

IBPG - Darwin

The Institute of Biopaleogeography
named under Charles R. Darwin



IBPG 15 (2022) 1-56

E-ISSN 2956-4573

Scientific and touristic expedition to the meeting the natural beauties in Arizona, U.S.

Fabio Rossano Dario^{1,2,a} & Maria Cristina Veiga De Vincenzo^{2,b}

¹The Institute of Biopaleogeography named under Charles R. Darwin,
Złocieniec, District Drawski, West Pomerania, Poland

²Instituto de Pesquisas e Estudos da Vida Silvestre
Rua Leonardo Mota, 66 - São Paulo-SP, ZIP 05586-090, Brazil

^{a,b}E-mail address: fabiorossano@hotmail.com , crisvincenzo@hotmail.com

The Institute of Biopaleogeography named under Charles R. Darwin

Publisher's Address:

Scientific Publishing House DARWIN at The Institute
22, Adama Mickiewicza Street, 78-520 Złocieniec,
District Drawski, West Pomerania, Poland

Cite of this article:

Fabio Rossano Dario, Maria Cristina Veiga De Vincenzo. Scientific and touristic expedition to the meeting the natural beauties in Arizona, U.S. *The Institute of Biopaleogeography named under Charles R. Darwin 15 (2022) 1-56*

ABSTRACT

This paper is a photographic summary of a scientific and touristic expedition carried out in May-June 2016 in Arizona State, U.S to know the natural beauties of the different ecosystems in the region, the U.S. National Park Service, and the structure of some National Parks, National Forests, and Wilderness Areas. The photos show some parks and wilderness areas structures, important geological formations, and some of the plants, birds, mammals, and lizards species registered.

Keywords: Arizona State, Sedona, National Park, Grand Canyon, Coconino National Forest

INTRODUCTION

The Arizona State, located in the Southern region of the United States (**Figure 1**), has a great wealth of landscapes full of natural beauty, with its extraordinary variety of rivers, canyons, deserts, and mountains.

The main objective of this scientific and touristic expedition, realized in May-June 2016 was to know the natural beauties of the different ecosystems existing in the State of Arizona, as well as to know the National Park Service and the structure of some National Parks, National Forests and Wilderness Areas (**Figure 2**), identifying and photographing the natural riches accessible to my lens and the main plant and animal species that I was lucky to see.



Figure 1. Localization of the Arizona State, US. Source: Google Earth.



Figure 2. Localization of the National Parks, National Forests, and Wilderness Areas of the Arizona State, US. Source: Rocky Mountain Maps & Guidebooks (<https://rockymountainmaps.com>)

The state park system in Arizona includes both, state parks and state historic parks and other designations such as natural areas and recreation areas. The Sonoran Desert (Desierto de Sonora) (**Photo 1**) is the hottest desert in both, Mexico and United States. It contains a wide variety of endemic plants and animals, like the saguaro (*Carnegiea gigantea*) (**Photo 2**). The saguaro is a tree-like cactus species. The saguaro blossom is the state wildflower of Arizona. In 1994, Saguaro National Park, near Tucson, Arizona, was created to help protect this species

and its habitat. This cactus has a long lifespan, often exceeding 150 years. It is a keystone species and provides food and habitat to many species. Saguaros have been a source of food and shelter for humans for thousands of years. Their sweet red-fleshed fruits are turned into syrup by native peoples, such as the Tohono O'odham and Pima. Their ribs are used as building materials in the wood-poor deserts. The saguaro cactus is a common image in Mexican culture and American Southwest films [1-4].

Sedona is a beautiful city that lies within the Coconino National Forest, and it is best known for its surreal landscape (**Photos 3-5**). It is located in the interior chaparral, semi-desert grassland, Great Basin conifer woodland biomes of northern Arizona, filled with dreamlike rock formations, cliffs, and canyons [5]. Most of the mountains in Sedona are large clusters of red sandstone. Each formation has distinct characteristics which provide unique names like Courthouse Butte (**Photo 6**), Bell Rock (**Photo 7**), and Cathedral Rock. Located in the picturesque Sedona area, Red Rock State Park is filled with glowing red rock formations. Home to the famous Cathedral Rocks, this 286-acre (thereabout 115 hectares) nature preserve offers panoramic views of Sedona's other famous formations.

Before the red rock was turned into rock, it was all soft mud and sand. Over a 320-million-year period changes in nature helped transform the sand and mud into something incredibly beautiful. Sea levels rose and fell during this time and with each rise and fall mud was added. During the sea level rise, the mud would be washed in, and then when it receded the wind brought in layers of sand. After years of this happening over and over again, the sediment was transformed into hard rock (**Photo 8**). The red rocks of Sedona are formed by a unique layer of rock known as the Schnebly Hill Formation. This geological formation is a dark red sandstone, 800 to 1000 feet thick (between 240 to 300 meters), that is the major component of the "Red Rocks" of Sedona [6, 7].

The Munds Wagon Trail is located on the outskirts of Sedona and offers extraordinary close-up and distant views of Sedona. This historic trail follows one of the first and most popular cattle trails out of the Sedona area (**Photos 9 & 10**).

Sedona interior chaparral has many shrubs and small tree species of *Quercus turbinella*, *Rhus ovata*, and a large population of *Quercus palmeri*. The Great Basin woodland has many small to medium trees of *Pinus monophylla*, *Juniperus arizonica*, *Juniperus deppeana*, *Juniperus osteosperma*, *Juniperus monosperma*, and a large population of *Cupressus glabra* [8-11]. Prickly Pear Cactus (**Photo 11**) represents about a dozen species of the *Opuntia* genus (Family Cactaceae) in the North American deserts. All have flat, fleshy pads that look like large leaves. The pads are modified branches or stems that serve several functions such as water storage, photosynthesis, and flower production [12, 13].

The Coconino National Forest is one of the most diverse National Forests in the United States, located in northern Arizona in the vicinity of Flagstaff, with landscapes ranging from the famous red rocks of Sedona to Ponderosa pine forests, from southwestern desert to alpine tundra (**Photos 12-19**). The Coconino covers 1,821,495 acres (thereabout 737,000 hectares) and it is one of the oldest National Forest in the country having been created by a proclamation signed on July 2, 1908, by President Theodore Roosevelt. This act consolidated all the San Francisco Mountains National Forest, parts of the Black Mesa and Tonto National Forest, all the Grand Canyon National Forest south and east of the Colorado River, into the Coconino National Forest.

The Coconino National Forest is home to over 500 vertebrate species, including at least 300 species of birds, almost 100 species of mammals, a wide variety of herpetofauna

(amphibians and reptiles), 16 native fish species, as well as many invertebrates. Having some understanding of the different animals' species can help you identify them quickly [14-17].

There are about 60 lizards in Arizona. The beautiful *Callisaurus draconoides* (Zebra-tailed lizards) is one such species of lizard (**Photo 20**). The Zebra-tailed lizard (*Callisaurus draconoides*) is a diurnal territorial lizard from arid areas of North America. Their habitats are sandy areas, and open gravel flats with few plants where they can escape predators by digging into the sand and then darting quickly away when necessary [18]. Their diet includes carnivorous, eating arthropods in general, like insects and spiders, some plant material, and occasionally other lizards. A good feature for its identification is the underside of its tail has a series of black bands on a white background; individuals raise the tail to expose the underside as a social signal and to deter pursuit by predators [19-21].

