

Coordinates: 36°06′N 112°06′W

Grand Canyon

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The **Grand Canyon** (Hopi: *Ongtupqa*; Yavapai: *Wi:ka'i:la*, Spanish: *Gran Cañón*), is a steep-sided canyon carved by the Colorado River in the state of Arizona in the United States. It is contained within and managed by Grand Canyon National Park, the Kaibab National Forest, Grand Canyon-Parashant National Monument, the Hualapai Tribal Nation, the Havasupai Tribe and the Navajo Nation. President Theodore Roosevelt was a major proponent of preservation of the Grand Canyon area, and visited it on numerous occasions to hunt and enjoy the scenery.

The Grand Canyon is 277 miles (446 km) long, up to 18 miles (29 km) wide and attains a depth of over a mile (6,093 feet or 1,857 meters).^[1] Nearly two billion years of Earth's geological history have been exposed as the Colorado River and its tributaries cut their channels through layer after layer of rock while the Colorado Plateau was uplifted.^[2] While the specific geologic processes and timing that formed the Grand Canyon are the subject of debate by geologists,^[3] recent evidence suggests that the Colorado River established its course through the canyon at least 17 million years ago.^{[4][5]} Since that time, the Colorado River continued to erode and form the canyon to its present-day configuration.^[6]

For thousands of years, the area has been continuously inhabited by Native Americans who built settlements within the canyon and its many caves. The Pueblo people considered the Grand Canyon ("Ongtupqa" in the Hopi language) a holy site, and made pilgrimages to it.^[7] The first European known to have viewed the Grand Canyon was García López de Cárdenas from Spain, who arrived in 1540.^[8]

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Grand Canyon



View from Mohave Point of the Colorado River flowing through the Grand Canyon.



Arizona, United States

Floor elevation	approx. 2,600 feet (800 m)
Long-axis length	277 miles (446 km)
Width	4 to 18 miles (6.4 to 29.0 km)
Geography	
Coordinates	36°06′N 112°06′W
Watercourses	Colorado River

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View from the South Rim

Geography

The Grand Canyon is a fissure in the Colorado Plateau that exposes uplifted Proterozoic and Paleozoic strata, and is also one of the 19 distinct physiographic sections of the Colorado Plateau province. It is not the deepest canyon in the world (Kali Gandaki Gorge in Nepal is far deeper), however, the Grand Canyon is known for its visually overwhelming size and its intricate and colorful landscape. Geologically it is significant because of the thick sequence of ancient rocks that are beautifully preserved and exposed in the walls of the canyon. These rock layers record much of the early geologic history of the North American continent.

Uplift associated with mountain formation later moved these sediments thousands of feet upward and created the Colorado Plateau. The higher elevation has also resulted in greater precipitation in the Colorado River drainage area, but not enough to change the Grand Canyon area from being semi-arid. The uplift of the Colorado Plateau is uneven, and the Kaibab Plateau that Grand Canyon bisects is over a thousand feet higher at the North Rim (about 1,000 ft or 300 m) than at the South Rim. Almost all runoff from the North Rim (which also gets more rain and snow) flows toward the Grand Canyon, while much of the runoff on the plateau behind the South Rim flows away from the canyon (following the general tilt). The result is deeper and longer tributary washes and canyons on the north side and shorter and steeper side canyons on the south side.



International Space Station image of the Grand Canyon and surrounding area.



A map of the Grand Canyon and surrounding areas, c. 1908.

Temperatures on the North Rim are generally lower than those on the South Rim because of the greater elevation (averaging 8,000 ft/2,438 m above sea level).^[9] Heavy rains are common on both rims during the summer months. Access to the North Rim via the primary route leading to the canyon (State Route 67) is limited during the winter season due to road closures.^[10]

Geology

The Grand Canyon is part of the Colorado River basin which has developed over the past 40 million years. A recent study places the origins of the canyon beginning about 17M years ago. Previous estimates had placed the age of the canyon at 5–6 million years.^[11] The study, which was published in the journal *Science* in 2008, used uranium-lead dating to analyze calcite deposits found on the walls of nine caves throughout the canyon.^[12] There is a substantial amount of controversy because this research suggests such a substantial departure from prior widely supported scientific consensus.^[13] In December 2012, a study published in the journal *Science* claimed new tests had suggested the Grand Canyon could be as old as 70M years.^[14] However, this study has been criticized as "[an] attempt to push the interpretation of their new data to their limits without consideration of the whole range of other geologic data sets."^[11]

The canyon is the result of erosion which creates one of the most complete geologic columns on the planet.

The major geologic exposures in the Grand Canyon range in age from the 2-billion-year-old Vishnu Schist at the bottom of the Inner Gorge to the 230M-year-old Kaibab Limestone on the Rim. There is a gap of about a billion years between the 500M-year-old stratum and the level below it, which dates to about 1.5 billion years ago. This large unconformity indicates a period of erosion between two periods of deposition.

Many of the formations were deposited in warm shallow seas, near-shore environments (such as beaches), and swamps as the seashore repeatedly advanced and retreated over the edge of a proto-North America. Major exceptions include the Permian Coconino Sandstone, which contains abundant geological evidence of aeolian sand dune deposition. Several parts of the Supai Group also were deposited in non-marine environments.

