

Hidden Passage

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Cover: Scientists taking part in GCI's BioBlitz make an observation of returning plant life in 50-Mile Canyon. Photo by Brendan Ladd.

Lake Powell: A One-Trick Pony

by Rich Ingebretsen

Right now, discussions are taking place among Western water managers as to how to better manage Colorado River water. For anyone who follows water policy in the West, this is not a big surprise. The current system of water management is collapsing in front of their eyes. Proposals that once seemed crazy are now on the table.

One of these proposals—considered a Don Quixote, “tilting at windmills” idea even a decade ago—is now a real possibility. The idea is simple: take Lake Powell water and transfer it to Lake Mead where less water will seep into the banks. That is, fill Mead first and use Lake Powell if needed.

Recent studies that the Glen Canyon Institute participated in show that storing water in Lake Mead rather than in Lake Powell could yield significant water savings. While more water likely evaporates from Lake Mead because of its higher temperatures, there is a lot more water seeping into the banks at Lake Powell. Lake Mead is mostly hard rock whereas Lake Powell is porous sandstone, which allows water to trickle through into underground aquifers, never to be recovered.

In water year 2019, we saw one of the snowiest winters of the past decade. But despite this, Lake Powell sits at a mere 53 percent full. In fact, the total water stored between Powell and Mead recently dipped to a record low of 45 percent—the lowest amount of water in the two reservoirs since water started backing up behind Glen Canyon Dam in 1963. In the past, big water years could be counted on to offset the drought years. However, that effectively ended at the turn of the millennium. The climate is warmer and drier, and the atmosphere is thirsty. This “aridification” means that large seasonal snowpacks don’t equate to equally large runoffs

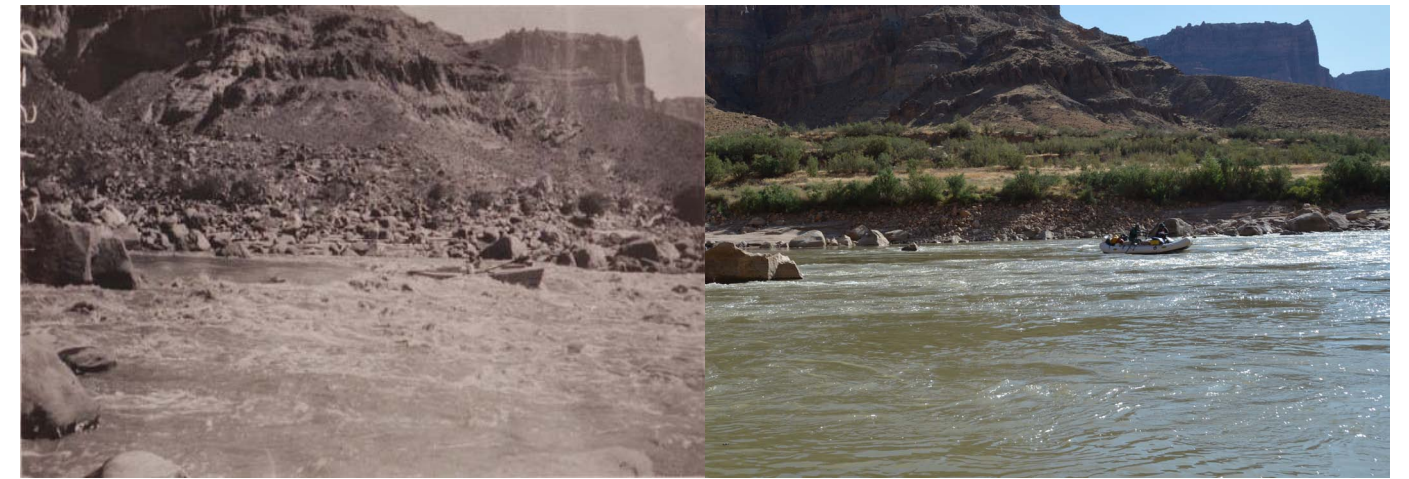
The overall snowpack from last year’s big winter in the Colorado River Basin amounted to about 130 percent of the long-term median, but the total runoff into Lake Powell was only 120 percent of average. This is a prime example of how compounding the “aridification” phenomenon with overall warming is resulting in reduced runoffs. It’s easy to see why scientists predict Lake Powell will never be full again. As Colorado River District engineers said, “It will take as many as 13 water years exactly like this one to erase the impacts of long-term drought in the West.” Lake Powell is the proverbial “one trick pony.”

Levels at Lake Powell and Lake Mead are dropping. Glen Canyon, the biological heart of the Colorado Plateau, has already begun to re-emerge from the water and restore itself. In Cataract Canyon, the river has washed out vast amounts of sediment, erased the bathtub ring, and restored 14 large rapids once drowned under Lake Powell. In the side canyons of the Escalante River, floods have brought the waterfalls, redbuds, and alcoves back to their original splendor. Nearly 35 miles of the mainstem, 20 miles of the San Juan, and 15 miles of the Escalante are free again. And the day nears when the reservoir level will fall so low that the dam’s generators will have to be able to be turned off. At that point, the last major argument to keep water behind the dam will, like millions of acre-feet of water behind it, evaporate.

Governments manage and make decisions in crisis. We are in one now. Currently the river is being managed under an interim agreement signed in 2007. It will expire in about 6 years, so water managers are beginning discussions on a new one. It’s time for the Basin States and Bureau of Reclamation to study Fill Mead First. In the 1950s, when decisions were first being made to build huge dams, there was not a strong voice to protect the environment, but there is one now. Let us be loud and strong, and let us be clear—Glen Canyon must be restored.

