WaterSMART

Internal Applied Science Project

BUREAU OF RECLAMATION

Quantifying Reservoir Sedimentation Following Wildfires

Wildfire Impacts on Reservoirs

Between 2018 and 2020, more than 120,000 acres of land were burned or affected by fires within the Provo Area Office's reservoir watersheds in the state of Utah. These wildfires are projected to increase reservoir sedimentation rates due to increases in burning and postfire soil erosion. Reservoir sedimentation is the process in which reservoirs lose water storage capacity to incoming sediment that deposits in the reservoir and is unable to pass through the dam.

This project examined the sediment yield at Starvation Reservoir. Sediment can have significant effects on allocated dead pool space within reservoirs, as well as repercussions upstream and downstream of the reservoir. Having accurate, up-to-date reservoir sedimentation information is crucial for meeting water supply needs, ensuring sufficient storage to retain floods and perpetuating the life of the reservoir to satisfy future demands.

Project Background

The project partners include Reclamation, Brigham Young University (BYU), United States Geological Survey (USGS), Central Utah Water Conservancy District, and Utah Division of Water Resources.

Starvation Reservoir is located in Duchesne County approximately 60-miles east of Provo, Utah (Figure 1).

Figure 1. Location map for Starvation Dam and Reservoir

In July 2018, the Dollar Ridge Fire burned approximately 70,000 acres along the Strawberry River between Soldier Creek Dam and Starvation Reservoir. In the following spring, brown, murky water was observed exiting downstream of Starvation Dam insinuating sediment traveled 6.5 miles through the reservoir. To assess how the fire impacted Starvation's sediment yield rate, bathymetry (below water) and photogrammetry (above water) surveys were conducted by BYU using sonar and drones. The above and below water surveys provided a comprehensive three-dimensional model of the reservoir.

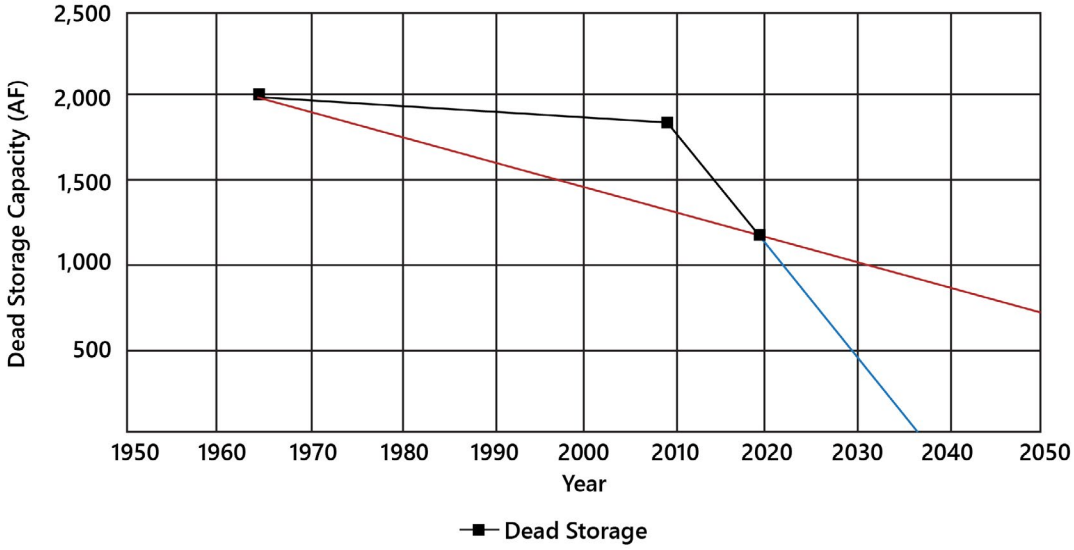

Figure 2. Starvation Reservoir dead storage capacity comparison

Prior to the Dollar Ridge Fire, Starvation had only been surveyed once since construction of the dam. The first survey was in 1964 and the second took place 45-years later in 2009 using a single-beam sonar. Since the 2018 fire, two more surveys have been performed: a full-reservoir survey in 2019 using an Imagenex DT101Xi multibeam sonar, and a partial reservoir survey in 2022 using a Norbit iWBMS-narrow multibeam sonar.

Key Results

Figure 2 graphs the dead storage capacity from the 1964, 2009, and 2019 surveys. Trendlines were added to extend the 1964-2019 (red) and 2009-2019 (blue) storage loss rates through to the year 2050. It's possible the dead storage may be filled by the year 2036 if the sedimentation rate observed over the last decade continues undisturbed.

Comparing the 2019 and 2022 surveys showed an approximate 250 feet northward movement of the river channel and deltaic deposits as the channel enters higher reservoir depths. These and other depth differences between the surveys are shown below in Figure 3. The cooler colors represent sediment scouring while the warmer colors represent sediment deposition. The water level was lower in 2019 than 2022 at the time of the surveys. LiDAR data collected in 2018 was used to create the full reservoir model with the 2019 multibeam survey. The gaps between the two datasets are interpolated so the large depth differences along the north and south reservoir perimeters in Figure 3 are most likely the result of those data interpolation errors.

NOTE: The 2019 survey had issues in the sonar data due to the lack of a reliable elevation source and the absence of a sound velocity profiler. The presented values here should not be used in any legal form including, but not limited to, amending dam operations or updating area-capacity tables. Following discussions using the 2019 survey will be pursued for the sake of comparison between the two previous and 2022 surveys.