The great depth of the Grand Canyon and especially the height of its strata (most of which formed below sea level) can be attributed to 5–10 thousand feet (1,500 to 3,000 m) of uplift of the Colorado Plateau, starting about 65M years ago (during the Laramide Orogeny). This uplift has steepened the stream gradient of the Colorado River and its tributaries, which in turn has increased their speed and thus their ability to cut through rock (see the elevation summary of the Colorado River for present conditions).

Weather conditions during the ice ages also increased the amount of water in the Colorado River drainage



The Grand Canyon from an airplane, with the Colorado River visible.

system. The ancestral Colorado River responded by cutting its channel faster and deeper.

The base level and course of the Colorado River (or its ancestral equivalent) changed 5.3M years ago when the Gulf of California opened and lowered the river's base level (its lowest point). This increased the rate of erosion and cut nearly all of the Grand Canyon's current depth by 1.2M years ago. The terraced walls of the canyon were created by differential erosion.^[15]

Between 100,000 and 3M years ago, volcanic activity deposited ash and lava over the area which at times completely obstructed the river. These volcanic rocks are the youngest in the canyon.

History

Native Americans

The Ancestral Puebloans were a Native American culture centered on the present-day Four Corners area of the United States. They were the first people known to live in the Grand Canyon area. The cultural group has often been referred to in archaeology as the Anasazi, although the term is not preferred by the modern Puebloan peoples. The word "Anasazi" is Navajo for "Ancient Ones" or "Ancient Enemy".^[16]

Archaeologists still debate when this distinct culture emerged. The current consensus, based on terminology defined by the Pecos Classification, suggests their emergence around 1200 BCE during the Basketmaker II Era. Beginning with the earliest explorations and excavations, researchers have believed that the Ancient Puebloans are ancestors of the modern Pueblo peoples.^[16]

In addition to the Ancestral Puebloans, a number of distinct cultures have inhabited the Grand Canyon area. The Cohonina lived to the west of the Grand Canyon, between 500 and 1200 CE.^{[17][18]} The Cohonina were ancestors of the Yuman, Havasupai, and Walapai peoples who inhabit the area today.^[19]

The Sinagua were a cultural group occupying an area to the southeast of the Grand Canyon, between the Little Colorado River and the Salt River, between approximately 500 and 1425 CE. The Sinagua may have been ancestors of several Hopi clans.

By the time of the arrival of Europeans in the 16th century, newer cultures had evolved. The Hualapai inhabit a 100-mile (160 km) stretch along the pine-clad southern side of the Grand Canyon. The Havasupai have been living in the area near Cataract Canyon since the beginning of the 13th century, occupying an area the size of Delaware.^[20] The Southern Paiutes live in what is now southern Utah and northern Arizona. The Navajo, or

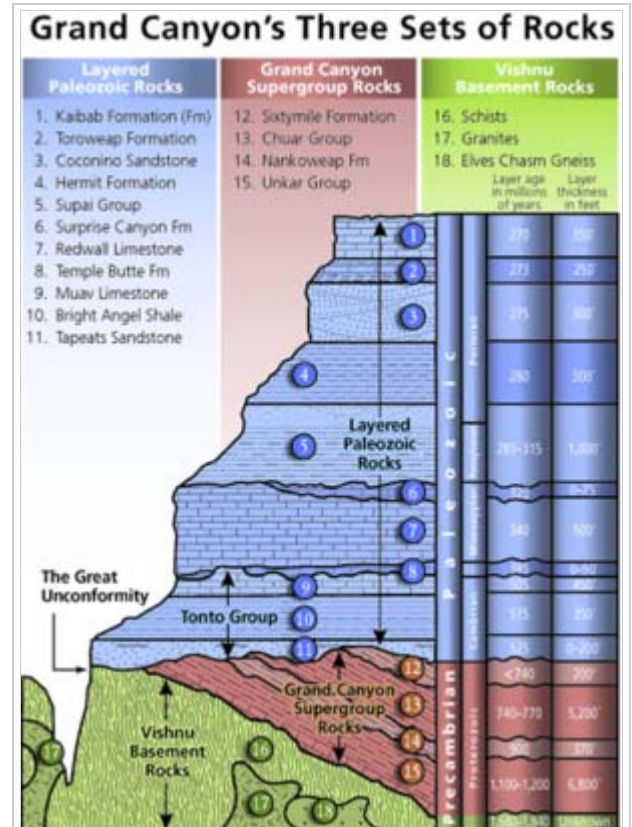


Diagram showing the placement, age and thickness of the rock units exposed in the Grand Canyon.



Rockfalls in recent times, along with other mass wasting, have further widened the canyon.

Diné, live in a wide area stretching from the San Francisco Peaks eastwards towards the Four Corners. Archaeological and linguistic evidence suggests the Navajo descended from the Athabaskan people near Great Slave Lake, Canada, who migrated after the 11th century.^[21]

European arrival and settlement

Spanish explorers

In September 1540, under orders from the conquistador Francisco Vázquez de Coronado to search for the fabled Seven Cities of Cibola, Captain Garcia Lopez de Cardenas, along with Hopi guides and a small group of Spanish soldiers, traveled to the South Rim of the Grand Canyon between Desert View and Moran Point. Pablo de Melgrossa, Juan Galeras, and a third soldier descended some one third of the way into the Canyon until they were forced to return because of lack of water. In their report, they noted that some of the rocks in the Canyon were "bigger than the great tower of Seville."^[22] It is speculated that their Hopi guides likely knew routes to the canyon floor, but may have been reluctant to lead the Spanish to the river. No Europeans visited the Canyon again for over two hundred years.