Arizona is a birdwatcher's paradise. The diversity of habitats in Arizona ranges from lowland desert up to pine forests, and these diverse ecosystems support a surprising array of birdlife. Common desert birds include greater roadrunners, Gila Woodpeckers, and Gambel's Quail (**Photo 21**). Northern goshawks, yellow-eyed juncos, and Mexican jays can be found in the higher elevations. There are 561 species of bird recorded in Arizona State [22-32]. Some of the highlight birds in Arizona include Barn Swallow (**Photo 22**), White-crowned Sparrow (**Photo 23**), Spotted Towhee (**Photo 24**), Western Scrub-jay (**Photo 25**), Steller's Jay (**Photo 26**), Broad-winged Hawk (**Photo 27**), California Condor (**Photo 28**), Common Raven (**Photo 29**), Tropical Kingbird (**Photo 30**), Cliff Swallows (**Photo 31**), Northern Rough-winged Swallow (**Photo 32**), House Wren (**Photo 33**), American Robin (**Photo 34**), House Finch (**Photo 35**), and Savannah Sparrows (**Photo 36**).

The California Condor (*Gymnogyps californianus*) (**Photo 28**) had a large range down the West coast of North America. However, by 1937 the range had contracted to California only. To ensure the survival of the species, in 1987 all the 27 remaining wild birds were placed in a captive breeding program. Reintroduction began in 1991 and has led to the wild population increasing to about 500 birds. In 2003 the first chick successfully fledged from a nest cave in the wild since the reintroduction [33, 34].

The California Condor is now found in remote and irregularly wooded hills and open-country scrubland with rocky terrain. Breeding sites are rocky outcrops, the cavities of large trees, or cracks in the cliffs. They mainly scavenge on the carcasses of large mammals but are also known to feed on dead rodents and rabbits. They roost on tree branches and along cliff ledges, often communally, although they do not nest communally and will defend their nesting area aggressively. The females lay a single egg every second year. This species has held mythological and cultural significance to Native American tribes, and interestingly the perception of it differs from tribe to tribe [35].

The Western Scrub-jay (*Aphelocoma californica*) (**Photo 25**) is a species of scrub jay native to western North America. It like many other corvids, exploit ephemeral surpluses by storing food in scattered caches within their territories. They rely on highly accurate and complex memories to recover the hidden caches, often after long periods. Research has suggested that western scrub jays, along with several other corvids, are among the most intelligent of animals. In the process of collecting and storing this food, they have shown an ability to plan in choosing cache sites to provide adequate food volume and variety for the future. Western scrub-jays are also able to rely on their accurate observational spatial memories to steal food from caches made by conspecifics [36-38].

The House Wren (*Troglodytes aedon*) (**Photo 33**) is a very small songbird of the wren family, Troglodytidae. It occurs from Canada to southernmost South America and is thus the most widely distributed native bird in the Americas. It occurs in most suburban areas in its range, and it is the single most common wren. Its taxonomy is highly complex, and some subspecies groups are often considered separate species. The name troglodytes means "hole dweller" and is a reference to bird's tendency to disappear into crevices when hunting insects or to seek shelter [39, 40].

The House Finch (*Haemorhous mexicanus*) (**Photo 35**) is a bird native to western North America and has been introduced to the eastern half of the continent and Hawaii. There are estimated to be anywhere from 267 million to 1.7 billion individuals across North America. Their finches forage on the ground or in vegetation normally. They primarily eat grains, seeds, and berries, being voracious consumers of weed seeds such as nettle and dandelion; included are incidental small insects such as aphids. They are frequent visitors to bird feeders throughout the year, particularly if stocked with sunflower or nyjer seed, and will congregate at hanging nyjer sock feeders. The house finch is known to damage orchard fruit and consume commercially grown grain but is generally considered an annoyance rather than a significant pest [41, 42].

An impressive site, the Meteor Crater (**Photos 37 & 38**) is the result of a collision between an asteroid traveling 26,000 miles per hour (thereabout 42,000 kilometers/hour) over 50,000 years ago. The meteorite impact site is 550 feet deep (168 meters) and has a diameter of just over a kilometer. It is located about 37 miles (60 km) east of Flagstaff, in the desert of northern Arizona. In 1929, astronomer Forest Ray Moulton investigated the physics of the impact event and concluded that the impactor likely weighed as little as 300,000 tons and that the impact of such a body would have generated enough heat to vaporize the impactor instantly [43].

Flagstaff Mountain is a foothill on the eastern flank of the Front Range of the Rocky Mountains of North America. The 6,983-foot (2,128 m) peak is in Boulder Mountain Park in Boulder County, Colorado, United States (**Photo 39**). As we drive from Flagstaff to Grand Canyon National Park, the soil turns red, hinting at what's to come. The Grand Canyon of the Colorado River is a showplace of geology (**Photos 40-57; 63-69; 74-76**). The Colorado River has carved the Grand Canyon into four plateaus of the Colorado Plateau Province [44]. The Plateau's arid climate produced many striking erosional forms, culminating in the Grand Canyon. The Canyon's mile-high (1,6 km) walls display a largely undisturbed cross-section of the Earth's crust extending back some two billion years. Rock layers formed during the Paleozoic Era are the most conspicuous in the Grand Canyon's walls. Layers from the Cambrian, Devonian, Mississippian, Pennsylvanian, and Permian periods are present.

Nearby rock outcrops suggest 4,000 to 8,000 feet (1,219 to 2,438 m) of sedimentary layers from the "Age of Dinosaurs" once covered the Grand Canyon area. Cenozoic Era (the "Age of Mammals") layers are limited to the western Grand Canyon and terraces near the river itself. About the formation of the Grand Canyon, research using apatite fission-track dating [45] revealed that two of the three middle segments, the Hurricane segment, and the Eastern Grand Canyon, formed between 70 and 50 million years ago and between 25 and 15 million years ago, respectively. However, the two end segments, the Marble Canyon and the Westernmost Grand Canyon are both young and were carved in the past 5-6 million years. Thus, although parts of the canyon are old, concludes that the integration of the Colorado River through older palaeocanyons carved the Grand Canyon, beginning 5-6 million years ago.

The Grand Canyon Supergroup is a Mesoproterozoic to a Neoproterozoic sequence of sedimentary strata (**Photos 70-73**), partially exposed in the eastern Grand Canyon of Arizona [46]. This group comprises the “Unnamed diabase sills and dikes”: black, medium- to coarse-grained, olivine-rich diabase; “Escalante Creek Member”: gray, light-brown to dark-brown, cliff-forming, fine to medium-grained sandstone and interbedded dark-brown to green, slope forming shale and mudstone. Includes gray contorted sandstone beds in lower part similar to those in underlying Shinumo Quartzite and small-scale, tabular planar cross-bedded and graded-bedding sets; “Shinumo Quartzite”: red-brown, purple, and gray, cliff-forming sandstone; “Hakatai Shale”: orange-red, purple, and red mudstone, shale, and sandstone. Forms an upper cliff unit, a middle slope unit, and a lower slope unit. The upper cliff unit consists of pale-purple or lavender, fine- to coarse-grained, thin- to medium bedded, cross-bedded sandstone. Middle slope unit is the most distinctive red-bed unit in the Grand Canyon; “Bass Formation”: red-brown and reddish-gray, ledge-forming dolomite, silty sandstone, and conglomerate; “Hotauta Conglomerate Member”: red-brown and gray conglomerate of well-rounded to subangular pebbles and boulders of granite, gneiss, and schist derived from underlying Early Proterozoic igneous and metamorphic rocks. Clasts are cemented in a red-brown, coarse-grained, gravelly sandstone matrix [47-49].

