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RECLAMATION

Glen Canyon Dam Air Injection Testing September 2023

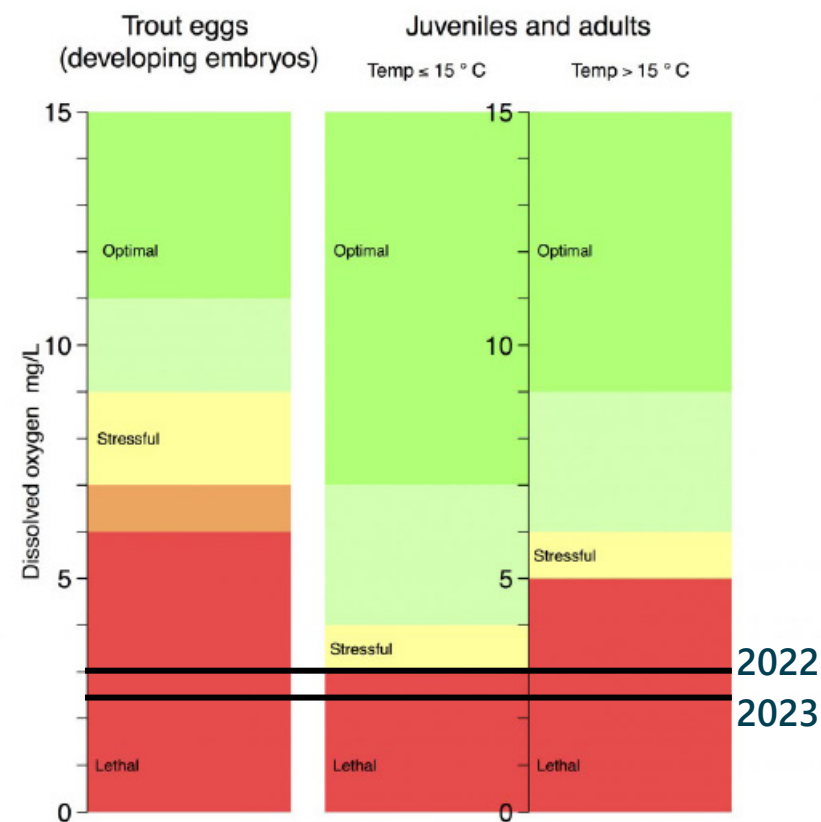
Clarence Fullard

WQG, AMWQ Division, UC Region

Background: Low DO in Glen Canyon

- Dissolved Oxygen concentrations:
 - 2.4 mg/L September 14, 2022
 - 2.9 mg/L September 19, 2023
- Low levels stress fish and cause mortality
- Reclamation and the GCDAMP is concerned about effects in Glen Canyon

Average dissolved oxygen requirements for salmonids
Genera *Oncorhynchus* which includes Rainbow Trout and *Salmo* which includes Brown Trout

