homesteaders have shaped the Mojave Desert. Iron work from abandoned wagons, dirt roads, pieces of mining equipment, mine shafts, dams, reservoirs, and remains of early homes dot the desert as reminders of past inhabitants.

WESTWARD EXPANSION

Early Explorers

Long before the Spanish and travelers from the American colonies arrived, a trade trail stretched across the Mojave Desert. The trail, blazed by the Mohave Indians, allowed trade with west coast Native Americans. It crossed the desert along the bed of the Mojave River, then climbed over the Cajon Pass, one of the best passes from the California desert to the coast.

In 1776, while the American colonies were winning their independence from England, Father Francisco Garces, a Spanish priest, was exploring the Mojave Desert. Using the Mohave Indian Trail, he walked across the desert with Native American guides, arriving at the San Gabriel Mission. In 1826 Jedediah Smith became the first American explorer to reach California via this trail. He was a fur trapper looking for new hunting areas, as were many to follow, and was also one of the first to travel through Death Valley. The Mormons came west in 1846, and later in 1855 Brigham Young established the Las Vegas Mission. According to legend, early Mormons named the Joshua tree. In the often-strange silhouettes of branches, they saw the outstretched arms of the biblical prophet Joshua leading them westward.

When the war with Mexico ended in 1847, California passed into American hands. The next year gold was discovered, and gold seekers crossed the Mojave Desert on their way north. In 1849, a group of emigrants known as the Bennet-Arcane party passed through Death Valley looking for a shortcut to the California gold fields. The shortcut cost them their wagons, oxen, and almost their lives. Because of this experience, a departing member of the party waved and said, "Good-bye, Death Valley," giving the area its name.

The push for commercial trade between California and other young western states caused the development of other routes. The Old Spanish Trail took a circuitous route from Santa Fe, New Mexico, through Utah and on to the Los Angeles basin. It followed a route through the Mojave Desert that today is Interstate 15.

Later, in the 1850s, more direct routes were surveyed and improved by François X. Aubry and Edward Fitzgerald Beale. Besides the need for passable wagon routes, there was a strong drive to establish a railroad reaching from the Atlantic to the Pacific. The huge land acquisitions resulting from the Mexican War, along with the discovery of gold in California and its admission as a state, made such a railroad a necessity to keep the distant parts of the Union connected. The most direct route established to Los Angeles became known as the 35th Parallel Route or Beale's Wagon Road. The route this trail followed through the Mojave Desert eventually became the site of the Santa Fe Railroad and Interstate 40.

Beale's Wagon Road opened in 1858. During the first summer, five emigrant trains attempted the trail. Mohave Indians attacked the trains, killing many people. At the same time, a postal route was established over the 35th Parallel Route from Kansas City, Missouri, to Stockton, California. When the first mail arrived in Stockton, it was reported that the Mohaves attacked the carriers. Because of these incidents and others, Major William Hoffman led the "Colorado Expedition" against the Mohaves in early 1859. The Mohaves surrendered to Major Hoffman, and Fort Mojave and the Fort Mojave Indian Reservation were

established on the Colorado River at the east (Arizona) side of Beale's original crossing point.

In the late 1800s steam-powered boats, similar to Mississippi river boats, traveled the sixty miles up from the mouth of the Colorado River. These boats, carrying both cargo and passengers, were pulled through the canyon using winches and cables strung through ring bolts in the canyon wall. Originally, these steamboats were to supply Fort Mojave. However, when it was discovered they were incapable of the task, another route had to be found.

Using government teams with civilian teamsters, wagon masters, and herders, the Mohave Indian Trail became a wagon road. Supplies could then be brought overland from Los Angeles. Emigrants rarely used the road, but prospectors and frontiersmen did provide traffic for the road and a purpose for Fort Mojave. When Prescott became the capital of Arizona, a new road was opened from there to Fort Mojave. Prescott was also supplied through California, so the Mojave Road became an important route for twenty years, until the opening of the railroad.

