Water Quality in Lake Powell and Glen Canyon during Cool Mix Flows

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U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center

Glen Canyon Dam Adaptive Management Program
Annual Reporting Meeting

Photo Credit: Ian Bishop

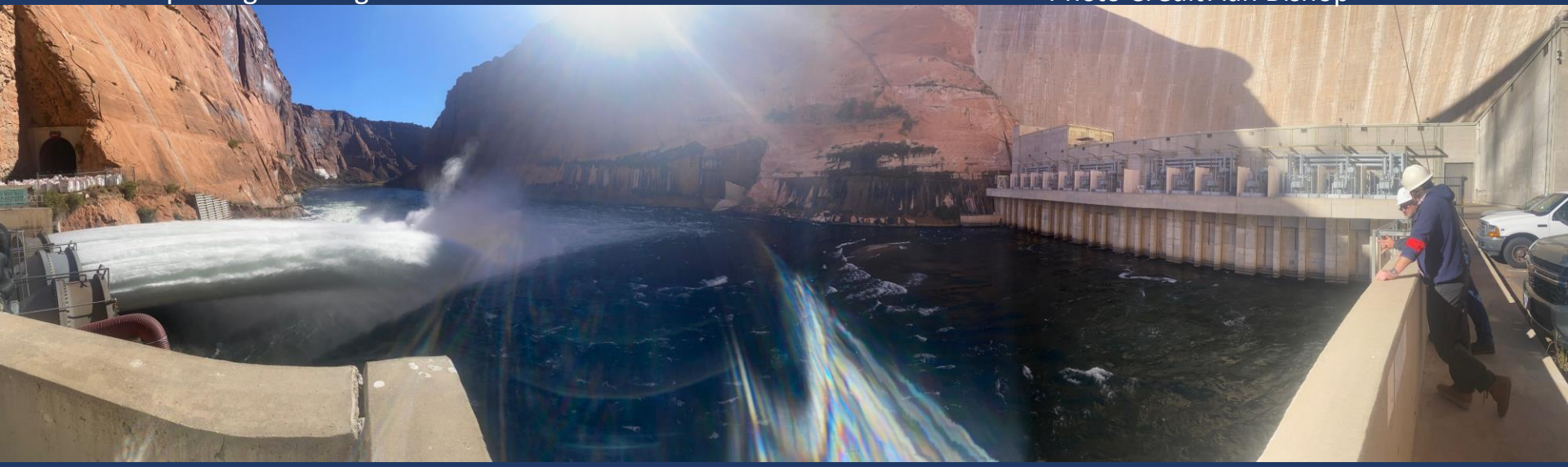
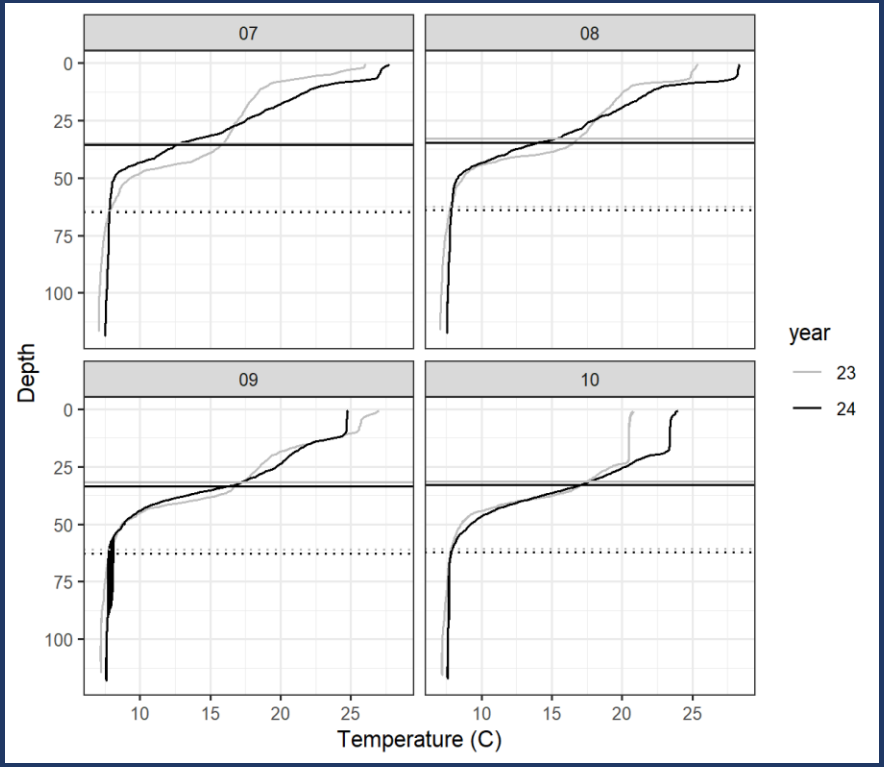


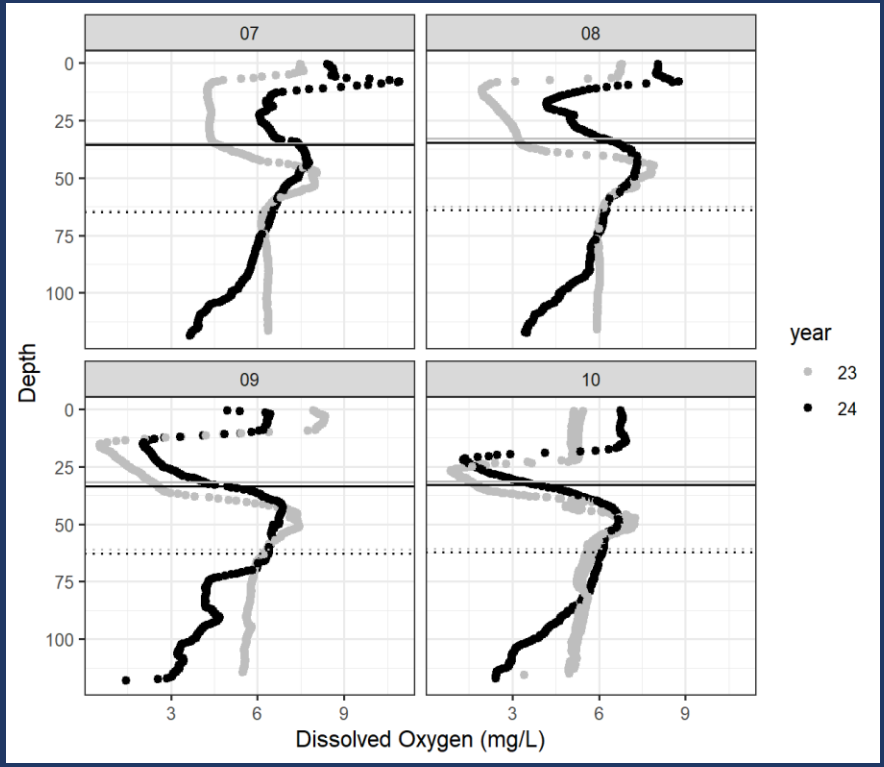
Photo Credit: Bridget Deemer

Lake Powell Water Quality

Similar reservoir elevations between 2023 and 2024

Notably warmer surface waters and higher dissolved oxygen in October 2024





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Lake Powell Water Quality

Almost 2˚C warmer in the very surface of the reservoir than the 90th quantile of the historic dataset (dating back to 1964)

