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# The Pikeminnow Against the Dam

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## The Pikeminnow Against the Dam

*“We have an unknown distance yet to run, an unknown river to explore. What falls there are, we know not. What rocks beset the channel, we know not. What walls rise over the river, we know not.”<sup>1</sup>*

*Major John Wesley Powell  
August 13, 1869*

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I first saw the Flaming Gorge Dam on April twenty-first, 2013. I got off a bus in the dam parking lot, used the restroom at the visitor’s center, peered over the edge, and then got back on the bus. I had just paddled an eighty-mile stretch of the Green River below Flaming Gorge. But before driving across the top of the dam, I hadn’t known that upstream of the eddies and undercuts that so thrilled and terrified me, a concrete colossus fought the Green – fought and was winning. The water discharge that created those exhilarating waves was entirely controlled by the dam! Peering over the edge, following the concrete arch as it curved to the river five hundred feet below me, I felt an uneasy awe. Managing a river as determined as the Green couldn’t be that simple, and yet the rapids I had paddled had been flush with water. The river seemed alive and well – and under control.

Appearances can be deceiving, however. The Green River has not always been as healthy as when I paddled it in 2013; in fact, the system is still recovering from a history environmental abuse. Initial exploration of the river revealed a system of steep-walled canyons and flashy floods, an environment hostile to settlement but perfect for a massive dam. The construction of a dam at Flaming Gorge in the early 1960s endangered endemic aquatic species, and the greed of sport fishermen paired with rotenone poison threatened to deal a final blow to the Green’s unique ecosystem. Fortunately, scientists and government agencies partnered in the nick of time to turn the Flaming Gorge operation into a national river management experiment. The dam and the near-loss of the Green’s fish also

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<sup>1</sup> deBuys.

provided inspiration for landmark environmental legislation during the 1960s and 1970s. Without the destruction that the Flaming Gorge Dam initially wrought on aquatic habitat, we might not now understand how to operate hydraulic infrastructure for both human and environmental benefit. And if we hadn't lost the Green's native fish, we might not now know how to get them back. The legacy of the Flaming Gorge Dam, a lesson in conservation and compromise and caution, has guided the United States in damming and managing rivers throughout the arid American West.

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Nearly one hundred and fifty years ago, the Green River was the last bastion of uncharted wilderness in the continental United States. On May twenty-fourth, 1869, Major John Wesley Powell and nine brave crewmen embarked from Green River City, Wyoming, to fill in the map. The ten men captained four river-running boats, each vessel between sixteen and twenty-one feet long. The crew had packed enough rations to last ten months, and their cargo holds brimmed with repair supplies, winter clothing, ammunition, and scientific measuring tools<sup>2</sup>.

Powell, one-armed, rugged, and professorial, had tasked himself with “exploring the Colorado River and solving the mysteries of its three hundred mile canyon.”<sup>3</sup> Perhaps the greatest student of the West that America has ever known, Powell enlisted with the Union during the Civil War, descended nearly the entire length of the Mississippi River alone, educated himself in botany, geology, and anthropology, and claimed the first summit of Longs Peak in Colorado – all before his thirty-fifth birthday. However, these achievements paled in comparison to the Powell Geographic Expedition of 1869 that explored the Colorado River Basin from the upper reaches of the Green River to the Colorado's confluence with the Virgin River in Nevada (see figure 1 for map). The unexplored “three hundred mile canyon” that intrigued Powell was actually a continuous succession of steep-walled

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<sup>2</sup> Powell 1.

<sup>3</sup> Stegner xi.

canyons that ran south and west for nearly one thousand miles.<sup>4</sup> Between the point of embarkation at Green River City and the expedition's eventual conclusion at the southern end of the Grand Canyon, the Green River offered few habitable stretches and even fewer escapes. Over the course of four summer months, the river cost the expedition three lives and one desertion. Massive, seething rapids swallowed boat parts and supplies on a nearly daily basis. Powell recorded these tribulations in the names he inscribed on his maps: Desolation Canyon, Firewater Rapids, Labyrinth Canyon, Last Chance Rapids, Separation Canyon.<sup>5</sup> But not all was desperate; scenes of great beauty emerged from between these moments of danger and anguish. The first of these magnificent landscapes greeted Powell three days into his journey.

