North American Deserts

Chihuahuan - Great Basin Desert - Sonoran – Mojave

http://www.desertusa.com/desert.html

In most modern classifications, the deserts of the United States and northern Mexico are grouped into four distinct categories. These distinctions are made on the basis of floristic composition and distribution -- the species of plants growing in a particular desert region. Plant communities, in turn, are determined by the geologic history of a region, the soil and mineral conditions, the elevation and the patterns of precipitation.

Three of these deserts -- the Chihuahuan, the Sonoran and the Mojave -- are called "hot deserts," because of their high temperatures during the long summer and because the evolutionary affinities of their plant life are largely with the subtropical plant communities to the south. The Great Basin Desert is called a "cold desert" because it is generally cooler and its dominant plant life is not subtropical in origin.

**Chihuahuan Desert**: A small area of southeastern New Mexico and extreme western Texas, extending south into a vast area of Mexico.

**Great Basin Desert**: The northern three-quarters of Nevada, western and southern Utah, to the southern third of Idaho and the southeastern corner of Oregon. According to some, it also includes small portions of western Colorado and southwestern Wyoming. Bordered on the south by the Mojave and Sonoran Deserts.

**Mojave Desert**: A portion of southern Nevada, extreme southwestern Utah and of eastern California, north of the Sonoran Desert.

**Sonoran Desert**: A relatively small region of extreme south-central California and most of the southern half of Arizona, east to almost the New Mexico line.
Desert Disagreements

This classification of North American Deserts is by no means universally accepted by all biologists, geologists and other scientists. For instance, some maintain that the Mojave is not a distinct desert at all, but simply a transition zone between the Great Basin and Sonoran deserts. Even among those who agree upon this classification, there is disagreement over the exact geographic areas circumscribed by each of the four deserts. Some scientists would use animals and other criteria, as well as distribution of plant species, to determine desert different boundaries for these four deserts.

The Colorado Plateau is another major source of disagreement among scientists. This semiarid region of southern Utah and northern Arizona contains many majestic national parks, including Arches and Grand Canyon. Yet, experts cannot agree on the desert classification of this geologically distinct region. Some do not include the Colorado Plateau within any desert at all; others call this area the Painted Desert; still others, DesertUSA included, consider this region the southeastern extent of the Great Basin Desert.

An additional source of confusion is provided by the great number of desert names (i.e. Yuman Desert, Colorado Desert, etc.) that do not match any of the four major deserts listed above. These names usually refer to local subdivisions within one of the four major deserts. These "deserts" are identified and defined below.

Other Desert Names & Subdivisions

Arizona Upland Desert: That elevated portion of the Sonoran Desert in southern Arizona characterized by Saguaro Cactus.
**Black Rock Desert:** A subdivision of the Great Basin Desert located in northwestern Nevada just northeast of Pyramid Lake.

**Borrego Desert:** The portion of the Sonoran Desert area just west of the the Salton Trough of southeast California.

**Colorado Desert:** The California portion of the Sonoran Desert west of the Colorado River.

**Escalante Desert:** A subdivision of the Great Basin desert just west of Cedar Breaks in southwestern Utah.

**Great American Desert:** An ill-defined, semiarid region of the Great Plains, or, all of the North American deserts combined.

**Great Sandy Desert:** A subdivision of the Great Basin Desert located in southeastern Oregon.

**Northern Mojave Desert:** The Mojave north of Las Vegas, Nevada.

**Magdalena Desert:** The Sonoran Desert on the lowest third of the Baja Peninsula.

**North American Desert:** The vast arid region between the Rocky Mountains and Sierra Nevada of western North America, encompassing all four major American deserts

**Painted Desert:** This term is used differently by different writers:

A narrow desert strip running west of the Grand Canyon, north-to-south along U.S. Route 89, then turning east along Interstate 40 to just beyond Petrified Forest National Monument.

OR

The entire region from the northern boundary of the Sonoran Desert of Arizona to southwestern Colorado and southern Utah, encompassing the Colorado River, the Colorado Plateau and its numerous parks and monuments.

**Red Desert:** The semiarid region of southwestern Wyoming, sometimes considered an extension of the Great Basin Desert.

**Sevier Desert:** A subdivision of the Great Basin desert just northwest of Delta in south-central Utah.

**Smoke Creek Desert:** A subdivision of the Great Basin Desert located in northwestern Nevada abutting the north end of Pyramid Lake.

**Southern Mojave Desert:** The Mojave south of Las Vegas, Nevada.

**Trans-Pecos Desert:** The Chihuahuan Desert west of Texas' Pecos River.

**Upland Desert:** (See Arizona Upland Desert.)
Desert Life

Animals - Plants - People

Deserts cover more than one fifth of the Earth's land, and they are found on every continent. Deserts can be classified as "hot" or "cold". Deserts receive less than 10 inches of precipitation a year, lack of water creates a survival problem for all desert organisms, animals, plants and people.
Desert Biome

Arid Regions with Animal and Plant life

Deserts in the Southwestern United States are areas of extreme heat and dryness, just as most of us envision them. More scientifically, deserts, also called arid regions, characteristically receive less than 10 inches of precipitation a year. In some deserts, the amount of evaporation is greater than the amount of rainfall. Semiarid regions average 10 to 20 inches of annual precipitation. Typically, desert moisture occurs in brief intervals and is unpredictable from year to year. About one-third of the earth's land mass is arid to semiarid (either desert or semidesert).

Evaporation is also an important factor contributing to aridity. In some deserts, the amount of water evaporating, exceeds the amount of rainfall. Rising air cools and can hold less moisture, producing clouds and precipitation; falling air warms, absorbing moisture. Areas with few clouds, bodies of water and little vegetation absorb most of the sun's radiation, thus heating the air at the soil surface. More humid areas deflect heat in clouds, water and vegetation, remaining cooler. High wind in open country also contributes to evaporation.

