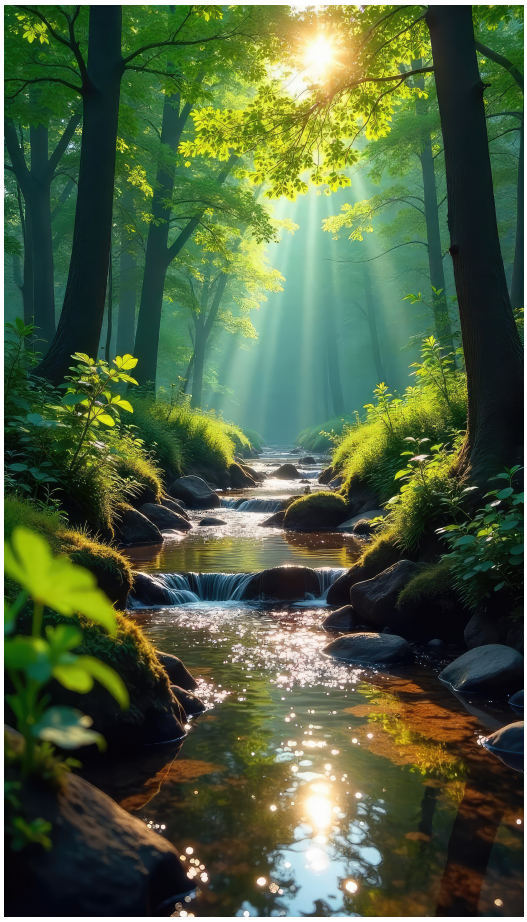
# Lesson 1 Background: Adaptations



Many of the human behaviors and engineering feats that help us conserve water and stay cool we learned from desert plants and animals that have practiced water conservation for thousands of years. In fact, these adaptations to arid environments are embedded in their genetic code and have evolved and been passed down from generation to generation. In many parts of Arizona, plants and animals have adapted to hot, dry conditions.

Although water is one of the most common substances on Earth, it is not distributed equally across the planet. Water in the air and soil as well as temperature are the most important environmental factors in determining the amount and type of vegetation in an area. Temperatures in Arizona vary depending on elevation. In the high plateau and mountainous regions of the state, summer temperatures average about 82 degrees (Fahrenheit) in the day and 50 degrees at night. At lower elevations, high temperatures are common during the summer months and average over 100 degrees. Throughout the state, temperatures vary greatly between day and night. The daily minimum and maximum temperatures can vary by 30 or 40 degrees.

Statewide, Arizona averages just thirteen inches of rain per year, with generally more precipitation at higher elevations, and less at lower elevations (e.g., twenty-one inches average annual precipitation in Payson vs. three inches in Yuma). There is very little surface water in Arizona—rivers and streams make up less than five percent of the state's surface area. **Riparian areas** occur along streams and rivers and around springs, ponds, lakes, and reservoirs. Examples include floodplains, stream banks, and lake-shores. More than 80 percent of the animal species in Arizona rely on riparian habitats for survival.

The place where a species lives is called its **habitat**. A habitat contains the food, water, and shelter that a plant or animal requires for survival. For simplicity, biologists, ecologists, and land managers often generalize habitats by associating them with types of vegetation or ecosystems. This makes it easier to understand where plants and animals live without having to know the exact needs of each species.

Because of variations in temperature, rainfall, altitude, and geography, Arizona has many different ecosystems that support different biotic communities, or groups of organisms. The plants, animals, fungi, microorganisms, etc. that live together and interact in a particular place make up a **community**. A community together with its physical environment (the soils, rock formations, water features, etc.) make up an **ecosystem**. Arizona's major ecosystems are: desert scrub, desert grasslands, chaparral, woodlands, pine forests, montane forests, sub-alpine forests, and riparian. These ecosystems are used to describe the habitats of plants and animals in this activity (see Pages # 8 &9 in Student Handbook for descriptions of these ecosystems).

# Lesson 1 Background: Adaptations

Arizona is among the top five U.S. states for **biodiversity**. This means that Arizona has many different living organisms that have adapted to live in its diverse habitats and ecosystems. There are more than four thousand different species of plants and animals that live in Arizona! Arizona's plants and animals have adopted various strategies to survive in environments that often have little water and high daytime temperatures. They find ways to avoid and dissipate heat, and to obtain and conserve water.

Plants and animals that have evolved with other organisms and have adapted to a specific place are called **native species**. Native species have evolved to live in the ecosystems of Arizona over thousands of years. **Nonnative species** are those that have been introduced or transported to a new environment that they did not evolve in. Some nonnatives do not have the mechanisms to survive in a new place. For example, a mangrove tree from the Everglades in Florida cannot survive the aridity in Arizona.

