

Information for Teachers and Suggested Activities



Docent-facilitated explorations

The purpose of the attached material is to introduce you and your students to Tohono Chul Park and give you an idea of what to expect during your guided tour. The materials are offered as preparation for your visit, and as ideas for additional activities in your classroom. These are suggestions only, and may be adapted to a wide range of ages, abilities, and grade levels (K-6). If you have any questions, please give us a call at 742-6455 x 228.

Guided Tours at Tohono Chul Park and the Arizona Standards

Depending on the grade level of your class, and your area of study, a docent-guided tour at Tohono Chul Park will touch on most, if not all of the following Arizona Standards:

Arizona Science Standards

Standard 1: Science as Inquiry

- 1SC-R2. Ask questions about the natural world
- 1SC-R6. Communicate observations and comparisons through various means
- 1SC-F4. Describe relationships among parts of a familiar system

Standard 3: Personal and Social Perspectives in Science and Technology

- 3SC-R2. Use simple technology (magnifiers)
- 3SC-F3. Describe and explain the interrelationship of populations, resources and environments
- 3SC-P4. Identify and describe the basic processes of the natural ecosystems and how these processes affect, and are affected by, humans
- 3SC-P5. Describe and explain factors that affect population size and growth (e.g., quality of environment)

Standard 4: Life Science

- 4SC-R1. Distinguish living from non-living things
- 4SC-R2. Describe the basic needs of living organisms
- 4SC-R3. Recognize and distinguish similarities and differences in diverse species
- 4SC-F1. Describe and explain cause-and-effect relationships in living systems
- 4SC-F2. Trace the life cycles of various organisms
- 4SC-F3. Identify the basic structures and functions of plants and animals

- 4SC-F4. Identify characteristics of plants and animals (including extinct organisms) that allow them to live in specific environments
- 4SC-F7. Explain the interaction of living and non-living components within ecosystems
- 4SC-E7. Explain and model the interaction and interdependence of living and non-living components within ecosystems, including the adaptation of plants and animals to their environment
- 4SC-P6. Describe and explain how the environment can affect the number of species and the diversity of species in an environment

Standard 6: Earth and Space Science

- 6SC-R2. Understand that the sun heats and lights the earth
- 6SC-R3. Identify how the weather affects daily activities
- 6SC-R4. Identify basic earth materials (rocks, soils, water) and their common uses
- 6SC-F3. Identify the seasons and their characteristics

Arizona Social Studies Standards

Standard 3: Geography

- 3SS-F2. Identify natural and human characteristics of places and how people interact with and modify their environment
- 3SS-E2. Describe the impact of interactions between people and the natural environment on the development of places and regions in Arizona, including how people have adapted to and modified the environment
- 3SS-E7. Explain the effects of interactions between human and natural systems, including the changes in the meaning, use, and distribution of natural resources, with emphasis on ways that humans depend upon limited resources and adapt to, and affect, the natural environment, changing ideas and disagreements on the best use of natural resources

If your docent-guided tour includes the topic of ethnobotany, it will cover most, if not all of the following Arizona Standards:

Arizona Social Studies Standards

Standard 1: History

- 1SS-F2. Describe everyday life in the past and recognize that some aspects change and others stay the same
- 1SS-F3. Use stories to describe past events, people, and places
- 1SS-E2. Describe the legacy and cultures of prehistoric American Indians in Arizona, including the impact of, and adaptations to geography

If your tour includes the changing indoor art/culture exhibits, the docent-guided tour will also include the following Arizona Standards:

The Arizona Arts Standards – Visual Arts

Standard 1: Creating Art

- 1AV-R2. Recognize that the visual arts are a form of communication

- 1AV-R3. Identify various subject matter, ideas, and symbols (e.g., lion representing courage, heart symbolizing love, road conveying journey) used in the work of others to convey meaning
- 1AV-R4. Begin to look at, and talk about, art

Standard 2: Art in Context

- 2AV-R2. Recognize and articulate how visual arts represent many cultures, times and places
- 2AV-E4. Describe the role art plays in culture and how it reflects, records and shapes history in various times, places and traditions



a tour of one of the Park's art exhibits

Standard 3: Art as Inquiry

- 3AV-R1. Identify design elements (e.g., line, color, shapes, texture) and design principles (e.g., balance, repetition, emphasis, perspective) and how they are used by visual artists to communicate meaning
- 3AV-R2. Know that art is a visual language and is a form of expression and communication
- 3AV-R3. Recognize and describe the many ways to create, value and respond to art
- 3AV-R4. Recognize and respect that there are many valid responses to works of art that may be different from their own
- 3AV-F2. Understand there are various purposes for creating works of art
- 3AV-F5. Describe how personal experiences and outside influences may affect the work of an artist, as well as the perceptions of the viewer

BEFORE YOUR VISIT

What is a Desert?

A desert is an ecosystem in which productivity is limited by water. In the strict sense, a desert is defined as a region that receives less than 10 inches of rain per year; but in practical application the climate, landform, soils, and vegetation are all considered when defining a region. Deserts, and the vast areas of arid grasslands and scrublands that often border them, cover about 30% of the earth's land area, and the area of the world's deserts is expanding.

The common denominator of all deserts is a lack of moisture. The availability of water is modified by seasonal fluctuations in length and intensity of rainfall, rate of evaporation, and the nature of the soil. ***Arid climates are those in which rainfall amounts are exceeded by greater losses in moisture through evaporation - it's not the amount of annual rainfall that determines a desert, but the ratio of precipitation to evapo-transpiration.*** Evapo-transpiration is defined as the total water loss from an area, by evaporation from the soil and by transpiration of water vapor from plants. The rate of evapo-transpiration is increased by high temperatures, low humidity, and drying wind. Many plants which are not adapted to arid environments would wilt and die on a hot, dry, windy day in the desert - even if growing in good, continuously damp soil.

The world's great deserts occur in about 30 degrees north and south of the equator, the "horse latitudes". They are sometimes called trade wind or subtropical deserts. Planetary air circulation is such that warm air masses in the equatorial regions rise and flow toward the poles. As the air rises, it cools, and can hold less water vapor, which then precipitates out as rain. The same mass of air then descends in the regions of the "horse latitudes" (30 degrees north and south of the equator), creating an area of high pressure. The air warms as it descends and absorbs moisture in the form of water vapor, resulting in low rainfall. The deserts of Mexico and the Southwest United States are primarily a result of this prevailing year-round trend of descending, warm, dry air.

