

*Chapter 4*

# COLORADO RIVER



*Key issues facing the Colorado River*

- 4.A DECISIONS THAT LIE AHEAD FOR THE COLORADO RIVER**
- 4.B CAN WE RELY ON DROUGHT-BUSTING “MIRACLES” IN THE COLORADO RIVER BASIN?**
- 4.C IRRIGATION OPTIMIZATION AND AGRICULTURE’S FUTURE IN THE COLORADO RIVER BASIN**
- 4.D DROUGHT AND WATER ACCESS HEAVILY IMPACT TRIBAL ECONOMIES**
- 4.E THE FUTURE OF OUTDOOR RECREATION ON THE COLORADO RIVER**
- 4.F MANAGING LAKE POWELL’S WATER LEVEL REQUIRES CONSTANT ATTENTION**

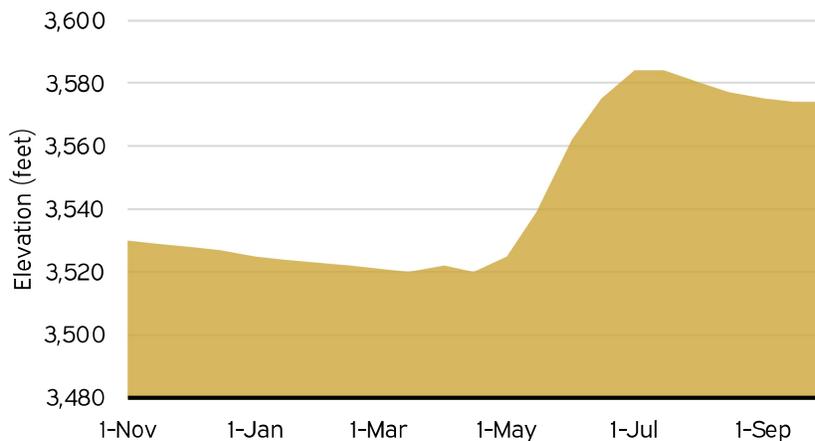
Chapter Summary by BRIAN STEED

The Colorado River system, a vitally important source of water to Utah and six other Southwestern states, is facing very real challenges. A big water year has helped the system avoid crisis in the short term. Lake Mead, Lake Powell, and Flaming Gorge all gained much-needed water this year. Inflows raised Lake Powell an amazing 65 feet. This gain in water was sufficient to allow access to boat ramps that had been inaccessible for several years.

Yet, major decisions remain in how the river system is to be managed. Even with the gain in elevation, Lake Powell remains at below 40% of capacity. Making matters more complicated, experts generally concede that the system is oversubscribed, creating uncertainty about how much water Utah can reliably count on receiving. The largest challenge to overcome is hydrology and the imbalance between supply and demand. The flows of the river are different than what was expected when the Colorado River Compact was negotiated between the states over 100 years ago.

Given this set of facts, the basin states have a number of decisions to make in the runup to 2026, when the current management plan for the river is set to expire. The states must agree on how much water to store and where. More problematically, the states must decide on how much and where water will be used. All of these questions require data and understanding. In the remaining sections in this section, we examine some of the ongoing work to understand the river, its importance, and its future.

Figure 4.I.1 Lake Powell elevation (Nov. 2022–Oct. 2023)