Locations of deserts have changed throughout geologic time as the result of continental drift and the uplifting of mountain ranges. Modern desert regions are centered in the horse latitudes, typically straddling the Tropic of Cancer and the Tropic of Capricorn, between 15 and 30 degrees north and south of the equator. Some deserts, such as the Kalahari in central Africa, are geologically ancient. The Sahara Desert in northern Africa is 65 million years old, while the Sonoran Desert of North America reached its northern limits only within the last 10,000 years.

Because they are poised in such harsh extremes of heat and aridity, deserts are among the most fragile ecosystems on the planet.
Geomorphology of the Deserts

Three of the four major deserts of North America are contained within a geological region called the Basin and Range Province, lying between the Rocky Mountains to the east and the Sierra Nevadas to the west. While the distinctiveness of each desert is based on the types of plant life found there (determined both by evolutionary history and climates), the geological structures of these three deserts are rather similar.

Captain John C. Fremont coined the term Great Basin. Actually, the region is a series of many basins, interrupted with mountain ranges produced by tilted and uplifted strata. Each range typically has a steep slope on one side and a gentle slope on the other. The ranges are roughly parallel. The basins or playas have no drainage. During wet cycles they become shallow playa lakes which may last from a few months, a few years or for longer periods.

During the Pleistocene interglacial, much of the Great Basin was flooded producing Lake Lahotan. The lake evaporated during the last 12,000 years, leaving only a few salty lakes between the Sierra Nevadas and the Rocky Mountains.
Undrained basins are also characteristic of the Mojave and Chihuahuan deserts. But the Sonoran Desert usually has hydraulic systems forming streams draining into the Gulf of California or the Pacific. There are also a few playas in the Sonoran Desert. One of these, called the Salton Sea, was filled by Colorado River flood waters in 1906 and remains full.

Alluvial fans are common in the Mojave Desert and the California portions of the Sonoran Desert. These are formed through geologic time where an arroyo or wash drains a mountain, depositing the detritus in a semicircle at the canyon’s mouth.

In the Sonoran Desert, the linear ranges, usually formed by volcanic uplift, are often surrounded by a skirt of detritus -- boulders, rocks, gravel, sand, soil -- that has eroded from the mountain over time. Much of this has been washed down during torrential summer downpours. In the Southwest these detritus skirts or pediments are frequently called bajadas. The substrate is coarser, with larger rocks on the upper bajada and finer at the lower elevation.

Deep arroyos may cut through the bajadas. Special plants such as the Desert Ironwood and Canyon Bursage may grow along the arroyos, giving them the appearance of dry creeks.

The areas between the desert ranges have been filled with water-washed alluvium. This alluvium, or fine soil, produces the extensive flat spaces one usually associates with deserts. The water table may be high on the flatlands, and the drainage is often slow. Poorly drained patches and larger playas become alkaline through accumulation of soluble chemicals. Special types of plants called halophytes (salt lovers) can grow here.

Desert streams and rivers are formed where there are grasslands, semiarid woodlands and forested uplands called watersheds. Like giant geological sponges, the upland watersheds collect and hold water throughout the year, releasing it slowly into the desert below. These desert streams with their riparian woodlands of cottonwoods, willows and other hydrophilic (water loving) plants were centers for abundant wildlife, as well as native peoples. However, abuse to the watersheds through overgrazing, timber cutting, mining and other modern activities has dried up many desert rivers. Also, much of the water table, once just below the desert floor, has been pumped lower and lower, and may now be hundreds of feet below the surface.
Lack of water creates a survival problem for all desert organisms, animals and plants alike. But animals have an additional problem -- they are more susceptible to extremes of temperature than are plants. Animals receive heat directly by radiation from the sun, and indirectly, by conduction from the substrate (rocks and soil) and convection from the air.

The biological processes of animal tissue can function only within a relatively narrow temperature range. When this range is exceeded, the animal dies. For four or five months of the year, the daily temperatures in the desert may actually exceed this range, called the range of thermoneutrality. Combined with the scarcity of life-sustaining water, survival for desert animals can become extremely tenuous.

Fortunately, most desert animals have evolved both behavioral and physiological mechanisms to solve the heat and water problems the desert environment creates. Among the thousands of desert animal species, there are almost as many remarkable behavioral and structural adaptations developed for avoiding excess heat.

Equally ingenious are the diverse mechanisms various animal species have developed to acquire, conserve, recycle, and actually manufacture water.

**Avoiding Heat**

Behavioral techniques for avoiding excess heat are numerous among desert animals. Certain species of birds, such as the Phainopepla, a slim, glossy, black bird with a slender crest, breed during the relatively cool spring, then leave the desert for cooler areas at higher elevations or along the Pacific coast. The Costa's Hummingbird, a purple-crowned and purple-throated desert species, begins breeding in late winter, then leaves in late spring when temperatures become extreme. Many birds are active primarily at dawn and within a few hours of sunset, retiring to a cool, shady spot for the remainder of the day. Some birds, such as the kingbird, continue activity throughout the day, but always perch in the shade.
Many animals (especially mammals and reptiles) are crepuscular, that is, they are active only at dusk and again at dawn. For this reason, humans seldom encounter rattlesnakes and Gila Monsters. Many animals are completely nocturnal, restricting all their activities to the cooler temperatures of the night. Bats, many snakes, most rodents and some larger mammals like foxes and skunks, are nocturnal, sleeping in a cool den, cave or burrow by day.

Some smaller desert animals burrow below the surface of the soil or sand to escape the high temperatures at the desert surface. These include many mammals, reptiles, insects and all the desert amphibians. Rodents may plug the entrances to their burrows to keep out hot, desiccating air.
A few desert animals, such as the Round-tailed Ground Squirrel, a diurnal mammal, enter a state of estivation when the days become too hot and the vegetation too dry. They sleep away the hottest part of the summer. (They also hibernate in winter to avoid the cold season.)