Rain Shadow or **Relief** deserts occur in the rain shadows of high mountains (lee side) and on high inland plateau regions. The air rising over a mountain range cools and drops most of its moisture on the windward slopes. As it descends on the other side of the range, it warms and absorbs water vapor, resulting in low precipitation. The same cooling, drying effect occurs as air masses ascend the slopes of high plateaus.

The Sonoran Desert

A subtropical desert, distinguished by features of both horse latitude and rain shadow deserts, it lies in portions of Arizona; Sonora and Baja California, Mexico; and southeast

California, encompassing approximately 120,000 square miles. Rainfall is biseasonal, with most of the precipitation falling in the winter and summer rainy periods. **Precipitation** ranges from 1 to 15 inches annually. Summer temperatures can be very high and winters are mild with only brief periods of freezing temperatures. The vegetation of much of the Sonoran Desert is more varied than that of any other North American desert, visually dominated by two life forms: legume trees and columnar cacti. Additionally, the desert supports a rich spectrum of some 2,500 plant species.

The amount of rain and the seasons in which it falls are the factors that make the Sonoran Desert what it is. Warm, cloudless days prevail during much of the year. Shielded from large, frequent Pacific storms by the high mountain ranges that lie along its western boundary, the Sonoran Desert receives only a small amount of rain during the winter. That which occurs falls primarily in the northwestern portion. Even during the summer "**monsoon season**", when moisture laden air sweeping in from the Gulf of Mexico causes large thunderstorms, only a few inches of precipitation fall on the desert itself, simply because the desert lies so far from the Gulf.

ACTIVITY - Evaporation

A simple way to illustrate evaporation is to wipe a damp sponge across a blackboard. Wait a few seconds for dry patches to appear and then ask your students "where did the water go?" (it changed from a liquid to invisible water vapor). Other examples would be clothes drying in the sun, wet streets after a rain.

Or, set out 2 pans, each with a half inch of water in them. Put one in the sun and one in the shade. At the end of the day have students measure the difference (heat speeds up the evaporation process).

To illustrate evaporation as a cooling mechanism, have students dip one arm in water. Wave both arms in the air. Which one feels cooler? This is the function of sweat - to cool the skin. How do animals stay cool? What about panting dogs? (Panting evaporates moisture from the mouth and lungs, cooling the animal inside.)

Tucson lies within the *Arizona Upland* subdivision of the Sonoran Desert. The saguaro-palo verde plant communities that surround the city are characteristic of this subdivision. The area is dominated by low mountain ranges with their **alluvial fans** and **bajadas**. There is not much flat, valley floor as compared to other areas of the Sonoran Desert. The average annual rainfall at the weather station at Tucson International Airport is 11.05 inches. Rainfall occurs primarily in the winter from December through March and in the summer from July through early September. The winter rains may fall intermittently for several days from cool, low pressure systems moving across from

the Pacific Ocean. Heavy snow often falls in the higher mountains and the Tucson area receives a light dusting of snow every several years. The majority of the rain falls during the summer monsoon season. The localized and often violent thunderstorms can drop prodigious amounts of rain in a short time. High winds, vivid lightning, and hail make these storms both spectacular and potentially dangerous.

Climate more than any other factor, influences the vegetation of an area. In the area surrounding Tucson, one can travel from saguaro cactus to ponderosa pine in less than one hour. The Santa Catalina Mountains are a fine illustration of this. The lower slopes have the saguaros, palo verde, and other plants typical of the Sonoran Desertscrub that surrounds Tucson. These gradually give way to semidesert grassland or chaparral and then to oak woodland vegetation. Higher up, there are pine-oak forests and the highest parts of the mountain range support a forest of pine and fir trees with aspen and maples. These plants thrive in the cooler, moister "island-in-the-desert" environment over a mile above the desert valleys.

QUESTION/ANSWER - Temperature 1

Have you ever noticed the drop in temperature while crossing a desert wash at night? Cold air, being heavier than warm, tends to flow down the mountain canyons and settle in low-lying areas, resulting in a temperature inversion. These colder, low-lying areas may be 10 degrees colder at night than surrounding areas and are sometimes called "frost pockets". The lighter, warm air forms "thermal belts" in areas with good air drainage. These thermal belts may be several degrees warmer than surrounding areas and much warmer than the frost pockets on a relatively still night. Strong winds will break up the inversion layers.

Desert Adaptations

Understanding the "why" of a desert leads to the "how". How do the plants and animals of the Sonoran Desert region survive blazing temperatures and lack of moisture? By **adapting** to their environment; by finding the habitat that allows them to live and reproduce. Some plants do it by storing water, others find ways of cutting down on the loss of available moisture. Still others simply "die" when it gets too hot and dry and come back to life when growing conditions are right.

Plants

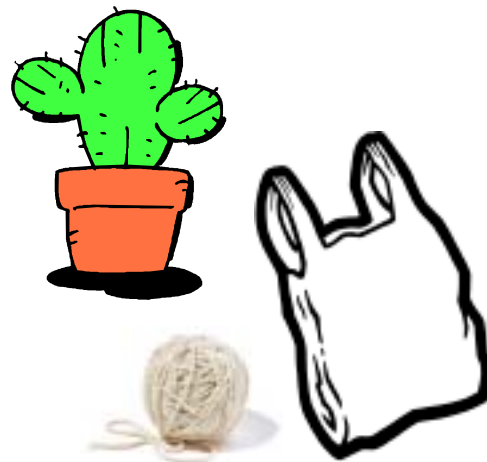
Plants are the only organisms that manufacture their own food, through the process of **photosynthesis**, using sunlight, water and carbon dioxide as raw materials. A necessary part of this process is **chlorophyll**, a green

pigment found in the leaves of most plants. In many desert plants where leaves may be absent for all or much of the year, this process can take place in the stems (palo verde/cactus). Having converted the necessary moisture and carbon dioxide into usable "food", the plant releases water and oxygen into air through **transpiration**, a process which can be compared to breathing in humans.