“The river is running to the south,” Powell wrote on May twenty-sixth, 1869,

“yet it glides on in a quiet way as if it thought a mountain range no formidable obstruction to its course. It enters the range by a flaring, brilliant, red gorge, that may be seen from the north a score of miles away. The great mass of the mountain ridge through which the gorge is cut is composed of bright vermilion rocks... This is the head of the first canyon we are about to explore – an introductory one to a series made by the river through this range. We name it Flaming Gorge.”<sup>6</sup>

The beauty of Flaming Gorge awed Powell, and he committed six entries in his expedition book to narrating the exploration's journey between its vermilion walls. Powell's peers shared his reaction to the landscape; upon seeing the canyons for the first time, explorer Lieutenant Joseph Ives, one of the first men to survey the Grand Canyon, announced that “it seems intended by nature that the Colorado River along the greater portion of its lonely and majestic way, shall be forever unvisited and undisturbed.”<sup>7</sup>

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<sup>4</sup> Stegner xii.

<sup>5</sup> “Ouray to Green River Town,” *American Whitewater*.

<sup>6</sup> Powell 4-5.

<sup>7</sup> deBuys.

Ives's prediction rings hollow a century and a half after it was issued. The Green River's channel through Flaming Gorge is now inundated by a reservoir four hundred and thirty six feet deep, suppressed by a massive dam that perhaps will never yield.<sup>8</sup>

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Construction of the Flaming Gorge Dam commenced in June of 1956 under the watchful gaze of the Bureau of Reclamation. However, initial discussions about harnessing the Green River began thirty-four years earlier with the passage of the 1922 Colorado River Compact. This legislation divided the Colorado River Basin into an upper region and a lower region, each with an allocation of 7.5 million acre-feet of water per year. The Green, Gunnison, San Juan, and other tributaries feed the Colorado River in the upper basin states of Wyoming, Utah, Colorado, and New Mexico before the river enters the lower basin states, Arizona, Nevada, and California (see figure 1 for map). The Compact made it the responsibility of the upper basin to guarantee the lower basin's annual allotment.<sup>9</sup>

This task proved to be difficult because, like many Western rivers, the Colorado's flow varies greatly from year to year. After a series of particularly dry years, the upper basin states decided that a large-scale storage project was necessary both to meet lower-basin delivery requirements and to fully harness their own upper-basin allotment. Additionally, growth in Salt Lake City and parts of Colorado made the possibility of hydropower attractive. In 1946, the Bureau of Reclamation began scouting the length of the Green River for suitable dam sites, and by the early 1950s, the Bureau had chosen an ideal canyon: Echo Park in Dinosaur National Monument. The dam constructed there would be "for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use... providing for the reclamation of arid and semiarid land, for the control of floods,

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<sup>8</sup> "Flaming Gorge Reservoir," Utah Division of Wildlife Resources.

<sup>9</sup> Bureau of Reclamation, "Flaming Gorge Unit," 8-13.

and for the generation of hydroelectric power.”<sup>10</sup> For the Bureau of Reclamation, this mission was like a mandate from heaven.

