

Background

- The native Colorado River cutthroat trout population are sensitive to temperature. The temperature of the Colorado River is increasing at an alarming rate¹
- Decrease in Discharge → Higher Temperatures → Dead Fish
- The water in the Colorado River has been historically low this year due to drought. This drought started in the early 2000s³
- Between 2000 and 2014 annual flow reduction along the Colorado River and Colorado River Basin averaged 19.3%⁴
- Environments cycling between 16 and 26 °C were not fatal, but induced sub-lethal effects. These effects include a decline or halt in feeding and growth and the appearance of heat stress proteins at temperatures above 22 to 24 °C. Laboratory experiments identified 24.2 °C as the 7- day upper incipient lethal temperature⁶
- The temperature of the Colorado River is also affected by the amount of discharge released from reservoirs upstream. There are 52 reservoirs/dams upstream from this reach (excluding mining debris dams) with the largest four being: Lake Granby, Lake Dillon, Green Mountain, and Williams Fork.⁷

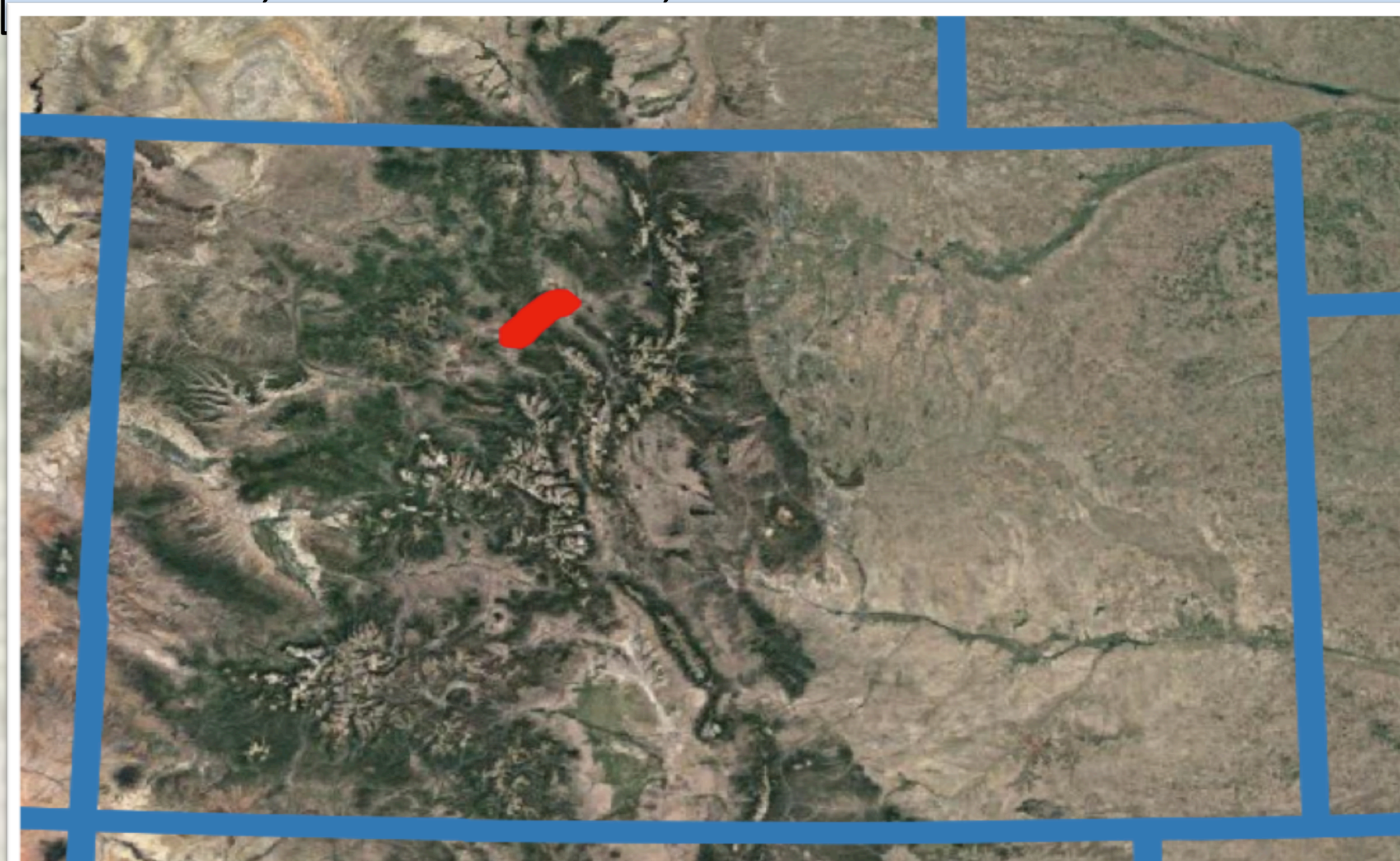
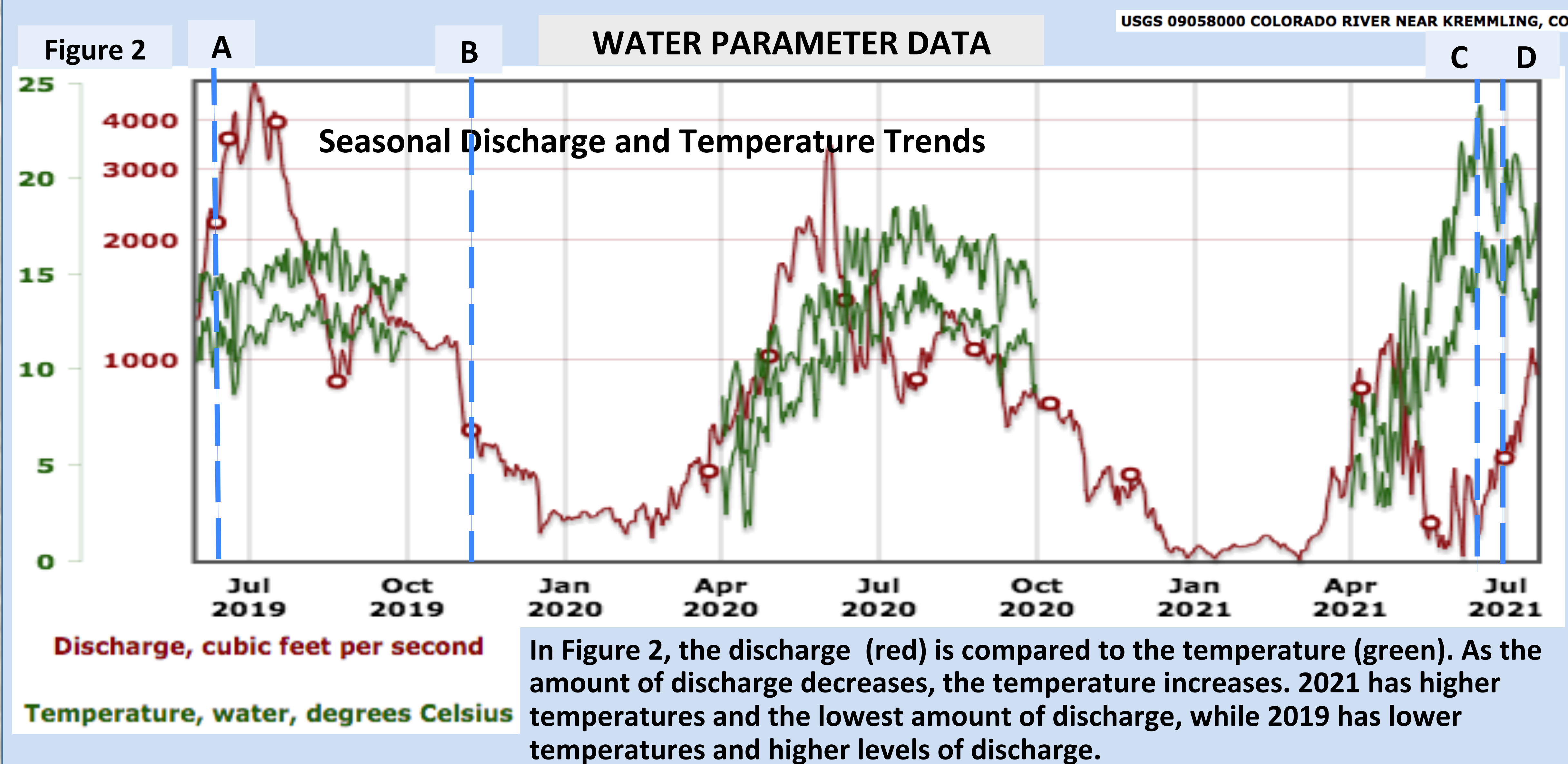