Source: Lake Powell Water Database





**WATER**

by JACK SCHMIDT

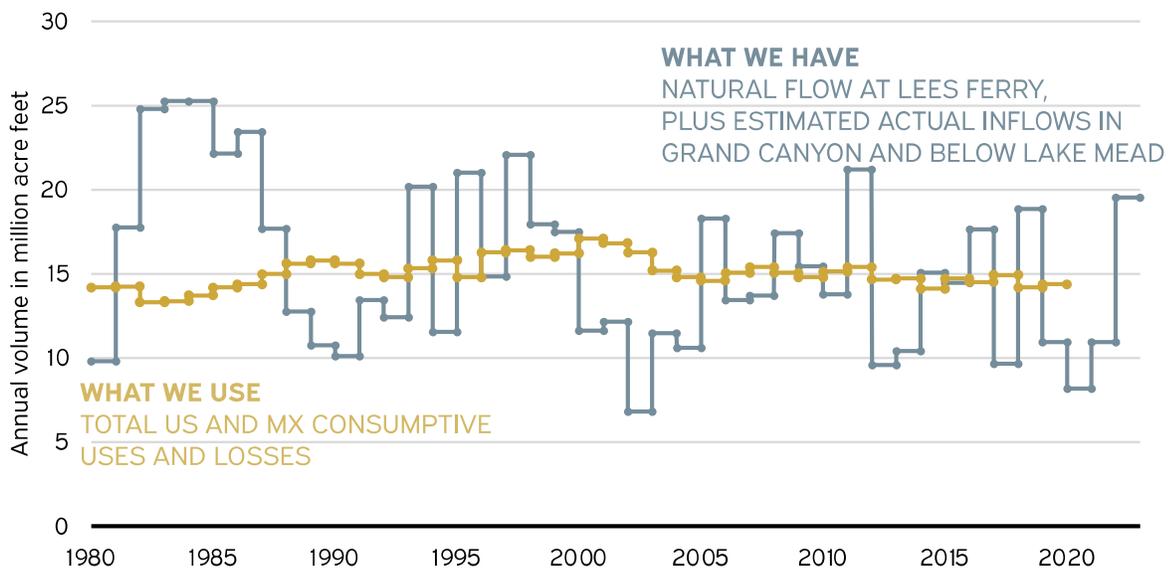
# 4.A Decisions that lie ahead for the Colorado River

**TAKEAWAY»** Despite a very wet winter, the best option for sustainable use and management of the Colorado River, and for the stability of Utah’s growing communities, is to focus on significant reductions in consumptive use.

Unregulated inflow to Lake Powell reservoir from this year’s large snowpack was 13.6 million acre feet (maf), an amount significantly greater than the 9.6 maf average managers have seen during the past three decades. This year’s inflow was second only to the inflow of 2011 that was the largest of the 21st century. The total annual water supply for the Colorado River Basin—the sum of unregulated inflows to Lake Powell, plus all upstream human uses and losses and all other water sources in the basin—is predicted to exceed

the rate of human use of the river’s water by almost 5 maf. A year of such a great snowfall and runoff might suggest to some that the water-supply crisis of the Colorado River is over. But the two largest reservoirs in the United States, Lake Mead and Lake Powell, are still more than 30 maf below full capacity. If 2023 were repeated multiple times, and basin-wide consumption remains as high as it is today, it would take six additional years to refill the two reservoirs—an unlikely scenario. The wet winter of 2023 came at a very

**Figure 4.A.1** Basinwide water supply and basinwide water use



The figure above shows the comparative difference between total consumptive uses and losses and the natural flow at Lees Ferry (where Colorado River water leaves Utah) plus estimated actual inflows in Grand Canyon and below Lake Mead. There is a water surplus when the natural flow exceeds consumptive uses, and a water deficit exists when the consumptive uses are higher than natural flow. (Adapted from Schmidt et al 2023)



**IT WOULD TAKE SIX ADDITIONAL  
WET YEARS TO REFILL LAKE  
POWELL AND LAKE MEAD —  
AN UNLIKELY SCENARIO.**

*ABOVE: LONE ROCK BEACH | LAKE POWELL | KANE COUNTY*

fortunate time for managers, but it is only a temporary reprieve.

The clock of water shortage is still ticking. The climate of the Intermountain West continues toward aridification, and warm temperatures combined with dry soils will continue to reduce the flow of the Colorado River.