The Bureau’s plan was met with impassioned resistance from the fledgling environmental movement in the American West. Led by David Brower of the Sierra Club, activists ran a national campaign of protest. Newspaper ads argued that dams built at Echo Park and downstream in the Grand Canyon would not “improve” the Colorado River, despite the Bureau of Reclamation’s insistence that they would. “Should we also flood the Sistine Chapel so that tourists can get nearer the ceiling?” asked full-page advertisements in national publications like *The New York Times*. The Sierra Club’s stirring rhetoric won the battle, and plans to dam Echo Park and the Grand Canyon were canceled.<sup>11</sup> In their stead, the Bureau chose four new sites, and in 1956, Congress authorized the construction of the original Colorado River Storage Project units: Glen Canyon, Navajo, Wayne Aspinall, and Flaming Gorge. Six years and 987,000 cubic tons of concrete later, a 502-foot-high thin arch dam stretched 1,285 feet across Flaming Gorge, and on December tenth, 1962, dam administrators closed most of the gates and waited for the reservoir to fill.<sup>12</sup> When the reservoir is full, it now extends ninety-one miles upstream of the dam.<sup>13</sup> At optimal operating conditions, the hydropower turbines and trio of generators installed at the dam churn out more than 150,000 kilowatts of power. According to the Bureau of Reclamation, “Flaming Gorge Dam stands as a tribute to man’s ingenuity” set against a backdrop of natural beauty.<sup>14</sup>

This ingenuity, however, comes at a cost. David Brower himself said that the comprise that led to the dams at Glen Canyon and Flaming Gorge was “America’s most regrettable environmental mistake.”<sup>15</sup> The canyon walls that amazed Powell nearly a century before the Flaming Gorge Reservoir was constructed are now hidden by hundreds of feet of water in a desert; their brilliant

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<sup>10</sup> Bureau of Reclamation, *Operation of Flaming Gorge Dam Draft Environmental Impact Statement*, S-3.

<sup>11</sup> Brower.

<sup>12</sup> Bureau of Reclamation, “Flaming Gorge Unit,” 20.

<sup>13</sup> “Flaming Gorge Dam,” Bureau of Reclamation.

<sup>14</sup> Bureau of Reclamation, “Flaming Gorge Unit,” 26.

<sup>15</sup> “David Brower Centennial Celebration,” The Glen Canyon Institute.

vermilion is masked by a growing veneer of reservoir sediment. And the fish that have lived in the Green River as long as it has been around are disappearing – each year they’re getting harder and harder to find. The effects of the dam on aquatic habitat have been profoundly harmful.

Primary among these effects has been the elimination of seasonal flow variation. Before the dam was installed, the Green River ran wild each spring. Each June, an average of 32,000 cubic feet of water would barrel past the gauging station in Green River, Utah, *every second*. One early summer day in 1917, the Green River reached an all-time high discharge of 68,100 cubic feet per second, nearly an entire Olympic swimming pool’s volume passing a single point every second. These torrential floods would originate in the mountain ranges surrounding the upper Green – the Uintas, Wasatches, and Rockies – and then scour sand and silt from low-lying areas and deliver it to the roiling Green.<sup>16</sup> Flashy summer storms would magnify the sediment yield of the Green River basin even further. Then, after a slow autumn decline, the river would lie dormant for the winter months, sometimes covered by ice as thick as three feet. This extreme variability in water volume, temperature, and sediment concentration provided a habitat for thirteen species of fish not found anywhere else in the world, including the Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker. Now, the Colorado pikeminnow and humpback chub are endangered. The razorback sucker is considered critically endangered, and the bonytail chub may be extinct – no reproducing wild populations are thought to exist anymore.

The pikeminnow is an impressive fish; it is the top predator in the Colorado River food chain. Many specimens weigh between twenty and forty pounds and grow to three or four feet in length. River anglers tell tales of six-foot-long pikeminnow weighing in excess of eighty pounds, although the veracity of these claims is debatable.<sup>17</sup> The bonytail chub and humpback chub are also members of the minnow family, and the razorback sucker, though not an enormous minnow like the other three

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<sup>16</sup> Collier et. al 55-56.

<sup>17</sup> “Program History,” Upper Colorado River Endangered Fish Recovery Program.

fish, can still grow to three feet in length. All four species require a habitat sculpted by sediment-loaded floods, varied water temperatures, and intact migration routes.<sup>18</sup> With the Flaming Gorge Dam stemming the Green's wild flow, none of these conditions any longer hold true.