Grand Canyon is considered one of the finest examples of arid-land erosion in the world. Incised by the Colorado River, the canyon is immense, averaging 4,000 feet deep for its entire 277 miles (thereabout 450 km). However, the significance of the Grand Canyon is not limited to its geology. The Park contains several major ecosystems, and 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: Lower Sonoran, Upper Sonoran, Transition, Canadian, and Hudsonian. The Park also serves as an ecological refuge, with relatively undisturbed remnants of dwindling ecosystems (such as boreal forest and desert riparian communities). It is home to numerous rare, endemic (found only at Grand Canyon), and specially protected (threatened or endangered) plant and animal species [50-52].

The Grand Canyon is home to 41 species of reptiles that live from the pine forests to the Colorado River (**Photo 59**). The 22 snakes, 18 lizards, and 1 tortoise species that live in the Grand Canyon are important species that play a very important ecological role. For example, many reptiles are prey for raptors and mammals, while lizards’ prey on insect populations, and snake species control rodent populations, preventing the spread of diseases like Bubonic Plague and Hantavirus. Many of the reptile species found inside the park are endemic, like the Grand Canyon rattlesnake (*Crotalus organus abyssus*) [53].

Because of its wide variety of ecosystems, Grand Canyon National Park is home to an incredible diversity of birdlife with nearly 450 species and over 90 species of mammals. Most visitors to the park see mule deer, elk (**Photos 61 & 62**), and squirrels (**Photo 60**), but many of Grand Canyon’s mammals are secretive or nocturnal and move around unnoticed, like the bats [54-64].

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. This variety is largely due to the 8,000 feet (thereabout 2,500 m) elevation change from the river up to the highest point on the North Rim. Grand Canyon boasts a dozen endemic, while only ten percent of the Park’s flora is exotic. Grand Canyon National Park contains 129 vegetation communities, and the composition and distribution of plant species are influenced by climate, geomorphology, and geology.

There are approximately 200 species of trees and shrubs in Grand Canyon National Park. Some of the tree species include the white fir, Engelman spruce, blue spruce, Douglas fir, corkbark fir, ponderosa pine, Utah juniper, alligator juniper, Colorado pinyon, quaking aspen, Fremont cottonwood, Gambel oak, and Arizona walnut. Some of the shrub species have compound leaves and they include creeping barberry, fernbush, honey mesquite, catclaw acacia, creosote bush, boxelder, and New Mexican locust. Shrub species with simple and alternating leaves are the chokeberry, big sagebrush, seep willow, birchleaf buckthorn, netleaf hackberry, Utah serviceberry, and desert bricklebrush (**Photos 46-49; 56-58**) [65, 66].

Bordered by Kaibab National Forest and Glen Canyon National Recreation Area, some of the most unusual geologic formations in the country are found in northern Arizona. It took millions of years for nature to make this magical place, anchored by an isolated maze of rock formations known as Vermilion Cliffs (**Photos 77-79**). In fact, the area is so removed from human activity, the cliffs were chosen as a site for the reintroduction of the California condor into the wild (**Photo 28**) [66, 67].

Near the State of Utah, has the Navajo Bridge (**Photos 80 & 81**). It is the name of twin steel spandrel arch bridges that cross the Colorado River in the Grand Canyon National Park in northern Coconino County. Before completion of the first Navajo Bridge, one of the only Colorado River crossings between Arizona and Utah was located about 5 miles (8.0 km) upstream from the bridge site, at the mouth of Glen Canyon. The dual spans of the Navajo Bridge are tied at ninth place among the highest bridges in the United States with nearly identical heights of 467 feet (142.3 m) for the original span, and 470 feet (143.3 m) for the second span. The Glen Canyon Dam (**Photos 82-84**) was constructed on the Colorado River from 1956-1964 as one of four dams in the United States Bureau of Reclamation's Colorado River Storage Project. Built to generate power and store water from the Colorado River in Lake Mead, the dam elicited a mixed response from people at the time it was constructed and continues to do so today.

There are twenty-two tribal governments within the boundaries of the state of Arizona, like Tonto Apache Tribe, Yavapai-Prescott Tribe, Hopi Tribe, and Navajo Nation. The varied geology and ecosystems in Arizona provided the basis for the diverse traditional economies of these Native people. Many tribes make the conscious decision to protect natural ecosystems, and Tribal Nations manage their hunting and fishing. The land of these indigenous often includes visitor's center, casinos, restaurants, and Inns, that offer spacious guest rooms and restaurants that serves breakfast, lunch, and dinner, such as the Hopi Cultural Center. The natural areas of these tribes can be visited with guides certified by the tribes. These guides pass on great knowledge about the traditions and culture of the indigenous people, and make the tour an unforgettable experience, combining the natural beauty with the culture of these traditional people.

All photos presented in this report were realized by Fabio Rossano Dario, using a digital photo camera Canon PowerShot.

CONCLUSIONS

The Arizona State has a great wealth of landscapes full of natural beauty, with its extraordinary variety of rivers, canyons, deserts, and mountains. These natural environments

host a wide variety of plant and animals' species, some endemic, others endangered, and many of which are still unknown.

The park system in Arizona is very well organized and includes National Parks, National Forests, and Wilderness Areas, with several parameters related to the physical infrastructure to the well-being of the visitors and comfort as well. It was very gratifying to know beautiful landscapes, such as dreamlike rock formations, cliffs, and canyons of the Coconino National Forest and Grand Canyon National Park, the beautiful cities like Flagstaff and Sedona, with their red rocks, plants like ponderosa pine and the saguaro cactus, the California Condor, and a wide variety of birds.

On a trip to Arizona, is essential to know a little about the culture of the traditional people, the Tribal Nations located within the boundaries of the State, their rich cultures, values, and principles of traditional cultures that sustain American Indigenous people for centuries.