Stomata, small pores on the leaves and stems of plants, are opened and closed to allow the absorption of CO_2 and the release of O_2 . Each time they open or close, precious water is lost to evaporation. Most plants can afford this water loss, but not desert plants. Succulents perform photosynthesis during the day, but unlike other plants, most of them transpire at night when temperatures are cooler and water loss is minimal, storing CO_2 for later use during the day.

ACTIVITY - Transpiration

Secure a plastic bag over the top of a small cactus plant, or go outside and find a creosote bush; put the bag over the end of one branch and secure it with a string or rubber band. Check it in about an hour and see the **condensation** forming on the inside of the plastic. You can also do this with an ordinary house plant and compare water loss between the two. Which has lost more moisture? Why?



In response to the dangers of water loss, three basic types of adaptations have evolved to combat the climatic rigors of the desert:

succulence - endure

drought avoidance - escape

drought dormancy - evade

Succulence refers to the ability of a plant to *store* water in fleshy leaves, stems or roots for use during periods of drought (agave, saguaro, night-blooming cereus). These plants often have visible pleats or folds which expand or contract as the plant loses or gains moisture. All cacti are

succulents, as are such non-desert plants as agave, aloe and many euphorbias. The saguaro is a stem succulent, while the agave is a leaf succulent. A good rule to remember is that *all cacti are succulents, but not all succulents are cacti*.

ACTIVITY - Succulence

Have pictures of saguaro cacti on hand, or go outside to give students a close-up look. To illustrate the storage ability of a saguaro cactus, have your students stand in a circle and join hands. Ask everyone to slowly move backward to make as big a circle as possible - the saguaro is absorbing water during a heavy summer rain. Next, everyone moves slowly forward to make as small a circle as they can - the saguaro is using that stored water during a dry spell.

Or, make saguaros from paper. Using a sheet of 8½ x 11 paper, fold it as you would pleat a fan, with folds about an inch wide. Staple the edges of the paper together to form a cylinder. Hold it upward with one hand inside, pressing it outward to show how the "pleats" in the cactus expand, becoming less noticeable. Withdraw your hand, pushing the pleats back into place to show how the cactus looks when it shrinks.



Drought avoidance is demonstrated by many desert wild flowers. The technique here is basically *escape*. By storing all of its available energy in its seeds, a plant can dry up and die during periods of drought. The seed, lying dormant in the soil, waits out the dry period, giving birth to a new plant only when its specific requirements are met - moisture and temperature levels (wildflowers). This may be yearly, or may occur only every ten or twenty years.

Drought dormancy refers to the plant's ability to withstand moisture deprivation by *conserving* what moisture it has, often shedding its leaves during periods of no rainfall (ocotillo). Some plants have photosynthetic stems so that leaf loss does not effect food production (palo verde). Smaller leaves reduce the surface area that is subject to desiccation and also break up drying wind currents (ironwood, mesquite). In plants which do not shed their leaves, the leaves may fold up when it is too hot and

dry (mesquite); there may be a waxy surface on the leaf (jojoba, creosote) which inhibits moisture loss; a shiny leaf surface will reflect light and reduce temperature; while fuzzy or hairy surfaces shade the leaf. Plants growing from bulbs or tubers produce stems only under favorable conditions, otherwise dying back to ground level (coyote gourd, wild onions).

These basic drought-coping strategies are not exclusive categories. Some desert plants have masses of shallow roots extending out from the plant in all directions. The roots are usually as long as the plant is tall. After the slightest rain many small hair-like roots can quickly develop to help the plant absorb water. Other plants, for instance mesquite, blue palo verde and ironwood, tap underground water with deep root systems often extending 100 feet. This is a form of *drought avoidance*, since these plants are less dependent on seasonal variations in rainfall. When their water supply is exhausted, however, they drop their leaves and become **dormant**. Similarly, succulents become dormant during prolonged droughts. Spines on desert plants help reduce moisture loss by breaking the wind, casting shadows on the plants and help to protect them from animal predation.

The creosote bush is an example of several desert survival strategies. Small leaves do not transpire much moisture, they are also covered with a waxy substance to retard moisture loss and both leaves and branches can be shed during times of little rain.

ACTIVITY - Water Conservation

Put vaseline on one side and all the edges of a small sponge. Place it, along with an uncoated sponge of the same size, in a shallow pan of water. Let both sponges soak up all the water they can hold. Take them out, set them on a plate and measure how long it takes for them to dry out. The vaseline will prevent the one sponge from drying out too quickly - just like the waxy coating on the leaves of a succulent keeps moisture in the plant.

ACTIVITY - Cactus Shadows

Shine a flashlight on a cactus to replicate the shadows cast by the sun's rays. What benefits do the shadows provide? Also note that the *shape* of the cactus itself, cylindrical (saguaro) or flattened (prickly pear), will help protect the plant from the sun by leaving less area exposed to its drying rays.



ACTIVITY - What's In A Name?

Have students draw pictures of how they think some desert plants with descriptive names would look, for example:

barrel cactus

rainbow cactus

pincushion cactus

teddy bear cholla

octopus cactus

jumping cholla

Show them pictures of the actual plants. Do they match? How are the plants like their names? Plan to look for these species when you come to the Park.

Buy some small potted cactus or succulents for the classroom, or grow some from seeds. Plant wildflowers, too, and chart the different plants' growth rates and flowering activities. Collect a variety of different kinds of seeds and look at them with a magnifying glass. How do they look the same, how different? Put a few large, dry bean seeds (lima, kidney) in a plastic lunch bag with a damp paper towel. Place in the sun and keep the towel wet. Watch what happens!

Animals

Animals in the Sonoran Desert have also learned to adapt in different ways to the extremes of temperature and lack of moisture. To protect sensitive, moist skins from dehydration, **amphibians** living in the desert will **estivate** - burrowing deeply into the ground and remaining dormant during dry periods, resurfacing only when the summer monsoons provide the right conditions for mating and reproduction. Eggs must be laid in or near the water to allow newly-hatched larvae to enter the water easily. In some species the entire cycle from mating to egg to larva to adult may be condensed into a few brief weeks - an adaptive response to quick-drying summer rain pools (spadefoot toad).