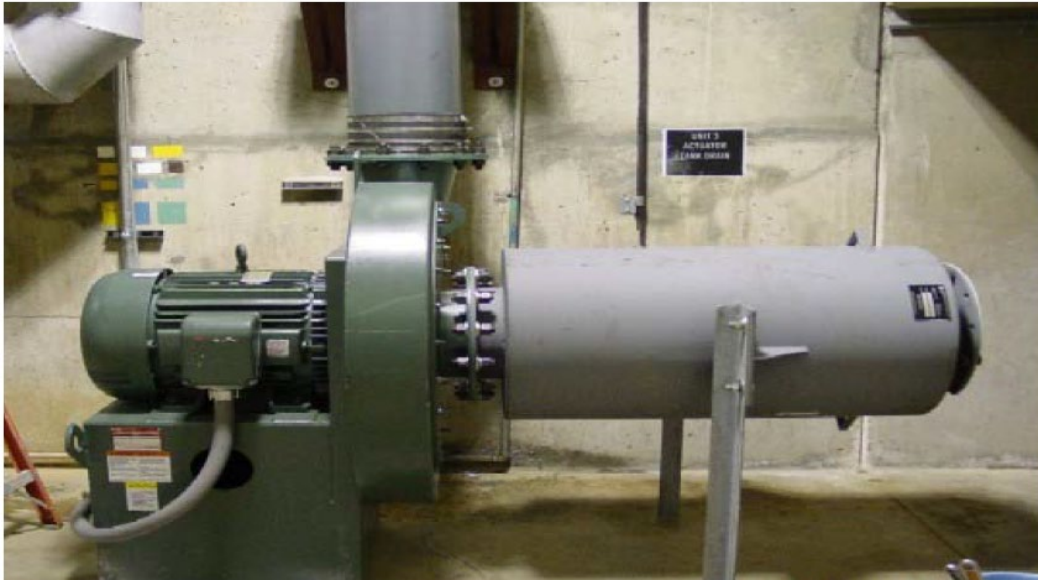


References: Chapman, G. 1986. Ambient water quality criteria for dissolved oxygen. U.S. E.P.A. EPA 440/5-86-003. 46 pp
Raleigh, R.F., T. Hickman, R.C. Solomon, and P. C.Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp
Raleigh, R.F., L. D. Zuckerman, and P. C.Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Brown trout, revised. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.124). 65 pp.

Image courtesy of Bridget Deemer and Ted Kennedy



Treatment: Air Injection



Turbine air injection blower at Canyon Ferry Powerplant

- Augment DO via air injected into draft tubes as it passes through GCD
- Successfully implemented by Reclamation at Canyon Ferry Dam, MT
 - Increased mean downstream DO from 4.6 to 6.0 mg/L
- GCD has service air system that is plumbed to draft tubes
 - No physical modifications needed for testing



Air Injection Testing

- Coordinated with GCD Operations in fall 2023 to test existing service air system for draft tube injection.
- Two short experiments
 - September 14, 9:30-10:15 am
 - September 18, 8:00-9:00 am
- Injected air into a single draft tube at a rate of ~1700 CFM
- Possible changes in DO monitored by sondes located:
 - Draft Tube 2 (baseline)
 - Draft Tube 8 (experiment)
 - Below Dam (USGS 09379901)
 - -8 mile in Glen Canyon



Testing Goals:

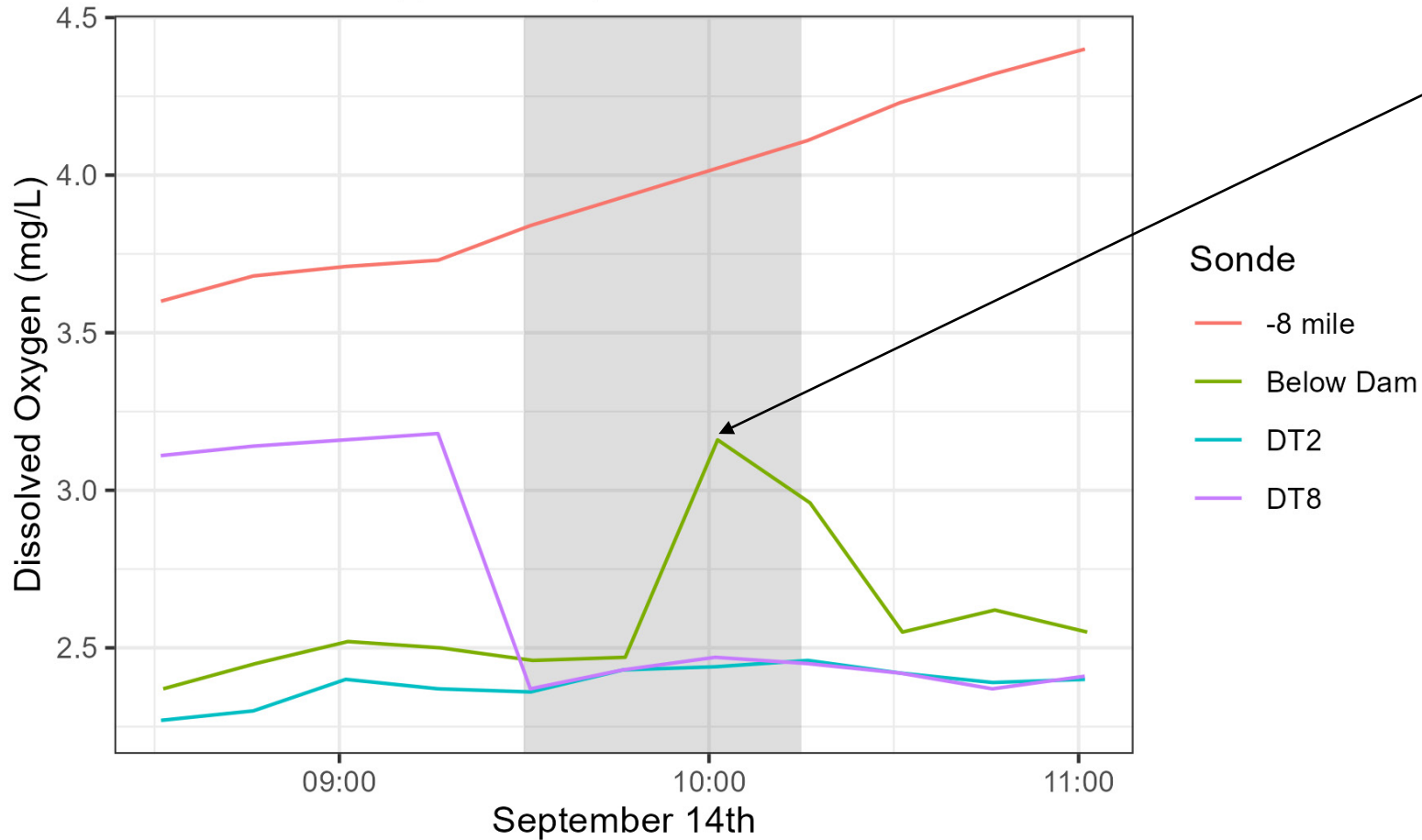
- Does this method measurably increase DO?