Our best option for the health of the Colorado River, and for the stability of growing communities, is to continue to find ways to make significant reductions

in consumptive use. Everyone needs to play a part to save water in the region. Fundamental changes in the Law of the River are needed to negotiate strategies to reduce consumptive use everywhere in the basin. Making difficult choices to cut consumptive use and face the tradeoffs that come with growing populations isn't straightforward or easy, but it remains the reality for managers and communities. This year's wet winter has offered leaders time to negotiate a more thoughtful, adaptive solution. The challenge now is not to squander that opportunity.

## WEATHER &amp; CLIMATE

by SIMON WANG

## 4.B Can we rely on drought-busting “miracles” in the Colorado River Basin?

**TAKEAWAY»** The frequency and intensity of drought-busting spring precipitation in the Colorado River Basin may decrease due to climate change, impacting water management strategies.

In recent years, we have witnessed drought-busting spring precipitation events in the Colorado River Basin, such as the so-called “Miracle May” of 2015. Some may consider spring 2023 to be another miracle. These events provide much-needed relief in times of severe drought, but their frequency and intensity have not been well researched or characterized. Our ongoing research aims to define and quantify these extreme dry-to-wet springtime transitions, which is crucial for understanding their future occurrence and potential impact on water management strategies.

As the world continues to warm, our research suggests that these miraculous events may become less frequent and less intense. This finding holds significant implications for water managers, as they must assume less-certain recurrence of such “miracles” and develop strategies to ensure an adequate water supply for agriculture, municipal uses, and ecological needs. As we delve deeper into the

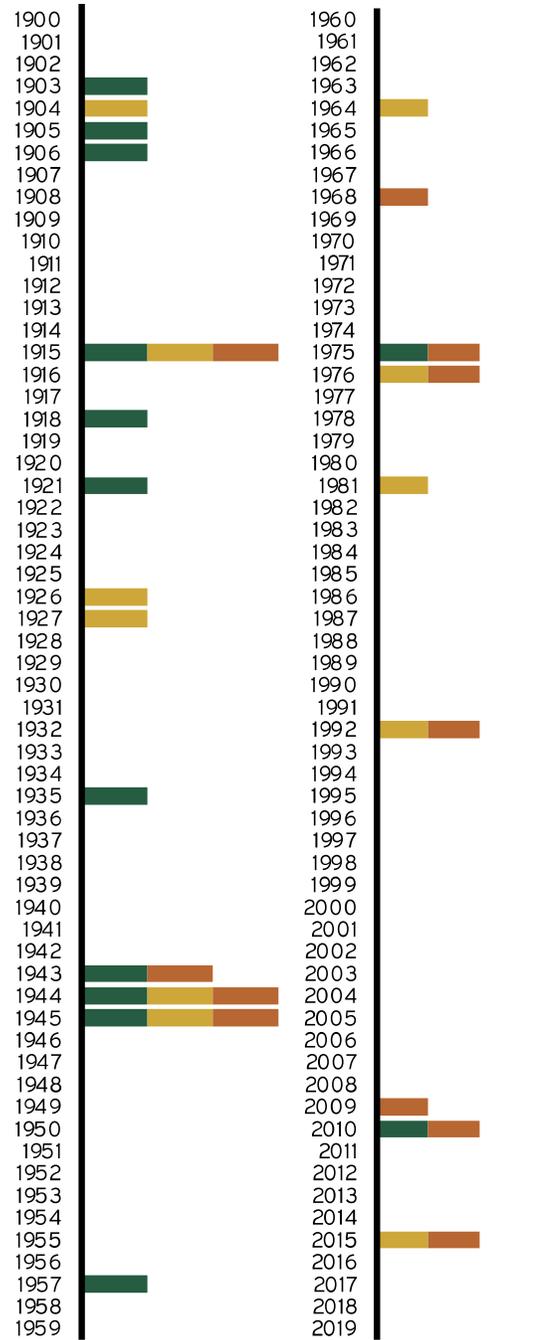
study of these events, it is essential to consider their spatial and temporal variability and the consequences they pose to different regions within the basin. For instance, an extreme dry-to-wet transition might benefit some areas while causing floods and fires in others, as was the case with the 2015 storm events that led to flooding in Texas.