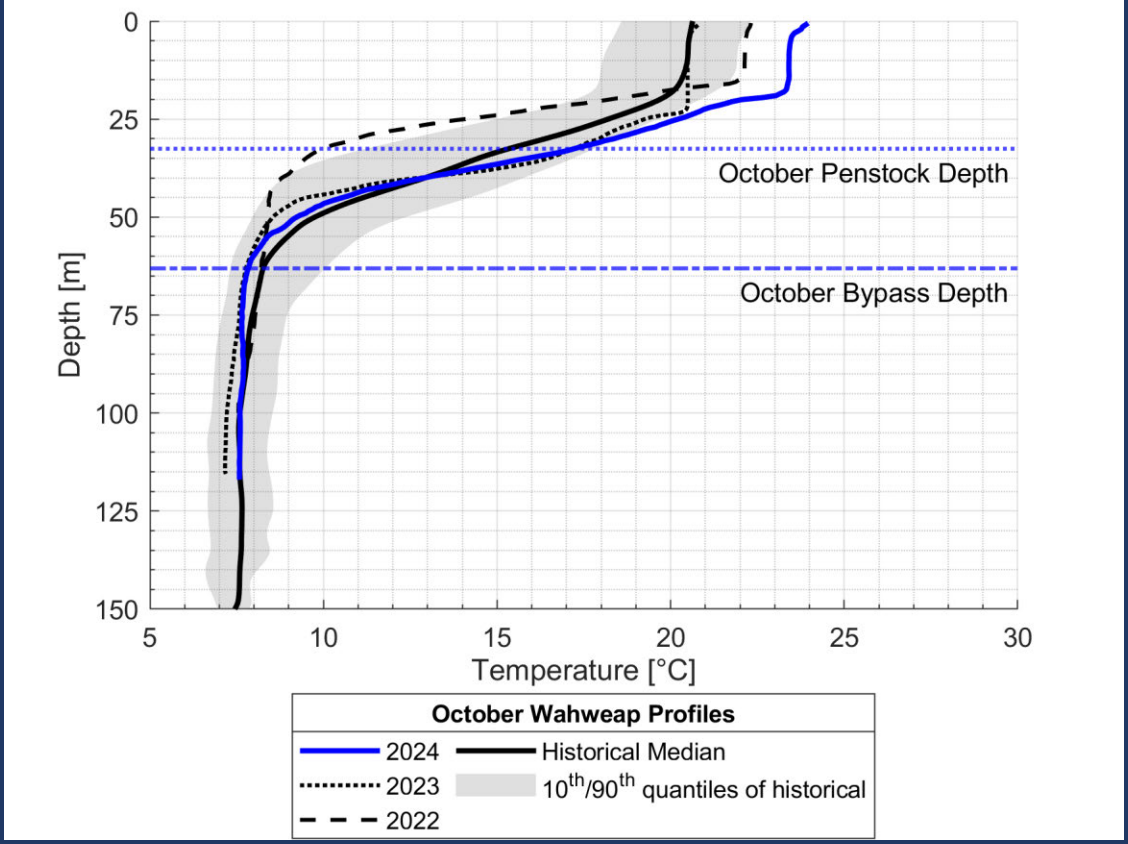

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Figure produced by Bryce Mihalevich

