

Trout Metrics and Synthesis of Flow Effects on Trout Population Dynamics

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Management Program
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U.S. Department of the Interior
U.S. Geological Survey

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Background & Outline

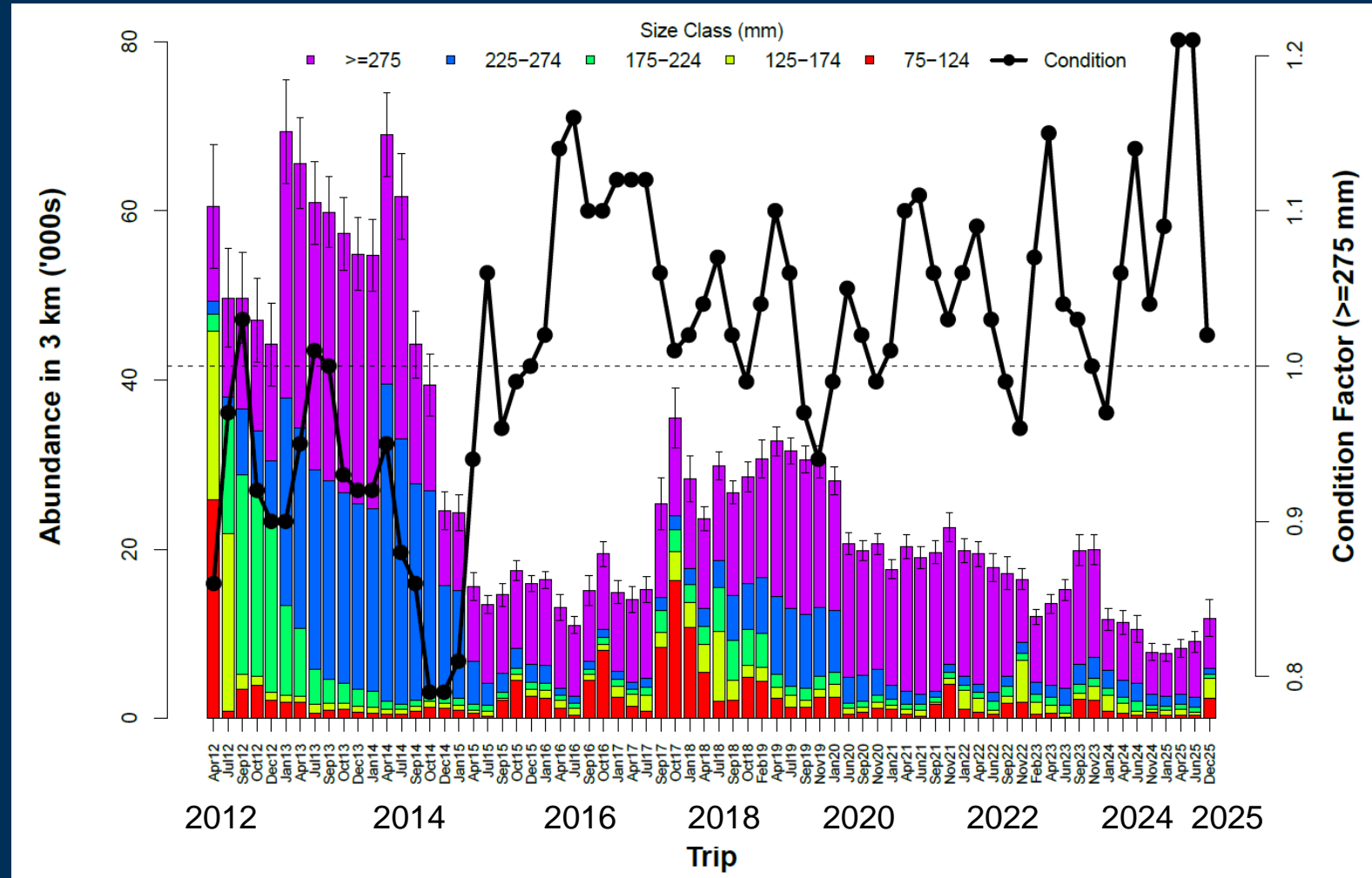
- Are we meeting the Long-term Experimental and Management Plan (LTEMP) goal?
 - *“Achieve a healthy high-quality recreational Rainbow Trout fishery in Glen Canyon National Recreation Area...”*
- Presentation 1-
 - Overview of metrics and abundance trends - Trout Growth and Recruitment Dynamics (TRGD) project results
 - Review history of Glen Canyon Dam flow experiments
 - >20 events
 - Highlight relevant examples and research findings
 - Next steps and discussion of ongoing trout research and planned value of information analysis
- Presentation 2-Lucas Bair
 - Relationships between trout and effects to other resources
- Presentation 3-Dale Fonken
 - Angler catch rate metrics, angler satisfaction, and angler participation
- “Take home message” – fishery goals are not being met

Rainbow Trout Fishery - Metrics

- Angler catch rates (1 fish/hour)
 - See Part 3
- Abundance
 - Age-1+ (April)
 - Indicator of potential downstream dispersal (e.g., concern related to Humpback Chub)

