"These Dismal Abysses": An Environmental History of Grand Canyon National Park

By Byron E. Pearson

Introduction

Grand Canyon is immutable and enduring. Its history is measured not in years but in geological epochs, a physical manifestation of ultimate truth. Grand Canyon National Park is an artificial geopolitical creation, an abstraction, imagined in words, captured in art, and codified in law. While the former is virtually timeless, this year marks the one hundredth anniversary of the latter's creation in 1919.

As we celebrate the Grand Canyon National Park centennial, it is a good time to reflect upon what a national park is . . . and what it isn't. Although many people view national parks as places where America's natural wonders have been protected from the encroachments of an increasingly industrialized, urban society bent upon environmental exploitation, they were not set aside to preserve pristine wilderness. In 1919, Grand Canyon National Park was created for people by people. It is public space and has been managed that way for a century.[1] However, park management philosophy has shifted over time. If in 2019 it appears as though it is becoming more ecologically sensitive, that is because park regulations

[1] "An Act to Establish the Grand Canyon National Park in the State of Arizona," Feb. 26, 1919, ch. 44, 40 *Stat.* 1175.

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reflect the shifting environmental consciousness of American society as a whole.

The boundaries of Grand Canyon National Park have also changed over time. For the purposes of this essay, I will write of Grand Canyon environmental issues concerning the entire length of the 277 miles of Grand Canyon as geologists define it, including all the areas that finally became part of Grand Canyon National Park in 1975. In the following pages I hope to create a written mosaic so that one can gain a sense of the number and complexity of the environmental problems—and the external forces that have created them—that have affected Grand Canyon National Park during its hundred years of existence.

Before the Park: The Road to 1919

A century of national park status is scarcely a blip on Grand Canyon's geological timeline. Yet during these past one hundred years, more environmental changes have occurred there than in the previous one hundred millennia. Some have been wrought by people trying to save the canyon, others by those interested in developing it, and some are the inevitable consequences of human endeavor far from the canyon.

Ironically, in many respects the forces that have exploited the American environment are the same as those which designated Grand Canyon National Park as a place worthy of protection. Scarcity, that economic determinant of value, is the reason why foresighted individuals extended federal protection to this magical place one hundred years ago and it is the reason why national parks and monuments remain protected now.

Beginnings

For thousands of years, the cultures and cosmologies of the region's Indigenous people have been centered around Grand Canyon. Paleo-Indians, including Ancestral Pueblo people, lived in and about the canyon region, crisscrossing it with trails, leaving petroglyphs and granaries, but never settling in the chasm proper, at least for very long. The archaeological evidence suggests a sudden departure from the canyon's interior by about 1250. The current Havasupai people have lived in the tributary canyon that bears their name for

hundreds of years and the canyon still holds a significant place in the cosmologies of the Navajo, Hopi, and other Indigenous groups. Eleven American Indian tribes have significant connections to this greatest of natural wonders.[2] Low population density and Indigenous lifeways meant that American Indian peoples' environmental impact upon Grand Canyon pre-contact with Europeans was negligible.

Although Spanish explorers encountered Grand Canyon in the sixteenth century, it was not until Anglo-Americans began to enter the region three hundred years later that humans became a significant factor in the canyon's environmental history. During the nineteenth century, trappers' tales of the canyon's vastness and depth, artistic depictions of it by Thomas Moran, and the enraptured language of John Wesley Powell's journals brought Grand Canyon to the attention of a nation curious about its western territories.[3]

Privateers

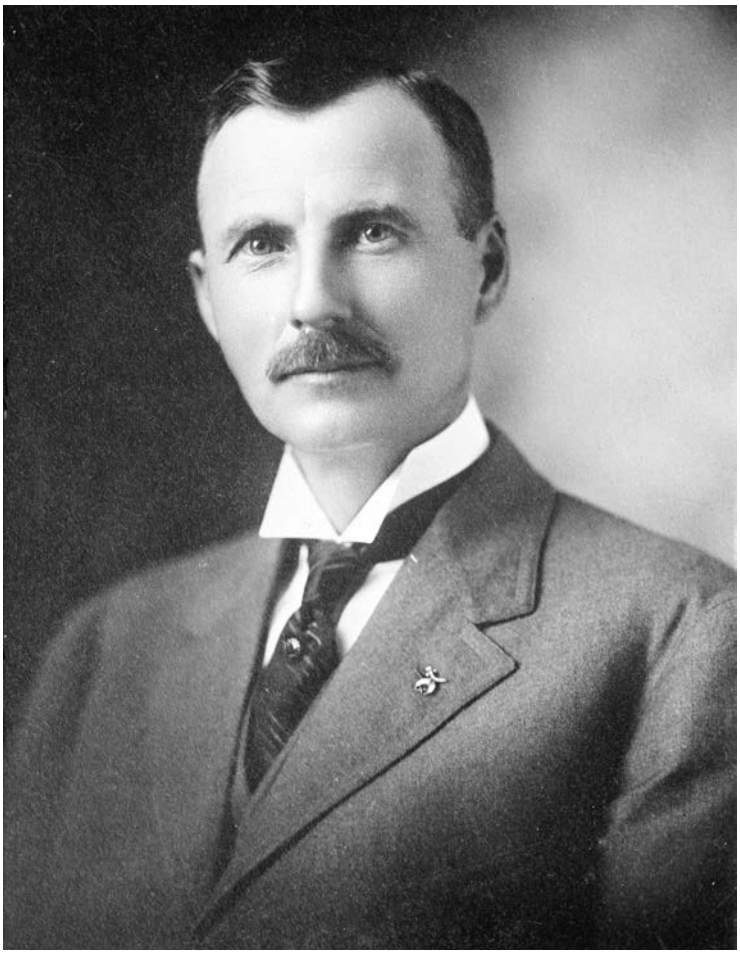
Prospectors began poking around in the depths of Grand Canyon in the mid-1860s and a few isolated mineral claims had been established by 1870. Mining shifted into high gear after Ralph Cameron arrived from Maine in 1883 and immediately initiated what would become a relentless five-decade effort to make money out of Grand Canyon by fostering tourism, logging, mining, and harnessing its water. Cameron soon had competition, for after the publication of railroad engineer Robert Brewster Stanton's mining and railroad feasibility report in the mid-1890s, miners looking for gold, silver, copper, and other minerals soon began staking claims within the canyon and along the rim. Stanton's findings prompted a consortium of eastern businessmen to form the Colorado Grand Canyon Mining and Improvement Company. These corporate efforts soon fizzled but several private entrepreneurs, including Cameron, continued working their claims.[4] Thus it was mining and its related consequences that would pose the first major environmental threat to what would become Grand Canyon National Park.

Despite the difficulty of access, tourists began arriving to see Grand Canyon in ever-increasing numbers during the last two

[2] J. Donald Hughes, *In the House of Stone and Light* (Grand Canyon, Ariz., 1978), 9–14; Janet R. Cohen, "Grand Canyon's Traditionally Associated Tribes," *Canyon News*, August 2016, p. 4. Even the Havasupai and Hualapai did not live in Grand Canyon proper, choosing instead to occupy the tributary canyons and plateau of the south rim.

[3] Hughes, *In the House of Stone and Light*, 1–27.

[4] Ibid.



Arizona's Ralph Henry Cameron, territorial representative, U.S. senator, and Grand Canyon promoter. George Grantham Bain Collection, Library of Congress Prints and Photographs Division.

decades of the nineteenth century. Prospector John Hance established a permanent tourist camp in 1886, and soon faced stiff competition from Cameron and William Wallace Bass. Cameron filed dozens of mining claims to establish title to property at key locations throughout the canyon and along its rim. He also built a hotel above his Grandview mine which became the most popular tourist destination in the vicinity of the canyon until 1901.

Additionally, Cameron built the first hotel near the head of the Bright Angel Trail in what became the modern-day Grand Canyon Village and gained control of Indian Gardens, the only reliable water source below the rim at that point. Cameron built Bright Angel Trail and charged guests who ventured into the canyon's depths excessive fees for water and accommodations at Indian Gardens, which quickly became notorious for polluted water and trash. Others built stage trails and primitive roads to the canyon from Flagstaff, Williams, and Ash Fork.[5] Tourism, and all it entailed, would become the second external force that would shape the future of the Grand Canyon environment.

Federal and Corporate Development

Federal protection of Grand Canyon initially had little effect upon these problems of sanitation and tourist accommodation and in some cases it exacerbated them. The first proposed federal protection of the Grand Canyon area was when Indiana senator Benjamin Harrison sponsored legislation to set it aside as a "public park" in 1882, but this and several other efforts died in committee. Later, after becoming president, Harrison created the Grand Canyon Forest Reserve in 1893, out of which Theodore Roosevelt (TR) carved the Grand Canyon Game Preserve in 1906 and Grand Canyon National Monument in 1908. None of these federal designations—save for the last one—prohibited the establishment of new private claims for grazing, timber cutting, and mineral extraction from Grand Canyon.[6]

By the time the Santa Fe Railroad Company completed a spur from Williams to the south rim in 1901, infrastructure for tourism had evolved haphazardly and was still controlled by a handful of private entrepreneurs. The railroad built the El Tovar Hotel and other accommodations and put the vast majority of pioneer entrepreneurs out of business within five years. Partnering with the Fred Harvey Company, the railroad constructed more substantial infrastructure to handle the increasing numbers of tourists who were beginning to visit Grand Canyon. With the establishment of Grand Canyon National Monument in 1908, it appeared

[5] Michael F. Anderson, *Polishing the Jewel: An Administrative History of Grand Canyon National Park* (Grand Canyon, Ariz., 2000), 3–5, available online at https://irma.nps.gov/DataStore/DownloadFile/490217 (accessed February 10, 2019).
[6] Ibid., 7–8.

The El Tovar Hotel, early 1900s. Courtesy of the U.S. National Park Service.

as though many of the area's initial growing pains were on the verge of being solved.[7]

A National Monument: 1908

With the creation of the national monument, the environmental history of Grand Canyon entered a new phase. Mining continued in the canyon, although many mines failed during the economic downturn of 1907, which devastated the market for copper. Although relatively few automobiles made the arduous journey to the monument, tourism increased dramatically with the coming of the railroad. The U.S. Forest Service, which continued to administer the area after the creation of the monument, was at best indifferent to it. In addition to fighting fires, foresters viewed their primary responsibilities as regulating timber-cutting and grazing, both of which were still allowed. Despite the efforts of the Santa Fe Railroad Company to build modern facilities, the south rim resembled a "western boom town," replete with garbage heaps, open-pit toilets, employees housed in tents and shacks, and tourists sleeping in their Model Ts.[8]

[7] Ibid.
[8] Ibid., 9.