Reptiles are better adapted to life on land than amphibians, beginning with an egg that does not require the presence of water in order to mature and hatch. A reptile's skin protects it from the dangers of dehydration and enables it to move freely. Reptiles, however, are **ectothermic**, relying on ambient temperatures around them to control their body temperature. When temperatures drop at night, it is necessary for them to move to warmer rock outcroppings and exposed areas to "soak up some rays." Color plays a role in temperature regulation as well; in some lizards, body color will darken when the animal is cool, making it more receptive to the absorption of sunlight. Warmer

temperatures will cause the color to lighten, reflecting excessive sunlight.

Birds, the next evolutionary step between reptiles and mammals, have advanced beyond the former by becoming **endothermic** - having the ability to raise body temperature above the surrounding environmental conditions by means of internal metabolism. This provides birds with a higher tolerance for changes in temperature, thus increasing their chances for survival. Bird wastes are excreted as uric acid instead of urea, saving a great deal of moisture. Urea must be kept in solution in order for it to be eliminated from the body. Birds, and reptiles, discharge uric acid with feces in a semisolid mass. Heat is tolerated through a combination of adaptations. Activity may be confined to the cooler hours of the day; wings may be spread away from the body or feathers ruffled to allow the release of heat through the skin; or a bird may use a **gular flutter**, panting much the way dogs do to release heat (birds have no sweat glands). If the heat becomes too much, they can always fly to a more suitable environment - a shaded branch, a cooling updraft at higher altitudes where soaring requires little effort, or migrate to cooler climes.

The adaptations of **mammals** combine the techniques of many other species. Some, like the kangaroo rat, never have to take a drink of water, but derive all the moisture they need from the seeds they eat. Many mammals are **nocturnal** rather than **diurnal** in their habits, preferring the coolness of evening for foraging and hunting, hiding during the heat of the day in burrows deep underground.

ACTIVITY - Temperature 2

Bury a thermometer under the ground and set another on the surface. Check the difference in temperatures during the hottest part of the day. Why are they different? How does this explain why an animal would seek shelter underground? What kinds of animals live underground?

ACTIVITY - Adaptation

Make a list of adaptation clues for several different desert dwellers. Write them on individual slips of paper. Divide students into teams,

providing each with mixed up sets of clues and pictures of the animals they refer to. The object is for the students to use reference books and your previous discussion to match clues and animals. The object is to be the first team to do so within a set time limit.

Discuss **diurnal** and **nocturnal** and have different groups of students create "day" and "night" drawings for the same desert area, featuring animals active by day and those active only at night.



Habitat

Every living species has certain requirements for survival. Where an area corresponds to these needs, the animal will usually be found; where conditions vary, sometimes by even the slightest degree, it will not. **Habitat** is more than “place”, and more than animals and plants - it includes water, soil, and the relationships between its living and the non-living elements. Rather like the pieces of a puzzle, there are five essential elements for a complete habitat: **food, water, shelter, space** and **arrangement** and they must all fit together.



The concept of **food** is not as simple as it first appears. Diet will change with the season and all animals must cope with lean times as well as those times of plenty. Some will actually store food in preparation of scarcity.

To a fish, **water** is his entire world, providing him with oxygen to breath, food to eat and the space in which to move. Other animals, and plants, need water to drink. Too much water, though, can be disastrous. Water must be of the right quality, quantity and come at the right time.

Shelter means cover for raising young, hiding from predators or protection from the elements. Shelter may be something you build yourself, dig in the ground or find along the way.

Space is “elbow room.” All animals, and some plants (like the creosote which releases chemicals designed to keep other plants from competing for limited water supplies), are territorial to a degree. Boundaries are needed to feel secure from other members of their own species. This may be space for the individual, the family or the herd.

The relationship of food, water, and shelter within a particular habitat is referred to as **arrangement**. All these elements must be properly distanced from each other - water cannot be too far from the food source and escape cover cannot be too far from either. Each species will have its own measure of what an acceptable arrangement is.

Another habitat term to be familiar with is **carrying capacity**. This refers to the ability of a particular habitat to support a given number of the kind of plants and animals found in that area. The carrying capacity of a particular habitat will change with the seasons - too much or too little water, an increase or decrease in the population of predator or prey animals. Other factors will influence capacity such as climatic changes, pollution, and habitat destruction.

ACTIVITY - Habitat Lap Sit

This illustration of the concept of habitat can be done inside the classroom, or preferably, outdoors in a large grassy area. Number students from 1 to 4, separating the resulting four groups and assigning each a concept: "1s" are food, "2s" are water, etc. Now build a circle with chains of food/water/shelter/space, alternating students in sets of four. Standing close together, have them all turn and face clockwise, place their hands on the waists of the person in front; at the count of three, have them *sit down on the knees of the person behind them*, keeping their own knees together to support the person in front. Announce that "food, water, shelter and space, in the proper arrangement represented by the lap-sit circle, are what is needed for a suitable habitat. "If things "fall apart" at this point, wait until quiet has returned and discuss the necessary components of habitat. Reconstruct the circle and then announce that a severe drought has created a shortage of water and ask all the "waters" to remove themselves from the circle - what happens now? Talk about what this would mean in the habitat you've created. What impact can be expected when different elements are in short supply, polluted or missing entirely?

DURING THE TOUR

For younger students, you can make copies of the “seek & find” lists of plants and animals most commonly seen in the Park (pp. 15-16), or create your own. During the tour, children can try to identify and ✓ as many species as they can. However, don’t let them lose sight of the purpose of the tour - it is not just about having the most check marks on your sheet, it is about learning to see what makes up our desert home.

Students can also look for evidence of animals that they may not actually see - tracks, scat, or other signs that animals “have passed this way” (p. 17). Looking for evidence of wildlife is one way to determine what types of animals are around. Signs such as webs, burrows, nests, droppings, or food litter can be identified so that even if the animal owner is not around, you can tell that he’s been there. For all ages, magnifying glasses or hand lenses can help bring the plant and mineral world “up close and personal.”

For older students, try creating your own plant observation worksheets based on the example on page 18. Reports can be written on their observations and some further research back in the classroom.