Lake Powell Water Quality

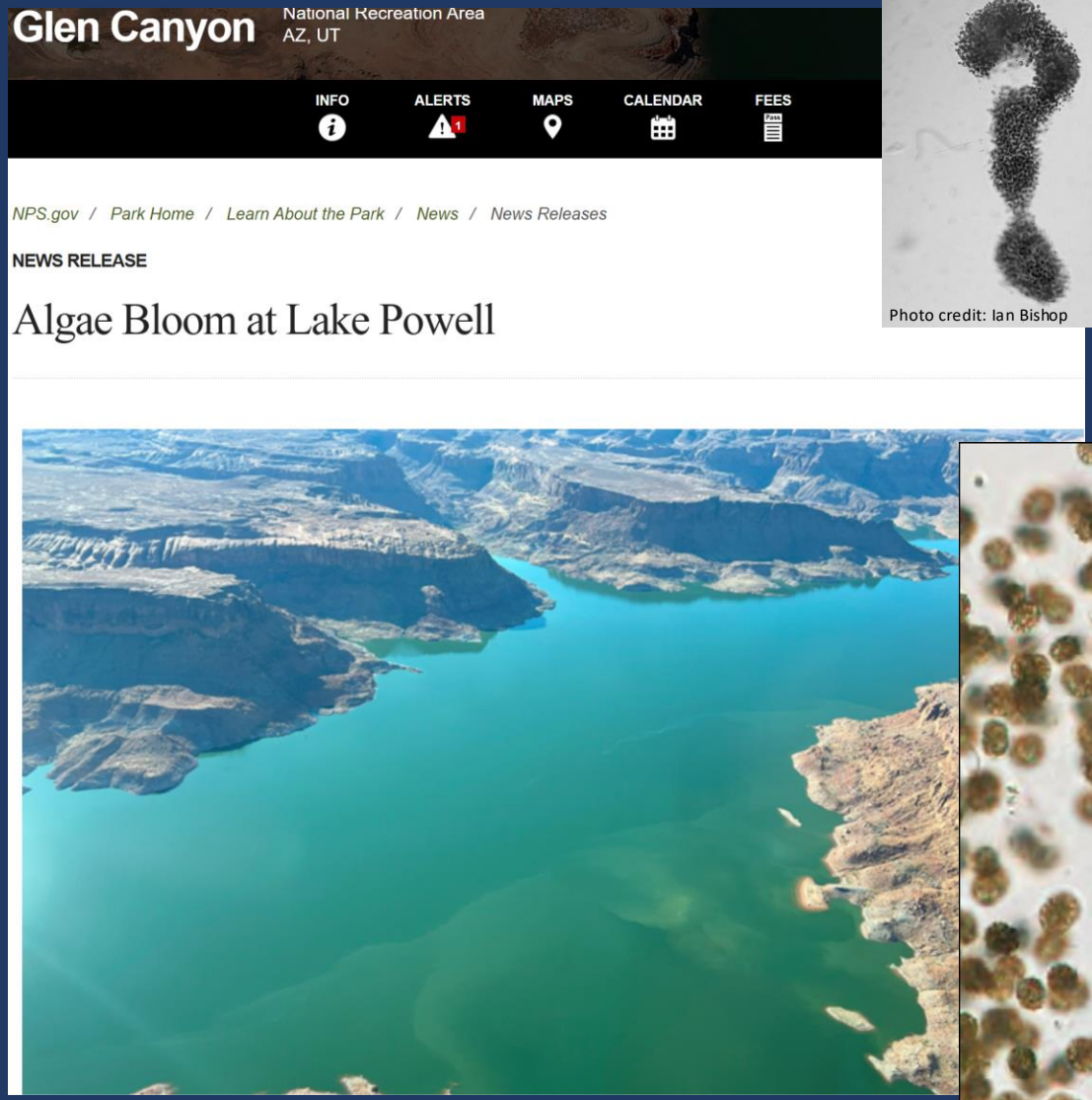



Photo credit: Ian Bishop

Development of Microcystis bloom on Lake Powell in October-November of 2024

Notes of blooms in some heavily visited side canyons such as Reflection

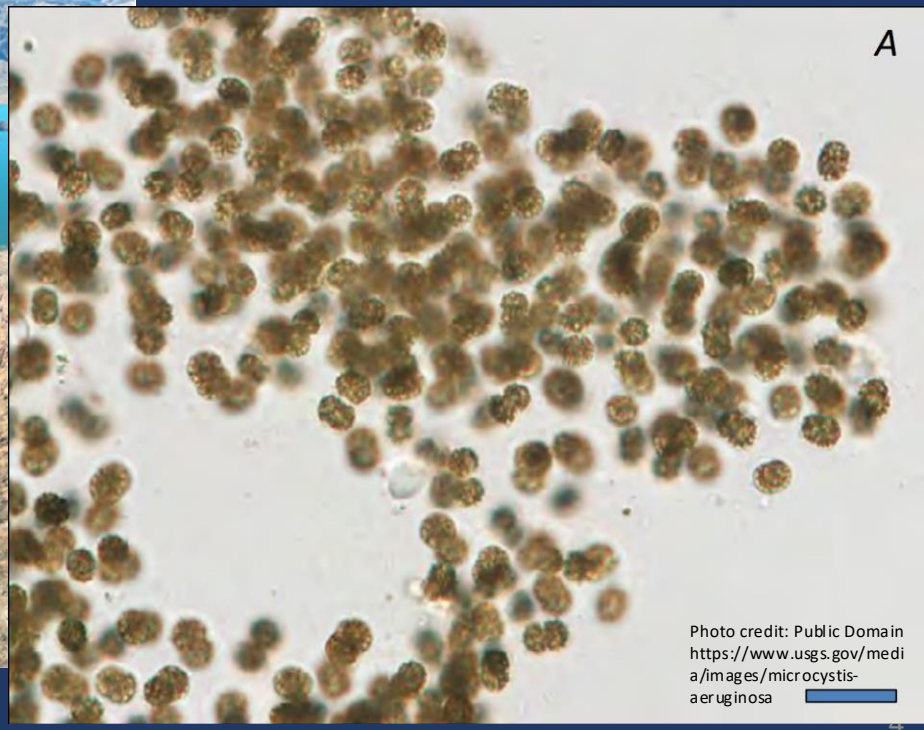
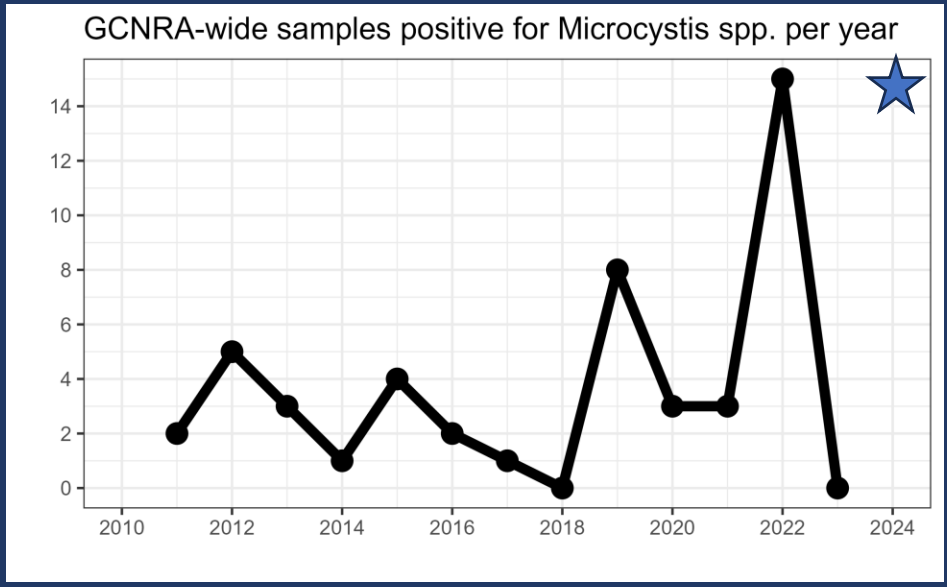
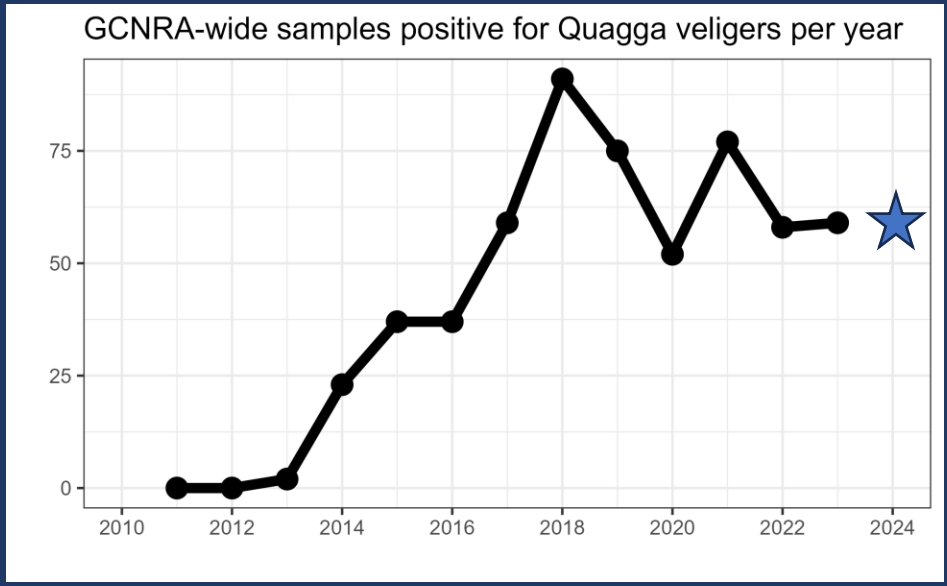


Photo credit: Public Domain https://www.usgs.gov/media/images/microcystis-aeruginosa

Lake Powell Water Quality





- Lake-wide Microcystis detection is variable from year to year, but on the rise.
- 2024 samples not analyzed yet, but manual checks for Microcystis presence in Summer 2024 Wahweap samples suggest detection will be high for this year too
- Quagga were first observed in Lake Powell in 2012 and have established throughout the reservoir. 2024 data also not yet available, but Quagga were detected in 59 samples in 2023 (91% of zooplankton samples collected that year)

Low Water Levels & Cyanobacteria Blooms

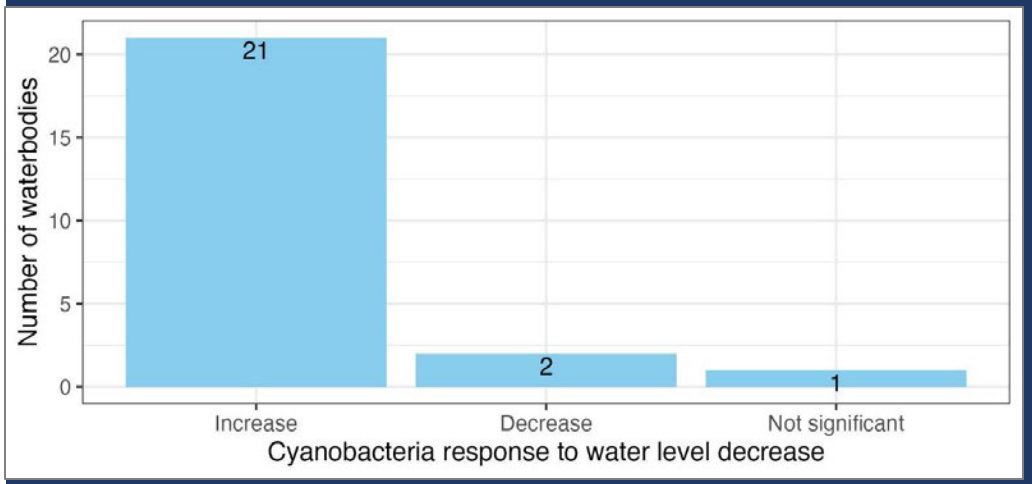
National Park Service
U.S. Department of the Interior