Dreams Of Wealth

Mining in all areas of the desert created boom towns with colorful names and characters. On Christmas Day, 1860, the first producing mine in Death Valley was opened. The mine was named Christmas Gift. The mining boom in Death Valley began with Panamint City and continued with Chloride City, Keane Wonder, Bullfrog, Rhyolite, Greenwater, Harrisburg, Skidoo, and Ashford Mill. Borax, "the white gold of the desert," was discovered and has been mined profitably in the Death Valley area since the 1880s.

Mining in what is today the Mojave National Preserve began in the Providence Mountains region. The Rock Springs Silver District began operating in 1863. This area later became known as the Macedonia Mining District. These mines were abandoned in 1866 due to a combination of Native American objections and isolation. During the 1870s, the Clark Mountain Mining District was established and with it the town of Ivanpah. This was the only community of any size within the eastern Mojave Desert.

Red Rock Canyon's Sandstone Quarry produced sandstone for buildings in San Francisco and Los Angeles. Gold was discovered in Eldorado Canyon in the late 1800s. This single mine produced $1,700,000 worth of gold. In 1865 the first mining claim was filed in what is today Joshua Tree National Park. It was for the Jeff Davis Mine in Rattlesnake Canyon.

Small prospectors in the Mojave Desert made very little money. It was "boom-or-bust" mining. As soon as a strike played out, miners moved on, leaving ghost towns behind.

The biggest problem preventing profitable mining, even by organized companies, was the cost of transportation. The coming of the Santa Fe Railroad changed everything. Along the railroad line, water and other supplies were available to facilitate the exploitation of the desert. In the years 1900 – 1919, when rail transportation was fully developed, more mines were open and profitable than at any previous time. Towns such as Ivanpah, Cima, Kelso, Goffs, Fenner, and Essex owe their creation to the railroad.

Demand increased for copper, lead, zinc, gold, and silver. During World War I, demand also increased for chromium, manganese, tungsten, and vanadium. Mining slowed down after the end of the war. However, with World War II came another increase in demand for base metals; mines were reopened for the duration of that war. Today, most mining is for gold and non-metals, such as clay and talc.

The Coming Of Cattle

Cattle ranchers in other areas probably heard rumors of fine pastures in the high desert from miners traveling through. The high desert then had adequate rainfall to provide good browse in the winter and fall. The first attempts at cattle raising took place in the early 1860s — stockmen grazed cattle in the high desert in the winter and along the river or wash bottoms in the summer. These ranches provided cattle, hay, and food for local miners. A decrease in rainfall and restrictions set after the establishment of some park areas have brought the cattle industry to an end in many areas of the Mojave Desert.

Land For Free

Starting in the early 1900s, land was homesteaded in the Mojave Desert. In many areas 160-acre parcels were available. Claimants had three years to "prove up" on their property. "Proving up" meant building a small cabin and an outhouse. When the "proof," a photo was mailed to Washington, D.C., the claimant received a deed to the property.

There were several wet years beginning in 1912, and crops were good enough to attract more people to the area. Veterans of World War I, suffering the effects of mustard gas, came hoping to benefit from the dry desert air. Later, because of hard times created by the Depression, some people sought out a rural lifestyle where they could raise their own food without relying on unstable markets and unpredictable prices.

But the rains didn't last. The scarcity

of water led to conflicts between homesteaders and ranchers over water rights. In the Mojave National Preserve the Rock Springs Land and Cattle Company had enjoyed exclusive use of the water and the land for the last fifteen years and had filed claims on them. Homesteaders drilled water wells, but were unsuccessful. In many cases, water had to be hauled several miles even for household purposes. Crops depended on rainfall. Several years passed with little or no rainfall and the crops failed.