Some desert animals such as Desert Toads, remain dormant deep in the ground until the summer rains fill ponds. They then emerge, breed, lay eggs and replenish their body reserves of food and water for another long period. Some arthropods, such as the fairy shrimps and brine shrimps, survive as eggs, hatching in saline ponds and playas during summer or winter rains, and completing their life cycles.

Certain desert lizards are active during the hottest seasons, but move extremely rapidly over hot surfaces, stopping in cooler "islands" of shade. Even their legs may be longer so they absorb less surface heat while running.

**Dissipating Heat**

Some animals dissipate heat absorbed from their surroundings by various mechanisms. Owls, Poorwills and nighthawks gape open-mouthed while rapidly fluttering their throat region to evaporate water from their mouth cavities. (Only animals with a good supply of water from prey can afford this type of cooling, however.) Many desert mammals have evolved long appendages to dissipate body heat into their environment. The enormous ears of jackrabbits, with their many blood vessels, release heat when the animal is resting in a cool, shady location. Their relatives in cooler regions have much shorter ears.

New World vultures, such as the Turkey and Black Vultures, are dark in color and thus absorb considerable heat in the desert. But they excrete urine on their legs, cooling them by evaporation, and circulate the cooled blood back through the body. This behavior, called urohydrosis, is shared with their relatives the storks, successful birds of the African deserts. Both vultures and storks may escape the hot midday temperatures of the desert by soaring effortlessly, high on thermals of cooler air.
Many desert animals are paler than their relatives elsewhere in more moderate environments. Pale colors may be seen in feathers, fur, scales or skin. Pale colors not only ensure that the animal takes in less heat from the environment, but help to make it less conspicuous to predators in the bright, pallid surroundings.

**Retaining Water**

The mechanisms some desert animals have evolved to retain water are even more elaborate. They range from simple to physiologically complex. Some retain water by burrowing into moist soil during the dry daylight hours (all desert toads). Some predatory and scavenging animals can obtain their entire moisture needs from the food they eat (e.g., Turkey Vulture) but still may drink when water is available. Reptiles and birds excrete metabolic wastes in the form of uric acid, an insoluble white compound, wasting very little water in the process. Mammals, however, excrete urea, a soluble compound that accounts for considerable water loss. Most mammals, therefore, need access to a good supply of fresh water, at least every few days, if not daily.

**Acquiring Water**

Desert creatures derive water directly from plants, particularly succulent ones, such as cactus. Many species of insects thrive in the deserts this way. Some insects tap plant fluids such as nectar or sap from stems, while others extract water from the plant parts they eat, such as leaves and fruit. The abundance of insect life permits insectivorous birds, bats and lizards to thrive in the desert.

Some desert creatures utilize all of these physical and behavioral mechanism to survive the extremes of heat and dryness. Certain desert mammals, such as Kangaroo Rats, live in underground dens which they seal off to block out midday heat and to recycle the moisture from their own breathing.

These ingenious rodents (there are a number of species) also have specialized kidneys with extra microscopic tubules to extract most of the water from their urine and return it to the blood stream. And much of the moisture that would be exhaled in breathing is recaptured in the nasal cavities by specialized organs.

If that weren't enough, Kangaroo Rats, and some other desert rodents, actually manufacture their water metabolically from the digestion of dry seeds. These highly specialized desert mammals will not drink water even when it is given to them in captivity!

These are just a few examples of the ingenious variety of adaptations animals use to survive in the desert, overcoming the extremes of heat and the paucity of water.

**Desert Animals**

**Animals that live in the Desert Biome**

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**Desert Animal Survival** - How animals adapt to the desert.

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**Desert Plant Survival**

**The Desert Page 1**

**Desert Plant Adaptations and Survival**

To survive, desert plants have adapted to the extremes of heat and aridity by using both physical and behavioral mechanisms, much like desert animals.

Plants that have adapted by altering their physical structure are called **xerophytes**. Xerophytes, such as cacti, usually have special means of storing and conserving water. They often have few or no leaves, which reduces transpiration.

**Phreatophytes** are plants that have adapted to arid environments by growing extremely long roots,
allowing them to acquire moisture at or near the water table.

Other desert plants, using behavioral adaptations, have developed a lifestyle in conformance with the seasons of greatest moisture and/or coolest temperatures. These type of plants are usually (and inaccurately) referred to as perennials, plants that live for several years, and annuals, plants that live for only a season.

Desert perennials often survive by remaining dormant during dry periods of the year, then springing to life when water becomes available.

Most annual desert plants germinate only after heavy seasonal rain, then complete their reproductive cycle very quickly. They bloom prodigiously for a few weeks in the spring, accounting for most of the annual wildflower explosions of the deserts. Their heat- and drought-resistant seeds remain dormant in the soil until the next year's annual rains.

Xerophytes
The physical and behavioral adaptations of desert plants are as numerous and innovative as those of desert animals. Xerophytes, plants that have altered their physical structure to survive extreme heat and lack of water, are the largest group of such plants living in the deserts of the American Southwest.

Each of the four southwestern deserts offers habitats in which most xerophytic plants survive. But each is characterized by specific plants that seem to thrive there. The Great Basin Desert is noted for vast rolling stands of Sagebrush and Saltbush, while in the Mojave Desert, Joshua Trees, Creosote Bush, and Burroweed predominate. The Sonoran Desert is home to an incredible variety of succulents, including the giant Saguaro Cactus, as well as shrubs and trees like mesquite, Paloverde, and Ironwood. The Chihuahuan Desert is noted for mesquite ground cover and shrubby undergrowth, such as Yucca and Prickly Pear Cactus.

