Ecological Succession in Emerging Tributaries to Cataract Canyon

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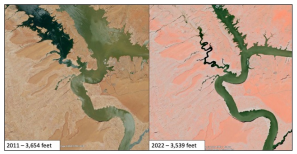
Introduction

In 1963, with Glen Canyon Dam completed and its floodgates closed, the 25 million acre-foot Lake Powell began to fill. When it reached full-pool elevation of 3,700 feet in 1980, Lake Powell inundated a 200-mile reach of the Colorado River, including all of Glen Canyon and half of Cataract Canyon. Beginning in 2000, the southwestern U.S. entered a period of megadrought that caused long-term declines in Lake Powell storage resulting in reservoir elevation falling over 180 feet to an all-time low of 3,519 feet by April 2023. Current low Lake Powell water storage is a result of water use, long-term drought and climate change. Attention by Colorado River Basin water managers, scientists and media has understandably focused on future water availability and maintaining Lake Powell above its minimum hydroelectric power generation elevation of 3,490 feet. A less-studied consequence of a low Lake Powell is the terrestrial landscape that is emerging from the reservoir. Ecological succession is occurring on over 100,000 acres of riparian and desert ecosystems in Glen and Cataract Canyons.

Lake Powell surface elevation, 1980-2023.



Satellite imagery of Halls and Bullfrog Bays in 2011 (3,654 feet) and 2022 (3,539 feet).

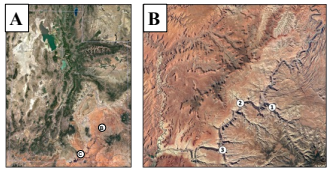


Image of Utah (A) showing the locations of Cataract Canyon (B) and Lake Powell (C). Cataract Canyon plant survey sites were located in Gypsum (1), Clearwater (2) and Dark (3) Canyons.

The lower 25 miles of Cataract Canyon was submerged when Lake Powell was full. The canyon and its tributaries began to emerge as reservoir elevations dropped in 2000. At current Lake Powell elevations, nearly 60 miles of flowing Colorado River now exist in locations that were covered by reservoir in 2000. A major change wrought to landscapes by the Lake Powell's inundation and subsequent recession is the deposition of Colorado River sediments. Deep deposits of fine sediment create a dynamic landscape that is very different from pre-Glen Canyon Dam conditions and is rapidly changed by erosion from flooding and wind. Since emergence from Lake Powell, landscapes along the Colorado River and in tributaries to Cataract Canyon are experiencing rapid ecological succession.

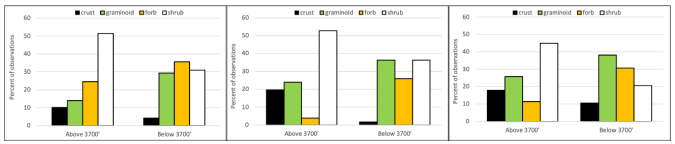
Images of riparian ecosystems in lower Cataract Canyon. Historical photograph (left) from the Huntington-Marston Collection taken in 1964 above Easter Pasture Canyon was matched in 2019 (center) by Mike Dehoff (Returning Rapids Project). River elevation in the 1964 image was 3,580 feet, but approximately 3,630 feet in 2019 due to 50 feet of sediment deposition. Tall sediment banks line the river in 2019 (center) and riparian vegetation, including willow and tamarisk, have established. Riparian vegetation growing in previously inundated portions of Dark Canyon (right) is dominated by native shrub species coyote willow and seep willow.