Remember to stay on the trails, walk - don’t run or climb and do not pick the plants or remove any rocks or other artifacts from the ground.

QUESTION/ANSWER - Outdoor Manners

What are “conservation values”? Before you leave the classroom for your field trip, ask students for their ideas about how people affect their environment. How should people behave when visiting wild areas? List the suggestions on the blackboard. For example: What happens when people litter? Besides making an outdoor area dirty or messy, what other affects does litter have on the environment? What about people who make a lot of noise or stray off marked trails or are careless with campfires and matches? What would happen if everybody wanted to pick wildflowers to take home? How can positive outdoor behaviors (manners) be applied to your own school yard or nearby park?



Field Study "Find" List



Saguaro



Foothill Palo Verde



Fishhook Barrel Cactus



Black-chinned Hummingbird



Creosote Bush



Velvet Mesquite



Desert Tortoise



Soaptree Yucca



Javelina



Engelmann Prickly Pear



Jumping Cholla



Cactus Wren



Cardinal



Desert Spiny Lizard



Gambel's Quail



Pincushion Cactus



Mourning Dove



Agave Americana



Ocotillo



Roadrunner



Gila Woodpecker



Black-tailed Jackrabbit



Desert Pupfish



Dragonfly



Curve-billed Thrasher



Tree Lizard



Verdin



Tarantula



Red-tailed Hawk



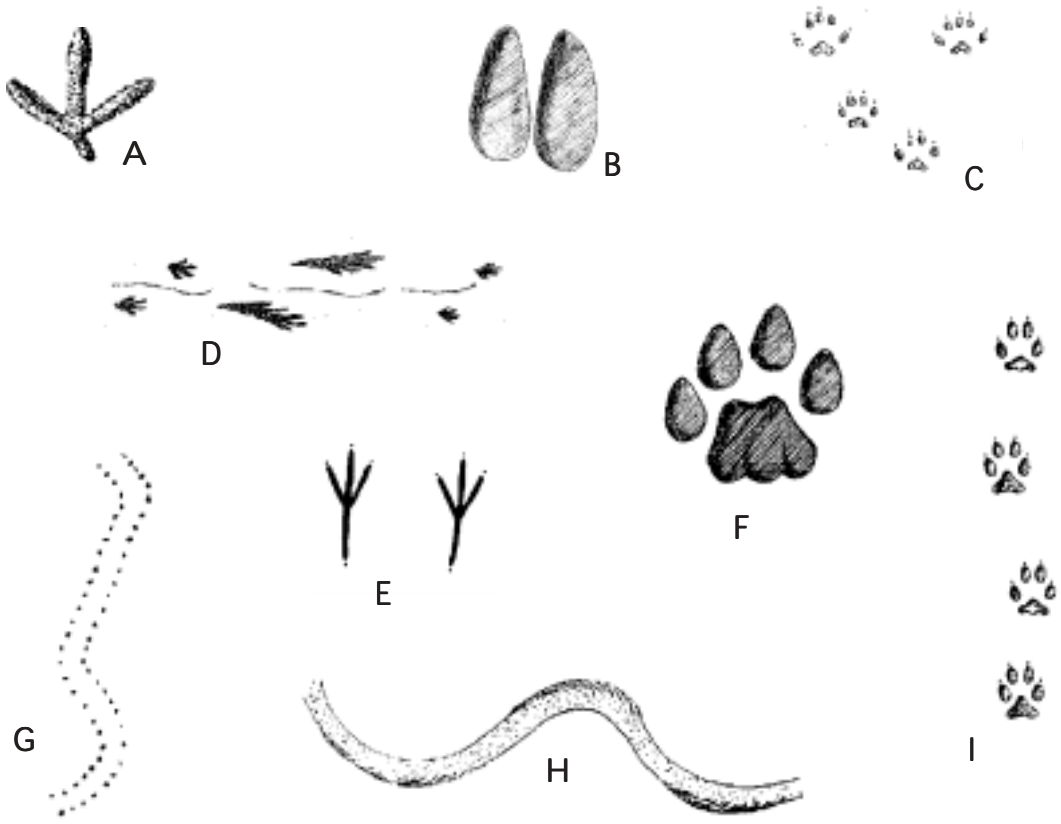
Organ Pipe Cactus

Tracks and Signs

Depending on how lucky you are during your visit to the Park, you may or may not see all of the critters listed on the Field Study "Find" list. Sometimes, animals can be hard to see, or you're just not there at the right time of day. In the desert, don't expect to see lots of wildlife during the day. The night protects small prey animals and precious moisture is not lost to heat and drying winds. However, if you look closely during the day, you may find "signs" that animals have passed your way!

A "sign" is a disturbance of the natural conditions of the environment that reveals the presence of animals and even people. It may be a footprint (track) in the sand, a broken branch, a chewed cactus pad, or even scat! If you are careful, and don't step on the tracks, you might be able to follow them and discover what happened during the night.

Can you identify these tracks? They belong to some of the animals you might find at Tohono Chul Park.



- Bobcat Gambel's Quail Lizard Snake Mouse
 Beetle Javelina Gray Fox Cactus Wren

Plant Observations

Honey Mesquite (*Prosopis velutina*)

This tree has been used from prehistoric times to the present day by dwellers in the Sonoran Desert. It was considered the staple of life for the Tohono O'odham and Pima Indians of the area. The entire seed pod is ground to make a meal (flour) for cereals and breads. The resinous sap collected from the bark was used for mending pottery, made into a black dye, or chewed like gum, among other things. The bark itself was used for tanning leather or dyeing; the wood for fuel, tools and building materials.

Draw a branchlet of leaves and a seed pod.

Write a brief description of the tree (height, color, branching pattern, etc.). What else do you notice about the tree - bird activity, insect life, other wildlife uses?

Creosote Bush (*Larrea tridentata*)

One of the most common shrubs of the Southwest deserts, the creosote has recently been found to be one of the longest-lived plants in North America. The bush produces a resin whose odor is particularly noticeable after a rain (cup your hands around the ends of a branch, breath heavily on the leaves and lean close to "smell the rain").

Draw the branching habit of this bush and the leaf, flower, and fruit shapes.