The Returning Rapids of Cataract Canyon

by Peter Lefebvre



The reemergence of a rapid at mile 196.8 in Cataract Canyon. The photo on the left shows Ellsworth Kolb running the rapid during the Birdseye Survey in 1921, at elevation 3,622’ above sea level (asl). The photo on the right shows a river runner in the exact same spot in October, 2019. Spanning nearly a century, this photo match showcases a rapid once inundated by 80 feet of reservoir water, only to resurface and begin returning to its natural state. Left photo courtesy of USGS Archives, right photo courtesy of Peter Lefebvre.

When people ask me what my favorite thing about Cataract Canyon is, I ponder: Is it the scenery, the rapids, a favorite camp? What I have come to realize is that every time I go down Cataract Canyon, I am excited to see what changes have happened since I was there last. Cataract Canyon is an unfinished sculpture that is being shaped in front of our very eyes.

All rivers change at a geologic rate that is only visible to the most patient observer. They carve through their respective canyons, rocks fall, and things change, but geologic time is hard for us to comprehend. A human life span is only the blink of an eye in the life span of a river and the canyon it carves. The magic of lower Cataract Canyon is that the river is carving through sediment deposits caused by Lake Powell, and the original canyon is re-emerging in “real time.”

Lake Powell first filled in 1980, almost topped over the dam in 1983, and remained mostly full into the late 1990s. When the reservoir was full, it backed up into Cataract Canyon all the way to Rapid #24, just below the Big Drops. The river flowed into the reservoir causing all its sediments to settle out and cover the downstream half of Cataract Canyon’s 45-mile stretch. In the drought years of the early 2000s the reservoir began to recede. During these years the river flowed through its own deposited sediments, which we have begun to refer to as the “Dominy Formation” after Floyd Dominy. As the river carves through its own delta, it reveals the original character of the riverbed, and the rapids of lower Cataract Canyon have been returning. Since the early 2000s, we have seen more than six major rapids come back. The rapid at Gypsum Canyon is just now beginning to show.

Our “Returning Rapids Project” is focused on questions regarding when and where other rapids may come back. We have been studying pre-Glen Canyon Dam maps, photos, and guidebooks. Using repeat photography, we are trying to see what has been buried and tell the story of Cataract’s re-emergence. Each returning rapid seems to start with one rock sticking up out of the river and slowly turns into another big rapid within a few years’ time. Each year after spring runoff we notice fresh beaches where there was mud or Dominy Formation the year before.

There is an acute paradox to our project. As the reservoir re-levels unearthing a historic feature, another may be buried downstream under more than just impounded water. Every slumped block of Dominy Formation that is swept away by the current doesn’t just disappear. It is transported downstream and deposited somewhere else—still trapped behind Glen Canyon Dam.

As these changes are happening, we are out there trying to document them. We are working to collect more pictures from the time period when the reservoir was filling, 1960s, to now. Pictures from recent history help us illustrate the canyon’s continued return. In the spring of 2019, we printed a first round of field binders to share our material with river runners and guides. We will be printing another round of field binders in the spring of 2020, full of repeat photography, historic photos, and updates on what is re-emerging. Also in the works is a website of time lapse videos and information that we can update as conditions change. This is an ongoing project of patience. We are excited to see where it goes!



Two photos taken just above the same riffle from the photos in the previous page. The left is from 2015 and the right is from 2019. The change is subtle, but notice the rocks sticking out of the water and along the right shore in the 2019 shot that are covered in the 2015 shot. The river is reclaiming itself. Photos: Peter Lefebvre.



Two aerial views of Gypsum Rapid: the left from 2011, when it was submerged from a record runoff, and the right from 2019 when the reservoir was at elevation 3,620' asl. Gypsum is the lowest of the six major rapids that are beginning to emerge as Lake Powell retreats. Notice the rock outcropping on river left in the 2019 photo, and the small riffles beginning to emerge in the adjacent main channel. Photos: Peter Lefebvre.



Here is a match of the "Howling Coyote" rock just above Clearwater Canyon. It gives an idea of how much is under water and mud. The historic photo on the left is by Raymond Cogswell, 1909. The phot match on the right is from May of 2014, by Peter Lefebvre.



A photo match of Clearwater Canyon. On the left, a group of dories stops for lunch in 1983, when the reservoir was at its highest. On the right, the Emerging Rapids crew recreates the photo, leaving their boats at the river. Left photo: Tim Cooper, right photo: Peter Lefebvre.

The Next Era of Colorado River Policy: Contingency Plans and New Guidelines

by Eric Balken and David Wegner

It's no secret that management of the Colorado River has faced a kind of existential crisis over the past decade. The ever-present forces of over-allocation, recognition of a structural deficit in the Lower Basin, a warming and more variable climate, reduced snowpack and diminished runoff have rattled the foundational assumptions of Colorado River policy. Scientists and almost everyone else agree that systemic changes driven by reduced supply and increasing demand are coming, but how, when, and which stakeholders will be most affected remains to be seen. The seven Colorado River Basin states are individually and collectively assessing impacts and options for future water management.

In water year 2018, we came closer than ever to crossing the thresholds that delineate a theoretical crisis from a “real” crisis of actual reduced water deliveries. The thresholds are the elevation levels of Lake Mead at which an official shortage is declared in the Upper and Lower basins. Shortage by definition is the inability of the states to meet 1922 Compact requirements. There are also requirements under the 1944 Treaty with Mexico with a directive to avoid shortage and the economic and legal ramifications that would come with it.

In Spring 2019, Lake Powell came within 45 feet of its official drought tier of 3,525 feet above sea level (fsl), while Lake Mead skirted its official shortage level of 1,075 fsl by just a few feet. The total amount of water stored between the two reservoirs dropped to their lowest level since Powell began filling in the 1960's.