However, dam infrastructure was only the beginning of the demise of the Green's fish. Upon completion of construction, the government's assault on endemic species continued with rotenone. Rotenone, a chemical often sold under brand names like Fish Tox, Chem-Fish, and Rotacide, is odorless, colorless, and acutely toxic to aquatic life.<sup>19</sup> In September of 1962, the Wyoming and Utah fish and game departments teamed with the U.S. Bureau of Sport Fisheries and Wildlife to reduce population levels of carp, perch, and endemic species of the Colorado. Flaming Gorge had a new lake, and sport fishermen were clamoring for the species they loved to catch: kokanee salmon, lake trout, and rainbow trout. The plan: dump more than 21,100 gallons of rotenone into the Green River. No permits were needed. No scientific analyses were conducted. Over the course of three days, more than one hundred government employees pumped rotenone into the river at fifty-five different drip stations, and within a couple of weeks, the Green River was mostly free of "coarse fish." In fact, in 1963, no fish were found in large swaths of the lower Green River *at all*.<sup>20,21</sup> No native fish meant that it was easier to restock the system with more desirable species. The Bureau of Sport Fisheries and Wildlife declared the rotenone project a success.

The native species that survived the rotenone flush far enough downstream and eventually found their way upstream again were to face even tougher challenges in the coming decades. The Flaming Gorge Reservoir and the river downstream were now full of introduced species that crowded out pikeminnow and chubs, and aquatic habitat below Flaming Gorge Dam had transformed rapidly. The river bed became coarser, the water was clearer, river stage was lower, and temperatures were colder; the Green River could no longer support habitat or reproduction for endemic fish. These dam-

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<sup>18</sup> "Endangered Fish," U.S. Fish and Wildlife Service.

<sup>19</sup> "Rotenone," EXTTOXNET.

<sup>20</sup> *Ibid* 109.

<sup>21</sup> Binns 51-54.



related environmental changes posed a more enduring and far-reaching threat to fish than the rotenone. However, without the three days of rotenone administration in 1962, the plight of the Green's fish might have gone unnoticed.

After learning of the Flaming Gorge rotenone operation, Stewart Udall, Secretary of the Interior, announced that "wherever there is a question of danger to a unique species, the potential loss to the pool of genes of living material is of such significance that this must be a dominant consideration in evaluating the advisability of the total project." Udall's reaction to the piscicide application became law in the historic 1966 Endangered Species Preservation Act that defined and protected endangered species. A year later, the humpback chub and Colorado pikeminnow became two of the first species to be guarded by the legislation. The scientists and engineers that formerly worked to eradicate the Green River's endemic fish with poison and a dam were now tasked with the job of protecting the fish.<sup>22</sup> Legal framework for this mission developed throughout the 1970s; landmark laws like the National Environmental Policy Act and the improved Endangered Species Act provided biologists and politicians alike the mandate and tools for studying and protecting aquatic life.<sup>23</sup>

With this new mission, government scientists spent years and millions of dollars dissecting the dam's effects on aquatic habitat. One of the most important lessons to come from this study of Flaming Gorge is the role that discharge regulation has in habitat maintenance. While the average annual flow released from the dam has not differed remarkably from pre-dam average annual flow, the timing of water discharge has been strikingly altered, and this has in turn affected aquatic conditions. After the reservoir finally filled to maximum capacity in 1966, winter water levels were orchestrated to flow much higher than the historic average, while spring freshet floods became nearly nonexistent compared to the inundations that used to sweep through the canyon each June. Reservoir

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<sup>22</sup> Adler 110.