Although the initial mining operations within the monument began to decline, the creation of Grand Canyon National Monument did not stem new threats to Grand Canyon as more people and capital poured into the West. Ambitious promoters eyed the Colorado River in Grand Canyon as a source of water and hydroelectric power. Utah developers spoke of damming the Colorado at Diamond Creek in lower Grand Canyon as early as 1893. Most of these plans never moved beyond the speculative stage during these early years, although David Babbitt—the great uncle of future Arizona governor and secretary of the interior Bruce Babbitt—succeeded in building a small water-powered generating station on Bright Angel Creek that, upon completion in 1905, furnished power to the south rim until 1965. Because the status of inholdings and title to lands remained unresolved after the monument's creation, Ralph Cameron moved ahead with plans to build a massive hydroelectric dam just downstream of where Bright Angel Trail meets the Colorado River in the heart of the monument.[9] By the early twentieth century, it was already clear that water development would also become an important catalyst for environmental change in Grand Canyon.

A Bigger Context: Progressive Conservation

In the years after the climactic battle over the proposed dam in Hetch Hetchy Valley within Yosemite National Park—a fight that environmentalists including John Muir and the Sierra Club lost in 1913—it appeared as though Cameron would have the last word with respect to water development within Grand Canyon National Monument. However, Chief Forester Henry Graves denied Cameron's application to build the dam in 1915 because he knew that Arizona politicians were seeking to have Grand Canyon designated as a national park and he believed it should be managed as though it were a park already. Cameron's bid to build a dam was dealt a further blow when Congress created the National Park Service (NPS) in 1916 and charged it with preserving the national parks in an "unimpaired" state, wording that would be subjected to creative interpretation for the next one hundred years.[10]

[9] *Salt Lake City Tribune*, November 28, 1893; Byron E. Pearson, "How the Forest Service Saved the Grand Canyon," *Forest History Today*, Spring 2012, pp. 4–8.

[10] Pearson, "How the Forest Service Saved the Grand Canyon," pp. 8–10.

As the nation geared up for World War One, Arizona representative Carl Hayden and Senator Henry Fountain Ashurst continued to focus on convincing Congress to approve of converting Grand Canyon National Monument into a national park. These efforts finally bore fruit when, on February 26, 1919, President Woodrow Wilson signed the bill creating Grand Canyon National Park.[11]

A New Park through World War Two: 1919–1940

Decades before the creation of Grand Canyon National Park, extractive industries had flourished along both rims and the U.S. Forest Service had allowed them to continue after President Theodore Roosevelt proclaimed Grand Canyon National Monument. The creation of Grand Canyon National Park and its administration by the NPS added a new level of environmental conflict. These two agencies—formed for very different purposes—often blurred the boundary between the park and the national forest lands adjacent to it, a microcosm of how environmental issues transcend human-created borders.

Water and Power

The Colorado River drops 1,950 feet as it flows through Grand Canyon. The legislation that created Grand Canyon National Park reserved the right of the federal government to build reclamation projects within Grand Canyon. As the seven states of the Colorado River basin contemplated how to divide the waters of the Colorado River, the fight to develop the nearly two thousand feet of hydroelectric power potential within Grand Canyon would become one of the most bitterly contested environmental battles of the twentieth century.[12]

Private developers had long coveted the water and power potential within Grand Canyon and the federal government soon got in on the speculation. In the early 1910s, the U.S. Geological Survey (USGS) began assaying the best places to build hydroelectric dams, and in 1923 it launched a full-blown river expedition to

[11] Andrew Glass, "Wilson Establishes Grand Canyon as a National Park, February 26, 1919," *Politico*, February 25, 2017, available online at https://www.politico.com/story/2017/02/wilson-establishes-grand-canyon-as-a-national-park-feb-26-1919-235306 (accessed June 15, 2019).

[12] Grand Canyon National Park Establishment Act, 16 U.S.C. § 221 (1919).

locate the best dam sites on the Colorado River. This 1923 expedition, led by hydrologist E. C. La Rue and USGS topographical engineer Claude Birdseye, identified no less than twenty-nine dam sites between Lee's Ferry and Black Canyon, the eventual site of Hoover Dam.[13] After the ratification of the Colorado River Compact in 1922, the emphasis upon water development shifted to dam sites above and below Grand Canyon and culminated with the construction of Boulder Dam (renamed Hoover in 1947) downstream of the park on the Arizona-Nevada border.

Disaster on the North Kaibab

The creation of the park led to tension between the park service, which managed Grand Canyon National Park, and the forest service, which managed the Kaibab National Forest immediately to the north and the Tusayan National Forest (which would become part of the Kaibab National Forest in 1934), just south of it. When TR created the Grand Canyon Game Preserve in 1906, the North Kaibab deer herd numbered about four thousand animals. The forest service, and later the park service, practiced predator control by hiring bounty hunters and using poison baits. These practices eradicated most of the wolves and cougars in the region between 1910 and 1926, especially near the north rim.[14] Forest rangers noticed a corresponding increase in the deer population in the late 1910s and began to contemplate ways to control it.[15]

Managing the Kaibab deer herd proved to be a vexing task from the beginning. Although the lands bordering the canyon are federal, game is a resource controlled by the state even when on national park and forest service lands. This situation was complicated further because: (1) the national forest included the remnants of the old Grand Canyon Game Preserve on which hunting was prohibited, and (2) deer don't pay attention to boundaries between parks and forests.

[13] Diane E. Boyer and Robert H. Webb, *Damming Grand Canyon: The 1923 USGS Colorado River Expedition* (Logan, Utah, 2007), x.

[14] Aldo Leopold, "Deer Irruptions" in *Report for the National Resources Committee of the Wisconsin Academy of Sciences, Arts, and Letters* (1943), 355, 361, available online at http://images.library.wisc.edu/WI/EFacs/transactions/WT1943/reference/wi.wt1943.aleopold.pdf(accessed February 23, 2019). Although numerous attempts have been made by wildlife biologists and other scholars to discredit Leopold's initial reports about the Kaibab deer die-off in the 1920s, the current consensus is that Aldo Leopold was right after all.

[15] Dan Binkley, Margaret M. Moore, William H. Romme, and Peter M. Brow, "Was Aldo Leopold Right about the Kaibab Deer Herd?" *Ecosystems* 9 (2006): 227–41.

A Rocky Mountain Mule Deer buck, probably on the North Kaibab. Josef Muench Collection, NAU.PH.2003.11.64.B1185, Cline Library, Northern Arizona University.

The deer herd swelled to one hundred thousand animals by the mid-1920s and the forest service had begun killing them even in the Grand Canyon Game Preserve over the objections of Arizona governor George W. P. Hunt who threatened to call out the National Guard. Arizona sued the forest service to stop the culling, but the Supreme Court ruled in the forest service's favor. The killing continued, but it was too late. A catastrophic die-off occurred, reducing the deer population to ten thousand by the end of the 1930s. However, predator control continued on both park and forest service lands, and there would be more bitter lessons to be learned as a result.[16]

[16] *Hunt v. United States*, 278 U.S. 96 (1928); Wendell D. Swank, "The History of the Kaibab Deer Herd: Beginning to 1968," *Proceedings of the 1997 Deer-Elk Workshop* (1997):

The Grand Canyon Fishery

Although non-native fish were introduced into Arizona's rivers and streams in the 1880s, the Colorado River in Grand Canyon remained relatively unaffected at the time the park was created. The Colorado River was exclusively a warm-water fishery prior to the construction of dams on the main stem of the river. Eight species of fish native to the ecosystem flourished at the time: five from the sucker family and three from the minnow family. The largest of these, the Colorado pike minnow migrated upstream in great numbers to spawn once a year and constituted a major source of protein for American Indians in the lower Colorado basin.[17] Specimens four feet long were caught, and fisheries biologists contend that fish six feet in length weighing up to one hundred pounds were not uncommon prior to 1900.[18]

Exotic species including the common carp had been introduced into the main stem of the Colorado River by the 1890s. These ubiquitous Eurasian imports immediately began to compete with native species for food. Because they are bottom feeders, carp eat the eggs of spawning native fishes such as razorback and humpback chub, harming their ability to reproduce.[19]

The park service introduced cold-water species such as brook, rainbow, and brown trout into tributaries including Bright Angel, Havasu, and Tapeats Creeks to attract tourists interested in sportfishing. The stocking began in 1920 when the park service put brook trout into Bright Angel Creek. Rainbows were introduced to Tapeats Creek in 1923, and browns to Shinumo Creek in 1926. The NPS and the Arizona Game and Fish Department (AZGFD) stocked numerous Grand Canyon tributaries with trouts through the 1960s.[20]

14–23, available online on the Western Association of Fish and Wildlife Agencies website, https://www.wafwa.org.

[17] Also called "squawfish" in dated literature.

[18] Richard Valdez, "Native Fishes of Grand Canyon," *Grand Canyon River Guides* (1993); W. L. Minkley, *Fishes of Arizona* (Phoenix, 1973), 120–25.

[19] Richard Valdez and Stephen Carothers, "The Aquatic Ecosystem of the Colorado River in Grand Canyon," report prepared by SWCA Inc., environmental consultants for the Bureau of Reclamation (1998), 100–103.

[20] Alan Haden, "Non-Native Fishes of the Grand Canyon," *Glen Canyon Environmental Studies*, 1992, pp. 12–14, available online at http://www.nativefishlab.net/library/textpdf/20950.pdf (accessed February 23, 2019).

Building a Tourist Infrastructure and Its Environmental Consequences

After the end of World War One, the tourists came in droves. In 1916, Congress passed a bill to fund a national highway system; by 1920 hundreds of miles of paved roads were under construction within the state of Arizona. The number of cars registered in Arizona jumped from 34,619 in 1920 to 147,048 by 1940, while hundreds of thousands more passed through the state from east to west.[21] The explosion in tourism that resulted made it difficult for the park service to build enough facilities to keep up with this skyrocketing demand by itself.