Science Report NPS/SR—2025/226
https://doi.org/10.36967/2307521

Assessing Risk for Enhanced Cyanobacteria, Phytoplankton, and Pathogens with Changes in Water Level Regime with Potential Application to Lake Powell and Lake Mead

A Mixed Methods Literature Review

A bloom of the cyanobacterium *Microcystis aeruginosa* in the spring and summer of 2015 caused parts of Lake Mead reservoir to turn bright green.
U.S. BUREAU OF RECLAMATION



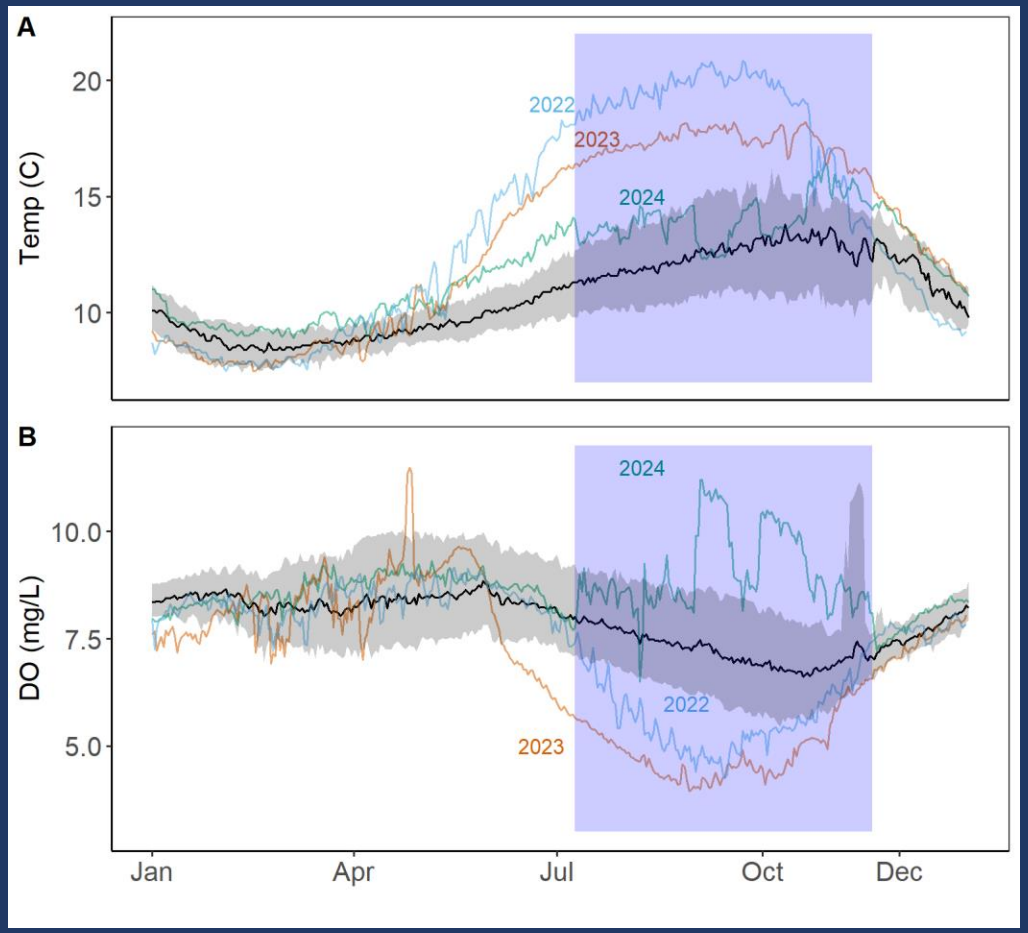
Hoffman et al. 2025

Downstream Water Quality

Water release temperatures in 2024 did not exceed 15 ˚C due to Cool Mix flows.

High dissolved oxygen concentrations during the cool mix time frame resemble those observed during fall High Flow Experiments.

Water quality record from the Colorado River at Lees Ferry, AZ (gage # 09380000) for temperature (A) and dissolved oxygen (B). Light blue, orange, and green lines show daily median values from 2022, 2023 and 2024 respectively (medians are from the continuous data record, logging at 15-minute increments). Black lines show the long-term median value for each parameter and the grey bands represent the daily 10th and 90th quantiles of temperature and dissolved oxygen. Blue shaded bars show the duration of the 2024 cool mix flows. The water quality record represented in this figure contains 10 years of data for temperature and dissolved oxygen. *Data from this site are currently posted and available through February 2025 at https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09380000#

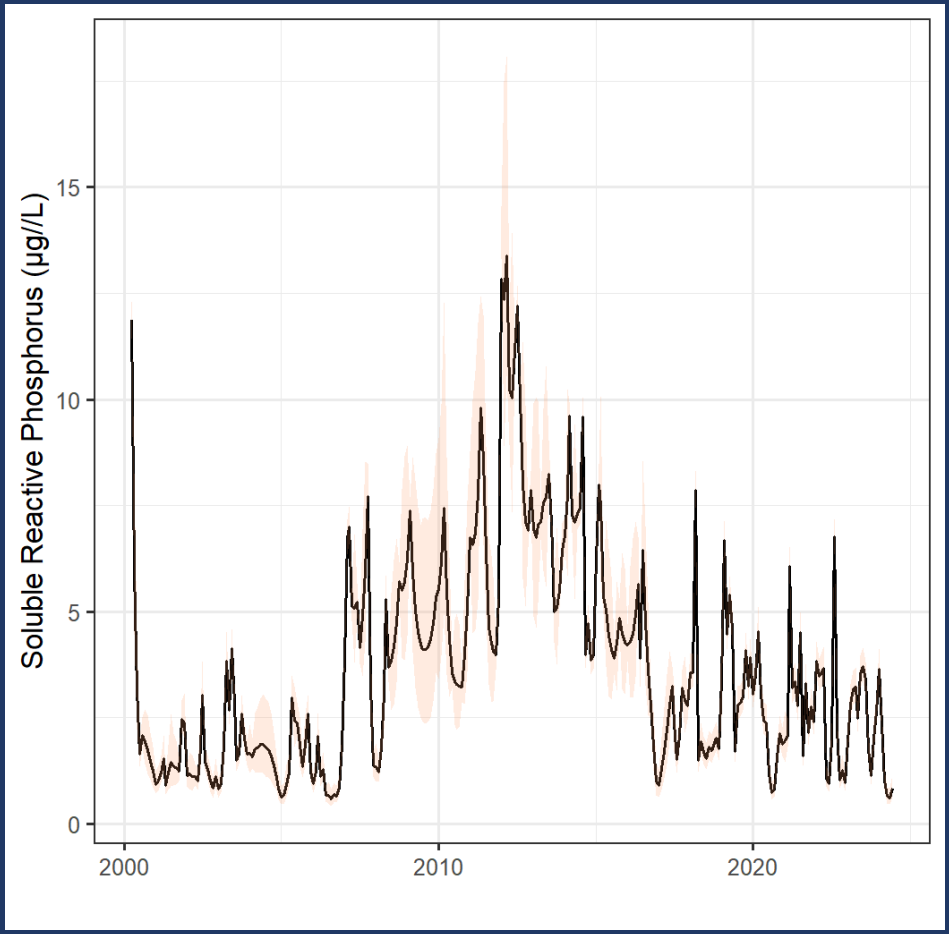


Downstream Water Quality

Soluble reactive phosphorus (SRP) is the most biologically available form of phosphorus to plants and microbes.