Results – September 14th 9:30-10:15

September 14th Test

Shaded area is approximate period of test



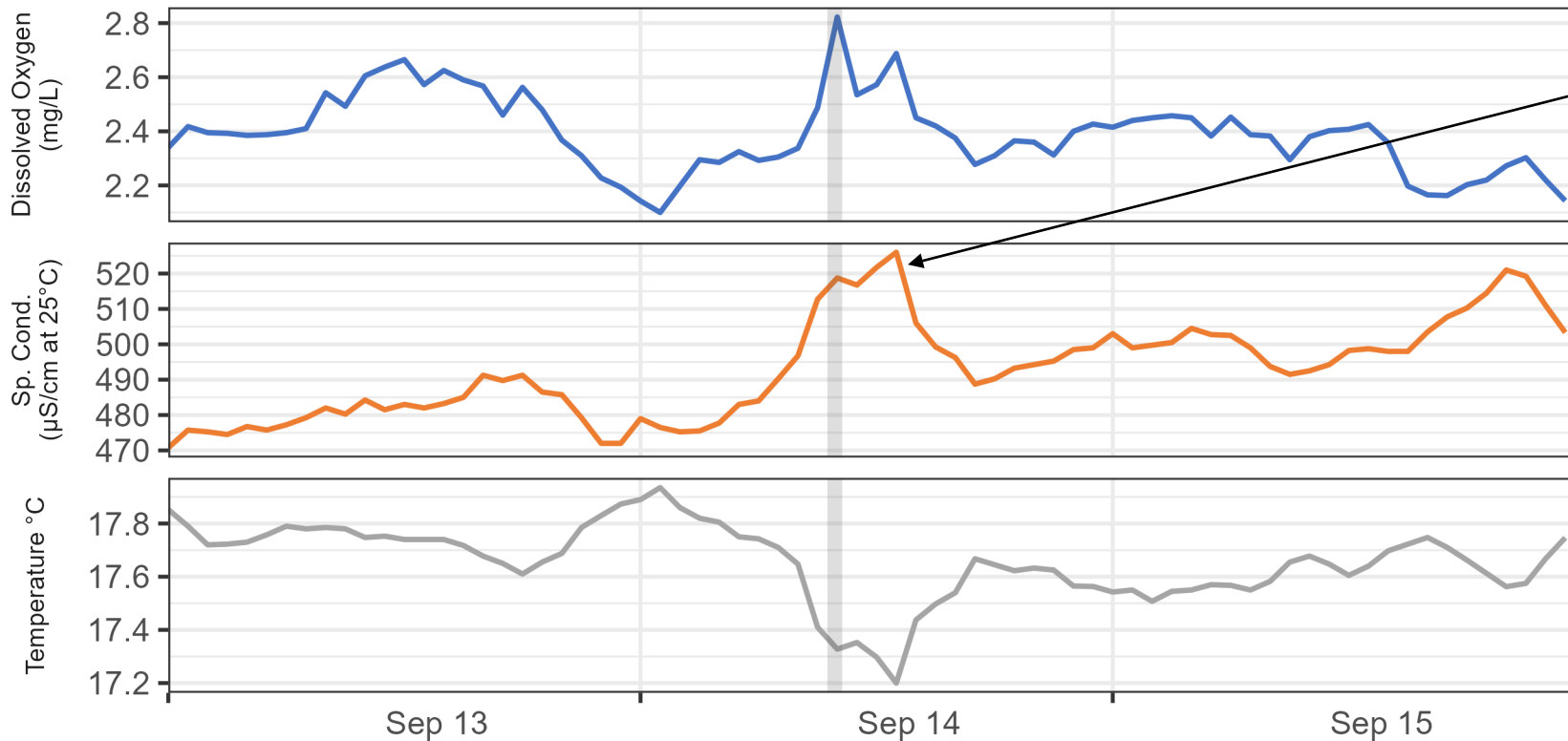
Minor increase in DO immediately below dam during test period, but also an increase in Draft Tube 8 (DT8) preceding start of test.