Until the mid-1920s, the Santa Fe Railroad simply collected garbage, which accumulated in at least a dozen open dumping sites, took it outside of the park boundaries, and dumped it alongside the tracks on national forest land. Human waste posed an even bigger problem; the railroad had built a septic system for the El Tovar Hotel in 1905, but when other structures connected to it, the system became overburdened. For a number of years, excess effluent was simply allowed to flow into an open ditch alongside the railroad tracks. A sewage-treatment plant completed in 1926 solved this problem. As a result of these joint efforts and despite a 500 percent increase in visitation since 1920—the 1929 total was 184,000—Grand Canyon National Park had finally built enough facilities to accommodate tourism and deal with many of the environmental consequences of it, at least for a little while.[22]

During the Great Depression, the number of visitors dropped dramatically between 1929 and 1934. This reprieve enabled the park service to continue building necessary improvements with the help of New Deal agencies such as the Works Progress Administration (WPA) and the Civilian Conservation Corps (CCC). The respite did not last long, however. Despite stagnant economic conditions, tourism climbed rapidly after 1934, peaking at 437,000 in 1941.[23] World War Two and its aftermath would bring a whole new set of external forces to bear upon Grand Canyon that defined

[21] Mark E. Pry and Fred Andersen, "Arizona Transportation History," Arizona Department of Transportation Research Center (2011), 41, 45, 52, available online at file:///C:/Users/182344/Downloads/dot_23907_DS1.pdf (accessed September 9, 2019).

[22] Anderson, *Polishing the Jewel*, 9. This plant recycled 99 percent of the water used for non-potable purposes such as flush toilets, the production of steam for power, and to run locomotives. It is probably the first example of what we would call sustainability in Grand Canyon National Park.

[23] Ibid., 25–28.

the fault lines of many of the modern environmental struggles the park still faces today.

Water, Power, and an Orphan: 1941–1962

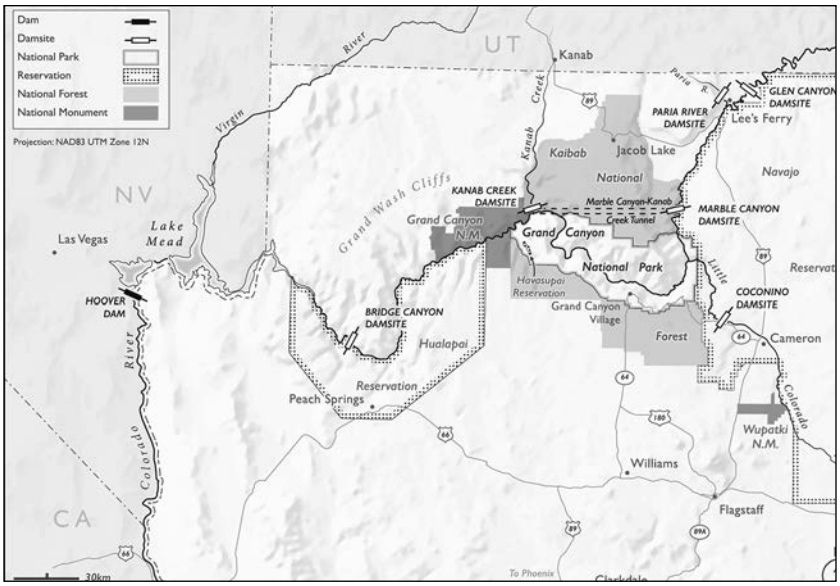
During the Second World War, the NPS confronted pressure from state and federal agencies that threatened to undermine the integrity of the entire system in the name of wartime expediency. Timber, mineral, and water resources all came under increasing pressure from developers. Although Grand Canyon National Park had left its initial growing pains behind in terms of facilities, soon officials within federal agencies, environmental groups, and the entire nation would grapple with the purpose and meaning of the parks. Grand Canyon was no exception.

Fortunately, Grand Canyon National Park contained meager timber resources and was largely devoid of significant mineral deposits, so it was not subjected to many of the demands put upon other parks during the war years. However, the almost two thousand feet of undeveloped hydroelectric potential within the canyon soon proved irresistible to dam builders and to people who wanted to make the desert bloom.

Serious Plans for Water Development

The inner gorge of lower Grand Canyon consists of sheer walls of hard black metamorphic rock—a formation geologists call the Vishnu Basement Rocks—ideal for dam construction. Identified as a potential site for high dams by USGS hydrologist E. C. La Rue in 1923, the Bridge Canyon site in lower Grand Canyon figured prominently in many water developers' plans. By the mid-1930s the Bureau of Reclamation and the park service were exchanging memos in which the latter even agreed to not oppose a dam 570 feet tall at Bridge Canyon that would split the new Grand Canyon National Monument, created in 1932 downstream of the park, in half with a reservoir.[24]

[24] E. C. LaRue, *Water Power and Flood Control of Colorado River Below Green River, Utah* (Washington, D.C., 1925), 74, 163; Elwood Mead to Horace Albright, June 14, 1932; Horace Albright to Roger Toll, August 3, 1932; Horace Albright to Elwood Mead, January 11, 1933, all in Record Group GRCA-04848, Grand Canyon Museum Collection, National Park Service, Grand Canyon, Arizona.



Map showing proposals released in the Bureau of Reclamation's 1946 report for Grand Canyon water development, including Bridge and Marble Canyon dams and the Marble Canyon-Kanab Creek Tunnel. Map by Nathaniel Douglass, ndcartography.com.

When Newton Drury became the NPS director in 1940, he confronted water-development schemes aimed at several national parks including Grand Canyon. In anticipation of the political battles to come he determined that keeping a reservoir out of the national monument was not possible given his agency's previous agreement with the bureau. But in 1946, Drury confronted an ambitious bureau proposal to build a Bridge Canyon Dam almost seven hundred feet tall. Such a dam would have backed water through the national monument and along thirteen miles of the park boundary. This proposal also included a dam in Marble Canyon just upstream of the park, and a tunnel forty-five miles long from Marble Canyon Reservoir underneath the North Kaibab Plateau to a dam and powerplant to be built in Kanab Creek.[25]

[25] U.S. Department of the Interior, Bureau of Reclamation, *The Colorado River: A Natural Menace Becomes a National Resource; A Comprehensive Report on the Development of the Water Resources of the Colorado River Basin for Irrigation, Power Production, and other Beneficial Uses in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming* (Washington, D.C.,

Drury fought so vociferously against the high Bridge Canyon Dam, the Marble Canyon-Kanab Creek tunnel and powerplant, and dams planned for Dinosaur National Monument, Interior Secretary Oscar Chapman fired him in 1951.[26]

In the late 1940s, Arizona politicians, including Senator Carl Hayden, began to push for the construction of a massive water project to divert Colorado River water to central Arizona. Hayden obtained Senate passage of a high Bridge Canyon Dam twice, in 1950 and 1951. But California blocked these bills in the House and forced the issue into the U.S. Supreme Court. Although federal proposals to build dams in Grand Canyon were now delayed indefinitely, Arizona unsuccessfully tried to obtain approval to construct Bridge and Marble Canyon dams as state projects through the early 1960s.[27]

The Bureau of Reclamation succeeded in obtaining congressional approval of a colossal regional proposal—the Colorado River Storage Project (CRSP)—in 1956. Consisting of ten dams in the upper basin of the river, the CRSP included a massive dam in Glen Canyon, fifteen miles upstream of Lee's Ferry. Environmental organizations rallied to the fight and succeeded in defeating two dams planned for Dinosaur National Monument but only after agreeing to allow the bureau to raise Glen Canyon Dam thirty-five feet to make up for the loss of the two reservoirs. Construction of Glen Canyon Dam began in 1956 and when its gates closed in 1963, it would change the Grand Canyon National Park riparian ecosystem forever.[28]

Cold War in the Canyon: Mining and Tourism

The Cold War created a demand for heavy metals that could be distilled into fissionable materials for the production of atomic and nuclear weapons.[29] One such mine was the Orphan Mine, located near the National Park Service visitor's center on the south rim, which was originally a copper mine claim patented in 1906. The mine was not profitable, and the twenty-acre site was developed for tourism.[30]

1946), 168–84. The Kanab Creek tunnel and powerplant proposal first appeared in a preliminary bureau report issued in 1944.

[26] Byron E. Pearson, *Saving Grand Canyon: Dams, Deals, and a Noble Myth* (Reno, 2019), 55–56, 65; David Ross Brower, interview with author, Berkeley, Calif., July 27, 1997. This aspect of the proposal was called the Marble Canyon–Kanab Creek Project.

[27] Pearson, *Saving Grand Canyon,* 46, 65–66, 81–84, 90–99.

[28] Ibid., 78–79.

[29] Anderson, *Polishing the Jewel,* 40, 42.

[30] Ibid., 40.

In 1946, the original owner sold the property, and it was eventually acquired in 1953 by the Golden Crown Mining Company of Prescott, a subsidiary of Western Gold and Uranium.[31]

Amateur prospectors found high-grade uranium in the tailings of the old mine in 1951 and the Atomic Energy Commission confirmed that it was of high enough quality to be profitable. The mining company began production in 1956 and built a tramway to ship ore to the rim, dug a sixteen-hundred-foot shaft from the rim to the mine, and installed an elevator. Working in shifts of twenty-five to thirty at a time, the miners extracted up to forty-five tons of high-grade uranium ore each day. The unsightly machinery, buildings, large elevator headframe, and deafening mining noise forced the park service to close the west half of the most popular south rim trail while the steady procession of large ore trucks to and from the mine clogged park roads and diminished the experiences of people who had come to Grand Canyon seeking unimpeded grandeur and silence. The Orphan Mine was highly profitable. It is estimated that in thirteen years of intense mining, it yielded almost five hundred thousand tons of high-grade uranium ore valued at $40,000,000 when it closed in 1969. But the profit came at a high price; the mine's unsightly steel headframe remained in place until 2009, and although the site is fenced, residual radiation poses a threat to park visitors in surrounding areas.[32]

Most people with even a passing interest in Grand Canyon have heard of the Orphan uranium mine but not many know about another mining venture that took place at river mile 266 at the far western edge of the canyon. A guano-filled cave, home to large numbers of Mexican free-tailed bats, was discovered on the north side in 1936. For twenty years people unsuccessfully tried to mine it before the claim was bought by Charles Parker, a mining engineer and president of the U.S. Guano Company. According to a report filed in July 1957, Parker initially estimated there were 250,000 tons (later revised to 100,000) of recoverable guano which he expected to extract and sell for $360 a ton.[33]

[31] Michael A. Amundsen, "Mining the Grand Canyon to Save It: The Orphan Lode Mine and National Security," *Western Historical Quarterly* 32 (Autumn 2001): 323–24.