Fathers Francisco Atanasio Domínguez and Silvestre Vélez de Escalante were two Spanish priests who, with a group of Spanish soldiers, explored southern Utah and traveled along the North Rim of the Canyon in Glen and Marble Canyons in search of a route from Santa Fe to California in 1776. They eventually found a crossing, formerly known as the "Crossing of the Fathers," that today lies under Lake Powell.

Also in 1776, Fray Francisco Garcés, a Franciscan missionary, spent a week near Havasupai, unsuccessfully attempting to convert a band of Native Americans to Christianity. He described the Canyon as "profound".^[22]

American exploration

James Ohio Pattie, along with a group of American trappers and mountain men, may have been the next European to reach the Canyon, in 1826.^[23]

Jacob Hamblin, a Mormon missionary, was sent by Brigham Young in the 1850s to locate suitable river crossing sites in the Canyon. Building good relations with local Native Americans Hualapai Nation and white settlers, he found the Crossing of the Fathers, and the locations what would become Lees Ferry in 1858 and Pearce Ferry (later operated by, and named for, Harrison Pearce) – only the latter two sites suitable for ferry operation. He also acted as an advisor to John Wesley Powell before his second expedition to the Grand Canyon, serving as a diplomat between Powell and the local native tribes to ensure the safety of his party.

In 1857, Edward Fitzgerald Beale was superintendent of an expedition to survey a wagon road along the 35th parallel from Fort Defiance, Arizona to the Colorado River. He led a small party of men in search of water on



Grand Canyon from the South Rim, near the NPS Visitor Center



Ancestral Puebloan granaries at Nankoweap Creek.



Eagle Rock (located at Eagle Point) on the west rim, aptly named for its shape, is considered sacred by the Hualapai Indians.



William Bell's photograph of the Grand Canyon, taken in 1872 as part of the Wheeler expedition

the Coconino Plateau near the Canyon's South Rim. On September 19, near present day National Canyon, they came upon what May Humphreys Stacey described in his journal as "...a wonderful canyon four thousand feet deep. Everyone (in the party) admitted that he never before saw anything to match or equal this astonishing natural curiosity."

Also in 1857, the U.S. War Department asked Lieutenant Joseph Ives to lead an expedition to assess the feasibility of an up-river navigation from the Gulf of California. Also in a stern wheeler steamboat "Explorer", after two months and 350 miles (560 km) of difficult navigation, his party reached Black Canyon some two months after George Johnson. The "Explorer" struck a rock and was abandoned. Ives led his party east into the Canyon — they may have been the first Europeans to travel the Diamond Creek drainage and traveled eastwards along the South Rim. In his "Colorado River of the West" report to the Senate in 1861 he states that "One or two trappers profess to have seen the canyon."

According to the *San Francisco Herald*, in a series of articles run in 1853, Captain Joseph R. Walker in January 1851 with his nephew James T. Walker and six men, traveled up the Colorado River to a point where it joined the Virgin River and continued east into Arizona, traveling along the Grand Canyon and making short exploratory side trips along the way. Walker is reported to have said he wanted to visit the Moqui Indians, as the Hopi were then called by whites. He had met these people briefly in previous years, thought them exceptionally interesting and wanted to become better acquainted. The Herald reporter then reported: "We believe that Capt. Joe Walker is the only white man in this country that has ever visited this strange people."

In 1858, John Strong Newberry became probably the first geologist to visit the Grand Canyon.

In 1869, Major John Wesley Powell led the first expedition down the Canyon. Powell set out to explore the Colorado River and the Grand Canyon. Gathering nine men, four boats and food for 10 months, he set out from Green River, Wyoming on May 24. Passing through (or portaging around) a series dangerous rapids, the group passed down the Green River to its confluence with the Colorado River, near present-day Moab, Utah and completed the journey with many hardships through the Grand Canyon on August 13, 1869.^[24] In 1871 Powell first used the term "Grand Canyon"; previously it had been called the "Big Canyon".^[25]

In 1889, Frank M. Brown wanted to build a railroad along the Colorado River to carry coal. He, his chief engineer Robert Brewster Stanton, and 14 others started to explore the Grand Canyon in poorly designed cedar wood boats, with no life preservers. Brown drowned in an accident near Marble Canyon: Stanton made new boats and proceeded to explore the Colorado all of the way to the Gulf of California.^[26]

The Grand Canyon^[27] became an official national monument in 1908 and a national park in 1919.