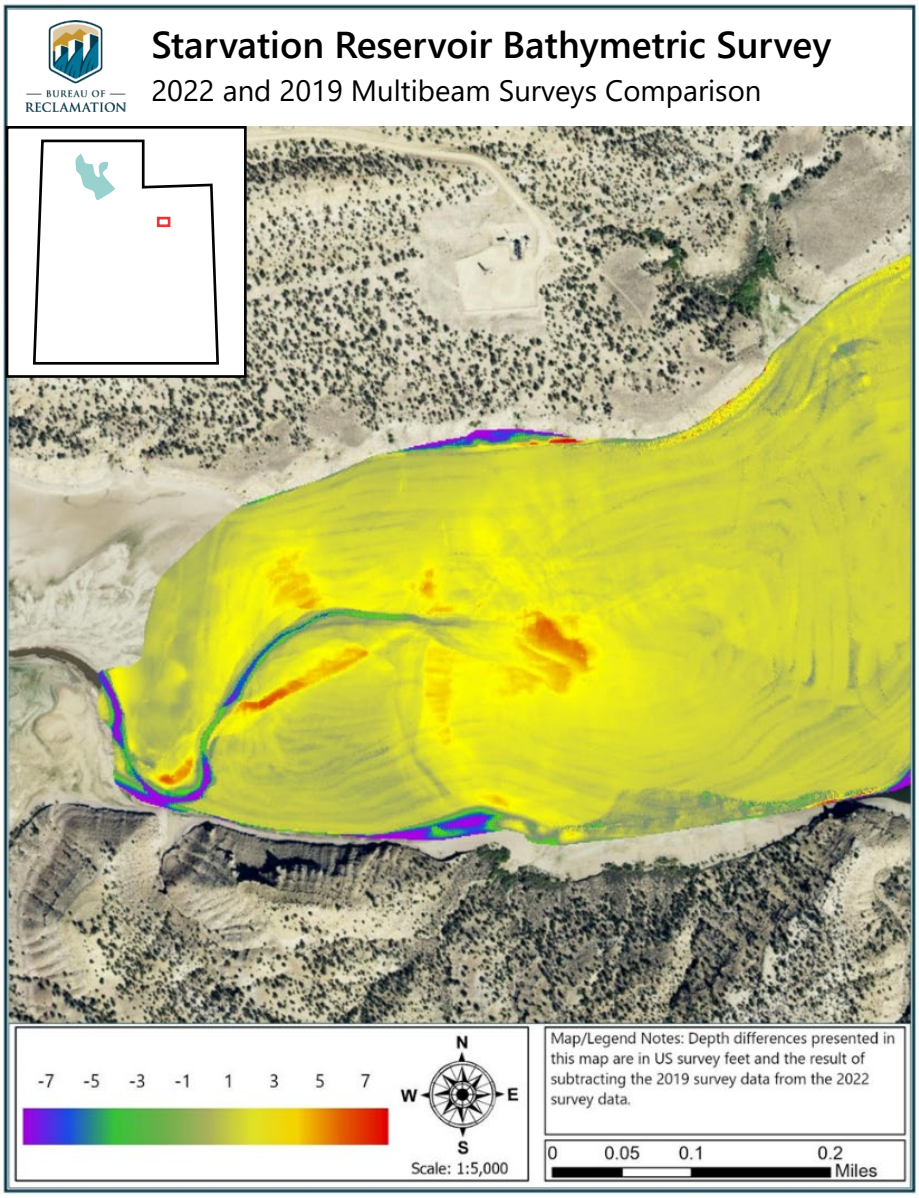

Figure 3. Comparison of 2019 and 2022 survey data near Strawberry River

Project Benefits

This study provided additional information to improve the understanding of potential sedimentation issues, both in terms of the deltaic deposits collecting near the Strawberry River outlet into the reservoir and highlighting the dead storage capacity loss rates from 1964-2019 and 2009-2019. The 2019 reservoir model can be used in future comparisons to continue monitoring Starvation's sediment trends and comparing area-capacity information.

Methods employed to collect, process, and incorporate the sonar survey data with photogrammetry or LiDAR will be used again. Since 2019, these methods have also been used for surveys on the Provo River, UT; the Delta-Mendota Canal, CA; Nambe Falls Reservoir, NM; Flaming Gorge Reservoir, WY and UT; Scofield Reservoir, UT; Upper Stillwater Reservoir, UT; Echo Reservoir, UT; Gunlock Reservoir, UT; Newcastle Reservoir, UT; and more.

Project Considerations

Starvation Reservoir was the first reservoir Provo Area Office conducted with multibeam sonar equipment. Below are a few considerations that will benefit others who may engage in similar work.

1. Consulting. Reach out to other Reclamation offices performing similar work. Review a sample image of data collected by the sonar equipment to view the results prior to purchase or use. Get professional opinions from experts who are not affiliated with one sonar company.

2. Training. Work jointly with the sonar company from project start-up to end. Training on equipment, data collection, troubleshooting, and process data.

3. Start small, then go big. It's much easier to make mistakes on a small, local project compared to large, far away project.

4. Get the full package. Ensure you have a solid Global Positioning System (GPS) source, real time kinematics (RTK) or post processed kinematics (PPK) recommended, a sound speed profiler, daylight-readable monitors, and a pole- mounting setup equipped for transit as well as surveying.

Additional Information

Useful Links for Applied Science:

https://www.usbr.gov/watersmart/appliedscience/index.html

WaterSMART Website:

https://www.usbr.gov/watersmart

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