This scenario was repeated in many areas. Besides the scarcity of water, life in the desert presented other challenges. Temperatures were extreme for those used to more temperate climates. Few homesteaders met the challenge. Many farms and small homesteads were abandoned, leaving behind the tiny cabins which still litter the desert in some places.

The Real Gold

Hoover Dam, which was completed in 1935, created Lake Mead. It took five thousand men, working day and night, five years to complete construction of the dam. Davis Dam was completed in 1953, downstream from Hoover Dam, and controls the flow of water from Lake Mohave.

Today over twenty million people can prosper in the area, thanks to the availability of the real gold — water. The area's future depends on the wise use of this limited resource.

Activity 1
Water Conflicts

OBJECTIVES: Describe circumstances in which interests may conflict in land and water rights. Evaluate points of view which may arise under such circumstances.

MATERIALS: A room arranged as a courtroom.

SUBJECTS: Drama, social studies.

SKILLS: Analysis, application, discussion, evaluation, inference, listening, problem solving, public speaking, research.

METHOD: Students participate in a role-playing activity. In the early twentieth century there were many conflicts between ranchers and homesteaders, particularly over water rights. The main purpose of this exercise is to provide students with the opportunity to look at various points of view in a land use issue.

1. Set up a role-playing situation in which students become:

- cattle ranchers
- homesteaders
- jury (twelve members)
- judge
- two lawyers
- witnesses (as many as needed — identify characters and perspectives which would be useful)

2. Provide students with background information: The year is 1910. The cattle companies have had exclusive use of the water and land for the last fifteen years. The companies' claims are now up for renewal. The United States government has set aside parcels of land for homesteaders adjacent to the cattle ranches, and more people are beginning to move into the area. The homesteaders need water for irrigating their crops and for personal use. However, the springs used by the ranches are the sole water sources. Wells on the homesteaders' land have so far been unsuccessful in providing enough water. A conflict over water rights has arisen. Ask them to describe any similar situations they may know about.

3. Provide time (a few days to a week) for students to research their positions and to develop their cases. During this time, ranchers and homesteaders will prepare their testimony, judge and jury will prepare to hear the case (plan procedures, etc.), and lawyers and witnesses will also prepare.

4. After all testimony has been given and opportunity for rebuttal provided, the jury should meet briefly to reach a decision. They should then return to report to the entire class, explaining the reasons for their decision.

5. Ask the students to discuss the results. What were the issues involved? What arguments support each side? Which arguments, if any, seem most persuasive? Which do not and why? What additional information, if any, would have been helpful to have in reaching a decision in this situation? Where and how could we get that information, if we need it?

EXTENDING THE EXPERIENCE: Have students research any local conflicts regarding water and mineral rights and other land use issues. Select students to present varying points of view. Follow these issues with newspaper articles posted on a classroom bulletin board.

Activity 2
Pulling Up Stakes

OBJECTIVES: Discuss and write about the inspirational value of the experience of the early settlers.

MATERIALS: Samples of pioneer poetry, cowboy songs, and early expressions; writing and drawing materials.

SUBJECTS: Art, language arts, social studies.

Fun Facts — A MINER'S VOCABULARY

amalgamation — a process using mercury to collect fine particles of gold or silver from pulverized ore. Both precious metals attach to the silvery liquid, while rock does not. They can later be collected by heating the mixture until the mercury forms a gas and rises, leaving the gold and silver behind.

bonanza — discovery of an exceptionally rich vein of gold or silver.

claim — a parcel of land that a person is legally entitled to mine because he had staked it out and recorded his title. The dimensions vary according to local laws and customs.

claim jumping — stealing someone else's mining property, usually after it had been staked out but before it had been officially recorded.

colors — the particles of gold gleaming amid the residue in a prospector's pan after washing.

coyoting — a method used by miners to reach gold deposits resting on bedrock without excavating all of the overlying soil. After a vertical shaft (called a coyote hole) was sunk, tunnels radiating like wheel spokes were dug along the bedrock.