Settlers in and near the canyon

- Miners: "Captain" John Hance, William W. Bass, Louis Boucher "The Hermit", Seth Tanner, Charles Spencer, D. W. "James" Mooney



Noon rest in Marble Canyon, second Powell Expedition, 1872

- Lees Ferry: John Doyle Lee, Emma Lee French (17th of John Lee's 19 wives), J. S. Emmett, Charles Spencer
- Phantom Ranch: David Rust, Mary Colter
- Grand Canyon Village: Ralph H. Cameron, Emery & Ellsworth Kolb

Federal protection

U.S. President Theodore Roosevelt visited the Grand Canyon in 1903. An avid outdoorsman and staunch conservationist, he established the Grand Canyon Game Preserve on November 28, 1906. Livestock grazing was reduced, but predators such as mountain lions, eagles, and wolves were eradicated. Roosevelt added adjacent national forest lands and redesignated the preserve a U.S. National Monument on January 11, 1908. Opponents such as land and mining claim holders blocked efforts to reclassify the monument as a U.S. National Park for 11 years. Grand Canyon National Park was finally established as the 17th U.S. National Park by an Act of Congress signed into law by President Woodrow Wilson on February 26, 1919.^[17]

The federal government administrators who manage park resources face many challenges. These include issues related to the recent reintroduction into the wild of the highly endangered California condor, air tour overflight noise levels, water rights disputes with various tribal reservations that border the park, and forest fire management. The Grand Canyon National Park superintendent is Steve Martin. Martin was named superintendent on February 5, 2007, to replace retiring superintendent Joe Alston. Martin was previously the National Park Service Deputy Director and superintendent of several other national parks, including Denali and Grand Teton.^[28] Federal officials started a flood in the Grand Canyon in hopes of restoring its ecosystem on March 5, 2008. The canyon's ecosystem was permanently changed after the construction of the Glen Canyon Dam in 1963.^[29]

Between 2003 and 2011, 2,215 mining claims have been requested that are adjacent to the Canyon, including claims for uranium mines. Mining has been suspended since 2009, when U.S. Interior Secretary Ken Salazar temporarily withdrew 1 million acres (4,000 km²) from the permitting process, pending assessment of the environmental impact of mining. Critics of the mines are concerned that, once mined, the uranium will leach into the water of the Colorado River and contaminate the water supply for up to 18 million people.^[30]

South Rim buildings

There are several historic buildings located along the South Rim with most in the vicinity of Grand Canyon Village.

- Buckey O'Neill Cabin was built during the 1890s by William Owen "Buckey" O'Neill. He built the cabin because of a copper deposit that was nearby. He had several occupations such as miner, judge, politician, author and tour guide. This cabin is the longest continually standing structure on the South Rim. It is currently used as a guest house; booking is required well in advance.
- Kolb Studio was built in 1904 by brothers Ellsworth and Emery Kolb. They were photographers who made a living by photographing visitors walking down the Bright Angel Trail. In 1911, the Kolb brothers filmed their journey down the Green and Colorado Rivers. Emery Kolb showed this movie regularly in his studio until 1976, when he died at the age of 95. Today the building serves as an art gallery and exhibit.
- The El Tovar Hotel was built in 1905 and is the most luxurious lodging on the South Rim. The hotel

consists of 4 stories with a rustic chalet appearance called "National Park Rustic." It was designed by Charles Whittlesley. A gift shop and restaurant are located inside the hotel.

- Hopi House was built by Mary Jane Colter in 1905. It is based on structures that were built in an ancient Hopi settlement called Old Oraibi, located on the Third Mesa in eastern Arizona. It served as a residence for the Hopi Indians who sold arts and crafts to South Rim visitors.
- Verkamp's Curios, which stands next to the Hopi House, was built by John Verkamp in 1905. He sold arts and crafts as well as souvenirs. Until September 2008, it was run by his descendants; in November 2008, the building reopened as a visitor center focusing on the history of the Grand Canyon Village community.
- Grand Canyon Railway Depot was completed in 1910 and contains 2 levels. Gordon Chappell, Regional Historian for the Park Service, claims that this depot building is one of only three log-cabin-style train stations currently standing, out of fourteen ever built in the U.S.^[31] The depot is the northern terminus of the Grand Canyon Railway which begins in Williams, Arizona.
- Lookout Studio, another Mary Colter design, was built in 1914. Photography, artwork, books, souvenirs, and rock and fossil specimens are sold here. A great view of Bright Angel Trail can be seen here.
- Desert View Watchtower, one of Mary Colter's best-known works, was built in 1932. Situated at the far eastern end of the South Rim, 27 miles (43 km) from Grand Canyon Village, the tower stands 70 feet (21 m) tall. The top of the tower is 7,522 feet (2,293 m) above sea level, the highest point on the South Rim. It offers one of the few full views of the bottom of the Canyon and the Colorado River. It was designed to mimic Anasazi watchtowers, though, with four levels, it is significantly taller than historical towers.^[32]
- Bright Angel Lodge was built of logs and stone in 1935. Mary Colter designed the lodge and it was built by the Fred Harvey Company. Inside the lodge is a small museum honoring Fred Harvey (June 27, 1835 – February 9, 1901), who played a major role in popularizing the Grand Canyon. In the History Room is a stone fireplace layered in the same sequence as those in the canyon.



Desert View Watchtower in 2004



Locomotive No. 4960 at the Grand Canyon Depot.