[32] Ibid., 327–28; "Miners: Dan Hogan; The Orphan Mine," National Park Service, Grand Canyon National Park website, https://www.nps.gov/grca/learn/historyculture/miners.htm (accessed February 25, 2019); "The Orphan Mine!," available online at https://www.grandcanyontreks.org/orphan.htm (accessed July 8, 2019).

[33] Robert B. Pape, "Biology and Ecology of Bat Cave, Grand Canyon National Park

Extensive infrastructure was built, including an aerial tramway to transport the guano across the river. This apparatus consisted of a bucket capable of hauling 2,500 pounds of guano and a six-man mining crew, massive steel towers on both sides of the canyon, and two steel cables nine thousand feet in length that spanned the gorge. The mining company leased land at Guano Point on the Hualapai Reservation and built a packaging station there. After the guano was packaged it was trucked to Kingman, Arizona, where it was flown to the west coast to be sold as fertilizer.[34]

Mining operations ceased in 1958, but the mining company left much of its hardware in the canyon. A fighter pilot from Nellis Air Force Base (near Las Vegas) who was "hotdogging" in lower Grand Canyon, hit one of the cables with his plane a few months later. The impact severed about six inches from one of the fighter's wingtips and snapped one of the cables in half. Both pilot and plane miraculously survived, and the cable was never replaced. The remaining cable later served as part of the set for the final scene in the 1959 movie *The Edge of Eternity*, which culminated with a fight in the mining bucket thousands of feet above the river. U.S. Guano successfully sued the U.S. government for the loss of its cable—despite the pilot's clear violation of Air Force regulations—and partially recouped its losses from the ill-fated mining venture. A popular tourist attraction today, the Bat Cave Mine and its unfulfilled promises of "black gold" in the form of guano remains an apt metaphor for much of the mining history of Grand Canyon as a whole.[35]

Americans took to the outdoors in massive numbers after the end of World War Two. The end of rationing, availability of cheap surplus camping equipment, new cars, and pent-up demand for leisure led to an explosion in outdoor recreation in the postwar years. Visitors to Grand Canyon National Park went from a wartime low of 64,500 in 1944, passed the half million mark in 1947, and exceeded one million in 1956.[36]

Arizona," *Journal of Cave and Karst Studies* 76 (April 2014): 1–2; Department of Mineral Resources, State of Arizona, "Field Engineer's Report," B-11, July 29, 1957, available online at http://docs.azgs.az.gov/OnlineAccessMineFiles/A-B/BatcaveMohave226a.pdf (accessed February 26, 2019).

[34] George H. Billingsley, "Prospector's Proving Ground: Mining in Grand Canyon," *Journal of Arizona History* 17 (Spring 1976): 82–85. It was later determined that only about a thousand tons of guano could be recovered.

[35] Ibid., 85; *Kingman Daily Miner*, January 4, 2014.

[36] Anderson, *Polishing the Jewel*, 42, 44.

Despite this increase in tourism, the federal government did not adequately fund the construction of new infrastructure, or the hiring of personnel, to accommodate the tsunami of visitors. As a result, the facilities at both the north and south rims, built during the 1920s and 1930s, soon became grossly inadequate. Deteriorating buildings, crowded campgrounds, and inadequate sanitation led to such noxious conditions that Grand Canyon historian Mike Anderson describes the south rim visitors' accommodations as "an inner village slum." Park service employees frequently complained about people carving their names in trees, graffiti, and litter throughout the park. Even the park service's ambitious "Mission 66" plan did not alleviate the environmental consequences of tourism on the rims of Grand Canyon National Park.[37]

Glen Canyon Dam and the New Environmentalism: 1963–1980

In 1963, two events occurred that would have an irreversible effect upon the environmental history of Grand Canyon National Park. The first was the completion of Glen Canyon Dam upstream. When the Bureau of Reclamation closed the gates and Lake Powell began to fill in 1963, it transformed the Colorado River from a warm-water to a cold-water fishery. Additionally, the rampaging seasonal floods that had created and maintained the riparian ecosystem, including the beaches throughout Grand Canyon, were replaced with controlled daily fluctuations caused by real-time demands for hydroelectric power.

The second was the release of proposals to build dams in Grand Canyon after the Supreme Court settled the issue of water allocations in the lower Colorado River basin in Arizona's favor in 1963. Although neither dam was planned for the national park as it existed at that time, the reservoir behind Bridge Canyon Dam would have created a slack-water lake through the entire length of the monument and along thirteen miles of the park boundary. Marble Canyon Dam upstream of the park would have caused additional flow fluctuations as it generated hydroelectric power for times of peak demand. Fortunately, the Kanab Creek Tunnel proposed in the 1940s was not included in the final version of the scheme.[38]

[37] Ibid., 45, 50–51.
[38] Pearson, *Saving Grand Canyon*, 114–23.

The grassroots campaign: Sierra Club executive director David Brower and supporters at Grand Canyon in March 1966. Arthur Schatz, The LIFE Picture Collection, Getty Images. Used by permission.

Damning Grand Canyon

By the mid-1960s, Grand Canyon had become the most iconic of America's national parks. Yellowstone and Yosemite were older, but Grand Canyon was one of the seven wonders of the natural world. The Sierra Club gained access to the national media through a massive grassroots campaign, challenged the Bureau of Reclamation's justification for these dams, and placed ads in national newspapers, which, in June 1966, provoked the IRS to take away the club's tax-deductible status in an effort to destroy the club financially. In an ad campaign filled with memorable quotes, the Sierra Club communicated the government's callous attitude toward the natural wonders it was supposed to defend with this simple summation: "Remember, with all the complexities of Washington politics and the ins and outs of committees and procedures, there is only one simple incredible issue here: This time it's the Grand Canyon they want to flood. *The Grand Canyon.*"[39]

The bureau and its supporters countered that neither dam would be located within Grand Canyon National Park. The public didn't care. Mountains of anti-dam mail arrived in Senate and

[39] Ibid., 216. Emphasis in original.

House offices. In the end, the dams were deleted from the legislation because political supporters of the project had overreached. In anticipation of future water shortages, the project included a massive water diversion scheme from the Columbia River. Washington senator Henry Jackson, the chair of the Senate Committee on Interior and Insular Affairs, swore to block any project with dams in it because they constituted a threat to his constituents' water. Unable to placate Jackson and faced with certain defeat, Arizona's political leaders gained Jackson's approval of a damless Central Arizona Project (CAP) bill that President Lyndon Johnson signed into law on September 30, 1968.[40] The Sierra Club emerged from the fight to save Grand Canyon as one of the most influential environmental organizations in the world.

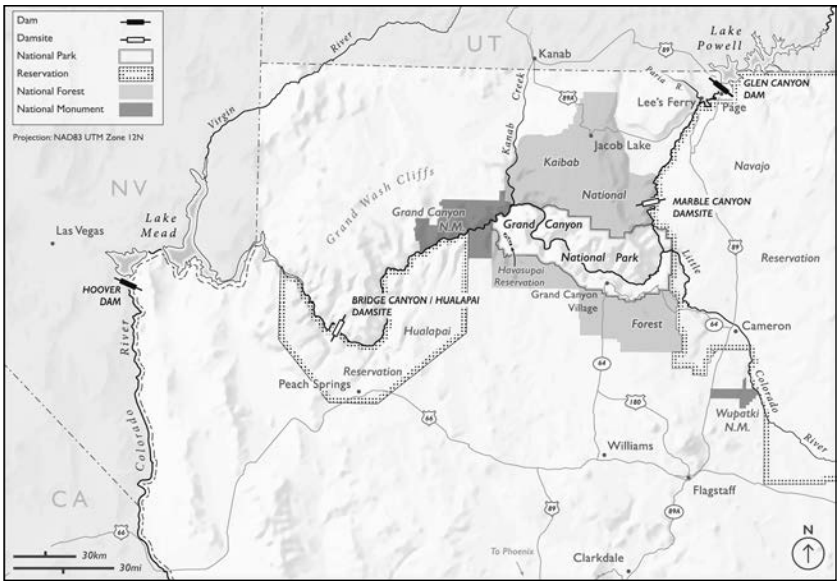
American Indians and the Grand Canyon Environment

American Indian groups were also deeply involved in the conflict over building dams in Grand Canyon. The proposed Bridge Canyon Dam's south abutment would have been built on the Hualapai Reservation and the east abutment for Marble Canyon Dam would have been anchored on Navajo land. The reservoirs created by both dams would have inundated thousands of acres of reservation land. From the late 1940s through the early 1960s, politicians from Arizona maneuvered to acquire the right to construct dams at both locations and the Bureau of Reclamation built construction camps and tramways at both places, and bored tunnels into the walls of Marble Canyon without permission from either tribe.[41]

Supporters of these federal projects, eager to counter perceptions of themselves as thoughtless despoilers of wilderness, successfully enlisted the aid of the Hualapai Nation in an attempt to portray environmentalists as racists at the height of the civil rights movement. Representatives of the Hualapai Nation testified at CAP hearings in 1965, 1966, and 1967, in favor of Bridge Canyon Dam, which was renamed Hualapai Dam by the bill's sponsors.

However, the dam lobby also blundered because they refused to grant concessions to the Navajo Nation for the right to build Marble Canyon Dam. Consequently, the Navajo voted to oppose all dams in Grand Canyon in 1966 and to support proposals favored

[40] Ibid., 240–47.
[41] Ibid., 53–56.



Map showing the proposed Bridge Canyon/Hualapai Dam and Marble Canyon Dam as they appeared in the Pacific Southwest Water Plan and Lower Colorado River Basin Project between 1963 and 1967 and their proximity to the Hualapai, Havasupai, and Navajo reservations. Map by Nathaniel Douglass, ndcartography.com.

by the Sierra Club and other environmental organizations for a CAP powered by coal-fired powerplants. In 1968, the CAP became law and instead of the controversial dams, the power for the project was provided by a new coal-fired plant, the Navajo Generating Station, to be built at Page, Arizona. Fed by coal mined at Black Mesa on the Navajo Reservation, the Navajo Generating Station became controversial in its own right as the emissions from its smokestacks fouled the air over Grand Canyon to such an extent that on some days, visitors to one rim could not see the other.[42]

Insect Control

When Rachel Carson published *Silent Spring* in 1962, it set off a seismic change in how Americans viewed their environment.