References

- [1] J.R. Hastings, S.M. Alcorn. Physical determinations of growth and age in the Giant Cactus. *Journal of the Arizona Academy of Science* 2(1) (1961) 32
- [2] J.G. Bruhn. *Carnegiea gigantea*: The Saguaro and its uses. *Economic Botany* 25(3) (1971) 320-329
- [3] J. Renzi. A decade of flowering phenology of the keystone saguaro cactus (*Carnegiea gigantea*). *American Journal of Botany* 106(2) (2019) 199-210.
- [4] R.S. Felger. Living resources at the center of the Sonoran Desert: Native American plant and animal utilization. (2007), Pages 147-192, in Felger & Broyles, editors. *Dry Borders*. University of Utah Press.
- [5] K. Christie. Phytogeography and floristics of pinyon-juniper woodlands in northern Arizona. *Western North American Naturalist* 69(2) (2009) 155-164
- [6] J.V. Bezy. A Guide to the Geology of the Sedona & Oak Creek Canyon area, Arizona. *Arizona Geological Survey* 20 (2012) 1-42
- [7] R.C. Blakey. Stratigraphy and geologic history of Pennsylvanian and Permian rocks, Mogollon Rim region, central Arizona and vicinity. *Geological Survey Bulletin* 102 (1990) 1189-1217
- [8] T.M. Wilson, A. Poulson, C. Packer, J. Marshall, R.E. Carlson, R.M. Buch. Essential oils of whole tree, trunk, limbs and leaves of *Juniperus osteosperma* from Utah. *Phytologia* 101(3) (2019) 188-193
- [9] J.C. Chambers, S.B. Vander Wall, E.W. Schupp. Seed and seedling ecology of piñon and juniper species in the pygmy woodlands of western North America. *The Botanical Review* 65(1) (1999) 1-38
- [10] K. Christie. Vascular flora of the lower San Francisco volcanic field, Coconino County, Arizona. *Madroño* 55(1) (2008) 1-14
- [11] F.C. Vasek. The distribution and taxonomy of three western junipers. *Brittonia* 18(4) (1966) 350-372

- [12] M.P. Griffith. The origins of an important cactus crop, *Opuntia ficus-indica* (Cactaceae): new molecular evidence. *American Journal of Botany* 91(11) (2004) 1915-1921
- [13] A.D. Stock, N. Hussey, M.D. Beckstrom. A new species of *Opuntia* (Cactaceae) from Mojave Co, Arizona. *Cactus and Succulent Journal* 86(2) (2014) 79-83
- [14] S. Tekiela. *Birds of Arizona Field Guide* (2003).
- [15] S. Tekiela. *Mammals of Arizona Field Guide* (2008).
- [16] T.C. Brennan, A.T. *A Field Guide to Amphibians and Reptiles in Arizona* (2006).
- [17] L.L.C. Jones, R.E. Lovich. *Lizards of the American Southwest: A Photographic Field Guide* (2009).
- [18] D.A. Eifler, M.A. Eifler. Characteristics and use of the tail in signaling by the Zebra-Tailed Lizard (*Callisaurus draconoides*). *The Southwestern Naturalist* 55(1) (2010) 104-109
- [19] G.A. Adest. Genetic differentiation among populations of the zebra-tail lizard, *Callisaurus draconoides* (Sauria: Iguanidae). *Copeia* 4 (1987) 854-859
- [20] P.J. Bergmann, A.M. Hobbs, M.L. Kavalanch, A.P. Russell. Modulated but conserved segmental growth of the original tail in *Callisaurus draconoides* (Phrynosomatidae) and *Calotes versicolor* (Agamidae). *Herpetologica* 60(1) (2004) 62-74
- [21] C.L. Frost, P.J. Bergmann. Spatial Distribution and Habitat Utilization of the Zebra-tailed Lizard (*Callisaurus draconoides*). *Journal of Herpetology* 46(2) (2012) 203-208
- [22] L.M. Huey. Some light on the introduction of Gambel Quail on San Clemente island, California. *Condor* 34(1) (1932) 46
- [23] N. Saino, S. Calza, A.P. Møller. Immunocompetence of nestling barn swallows in relation to brood size and parental effort. *Journal of Animal Ecology* 66 (1997) 827-836
- [24] R.A. Robinson, H.Q.P. Crick, W. Peach. Population trends of Swallows *Hirundo rustica* breeding in Britain. *Bird Study* 50 (2003) 1-7
- [25] G. Orłowski, J. Karg. Diet of nestling Barn Swallows *Hirundo rustica* in rural areas of Poland. *Central European Journal of Biology* 6 (2011) 1023-1035
- [26] K.L. Evans, J.D. Wilson, R.D. Bradbury. Effects of crop type and aerial invertebrate abundance on foraging barn swallows *Hirundo rustica*. *Agriculture, Ecosystems & Environment* 122 (2007) 267-273
- [27] H. Hussey. The White-crowned Sparrow in County Cork. *Birding World* 16(5) (2003) 203-205
- [28] J. Davis. Comparative foraging behavior of the Spotted and Brown Towhees. *The Auk* 74(2) (1957) 129-166
- [29] J.L. Brown. The integration of agonistic behavior in the Steller's Jay, *Cyanocitta stelleri* (Gmelin). *University of California Publications in Zoology* 60 (1964) 223-328

- [30] M. Slaby, F. Slaby. Color preference and short-term learning by Steller's Jays. *The Condor* 79 (1977) 384-386
- [31] D.W. Hengstenberg, J.F. Vilella. Nesting ecology and behaviour of Broad-winged Hawks in moist karst forest of Puerto Rico. *Journal of Raptor Research* 39(4) (2005) 404-416
- [32] H.S. Fitch. Observations of the Food and Nesting of the Broad-winged Hawk (*Buteo platypterus*) in Northeastern Kansas. *The Condor* 76(3) (1974) 331-333
- [33] G. Herring, C.A. Eagles-Smith, D.E. Varland. Mercury and lead exposure in avian scavengers from the Pacific Northwest suggest risks to California condors: Implications for reintroduction and recovery. *Environmental Pollution* 243 (2018) 610-619
- [34] P.I. Plaza, S.A. Lambertucci. What do we know about lead contamination in wild vultures and condors? A review of decades of research. *Science of the Total Environment* 1(654) (2019) 409-417
- [35] J. D'Elia, S.M. Haig, B. Marcot, J.M. Johnson, R. Young. Activity-specific ecological niche models for planning reintroductions of California Condors (*Gymnogyps californianus*). *Condor* 118 (2015) 703-714
- [36] J.M. Dally, N.J. Emery, N.S. Clayton. Cache protection strategies by Western scrub-jays (*Aphelocoma californica*): hiding food in the shade. *Biological Sciences* 271(6) (2004) 387-390
- [37] S.R. Kort, S.P.C. Correia, D.M. Alexis, A. Dickinson, N.S. Clayton. The control of food-caching behavior by Western scrub-jays (*Aphelocoma californica*). *Journal of Experimental Psychology* 33 (4) (2007) 361-370
- [38] C.R. Raby, D.M. Alexis, A. Dickinson, N.S. Clayton. Planning for the future by Western scrub-jays. *Nature* 445(7130) (2007) 919-921
- [39] M.E. Carro, P.E. Llambías, G.J. Fernández. Mate and territory availability affect breeding dispersal and divorce in a resident Southern House Wren *Troglodytes aedon* musculus population. *Ibis* 159(1) (2017) 168-179
- [40] M. Newhouse, P.P. Marra, L.S. Johnson. Reproductive success of House Wrens in suburban and rural land-use areas. *The Wilson Journal of Ornithology* 20 (2008) 99-104
- [41] J.R. Belthoff, S.A. Gauthreaux. Partial migration and differential winter distribution of House Finches in the Eastern United States. *The Condor* 93(2) (1991) 374-382
- [42] J.T. Wootton. Interspecific competition between introduced House Finch populations and two associated passerine species. *Oecologia* 71(3) (1987) 325-331
- [43] H.L. Crowson. A method for determining the residual meteoritical mass in the Barringer Meteor Crater. *Pure and Applied Geophysics* 85(1) (1971) 38-68
- [44] M.C. Rabbitt. The Colorado Plateau Province as a Field for Geological Survey Study. *The Scientific Monthly* 78(6) (1954) 346-58
- [45] K. Karlstrom, J.P. Lee, S.A. Kelley, R.S. Crow, L.J. Crossey, R.A. Young, G. Lazear, L.S. Beard, J.W. Ricketts, M. Fox, D.L. Shuster. Formation of the Grand Canyon 5 to 6