Weather

Weather in the Grand Canyon varies according to elevation. The forested rims are high enough to receive winter snowfall, but along the Colorado River in the Inner Gorge, temperatures are similar to those found in Tucson and other low elevation desert locations in Arizona. Conditions in the Grand Canyon region are generally dry, but substantial precipitation occurs twice annually, during seasonal pattern shifts in winter (when Pacific storms usually deliver widespread, moderate rain and high-elevation snow to the region from the west) and in late summer (due to the North American Monsoon, which delivers waves of moisture from the southeast, causing dramatic, localized thunderstorms fueled by the heat of the day).^[33] Average annual precipitation on the South

Rim is less than 16 inches (35 cm), with 60 inches (132 cm) of snow; the higher North Rim usually receives 27 inches (59 cm) of moisture, with a typical snowfall of 144 inches (317 cm); and Phantom Ranch, far below the Canyon's rims along the Colorado River at 2,500 feet (762 m) gets just 8 inches (17.6 cm) of rain, and snow is a rarity.



Grand Canyon covered with snow

Temperatures vary wildly throughout the year, with summer highs within the Inner Gorge commonly exceeding 100 °F (37.8 °C) and winter minimum temperatures sometimes falling below zero degrees Fahrenheit (−17.8 °C) along the canyon's rims.^[33] Visitors are often surprised by these potentially extreme conditions, and this, along with the high altitude of the canyon's rims, can lead to unpleasant side effects such as dehydration, sunburn, and hypothermia.



A storm over the Grand Canyon

Weather conditions can greatly affect hiking and canyon exploration, and visitors should obtain accurate forecasts because of hazards posed by exposure to extreme temperatures, winter storms and late summer monsoons. While the park service posts weather information at gates and visitor centers, this is a rough approximation only, and should not be relied upon for trip planning. For accurate weather in the Canyon, hikers should consult the National Weather Service's NOAA weather radio or the official National Weather Service website.^[34]

The National Weather Service has had a cooperative station on the South Rim since 1903. The record high temperature on the South Rim was 105 °F (41 °C) on June 26, 1974, and the record low temperature was −20 °F (−29 °C) on January 1, 1919, February 1, 1985, and December 23, 1990.^{[35][36][37]}

Air quality

The Grand Canyon area has some of the cleanest air in the United States.^{[39]:p.5-2} ^[40] However at times the air quality can be considerably affected by events such as forest fires and dust storms in the Southwest.

What effect there is on air quality and visibility in the Canyon has been mainly from sulfates, soils, and organics. The sulfates largely result from urban emissions in southern California, borne on the prevailing westerly winds throughout much of the year, and emissions from Arizona's copper smelter region, borne on southerly or southeasterly winds during the monsoon season. Airborne soils originate with windy conditions and road dust. Organic particles result from vehicle emissions, long-range transport from urban areas, and forest fires, as well as from VOCs emitted by vegetation in the surrounding forests. Nitrates, carried in from urban areas, stationary sources, and vehicle emissions; as well as black carbon from forest fires and vehicle emissions, also contribute to a lesser extent. ^[40] ^{[41]:p.26, 49–51}



Smoke from prescribed fires on the south rim, as seen from Yavapai Point, April 2007.^[38]

A number of actions have been taken to preserve and further improve air quality and visibility at the Canyon. In 1990, amendments to the Clean Air Act established the Grand Canyon Visibility Transport Commission

(GCVTC) to advise the US EPA on strategies for protecting visual air quality on the Colorado Plateau. The GCVTC released its final report in 1996 and initiated the Western Regional Air Partnership (WRAP), a partnership of state, tribal and federal agencies to help coordinate implementation of the Commission's recommendations. ^[42] ^[43]

In 1999, the Regional Haze Rule established a goal of restoring visibility in national parks and wilderness areas (Class 1 areas), such as the Grand Canyon, to natural background levels by 2064. Subsequent revisions to the rule provide specific requirements for making reasonable progress toward that goal. ^[44]



Natural fog sometimes fills the canyon, during temperature inversions

In the early 1990s, studies indicated that emissions of SO₂, a sulfate precursor, from the Navajo Generating Station affected visibility in the Canyon mainly in the winter, and which if controlled would improve wintertime visibility by 2 to 7%. ^[45]:p.C-2,C-6 As a result, scrubbers were added to the plant's three units in 1997 through 1999, reducing SO₂ emissions by more than 90%. The plant also installed low-NO_x SOFA burners in 2009 -2011, reducing emissions of NO_x, a nitrate precursor, by 40%. Emissions from the Mohave

Generating Station to the west were similarly found to affect visibility in the Canyon. The plant was required to have installed SO₂ scrubbers, but was instead shut down in 2005, completely eliminating its emissions. ^[46]

Prescribed fires are typically conducted in the spring and fall in the forests adjacent to the Canyon to reduce the potential for severe forest fires and resulting smoke conditions. Although prescribed fires also affect air quality, the controlled conditions allow the use of management techniques to minimize their impact. ^[47] ^[48]:p.86,93