Cactus, xerophytic adaptations of the rose family, are among the most drought-resistant plants on the planet due to their absence of leaves, shallow root systems, ability to store water in their stems, spines for shade and waxy skin to seal in moisture. Cacti originated in the West Indies and migrated to many parts of the New World, populating the deserts of the Southwest with hundreds of varieties, such as the Beavertail Cactus and Jumping Cholla.

Cacti depend on chlorophyll in the outer tissue of their skin and stems to conduct photosynthesis for the manufacture of food. Spines protect the plant from animals, shade it from the sun and also collect moisture. Extensive shallow root systems are usually radial, allowing for the quick acquisition of large quantities of water when it rains. Because they store water in the core of both stems and roots, cacti are well-suited to dry climates and can survive years of drought on the water collected from a single rainfall.

Many other desert trees and shrubs have also adapted by eliminating leaves -- replacing them with thorns, not spines -- or by greatly reducing leaf size to eliminate transpiration (loss of water to the air). Such plants also usually have smooth, green bark on stems and trunks serving to both produce food and seal in moisture.
Phreatophytes

Phreatophytes, like the mesquite tree, have adapted to desert conditions by developing extremely long root systems to draw water from deep underground near the water table. The mesquite's roots are considered the longest of any desert plant and have been recorded as long as 80 feet. Botanists do not agree on the exact classification of the three mesquite trees: the Honey Mesquite, Screwbean Mesquite and the Velvet Mesquite, but no one disputes the success of their adaptation to the desert environment. Mesquites are abundant throughout all the southwestern deserts.

The Creosote Bush is one of the most successful of all desert species because it utilizes a combination of many adaptations. Instead of thorns, it relies for protection on a smell and taste wildlife find unpleasant. It has tiny leaves that close their stomata (pores) during the day to avoid water loss and open them at night to absorb moisture. Creosote has an extensive double root system -- both radial and deep -- to accumulate water from both surface and ground water.

Perennials

Some perennials, such as the Ocotillo, survive by becoming dormant during dry periods, then springing to life when water becomes available. After rain falls, the Ocotillo quickly grows a new suit of leaves to photosynthesize food. Flowers bloom within a few weeks, and when seeds become ripe and fall, the Ocotillo loses its leaves again and re-enters dormancy. This process may occur as many as five times a year. The Ocotillo also has a waxy coating on stems which serves to seal in moisture during periods of dormancy.

Another example of perennials that utilize dormancy as a means of evading drought are bulbs, members of the lily family. The tops of bulbs dry out completely and leave no trace of their existence.
above ground during dormant periods. They are able to store enough nourishment to survive for long periods in rocky or alluvial soils. The Desert Lily, also known as the Ajo, is found at a depth of 18 inches or more. Adequate winter rains can rouse it to life after years of dormancy.

**Seeds**
- Desert Garden Seed Starter Kit
- Joshua Tree Incubator Set
- Giant Saguaro Incubator Kit

### Annuals (Ephemerals)

The term "annuals" implies blooming yearly, but since this is not always the case, desert annuals are more accurately referred to as "ephemerals." Many of them can complete an entire life cycle in a matter of months, some in just weeks.

Contrary to the usual idea that deserts are uniformly hot, dry and homogeneous in their lack of plant life, they are actually biologically diverse and comprise a multitude of micro-climates changing from year to year. Each season's unique precipitation pattern falls on a huge variety of mini-environments. And each year in each of these tiny eco-niches, a different medley of plants bloom as different species thrive.

Desert plants must act quickly when heat, moisture and light inform them it's time to bloom. Ephemerals are the sprinters of the plant world, sending flower stalks jetting out in a few days. The peak of this bloom may last for just days or many weeks, depending on the weather and difference in elevation. The higher one goes, the later blooms come. Different varieties of plants will be in bloom from day to day, and even hour to hour, since some open early and others later in the day.

Ephemerals such as the Desert Sand Verbena, Desert Paintbrush and Mojave Aster usually germinate in the spring following winter rains. They grow quickly, flower and produce seeds before dying and scattering their progeny to the desert floor. These seeds are extremely hardy. They remain dormant, resisting drought and heat, until the following spring -- sometimes 2 or 3 springs -- when they repeat the cycle, germinating after winter rains to bloom again in the spring. There are hundreds of species of ephemerals that thrive in the deserts of the American Southwest.

If you examine desert soils closely, you will dispel forever any notion you might have of the desert as a barren environment, for you will likely find dozens of both annual and perennial seeds in every handful of desert soil. In the Sonoran Desert, seed densities average between 5,000 and 10,000 per square meter. The world record is over 200,000 seeds per square meter.

This "seed bank" attests to the remarkable reproductive success of desert flora, made possible by their symbiotic relationship with desert fauna -- birds, insects, reptiles and even mammals. Animals aid in both fertilization and dispersion of seeds, assuring the continued profusion and diversity of plant life throughout the deserts of the Southwest. For more information see
Desert Plants

How Do Plants Survive the Desert? -- Desert flora have adapted to the extremes of heat and aridity by using both physical and behavioral mechanisms, much like desert animals. The ingenuity and variety of these many adaptations are explored in Desert Plant Survival and the Desert Food Chain. Below are links to the flora found in the deserts, with photos and information about each plant.