cross-cut — a mine tunnel going across an ore vein, used for ventilation and communication between work areas.

drift — a mine tunnel following the direction, or "drift," of a vein, opposite of a cross-cut.

giant powder — a miner's expression for dynamite.

grubstaking — supplying a prospector with food and gear in return for a share of his findings.

hard rock — ore that can be removed only by blasting, as opposed to ore that can be worked with hand tools.

high grading — the theft of chunks of ore by mine employees, who usually took only the valuable high-grade pieces.

lode — a clearly defined vein of rich ore. The principal vein in a region is called the "mother lode."

muck — the debris left behind after blasting hard rock. The miner who shoveled this ore-bearing material into a car or chute was known as a mucker.

placer — a deposit of sand, dirt, or clay, often in an active or ancient stream bed, containing fine particles of gold or silver, which can be mined by washing.

pyrite — fool's gold, a mineral composed of silicon and oxygen that is often mistaken for real gold.

quartz — a crystalline mineral, often transparent, in which gold and silver veins are most commonly found.

salting — planting rich ore samples in an unprofitable mine to attract unwary buyers.

shaft — a vertical or inclined excavation, usually a mine's main entrance and hoist way leading to the tunnels where the ore is dug.

sluice — a wooden trough for washing placer gold. As soil is shoveled into a steady stream of water, gold and other heavy particles sink to the bottom where they are caught by cleats, known as riffles. Some small, portable sluices, or rockers, can be rocked back and forth like a cradle to hasten the washing of gold.

stamp mill — a device that was powered by steam or water in which ores were pounded to a fine powder by heavy iron stamps, rising and falling like pile drivers.

widow-maker — a compressed-air drill, used to bore holes for dynamite in hard rock. Prolonged inhalation of the fine dust created by early models of this drill subjected miners to a deadly lung disease called silicosis.

winze — a passageway usually connecting two tunnels at different levels.

SKILLS: Description, drawing, invention, observation, writing.

METHOD: Students will imagine themselves to be early settlers in the western desert (miners, ranchers, trappers, explorers, homesteaders, etc.) and then write a poem or story.

1. Ask everyone to close their eyes for a few minutes and imagine what it must have been like to be one of the early settlers. Imagine crossing the desert, on foot or by wagon, looking for water, shelter, and food. Imagine being a miner and searching for gold. Imagine homesteading and creating a farm out of the desert. Imagine yourself to be a rancher and raising cattle. You can guide their imagery with a few words or leave them on their own. Read to the students

from an actual pioneer diary or pioneer poetry related to early life in the desert.

2. Have students draw pictures to describe what they imagined and then ask everyone to write a short poem or story. Poems can be free verse or rhyming. Consider writing a group poem or story. Stories might begin with "The first day I arrived in the desert I . . . "

3. Encourage students to share their poems and stories with the class. Put them together in a class book about the westward movement. Share the book with other classes.

EXTENDING THE EXPERIENCE:
Do research on early routes that settlers followed coming west. Have students draw maps to go with their stories or poems, showing the possible route their story or poem might be describing.

Activity 3
To Tell The Truth

OBJECTIVES: Name an early American tool or piece of machinery and describe its use.

MATERIALS: Butcher paper; drawing materials; index cards; masking tape; pictures of old tools, machinery, and appliances.

SUBJECTS: Art, drama, language arts, social studies.

SKILLS: Description, discussion, drawing, invention, observation, public speaking, small group work, writing.

METHOD:

1. Find pictures of old tools, machinery, and appliances. Excellent sources are books by Eric Sloane, such as *A Museum of Early American Tools*. Enlarge the pictures, attach a description of what it is and how it was used on the back of each, and laminate. Make enough to give one to each group of three or four students.

2. Split the class into groups. Give each group a picture, telling them not to let other groups see the names or descriptions. Allow groups to go off to separate areas to discuss their pictures. Each group will decide who is to present the real description of the object. Others in the group are to make up phony, yet perhaps believable, descriptions (and names, if they wish).