Can you locate an insect gall on a branch? What causes this? Draw it.

What do you see under the bush? Who lives here?

BACK IN THE CLASSROOM

Discuss the field trip to the Park with your students. Have all groups share their experiences, observations and questions.

ACTIVITY - Web of Life

Students can create a mural of the Sonoran Desert ecosystem, using the information from your pre-visit activities, the field trip itself and their independent research. Students can use their own drawings or photographs cut from magazines of desert plants and animals; each placed in its proper habitat. Students can then share their research with classmates, telling why that particular habitat and how the plant or animal has adapted to extremes of temperature or water loss.

When the mural is complete, discuss the **web of life**, or **food chain**, concept and the predator/prey relationship. Use push pins and yarn or string to connect each plant or animal to those with which it interacts (for example: _____ eats _____, is eaten by _____ and needs _____ for shelter, etc.). Different colors can be used to distinguish levels on the food chain.

By extension, discuss the “webs of life” that exist in your home, classroom, school or community. Who depends on whom for food, water, shelter and space?

Native peoples of the Southwest survived because they, like the animals and plants of the desert, lived in a flexible state of harmony with the land. **Ethnobotany** is the study of the relationship between human society (ethno) and plants (botany). This includes how native peoples used plants, both wild and cultivated, for food, medicine, clothing, dyes, shelter, tools, etc. Hunting and gathering societies relied solely on wild plants gathered from around campsites and along migration trails. Agricultural societies domesticated and then cultivated plants to meet their food and utensil needs, while continuing to gather those wild plants readily available.

Early farming methods included dry land farming, reliance on natural rainfall for irrigation; terrace farming, plots built up from surrounding land to catch and hold available rainfall; and irrigation farming through the building of canals and the diversion of stream and river flows.

Native peoples exploited available resources to the limits of their technology, but their lifeways dictated a conservative, communal approach; unwarranted depletion of sustainable food sources would mean eventual starvation. Native cultures knew enough to harvest indigenous foods and introduced crops on a renewal basis.

ACTIVITY - Desert Cultures Day

Students can plan a “Desert Cultures Day”, presenting reports on the lifeways of the early native peoples of the Sonoran Desert. Local tribes that you should consider researching are the Tohono O’odham and the Yaqui (Yoeme). In addition, the Hopi of northern Arizona have a rich farming tradition.

A local seasonal calendar of edible wild plants and their uses can be prepared. Each plant can be illustrated with information on growing season, edible products, method of preparation and perhaps actual samples for classmates. Please remind students **NOT TO PICK ANY WILD PLANTS** without permission of the land owner and a knowledgeable resource person available to verify that the plants are indeed edible. Also, harvest so as not to adversely affect the abundance or reproductive capabilities of the plant in the area.

Another class project could involve growing tepary beans, a staple crop of the Tohono O’odham. The tepary, uniquely adapted to the Southwest, is very drought, heat and alkali tolerant. Students can investigate the benefits of such a crop by comparing its growth rates and tolerance levels to pinto beans, a non-native. Groups can plant both types of beans, setting up control groups, and chart differences in growth rate based on varying amounts of heat, light and water provided.



With seeds from organizations such as Native Seed/SEARCH (www.nativeseeds.org) here in Tucson, students can design and plant their own ethnobotanical garden. Based on the garden at Tohono Chul Park, several species of native and introduced arid adapted crops can be included - corn, squash, beans for staples, along with sunflowers, chilies, gourds, devil’s claw and herbs. Students can research different farming methods and ways to capture rainfall runoff to irrigate their crops.

books about the plant/people connection

Caduto, Michael J. and Joseph Bruchac. *Native American Gardening: Stories, Projects, and Recipes for Families*. Golden, CO: Fulcrum Publishing, 1996.

Castetter, Edward Franklin. *The Ethnobiology of the Papago Indians*. NY: AMS Press, 1978.

Curtin, L.S.M. *By the Prophet of the Earth: Ethnobotany of the Pima*. Tucson: University of Arizona Press, 1984.

English, Sandal. *Fruits of the Desert*. Tucson: Arizona Daily Star, 1981.

Foster, Nelson and Linda S. Cordell. *Chilies to Chocolate: Food the Americas Gave the World*. Tucson: University of Arizona Press, 1992.

Hodgson, Wendy C. *Food Plants of the Sonoran Desert*. Tucson: University of Arizona Press, 2001.

Jabs, Carolyn. *The Heirloom Gardener*. San Francisco: Sierra Club Books, 1984.

Moerman, Daniel E. *Native American Ethnobotany*. Portland: Timber Press, 1998.

Moore, Michael. *Los Remedios: Traditional Herbal Remedies of the Southwest*. Santa Fe: Red Crane Books, 1990.

Moore, Michael. *Medicinal Plants of the Mountain West*. Santa Fe: Museum of New Mexico Press, 1979.

Moore, Michael. *Medicinal Plants of the Desert and Canyon West*. Santa Fe: Museum of New Mexico Press, 1989.

Nabhan, Gary Paul. *Coming Home to Eat: The Pleasures and Politics of Local Foods*. NY: W.W. Norton and Company, 2002.

Nabhan, Gary Paul. *Enduring Seeds: Native American Agriculture and Wild Plant Conservation*. San Francisco: Northpoint Press, 1989.

Nabhan, Gary Paul. *Gathering the Desert*. Tucson: University of Arizona Press, 1985.

Niethammer, Carolyn J. *American Indian Cooking: Recipes from the Southwest*. NY: University of Nebraska Press, 1999.

Rea, Amadeo M. *At the Desert's Green Edge: An Ethnobotany of the Gila River Pima*. Tucson: University of Arizona Press, 1997.

Rozin, Elizabeth. *Blue Corn and Chocolate*. NY: Alfred A. Knopf, 1994.

Tilford, Gregory L. *Edible and Medicinal Plants of the West*. Missoula, MT: Mountain Press Publishing Company, 1997.

Whiting, Alfred F. *Ethnobotany of the Hopi*. NY: AMS Press, 1978.



A naturalist is a person who studies nature, especially by direct observation of plants, animals and their environments. Naturalists often record their observations in sketchings, drawings, photos, poetry and/or prose. Try motivating students to become more aware of the world around them by keeping track of observations they make; motivation can be through a love of nature, scientific curiosity, a love of writing itself, or just a desire to be in the natural world.