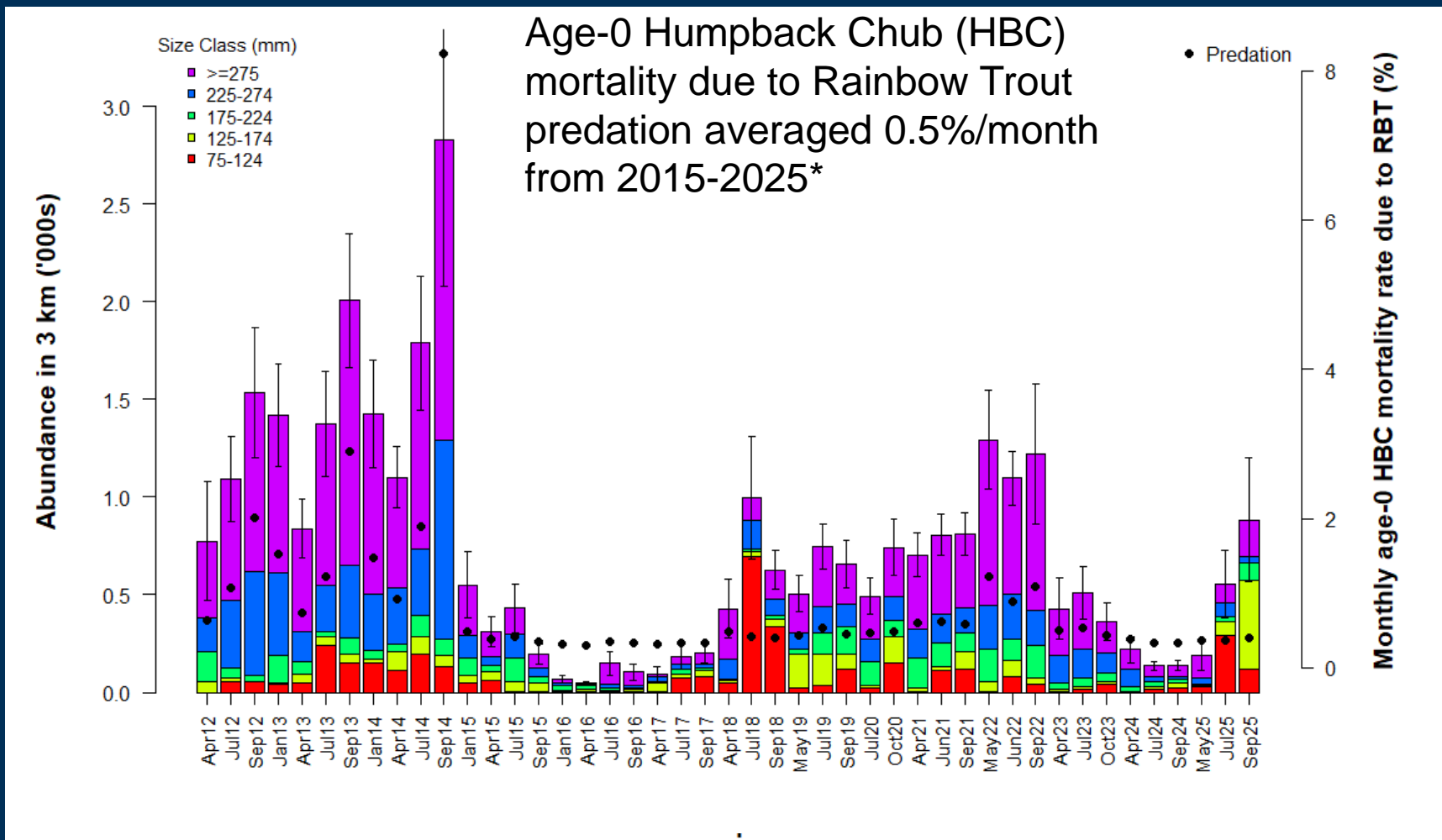


Rainbow Trout Abundance – Glen Canyon Site 1C



Preliminary unpublished data, do not cite

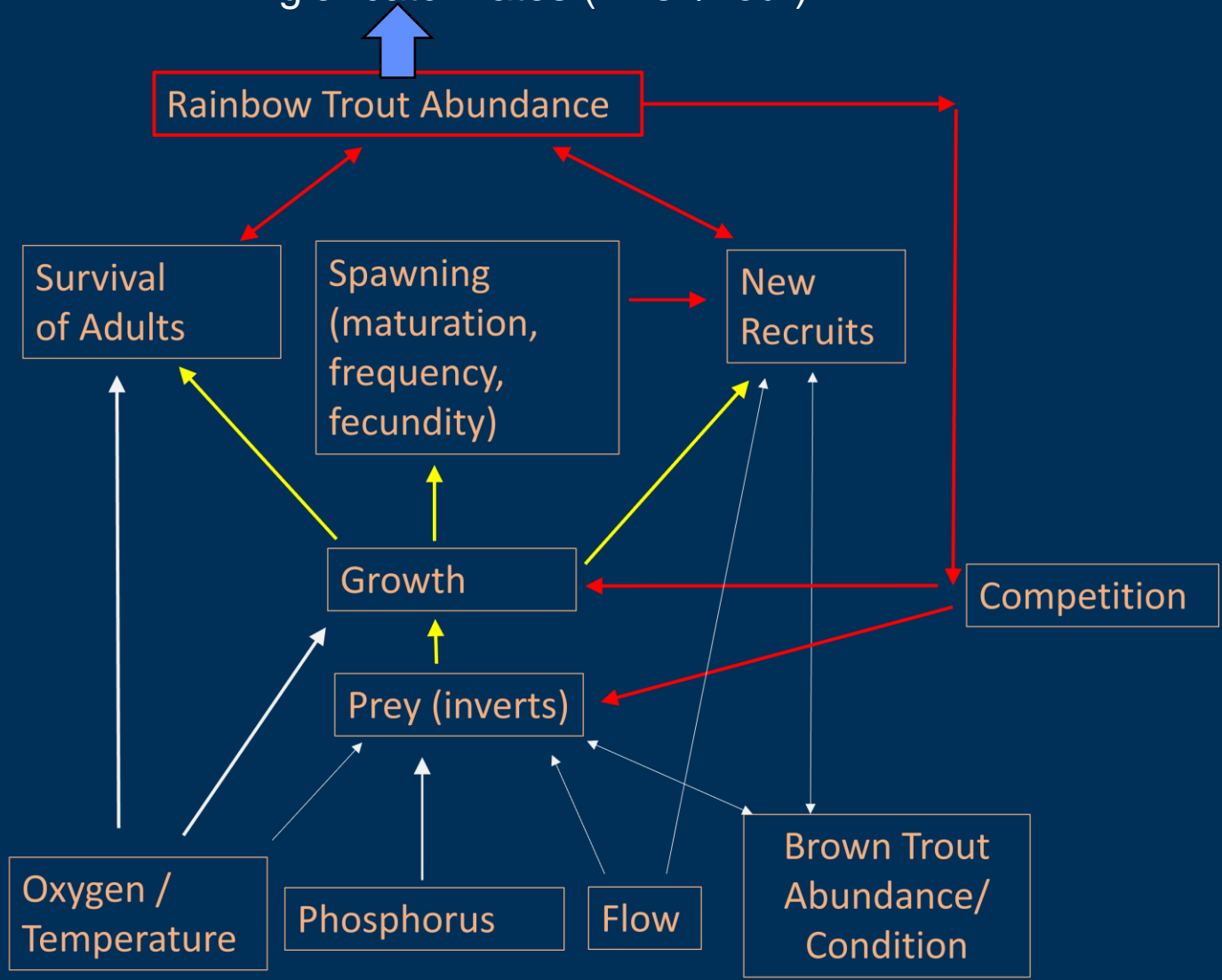