We will continue to collaborate with stakeholders and water managers to identify the best metrics for characterizing these events and refine our understanding of their climatological characteristics. By doing so, we can better prepare for the challenges ahead and develop informed, adaptive strategies for managing water resources in the Colorado River Basin. With a proactive approach, including utilizing advanced climate prediction methods, we can mitigate some effects of climate change and ensure the basin's water supply remains sustainable for future generations.

**AN EXTREME DRY-TO-WET  
TRANSITION MIGHT BENEFIT  
SOME AREAS WHILE CAUSING  
FLOODS AND FIRES IN OTHERS.**



**Figure 4.B.1** Historical miracle events calculated by three different indices



- Palmer Drought Severity Index (PDSI)
- Standardized Precip. Index - 3 months (SPI03)
- Standardized Precip. Index - 6 months (SPI06)

*A miracle event occurs when at least four consecutively anomalously dry months are followed by at least three consecutive anomalously wet months.*



W  
R  
C

## 4.C Irrigation optimization and agriculture's future in the Colorado River Basin

**TAKEAWAY»** The Colorado River is vital to Utah food production and can thrive through strategic water optimization, deficit irrigation, and fallowing.

Agriculture annually consumes about half of the total water share in the upper and lower basins of the Colorado River. This water supports over 360 thousand acres of irrigated cropland. The predominant crops include alfalfa and grass hay, accompanied by a significant portion of pastureland. These crops are well adapted to the high elevation, variable terrain, and frequent droughts that are common in the eastern half of Utah. Sprinkler (wheel-lines and pivots) irrigation is the dominant irrigation method, followed by surface irrigation. Water optimization is possible through water conveyance systems and on-farm improvements.

There are over 1,000 miles of open channel canals in this basin where water losses could be reduced. However, quantifying the opportunity for reduced water consumption is difficult due to high variability and high uncertainty in water losses and return flow in these delivery systems. On-farm improvements

through advanced irrigation systems could reduce annual water consumption by up to approximately 10% or 36,000 acre-feet per year if all systems were converted to more-efficient sprinklers or drip irrigation. Changing crop types and ensuring they could be successfully marketed could save up to about one acre-foot per acre of consumption. These improvements would result in long-term investments in water reductions that would not reduce food production.

Deficit irrigation and fallowing provide the largest opportunities to reduce water consumption, with savings of up to two acre-feet per acre. These are short-term but sometimes necessary solutions that reduce crop production. Thus, combinations of optimization in off- and on-farm water use (long-term reductions), and deficit irrigation and fallowing, when necessary, will ensure that agriculture thrives and downstream demands are met.

**ON-FARM IMPROVEMENTS THROUGH ADVANCED IRRIGATION SYSTEMS COULD REDUCE ANNUAL WATER CONSUMPTION.**

**NATIVE LANDS**

by KYNDA CURTIS, MAN-KEUN KIM and TATIANA DRUGOVA

# 4.D Drought and water access heavily impact tribal economies

**TAKEAWAY»** Drought negatively impacts cattle and forage production on tribal lands, affecting economies and necessitating policies that support the resilience of Native American communities.

Indigenous people in the Colorado River Basin have claims to Colorado River water. Tribes have ancestral land and reservations in the basin and rely on the river for agricultural, cultural, and economic purposes. Unfortunately, legal challenges continue to shape claims and the access many native people have to that water.

As part of the USDA-funded Native Waters on Arid Lands project, we examined the impacts of drought on tribal economies in the Southwest, focusing on reservations heavily reliant on agricultural production. Specifically, we evaluated the economic effects of

drought on cattle and hay production sectors in Arizona, Nevada, New Mexico, and Utah and projected economic impacts given hypothetical drought scenarios.

Drought has significant negative consequences on tribal economies, specifically on cattle and forage production, with cattle inventory decreasing with each successive year of drought.