ACTIVITY - Nature Journal



Writing and observation skills can be practiced by encouraging students to begin a nature journal. Perhaps begin with readings from some famous nature writers, such as Henry Thoreau, Rachel Carson or Barry Lopez. Byrd Baylor's books can be read to younger children. A good place to start is *The Illustrated Nature Journal* at www.pinicola.ca/jourpage.htm.

Students can make their own journals using construction paper or cardboard for covers and lined or plain paper for the journal pages. The covers can be decorated with pictures of the desert.

Take students for a nature walk around the school grounds or to a local park, even out in an open expanse of desert. Be alert for interesting nature happenings. Find a quiet spot to settle down to watch and listen. How does the sun feel? What sounds can be heard? Look at the total environment, not focusing on any one element. Get a "feel" for being a part of the natural setting. Now begin to focus on specific elements - the bird in the tree, the rabbit under the bush. What are they doing? Are they watching you? Try a guided imagery exercise - what is it like being a rabbit?



Now it's time to write those thoughts and observations down. Try poetry or blank verse; sketches and watercolors can be done as well. Encourage creativity and help students to express themselves! Suggest that they keep their journals handy and write in them once a week. Come back to the same spot at different times of the year - what changes? Talk about the value of journal writing and the power of the written word to persuade and inform. How can this be used to teach others to value and preserve nature?

books with a sense of place

Abbey, Edward. *Desert Solitaire: A Season in the Wilderness*. Tucson: University of Arizona Press, 1988.

Alcock, John. *Sonoran Desert Summer*. Tucson: University of Arizona Press, 1990; *Sonoran Desert Spring*. Chicago: University of Chicago Press, 1985.

Austin, Mary Hunter. *The Land of Little Rain*. NY: Penguin Books, 1988.

Bowers, Janice Emily. *A Full Life in a Small Place and Other Essays from a Desert Garden*. Tucson: University of Arizona Press, 1993; *Fear Falls Away and Other Essays from Hard and Rocky Places*. Tucson: University of Arizona Press, 1997; *The Mountains Next Door*. Tucson: University of Arizona Press, 1991.

Hinchman, Hannah. *A Trail Through Leaves: The Journal as a Path to Place*. NY: W.W. Norton and Company, 1997.

Kappel-Smith, Diana. *Desert Time: A Journey Through the American Southwest*. Boston: Little Brown, 1992.

Krutch, Joseph Wood. *The Desert Year*. NY: Penguin Books, 1977; *The Voice of the Desert*. NY: W. Sloane Associates, 1975.

Lazaroff, David Wentworth. *Sabino Canyon: Life of a Southwestern Oasis*. Tucson: University of Arizona Press, 1993.

Lopez, Barry Holstun. *Desert Notes: Reflections in the Eye of a Raven*. Kansas City, KS: Sheed and Ward, 1976; *Crossing Open Ground*. NY: Scribner's, 1988.

Murray, John A. *The Sierra Club Nature Writing Handbook: A Creative Guide*. San Francisco: Sierra Club Books, 1995.

Nabhan, Gary Paul. *The Desert Smells Like Rain: A Naturalist in Papago Country*. San Francisco: Northpoint Press, 1982.

Norwood, Vera and Janice Monk, ed. *The Desert Is No Lady: Southwest Landscapes in Women's Writing and Art*. New Haven: Yale University Press, 1987.

Peterson, David. *Writing Naturally: A Down-to-Earth Guide to Nature Writing*. Boulder, CO: Johnson Books, 2001.

Trimble, Stephen, ed. *Words from the Land: Encounters with Natural History Writing*. Salt Lake City: Peregrine Smith Books, 1989.

Van Matre, Steve and Bill Weiler, ed. *The Earth Speaks*. Warrenville, IL: Institute for Earth Education, 1983.

Suggested Reading for the Well-Read "Desert Rat" . . .

books about the Sonoran Desert – its art, history (natural and otherwise), and culture . . .

Natural History

Arizona-Sonora Desert Museum. *A Natural History of the Sonoran Desert*. Tucson: ASDM Press, 2000

Chronic, Halka. *Roadside Geology of Arizona*. Missoula, MT: Mountain Press Publishing Company, 1983.

Hanson, Roseanne Beggy. *The San Pedro River: A Discovery Guide*. Tucson: University of Arizona Press, 2001; *Southern Arizona Nature Almanac*. Boulder, CO: Pruett Publishing Company, 1996.

Lazaroff, David Wentworth. *Arizona-Sonora Desert Museum Book of Answers*. Tucson: Arizona-Sonora Desert Museum Press, 1998.

MacMahon, James A. *The Audubon Society Nature Guides: Deserts*. NY: Alfred A. Knopf, 1985.

Merlin, Pinau. *A Field Guide to Desert Holes*. Tucson: Arizona-Sonora Desert Museum Press, 1999.

Olin, George. *House in the Sun: A Natural History of the Sonoran Desert*. Tucson: Southwest Parks and Monuments Association, 1994.

Tweit, Susan J. *The Great Southwest Nature Factbook: A Guide to the Region's Remarkable Animals, Plants and Natural Features*. Seattle: Alaska Northwest Books, 1995.

History

Campbell, Julie A. *Studies in Arizona History*. Tucson: The Arizona Historical Society, 1998.

Carmony, Neil, ed. *Whiskey, Six-guns & Red-light Ladies: George Hand's Saloon Diary, Tucson, 1875-1878*. Silver City, NM: High-Lonesome Books, 1994.

Cuming, Harry and Mary. *Yesterday's Tucson Today, Books 1 and 2*. Tucson: Trillium Enterprises, 1996.

Fontana, Bernard L. *Entrada: The Legacy of Spain and Mexico in the United States*. Tucson: Southwest Parks and Monuments Association, 1994.

Officer, James E., ed. *The Pimería Alta: Missions and More*. Tucson: The Southwestern Mission Research Center, 1996.

Santiago, Mark. *The Red Captain: The Life of Hugo O'Connor*. Tucson: The Arizona Historical Society Museum Monograph No. 9, 1994.