Quick Links by Type of Plant
- Wildflowers
- Cactus & Succulents
- Trees, Shrubs, Grasses
- Wildflower Articles
- Related Information
- Desert Gardening

What's Blooming Now? Check the Wildflower Reports

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| Chain Fruit Cholla | Kingcup Cactus | Soaptree Yucca |
| Cholla Cactus | Mojave Mound Cactus |  |
| Claret Cup Cactus | Mojave Yucca |  |
| Desert Christmas Cactus | Night-Blooming Cereus |  |
|  | Organ Pipe Cactus |  |

**TREES, SHRUBS, GRASSES> LINKS>**

| Bastard Toadflax | Juniper | Smoke Tree |
| Crucifixion Thorn | Mormon Tea | Stinging Nettles |
| California Fan Palm | Ocotillo | Tumbleweed |
| Cocklebur | Mesquite Tree | Whitethorn Acacia |
| Cottonwood | Palo Verde Tree | Winterfat |
| Creosote Bush | Poison Ivy |  |
| Desert Willow | Ponderosa Pine |  |
| Elephant Tree | Four-Wing Saltbush |  |
| Greasewood | Showy Milkweed |  |
| Joshua Tree |  |  |

**DESERT GARDENING> LINKS>**

| Gardening the Desert in Southern New Mexico |
| How to Attract Hummingbirds and Butterflies to Your Garden |
| My Brown Thumb: |
| Gardens |
| Phoenix Desert Botanical Garden |
| The Arboretum at Flagstaff |
| Tucson Botanical Gardens |
| Arboretum at Arizona State University |
| Tohono Chul Park in Tucson |
| Arizona-Sonora Desert Museum |
Desert Food Chain –

Part 1
By Jay W. Sharp

Click Here for a movie on the Food Chain

A food chain constitutes a complex network of organisms, from plants to animals, through which energy, derived from the sun, flows in the form of organic matter and dissipates in the form of waste heat. The food chain’s biological productivity and species diversification depend on factors such as the daily duration and angle of seasonal sunlight, the timely availability of water, the daily swings of seasonal temperatures, the chemical content of the soils, and the availability of nutrients.

The food chain complies with two of the most basic notions in biology. First, it has an energy source, in this case, the sun, and an energy “sink,” in this instance, space. The sun fuels the work required for biologic processes. Space receives the waste heat produced by the work. Otherwise, temperatures would rise to the point that the community of organisms would perish. Second, by definition, a food chain comprises a system of interdependent species. A single isolated species would sooner or later consume the supply of chemicals it needs to live, grow and reproduce. It would perish.

Producers and Consumers

In a food chain in our Southwestern desert region – as in a food chain in any other biologically distinctive region, or “biome,” on earth – it is the plants, or the "producers,” that capture the energy from the sun and initiate the flow, becoming the first link in the chain. In an almost magical-seeming process called “photosynthesis,” which means “gathering of light,” all plants – from one-celled diatoms to mesquite and creosote shrubs to the towering saguaro cactus to riverside cottonwoods and willows – use the sun’s energy, with water and carbon dioxide, to produce a carbohydrate, or sugar, called “glucose,” a basic component in the food chain. The plants then use the glucose to
produce the carbohydrates, proteins and fats required for reproduction and growth, drawing nourishment from various soil nutrients, for instance, nitrogen, phosphorus and potassium. As producers, the plants, in effect, create storehouses of solar energy, setting the dinner table, often impoverished in the desert, for the animals, the “consumers.”

Plant-eating animals – the herbivores, or “primary” consumers – become the second link in the food chain. Flesh-eating animals – the carnivores, or “secondary” and even “tertiary” consumers – become the next links. Plant and flesh eaters – the omnivores, like human beings, for example – span two or three links. Scavengers, or the detritivores, become the next link in the food chain, and microorganisms, or decomposers, the final consumer link. Decomposers free up nutrients for recycling within the food chain.
In eating plant and/or animal matter, consumers are, in effect, “fueling up” on stored solar energy, although they surrender the great majority of it as waste heat. At each of the food chain links – called “trophic levels” – the consumers give up roughly 90 percent of the energy they ingest. This means that 100 units of plant energy are required to sustain the 10 units of herbivore energy that are required to sustain one unit of carnivore energy. For example, 100 units of grass and shrub energy are required to sustain the 10 units of desert cottontail energy that are required to sustain one unit of red-tailed hawk energy. It also means that the producers – the plants – constitute 90 percent of all living matter, or “biomass,” in a biological system such as a food chain, and that the consumers – the animals – account for only the remaining 10 percent. Plant productivity, always tenuous in our hard and unforgiving deserts, can impose severe limits on the consumer population.

**The Southwest Deserts vs Tropical Rainforests**

Our Southwest deserts, which rank among the least biologically productive biomes on earth, resemble a biological wasteland in comparison, for instance, to tropical rainforests, which rank among the most biologically productive biomes. The contrast reflects differences in those factors that impose limits on biological productivity and diversity.

In our deserts, which lie about 2500 to 3000 miles north of the equator, our longest summer days last for about 14 hours and the shortest winter days, about 10 hours. Energy received from the sun waxes and wanes with the seasons. Our precipitation, totaling no more than a few inches in an average year, falls erratically, primarily in the late summer, in late summer and winter, or in the winter, depending on location. Moreover, our evaporation rates, accelerated by a relentless sun and restless winds, can exceed the precipitation rates by tenfold or more. Our daily air temperatures swing from moderate to very hot in the summer and cold to moderate in the winter. We have clearly defined growing seasons and dormant seasons. Our soils, especially in the dry lower basins where brimming lakes stood during the late Pleistocene, or

**Ladybird Beetle, secondary consumer that feeds on plant-eating insects such as aphids.**
Ice Age, times, often bear heavy concentrations of minerals, especially alkali salts – a poison to the food chain – and they offer relatively little organic matter, or nutrients, for instance, nitrogen, to foster plant growth.

In tropical rainforests – equatorial lands of perpetual summer and a never-ending growing season – daylight lasts for roughly half of the 24 hours all year long. Energy received from the sun remains fairly constant throughout the year. Rain comes, not by the inch, but by the foot—from six to 30 feet per year. Water lost by evaporation is largely trapped in the humid microclimate surrounding a rainforest then simply returns in the form of more rainfall. Air temperatures range from the high 60s (in degrees Fahrenheit) to the low 90s throughout the year. Rainforest soils are comparatively free of harmful mineral residue. Nutrients, freed from rapidly decomposing organic matter by the decomposers, re-enter the food chain almost immediately, always encouraging more growth.