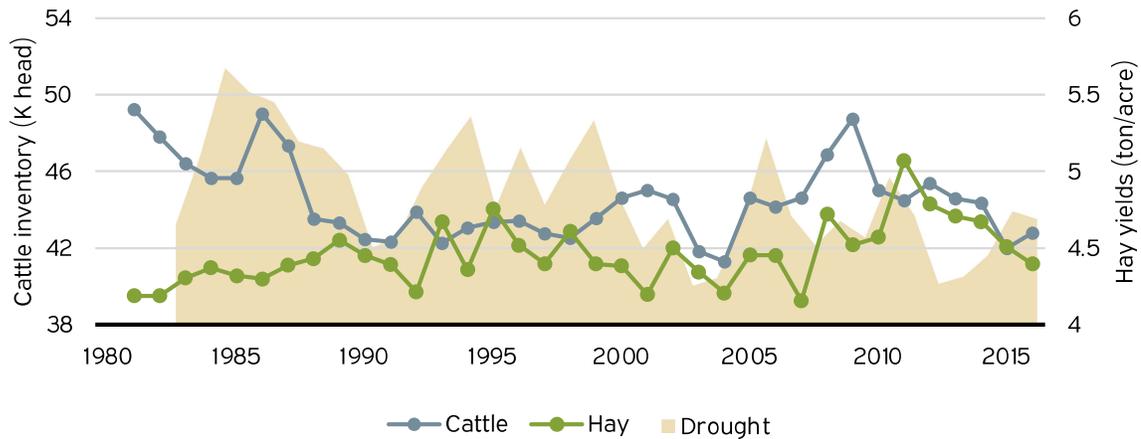
The economic losses resulting from drought scenarios were substantial for large reservation areas, such as the Uintah and Ouray Reservation, Navajo Nation, and

A large, arid mountain range with a tractor in the foreground. The text is overlaid on the image.

**TRIBAL CHALLENGES INCLUDE UNSETTLED WATER RIGHTS, LACK OF RESOURCES TO RESPOND TO DROUGHT CONDITIONS, AND LIMITED AUTHORITY TO PREVENT WATER POLLUTION.**

## Figure 4.D.1 Direct impacts of drought on reservation cattle and hay sectors

This graph compares cattle inventory and hay yield on studied tribal lands over time (averaged across reservations by year). The Palmer Drought Severity Index (PDSI) is included as the yellow background area, with a range of -5.3 to 7.4. This study was supported by the Native Waters on Arid Lands project, the Utah Division of Water Resources, and Utah State University Extension.



Tohono O’odham Nation. These losses have significant implications for the livelihoods of tribal communities, as agriculture plays a crucial role in their economic sustainability.

Climate change and drought affect the viability of tribal economies and disrupt traditional foodways and ceremonies, creating a range of adverse effects on the well-being of individuals and communities.

To address the negative impacts of drought on reservation economies, the study suggests a need to tackle barriers that hinder tribal communities’

capacity to mitigate and adapt to drought and climate change. Some of these challenges include unsettled water rights, lack of financial and labor resources to monitor, prepare, and respond to drought conditions, and limited authority to prevent water pollution that originates outside reservations.

Our work underscores the importance of understanding and addressing the effects of drought on tribal economies. Developing targeted policies and support systems may enhance the resilience of Native American communities to climate-induced challenges and safeguard traditional ways of life.

Table 4.D.1 Reservations included in study

Acoma Pueblo	Mescalero	Tohono O’odham
Duck Valley	Apache	Uintah and Ouray
Goshute	Moapa River	Washoe
Hopi	Navajo Nation	White Mountain
Jicarilla Apache	Pyramid Lake	Zuni Pueblo
Laguna Pueblo	Pueblo of Isleta	
	San Carlos	

## RECREATION

by ANNA MILLER

# 4.E The future of outdoor recreation on the Colorado River

**TAKEAWAY»** The trend toward an increasingly dry climate has practical and economic impacts for recreation hubs on the Colorado River.