3. When the class gets back together, have each group come tot he front one at a time. Holding up the picture, each student describes what it is and how it was used.

4. The class votes to select which group member they think is telling the truth. Repeat for each group. Discuss the creativity of the other descriptions.

EXTENDING THE EXPERIENCE:
Place a butcher paper time line along a classroom wall. Copy the dates and the inventions from page 7 onto index cards. Pass out cards to students. Have them place the cards on the time line. Then have students select a date and draw a picture of how their early home might have looked, inside and outside. Remind them to pay attention to furnishings and other items.

Activity 4
Way Back Then

OBJECTIVES: Name two activities people did in the 1800s that are still done today and two that are no longer done by most people.

MATERIALS: Discovery Activity Page #1.

SUBJECTS: Language arts, social studies.

SKILLS: Comparison, discussion, interview, listening, writing.

METHOD:

1. Hand out the activity page, go over the directions, and have students complete it at home.

2. When the activity page is completed, discuss the results. How old were the oldest people they talked with? Can they think of other activities they've done that people did way back then?

EXTENDING THE EXPERIENCE:
Have students interview older people they know who have lived in the community a long time. Help prepare questions to ask. The interviews could be done in small groups. They may want to tape-record them. Select some of these old-timers to come to talk to the whole class. Use the information gathered to put together a class book on local history.

Changing Times

FAIRY TALES

9th century	*Cinderella*
1553	*Puss-in-Boots*
1636	*Sleeping Beauty*
1697	*Little Red Riding Hood*
1697	*Mother Goose*
1812	*Hansel and Gretel*
1812	*Snow White*
1831	*Goldilocks and the Three Bears*
1835	*The Princess and the Pea*

SONGS

1609	Three Blind Mice
1744	London Bridge
1765	Twinkle, Twinkle Little Star
1818	Silent Night
1832	America
1848	Oh Susanna
1853	Pop Goes the Weasel
1867	Mary Had a Little Lamb
1883	Polly Wolly Doodle
1884	Clementine
1899	She'll Be Coming Round the Mountain

AMUSEMENTS

40,000 ago	dolls, Africa and Asiayrs.
3,000 B.C.	marbles, Egypt
3,000 B.C.	tops, Babylonia
2,000 B.C.	checkers
1,200 B.C.	kite, China (first used as military signaling device)
1,000 B.C.	hula hoop, Near East
1,000 B.C.	yo-yo, China
5th century	chess
10th century	firecrackers, China
1570	Parcheesi, China
1902	teddy bear (named for bear cub Teddy Roosevelt refused to shoot)
1913	crossword puzzle
1931	Scrabble
1933	Monopoly

FOODS

4,000 B.C.	pie
2,000 B.C.	cookie
1847	doughnut with hole
1853	potato chip
1880s	hotdog (called frankfurter, came from Frankfurt, Germany with immigrants)
1880s	hamburger (came from Hamburg, Germany with immigrants)
1893	Cracker Jacks
1895	fig newton
1902	ice cream cone
1928	Double Bubble gum
1930	chocolate chip cookie (at Toll House Inn)

CONVENIENCES

1826	matches
1870	can opener
1870s	rubber hose (used leather fire hoses before)
1883	brown paper bag
1884	toilet paper
1907	paper towel
1920	hair dryer
1924	Kleenex
1947	aluminum foil
1940s, 1950s	plastics

CLOTHING

1820	blouse
1860s	Levis jeans (Levi Strauss began making pants for gold miners)
1893	zipper (to replace shoelaces on high boots, not on clothing until 1920s)
1910	sneakers (Keds started in 1917)

AROUND THE HOUSE

early 1800s	people used spinning wheels, candles for light, and plows
1803	ice box (wooden chest with tin container to hold ice)
1860s	gas lights
1870s	flush toilets becoming popular
1879	first electric light
late 1800s	bathtub (tin or wooden tub used before)
1890s	flashlights
1906	electric iron
1939	washer, dryer automated