- million years ago through integration of older palaeocanyons. *Nature Geoscience* 7 (2014) 239-244
- [46] P.W. Huntoon. Phanerozoic structural geology of the Grand Canyon. In: S.S. Beus, M. Morales (eds.). *Grand Canyon Geology: Flagstaff, Arizona*. University Press and the Museum of Northern Arizona Press (1990) 261-310
- [47] D.P. Elston, G.R. Scott. Unconformity at the Cardenas-Nankowep contact (Precambrian), Grand Canyon Supergroup, northern Arizona. *Geological Society of America Bulletin* 87(12) (1976) 1763-1772
- [48] G.M. Stevenson, S.S. Beus. Stratigraphy and depositional setting of the upper Precambrian Dox Formation in Grand Canyon: *Geological Society of America Bulletin* 93(2) (1982) 163-173
- [49] J.M. Timmons, K.E. Karlstrom, M.T. Heizler, S.A. Bowring. A synthesis from the Unkar Group of Grand Canyon, and inferences on late Mesoproterozoic intracratonic sedimentation and deformation in the Western U.S. *Geological Society of America* 33(5) (2001) 20
- [50] R.G. Bailey. Ecoregions of the continents (map). *Environmental Conservation* 16(4) (1989) 307-310
- [51] T.R. Loveland, J.W. Merchant, D.O. Ohlen, J.F. Brown, B.C. Reed, P. Olson, J. Hutchinson. Seasonal land-cover regions of the United States. *Annals of the Association of American Geographers* 85(2) (1995) 339-355
- [52] J.M. Omernik. Ecoregions of the conterminous United States. *Annals of the Association of American Geographers* 77(1) (1987) 118-125
- [53] J.M. Parker, S.H. Anderson. Ecology and Behavior of the Midget Faded Rattlesnake (*Crotalus oreganus concolor*) in Wyoming. *Journal of Herpetology* 41(1) (2007) 41-51
- [54] C.E. Bock, J.F. Lynch. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. *Condor* 72 (1970) 182-189
- [55] D.S. Singer, J.L. Dunn, L.B. Harter, G. McCaskie. The 40th annual report of the California Bird Records Committee. *Western Birds* 47 (2016) 291-313
- [56] K.V. Rosenberg, R.D. Ohmart, B.W. Anderson. Community organization of riparian breeding birds: response to an annual resource peak. *Auk* 99 (1982) 260-274
- [57] B.T. Brown. Rates of brood parasitism by Brown-headed Cowbirds on riparian passerines in Arizona. *Journal of Field Ornithology* 65(2) (1994) 160-168
- [58] B.T. Brown, R. Mesta, L.E. Stevens, J. Weisheit. Changes in winter distribution of bald eagles along the Colorado River in Grand Canyon, Arizona. *Journal of Raptor Research* 23 (1989) 110-113
- [59] M.K. Sogge, T.J. Tibbitts, J.A. Petterson. Status and Ecology and ecology of the Southwestern Willow Flycatcher in the Grand Canyon. *Western Birds* 28 (1997) 142-157
- [60] A. Cardini, P. Tongiorgi. Yellow-bellied marmots “in the shape space”: sexual dimorphism, growth and allometry of the mandible. *Zoomorphology* 122 (2003) 11-23

- [61] J. Hamr, F.F. Mallory, I. Fillion. History of Elk (*Cervus canadensis*) restoration in Ontario. *Canadian Field Naturalist* 130(2) (2016) 167-173
- [62] J.G. Blake. Avifauna of the Mt. Dellenbaugh Region, Shivwits Plateau, Arizona. *Great Basin Naturalist* 41 (1981) 259-268
- [63] W.H. Behle. Birds of the Pine Valley Mountain Region, Southwestern Utah. *University of Utah Bulletin* 34 (1943) 1-85
- [64] L.M. Huey. Birds of the Mt. Trumbull Region, Arizona. *Auk* 56 (1939) 320-325
- [65] D.M. Bell, P.F. Parysow, M.M Moore. Assessing the representativeness of the oldest permanent inventory plots in northern Arizona ponderosa pine forests. *Restoration Ecology* 17 (2009) 369-377
- [66] Pearson, G.A. Herbaceous vegetation as a factor in natural regeneration of ponderosa pine in the Southwest. *Ecological Monographs* 12 (1942) 315-338
- [67] G.H. Billingsley, R.C. Blakey, R. Knepp. Pennsylvanian and Permian Geology of Arizona. *Arizona Geological Society Digest* 17 (1989) 313-347
- [68] E.D. Koons. Geology of the Uinkaret Plateau, Northern Arizona. *Geological Society of America Bulletin* 56 (1945) 151-180



Photo 1. The Sonoran Desert is the hottest desert in both, Mexico and United States. It contains a variety of unique endemic plants and animals.



Photo 2. The saguaro (*Carnegiea gigantea*) is one of the most famous columnar cactus in the world.



Photo 3. Sedona is known worldwide for its colorful, surreal red rock formations.