Results – September 14th 9:30-10:15

Observed Water Quality at Glen Canyon Dam

These data are preliminary or provisional and subject to revision



At time of test, observed a concurrent increase in Specific Conductance and decrease in Temperature

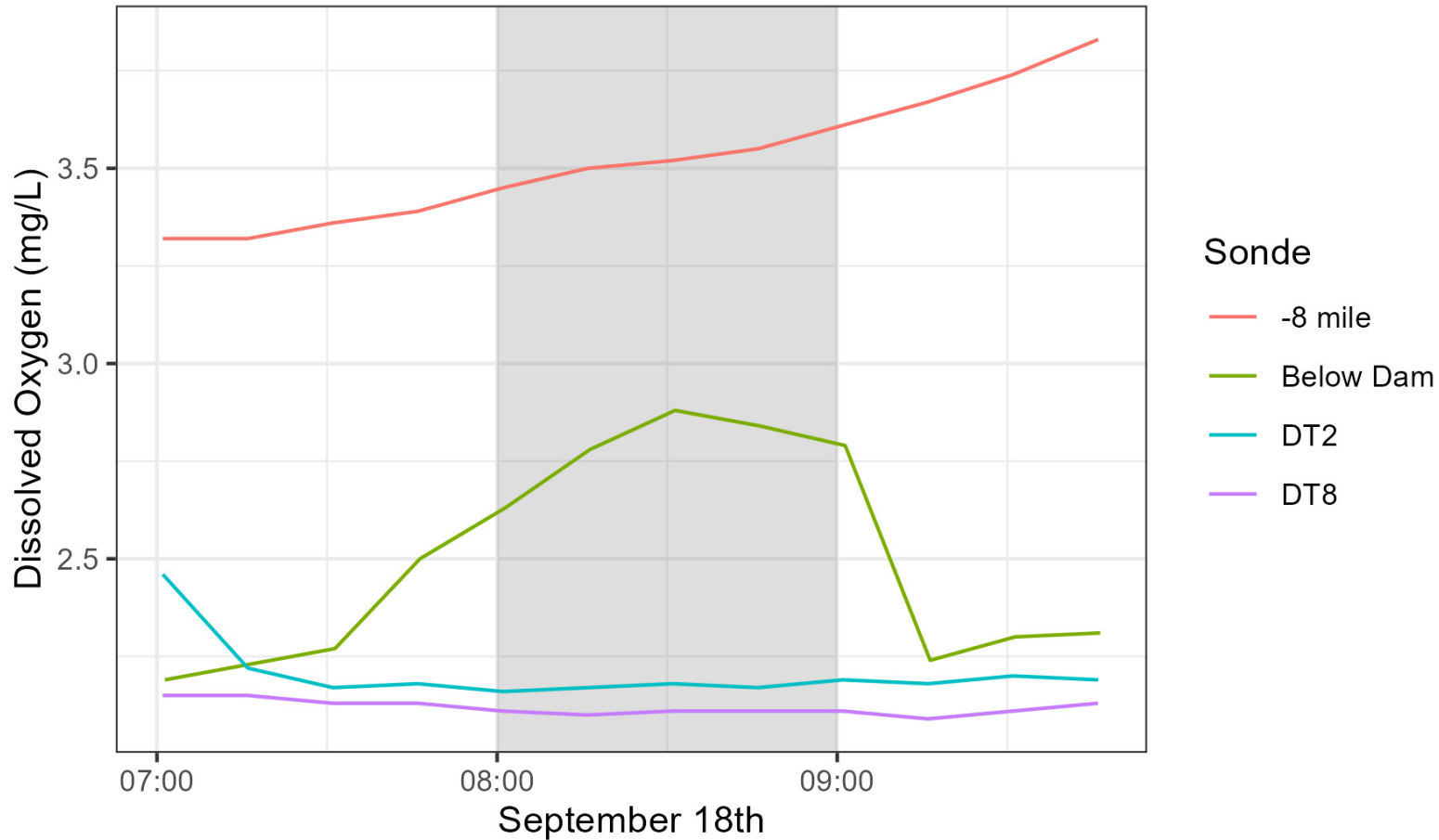
Due to this uncertainty, scheduled a second test for Sept. 18th