As a result of the differences between the two biomes, the total organic matter, or "biomass," produced by the food chains of our Southwestern deserts amounts to no more than a small fraction of the biomass produced by the food chains of comparably sized tropical rainforests. The variety of species of wild plants and animals supported by our Southwestern desert biome probably numbers in the few tens of thousands. The number of species supported by a comparably sized rain forest might number in hundreds of thousands or even millions.
The Setting, Origin and Development of Our Deserts

Our biologically demanding Chihuahuan, Sonoran and Mojave Deserts – each a collection of basins – bear the designation of “hot” deserts, contrasting starkly, for example, with the much colder Great Basin Desert. The hot deserts’ basins lie among a succession of roughly linear, north-south trending mountain ranges, with some peaks reaching 13,000 feet in height, well above the timber line. The desert basins and their mountain neighbors form the geographic heart of what geologists call the “Basin and Range Province,” which extends across the Southwestern United States from the Pecos River in the east to the Pacific coast in the west.

Generally, the three deserts, which blanket more than 350,000 square miles – an area larger than France, Great Britain and Portugal combined – have been filled with sandy-to-fine stream-deposited, or “alluvium,” soils, which form the classic broad desert “flats.” The soils, products not only of flowing water, wind and changing temperatures but also of chemical processes and biological agents, often have upper layers that are impoverished in organic content and lower layers, or hardpans, that are virtually solidified beds of calcium carbonate and silica. At the mouths of mountain canyons, the basins are marked by semicircular...
alluvial "fans" or by coalescing alluvial fans (called "bajadas"), which have been formed by loosely consolidated sand, silt, rocks and boulders carried down the drainages by rushing waters in partnership with gravity. Basin runoff from the mountain slopes and the irregular but often intense desert rain storms empties into either the Rio Grande or the Colorado River drainage systems, or soaks down and disappears into loosely compacted desert soils, or collects temporarily in the highly mineralized normally dry lake beds called "playas."

The Basin and Range Province’s stratified sedimentary mountains such as the Sacramentos of south-central New Mexico or the Franklins of western Texas have uplifted and tilted like listing barges along fault lines, leaving a steep slope (like the side of the barge) on one side and a more gentle slope (like the deck of the barge) on the other. The volcanic ranges such as the Santa Catalinas near Tucson formed when molten rock from deep within the earth erupted through the surface, raising a tortured, mountainous mass of basalt and other igneous materials.

The basins, already arid, evolved into full deserts beginning about eight to 10 thousand years ago, as the Pleistocene Epoch and the last great Ice Age, drew to a close. While their annual average temperatures rose gradually through time on one hand, the basins experienced dwindling rainfall on the other hand. Eastern mountain ranges hijacked much of the moisture from summertime systems moving west and northwest from the Gulf of Mexico. Western mountain ranges stole most of the moisture from winter storm systems moving onshore from the Pacific Ocean. The basins’ wide-spread Ice Age pinyon-juniper-oak woodlands – or, "pygmy” forests – retreated, over time, from the basin floors up to the lower slopes of the mountains, giving way to desert vegetation and animal life. The Chihuahuan, Sonoran and Mojave Deserts, with differing elevations and climates, gave rise to varying plant and animal communities.

The Chihuahuan Desert

The Chihuahuan Desert, the easternmost of the three deserts, begins deep in Mexico, near San Luis Potosi, and extends north northwest between two mountain ranges, for more than 1000 miles, reaching across western Texas and into New Mexico and southeastern Arizona. The largest desert in north America, it spans 175,000 to 200,000 square miles, an area roughly the size of Spain.

With most of its rainfall intercepted by mountain ranges to its immediate east and west, the Chihuahuan Desert typically receives only about eight or nine inches of precipitation a year, primarily from summer storm cells out of the Gulf of Mexico. Its summer air temperatures range from the 60s at night to 100 degrees or more during the daytime. Its winter temperatures frequently fall below freezing at night, especially in the northernmost basins, and usually rise to the high 50s or low 60s during the day. The Chihuahuan Desert’s chilly winters reflect its relatively high elevations, which range from 1000 to 5000 feet but average
approximately four-fifths of a mile above sea level.

In the northern half of the Chihuahuan Desert, much of the water runoff flows down the Rio Grande drainage system, headed for the Gulf of Mexico. Other runoff flows down streams, for instance, the Mimbres River out of the Gila Wilderness, only to disappear into desert sands. Still other runoff collects in playas (remnant lakes from the Ice Ages), for example, the salt flats immediately west of the Guadalupe Mountains in western Texas or the mineralized Live Oak and Duck Lakes beside the historic Camino Real de Tierra Adentro in Mexico’s state of Chihuahua.

Typically, honey mesquites, prickly pears, yuccas and grama grasses dominate the lower basin soils. The creosote bush, a tenacious and toxic competitor for water, takes over on the gravely slopes. The lechugilla presides over a spiny armada of ocotilla, sotol, barrel cactus, cholla and yuccas on the alluvial fans and bajadas. Before settlers cleared bottomlands to make way for the plow, dense stands of willows and cottonwoods crowded the banks of the Rio Grande. Salt-loving, or halophytic, plants grow along the margins of the alkaline playas. A surprisingly lengthy list of desert-adapted mammals, birds, reptiles, amphibians, invertebrates and even fish represent the animal life of the Chihuahuan Desert.

**The Sonoran Desert**

The Sonoran Desert begins in northwestern Mexico, on both sides of the Gulf of California, and it extends northward for hundreds of miles into southern Arizona and California. It covers about 120,000 square miles, an area comparable to the total land mass of the British Isles. The northern one-third of the desert lies within Arizona and California.