SRP concentrations in Glen Canyon have been related to drift and to Rainbow Trout growth.

SRP concentrations have been relatively low in recent years compared to in the early 2010s.



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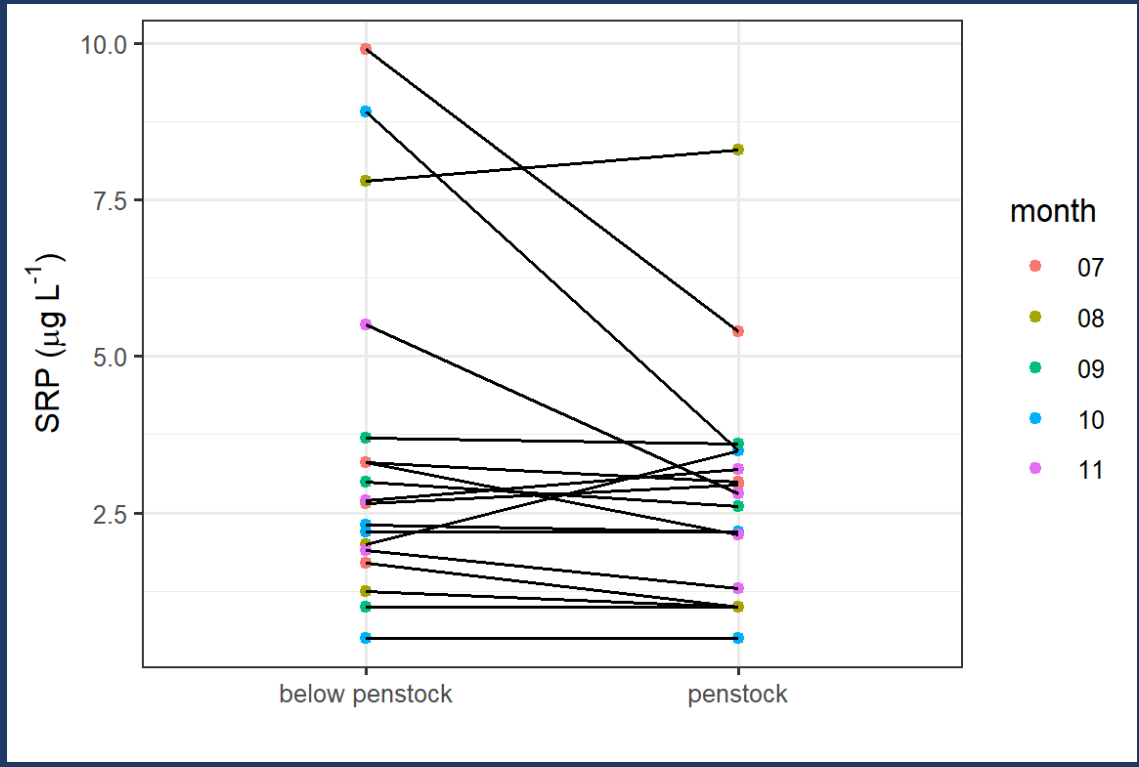
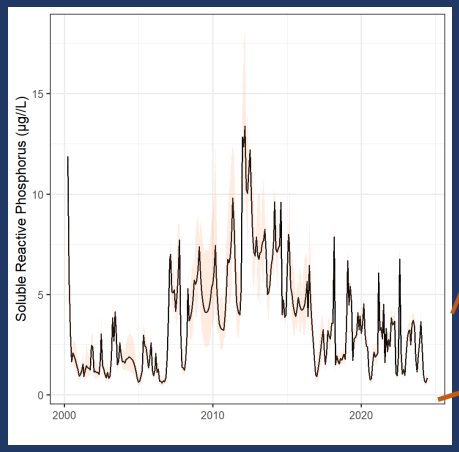
Downstream Water Quality

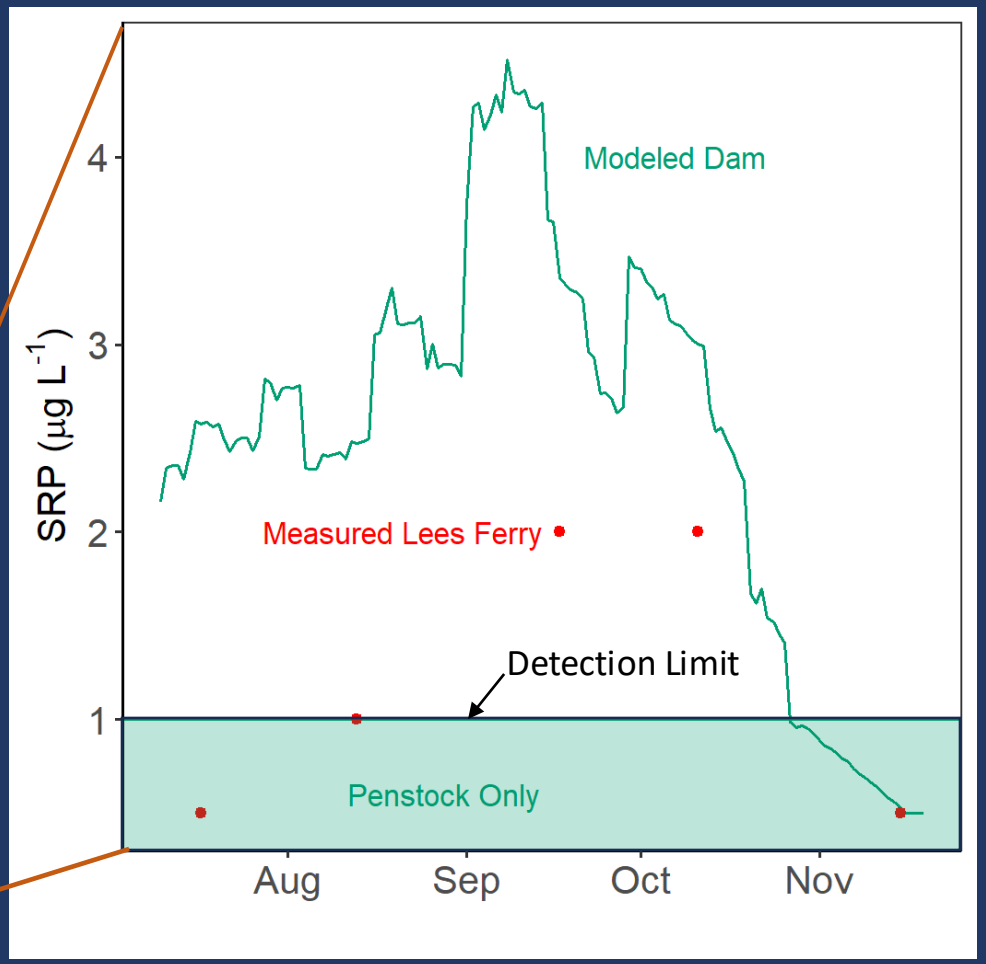
- Soluble reactive phosphorus concentrations are higher deeper in the reservoir
- Bypass spill during cool mix should elevate P availability in Glen Canyon



Downstream Water Quality

SRP in 2024 was relatively low, but cool mix at least doubled the SRP concentrations released from the dam during most days