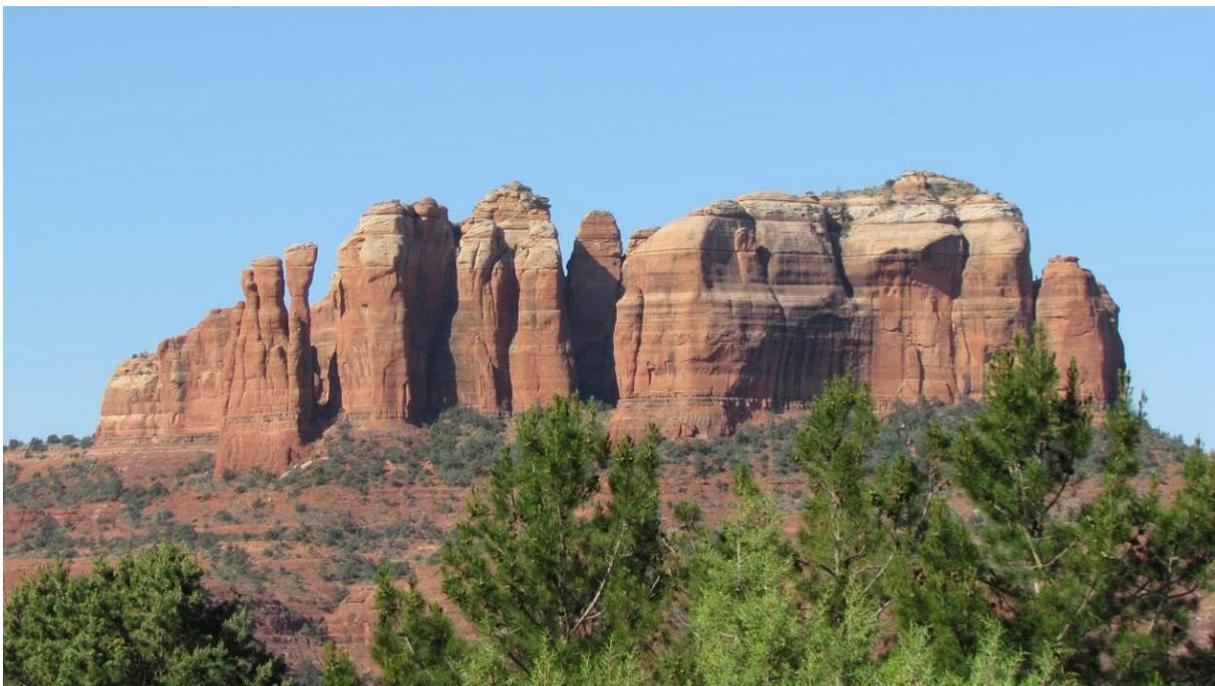


Photo 4. The most notable of the natural landscapes in Sedona is the red rock formations.



Photo 5. The famous red rocks in and around Sedona are, for the most part, the same layers that make up the upper walls of the Grand Canyon.



Photo 6. The Courthouse Butte in Sedona is one of the many breathtaking red rock formations that can be found throughout this area.



Photo 7. Bell Rock is one of the most easily recognizable formations in Sedona with its dome-like silhouette.



Photo 8. The red rocks of Sedona are formed by a unique layer of rock known as the Schnebly Hill formation.



Photo 9. The Munds Wagon Trail follows one of the first and most popular cattle trails out of the Sedona area.



Photo 10. The Munds Wagon Trail is located on the outskirts of Sedona and offers extraordinary close-up and distant views of Sedona.



Photo 11. Prickly Pear Cactus (*Opuntia* sp) is one of the fascinating native plants of Sedona.



Photo 12. Bridge across the valley.



Photo 13. The Coconino National Forest is one of the most diverse National Forests in the United States.



Photo 14. The Coconino National Forest is a paradise where deserts climb mountains to become forests.



Photo 15. This rolling highland is a land of ponderosa pine forests and pinyon, juniper woodlands clustered around broad prairies and small lakes.



Photo 16. Coconino National Forest is one of six national forests in Arizona.



Photo 17. The Coconino National Forest region is sacred to the native peoples that live in the area.



Photo 18. Virtually every square foot of the Coconino National Forest would fall into these three categories: plants, scenery, and wildlife.



Photo 19. The wildlife and fish resources of the Coconino National Forest are among the most diverse and unique within the Southwestern region.



Photo 20. The Zebra-tailed Lizard (*Callisaurus draconoides*) is one of 60 lizards' species recorded for Arizona State. Note how their color blends almost perfectly with the rock they hang out on.



Photo 21. Gambel's Quail (*Callipepla gambelii*) is a small ground-dwelling bird. It inhabits the desert regions of Arizona, California, Colorado, New Mexico, Nevada, Utah, Texas, and Sonora.



Photo 22. The Barn Swallow (*Hirundo rustica*) is the most widespread species of swallow in the world. It appears to have the largest natural distribution of any of the world's passerine.



Photo 23. The White-crowned Sparrow (*Zonotrichia leucophrys*) is a species of passerine bird native to North America. These birds forage on the ground or in low vegetation, but sometimes make short flights to catch flying insects. They mainly eat seeds, other plant parts, and insects.



Photo 24. The Spotted Towhee (*Pipilo maculatus*) lives in dry upland forests, open forests, brushy fields, and chaparrals. These birds forage on the ground or in low vegetation, with a habit of noisily rummaging through dry leaves searching for food. They mainly eat insects, ground-dwelling beetles, spiders, and other arthropods that reside in the leaf litter.



Photo 25. Attractive jay of oak woodlands, dry scrublands, and mixed pine-oak. The Western Scrub-jay (*Aphelocoma californica*) feed on small animals, such as frogs and lizards, eggs, and young of other birds, insects, grains, nuts, and berries. Scrub jays are the only non-primate or non-dolphin shown to plan for the future, known as metacognition.



Photo 26. Like other jays, Steller's Jays (*Cyanocitta stelleri*) are bold, inquisitive, intelligent, and noisy. Steller's Jays spend much of their time exploring the forest canopy, flying with patient wingbeats. They come to the forest floor to investigate visitors and look for food, moving with decisive hops of their long legs.



Photo 27. The Broad-winged Hawks (*Buteo platypterus*) are carnivores and have a wide range in North America and South America. They breed in deciduous forests good for nesting and forage primarily in wetlands and meadows.



Photo 28. The biggest bird in Arizona is the California Condor (*Gymnogyps californianus*), with a wingspan of up to 8 feet (3 meters). It has suffered at the hand of persecution, lead poisoning, and habitat destruction. It has held mythological and cultural significance to Native American tribes, and interestingly the perception of it differs from tribe to tribe. This condor was registered on the Navajo Bridge (36°49' N; 111°37' S) on 28th May, 2016.



Photo 29. The Common Raven (*Corvus corax*) is widely known for being a scavenger of animal carcasses and human garbage.



P

Photo 30. The Tropical Kingbird (*Tyrannus melancholicus*) is a large tyrant flycatcher. This bird breeds from southern Arizona.



Photo 31. Cliff Swallows (*Petrochelidon pyrrhonota*) are colony nesting birds. Their build gourd-shaped nests are made from mud with a small entrance.



Photo 32. The Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) is a small, migratory swallow.



Photo 33. The House Wren (*Troglodytes aedon*) is a very small songbird of the wren family. It occurs from Canada to southernmost South America and is thus the most widely distributed native bird in the Americas.