![Big Horn Sheep grazing on vegetation in the desert.](image)

The Sonoran Desert, in the United States, receives about six to 12
inches of rain per year in the northeast, in the region called the "Arizona Upland," where elevations reach about 3000 feet above sea level. It receives three inches or less in the southwest, in the region called the "Lower Colorado Valley," where the Colorado River enters the Gulf of California at sea level. The Arizona Upland, the wettest part of the desert, experiences two rainy seasons each year, one in late summer as a result of storm systems from the Gulf, the other in the winter as a result of storm systems from the Pacific. On average, the Lower Colorado Valley – well beyond the reach of Gulf storms – receives barely a quarter to a half inch of rain per month from the late summer into the following spring and less than one-tenth of an inch per month in early summer. It is the driest region within the Sonoran Desert and among the most parched within the United States.

The Arizona Upland summer air temperatures range from the mid-70s at night to over 100 degrees Fahrenheit during the day. Its winter temperatures range from the 40s at night to the mid 60s during the day. By contrast, the Lower Colorado Valley summertime temperatures range from the high 70s or low 80s at night to well over 100 degrees during the day. The summer daily temperatures, in fact, often rank among the nation’s highest, sometimes reaching 120 degrees during the day with surface soil temperatures reaching 180 degrees. The Lower Colorado Valley’s winter temperatures typically fall between mid- to high 40s at night and climb to the high to low 60s during the day.

In the United States’ third of the Sonoran Desert, water runoff flows down the Colorado River drainage system, toward the Gulf of California. In other instances, it simply soaks into the desert floor or empties into playas.

As a result of summer and winter rainy seasons, higher annual average rainfall, relatively low elevation and moderate winter temperatures, the most diverse wild plant and animal communities of all the deserts in the Basin and Range Province populate the Arizona Upland. In fact, the mix of pod-bearing trees, 50-foot tall Saguaros and other columnar cacti, and various shrubs of the Arizona Upland is viewed by some scientists, not as a desert, but as a "thornscrub," plant population. The more humble creosote, brittlebush and bursage shrubs grow in the hotter and drier Lower Colorado Valley. Altogether, the richly varied Sonoran Desert biological community includes not only several thousand species of plants, but also more than 100 species of mammals, more than 500 species of birds, about 100 species of reptiles, 20 species of amphibians, 30 species of freshwater fishes, and a large cast of insects and spiders.

The Mojave Desert

The Mojave Desert, covering 54,000 square miles and encompassing the storied Death Valley, lies north of the Sonoran Desert, in southern California, southern Nevada, northwestern Arizona and southwestern Utah. Although it is the smallest of the three deserts, it has the most widely contrasting environments and landscapes.
In its higher elevations, at approximately 5000 feet, the desert’s annual rainfall varies widely from year to year but averages perhaps five or six inches, primarily the product of winter Pacific storms. Typical summer temperatures range from the 60s to the 90s, and winter temperatures range from solid freezes to high 50s and to low 60s. In the lower elevations, for instance, in salt flats in Death Valley, the rainfall may average no more than two inches per year, falling primarily in the winter, and it may not come at all in some years. The summer temperatures typically remain in the 80s at night and climb to more than 110 degrees during the day. Summer air temperatures at Death Valley’s Badwater, 282 feet below sea level – the lowest point in the Western Hemisphere – can exceed 130 degrees, higher, even, than the temperature of the Lower Colorado River and some of the highest recorded in North America. Soil temperatures at the surface can reach 190 degrees, just 22 degrees short of the boiling temperature of water at sea level. Winters bring much cooler weather, with typical temperatures ranging between the 40s and the 60s and 70s. The Mojave Desert, with more than 500 square miles lying below sea level, traps virtually all the runoff from mountain ranges and occasional showers.

Although the Mojave is the least hospitable of our deserts, it nevertheless harbors an interesting and varied population of wild plants and animals. Lying between the hot Sonoran Desert immediately to the south and the much cooler Great Basin Desert immediately to the north, it shares some plant and animal species with its neighbors, but it also has its own signature species, most notably, the Joshua tree, a 50-foot tall yucca that grows in the higher elevations. Desert brush such as mesquites, creosote bush, big sagebrush and various cactus species – widely scattered in their competition for the limited water – cover much of the lower elevations. With the exception of microscopic plants, only a few salt-tolerant species such as the pickleweed and rushes grow within the salt flats. In spite of the harsh conditions, the Mojave has dozens of species of mammals, birds, reptiles and amphibians as well as several species of fish, and it has an abundance of invertebrate creatures.

**Mountain and River Plants and Animals**

While the distinctive plant and animal communities of our three hot deserts typify the resilience and adaptability of life under harsh conditions, the plant and animal life of the mountains and river systems enrich the biological stew of the Basin and Range Province.
In the ranges, which rise like islands from the desert floor, precipitation increases (up to an annual average of 30 inches or more) and temperatures decline with rising mountain elevations. Pygmy forests of juniper, pinyon pine and oaks mixed with shrubs – refugees from the Ice Age basins – cover the lower slopes. As the slopes ascend, the pygmy forests melt into ponderosa pine forests that give way to mixed conifer forests that, in turn, give way to subalpine forests that finally, at about 11,500 feet elevation, fade into treeless alpine tundra. Mammals, birds, reptiles, amphibians, fish and invertebrates, occupying environmental niches quite different from those of the desert, form distinctive mountain communities. Some mammals and many birds migrate between the mountains and the deserts in seasonal quests for food sources and accommodating habitat.

Along the Rio Grande and its tributaries, which drain most of the northern Chihuahuan Desert, and along the Colorado River and its tributaries, which drain most of the northern Sonoran Desert, gallery forests of cottonwoods, willows and, sometimes, mesquites once covered the flood plains, attracting and nurturing the densest concentration of animal life in the desert basins. They formed meandering threads of green across the hard desert landscape. Most of the riverine forests have now been replaced by farm land.

Combined with the mountains and rivers, the Chihuahuan, Sonoran and Mojave Desert basins form what is perhaps the most diverse landscape in the United States.