The current drought in the Colorado River system began in the early 2000s and has continued for the last 18 years. In 2007, when faced with the increased probability that water delivery requirements needed to satisfy the 1922 Compact may be compromised, the seven Basin states, under direction from the Department of the Interior, developed the 2007 Interim Guidelines that established a process for managing a drought-driven Colorado River. The 2007 Interim Guidelines were designed to serve as a framework and path for dialogue with a life span of 20 years. Starting in 2018, with increasing drought shortages weighing on policy makers, the Basin States and Mexico decided that they had to take more immediate steps to avoid a shortage declaration. As a result, they drafted a Drought Contingency Plan (DCP) to address how they will adapt to life with less water.

The Drought Contingency Plan, with separate agreements created for the Upper and Lower Basins, was passed by Congress and signed into law by the President on May 20th. The finalization of these plans was hailed as a great success by lawmakers across the country. However it's important to remember that the Drought Contingency Plan is only a temporary agreement intended to bridge the gap between today and

the next iteration of Interim Guidelines, which begin in 2026. These DCPs only pull the states into an agreement where they can comply with the 2007 Interim Guidelines—a management protocol that was meant to hold the states over during the “interim” of the drought.

We now know that the supply and demand imbalance on the river isn't a short-term drought, but a long-term systemic shortage that will require a significant management overhaul. The negotiations for the next phase of Colorado River management, which officially begin in 2020, will be long, tough, and by necessity, need to accept that past assumptions on water supply and state depletions will need to be addressed in a more definitive and data-based manner.

What's in the Drought Contingency Plans?

Lower Basin

The DCPs for both the Upper and Lower Basin call for reduced consumption of water, with the Lower Basin Plan being much more immediate. The Lower Basin states of California, Arizona, and Nevada will now be required to reduce their consumption of water out of Lake Mead sooner than anticipated in the 2007 Interim Guidelines. To the Lower Basin states, Lake Mead is the beating heart of the Colorado River delivery system and is the primary source of water needed to meet delivery requirements established under the 1968 Colorado River Basin Act, Supreme Court decisions, and the 1944 Treaty with Mexico.

Under the rules of the 2007 Interim Guidelines, the Lower Basin states wouldn't see delivery cuts until Lake Mead drops below 1,075' on January 1st, known as “Tier 1”. Under the new DCP agreement, the states curtail deliveries if Lake Mead drops below 1,090', or “Tier 0”, at the first of the year—which the Bureau of Reclamation now predicts will likely happen in 2020. If Mead drops even lower, the states will continue to take deeper cuts. Arizona, based on its junior water status, will absorb the bulk of the cuts. It's worth noting that all of the Lower Basin states and Mexico have proactively volunteered to reduce their consumption of Colorado River water in an effort to prop up Lake Mead. Under the '07 guidelines, California wasn't required to take cuts until Mead dropped to lower elevations. Their willingness to support voluntary reductions shows how seriously Lower Basin states are in avoiding shortage declarations and potential litigation.

While the creation of the Lower Basin DCP reflects a commendable effort of collaboration, the process was anything but clean. In both California and Arizona, there was contentious infighting within state agencies that nearly derailed the whole plan. In Arizona, entities like the Central Arizona Project, the



Glen Canyon Dam. Photo by Mike Sargetakis.

Arizona Department of Water Resources, Salt River Project, and Pinal County farmers went through exhaustive negotiations to decide who would bear the brunt of impending cutbacks. Arizona farmers will be the first to feel the impacts of reduced water deliveries. Initially these surface water cutbacks will be covered by increased groundwater pumping. In California, the Imperial Irrigation District and Metropolitan Water District fought over cutbacks and demands for Federal funds for infrastructure.

Upper Basin

The Upper Basin's Drought Contingency Plan is much less committing, as the Upper Basin states do not use their full allotment under the Law of the River and the 1948 Upper Colorado River Compact. Because of this, the plan has less specific commitments from each state, but rather an overall strategy that could be implemented. The most notable element of this plan is what's known as “extended operations”—a euphemistic way of describing the draining of upstream Colorado River Storage Project (CRSP) reservoirs to save Lake Powell. While this idea has been widely discussed for years, this is the most substantial effort to make it official policy. The two stated reasons for this are to ensure that there is enough water in Lake Powell to be released to meet Compact requirements and to keep the elevations in Lake Powell high enough to allow for the generation of hydropower at Glen Canyon Dam (elevation 3,525').

As for how the states will reduce their consumption in the future, under the umbrella of “demand management,” the plan effectively states that details will be worked out at a future time. The plan also fails to address a glaring contradiction: how are Upper Basin states going to reduce their water use while simultaneously pushing to export more water with projects like the Lake Powell Pipeline, the Moffat Tunnel expansion, and the Fontanelle reservoir expansion? While the states have signed onto this agreement, the stated goal of reducing reliance on the fickle Colorado seems like mere lip service

while massive diversions are still on the table. Clearly the DCP is a work in progress and first of many steps that will be necessary to address future Colorado River water delivery issues.

The Next Interim Guidelines

The DCPs will likely allow the basin states to stay within the management protocols of the 2007 Interim Guidelines and avoid a meltdown before the next round of guidelines is ratified in 2026. But as the name suggests, they are only a temporary stop-gap. The new management guidelines will have to be bold, and incorporate “outside of the box ideas” in respect to the future use and management of the Colorado River.