<sup>23</sup> "Humpback Chub," Upper Colorado River Endangered Fish Recovery Program.

discharge was managed to never exceed hydropower production capacity, and so the Green ceased to behave as an undammed river in the American West would.<sup>24</sup> Even small daily changes in water level mimicked peak energy demand hours, not natural patterns. Additionally, the dam effectively trapped the upper Green's sediment load, and the river downstream of the dam responded by downcutting and winnowing its bed.

This all changed on February twenty-seventh, 1980, when the United States Fish and Wildlife Service invoked the Endangered Species Act on behalf of the Colorado pikeminnow, the razorback sucker, and the humpback and bonytail chubs. Only eighteen years earlier, this same ministry intentionally and successfully decimated the populations of these four species. Now, the Fish and Wildlife Service was fighting to alter dam management practices in order to save the few specimens that remained. After a series of negotiations between the Fish and Wildlife Service and the Department of the Interior, the Bureau of Reclamation agreed in 1984 to administer the dam to protect the habitat, spawning, and migration of fish native to the Green River.<sup>25</sup> Dam releases were modified to imitate seasonal patterns in the pre-dam hydrograph.<sup>26</sup> Over the next few years, debates raged between scientists, engineers, and bureaucrats as to whether the altered flows were based on historic hydrographs instead of the fish's true habitat requirements; after all, the fish were costing the dam managers money in the form of lost hydropower.<sup>27</sup> Ultimately, the scientific community's recommendations of an iterative and research-oriented management practice won out, and the Flaming Gorge system became a national experiment in balancing the needs of endangered species with water resource management. Between 1985 and 1992, the Bureau of Reclamation operated the dam to provide critical lower flows during fall and winter and controlled the reservoir level to avoid spills and emergency releases. In 1993, the Bureau began to copy historical floods and released high volumes of water periodically during spring and early summer months. Additionally, the dam was

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<sup>24</sup> Collier et. al 58.

<sup>25</sup> "Environment." Colorado River Water Users Association.

<sup>26</sup> Collier et. al 59.

<sup>27</sup> Adler 134.

retrofitted with intake infrastructure higher up to provide warmer water for minnow spawning. Each experimental alteration was studied, analyzed, and recorded to identify ideal conditions for chub, pikeminnow, and razorback recovery.<sup>28</sup> All results were published and then applied to other similar hydraulic projects. Flaming Gorge, the dam that had once served as the death sentence for native species, became the setting for research that would stimulate endangered species population growth in the Colorado River Storage Project area and other arid rivers across the American West.

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“This evening, as I write, the sun is going down, and the shadows are settling in the canyon. The vermilion gleams and roseate hues, blending with the green and gray tints, are slowly changing to somber brown above, and black shadows are creeping over them below,” wrote Powell on June seventh from inside Flaming Gorge. “And now it is a dark portal to a region of gloom – the gateway through which we are to enter on our voyage of exploration tomorrow. What shall we find?”<sup>29</sup>

*What shall we find?* Powell could not have known that the canyon walls that rose thousands of vertical feet above him would ensnare him for nearly one thousands miles before setting him free. He could not have known that the churning water of the Green River would swallow his supplies and his men. He could not have known the unique beauty that would meet him around every canyon bend. And he could not have known that nearly one hundred years after his historic expedition, the vermilion canyon he christened Flaming Gorge would play host to both “America’s most regrettable environmental mistake” and an astounding scientific journey from ignorance to ignominy to insight. Without Flaming Gorge Dam and rotenone, without fish and floods and fervor, America’s western rivers might still be running flat, over-managed and devoid of life, devoid of the same mystery and majesty that propelled Powell down a river unknown in 1869.

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<sup>28</sup> Bureau of Reclamation, *Operation of Flaming Gorge Dam Draft Environmental Impact Statement*, S-5.

<sup>29</sup> Powell 15.