[42] Ibid., 270–72. It is important to note that the Navajo had contracted to provide coal for other powerplants and that coal mining at Black Mesa would have occurred whether or not the dams had been built.

Environmentalism was no longer just about preserving redwoods, natural bridges, geysers, and other natural curiosities; it now cut across racial and class lines to include threats to air, water, and food. Carson laid bare the unholy alliance between the chemical pesticide industry and the United States Department of Agriculture, and in the process, destroyed the myth of scientific objectivity.

Carson's work evokes images of crop-dusting planes swooping low over fields to blanket them with pesticides. However, pesticides were not just limited to food production. As early as the mid-1920s, the park service began to take proactive efforts to control insects that threatened to destroy stands of trees in "areas of scenic importance." Spurred on by federal funding from the 1947 Forest Pest Control Act, by the late 1940s the park service had initiated massive spraying campaigns using DDT throughout the national park system.[43]

At Grand Canyon, insect control began with efforts to control the Black Hills beetle on the north rim in the mid-1920s and tent caterpillars on the south rim in 1933. By 1953, the park service had begun spraying stands of trees in areas of high traffic in Grand Canyon Village along the south rim with DDT to eliminate the tent caterpillars, a tactic that was reported to be 100 percent effective. Park service use of pesticides continued after the publication of Carson's book, and it was only in the late 1970s to 1980s that it officially adopted "integrated pest management" and greatly curtailed the use of pesticides in all units of the national park system.[44]

The 1975 Park Enlargement

In 1975, Congress enlarged Grand Canyon National Park to its modern configuration. Encompassing the entire 277 miles of Grand Canyon from Lee's Ferry to the Grand Wash Cliffs at the head of Lake Mead, the new park boundaries finally reflected what many environmentalists had been arguing for decades—that all of Grand Canyon should receive park protection. With the stroke of a pen, President Gerald Ford almost doubled the size of the park to more than 1.2 million acres.[45]

The expansion was not without controversy, however, as

[43] Richard West Sellars, *Preserving Nature in the National Parks: A History* (New Haven, Conn., 1997; repr., 1999), 85, 162, 255.
[44] Ibid.; Anderson, *Polishing the Jewel*, 72.
[45] Ibid., 67.

the national park did not include the section of the canyon that constitutes the northern boundary of the Hualapai Reservation. Additionally, the Havasupai Reservation, which had consisted of a few hundred acres entirely surrounded by park land, was also greatly expanded to more than 83,800 acres (with an additional 95,300 reserved for the tribe's "traditional use"). Much of this expansion was carved from park-service land. Some environmentalists contended that the new park boundaries actually reduced the amount of territory under federal protection—and in many respects they were right.[46] However, one advantage to the park enlargement was that most Grand Canyon environmental issues could now be managed by one agency, the National Park Service, as opposed to the hodgepodge of agencies with overlapping jurisdictions that had rendered differing degrees of protection to Grand Canyon since the creation of the Grand Canyon Forest Reserve in 1893.

The Environmental Impact of Modernity: 1976–2000

After the monumental events of the 1960s, the enacting of the National Environmental Policy Act (NEPA) in 1970, and the 1975 park expansion, it was highly unlikely that the federal government would seek to build dams within Grand Canyon National Park in the future. But the defeat of the dams did not mean a decrease in environmental issues. New controversies surfaced in the 1970s, many of which were the direct result of the publicity given to the fight to keep dams out of the canyon during the mid-1960s. Skyrocketing visitor numbers and entrepreneurial responses to tourist demands to venture further into the canyon created concerns that the park's founders could never have foreseen.

Additionally, the long-term environmental effects of Glen Canyon Dam upon the Colorado River ecosystem downstream would result in a host of legal actions designed to minimize the dam's negative impact by the mid-1970s. Framed by new environmental laws that mandated the initiation of comprehensive environmental studies and dam-management regulations, the last twenty-five years of the twentieth century witnessed the creation of a myriad of policies designed to attain a balance between the generation

[46] Ibid.; John McComb, "Regional Rep's Report: Southwest: The Grand Canyon National Park Diminution Act," *Sierra Club Bulletin*, February 1975, pp. 18–19.

of hydroelectric power, tourist demands, water storage, and species protection in this now almost completely artificially managed ecosystem.[47]

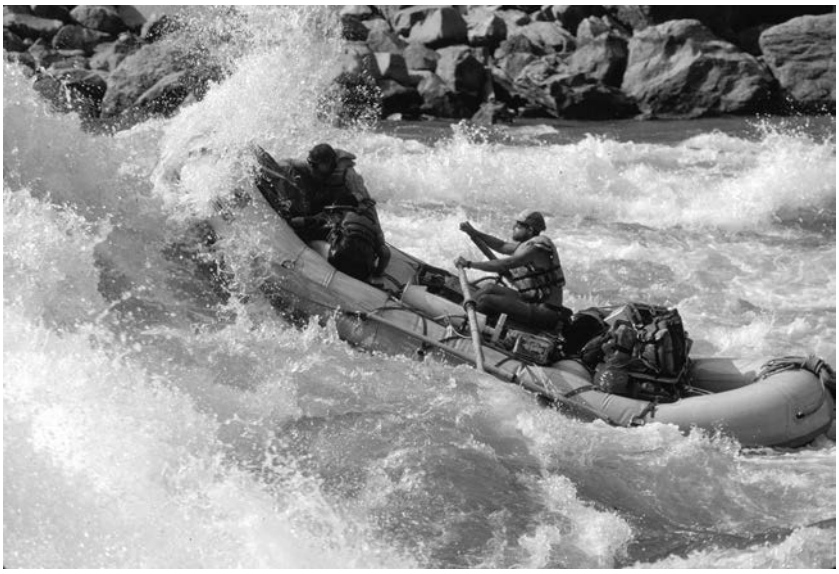
River Running

Prior to the 1960s, river running in the national parks was still something only undertaken by an adventurous few. The fights to keep dams out of Dinosaur National Monument and Grand Canyon popularized white-water rafting. Grand Canyon became a popular destination for this type of ecotourism after the completion of Glen Canyon Dam, which stabilized the flow when its gates were closed in 1963. River guide Georgie White pioneered a new kind of mass river tourism when she began to take forty-foot-long war-surplus pontoon rigs powered by outboard motors down the river. White's methods were more profitable than the small boats other commercial outfitters used. Soon other companies were offering similar experiences even while criticizing the woman who pioneered these large trips.[48]

As a result, Grand Canyon river trips became a hot-ticket item. In 1965, 547 people traveled down the river. In 1972, 16,248 people made the journey. These crowds of river runners, 80 percent of whom traveled with commercial companies, threatened to destroy the inner canyon's fragile ecosystem with pollution and human waste. Belatedly catching up with the issue, the NPS issued its first comprehensive river-running regulations in 1981. This policy limited the number of river runners, restricted the number of user-days, and required that all human waste be removed. It also attempted to balance the desires of commercial companies that offered large motorized pontoon trips with those that offered a more wilderness-type experience with small oar-driven craft. By 1987, twenty-one commercial rafting companies were licensed to take tourists down

[47] Steven P. Gloss, Jeffrey E. Lovich, and Theodore S. Melis, eds., "The State of the Colorado River Ecosystem in Grand Canyon: A Report of the Grand Canyon Monitoring and Research Center, 1991–2004" (U.S. Geological Survey, 2005), 4–5, available online at https://pubs.usgs.gov/circ/1282/c1282.pdf (accessed June 15, 2019).

[48] Richard J. Bishop, Kevin J. Boyle, Michael P. Welsh, Robert M. Baumgartner, and Pamala R. Rathburn, "Glen Canyon Dam Releases and Downstream Recreation: An Analysis of User Preferences and Economic Values" (U.S. Bureau of Reclamation: Glen Canyon Environmental Studies, 1987), 49–50, 74–76; Megan Michelson, "The Rabblerousing Queen of Grand Canyon Rafting," *Outside*, May 24, 2018, available online at https://www.outsideonline.com/2301371/rabblerouser (accessed June 11, 2019).



A river guide and his passengers navigate a massive rapid (probably Hance) on the Colorado River in Grand Canyon. John Running Collection, NAU. PH.2013.4.1.21.10.4, Cline Library, Northern Arizona University.

250 miles of the Colorado River in Grand Canyon National Park.[49] Skyrocketing numbers of people seeking to take a Grand Canyon river trip exacerbated these environmental problems and eventually forced the park service to adjust its regulations and permit system for private trips after the turn of the millennium.

Aerial Tourism

The first airplane landed in Grand Canyon in 1922, the first commercial tourist flight over it occurred in 1926, and the first air-tour company began operations the following year. For much of the first fifty years of the park's existence, aircraft noise was not an issue. However, with the explosion of park visitation after World War II, and paralleling the rise in river running, concessionaires began to offer air tours using both fixed-wing aircraft and, after 1960, helicopters. These overflights forced the federal government to

[49] Bishop et al, "Glen Canyon Dam Releases and Downstream Recreation," 74–76; Michelson, "Rabblerousing Queen."

reexamine the language in the National Park Service Organic Act in order to strike a balance between giving some visitors an "unimpaired" experience and others who wanted to see America's greatest natural wonder from the sky.[50]

The 1975 national park expansion specifically targeted aircraft noise as something that could impede the primary purpose of the park. However, the NPS has no authority to control air tourism; that lies under the purview of the Federal Aviation Administration (FAA). Although the two agencies have worked reasonably well together, environmentalists and air-tour operators have battled over altitude, no-fly zones, the number of flights per day, and the use of "quiet" aircraft technology. After several tragedies, most notably one in June 1986 when a collision between a plane operated by Grand Canyon Airlines and a helicopter owned by Helitech Choppers killed twenty-five people, the FAA issued special flight rules and noise pollution recommendations for Grand Canyon National Park. As a result, Congress passed the National Park Overflights Act in 1987. This was the first law designed to restrict overflights and noise pollution in the park.[51]

Although the park service had achieved some regulation, the forty affected air-tour companies proved to be very influential. Operating from cities such as Las Vegas and from the Grand Canyon airport located at the town of Tusayan near the south rim, the FAA rules allowed for 93,971 annual overflights for airplanes and helicopters over the park. Additionally, the FAA created an exemption for flights over the Hualapai portion of the canyon. At the turn of the new millennium, the number of exempt flights in Hualapai airspace had yet to be defined and the regulation of noise pollution was still being hotly debated.[52]

Endangered and Exotic Species

The last quarter of the twentieth century also witnessed debates over the restoration of native species of plants and animals, as well as a dilemma about what to do with exotic species that had been introduced to the ecosystem. One of the most controversial was the park

[50] Anderson, *Polishing the Jewel*, 54; "Overflights: Chronology of Significant Events," National Park Service website, https://www.nps.gov/grca/learn/nature/airoverflights_chrono.htm (accessed April 14, 2019).