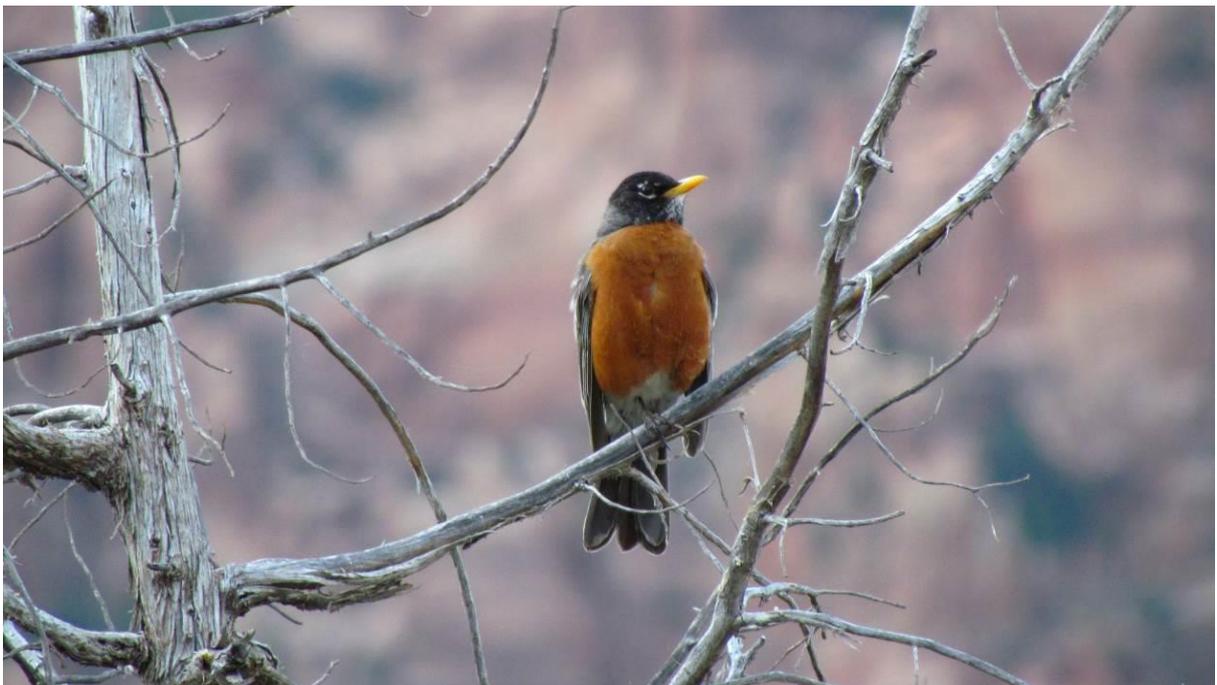


Photo 34. The American robin (*Turdus migratorius*) is a migratory songbird. It is named after the European robin because of its reddish-orange breast, though the two species are not closely related.



Photo 35. The most common bird in Arizona is the House Finch (*Haemorhous mexicanus*), which is seen in 46% of recorded checklists for the state on birds throughout the year.



Photo 36. The Savannah Sparrows (*Passerculus sandwichensis*) are medium-sized sparrows with short, notched tails. Look for a small yellow patch on the face in front of the eye.



Photo 37. The Meteor Crater is the result of a collision between an asteroid traveling 26,000 miles per hour (thereabout 42,000 kilometers/hour).



Photo 38. The meteorite impact site is 550 feet deep (168 meters) and has a diameter of just over a kilometer in diameter.



Photo 39. Flagstaff Mountain offers climbing and hiking trails with sweeping views.



Photo 40. Around 5.5 million people each year see the Grand Canyon, National Park.



Photo 41. Located in Arizona, Grand Canyon National Park encompasses 277 miles (thereabout 450 km) of the Colorado River and adjacent uplands.



Photo 42. The immense Grand Canyon is a mile (1.6 km) deep, and up to 18 miles (29 km) wide.



Photo 43. Grand Canyon National Park.



Photo 44. Grand Canyon National Park.



Photo 45. Nearly 40 identified rock layers form the Grand Canyon's walls. They have attracted students of earth history since 1858.



Photo 46. Grand Canyon National Park.



Photo 47. The whole Grand Canyon is one big must-see.



Photo 48. Grand Canyon National Park.



Photo 49. The Pinyon pine is a short tree, up to 45 feet (15 meters) tall. It makes up the pinyon-juniper woodlands that hug the rims of the Grand Canyon as well as parts of the inner canyon.

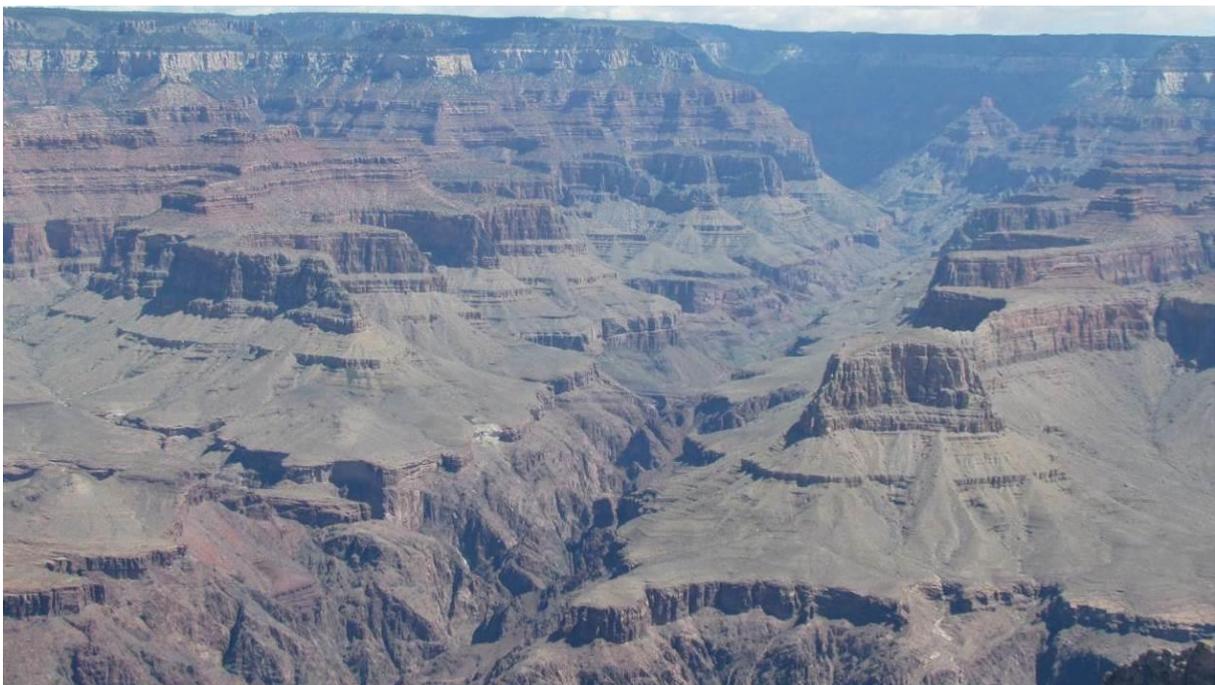


Photo 50. Layered bands of colorful rock reveal millions of years of geologic history with unmatched vistas from the rim.



Photo 51. There are approximately 200 species of trees and shrubs in Grand Canyon National Park.



Photo 52. Grand Canyon National Park.



Photo 53. Grand Canyon National Park.



Photo 54. The pinyon-juniper woodlands hug the rims of the Grand Canyon.



Photo 55. Yavapai Point affords panoramic views of Havasupai Point to the west and Desert View to the east.



Photo 56. Grand Canyon is considered one of the finest examples of arid-land erosion in the world.