Figure 1: Colorado and Colorado River Reach

Methods

My study was conducted using data imported from the USGS water data websites for site number 09058000 Colorado River near Kremmling, CO. Seasonal snapshots from 2019 and 2021 were compared. I downloaded GIS data from the USGS national map and into QGIS to examine the HUCs and flow lines within the reach. I obtained Digital Elevation Models and used QGIS to examine elevation and general changes to the channels over the low flow/high flow periods. I researched past projects that focused on trout habitat and conservation. Research was also done on the history of the Colorado River and its watersheds. I wrote code for Google Earth Engine to obtain the NDWI imagery. The DEMs were meant to study the overlap of the change of shoreline in the reach, but due to location and shadowing, they were unusable. If I had more DEM imagery, I could examine the shoreline to study the water area versus the NDWI imagery. **Equation 1: $NDWI = \frac{G - NIR}{G + NIR}$ The Normalized Difference Water Index (NDWI) is derived from the Near-Infrared (NIR) and Green (G) channels. This formula highlights the amount of water in water bodies.**

Results



Discussion/Conclusions

In looking at the data, there is a correlation with the decrease of discharge creating a decrease in velocity and saturated oxygen. Regardless of how much dissolved oxygen is in the water, trout struggle to use oxygen in water when the temperature is over 20°C. ² There have been many days over 20°C this year. This increase in temperature is exceeding lab predictions from the last 20 years, leading to conditions being unsuitable. The current conditions: temperature, discharge, velocity, and water quality, are unsuitable for cutthroat trout survival let alone conservation. One way to ensure viability of cutthroat trout, is to decrease the temperature of the Colorado River and increase the amount of discharge. This can be partially achieved in more discharge being released into the reach from reservoirs, dams, and lakes upstream.