Rainbow Trout Abundance – Little Colorado River Inflow



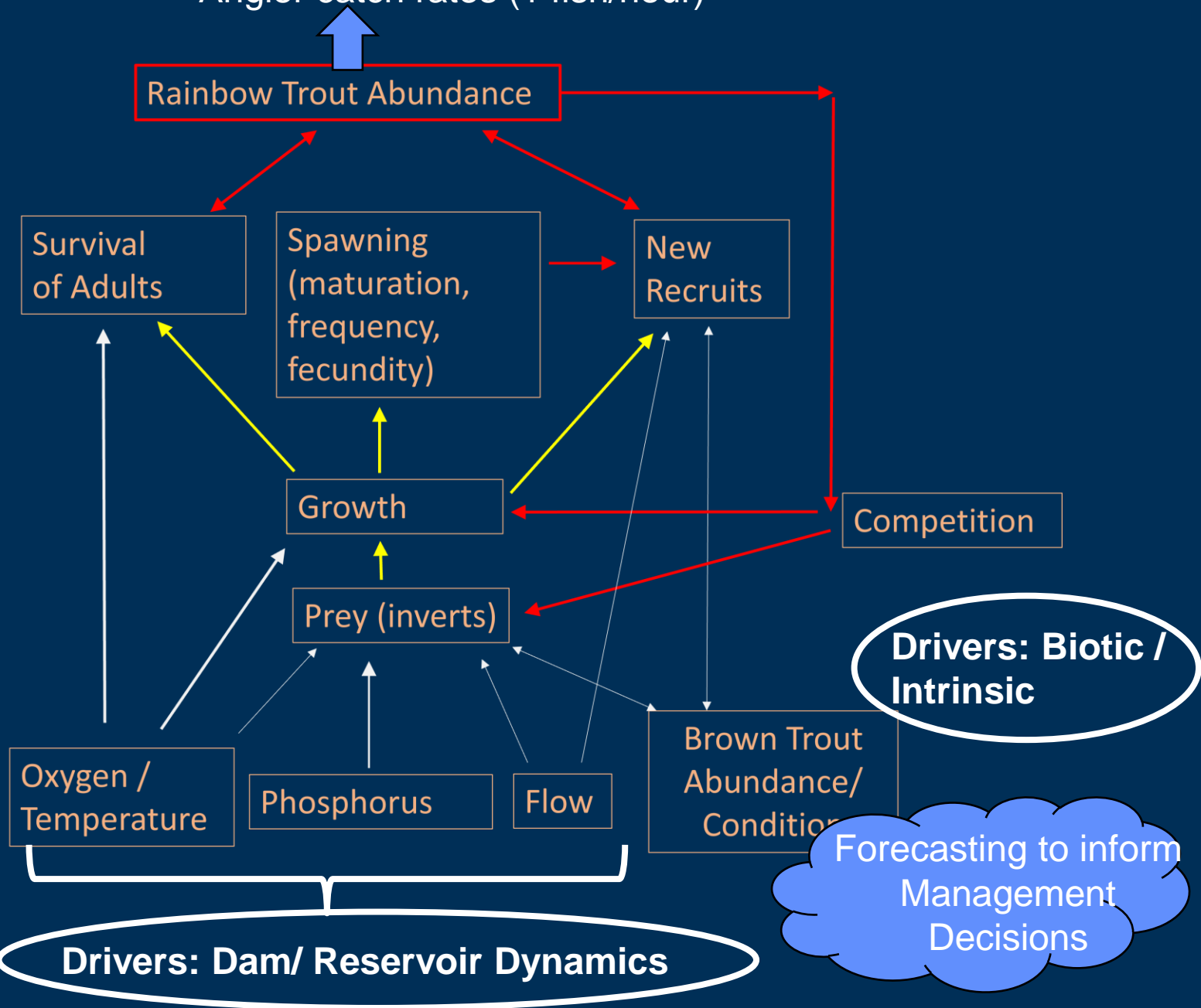
Preliminary unpublished data, do not cite