Results – September 18th 8:00-9:00

September 18th Test

Shaded areas is approximate period of test



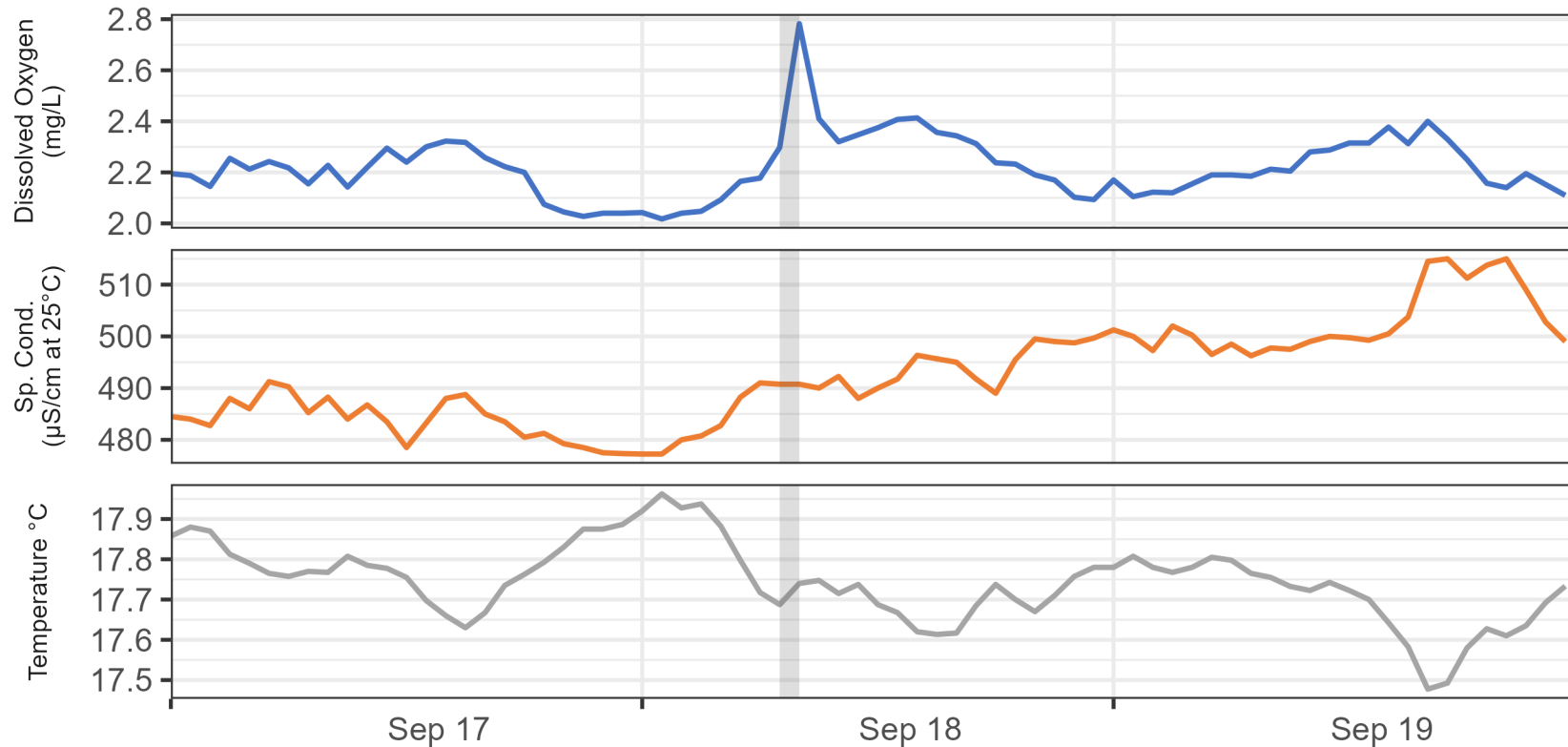
For this test, we see an increase above the baseline DO measured in DT2 and DT8 during the period of testing.