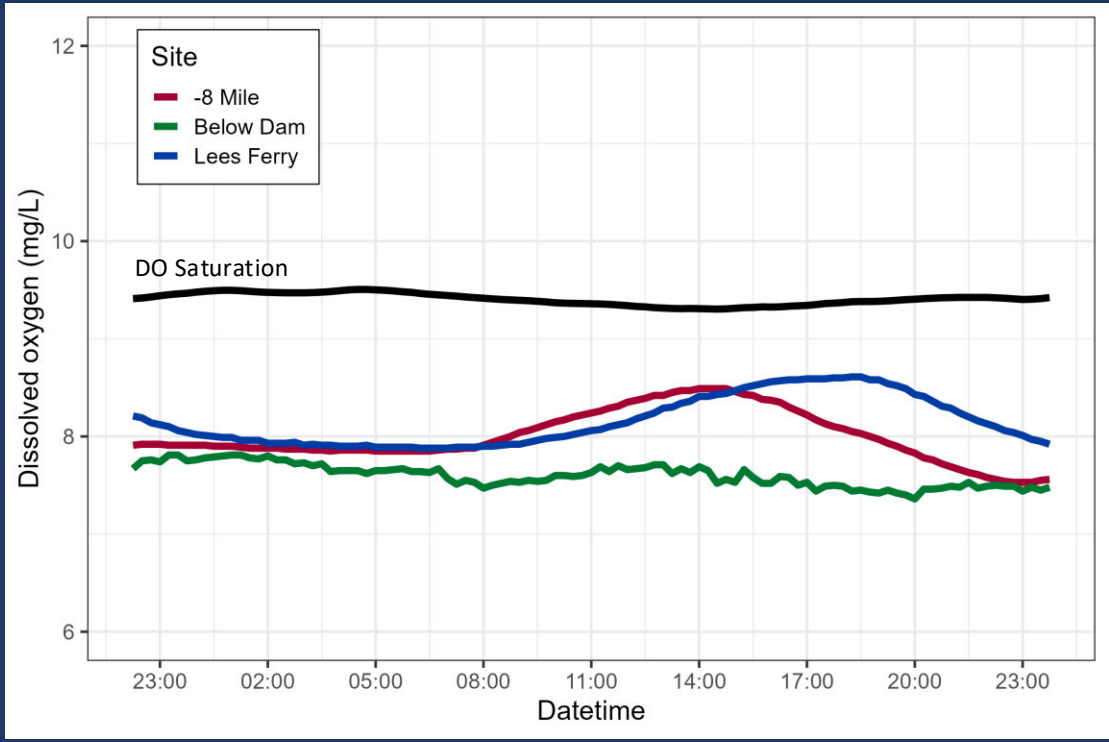




Downstream Water Quality

Photo Credit: Ian Bishop, Diatom-colonized macrophytes, downstream of Waterholes Canyon, Sept 30, 2024

Downstream Water Quality



- DO levels change as water moves downstream for both biotic and abiotic reasons:
  - Gas exchange between water and air
  - Daytime photosynthesis by macrophytes and diatoms
  - Continuous respiration by all biota

Downstream Water Quality

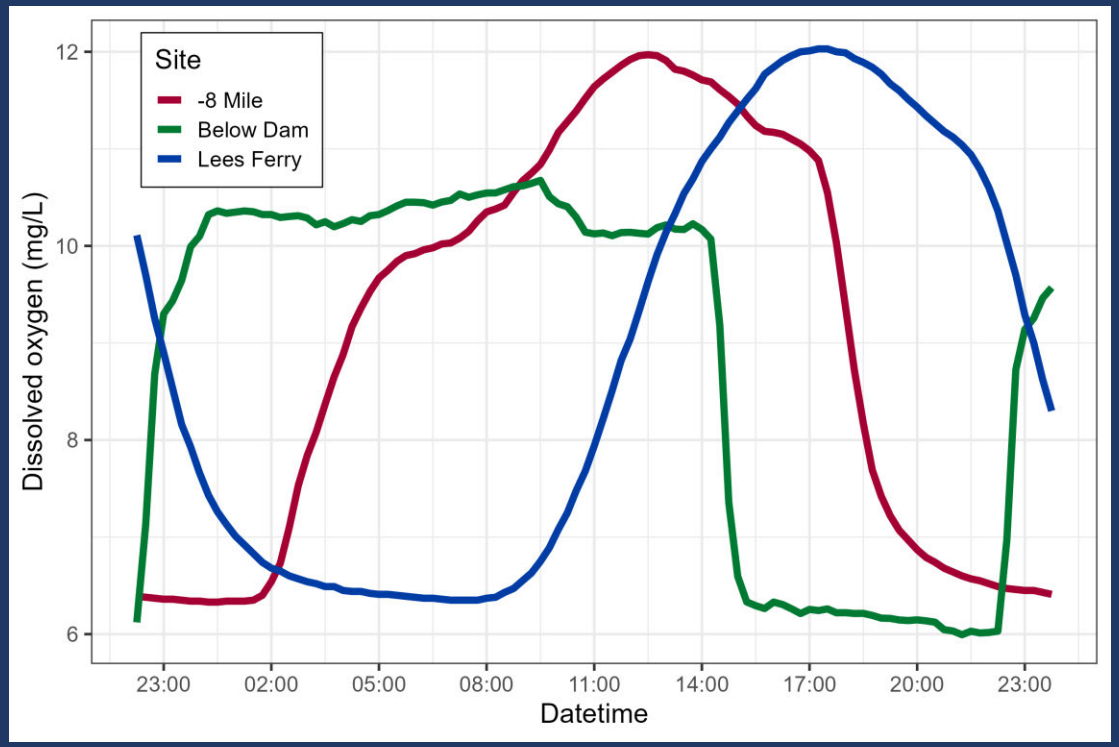


Photo Credit: Bridget Deemer, Cool Mix Bypass Release, November 14, 2024

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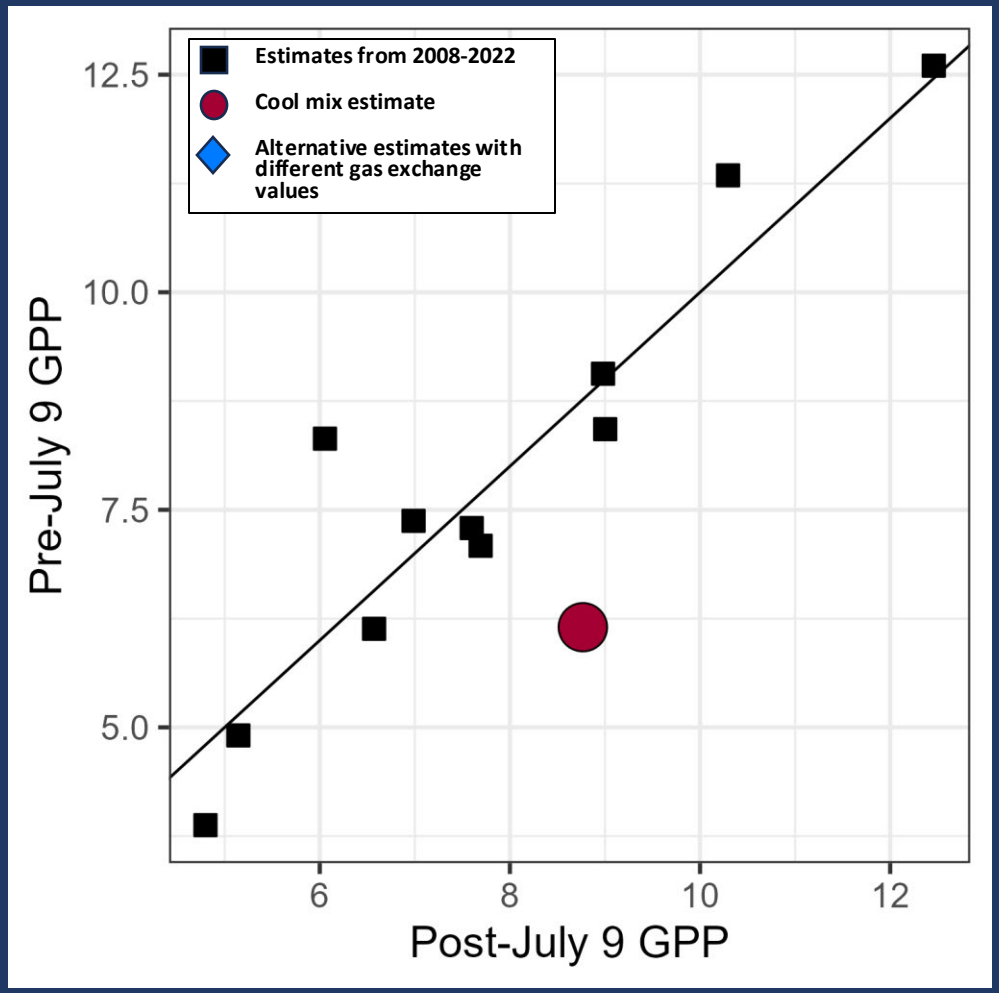
Gross Primary Production