Biology and ecology

Plants

There are approximately 1,737 known species of vascular plants, 167 species of fungi, 64 species of moss and 195 species of lichen found in Grand Canyon National Park.^[49] This variety is largely due to the 8,000 foot (2,400 m) elevation change from the Colorado River up to the highest point on the North Rim.^[49] Grand Canyon boasts a dozen endemic plants (known only within the Park's boundaries) while only ten percent of the Park's flora is exotic.^[49] Sixty-three plants found here have been given special status by the U.S. Fish and Wildlife Service.^[49]

The Mojave Desert influences the western sections of the canyon, Sonoran Desert vegetation covers the eastern sections, and ponderosa and pinyon pine forests grow on both rims.^[50]

Natural seeps and springs percolating out of the canyon walls are home to 11% of all the plant species found in the Grand Canyon.^[50] The Canyon itself can act as a connection between the east and the west by providing corridors of appropriate habitat along its length.^[50] The canyon can also be a genetic barrier to some species,



Grand Canyon Clouds time lapse VP8

like the tassel-eared squirrel.^[50]

The aspect, or direction a slope faces, also plays a major role in adding diversity to the Grand Canyon. North-facing slopes receive about one-third the normal amount of sunlight, so plants growing there are similar to plants found at higher elevations, or in more northern latitudes.^[50] The south-facing slopes receive the full amount of sunlight and are covered in vegetation typical of the Sonoran Desert.^[50]

Animals

Of the 34 mammal species found along the Colorado River corridor, 18 are rodents and eight are bats.^[51]

Life zones and communities

The Park contains several major ecosystems.^[9] Its great biological diversity can be attributed to the presence of five of the seven life zones and three of the four desert types in North America.^[9] The five life zones represented are the Lower Sonoran, Upper Sonoran, Transition, Canadian, and Hudsonian.^[9] This is equivalent to traveling from Mexico to Canada. Differences in elevation and the resulting variations in climate are the major factors that form the various life zones and communities in and around the canyon. Grand Canyon National Park contains 129 vegetation communities, and the composition and distribution of plant species is influenced by climate, geomorphology and geology.^[49]

Lower Sonoran

The Lower Sonoran life zone spans from the Colorado River up to 3,500 feet (1,100 m). Along the Colorado River and its perennial tributaries, a riparian community exists.^[49] Coyote willow, arrowweed, seep-willow, western honey mesquite, catclaw acacia, and exotic tamarisk (saltcedar) are the predominant species.^[49] Hanging gardens, seeps and springs often contain rare plants such as the white-flowering western redbud, stream orchid, and McDougall's flaveria.^[49] Endangered fish in the river include the humpback chub and the razorback sucker.^[52]

The three most common amphibians in these riparian communities are the canyon tree frog, red-spotted toad, and Woodhouse's Rocky Mountain toad.^[53] Leopard frogs are very rare in the Colorado River corridor, and are known to exist at only a few sites.^[53] There are 33 crustacean species found in the Colorado River and its tributaries within Grand Canyon National Park. Of these 33, 16 are considered true zooplankton organisms.^[54]

Only 48 bird species regularly nest along the river, while others use the river as a migration corridor or as overwintering habitat. The bald eagle is one species that uses the river corridor as winter habitat.^[55]

River otters may have disappeared from the park in late 20th century, and muskrats are extremely rare.^[51] Beavers cut willows, cottonwoods, and shrubs for food, and can significantly affect the riparian vegetation.^[51] Other rodents, such as antelope squirrels and pocket mice, are mostly omnivorous, using many different vegetation types.^[51] Grand Canyon bats typically roost in desert uplands, but forage on the abundance of insects



A bighorn ewe at the Grand Canyon, 2008

along the river and its tributaries.^[51] In addition to bats, coyotes, ringtails, and spotted skunks are the most numerous riparian predators and prey on invertebrates, rodents, and reptiles.^[51]

Raccoons, weasels, bobcats, gray foxes, and mountain lions are also present, but are much more rare.^[51] Mule deer and desert bighorn sheep are the ungulates that frequent the river corridor. Since the removal of 500 feral burros in the early 1980s, bighorn sheep numbers have rebounded.^[51] Mule deer are generally not permanent residents along the river, but travel down from the rim when food and water resources there become scarce.^[51]

The insect species commonly found in the river corridor and tributaries are midges, caddis flies, mayflies, stoneflies, black flies, mites, beetles, butterflies, moths, and fire ants.^[56] Numerous species of spiders and several species of scorpions including the bark scorpion and the giant desert hairy scorpion inhabit the riparian zone.^[56]

Eleven aquatic and 26 terrestrial species of mollusks have been identified in and around Grand Canyon National Park.^[57] Of the aquatic species, two are bivalves (clams) and nine are gastropods (snails).^[57] Twenty-six species of terrestrial gastropods have been identified, primarily land snails and slugs.^[57]

There are approximately 47 reptile species in Grand Canyon National Park. Ten are considered common along the river corridor and include lizards and snakes.^[58] Lizard density tends to be highest along the stretch of land between the water's edge and the beginning of the upland desert community.^[58] The two largest lizards in the Canyon are gila monsters and chuckwallas.^[58] Many snake species, which are not directly dependent on surface water, may be found both within the inner gorge and the Colorado River corridor. Six rattlesnake species have been recorded in the park.^[58]