*Results modeled using methods in Yackulic and others, 2018, DOI: 10.1002/ecy.2166

Angler catch rates (1 fish/hour)



Angler catch rates (1 fish/hour)



Drivers: Dam/ Reservoir Dynamics

Drivers: Biotic / Intrinsic

Forecasting to inform Management Decisions

Flow Experiment Summary



Flow	Primary Objective	Design considerations/ timing	Replicates
High flow experiments	Conserve sediment & beaches	Triggered by sediment loading	Spring (3) Fall (6)
Low steady summer flows	Improve native fish growth & recruitment	Summer (June-Sept.)	2000 (1)
Nonnative fish suppression flows	Reduce Rainbow Trout recruitment	Spring (January-March)	2003-2005 (3)
Fall steady flows	Stabilize shoreline habitats for native fish rearing	Limited to fall	2009-2012 (4)
Macroinvertebrate production flows	Improve egg-laying conditions	Weekends May-August	2018-2020, 2022 (4)
Coolmix	Suppress Smallmouth Bass reproduction	Summer	2024-2025



Flow Experiment Summary

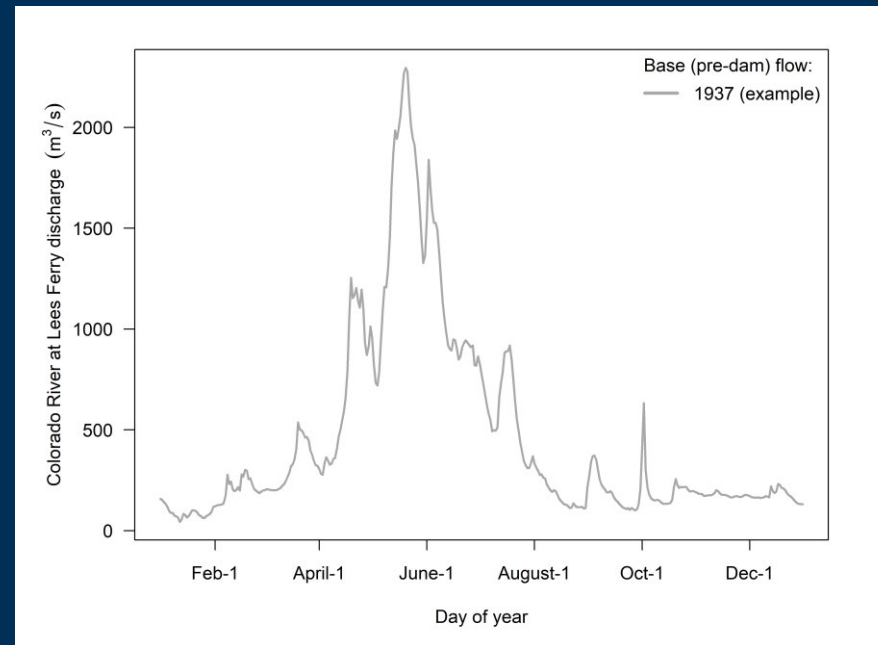


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Typical pre-dam hydrology

- Colorado River at Lees Ferry (1937)



Nonnative Suppression Flows

- Objectives:
 - Suppress recruitment of Glen Canyon Rainbow Trout (2003-2005)