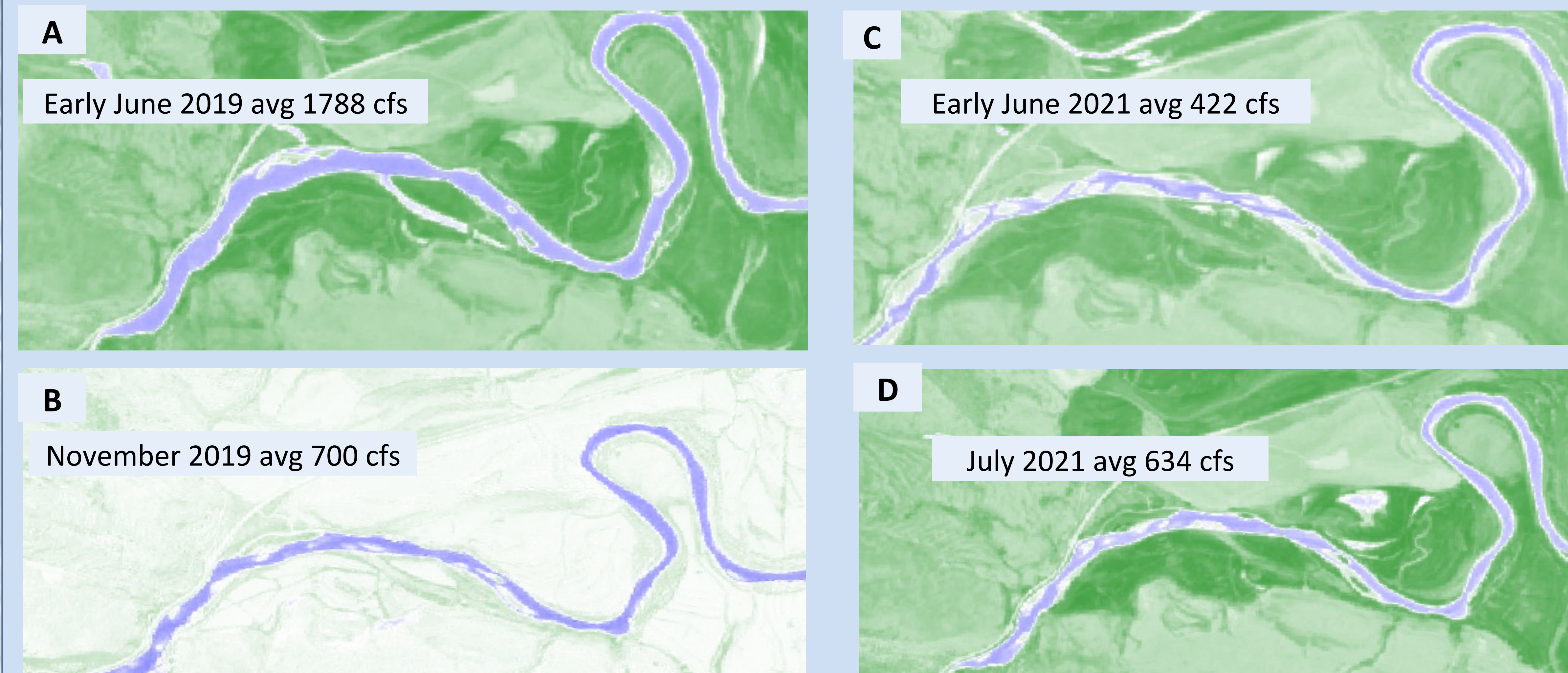


Figure 3: A-D, NDWI Imagery from Sentinel -2 was calculated according to Equation 1 using Band 3 (Green) and Band 8 (NIR). There is a big difference in surface area between June 2019 and June 2021. Similar images were produced for November 2019 and July 2021 based on their discharge rates.

Future Works

With the trend of decrease in discharge, consistent water quality testing is needed to be done on the reach. There was significant mine activity upstream of this reach, and there could be long term ecological effects. This testing could find a correlation between the decrease in discharge and a possible increase in contaminants. The cutthroat trout also require testing for contaminants and more action taken for their conservation. The implications for the release of more water from the upstream reservoirs should be studied for the effects on the reservoirs themselves, the Colorado River, and the Colorado River Basin.

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