Above the river corridor a desert scrub community, composed of North American desert flora, thrives. Typical warm desert species such as creosote bush, white bursage, brittlebush, catclaw acacia, ocotillo, mariola, western honey mesquite, four-wing saltbush, big sagebrush, blackbrush and rubber rabbitbrush grow in this community.^[49] The mammalian fauna in the woodland scrub community consists of 50 species, mostly rodents and bats.^[51] Three of the five Park woodrat species live in the desert scrub community.^[51]

Except for the western (desert) banded gecko, which seems to be distributed only near water along the Colorado River, all of the reptiles found near the river also appear in the uplands, but in lower densities.^[58] The desert gopher tortoise, a threatened species, inhabits the desert scrublands in the western end of the park.^[58]

Some of the common insects found at elevations above 2,000 feet (610 m) are orange paper wasps, honey bees, black flies, tarantula hawks, stink bugs, beetles, black ants, and monarch and swallowtail butterflies.^[56] Solifugids, wood spiders, garden spiders, black widow spiders and tarantulas can be found in the desert scrub and higher elevations.^[56]

Upper Sonoran and Transition

The Upper Sonoran Life Zone includes most of the inner canyon and South Rim at elevations from 3,500 to 7,000 feet (1,100 to 2,100 m).^[50] This zone is generally dominated by blackbrush, sagebrush, and pinyon-juniper woodlands. Elevations of 3,500 to 4,000 feet (1,100 to 1,200 m) are in the Mojave Desert Scrub community of the Upper Sonoran. This community is dominated by the four-winged saltbush and creosote bush; other important plants include Utah agave, narrowleaf mesquite, ratany, catclaw acacia, and various cacti species.^[50]

Approximately 30 bird species breed primarily in the desert uplands and cliffs of the inner canyon.^[55] Virtually all bird species present breed in other suitable habitats throughout the Sonoran and Mohave deserts.^[55] The abundance of bats, swifts, and riparian birds provides ample food for peregrines, and suitable eyrie sites are plentiful along the steep canyon walls. Also, several critically endangered California condors that were re-introduced to the Colorado Plateau on the Arizona Strip, have made the eastern part of the Park their home.^[55]

The conifer forests provide habitat for 52 mammal species.^[51] Porcupines, shrews, red squirrels, tassel eared Kaibab and Abert's squirrels, black bear, mule deer, and elk are found at the park's higher elevations on the Kaibab Plateau.^[51]

Above the desert scrub and up to 6,200 feet (1,900 m) is a pinyon pine forest and one seed juniper woodland.^[49] Within this woodland one can find big sagebrush, snakeweed, Mormon tea, Utah agave, banana and narrowleaf Yucca, winterfat, Indian ricegrass, dropseed, and needlegrass.^[49] There are a variety of snakes and lizards here, but one species of reptile, the mountain short-horned lizard, is a particularly abundant inhabitant of the piñon-juniper and ponderosa pine forests.^[58]

Ponderosa pine forests grow at elevations between 6,500 and 8,200 feet (2,000 and 2,500 m), on both North and South rims in the Transition life zone.^[49] The South Rim includes species such as gray fox, mule deer, bighorn sheep, rock squirrels, pinyon pine and Utah juniper.^[50] Additional species such as Gambel oak, New Mexico locust, mountain mahogany, elderberry, creeping mahonia, and fescue have been identified in these forests.^[49] The Utah tiger salamander and the Great Basin spadefoot toad are two amphibians that are common in the rim forests.^[53] Of the approximately 90 bird species that breed in the coniferous forests, 51 are summer residents and at least 15 of these are known to be neotropical migrants.^[55]

Canadian and Hudsonian

Elevations of 8,200 to 9,000 feet (2,500 to 2,700 m) are in the Canadian Life Zone, which includes the North Rim and the Kaibab Plateau.^[50] Spruce-fir forests characterized by Englemann spruce, blue spruce, Douglas fir, white fir, aspen, and mountain ash, along with several species of perennial grasses, groundsels, yarrow, cinquefoil, lupines, sedges, and asters, grow in this sub-alpine climate.^[49] Mountain lions, Kaibab squirrels, and northern goshawks are found here.^[50]

Montane meadows and subalpine grassland communities of the Hudsonian life zone are rare and located only on the North Rim.^[49] Both are typified by many grass species. Some of these grasses include blue and black grama, big galleta, Indian ricegrass and three-awns.^[49] The wettest areas support sedges and forbs.^[49]

Grand Canyon tourism

Grand Canyon National Park is one of the world's premier natural attractions, attracting about five million visitors per year. Overall, 83% were from the United States: California (12.2%), Arizona (8.9%), Texas (4.8%), Florida (3.4%) and New York (3.2%) represented the top domestic visitors. Seventeen percent of visitors were from outside the United States; the most prominently represented nations were the United Kingdom (3.8%), Canada (3.5%), Japan (2.1%), Germany (1.9%) and The Netherlands (1.2%).^[59] The South Rim is open all year



A California condor in flight, photographed from Navajo Bridge at Marble Canyon, 2008. Wild condors are numbered to aid wildlife researchers. As of April 2009, there were 172 wild California condors known.

round weather permitting. The North Rim is generally open mid-May to mid-October.^[60]

Activities

Aside from casual sightseeing from the South Rim (averaging 7,000 feet [2,100 m] above sea level), rafting, hiking, running, and helicopter tours are popular. The Grand Canyon Ultra Marathon is a 78-mile (126 km) race over 24 hours. The floor of the valley is accessible by foot, muleback, or by boat or raft from upriver. Hiking down to the river and back up to the rim in one day is discouraged by park officials because of the distance, steep and rocky trails, change in elevation, and danger of heat exhaustion from the much higher temperatures at the bottom. Rescues are required annually of unsuccessful rim-to-river-to-rim travelers. Nevertheless, hundreds of fit and experienced hikers complete the trip every year.