Sheridan, Thomas E. *Arizona: A History*. Tucson: The University of Arizona Press, 1996; *Los Tucsonenses: The Mexican Community in Tucson, 1854-1941*. Tucson and London: The University of Arizona Press, 1992.

Sonnichsen, C.L. *Tucson: The Life and Times of an American City*. Norman, OK: University of Oklahoma Press, 1982.

Southwestern Mission Research Center. *Tucson: A Short History*. Tucson: The Southwestern Mission Research Center, 1986.

Summerhayes, Martha. *Vanished Arizona: Recollections of the Army Life (1870s) of a New England Woman*. Lincoln, NB: The University of Nebraska Press, 1979.

Arts and Culture

Engels, Mary Tate and Madeline Thorpe Gallego. *Corazón Contento: Sonoran Recipes and Stories from the Heart*. Lubbock, TX: Texas Tech University Press, 1999.

Fontana, Bernard L. *Of Earth and Little Rain*. Tucson: University of Arizona Press, 1989.

Griffith, James S. *Beliefs and Holy Places: A Spiritual Geography of the Pimería Alta*. Tucson: University of Arizona Press, 1992; *Hecho a Mano: The Traditional Arts of Tucson's Mexican American Community*. Tucson: The University of Arizona Press, 2000; *Saints of the Southwest*. Tucson: Rio Nuevo Publishers, 2000; *Southern Arizona Folk Arts*. Tucson: University of Arizona Press, 1988.

Martin, Patricia Preciado. *El Milagro and Other Stories*. Tucson: University of Arizona Press, 1996; *Songs My Mother Sang to Me: An Oral History of Mexican-American Women*. Tucson: University of Arizona Press, 1996.

Oktavec, Eileen. *Answered Prayers: Miracles and Milagros Along the Border*. Tucson: University of Arizona Press, 1995.

Sheridan, Thomas E. and Nancy J. Parezo, ed. *Paths of Life: American Indians of the Southwest and Northern Mexico*. Tucson: University of Arizona Press, 1996.

A Child's Eye View

books about the Sonoran Desert for children and their families

Albert, Richard E. *Alejandro's Gift*. San Francisco: Chronicle Books, 1994.

Astorga, Amalia. *Efrain of the Sonoran Desert: A Lizard's Life Among the Seri Indians*. El Paso, TX: Cinco Puntos Press, 2001.

Bash, Barbara. *Desert Giant: The World of the Saguaro Cactus*. San Francisco: Sierra Club Books, 1989.

Baylor, Byrd and Peter Parnall. *Desert Voices*. NY: Charles Scribner's and Sons, 1981; *The Other Way to Listen*. NY: Charles Scribner's Sons, 1978; *Moon Song*. NY: Charles Scribner's and Sons, 1982.

Blood, Charles L. and Martin Link. *The Goat in the Rug*. NY: Aladdin Paperbacks, 1990.

Buchanan, Ken and Debby. *It Rained on the Desert Today*. Flagstaff, AZ: Northland Publishing, 1994; *This House is Made of Mud*. Flagstaff, AZ: Northland Publishing, 1994.

Cooper, Ann. *In The Desert*. Denver: Denver Museum of Natural History Press, 1997.

George, Jean Craighead. *One Day in the Desert*. NY: Thomas Y. Crowell, 1983; *The Moon of the Wild Pigs*. NY: Harper Collins Publishers, 1992.

Guiberson, Brenda Z. *Cactus Hotel*. NY: Henry Holt and Company, 1991.

- Hauth, Katherine B. *Night Life of the Yucca: The Story of a Flower and a Moth*. Boulder, CO: Harbinger House, 1996.
- Holmes, Anita. *The 100-Year-Old Cactus*. NY: Four Winds Press, 1983.
- Jablonsky, Alice. *101 Questions About Desert Life*. Tucson: Southwest Parks and Monuments Association, 1994.
- Jernigan, Gisela. *Agave Blooms Just Once*. Tucson: Harbinger House, 1989; *One Green Mesquite Tree*. Tucson: Harbinger House, 1988; *Sonoran Seasons: A Year in the Desert*. Tucson: Harbinger House, 1994.
- Lesser, Carolyn. *Storm on the Desert*. San Diego: Harcourt Brace and Company, 1997.
- Lowell, Susan. *The Three Little Javelinas*. Flagstaff, AZ: Northland Publishing, 1992.
- Luenn, Nancy. *A Gift for Abuelita: Celebrating the Day of the Dead*. Flagstaff, AZ: Rising Moon, 1998.
- March, T.J. and Jennifer Ward. *Way Out in the Desert*. Flagstaff, AZ: Rising Moon, 1998.
- Moreillon, Judi. *Sing Down the Rain*. Walnut, CA: Kiva Publishing, 1997.
- Philabaum, Dabney Miller and Nancy Lenches Alegret. *Desert Buddies: Life in a Sunbaked Land*. Tucson, AZ: Earth Buddies, 1996.
- Sayre, April Pulley. *Dig, Wait, Listen: A Desert Toad's Tale*. NY: Greenwillow Books, 2001.
- Schweitzer, Byrd Baylor. *Amigo*. NY: Collier Books, 1963.
- Silver, Donald M. *One Small Square: Cactus Desert*. NY: Learning Triangle Press/McGraw-Hill, 1995.
- Skramstad, Jill. *Wildlife Southwest*. San Francisco: Chronicle Books, 1992.
- Storad, Conrad J. *Don't Call Me Pig!: A Javelina Story*. Tempe, AZ: Resort Gifts Unlimited, 1999; *Lizards for Lunch: A Roadrunner's Tale*. Tempe, AZ: Resort Gifts Unlimited, 1999.
- Urquhart, Jennifer C. *Creatures of the Desert World*. Washington, DC: National Geographic Society, 1987.
- Wallace, Marianne D. *America's Deserts: Guide to Plants and Animals*. Golden, CO: Fulcrum Kids, 1996.
- Yolen, Jane. *Welcome to the Sea of Sand*. NY: Putnam's Sons, 1996.
- Zoehfeld, Kathleen Weidner. *Cactus Café: A Story of the Sonoran Desert*. Norwalk, CT: Soundprints, 1997.