**Desert Geological Terms**

*Definitions of Important Geologial Features*
About one-third of the earth's landmass is desert or semi-desert. These regions have unique geologic features not found in more humid environments. These features are most often caused by wind and water erosion in the stark desert environment.

Deserts are usually created because they are located in a Rain Shadow -- a dry region downwind of mountain ranges caused by air losing its moisture as it passes over mountains.

Desert areas usually have Internal Drainage -- when streams drain toward landlocked basins rather than flowing eventually to the sea. When the water from these basins dry it is called a playa.

Because of the factors above, deserts often have less vegetation to prevent erosion, which in turn leads to further barrenness through Deflation -- the removal of silt and sand particles from the land surface by wind.

Below are some geologic features and unique characteristic of the desert regions:

**Alluvial Fan:** A large, fan-shaped pile of sediment forming at the base of narrow canyons onto a flat plain at the foot of a mountain range.

![Alluvial Fan](image)

**Alluvium:** Unconsolidated gravel, sand, silt and clay deposited by streams.

**Anticline:** An arched fold, usually in the shape of an inverted U.

**Arroyo:** A dry desert gully.

**Bajada:** A broad, sloping depositional deposit caused by the coalescing of alluvial fans.

**Blowout:** A depression in the land surface caused by wind erosion.

**Butte:** A narrow flat-topped hill of resistant rock with very steep sides. Probably formerly a mesa.

**Cenozoic Era:** 0 to 65 million years ago includes the Quaternary and Tertiary Periods.

**Desert:** Receiving less than 10 inches of precipitation annually.

**Desert Pavement:** A thin, surface layer of closely packed pebbles.

**Desert Varnish:** A hard, dark, shiny coating on rocks caused by chemical action.
Detritus: Boulders, rocks, gravel, sand, soil that has eroded from mountains over time.

Dunes: Mounds of loose sand grains shaped up by the wind.

Hogback: An eroded, steeply tilted ridge of resistant rocks with equal slopes on the sides.

Hoodoo: A column or pillar of bizarre shape caused by differential erosion on rocks of different hardness.
Jurassic Period: Age in which dinosaurs flourished, 144 to 288 million years ago.

Loess: A deposit of windblown sand and clay weakly cemented by calcite.

Mesa: Broad, flat-topped hill rounded by cliffs and capped with a resistant rock layer.


Mesozoic Era: 66 to 245 million years ago, includes the Cretaceous, Jurassic and Triassic Periods.

Monocline: An open, step-like fold in rock over a large area.

Paleozoic Era: 245 to 570 million years ago.

Pangea: The super continent that broke apart 200 million years ago to form the present continents.

Pediment: A gently sloping surface, usually covered with gravel, the result of erosion.

Plate Tectonics: The theory that the earth's surface is divided into a few large, thick plates that are continually moving.

Precambrian Era: Prior to the Paleozoic Era, 570 millions years ago.

Semiarid: Receiving between 10 and 20 inches of precipitation annually.

Syncline: An arched fold in the shape of a U.

Triassic Period: 208 to 245 million years ago when large predatory reptiles (dinosaurs) evolved.

- Plants and Animals, How They Are Classified - For centuries, biological scientists have worked to classify organisms in a way that would help clarify
relationships among species through time, and across different and constantly changing environments.

- **Desert Food Chain in Depth** - A food chain constitutes a complex network of organisms, from plants to animals, through which energy, derived from the sun, flows in the form of organic matter and dissipates in the form of waste heat.

- **Desert Food Chain for the Young Student**

- **Need for Water in the Deserts** - Learn what can happen in a desert basin where no more than a few inches of rain fall in a typical year; where dependable natural water holes and streams lie far apart; where summer daytime air temperatures can soar to well over 100 degrees Fahrenheit and the soil temperatures to well over 150 degrees; and where small-leaf, spiny, low-growing and widely scattered plants offer scant shade or comfort.

- **Desert People & Cultures** - For many centuries the desert has been home to human life, from ancient hunters and farmers, to the native cultures Euro-American explorers first recorded, to settlers and modern inhabitants who enjoy its warm, dry climate and stunning vistas. Throughout the desert regions, monuments and parks have been established to preserve the record of these ancient and historic peoples, including cliff dwellings, rock art, ghost towns and historic sites commemorating all manner of human endeavors, adventures and travails.

- **Desert Survival for People** - Learning to be part of the desert's ecosystem is the first step of desert survival. Our philosophy is not to fight the desert, but to become part of its ecosystem. Being prepared is an obvious benefit.

- **Desert Environment & Geology** - Learn about the rocks, minerals and gemstones that form our North American deserts.

- **Water Resources in the Southwest**
  - Dwindling Southwest Water Resources - Part I
  - Southwest Water Resources - The Problems We Face (Part II)
  - Southwest Water Resources - A Glimmer of Hope (Part III)

- **Wildfires** - In some instances in the chaparral shrublands of coastal California, wildfires trigger germination of various plant seeds.
  - It's Fire Season and the Santa Ana Winds Are Lurking - The Santa Ana winds have fueled some of the largest wildfires including the Cedar Fire, Laguna Fire, Old fire, Esperanza Fire, Santiago Canyon Fire of 1889 and the Witch Fire.

- **Seasonal Migrations** - Seasonal migration is one of the most fascinating feats of the animal world. Although birds are often the most evident of the migrants, animals as small as pinhead-sized spiders and as large as blue whales migrate by land, air or water. Movements can range in length from less than a mile, for Eurasian milkweed bugs, for example, to the incredible 25,000 miles per year of the arctic tern. Migrations may only be seasonal or may take a lifetime to complete.

**Deserts of the United States**
Deserts in the southwestern United States are areas of extreme heat and dryness, just as most of us envision them. The deserts in the United States and northern Mexico are grouped into four distinct categories. More on the deserts.