As members of the Colorado River Research Group stated in a *High Country News* article this summer, “the process should be open and inclusive, given the huge number of competing interests in the region, including municipalities, agriculture, tribes and the environment.” The group of scientists and academics suggest the new management plan should consider outside-of-the-box ideas and “revisit a number of longstanding assumptions.” Historically the Basin States and Federal government have relied on looking at the historic record to define water management decisions. Climate change and the resulting impacts on Basin hydrology are not fitting into that historic dependence and require a forward-looking predictive approach that incorporates the possibility of extreme weather events and a prolonged period of below historic normal flows.

Officially, the renegotiations of the Interim Guidelines won't begin until 2020, but the current discussions of state and Federal policy makers are already laying the groundwork for what's to come. These discussions and the official renegotiations of the 2007 Interim Guidelines will be the strongest opportunity for Fill Mead First and Glen Canyon's restoration to become a pragmatic part of Colorado River policy. All of the research and advocacy that GCI has worked toward for over 20 years has brought us to this point. In the crucial coming years, GCI will continue to fight for Glen Canyon's restoration and ensure Fill Mead First is given the consideration it deserves.

High Flows and History on the San Juan River!

—EB



The GCI San Juan Crew basks in the shallow waters of Oljeto Wash. Photo: TJ Sattelmeier.

With the first heat of the morning sun beginning to wake up the Southern Utah desert, a group of 15 adventurous GCI members gathered at the Mexican Hat boat ramp on the banks of the San Juan River to embark on four-day journey together. Often known for its sandy, warm water and tame summer flows, the river on this day was surging near 10,000 cubic feet per second—a result of record large snowpack in the San Juan Mountains of Colorado. Massive logs, bushes, trees, and the occasional truck tire could be seen careening down the river channel at high speeds.

As the group got acquainted with one another, we picked out our life jackets and piled into the famous white Holiday River Expeditions rafts and swiftly set forth down the river. Our crew was an eclectic mix of supporters from Boston, Park City, the Navajo Nation, California, Colorado, and Arizona. We had several veterans of GCI expeditions, as well as a few newcomers who recently learned about Glen Canyon Institute and our summer trips. Our featured guest of the journey was author and historian Roy Webb, a longtime friend and advisory board member of Glen Canyon Institute.

With the river pumping near its highest flow in several years, it didn't take long for our group to make miles downstream. This left plenty of hours in the day for us to enjoy hikes and have discussions about the unique human and geological his-

stories of the San Juan. Our first hike was to the Mendenhall Cabin, a relic of the brief rush of gold prospectors that tried to make a living mining along the river. Like most of the prospectors of the San Juan and Glen Canyon, Walter Mendenhall's dreams of striking gold along the river ultimately ended in failure—the cabin remains as a testament to the ambitions and harsh realities of life deep in these canyons.

Over gourmet dinners of Dutch oven lasagna and grilled salmon prepared by the Holiday guides, our group shared river stories and tales of how we all came to fall in love with the desert. Roy Webb provided us with a deep history of the early prospectors, explorers, and river runners who began running trips through the San Juan and Glen Canyon in the 1900s. The San Juan holds a special significance for Roy—as a child growing up in Farmington, New Mexico, some of his earliest memories are playing along the banks of the river with his siblings. He regaled us with stories about the early pioneers of commercial river running like Bus Hatch and Norm Nevills. Nevills began running the San Juan River in the 1930s, sharing its beauty with the public until he perished in a nearby plane crash decades later.

Most of our days were spent leisurely floating beneath the towering sandstone walls, having lively conversation and absorbing the beauty of cloudless skies and the constant mur-

mur of moving water. As we passed new river bends, we were greeted by Canada geese and great blue herons coasting above the water, and families of desert bighorn sheep coming down to the river's edge for a drink. The sounds of canyon wrens and other songbirds filled the air, welcoming us as we pulled up to camp.

Since the river was swollen to the brim from massive snow-melt, pulling into camps was sometimes a unique challenge for the guides (and the guests). Some of the beaches and camp trails were completely submerged under the river, and we had to improvise, hauling gear to shore using inflatable kayaks and human "fire lines" through passages in the willows. A hike up Slickhorn Gulch provided a wonderful respite for our group to bath in crystal clear pools, and bask under a waterfall pouring over maidenhair ferns and moss. Nothing compares to the allure of a good desert swimming hole, they seem to bring out the child in everyone. We all splashed and laughed in the pool, forgetting all of our wordly problems and letting the hours pass by.

One of GCI's members on the trip lives and was born on the Navajo Nation, not far from where we were floating. We were lucky enough to hear her stories about how her family grew up on the land nearby, and to learn about the Navajo's relationship to the land and water. She taught us about the native plants, some of which are used by Navajo people for food and medicine. The morning we put onto the river above Government Rapid, the only real whitewater of note on the San Juan, she passed around corn pollen for everyone to sprinkle into the river and lead a prayer for the group to have safe passage (we made it through flawlessly).

As we floated toward our take-out at Clay Hills, the sandstone walls began to resemble the curvy mysterious sandstone that epitomizes Glen Canyon. Now below Lake Powell's high water line, we were able to take in the miracle of the flowing river that was once inundated by the reservoir. Many in our group have been a part of the movement to restore Glen Canyon for more than a decade, and after spending a few days learning about the natural and human history of this place and discussing about the work being done to restore it, it seemed fitting that we all got to relish in the beauty of its reemergence together.



Above: Roy Webb regales the group with tales of the San Juan's early river runners. Left: The group meanders down the river. Left Below: Spring wildflowers greeted us at every camp. Photo: Dan Quigley.

Mega Floods on the Colorado: a Potential Catastrophe

—Jack Stauss

Nowadays, the story of the Colorado River is one of drought and shortage. Climate change, overuse, over-allocation have stretched the once-wild river so that it no longer reaches the ocean. But what does paleo history tell us about the hydrology of the river? In recent years Dr. Victor Baker and his colleagues at the University of Arizona have been studying a phenomenon on the river that has traditionally been overlooked or underestimated: the magnitude and frequency of massive “black swan” flood events—something that may become more likely with erratic weather events associated with climate change.