Results – September 18th 8:00-9:00

Observed Water Quality at Glen Canyon Dam

These data are preliminary or provisional and subject to revision



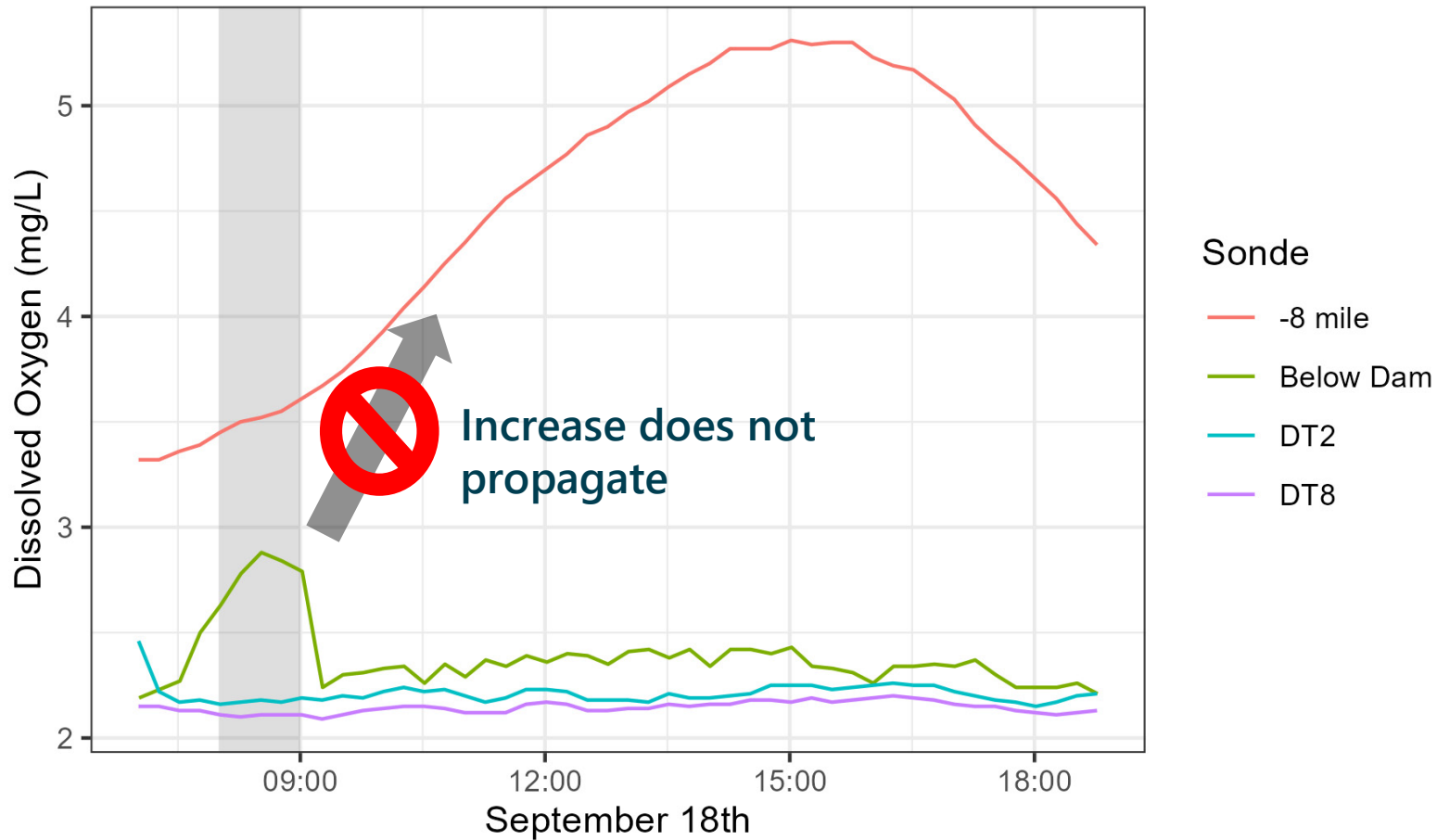
Other WQ parameters stay more stable during test, giving more evidence to air injection increasing DO immediately below dam