[51] Robert W. Moorman, "Noise in the National Parks," *Vertiflight*, March/April 2015, pp. 34–37; National Park Service, "Overflights-Chronology of Significant Events," NPS website.

[52] Moorman, "Noise in the National Parks," 35.

A Grand Canyon tourist helicopter takes off from Tusayan near the south rim. George Billingsley Collection, NAU.PH.2000.54.10.15.26, Cline Library, Northern Arizona University.

service's burro-removal program. Burros, which were introduced to the West by the Spanish, breed quickly; a feral donkey herd can double in size in just four or five years under the right conditions. Over the years, the park service killed thousands of feral burros in Grand Canyon and incurred a firestorm of protest as a result. After Marguerite Henry published *Brighty of the Grand Canyon* in 1953, a children's book about a free-spirited burro in Grand Canyon, thousands of letters from children swamped park service offices. Eventually, the service chose to allow animal rights organizations to airlift burros out of the park as opposed to killing them. The operation ended in the early 1980s, and Grand Canyon National Park is virtually free of feral burros today as a result.[53]

When the Bureau of Reclamation closed Glen Canyon Dam's gates in 1963, it transformed the Colorado from a warm-water stream of extreme seasonal floods to a highly regulated cold-water river

[53] Nicholas Brulliard, "The Burro Quandry," *National Parks* (Winter 2017), https://www.npca.org/articles/1409-the-burro-quandary (accessed April 14, 2019).

that fluctuated daily in accordance with demands for hydroelectric power hundreds of miles away. Though it retained its fearsome rapids, the river's color changed from the deep red from which its name was derived to a clear blue-green, its silt load trapped within the slack water of Lake Powell. What had begun with Hoover Dam in 1936 was now complete—the Colorado River in Grand Canyon had become a completely human-managed ecosystem with dramatic consequences for aquatic and terrestrial riparian habitat as well as the native and exotic species of plants and animals that inhabited both.

Glen Canyon Dam eliminated seasonal flood peaks, resulting in a reconfiguration of the vegetation of the riparian zone along the river. Seasonal floods had the effect of scouring plants from near the river and numerous species that evolved near the old high-water line were dependent upon occasional flooding to survive. The river's more even flow has resulted in the lowering of the high-water mark and the elimination of the floods that once removed vegetation from along the riverbank. Consequently, vegetation rapidly became thick near the river's edge, consisting of native plants such as coyote willow and invasive species such as tamarisk, altering the habitat for bird species such as the southwestern willow flycatcher.[54]

The dramatic decrease in driftwood deposition also eliminated the favored habitat for numerous native species of insects such as crickets and wasps and is probably why exotic species such as mayflies, which were introduced to support the new tailwater trout fishery, failed to become established. The more constant flows enhanced the growth of algae and created a good habitat for introduced aquatic species such as midges and freshwater shrimp, which quickly became the primary food sources for non-native fish species including rainbow trout.[55]

Below Glen Canyon Dam, the Colorado River measures a crisp forty-six degrees Fahrenheit. The river enters Grand Canyon at Lee's Ferry, 15.5 miles downstream, and the temperature is a constant 47.3 degrees. For most of the length of Grand Canyon the Colorado

[54] Valdez and Carothers, "The Aquatic Ecosystem of the Colorado River in Grand Canyon," 34–40; Anne Minard, "Grand Canyon National Park Ecosystem Threatened by Kazakhstan Beetle?," *National Geographic News*, April 21, 2011, available online at https://news.nationalgeographic.com/news/2011/04/110421-national-parks-grand-canyon-water-tamarisk-flycatcher/ (accessed April 15, 2019).

[55] Valdez and Carothers, "The Aquatic Ecosystem of the Colorado River in Grand Canyon," 34–40.

River's temperature remains low, and it only reaches sixty degrees Fahrenheit at Diamond Creek more than 240 miles downstream.[56]

As Lake Powell filled and the temperature of the Colorado River dropped, native fish were forced to seek out places with warm temperatures to survive. Meanwhile, the trouts moved out of tributary streams where they had been stocked, into the cold water of the main stem of the river. It was not long before native fish populations began to decline. During the 1960s, the NPS began stocking rainbow trout at Lee's Ferry, which by 1978 had become trophy trout water. The park service managed the fishery to maximize trout production through the new millennium.[57]

Shifting Values, Shifting Policies

As was the case with most of the Southwest's great dams, Glen Canyon Dam was designed and initially operated to maximize hydroelectric power production with little consideration for its impact upon the downstream environment. Unthinkable in 1963 when the dam's valves closed, less than twenty years later the Bureau of Reclamation bowed to public pressure and initiated the Glen Canyon Environmental Studies Program in 1982 to analyze the downstream environmental effects of the dam. Researchers issued their final report in 1988 and concluded that alterations in the timing and volume of water released from Glen Canyon Dam could potentially reduce the detrimental effects caused by managing the dam to maximize hydroelectric power production alone.[58]

Interior Secretary Manuel Lujan subsequently directed the bureau to comply with the provisions of NEPA and draft an environmental impact statement (EIS) that proposed several alternative flow scenarios and the downstream impact of each. Lujan imposed interim regulations in 1991 while the bureau completed its analysis, and in 1992, Congress passed the Grand Canyon Protection Act, a comprehensive set of regulations designed to mitigate the downstream damage and to incorporate environmental values into the operation of the dam. Specifically, the law charged the interior secretary with operating Glen Canyon Dam to: "protect and improve downstream resources," "validate the interim operating

[56] Ibid., 34.
[57] Gloss, Lovich, and Melis, "The State of the Colorado River Ecosystem in Grand Canyon," 36.
[58] Ibid., 4–5.

Glen Canyon Dam. Josef Muench Collection, NAU.PH.2003.11.1.2.H-4702, Cline Library, Northern Arizona University.

criteria," force the bureau to complete its EIS, and create a "long-term monitoring and research program."[59]

With these legal protections in place, the stage was set for a new, more environmentally sensitive management plan for the Colorado River in Grand Canyon. Although a dramatic departure from past policy, the new plan did not require the dam to be operated to maximize downstream benefits to resources. Instead, Congress stipulated the plan should only limit hydroelectric generation "to the extent necessary to achieve recovery and long-term sustainability."[60]

The thoughtfully stated goals, articulated within this Glen Canyon Dam Adaptive Management Program, have proven difficult to realize due to the complexity of the ecosystem, scientific

[59] Ibid., 5.
[60] Ibid., 6.

uncertainty, shifting political winds, and competition among tourists, environmentalists, sport-fishers, and American Indian nations. As a new era of environmental management dawned, Grand Canyon National Park was finally managed to place a higher priority upon preserving (and restoring) its environment, rather than meeting the needs of the millions of tourists who come every year to see it.[61] Elegant in conception and theory, the plan would prove controversial to implement.

Into the Great Unknown: Issues for the New Millennium, 2000–2019

In the year 2000, eighty-one years after its founding, Grand Canyon National Park faced a rising tide of external forces that would accelerate environmental changes within the canyon. In the wake of NEPA, the Endangered Species Act, and the Grand Canyon Protection Act, the park service struggled to implement management practices that placed a greater emphasis upon ecosystem preservation and rehabilitation. As it changed its priorities and began to move away from what park service historian Richard Sellars calls "facade management," the agency soon found itself in conflict with the very people who had been drawn to Grand Canyon by its previous practices of maximizing tourism to fulfill popular expectations of what many people believed a national park experience should be.[62]

As has been the case throughout much of the history of Grand Canyon National Park, infrastructure continues to lack the capacity to handle the overwhelming environmental impact of the more than 6.5 million people who visit Grand Canyon National Park each year. These massive numbers have forced park-service officials to rethink how people experience the park, particularly at the south rim. Many parking lots are now sited away from the rim and shuttle busses move people into and out of the park's most congested areas. Park hotels are often booked years in advance during times of peak visitation and the demand for private river-trip permits became so high that before the park service instituted a lottery

[61] Ibid., 5–9.
[62] Sellars, *Preserving Nature in the National Parks*, 4–5.

system in 2006, the waiting time was twenty-five years.[63] The park administration continues to be beset with environmental issues in the new millennium, ranging from providing adequate water, sewage treatment, and trash disposal for the south rim, to the removal of exotic species, some of which it was responsible for introducing in the first place.

A relatively new area of concern related to tourism is the growing impact of river trips upon the canyon's fragile riparian environment. Currently more than twenty-five thousand people take commercial and private Colorado River trips through Grand Canyon each year. Although trips are now highly regulated with the objective of keeping the canyon as pollution-free as possible, the tens of thousands of people who raft the Colorado every year generate an estimated three hundred thousand pounds of solid human waste, every ounce of which must be transported out of Grand Canyon.[64]

American Indian tribes whose lands border Grand Canyon have also begun to build their own tourist facilities. These efforts, often financed by private developers, have brought these groups into conflict with environmental organizations that oppose more development along the rim, intensifying existing conflicts about American Indian sovereignty within the federal constitutional framework. As has been the case with many Native American groups during the last 150 years, the Navajo have split into factions that either favor new development (Progressives) or oppose it (Traditionalists). Environmentalists who fought against the construction of dams in the 1960s testified before Congress that the Navajo and Hualapai people would be better served if encouraged to develop tourism in their respective parts of Grand Canyon. Ironically, as these American Indian groups have pursued these opportunities, the same environmental organizations that once supported development have become some of its most vociferous critics.[65]

[63] "12 to 25 Day Noncommercial River Trips: Lees Ferry to Diamond Creek," National Park Service website, https://www.nps.gov/grca/planyourvisit/overview-lees-ferry-diamond-ck.htm (accessed February 25, 2019).