Dr. Baker and his team have been calculating the size and dates of floods that occurred well before streamflow gages were installed. The study of mega floods or “paleofloods” combines geological and hydrological approaches, and uses modern technological advances in geochronology and hydraulic flow modeling to estimate their magnitude. When rivers flood, they deposit a large amount of sediment in a short amount of time. Certain geographic formations, like Axehandle Alcove below Lees Ferry, offer the perfect location to preserve a stratigraphic record of the sediment deposited in eddies near their high water lines. The elevation and location of these layers allow scientists to estimate the flood’s volume. Then they use geochronology and radiocarbon dating of plant matter and animal fecal matter to estimate the date of the flood.

Some of the largest observed floods on the Colorado River in the last 150 years include a peak flow of 170,000 cubic feet per second (cfs) in 1921 and an estimated peak flow of 210,000 cfs in 1884. The 1884 flood volume was estimated based on an account of a Lees Ferry resident who rescued his cat from an apple tree during its peak. He recalled “the height of the water on the trunk of the tree... well impressed on his mind.” The new paleo hydrology studies show that in the last 500 years there have at least two floods exceeding 300,000 cfs, and one

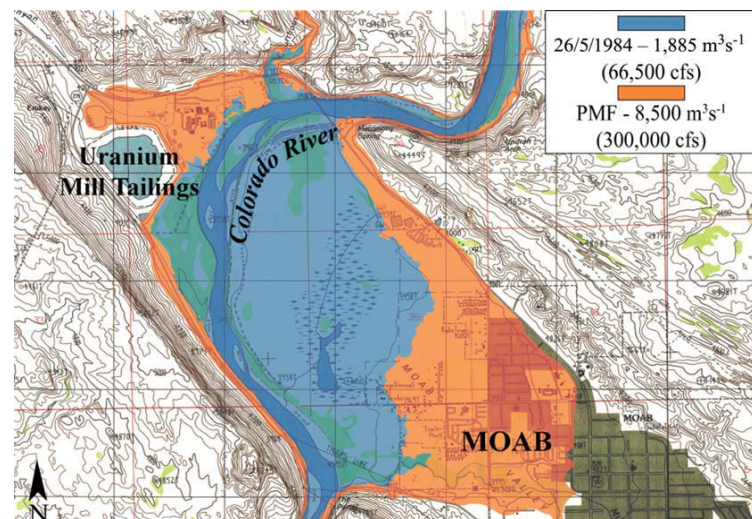
flood of over 500,000 cfs in the last 1400 years.

Compare those to the great flood year of the modern era, 1983, which peaked at around 120,000 cfs. Relative to historic mega floods, 1983 was a small event—yet it caught water managers off guard and nearly brought down Glen Canyon Dam.

What made that year so scary for water managers? The expected runoff and miscalculation of available capacity at Lake Powell to absorb it. The winter of ’83 was massive, went late into the spring, and then the snowpack melted off at an extremely fast rate. Bureau of Reclamation workers famously put up plywood barriers (later reinforced by steel) to prevent water from overtopping the dam.

When Lake Powell is full or even partially full, one of these historically large runoffs can evolve into an outright catastrophe. What we learned from 1983 is that when the Colorado swells to over 120,000 cfs under “normal” operations, there is potential for the dam to fail. Reservoir operators learned many lessons from that event, and have since exercised greater caution in managing flood years. But as long as Lake Powell is even partially full, the hazard of overtopping the dam exists. If that were to happen, a mass of water to the tune of 25 million acre-feet would erupt through Grand Canyon and into Lake Mead, and onward to the populations living downstream.

What Dr. Baker and his colleagues have learned from studying the historical floods of the river is that “what has happened before, can happen again”. Under GCI’s Fill Mead First proposal, Lake Mead would be the primary storage reservoir for the system and Lake Powell would remain empty—only to be used as a backup. Should we experience an extreme flood event like the catastrophic mega flood in our lifetime, having an empty Lake Powell would serve as the ultimate hedge against disaster.



Inundation maps of the Moab Valley for the measured 26 May 1984 flood—1885 m³s⁻¹ (66,500 cfs) and for the estimated Probable Maximum Flood (PMF)—8500 m³s⁻¹ (300,000 cfs) [Kenney, 2004; Weisheit and Fields, 2006].

GCI Presents FMF to Colorado River Leaders

—EB



Eric Balken speaks at the CU Boulder College of Law. Photo: John Bergrend.

In June, GCI gave a presentation on the Fill Mead First (FMF) proposal at the 40th annual Getches-Wilkinson Center Summer Conference in Boulder—one of the foremost gatherings of Colorado River decision makers. The theme of the conference was “Charting a Better Course for the Colorado River: Identifying the Data and Concepts to Shape the Interim Guidelines Renegotiation.” Presenting at this conference was a milestone for GCI, as the forum is the highest-profile venue in which FMF has been heard by leading policy makers. For 30 minutes, every decision maker on the Colorado River listened to the argument for filling Lake Mead and restoring Glen Canyon.

For a long time, FMF was deemed a crazy idea by many Colorado River policy leaders. But after years of facilitating research to vet the concept, building media attention around it, and working to educate and inform the public, FMF is now being researched by leading scientists and is being discussed as a legitimate policy alternative. At the conference, Kevin Wheeler, a water resource scientist from Oxford University, presented some of his modelling on “alternative concepts” like a demand cap for the Upper Basin, Fill Mead First, and Fill Powell First. An important takeaway from his talk was that a Fill Powell First scenario would be a major safety hazard, because it would increase the likelihood of spring floods overwhelming the reservoir.