Results – September 18th 8:00-9:00

September 18th Test

Shaded areas is approximate period of test

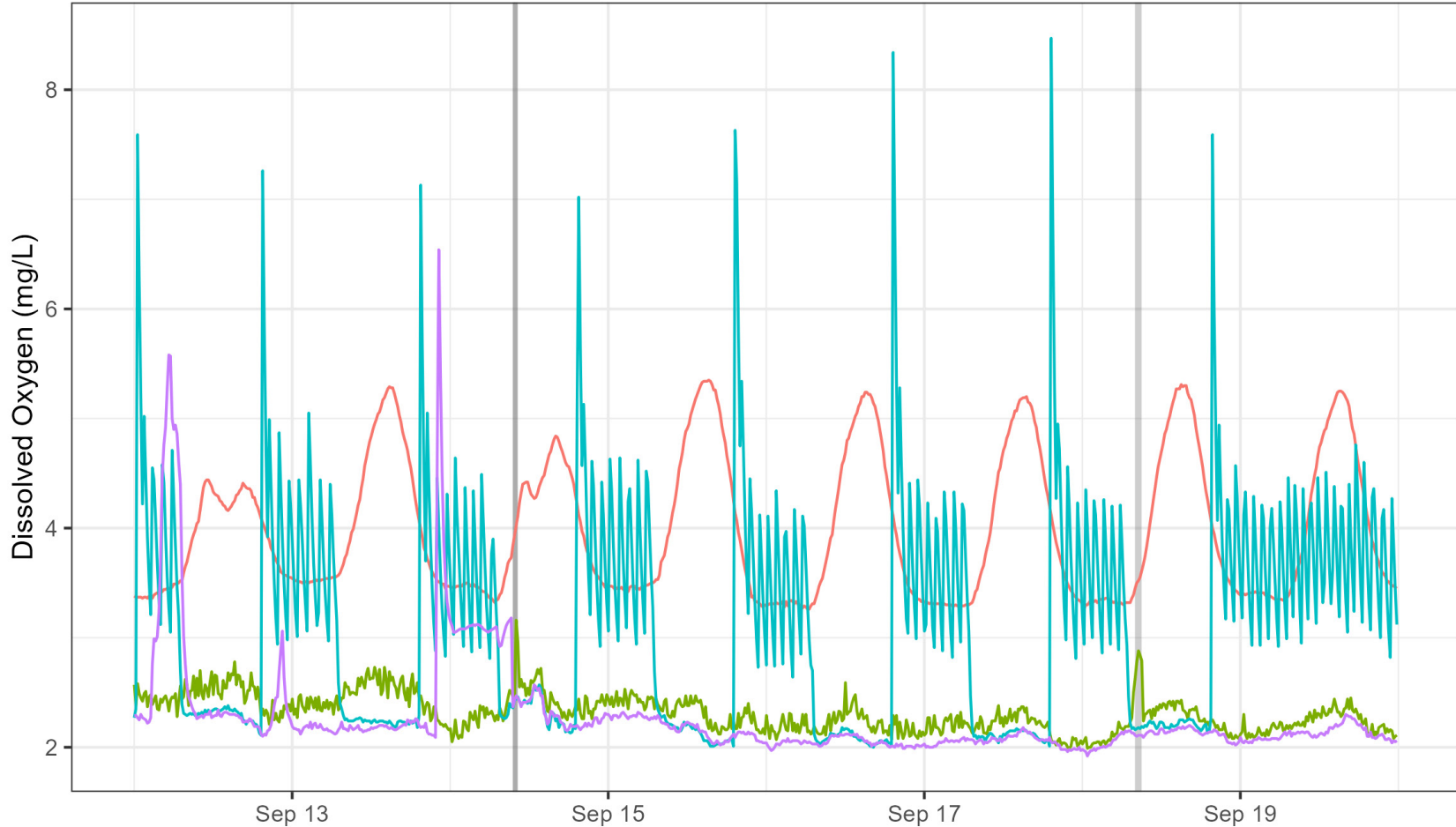


No measurable increase in DO recorded downstream in Glen Canyon.