[64] Rich Landers, "National Park Regulations Pass Sniff Test at Grand Canyon," *Spokesman-Review* (Spokane, Wash.), March 14, 2019, available online at http://www.spokesman.com/stories/2019/mar/14/national-park-regulations-pass-sniff-test-at-grand/ (accessed April 14, 2019).

[65] Pearson, *Saving Grand Canyon*, 205, 228, 241.

American Indian Tourism: Modern Issues

The Navajo Nation and Grand Canyon National Park share a border along the eastern edge of Grand Canyon starting at Lee's Ferry and running downstream past the confluence of the Colorado and Little Colorado Rivers. Although the Navajo Nation has constructed tourist facilities on other parts of its reservation at places such as Monument Valley and Canyon de Chelly, the Navajo rim of Grand Canyon has remained virtually development-free.

Home to some of the most sacred sites in Navajo and Hopi cosmology, the east rim of Grand Canyon was also the subject of a land dispute between the Navajo and Hopi Nations that lasted more than a century. Ambiguous language in the presidential proclamation that established the Hopi Reservation in 1882 led to so much controversy that the Bureau of Indian Affairs imposed a freeze on development in 1966 that lasted until President Barack Obama signed a bill to repeal it in 2009.[66]

The repeal led to an immediate attempt on the part of outside developers, allied with a handful of people with tribal affiliations, to persuade the Navajo Nation to allow it to build a 420-acre hotel/mall/restaurant complex complete with cable cars to take an estimated ten thousand tourists a day from the rim to a "river walk" near the sacred confluence. The Scottsdale-based development company, Confluence Partners, Inc., promised that this new development, which it christened the "Escalade," would, for an initial cost of $120 million, result in an infusion of $50 to $95 million annually into the Navajo economy and provide two thousand new jobs.[67]

Despite an expensive public-relations campaign waged by the project's supporters, in November 2017 the Navajo tribal council voted 16-2 to kill "the monster" as it had come to be called.[68]

[66] "Lawmakers Seek to Wrap up Costly Navajo-Hopi Relocation Program," *AZCentral*, February 9, 2015, available online at https://www.azcentral.com/story/news/arizona/politics/2015/02/09/lawmakers-seek-to-wrap-up-costly-tribal-relocation-program/23122259/ (accessed June 15, 2019); Bill Donovan, "Obama Signs Bennett Freeze Repeal," *Navajo Times*, May 14, 2009, available online at https://navajotimes.com/news/2009/0509/051409freeze.php (accessed April 27, 2019).

[67] Cindy Yurth and Duane Beyal, "Targeting the Confluence: Group Unveils Sweeping Plans for Project at Sacred Site," *Navajo Times*, June 14, 2012, available online at https://www.navajotimes.com/news/2012/0612/061412con.php (accessed April 27, 2019).

[68] "Watch: Grand Canyon Escalade Developer Gives Navajo Nation the Bird," *Phoenix New Times*, November 11, 2017, available online at https://www.phoenixnewtimes.com/news/developer-give-navajos-the-bird-after-grand-canyon-project-fails-9858650 (accessed

Although the potential for development remains, the sacred confluence and Navajo rim of Grand Canyon will remain free of major intrusive development for the foreseeable future.

The Hualapai Nation opened Grand Canyon West as an alternative destination to Grand Canyon National Park. The most popular—and controversial—tourist attraction at the development is the Skywalk, a cantilevered glass-bottomed walkway completed in 2007, that extends seventy feet beyond the rim of a tributary canyon of Grand Canyon proper. More than seven hundred feet above the canyon floor, it offers spectacular views of the Colorado River just over a mile away. It has become an object of scorn from both park service personnel and environmental groups. Grand Canyon West, the brainchild of the late Las Vegas developer David Jin, is planned to eventually include hotels, a golf course, and even a rim to river cable car. When finished, it will sprawl over nine thousand acres, more than twenty times the size of the Escalade project the Navajo Nation recently defeated.[69]

Park service officials view the Hualapai construction of this project as hypocritical and argue that it does not fit with the tribe's frequent claims of environmental stewardship. But Hualapai officials contend they will not repeat the park service's mistakes at the south rim and that they have conducted environmental and cultural studies to minimize any detrimental impact.[70] Because the project does not threaten any significant religious sites, Grand Canyon West has great support among the Hualapai people. The Hualapai Nation has the legal right to develop its portion of the south rim of the canyon; thus, the environment in lower Grand Canyon, currently a place where it is still easy to find solitude and quiet, could soon be dramatically changed.

The Effects of Climate Change

The environmental impact of climate change on Grand Canyon National Park cannot be overstated. Although a relatively new

April 27, 2019).

[69] "Grand Canyon Skywalk," on Highestbridges.com website, http://highestbridges.com/wiki/index.php%3Ftitle%3DGrand_Canyon_Skywalk (accessed April 27, 2019); Felicia Fonseca, "Paved Road to Grand Canyon Skywalk Opens," *AZCentral*, August 13, 2014, available online at https://www.azcentral.com/story/travel/road-trips/2014/08/13/grand-canyon-skywalk-road-paved/14005873/ (accessed April 27, 2019). The skywalk does not jut out over the main chasm four thousand feet above the canyon floor as some claim.

[70] Fonseca, "Paved Road."

external factor, it could potentially become the most important agent of environmental transformation during Grand Canyon National Park's second century as federal agencies struggle to mitigate its impacts upon the park and surrounding areas.

Climate change, and the prolonged drought and higher temperatures it has caused, when combined with decades of misguided forest management—which dictated that all fires be put out as soon as possible—has increased the frequency and intensity of wildfires in the park as well as in the Kaibab National Forest that borders it to the north and south. Now, when fires occur, they burn with greater intensity and often become high-temperature crown fires that devastate vast swaths of forest due to a higher density of trees and decades of fuel buildup.[71]

Near Grand Canyon, the park and forest services have replaced total fire suppression with a strategy of setting prescribed control burns and allowing most naturally caused wildfires to burn in the hope that they will consume the fuel that has built up on the forest floor. However, fires on the North Kaibab, such as the Warm Fire of 2006, have sometimes raged out of control. Fire ecologists estimate that of all the forest that burned in the park between 1919 and 2006, 95 percent of that acreage burned after 1992, the date the park service implemented its wildland fire policy. Forest experts are not optimistic about the future of the forests in and bordering Grand Canyon National Park because of ongoing drought, increasing temperatures, and the sheer amount of fuel that accumulated under previous fire suppression policies.[72] Although the next chapters of Grand Canyon National Park's fire story have yet to be written, the forecast so far is rather grim.

Climate change has also affected the behavior and population of exotic species within the national park. Buffalo were brought to the North Kaibab plateau at the turn of the twentieth century as part of an ill-fated attempt to crossbreed cattle and bison. They became a popular tourist attraction at the north rim of Grand

[71] Stephen Pyne, *The Southwest: A Fire Survey* (Tucson, 2016), 59–60; "Climate Change Tipping Points: A Point of No Return?," *Fire Science Digest*, May 2013, pp. 4–7, available online at https://www.firescience.gov/Digest/FSdigest15.pdf (accessed June 7, 2019).

[72] Pyne, *Southwest*, 52–57; Brandon Loomis, "Arizona's Forests are being Ravaged by Climate Change. How Much Can We Save?," *Arizona Republic*, August 1, 2018, available online at https://www.azcentral.com/in-depth/news/local/arizona-environment/2018/08/01/climate-change-wildfires-frantic-fight-save-arizona-forests/609566002/ (accessed June 7, 2019).

American Bison. From Agricultural Research Service, U.S. Department of Agriculture. Photograph by Jack Dykinga, available online at https://www.ars.usda.gov/oc/images/photos/k5680-1/.

Canyon before migrating to the warmer grasslands of the House Rock Valley east of the Kaibab. For several decades they migrated back and forth from the high country to calve during the winter at House Rock Valley. However, the diminution of grasslands has forced the herd to seek the cooler climes and more reliable food sources of the Kaibab Plateau. Since 2009, they have resided permanently in the forests of the North Kaibab.[73]

Bison trample and eat native plants, turn fragile springs into mudholes, and have even adapted to living below the canyon rim. The buffalo have also proven very difficult to eradicate. They acclimate to the forest environment well, are hard to find despite their size, and cannot easily be airlifted away as was the case with burros in the early 1980s. When the state of Arizona began to allow limited buffalo hunting in the Kaibab National

[73] Ron Dungan, "Bison in Arizona?" *Arizona Republic*, February 19, 2016, available online at https://www.azcentral.com/story/news/local/best-reads/2016/02/19/bison-grand-canyon-buffalo-jones-house-rock-valley/79884888/ (accessed June 7, 2019); Anderson, *Polishing the Jewel*, 15. How the bison got to House Rock Valley is somewhat of a mystery. Some sources indicate that they migrated while others contend they were driven there.

Forest, the herd moved inside the national park boundary and stayed there. Simply relocating buffalo does not work because trial relocations have shown that buffalo often find their way back to the park. To address the problem, the park service decided to implement a bison reduction plan in 2018 that includes relocation and "lethal culling." Given the NPS's mixed legacy with respect to exotic species, the decision to reduce the size of the park's bison herd poses a difficult dilemma for a federal agency whose logo prominently features a buffalo.[74] How the public reacts to these efforts remains to be seen.

The effect of climate change upon the Grand Canyon fishery and riparian zone along the Colorado River is worthy of a book-length study in and of itself. Pursuant to the Grand Canyon Protection Act of 1992 and subsequent legislation, the Bureau of Reclamation has periodically conducted "highwater" releases from Glen Canyon Dam in an attempt to restore the beaches along the river that are indispensable to the riparian habitat.