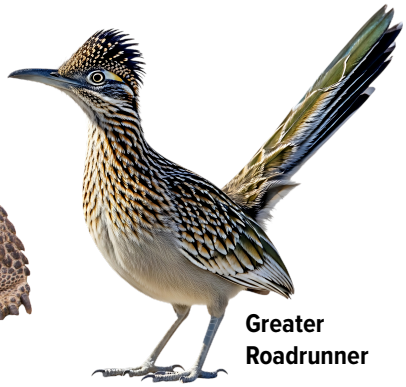
## Native Species

Saguaro Cactus

Gila Monster

Big Horn Sheep

Desert Tortoise



Greater Roadrunner

Other nonnatives have adaptations that help them to out-compete native species. An example is Tamarisk, or salt cedar, a phreatophyte from the Middle East and the Mediterranean that was planted in the western United States to help control erosion along stream banks. A **phreatophyte** is a deep-rooted plant that obtains its water from the water table or layer of soil just above it. Tamarisk have long taproots, but they also have shallow roots that allow them to utilize water near the soil surface. Tamarisk's ability to survive periods of drought, as well as tolerate saline soils, gives it a competitive advantage over native riparian plants in many desert riparian areas (especially those that don't experience natural flood events regularly). When Tamarisk becomes dominant in an area, it can reduce habitat for certain species of wildlife (and other plants) that have evolved in relationship with other native species.

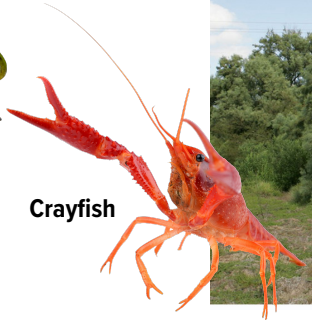
## Nonnative Species

Fountain Grass

Stink Weed

Bull Frog

Crayfish



Tamarisk

# Lesson 1 Background: Adaptations

## Animal Adaptations

One of the advantages that animals have over plants, when it comes to coping with environmental conditions, is that they are mobile. Some animals, like the big brown bat, live in the deserts in the wintertime and move to cooler areas in the summer to escape the extreme heat and dryness in the desert valleys. Other animals, such as the round-tailed ground squirrel, go into their burrows and **estivate** in the heat of the summer. **Estivation** is like hibernation, except it occurs in the hot dry summer instead of the cold wet winter. Desert toads, such as the Couch's Spadefoot, also estivate, burrowing underground during the dry part of the year and awakening when the first summer thunderstorms come.

**Antelope Squirrel**

**Spadefoot Toad**

**Burrowing Owl**

Another strategy that animals use to avoid the heat of the day is to sleep underground in their burrows or in the shade and then to come out and be active at dusk or dawn (**crepuscular** activity) or at night (**nocturnal** activity). Mule deer, Gila monsters, javelina, and many birds are crepuscular. Bats, foxes, skunks, rodents, and snakes are primarily nocturnal.

Some animals, such as brine shrimp and fairy shrimp, survive dry spells as eggs when the water evaporates. When the water returns, the eggs hatch and the shrimp grow and mature and lay new eggs before their habitat dries up again.

Animals have developed ways to dissipate the desert heat. Many desert animals are light-colored, which helps them to stay cooler by not absorbing as much of the sun's heat. Light-colored scales, feathers, and fur also serve as camouflage and protect against predators.

**Ringtail Cat**

**Big Brown Bat**

**Skunk**

**Rattlesnake**

# Lesson 1 Background: Adaptations

**Coyote**

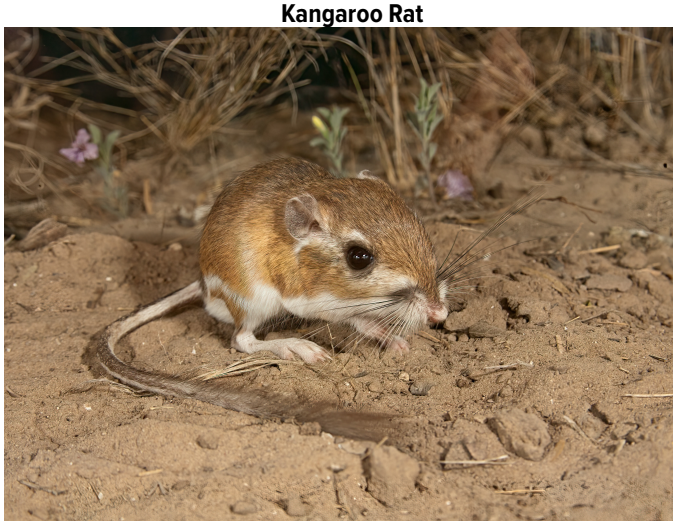
Using **evaporation** is an effective way to cool down in the desert. Perspiration is one method; the skin gives off water either as a vapor by simple evaporation from the skin or as sweat. When humans get too hot, we sweat and the moisture evaporates off of our bodies to help us cool down. Coyotes can pant to stay cool. The air moving in and out of a coyote's lungs evaporates moisture on its tongue and in its mouth, which helps to lower its body temperature. Owls and nighthawks stay cool by opening their mouths and moving their throats in an action similar to panting. Some desert animals, such as the jackrabbit, have long appendages that help to cool them. A jackrabbit's ears can be five to eight inches long! The blood vessels in their ears are close to the surface, which helps dissipate heat.