Test Period

September Air Injection Test
Shaded areas are test periods



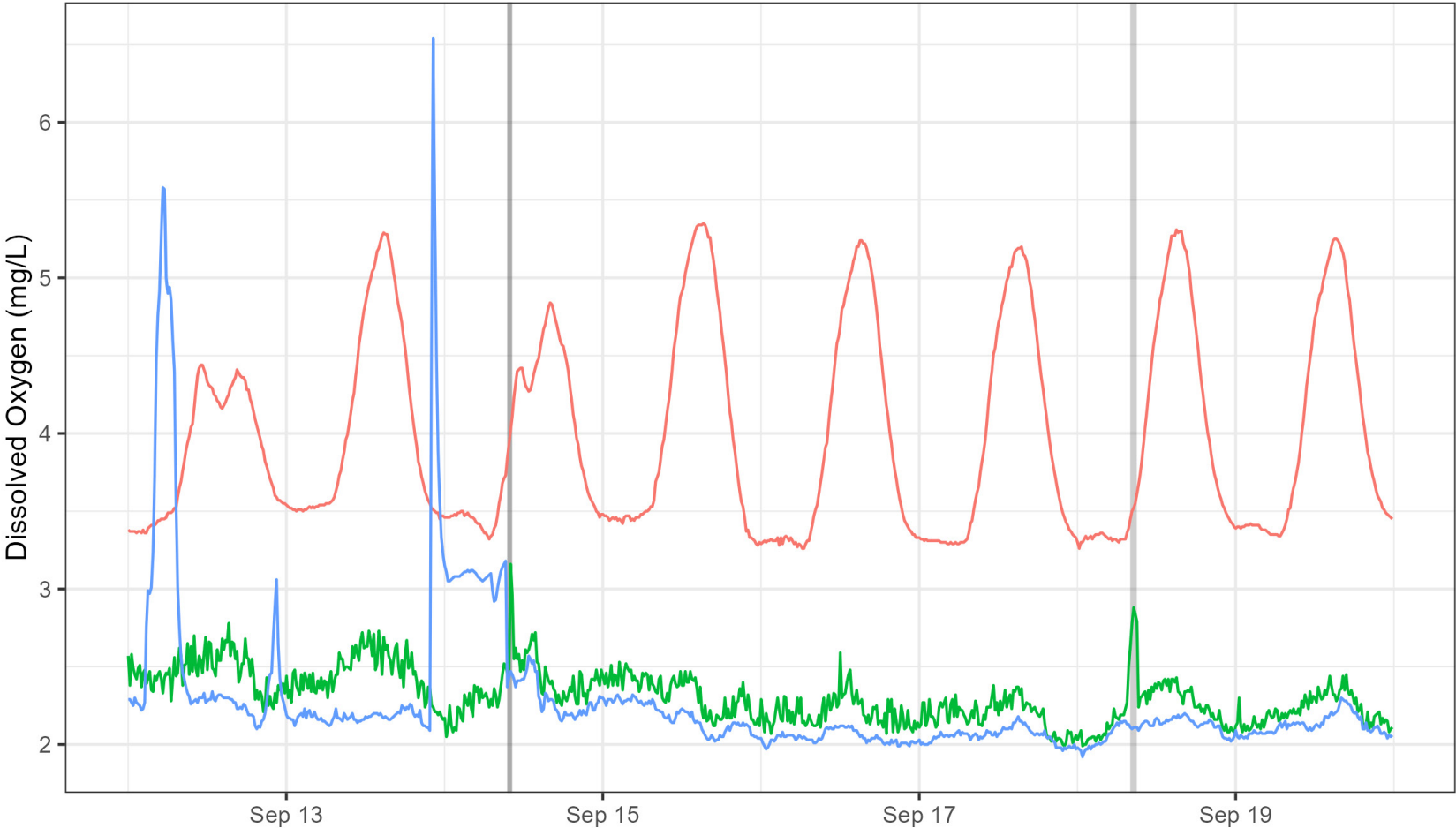
Extreme amount of noise in DT2 DO sensor during nighttime/lower flow periods, likely due to differing flow rates between draft tubes

- Sonde
- 8 mile
 - Below Dam
 - DT2
 - DT8



Test Period

September Air Injection Test
Shaded areas are test periods



Removing DT2 for clarity - possible increases in DO below dam do not register downstream.

- Sonde
- 8 mile
 - Below Dam
 - DT8



Testing Goals:

- Does this method measurably increase DO?
 - Yes...but also no
 - Did not create a measurable increase in DO downstream.



Takeaways

- In spite of ideal testing conditions (low flows, low starting DO, max possible air injection), we did not see any meaningful increase in dissolved oxygen propagate downstream.
- Air injection with existing equipment at GCD is not suitable for resolving low dissolved oxygen issues.



Potential next steps:

- Need to augment current system if we want more air or a longer test
 - Dedicated blower system.
 - Modify air lines in GCD for blower and to monitor flow rate.
- Understand effects at higher discharges.
- Understand effects on hydropower:
 - Estimated by staff to be marginal, but need dedicated monitoring.
- What are the DO dynamics downstream?
 - How does DO increase?
 - Preferred DO levels?
 - Marginal increase in survival for trout? Decision framework for initiating costly mitigation?



Acknowledgements

- **Glen Canyon Dam**
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