Outdoor recreation in Utah accounts for 2.7% of the state's GDP, supports over 66,000 jobs<sup>4E1</sup> and is a vital part of the state's economy—but the water resources on which these experiences rely are in flux. Utah's section of Colorado River is an important recreation resource for Moab and Lake Powell. Drought has reduced the river's flows, decreasing water-based recreation opportunities for local, national and international visitors. For example, white-water rafting in Cataract Canyon (a popular stretch of river running from Moab to Lake Powell) is possible for 257 days per year in dry years, down from 362 days in wet years. However, the number of days considered 'optimal' for whitewater boating drops dramatically from 121 days in wet years to 37 days in dry years<sup>4E2</sup>. This substantial drop has important economic implications.

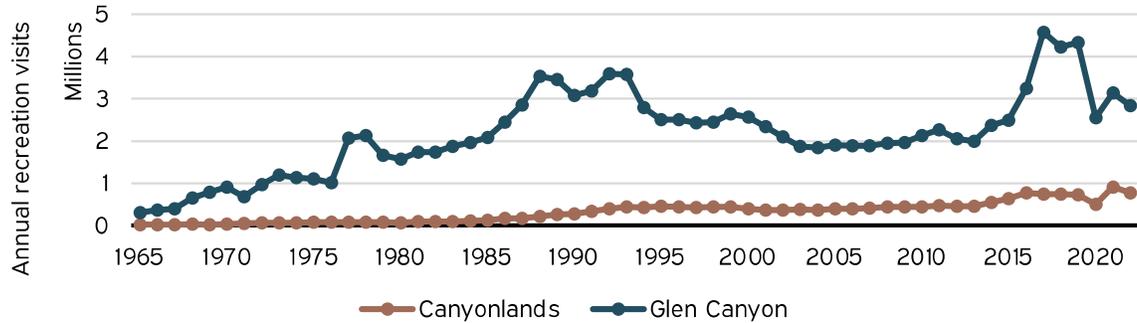
At Lake Powell, low water levels may mean that boat ramps can't reach the lake. In 2022, significantly low water levels prompted managers to close one

marina for the season, and to build an extension to facilitate lake access at another ramp<sup>4E3</sup>. In May 2023, four of 15 boat launch ramps were closed to non-motorized access, and eight were closed to motorized access due to problematic water levels<sup>4E4</sup>. Although the record-breaking water year of 2023 may temporarily moderate this issue, ongoing aridification will likely continue to create real-world implications for recreationists and the state's tourism economy.

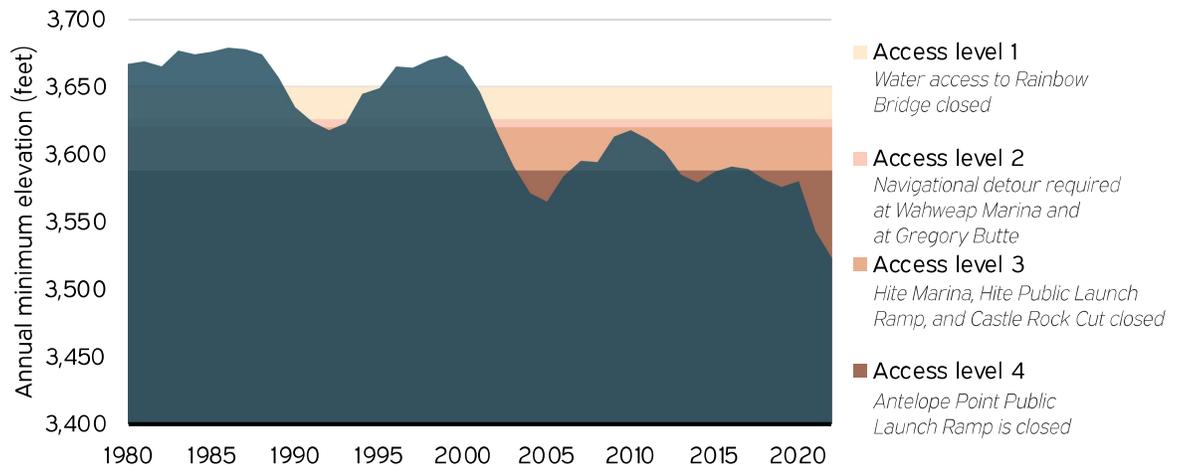
Models based on long-term data indicate that a 10.3-inch drop in Lake Powell's water level (equivalent to 100,000 less acre-feet of water) in a year are associated with over 5,000 fewer recreational visits to Lake Powell, and \$374,000 less in annual visitor spending<sup>4E5</sup>. As a changing climate continues to push the Colorado River Basin toward aridification, Utah's recreation industry will need to be aware of thresholds that could change the way people use the land.