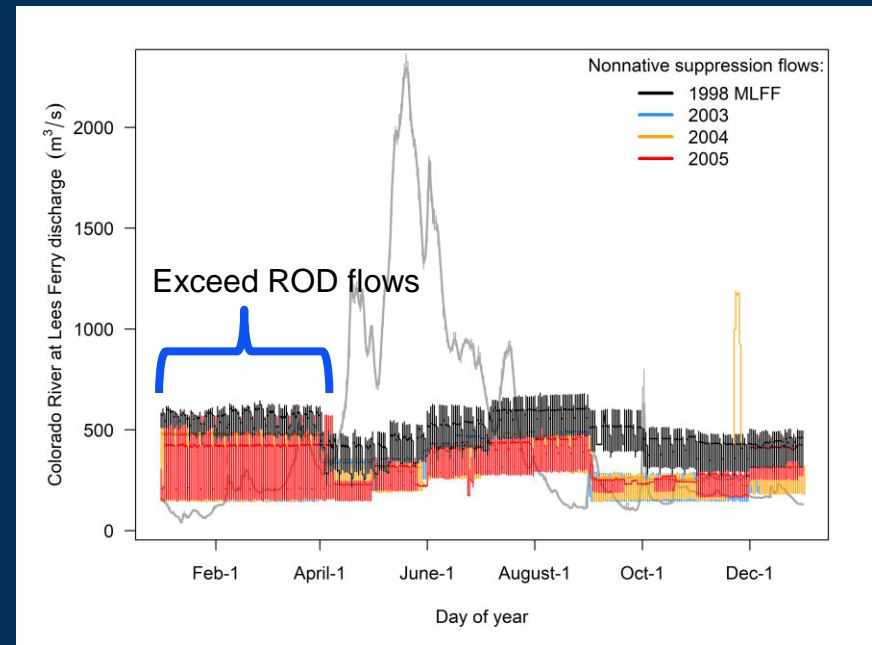
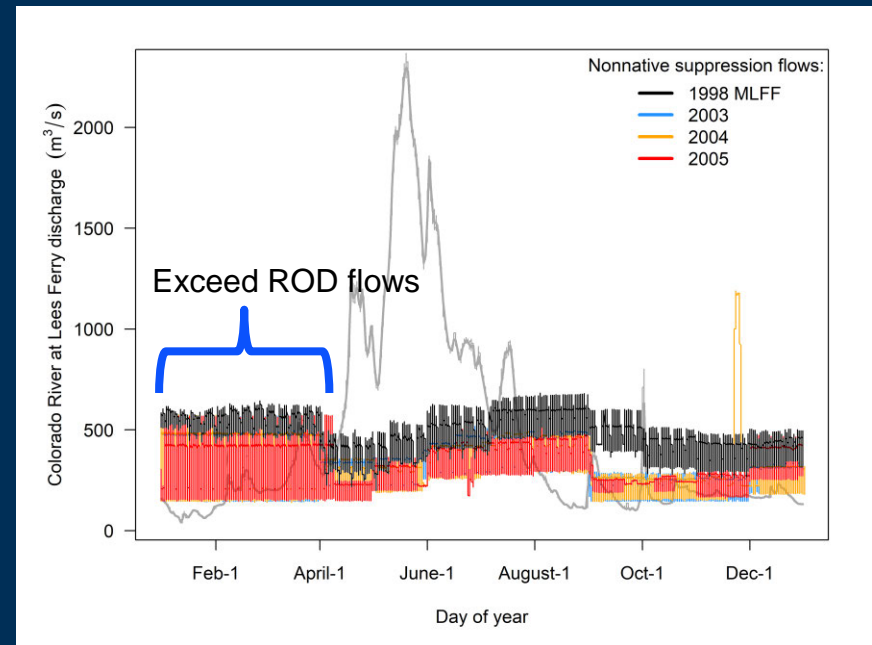


Illustration by Joe Tomelleri

Nonnative Suppression Flows

- Objectives:
 - Suppress recruitment of Glen Canyon Rainbow Trout (2003-2005)
- Result:
 - Incubation mortality increased (5-11% to 23-49%)
 - No effect on fry abundance



USGS data, gaging station: 09380000

Effects of Fluctuating Flows and a Controlled Flood on Incubation Success and Early Survival Rates and Growth of Age-0 Rainbow Trout in a Large Regulated River