The bureau managed river flows to maximize hydroelectric power for the first three decades of the dam's operation but in the mid-1990s multiple federal agencies began to work together to find a compromise with respect to power production, environmental restoration, recreational fishing, the removal of exotic plants such as tamarisks through the importation of exotic insects such as Kazakhstan tamarisk leaf beetles, and a myriad of other agendas many of which were, and continue to be, irreconcilable.[75]

A Species Good or Bad? A Brown Trout Saga

Perhaps the most difficult dilemma facing these agencies is the question of how to encourage the restoration of native warm-water fishes—whose remnant populations have been driven to the few places in the canyon where water maintains a relatively warm temperature such as the confluence of the Colorado and Little Colorado Rivers—with the maintenance of the blue-ribbon trout fishery from Lee's Ferry upstream to Glen Canyon Dam.

[74] "Bison at Grand Canyon National Park," National Park Service website, https://www.nps.gov/articles/bison-management.htm (accessed June 7, 2019); Dungan, "Bison in Arizona?"

[75] Minard, "Grand Canyon National Park Ecosystem Threatened." For example, although tamarisk leaf beetles have proven to effectively control and reverse the spread of tamarisk—a notorious exotic water-usurping shrub—the tamarisk has become prime habitat for the southwestern willow flycatcher, an endangered native bird species.

A Lee's Ferry Rainbow Trout. Photograph courtesy of Steve Ostwinkle.

At the center of this debate over the future of the Grand Canyon fishery is the brown trout. Introduced to Shinumo Creek in 1926, browns are secretive and are more difficult to catch than rainbows. Although neither fish is native, rainbow trout are almost completely artificial, a product of more than a century of hybridization, "an entirely synthetic fish" in what has become a completely artificially managed aquatic environment.[76]

The USGS in conjunction with the park service and several other agencies within the Department of the Interior, released a report in 2018 identifying several priorities, the two most important of which are to: (1) protect remnant populations of endangered native fishes such as humpback chub in the Colorado River below Glen Canyon Dam, and (2) protect and enhance the rainbow trout fishery above and below Lee's Ferry. The document concluded that the steady increase in the population of brown trout in this reach of the canyon is the primary threat to both of these objectives.[77]

[76] Anders Halverson, *An Entirely Synthetic Fish: How Rainbow Trout Beguiled America and Overran the World* (New Haven, Conn., 2010), 48–57, 150–53.

[77] M. C. Runge et al, *Brown Trout in the Lees Ferry Reach of the Colorado River—Evaluation*

The NPS declared war on the brown trout in Grand Canyon and at the beginning of 2019 released its brown-trout management plan for Glen and Grand Canyons. The regulations allow anglers to catch unlimited numbers of browns in the Colorado River and its tributaries in Grand Canyon and includes "mechanical removal" through electrofishing the river above Lee's Ferry if certain "trigger" conditions exist. Electrofishing does not discriminate between different species of fish, it stuns—or kills outright—fish of all species, as demonstrated by three AZGFD electrofishing studies conducted at Lee's Ferry in 2017. Though mechanical removal has been used to successfully eradicate brown trout from small tributaries such as Bright Angel Creek, using it to eliminate browns from the main stem of the Colorado River is another matter entirely.[78]

Perhaps the most rational assessment of this latest attempt to manipulate the environment within Grand Canyon National Park was given by Michael Yeatts, a member of the Hopi Tribe who contributed the following perspective to the aforementioned 2018 USGS report:

> The Hopi express puzzlement at the seemingly conflicting management goals of maintaining native fish and having a recreational trout fishery in the same river; and then fingering the trout as the threat to the native fish. While there are certainly many avenues being pursued that make managers feel that these divergent goals are possible, the simplest reading of the situation is that trying to achieve both of these goals is not appropriate.[79]

of Causal Hypotheses and Potential Interventions (United States Geological Survey report, 2018), 2–6.

[78] Ibid.; "Expanded Non-Native Aquatic Species Management Plan/EA," National Park Service website, https://parkplanning.nps.gov/document.cfm?parkID=62&projectID=74515&documentID=90478(accessed June 9, 2019); "Fishing," Glen Canyon, National Park Service website, https://www.nps.gov/glca/planyourvisit/fishing.htm (accessed June 8, 2019); Jim Strongen, "Turns Out, Nature Resists Manipulation," *Payson* (Ariz.) *Roundup*, January 2, 2018, available online at https://www.paysonroundup.com/outdoors/turns-out-nature-resists-manipulation/article_d7967431-b5aa-57f3-bcfe-818448b13884.html (accessed June 9, 2019); David Rogowski and Jan Boyer, "Brown Trout at Lee's Ferry, Crisis or Red Herring," Research Branch, Arizona Game and Fish Department website, available online at https://www.lcrmscp.gov/crab/presentations/2018/crab18_30.pdf (accessed June 11, 2019). For example, the AZGFD report records a total of 557 rainbows and 37 browns captured from one electrofishing expedition at Lee's Ferry in March 2017. The removal of bag limits on brown trout in Glen and Grand Canyons is a continuation of existing NPS policy.

[79] K. E. Dongoske and M. Yeatts, "Tribal Perspectives of Nonnative Fish Removal," quoted in Runge et al, *Brown Trout in the Lees Ferry Reach of the Colorado River*, 63–66.

Indeed. Although Glen Canyon Dam can be managed to some degree, the river will remain a cold-water fishery for as long as Lake Powell exists and the park service will make fruitless attempts to restore native warm-water species to a cold-water fishery while incurring the wrath of trout anglers, a constituency it courted for most of the twentieth century and the reason these exotic fishes are in the river in the first place.

Some Good News in 2019

Fittingly in this centennial year of Grand Canyon National Park, the coal-fired Navajo Generating Plant at Page, Arizona, a smoke-belching behemoth that has fouled the air over Grand Canyon for forty years, is scheduled to shut down on December 22, 2019, because it can no longer compete economically with natural gas and green-energy production.[80] And so we celebrate the one hundredth birthday of Grand Canyon National Park with the promise of clearer skies over the canyon and a glimpse of what clean-energy alternatives could potentially mean for the rest of the planet.

Conclusion: The Environmental Future of Grand Canyon

Historian William Cronon wrote in *Changes in the Land* that nature is chaotic, that "there has been no timeless wilderness in a state of perfect changelessness."[81] The environmental history of Grand Canyon certainly demonstrates the unpredictability of nature. The only certainty—other than Grand Canyon's popularity with tourists—is that its environmental future remains, at best, uncertain.

In 1979, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) designated Grand Canyon National Park as a World Heritage site.[82] Long viewed as one of the seven natural wonders of the world, Grand Canyon belongs to all of

[80] John Hollenhorst, "Power Plant Shutdown Looms over Navajo Nation," *Deseret News*, June 2, 2019, available online at https://www.deseretnews.com/article/900073525/power-plant-shutdown-looms-over-navajo-nation.html (accessed June 14, 2019); James Rainy, "Biggest Coal-burning Power Plant in the West Is Most Likely Shutting Down," April 11, 2018, NBC News website, https://www.nbcnews.com/news/us-news/biggest-coal-burning-power-plant-west-most-likely-shutting-down-n864981 (accessed June 14, 2019).

[81] William Cronon, *Changes in the Land: Indians, Colonists, and the Ecology of New England* (New York, 1983), 11.

[82] "Grand Canyon National Park Foundation Statement," National Park Service website, https://www.nps.gov/grca/learn/management/upload/grca-foundation20100414.pdf (accessed June 11, 2019).

humanity. But it also belongs to each of us individually. Every one of us experiences Grand Canyon in our own way, through taking a river trip, hiking its trails, or taking a moment to quietly contemplate it from far away. There are as many ways to celebrate Grand Canyon as there are people to celebrate it.

But as we reflect during this centennial year, we must also look ahead to the future. What is our responsibility to those who will come after us? How do we guarantee that our grandchildren, and their grandchildren, will be able to experience Grand Canyon as we have? What will that experience be like? Are we willing to make appropriate compromises, or will we love it to death? Will we have to limit visitors to it—or more widely distribute them? Will we succeed in finding a balance between protecting the park with the legal rights of real-estate developers who wish to build housing developments and mining companies that seek to mine uranium close to its boundaries? What can be done about invasive quagga mussels that have shown up in the river? What of the bison and the brown trout?

Ultimately these questions will be decided by the application of law and politics. The park's very existence as an artificial political and social abstraction is because in 1919 Congress passed a law writing it into being. It was and remains "a legal creation" that reflects the will of the American people. Hopefully Grand Canyon National Park—and the legal and constitutional framework that created and protects it—will still exist in 2119 because the American people will wish it to be so.[83]

But the environmental future of Grand Canyon as a geological entity is another matter entirely. The chasm has evoked awe and terror since people first encountered it. It has inspired petroglyphs and torrents of words—and been described as indescribable. It has moved artists, poets, scientists, cartographers, and souls from all over the world who come to it seeking something, *someone* (?), infinitely more powerful than us. Grand Canyon is more evocative of the awe and terror that define absolute sublimity than any other place on earth. It stands apart from, to paraphrase Abraham Lincoln, "our poor ability to add or detract."[84] It is comforting—at least for those of us who love the canyon—to

[83] Quotation from title of Jason Robison's essay in this special issue.
[84] Quotation from Abraham Lincoln's "Gettysburg Address" (1863).

know that ultimately it doesn't need our help. It doesn't need us to save it. Because . . .

Someday, thousands of millennia beyond this centennial year, Grand Canyon will be as it once was. The buildings, trails, and dams that have altered the ecosystem of river and canyon will have been effaced through eons of weathering and time. The great river will carry the rotten concrete and the silt deposited behind it away. The remnants of the scenic overlooks where millions once gazed awe-struck into "these dismal abysses," will now host only the sound of wind in the trees—and perhaps birdsong—the haunting arpeggios of baying wolves, the echoing thunder of the unfettered river, or the sandpaper rasp of lizards scuttling across warm sandstone.[85]

The forests that line its rims will return to their natural state of chaos—as will the riverine ecosystem a mile below. The canyon will be unnamed—unnamed but still grand. It will remain beyond humanity's capacity to comprehend, and it will have passed beyond humanity's capacity to destroy. The sky over the north rim will once again be crystalline, azure, incandescent, the canyon's vertical stone faces set aflame with molten slashes of orange, purple, and scarlet by the rising and setting sun until the end of time itself.

In the end, Grand Canyon doesn't need us to save it. But perhaps we need it to save us from ourselves.

[85] Quotation from Joseph C. Ives, *Report upon the Colorado River of the West* (Washington, D.C., 1861), 110.