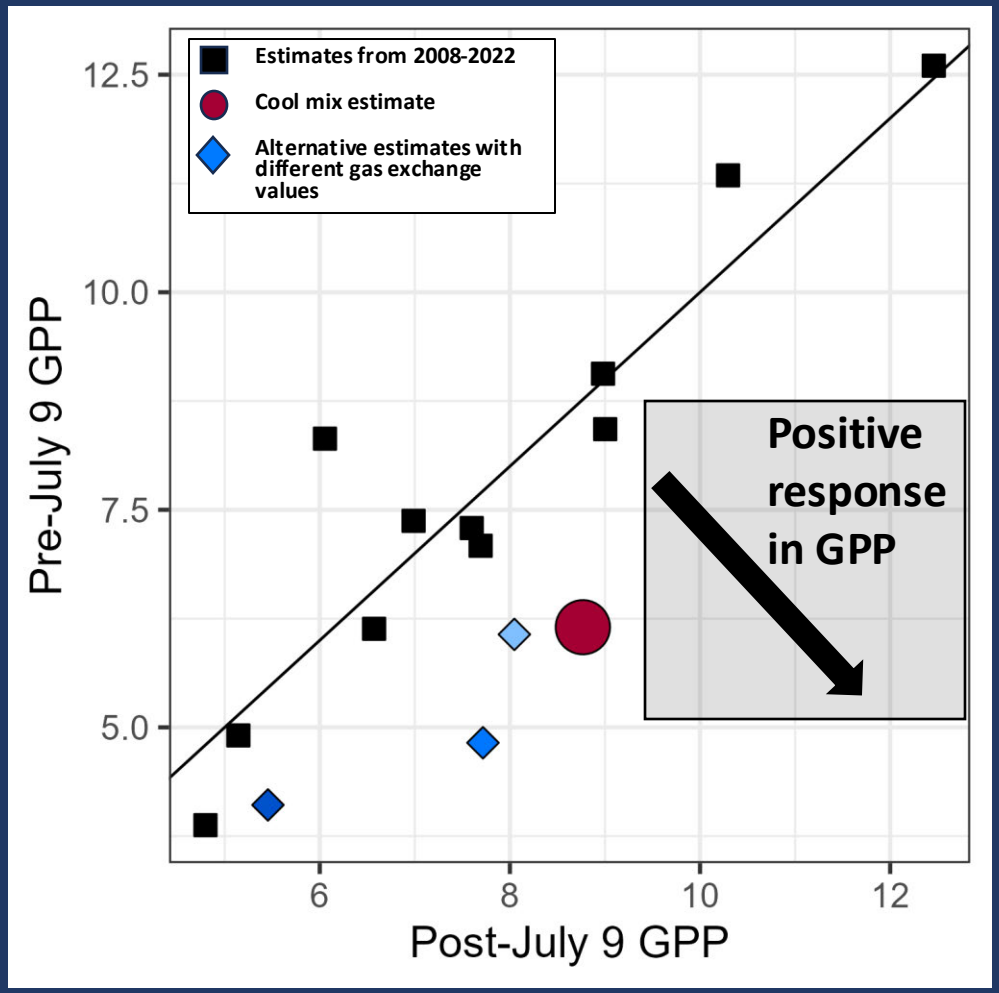
- GPP is more complicated to model in tailwaters than further downstream
  - DO undersaturation
  - Subdaily variable flow
- We developed a new model to specifically estimate tailwater metabolism. It performs very well under most conditions, but HFEs and Cool Mix make estimating gas transfer challenging
- We fixed gas transfer at several commonly observed values to test GPP response to Cool Mix

Gross Primary Production



- Tailwater GPP increases in response to cool mix flows, no GPP increases detected during same period in earlier reference years.
- Each point represents mean GPP (mg O_2 m^{-2} d^{-1}) for the two weeks before vs. after July 9

Gross Primary Production



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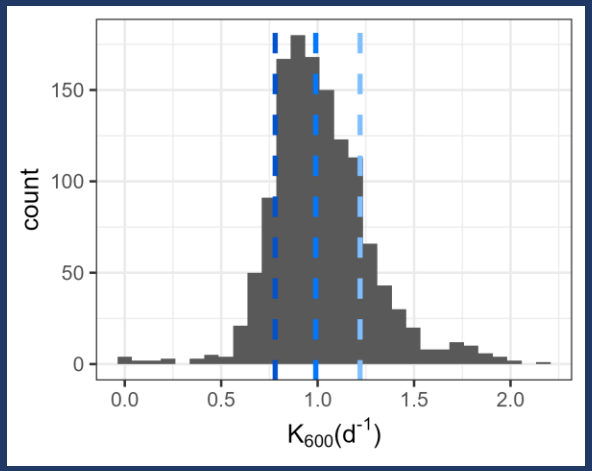

Conclusions

- We documented a Microcystis bloom at Wahweap on Lake Powell during a year with anomalously high fall surface water temperatures
- Cool mix resulted in colder water releases with higher dissolved oxygen and SRP concentrations
- Cool mix likely led to higher rates of GPP