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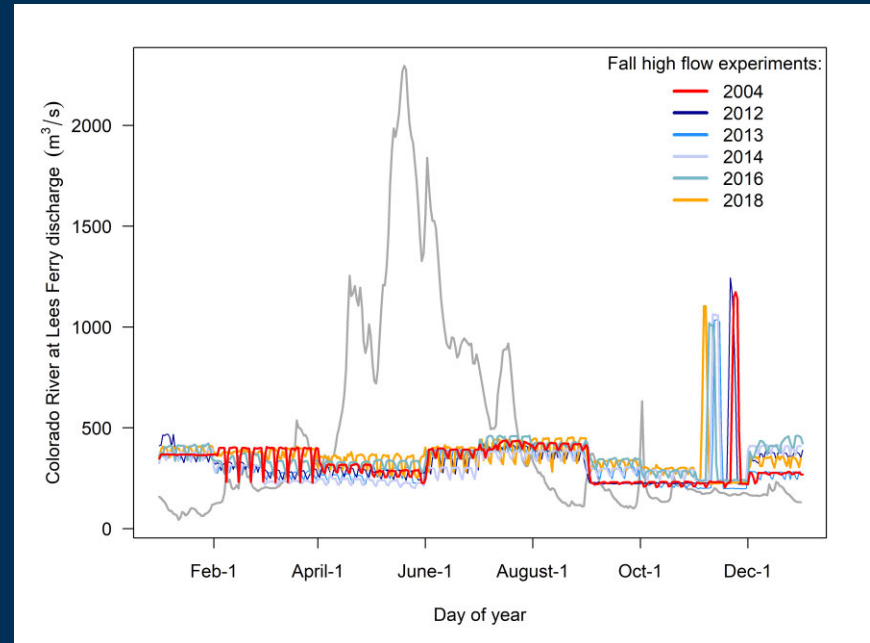


High Flow Experiments

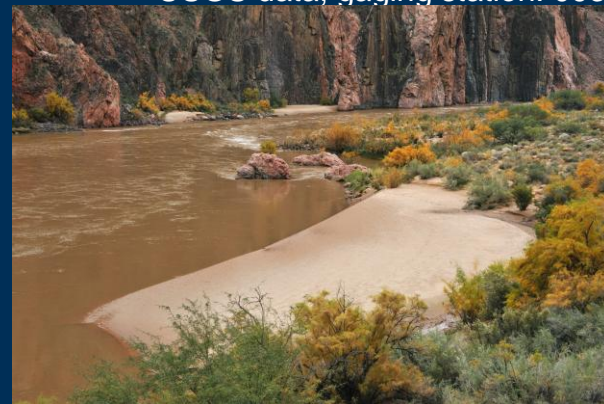
- Objectives:
 - Build beaches
 - Backwater habitats



USGS photos



USGS data, gauging station: 09380000



High Flow Experiments (Fall)

- **Effects:**
 - Stimulated straying & expansion of Brown Trout in Glen Canyon
 - Weir effect

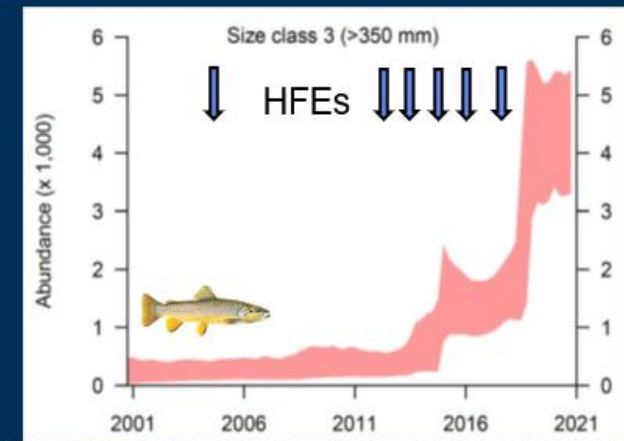
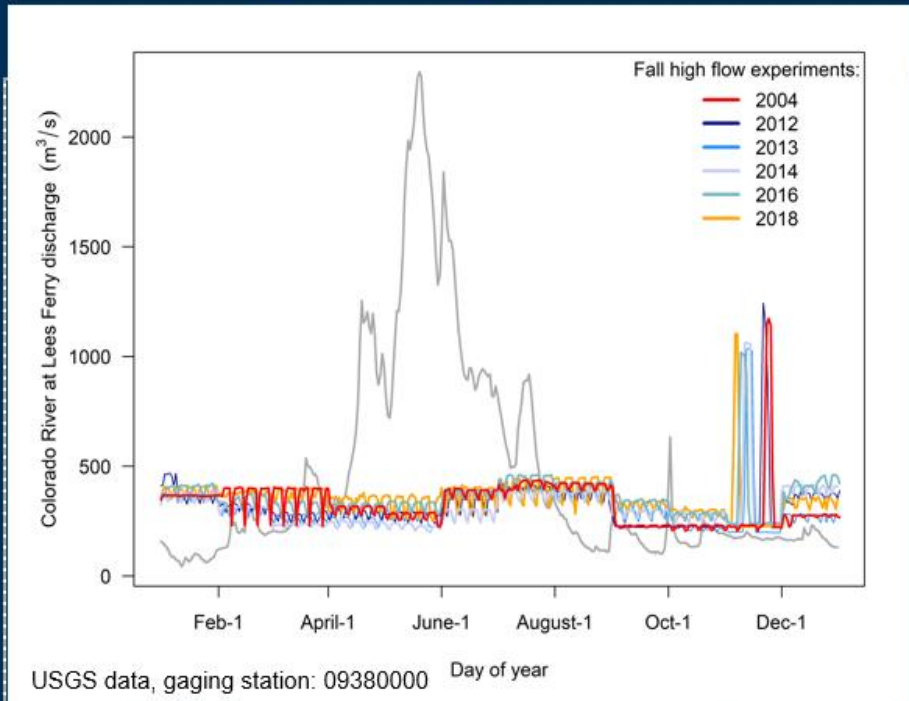
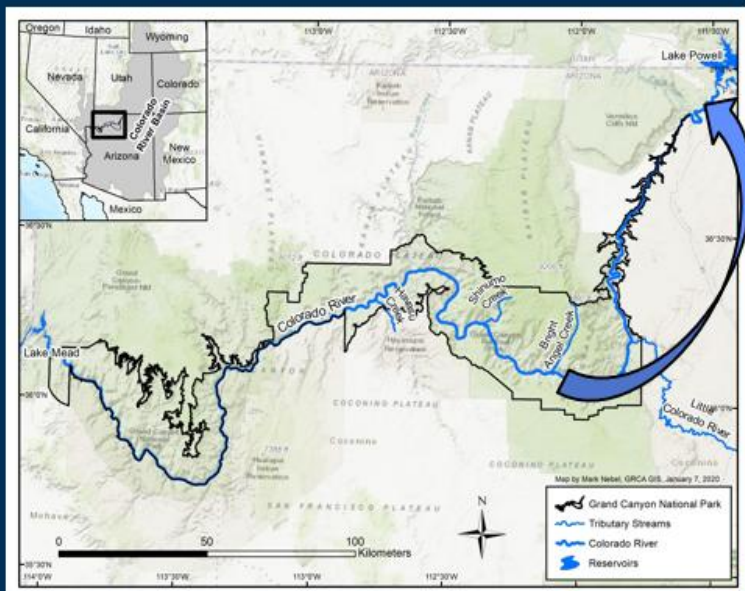
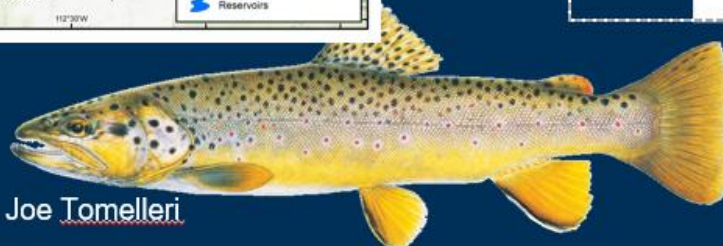