Dr. Wheeler’s research is part of the Future of the Colorado project, a consortium of researchers and policy leaders working to explore alternative management options on the Colorado River. GCI serves as an advisory to this group, which is currently working on modelling FMF Phase I (Lake Powell near power pool), using state-of-the-science techniques incorporating the CRSS software used by Bureau of Reclamation.

Under FMF and a full phasing-out of Lake Powell, there would be three distinctive phases as the reservoir drops to river level. The characteristics of these phases are predicated by the ability to move water through the dam at different elevations.

Phase I

- Lake Powell is at or near minimum power pool, elevation approximately 3,490’ asl
- Some hydropower generation remains
- Recreation in Grand Canyon largely stays the same
- ~100 miles of restored river in Glen Canyon (Colorado, San Juan, Escalante, and Dirty Devil)
- 175 sq. miles of newly-emerged land in Glen Canyon

Phase II

- Lake Powell is below power pool and above dead pool, between elevations 3,490’ – 3,374’ asl
- No hydropower generation
- Flows in Grand Canyon limited to a maximum of 15,000 cfs
- ~150 newly flowing river miles combined
- 222 sq. miles of newly-emerged land in Glen Canyon

Phase III

- River runs freely through Glen Canyon Dam
- Requires construction of new bypass tunnels
- Maximum restoration opportunity of Glen Canyon and Grand Canyon
- Grand Canyon recreation resembles pre-dam conditions
- All 254 sq. miles of Glen Canyon emerge
- Newly-flowing river miles:
 - Colorado River: 186 Miles
 - San Juan: 71 miles
 - Escalante: 22 Miles
 - Dirty Devil: 13 Miles

Water shortage has already brought Lake Powell near Phase I territory, and modelling is being done to develop a deeper understanding of it in practice. Phase II is problematic for several reasons, the most significant being the limited flows from the river outlet works and resulting impact on Grand Canyon.

The main focus of GCI’s talk was the need to begin studying FMF Phase III: fully phasing out Lake Powell. We included a cost estimate for drilling new bypass tunnels, the possibility of generating hydropower in those tunnels, feasibility under the Law of the River, potential water savings, protection against mega floods, recreation, and implementing FMF as a form of intentionally created surplus (ICS).

FMF has now entered the mainstream dialogue of Colorado River policy. Our work will become ever more important as decision makers of the Basin negotiate the next round of interim guidelines beginning in 2020. These talks will be a crucial opportunity to make FMF a reality and see Glen Canyon’s restoration.

Glen Canyon BioBlitz: A First Study of a Returning Ecosystem

—EB



Blake Wellard getting acquainted with the maidenhair fern reestablishing in the subway section of 50-Mile canyon, once drowned 50 feet under Lake Powell. Photo: Eric Balken.

In May 2019, GCI teamed up with Wild Utah Project, the National Park Service, and 15 scientists from around Utah for the first ever Glen Canyon BioBlitz: a weekend-long event aiming to find as many species as possible in our area of interest, 50-Mile Canyon. The aim of BioBlitz events is for expert and citizen scientists to collect, identify, and count as many species as possible, while also building interest and public involvement in the effort. Below the high water mark of Glen Canyon, there has been no organized prior ecological research focusing on Glen Canyon's recovery, so it was a novel experience for everyone involved.

Accompanied by a reporter from KSL News, our team was made up of GCI and WUP staff, volunteers and expert scientists from a variety of backgrounds. We had botanists, entomologists, a team of National Park Service bat and bird biologists, a bee specialist, a lichen specialist, and a fish biologist. We hiked into 50-Mile Canyon to observe and collect specimens above and below Lake Powell's high water mark, with the goal of collecting data on the recovering ecosystems that were once submerged under Lake Powell. This collaborative research effort amounts to the first biological survey of Glen Canyon's recovery.

The first day of the BioBlitz was an "upland" survey, focusing on the species above the high water mark occupying the slopes and tiers leading into the canyon, as well as the deeper riparian sections further down. The goal of this day was to get a sense

of what the "undisturbed" ecosystem might look like compared to the once-submerged canyons further down.

On the second day, we made a further push into the twisting red rock canyon to collect data and specimens below the high water mark, observing similarities and differences between the two places. We were excited to scientifically observe what had so far only been documented anecdotally: many plants, insects, soil crusts, and lichen are coming back to life below Lake Powell's high water mark.

Fully understanding the process and scope of ecological succession in Glen Canyon will require years of research, but this is an important first step. This lead effort was a great chance to bring together an all-star group of scientists, and begin building the data and public interest in Glen Canyon's ongoing ecological recovery.

Along with catching specimens in bug nets, the insect specialists set traps and found many different species of bees, beetles, crickets, caterpillars, and more. The bats were a little trickier for our group to observe, likely because of a windy weekend. As for larger vertebrates, we saw a multitude of birds, lizards, frogs, evidence of beavers, and even a baby rattlesnake.

For more information on the data gathered from this research effort, please visit www.glencanyon.org. GCI aims to build on this initial research effort and expand interest in studying Glen Canyon's recovery. Stay tuned for more information about future research efforts to follow up the BioBlitz!