Acknowledgements

- Ted Kennedy and Rob Payn
- Taryn Preston and Conor Clancy
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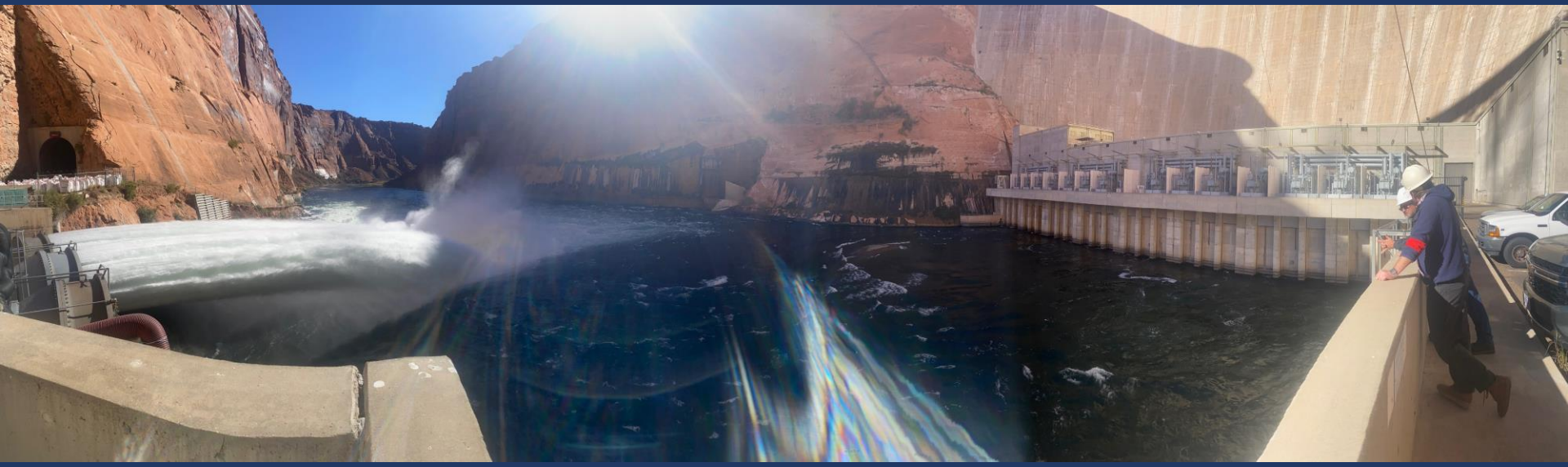
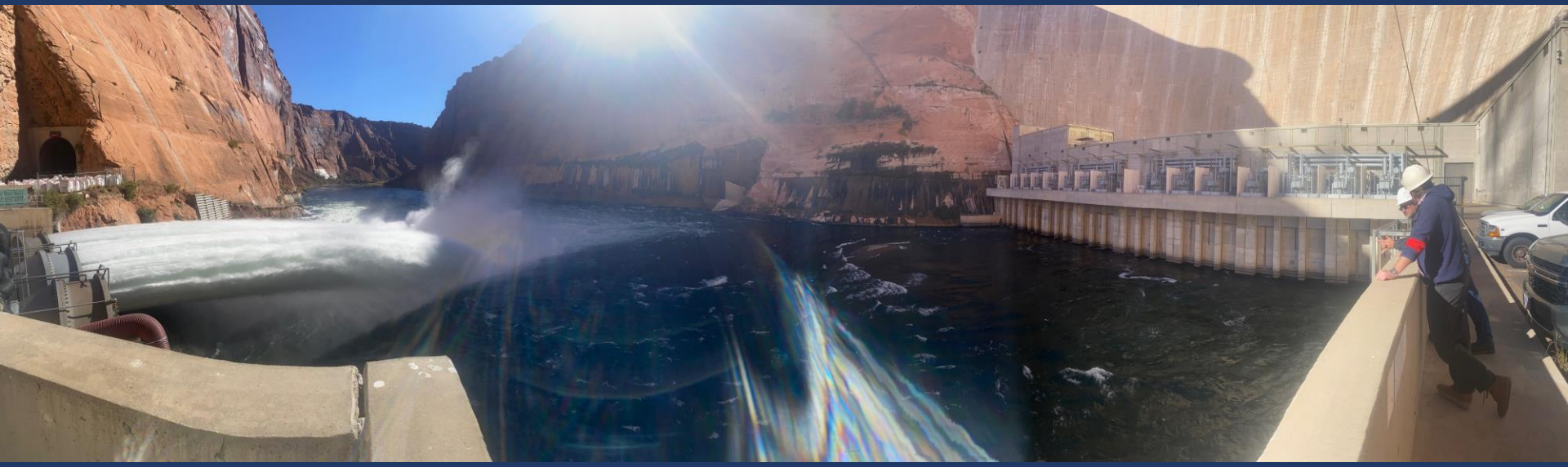


Photo Credit: Bridget Deemer, Cool Mix Bypass Release, November 14, 2024

Questions?



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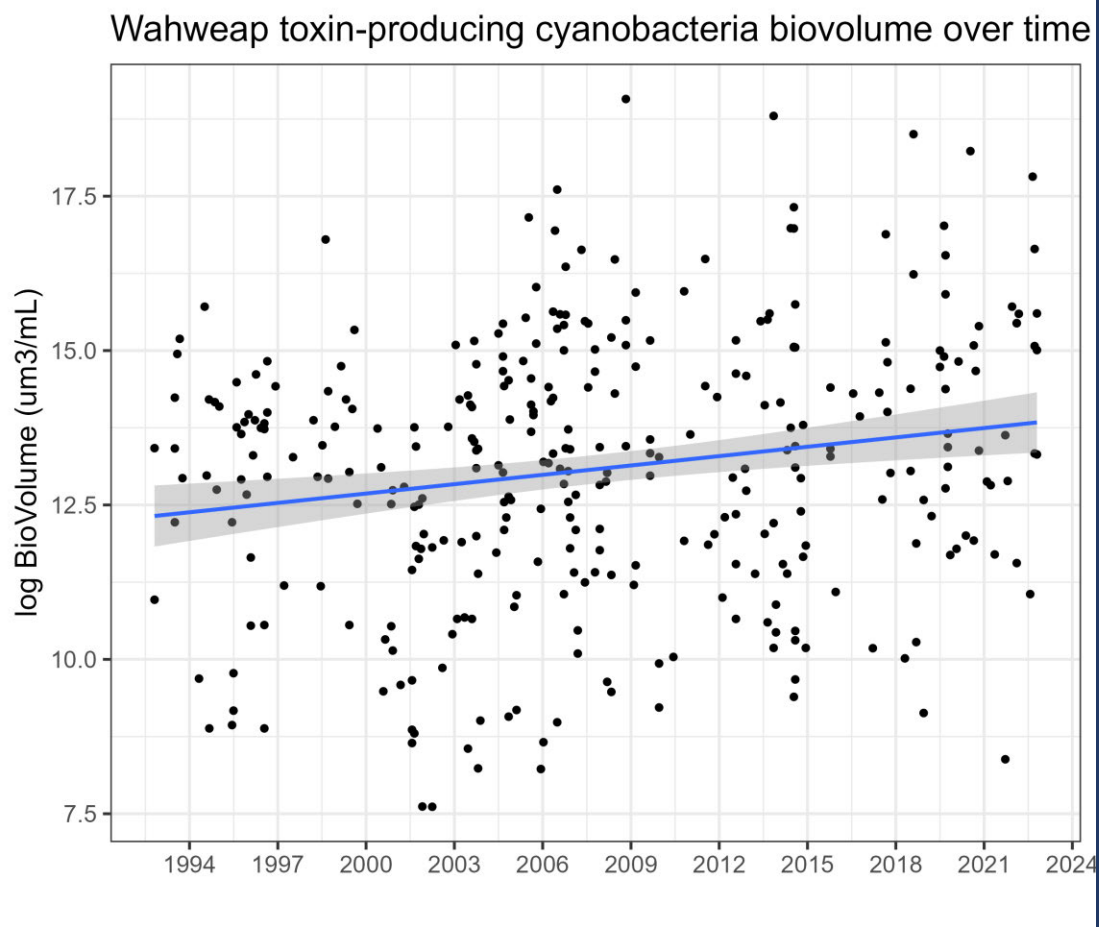
Lake Powell Water Quality



Data *from samples collected at 1m depth at 10 long-term sites in Lake Powell reservoir.*

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