COMMUNICATION, MUSIC, AND PHOTOGRAPHY

1860	pony express between St. Joseph, Missouri and Sacramento
1876	first telephone communication
1877	cylinder phonograph
1887	first flat record
1899	Kodak box camera
1920	radio shows
1945	television
1970s	VCR searly
1980s	personal computers
1980s	Nintendo

GETTING AROUND

mid-1700s	Conestoga (covered) wagon
1810	steamboat
1813	buckboard wagon
1830s	railroad car and engine
1869	transcontinental railroad
1903	Wright brothers fly
1909	first model T on sale
1939	jet engine
1961	first man in orbit

SPORTS

10th century	lawn bowling
1572	ice-skatingearly
1800s	roller-skating
mid-1800s	swimming as a sport
1855	ice hockey
1860	croquet comes to
U.S.1866	baseball becomes
popular1869	football (developed from rugby)
1873	tennis, Wales
1880s	skiing as a sport (first used in war)
1885	modern bicycle
1886	soccer comes to U.S.
1891	basketball invented

Discovery Activity Page #1

Way Back Then

This is a list of some activities people did in the 1800s and early 1900s. How many have you done? What about your parents? How about one of the oldest people you know?

HAVE YOU EVER:	YOU	YOUR PARENTS	AN EVEN OLDER PERSON
Carried firewood?			
Cut wood with a hand saw?			
Watched a hen lay an egg?			
Fed chickens?			
Ground corn for corn bread?			
Baked bread?			
Churned butter?			
Milked a cow?			
Planted a vegetable garden?			
Picked and eaten wild greens?			
Ridden a horse?			
Brushed a horse?			
Ridden in a horse-drawn wagon?			
Seen a field plowed with a horse-drawn plow?			
Dyed yarn with plant dyes?			
Spun wool?			
Tracked an animal?			
Gone fishing?			
Cleaned a fish?			
Visited a farm, mine, or cattle ranch?			
Sung a pioneer song?			
Made a pioneer toy?			
Dug a fence post?			
Panned for gold?			

MAKING A DIFFERENCE

Often students think they are too young to make a difference. Many Americans believe that an individual can't change a majority. History has proven the opposite is true. McDonald's changed from styrofoam to paper because of a school campaign and boycott. **Your class can make a difference**. It's up to you, the teacher, to challenge your students to work to change the world for the better.

MAKING A DIFFERENCE

After having explored the different aspects of the Mojave Desert, you and your class may be wondering what you can do to make a difference. Your students can now become teachers, passing the information they have learned to others. They can help others to recognize the different Mojave Desert ecosystems and to understand why each is important. There are a variety of ways to share the information learned.

Bulletin Boards — A school bulletin board presents an opportunity for creative sharing, combining art, writing, and research into one project. Bulletin board displays can include the different desert communities, inhabitants, and habitats. Endangered species and their protection can provide a focus for each community. Boards can also show how each community is intertwined with the others. This will give students an opportunity to conduct research and to look more closely at individual species of plants and animals. If a board is not available, consider creating an entire desert ecosystem hallway, from floor to ceiling, with wildlife peeping out from all corners.

Adopt — In many areas there are "adoption" programs. Your students might adopt a beach, an area in the desert, a piece of highway, or even a schoolyard. It will be their responsibility for the school year to keep the area clean and litter free. At the same time students can explore the concept of the "Three Rs": reduce, reuse, and recycle. Adopt the concept of the three Rs in your classroom. How can the students reduce, reuse, and recycle the things they use in school? Now look at home. How can students apply those concepts to their home life? Relate these discoveries to the preservation of the desert and the Earth.