The Botanical Recovery of 50-Mile Canyon

—Kendra Babitz, MPP, Policy Coordinator and Blake Wellard, MS, Botanical Consultant

The botanical experience on the Glen Canyon Bioblitz was enlightening and thrilling, between compiling a dream team of scientists to bounce ideas across, and a fascinating area to explore that has changed so much in a short amount of time. Botany in the canyon above the high water mark was in excellent condition considering that some of the areas above the canyons still showed evidence of recovery from early grazing. The climax communities above the high waterline were well established with abundance of oak, indigo bush, sage brush, rabbit brush, and netleaf hackberry, and the ecosystem was well balanced with species diversity and dispersion. The deeper into the canyon we descended, the better the botany and ecosystems appeared with fewer and fewer weeds that came along with more difficult terrain for grazing animals to access.

The botany did not change starkly until we descended below the high water mark. The most glaring contrast was the disappearance of almost all of the shrub and tree species that were so prevalent in defining the ecosystem just 20 meters higher in the canyon. These community species were replaced by invasive species like cheat grass and tamarisk. Even 25 years after the Lake Powell water line receded, very few community-level plants had returned, most likely due to resource competition. However, roughly 20 native species were observed. Those were species with higher reproduction rates and broader ranges of habitat adaptation. Plants like desert trumpet and James' galleta grass were making their way back into establishment in the ecosystem.

Why were key community-level plants not getting established like indigo bush, netleaf hackberry, and oak, even after so many years? One idea is that there simply was not room in a plant community that was dominated by tamarisk and other invasive species immediately following the drop in lake level. This drastically limited the number of native plants, soil microbiome species, and biocrust species like lichen and moss that could get established. Native plants seeds continue to land in the space formerly occupied by the lake and some get established year after year but with an established invasive plant community, reestablishment of a community resembling the rest of the canyon has been slowed. Yet, many native plants have become established and some of these species include: globemallow, wirelettuce, scorpion weed, sacred datura, four wing salt bush, matted crinkle mat, wooly plantain, Jones' blue star, woody aster, desert trumpet, milkvetch, sticky brittle bush, purple three awn, common pepperweed, threadleaf sunflower, Indian rice grass, sand sage, and prickly pear cactus. The bright side to this is that these plants are the beginnings of desert ecosystem restoration.

Another exciting find was the establishment of native plants in many of the wet areas of the canyon bottoms and seepy cliffs

such as stream orchid, which was very well established below high waterline. Stream orchid requires very specific ecosystem requirements for it to exist and thrive, much of which concern mycorrhizal fungi. Mycorrhizal fungi are needed to promote seed germination and subsequent development of seedlings. As a result, the availability of suitable mycorrhizal fungi and the level of specialization between orchids and mycorrhizal fungi can have broad implications for the distribution and fitness of future orchid populations. With our understanding of the base level of the ecosystem in Glen Canyon, the soil microbiome is intact enough to host a species like an orchid. Maiden hair fern is another exciting wind dispersed pioneer species. When both these species are present, it shows the beginnings of a healthy canyon seep community.

However, our observations were limited to one canyon of data collection above and below the high water mark. It would be helpful to hike down additional borderline canyons surrounding Lake Powell to gather data above and beneath the high water mark to see if this example holds true for other areas in Glen Canyon.



Above: Ron Cass & Paul Dawson cataloguing plant specimens. Below: The team cataloguing the first insect of the trip heading into 50-Mile Canyon Photos: Eric Balken.



A beam of light illuminates the waterfall of Cathedral in the Desert—March, 2019. Photo: Eric Balken.

Over the last years of sustained water shortage, we at GCI have been waiting for an important threshold. When Lake Powell drops to elevation 3,605', we know that Cathedral in the Desert begins to reemerge from under the high-water mark. At 3,580', the waterfall itself is flowing. And, we hope, at 3,575', the "new floor" is out to the point where we can stand in and appreciate the grandeur of the chamber. We saw these important elevations present themselves after a historically dry 2018, and before the runoff of 2019 began, we saw our chance.

I had not been to the reservoir in many years, and had not spent any time out on the water. I have been in the canyons of the Escalante Arm, and down the San Juan River. So, as close to the classic Glen Canyon as one can get these days. I had heard stories of the reservoir. People spoke of the eerie juxtaposition of still water, stone, and sky. The lifelessness of the barren landscape. The houseboat culture. The sport fishers. And of course, I had heard of the smell in the backwaters. Rotting plants in still water. I tried to push all of those aside,

and to keep an open mind about a place that I had yet to experience.

At Bullfrog Marina we wandered around in the wasteland that was once a tributary creekside, then reservoir, now it was a half bulldozed mud pit. Channels and roads were left partially complete, loaders and machines were parked haphazardly waiting for their operators to retrieve them, or for the water to come up and drown them. We walked around the machines through the sediment banks to the edge of the reservoir. Quagga mussels coated the calcium-caked sandstone. We chatted about the river, sipped beers, and watch the sun slip down behind the horizon.

The next morning our team, consisting of myself, Eric (GCI's ED), Mike (GCI Board member), and three longtime GCI members/co-conspirators climbed onto a rented pontoon boat and zoomed downstream.

Once we were out of the marina and on to the main stem of what was once the Colorado River, I watched the red rock walls

rise and fall against the sky. I looked for the usual signs of life in the desert. Birds, plants, insects. Besides the high shadow of vultures, I saw none. The stained red walls gave a story of the fluctuating water. Near the edge of the reservoir, bone white calcite-stained rock reminded us of how recently the water was higher. Up the wall, the white turned to brown, and ultimately back to red. The high water mark—a hundred feet up the wall—was visible, but only barely. Black streaks on the sandstone showed through from water that had slowly bled down the walls, washing away the reservoir's stain.

We snaked around bends in the reservoir and I imagined how it must have looked and felt as a river. Wide and powerful, carving through these ancient rocks. Beaches, birds, green life. Now there was none of that. A snake-shaped lake. For the first time in my work with Glen Canyon, I felt the sorrow that I had heard from the river runners that knew the canyon before it was drowned.