Approach and Methods

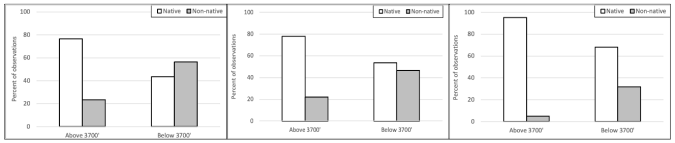
The objective of this pilot study is to determine vascular plant species composition on sites previously inundated by Lake Powell, how those sites differed from sites not flooded by Lake Powell and how plant species composition and ecosystem structure changed over time. Plant survey sites were established in Gypsum and Clearwater Canyons in October 2019 and in Dark Canyon in October 2020. Site were re-surveyed in the following one or two years. In each tributary canyon, two sites were established in locations never flooded (above 3,700 feet) and previously flooded (below 3,700 feet) by Lake Powell. At each plant survey site, a belt transect was used and all vascular plant species were identified in 1-meter sections along the transect. In each 1-meter section of the belt transect, the presence of a plant was considered one observation and multiple observation of a species were not counted. Transects were delineated perpendicular to the flow of the creek and transect length varied depending on the width of the canyon. Each transect contained flood zone, terrace and upland locations.

Results

Across all sites and years, 44 vascular plant species were observed in belt transects. At sites above 3,700 feet and not flooded by Lake Powell, 41 plant species were observed; at sites below 3,700 feet, 28 plant species were observed. Plant species present in transects were generally typical to Colorado Plateau upland desert and riparian ecosystems. Several previously flooded sites were dominated by native shrub species (coyote willow and seep willow), had lower abundance of non-native plants and native shrubs were generally more abundant than the non-native tamarisk.

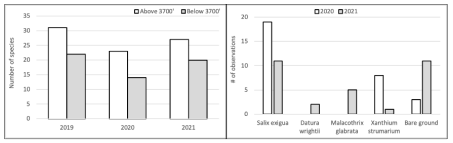


Percent of plant species observations by plant functional group, including a category for cryptobiotic crust and site elevation from belt transects at all sites in 2019 (left), 2020 (center) and 2021 (right).



Percent of native and non-native plant species observations grouped by site, above (not flooded) or below (flooded) 3,700 feet, from belt transects at all sites in 2019 (left), 2020 (center) and 2021 (right).

Cheatgrass and Russian thistle were other common non-native plants. Russian thistle was particularly abundant at dry sites and often formed dense stands that excluded other plants. There was a higher percentage of non-native plant observations at sites below 3,700 feet compared to sites above 3,700 feet. At sites never flooded, shrubs were the dominant plant functional group with grasses and forbs comprising smaller components of the plant community. At previously flooded sites, shrubs, grasses and forbs were similarly abundant. Notably, cryptobiotic crusts were present at some previously flooded sites. A strong monsoon season in 2020 and 2021 caused flash flooding and altered species composition. The decease in relative abundance of non-native plants below 3,700 feet in 2020 was the result of a Gypsum Canyon flash flood that removed two large stands of Russian thistle. In 2021, a very large flash flood in Dark Canyon eroded a huge volume of sediment, removed a beaver dam with a 300-meter long pond, washed away a large portion of a mature willow stand at a plant survey site and helped to further decrease the relative abundance of non-native plants.



Species richness grouped by sites above and below 3,700 feet (left). On the right, the number of observations of dominant plants from a site below 3,700 feet in Dark Canyon is shown for 2020 and 2021. Changes in species composition are due to a large flash flood in August 2021.

Conclusions and Future Work

Ecological succession on previously flooded Cataract Canyon landscapes has been occurring for 20 years. The changes in Cataract Canyon and the larger Lake Powell region are novel, dynamic and without a clear analog for comparison. The path of ecological succession is not straightforward in these systems. Many factors impact the establishment, development and persistence of riparian systems, including reservoir levels, stability of sediments, flash floods, climate and non-native species invasions. Through work in Cataract Canyon and ongoing similar research in tributaries to Glen Canyon and Lake Powell, it is clear that riparian ecosystems are quickly re-establishing on previously inundated landscapes and relatively native assemblages of species are often present.

Ecological succession on landscapes previously flooded by Lake Powell is a significant management concern not currently considered by land managers or in the Draft Supplemental Environmental Impact Statement for Near-term Colorado River Operations. Inadequate consideration to developing ecological resources on landscaped below 3,700 feet in the Lake Powell region is due to a lack of information and the speed of change. An ongoing four-year study of emerging landscapes in the Lake Powell region hopes to inform both land and water management.