Rafters in the Grand Canyon pass one of the rapids of the (mud-) "colored" Colorado River

Camping on the North and South Rims is generally restricted to established campgrounds and reservations are highly recommended, especially at the busier South Rim. There is at large camping available along many parts of the North Rim managed by Kaibab National Forest. North Rim campsites are only open seasonally due to road closures from weather and winter snowpack. All overnight camping below the rim requires a backcountry permit from the Backcountry Office (BCO).^[61] Each year Grand Canyon National Park receives approximately 30,000 requests for backcountry permits. The park issues 13,000 permits, and close to 40,000 people camp overnight.^[61] The earliest a permit application is accepted is the first of the month, four months before the proposed start month.



A 6-minute video of a flight over the Grand Canyon (view in high quality)

Tourists wishing for a more vertical perspective can board helicopters and small airplanes in Boulder, Las Vegas, Phoenix and Grand Canyon National Park Airport (seven miles from the South Rim) for canyon flyovers. Scenic flights are no longer allowed to fly within 1500 feet of the rim within the national park because of a late 1990s crash.^[62] The last aerial video footage from below the rim was filmed in 1984. However, some helicopter flights land on the Havasupai and Hualapai Indian Reservations within Grand Canyon (outside of the park boundaries). Recently, the Hualapai Tribe opened the glass-bottomed Grand Canyon Skywalk on their property, Grand Canyon West. The Skywalk has seen mixed reviews since the site is only accessible by driving down a 10-mile (16 km) dirt road, costs a minimum of \$85 in total for reservation fees, a tour package and admission to the Skywalk

itself and the fact that cameras or other personal equipment are not permitted on the Skywalk at any time due to the hazard of damaging the glass if dropped. The Skywalk is about 250 miles (400 km) by road from Grand Canyon Village at the South Rim.^[63]

Viewing the canyon

Lipan Point is a promontory located on the South Rim. This point is located to the east of the Grand Canyon Village along the Desert View Drive. There is a parking lot for visitors who care to drive along with the Canyon's bus service that routinely stops at the point. The trailhead to the Tanner Trail is located just before the parking lot. The view from Lipan Point shows a wide array of rock strata and the Unkar Creek area in the inner canyon.

The canyon can be seen from the Toroweap (or Tuweep) Overlook situated 3000 vertical feet above the Colorado River, about 50 miles downriver from the South Rim and 70 upriver from the Grand Canyon Skywalk. This region — "one of the most remote in the United States" according to the National Park Service — is reached only by one of three lengthy dirt tracks beginning in from St. George, Utah, Colorado City or near Pipe Spring National Monument (both in Arizona). Each road traverses wild, uninhabited land for 97, 62 and 64 miles respectively. The Park Service manages the area for primitive value with minimal improvements and services.

Grand Canyon fatalities

About 600 deaths have occurred in the Grand Canyon since the 1870s. Some of these deaths occurred as the result of overly zealous photographic endeavors, some were the result of airplane collisions within the canyon, and some visitors drowned in the Colorado River.

Of the fatalities, 53 have resulted from falls; 65 deaths were attributable to environmental causes, including heat stroke, cardiac arrest, dehydration, and hypothermia; 7 were caught in flash floods; 79 were drowned in the Colorado River; 242 perished in airplane and helicopter crashes (128 of them in the 1956 disaster mentioned below); 25 died in freak errors and accidents, including lightning strikes and rock falls; and 23 were the victims of homicides.^[64]

1956 air disaster

In 1956 the Grand Canyon was the site of the deadliest commercial aviation disaster in history at the time.

On the morning of June 30, 1956, a TWA Lockheed Super Constellation and a United Airlines Douglas DC-7 departed Los Angeles International Airport within three minutes of one another on eastbound transcontinental flights. Approximately 90 minutes later, the two propeller-driven airliners collided above the canyon while both were flying in unmonitored airspace.

The wreckage of both planes fell into the eastern portion of the canyon, on Temple and Chuar Buttes, near the confluence of the Colorado and Little Colorado rivers. The disaster killed all 128 passengers and crew members aboard both planes.

This accident led to the institution of high-altitude airways and positive control by en route ground controllers.

Evacuation

Canyon tourists and residents of Supai, a town located in the bottom of the canyon, were evacuated from the Supai area on August 17–18, 2008^[65] due to a break in the earthen Redlands Dam, located upstream of Supai,



Sunset from Toroweap Overlook



Guano Point - a popular vantage point for tourists, situated on the West Rim of the Grand Canyon, Hualapai Indian Reservation



Grand Canyon rescue Helicopter, 1978