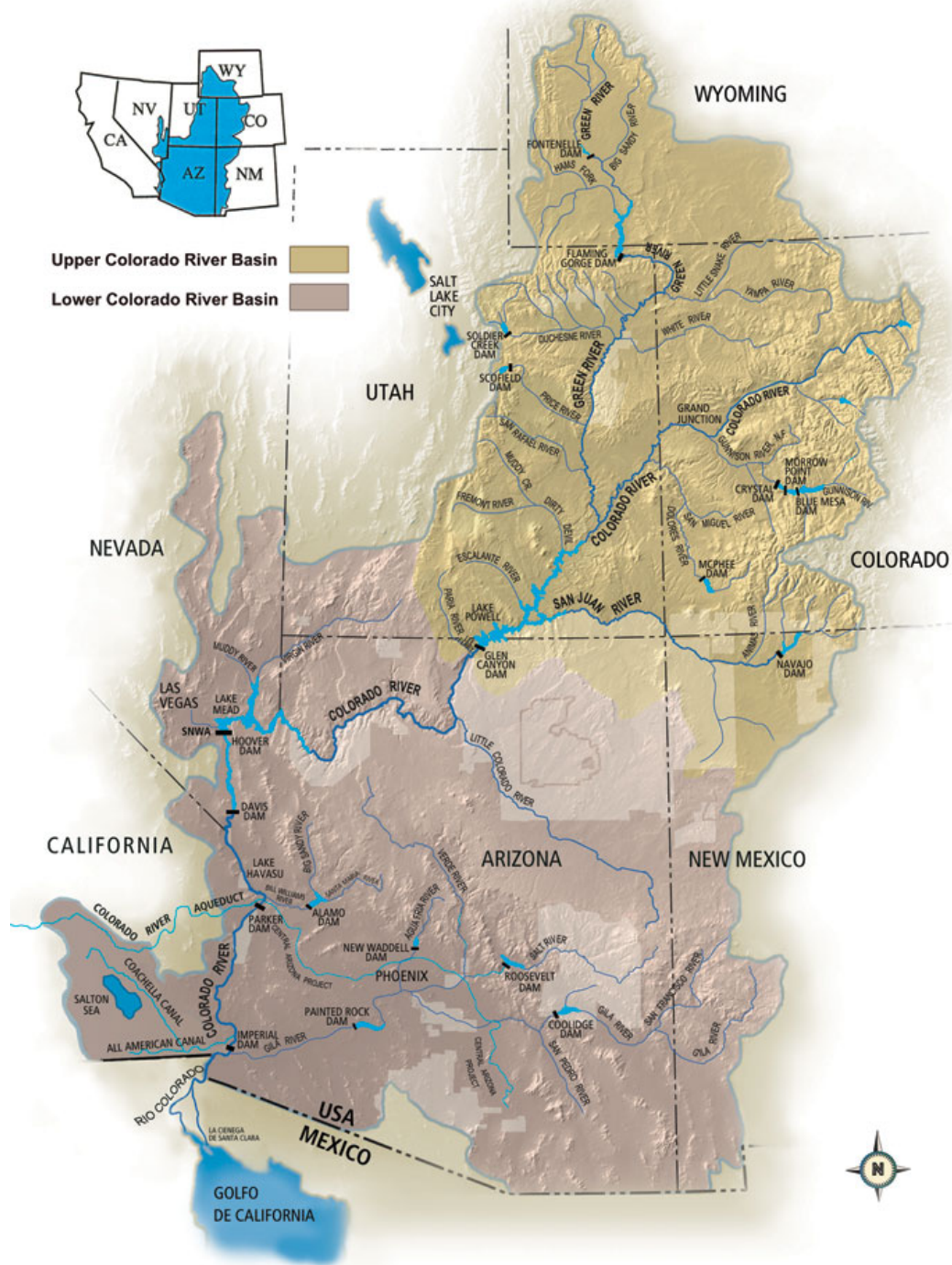


Figure 1: the Colorado River as divided into upper basin and lower basin.<sup>30</sup>

<sup>30</sup> "Map 1: The Colorado River," National Park Service.

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