**Figure 4.E.1** Annual visitation to Canyonlands National Park and Glen Canyon National Recreation Area (1965–2022)



**Figure 4.E.2** Lake Powell minimum elevation levels and key recreational access levels (1980–2022)



Source: National Park Service, USBR

LAKE POWELL MARINA | KANE COUNTY



RESERVOIRS

by AMY HAAS, Colorado River Authority of Utah

# 4.F Managing Lake Powell's water level requires constant attention

**TAKEAWAY»** The Drought Response Operations Agreement (DROA) released approximately 580 thousand acre-feet of water from Flaming Gorge to Lake Powell in 2021 and 2022. Water managers should be careful to ensure such transfers don't incentivize further releases from Lake Powell to the Lower Basin.

Lake Powell is a centerpiece of the Colorado River system with the capacity to store approximately 24 million acre-feet of water and make releases for municipal use, agriculture and power generation, while supporting native species recovery efforts and recreational interests. However, the reservoir has been declining since 2000, approaching critically low elevations in recent years and threatening safe operations of Glen Canyon Dam. To protect critical elevations at Lake Powell, the Bureau of Reclamation released approximately 588,000 acre-feet of water from Flaming Gorge Reservoir to Lake Powell in 2021 and 2022 under the Drought Response Operations Agreement (DROA).

The combination of wet hydrology in 2023 and DROA releases succeeded in stabilizing Lake Powell elevations. Accordingly, additional releases from Flaming Gorge were suspended in March 2023 giving

way to efforts to recover the previously released water. Full recovery at Flaming Gorge is anticipated in February 2024.

While DROA has proven to be both an effective and flexible tool, proper accounting is essential to ensuring DROA fulfills its objective. If not accounted for separately, the presence of DROA water at Lake Powell may lead to greater releases from Glen Canyon Dam for the benefit of the Lower Basin. This type of "mining" of Lake Powell can only be avoided if the Bureau of Reclamation ensures that future DROA releases are retained at Lake Powell until full recovery at Flaming Gorge, or any other participating upstream reservoir, is achieved. Unfortunately, this has not occurred and releases under DROA intended to protect Lake Powell ultimately have had the opposite effect. In 2023, the reservoir will be approximately 180,000 acre-feet lower had the DROA releases not occurred.