**Night Hawk**

**Jack Rabbit**

Because water is so scarce, desert animals have developed ways to obtain and retain water. Most desert animals get their water from the food they eat. Insects, birds, and animals all obtain essential water from the flowers, fruits, seeds, stems, leaves, and roots of plants. Kangaroo rats use water more efficiently than most other mammals. They are able to metabolize all the moisture they need from the dry seeds they eat. Kangaroo rats also have special organs in their noses that help to capture moisture from their breath so it isn't lost when they exhale, and specialized kidneys that concentrate their urine to retain water within their systems. Some scavengers and predators, such as turkey vultures and owls, also can get all the moisture they need from their food.

**Kangaroo Rat**



**Turkey Vulture**

# Lesson 1 Background: Adaptations

Thick, fleshy, and waxy leaves or stems can help plants store water.

**Plant Adaptations**

Arizona plants have also adapted in interesting ways to the desert heat and aridity. Some plants have shallow roots to soak up lots of rainwater quickly, while others have long taproots to draw water from deep in the ground (and some have both!). Many desert plants begin to grow in the shade of larger plants, or "nurse" plants, because they can't survive the full sun when they are young. Saguaro cacti often germinate in the shade of nurse plants.

**Xerophytes** are plants that have adapted to arid environments by developing physical structures that help them to survive extreme heat and water deprivation. Sagebrush, saltbush, creosote bush, palo verde, agave, and cacti are all examples of xerophytes. Cacti are some of the most drought-tolerant plants on Earth. Their shallow root systems can soak up lots of water quickly when it rains, and they can store enough water in their stems to meet their needs for over a year. Cacti reduce the amount of water lost to the environment through **transpiration** by having spines instead of leaves and thick waxy skin (transpiration occurs when water vapor in a plant is lost to the atmosphere through pores in its leaves, called stomata). They also utilize a specialized metabolic system (Crassulacean Acid Metabolism or CAM) that allows them to keep their stomata closed during the day, opening them at night for the exchange of carbon dioxide and oxygen that allows the plant to complete its cycles of photosynthesis and respiration.

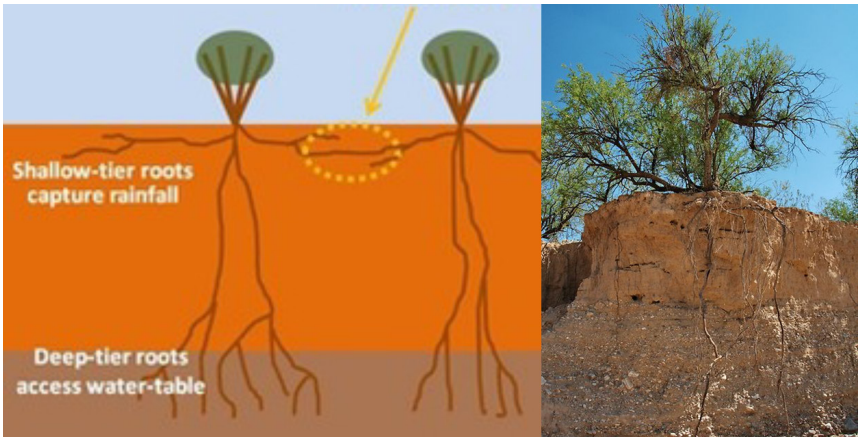
Other xerophytes have adapted by reducing or eliminating their leaves to reduce the amount of water lost through the leaves. They often have green bark like the palo verde tree to enhance photosynthesis. Sagebrush leaves have silvery hairs that reflect sunlight and keep the leaf surfaces cooler.

Small, waxy, hairy leaves, or spines help reduce water loss through evaporation.

# Lesson 1 Background: Adaptations

**Plant Adaptations Continued**

**Phreatophytes**, such as mesquite, grow extremely long roots to tap into water deep beneath the surface. Mesquite trees have the deepest roots of any native desert plant and can reach down eighty feet. Both mesquite trees and creosote bushes have deep taproots that allow them to draw up deeper ground water and shallow radial roots that absorb rainwater from near the surface.




Desert **perennials** survive by becoming dormant when it is hot and dry and then rejuvenating when it rains. Ocotillo will appear to be dead until it rains, and then they spring to life, growing new leaves within a couple of weeks. When the weather becomes hot and dry again, the ocotillo loses its leaves and goes dormant again until the next rainfall. It can repeat this cycle as many as five times a year. The desert lily is a bulb that can store food and moisture underground for years before it comes out of dormancy.

**Ephemeral** plants germinate when it rains and can complete their entire life cycle in a few weeks or months. There are hundreds of species of ephemerals that have adapted to life in the desert. Examples include lupine, desert sand verbena, and Mojave aster. They grow, flower, and produce seeds in just a few weeks. The seeds can remain viable in the soil for years, waiting for just the right wet spring conditions to germinate.