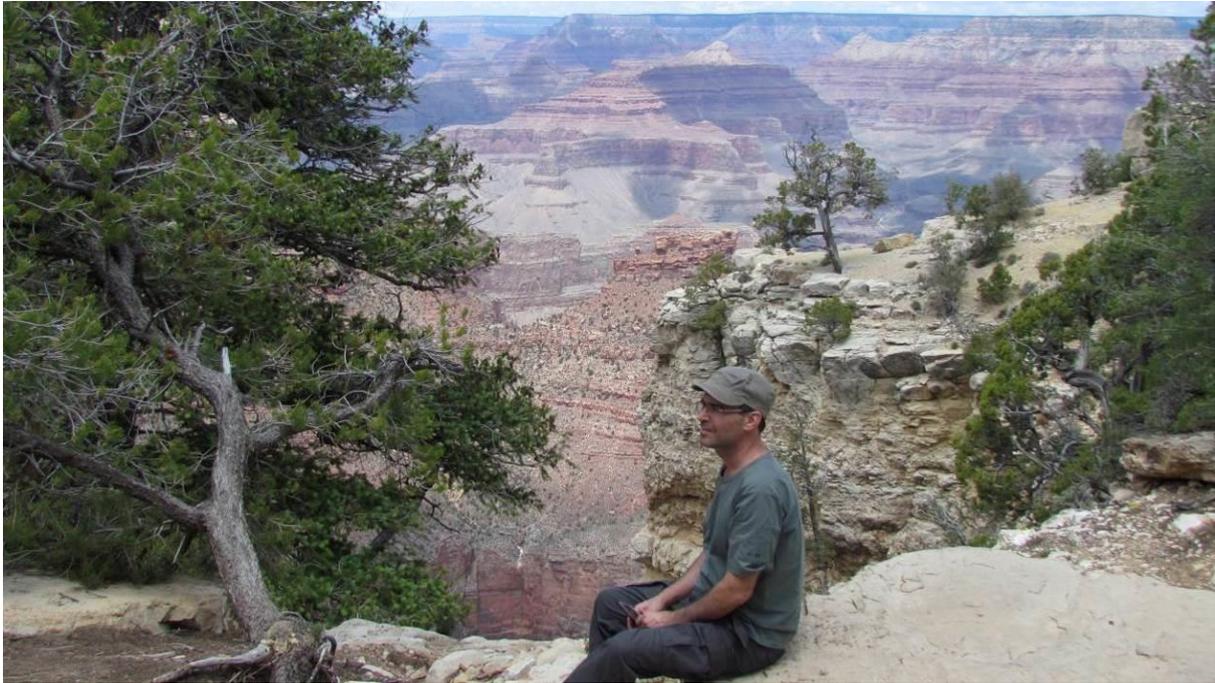


Photo 57. Resting with an amazing panoramic view.



Photo 58. Common shrub at Grand Canyon.



Photo 59. At Grand Canyon, lizards are found on the Rims and inside the Canyon. Their camouflage makes them very difficult to see.



Photo 60. The marmots (genus *Marmota*) comprise 14 species of giant ground squirrels.



Photo 61. Elk (*Cervus elaphus*) is the largest member of the deer family (Cervidae) in Grand Canyon National Park.



Photo 62. The male elk are called bulls. Approximately 100 elk live in Grand Canyon National Park.



Photo 63. A hike into the Grand Canyon will test your physical and mental endurance. Hikers should bring foot traction devices and trekking poles to help maintain balance on icy trail surfaces.



Photo 64. Going on a hike is a wonderful way to experience some of the canyon's rich natural beauty and immense size.



Photo 65. Grand Canyon National Park.



Photo 66. Grand Canyon National Park.



Photo 67. Drainage systems have cut deeply through the rock, forming numerous steep-walled canyons.



Photo 68. Grand Canyon is one of the most studied geologic landscapes in the world. It offers an excellent record of three of the four eras of geological time.



Photo 69. Because most layers are exposed through the Canyon's 277-mile length (thereabout 450 km), they allow detailed studies of environmental changes from place to place (within a layer) in the geologic past.



Photo 70. Geologic evolution through time can be studied through the changes between different layers.

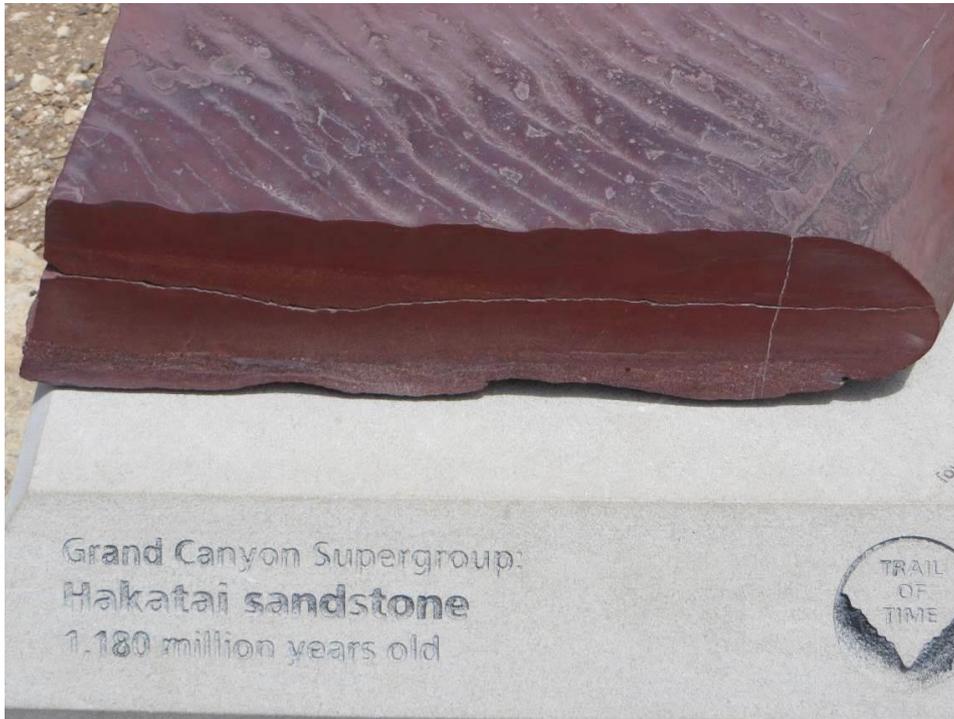


Photo 71. The Lower Permian Esplanade Sandstone is a cliff-forming, resistant sandstone, dark red, geologic unit found in the Grand Canyon.



Photo 72. Red-brown and gray conglomerate of well-rounded to subangular pebbles and boulders of granite, gneiss, and schist derived from underlying Early Proterozoic igneous and metamorphic rocks.



Photo 73. Perhaps the biggest question of all, how the Colorado River chose this course and began carving the Canyon, still awaits a clear answer.



Photo 74. Grand Canyon National Park.



Photo 75. Grand Canyon National Park.



Photo 76. Grand Canyon National Park.



Photo 77. Vermilion Cliffs Scenic Highway, also known as Fredonia-Vermilion Cliffs Scenic Road, is a 92-mile highway along magnificent towering cliffs.



Photo 78. Vermilion Cliffs Scenic Highway as viewed near Pasture Canyon Lookout.



Photo 79. Highway to Glen Canyon Dam.



Photo 80. Colorado River.



Photo 81. Navajo Bridge is the name of twin steel spandrel arch bridges that cross the Colorado River. The dual spans of bridges are tied at ninth place among the highest bridges in the United States with nearly identical heights of 467 feet (142.3 m) for the original span, and 470 feet (143.3 m) for the second span.



Photo 82. Glen Canyon Dam is the second highest concrete arch dam in the United States.



Photo 83. The Glen Canyon Dam bridge.



Photo 84. Colorado River.