Illustration by Joe Tomelleri



Canadian Journal of Fisheries and Aquatic Sciences

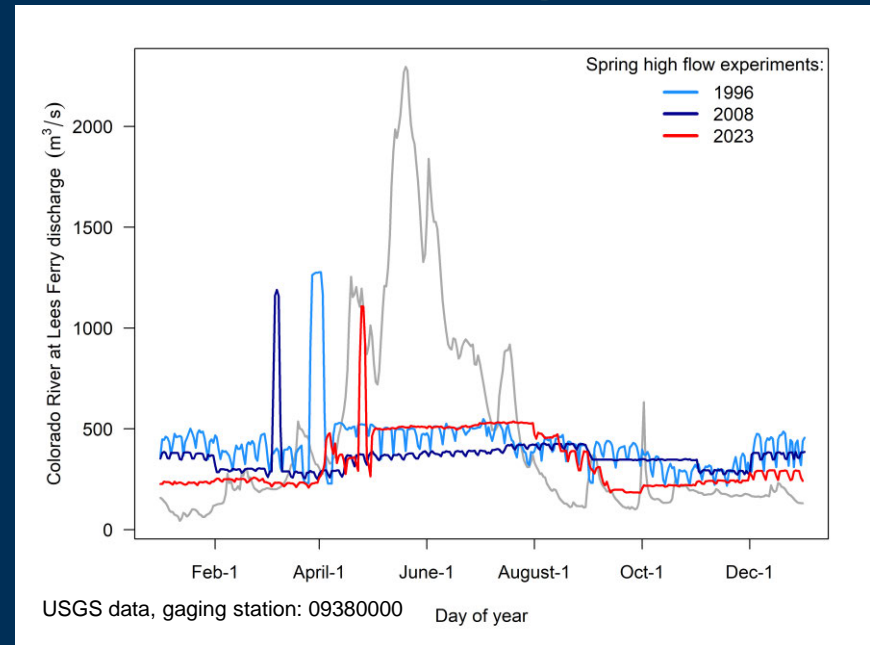
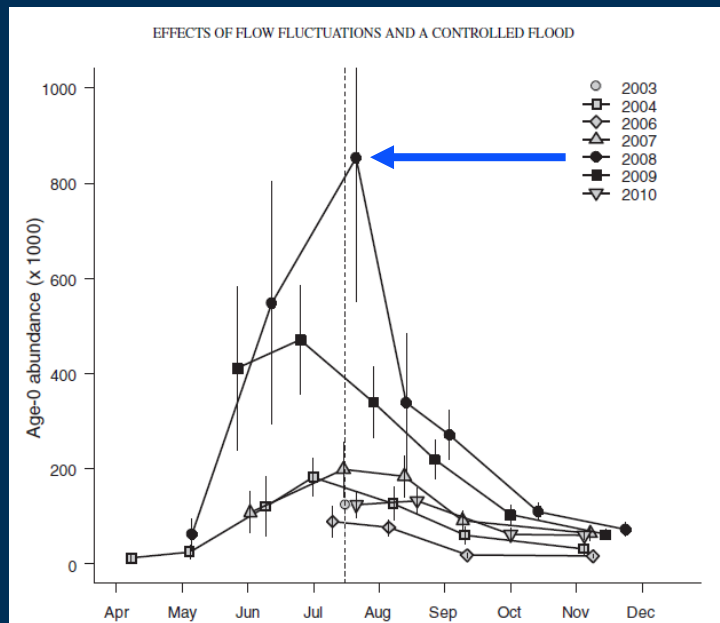
OPEN ACCESS | Article