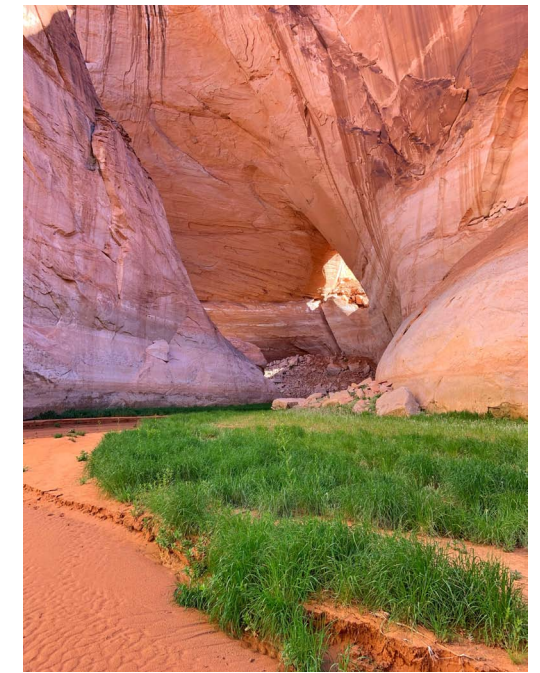
After a couple hours listening to the drone of the engine, we turned toward the eastern wall, and a small white buoy told us we had reached the Escalante River mouth. While I think of the Escalante as a shallow but mighty desert creek, here we were into more lake. In the Escalante Arm, the walls started to close in, and islands of stone that were once amazing formations poked up out of the water. Once again, the high water mark showed us that if we had come a few years prior, we might not have seen these at all.

One of the first canyons that breaks off from the Escalante is Clear Creek. We found this with little trouble, and almost immediately were in a different world. The open stillness of the reservoir was gone, the canyon walls bent in around us, casting long shadows with the feeling that we had entered a cave. The towering chamber seemed to dead-end in front of us, but it was just a tight turn. We killed the motor and drifted quietly around the bend. What lay ahead hushed all of us on board.

The sun shone bright and powerful through a small notch in the middle of a giant chamber. From where the sun hit, a 30-foot waterfall trickled down into a perfectly clear pool. The light refracted off the water, and bounced around the massive chamber. The walls, and circular ceiling were all different neon shades of orange, red, yellow, and gold. The floor was the first sandy beach we had seen since we left Bullfrog. The sandy mound had plenty of space for us to all spread out and take in the beauty of Cathedral in the Desert. Frank, one of our members on the trip, said it was the best conditions he had ever seen the feature in, and he goes anytime the waterfall is out of the reservoir.

Like the height of the water, my happiness rose and fell. It was amazing to witness Cathedral in the Desert like this. To hear the water cascading down. To have the sun perfectly placed to shine through into the room. To know this feature had inspired so many before me. But there was a lot of snow in the Rockies. We knew that that this summer, Cathedral would be drowned again. Waiting for another dry spell. Or waiting to emerge permanently.

That night we camped in the Escalante Arm on the reservoir. The stories I had heard of the res were mostly all confirmed.

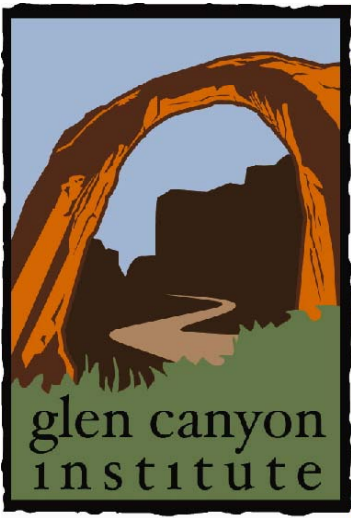


Meadows of grass return to the creekbed in Davis Gulch . Photo: EB.

The water had a ripe smell to it, and the slimy green color was not inviting to swim or wade in. Quagga mussels lined every inch of the little rocky beach we camped on. Between the broken glass, old fire pits, and the mussels it was hard to find a place to pitch my tent. But, we made the best of the evening and ate a big meal. A night out in the wild is better than a night in the city, even when camping in a place with such a sordid history.

In the morning, we had another canyon we wanted to explore. Davis Gulch was just a few miles upstream and is another great place to observe restoration. The first mile of the canyon was still very much affected from the fluctuation of the reservoir. The floor is muddy sediment. The water flowing down from the upper canyon only has time to make shallow braided paths before the runoff buries it again. But even there, plants are starting to shoot up. After that first mile, it was astonishing to see what had come back. First, small grasses and riparian plants. Then further up, a greater abundance and diversity of reeds, willows, and baby cottonwoods started to grow. We walked past iconic geologic features that had once been partially or fully submerged like Le Gorce Arch and a sublime waterfall that trickled into an emerald pool. I was awestruck in both the beauty of the place, as well as the idea that at one time people thought it made sense to drown it.

After we cleaned up a couple bags of trash from the canyon, we boarded our boat and began the long ride back to Bullfrog. This time, while I lay listening to the motor and watching the sky, I thought of the canyons. People often ask me about them, what are the canyons like now? What is happening to these features that Katie Lee, Ken Sleight, and David Brower were so enamored by? And we know now, that when given the chance, these places not only come back from under the river, they are still beautiful and worth protecting for future generations.



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"This is a landscape that has not been explored very much. There's just lots to learn here. It's a wonderfully complicated environment."

—Dr. Larry Stevens, Curator of Ecology, Museum of Northern Arizona

GCI's BioBlitz team makes its way down 50-Mile Canyon. Photo: Carston Oliver.