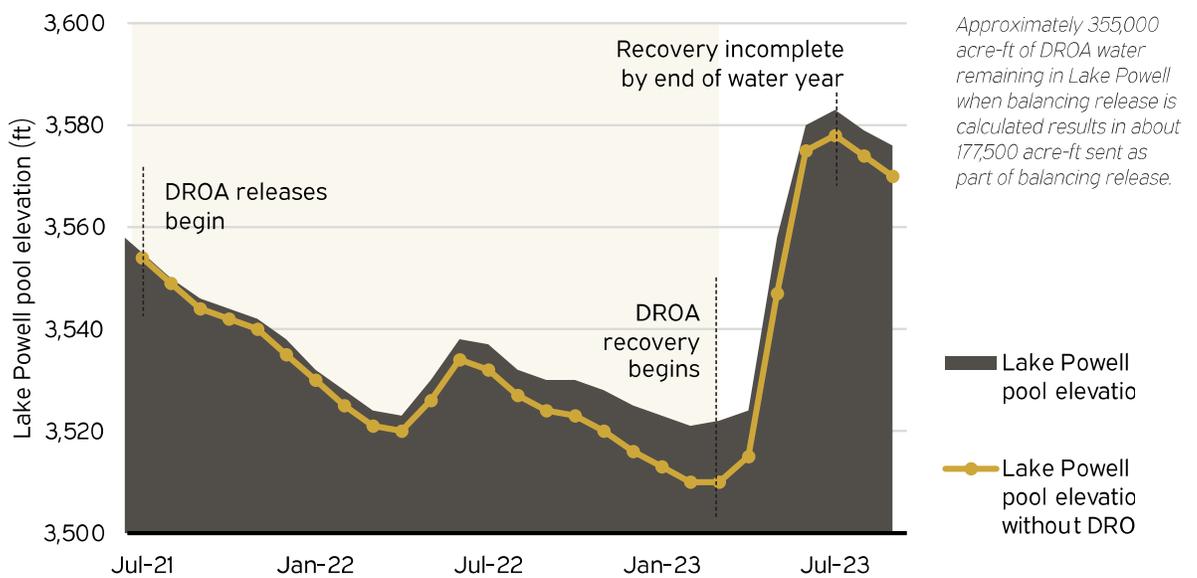
**RELEASES UNDER DROA INTENDED TO PROTECT LAKE POWELL ULTIMATELY HAD THE OPPOSITE EFFECT.**





FLAMING GORGE DAM | DAGGETT COUNTY

**Figure 4.F.1** Lake Powell elevation scenarios with the Drought Response Operations Agreement (2021-2023)



# COLORADO RIVER *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key Colorado River issues and topics that have appeared in media outlets this year.

## 01. TEMPORARY WATER REDUCTION PLAN

The Colorado River negotiations have seen several key milestones. Six states in the basin initially agreed to a water-reduction plan, with California resisting. Federal proposals for water cuts brought further disagreements. Eventually, all seven states reached a temporary conservation agreement but faced skepticism regarding long-term solutions. Future management and federal assistance efforts are ongoing as they plan for the river's future beyond 2026.

## 02. LAKE POWELL RISING ABOVE RECORD LOWS

Lake Powell's water levels have experienced significant fluctuations. In recent years, the lake reached record lows. However, heavy snowpack and wet weather patterns have led to notable rises, offering temporary relief. Still, hydrologists estimate it would take many years of above-average snowpack to fill the lake back to peak levels.

## 03. DISCUSSIONS ON THE FUTURE OF LAKE POWELL

The Colorado River's water capacity to support Lake Powell and Lake Mead is in question, with concerns that these reservoirs may not refill in our lifetimes. Public input is sought on the fate of Lake Powell, with proposals ranging from draining it to restoring Glen Canyon. Some proposals suggest focusing on Lake Mead and restoring natural river flow. Debate rages over the potential impact on recreation and tourism.

## 04. INDIGENOUS PEOPLE'S WATER RIGHTS

Native American water rights took center stage in the Colorado River narrative. The Gila River Indian Community secured a deal with the U.S. government. The Navajo Nation faced a Supreme Court setback over treaty-based water access. Tribes' involvement gained importance in river operations, emphasizing inclusivity and consultation in the ongoing struggle for fair water allocation.

## 05. UNDERSTANDING COLORADO RIVER'S WATER SUPPLY

Evaporation from the Colorado River intensified disputes between Lower and Upper Basin states, as water allocation becomes meticulous. Researchers delved into sublimation, unearthing the river's hidden losses. Changes in long-term weather patterns exacerbate the problem, with higher temperatures deemed responsible for significant "water theft." Studies reveal that "low is the new average" on the Colorado River.



### What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: [usu.edu/ilwa/newsletter](https://usu.edu/ilwa/newsletter).



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