Go Native — Have the students look at your schoolyard. What types of

plants are used in landscaping? Are the plants native to the desert, or do they require lots of water? Xerophytic plants are those adapted for growth under dry conditions. If your school did not landscape for the desert, have the class find out about planting a native plants garden. Often local nurseries will donate desert plants for such projects. Let the class explore the avenues of change. Who must be contacted, and what must be done to effect change? Each school will have different procedures. Your students may find it challenging to change the minds of administrators, school personnel, other students, and parents in regard to the benefits of xerophytic landscaping.

Write — Most areas have local nature clubs or chapters of better known national groups such as the Sierra Club and The Nature Conservancy. These organizations usually have members willing to come to classes and speak about the resource issues with which they are most concerned. Have your class contact a group to learn about these issues. Your students can then voice their opinions through letters to local and national politicians. Most politicians listen seriously to the concerns expressed by students, even though they are not yet voters, and this can be an important empowering experience for young people.

Advertise — Radio and television stations are required to present public service messages. Have your class contact the local stations and offer to write and record a public service message on preservation of the Mojave Desert. Why not involve drama and music teachers in this effort? Students can also contact local groups for information and support of desert environments.

Celebrate — As a culmination of Mojave Desert studies, your students may want to plan a "Desert Celebration." This is a way to get the entire school involved and to create awareness of the wonders of the desert. The class can make canvas grocery bags decorated with desert scenes. Students can make individual pledges, both written and spoken, to help protect the desert. The written pledges can be collected and displayed in a public area. Desert community mobiles can be made and hung in the classroom, cafeteria, auditorium, and front office. A large mural of the desert can be made and hung in the school. Many local businesses and malls welcome the opportunity to display school creations. Students can create posters, bumper stickers, and buttons as a way of enhancing desert awareness.

MAKING A DIFFERENCE

Volunteer — Within the Mojave Desert there are a variety of parks and agencies — local, state, and federal — that can offer your class an opportunity to make a difference in the community. Frequently there are a number of projects, such as revegetation of picnic areas or the creation of trail brochures, that cannot be funded and, therefore, remain unfinished. Individual volunteers and volunteer groups are often sought to contribute to the project's completion. Contact these agencies regarding projects that can involve your class.

Other Class Project Ideas:

- Create a slide program or video about your local desert.
- Create a play starring desert creatures.
- Create a parade float in support of desert conservation.
- Create a book of collected poems students have written about their desert home.
- Create and perform a desert rap. How about a raptor rap or a reptile rap?
- Sponsor a Desert Dime-A-Dance and give the proceeds to a desert conservation program.

RESOURCES

Entries preceded by * are children's books.

Animals

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Ortleb, Edward P., Nancy D'Arcy, Dolois Pepple, and Diane Robinson. *Wildlife Populations and Resources*. St. Louis: Milliken Publishing Co., 1991.

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Steinhart, Peter. *California's Wild Heritage — Threatened and Endangered Animals in the Golden State*. San Francisco: Sierra Club Books, 1990. *(out of print)*

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_____, Gabrielson, and Robbins. *Birds*. New York: Golden Press, 1987.

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www.nps.gov

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www.nps.gov/deva

JOSHUA TREE NATIONAL PARK
www.nps.gov/jotr

LAKE MEAD NATIONAL RECREATION AREA
www.nps.gov/lame

MOJAVE NATIONAL PRESERVE
www.nps.gov/moja

RED ROCK CANYON NATIONAL CONSERVATION AREA
www.redrockcanyon.blm.gov

DESERTS USA
www.desertusa.com

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Sources for Supplies

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P.O. Box 188
Death Valley, CA 92328
760-786-3285

JOSHUA TREE NATIONAL PARK ASSOCIATION
74485 National Park Drive
Twentynine Palms, CA 92277
760-367-5525

RED ROCK CANYON INTERPRETIVE ASSOCIATION
HCR 33, Box 5500
Las Vegas, NV 89124
702-363-1921

SOUTHWEST PARKS AND MONUMENTS ASSOCIATION
221 N. Court Avenue
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