Impeding access to tributary spawning habitat and releasing experimental fall-timed floods increase brown trout immigration into a dam's tailwater

Brian D. Healy, Charles B. Yackulic, and Robert C. Schelly

High Flow Experiments (Spring)

- Effects:
 - 2008
 - Large cohort
 - Confounded?



Effects of Fluctuating Flows and a Controlled Flood on Incubation Success and Early Survival Rates and Growth of Age-0 Rainbow Trout in a Large Regulated River

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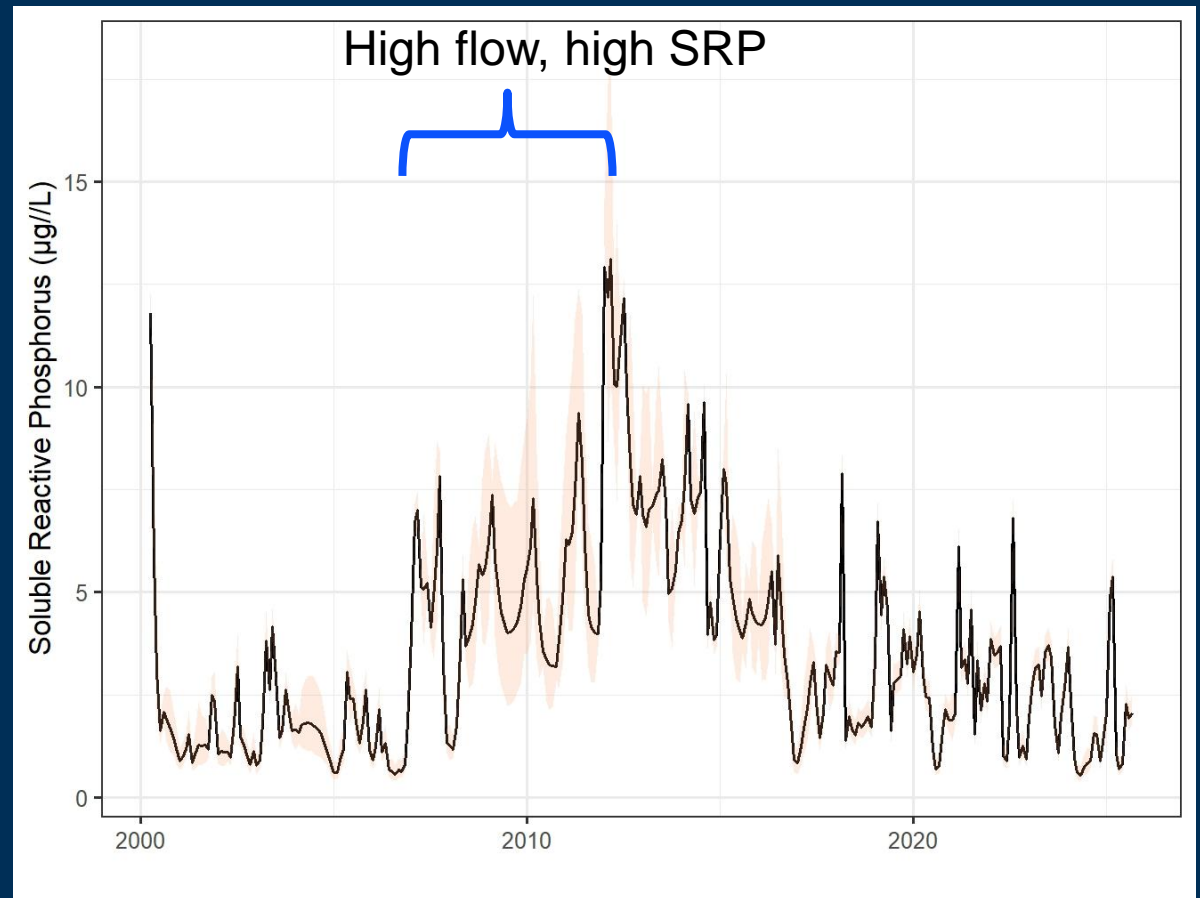
U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, 2255 North Gemini Drive, Flagstaff, Arizona 86001, USA

Water Quality - Phosphorous

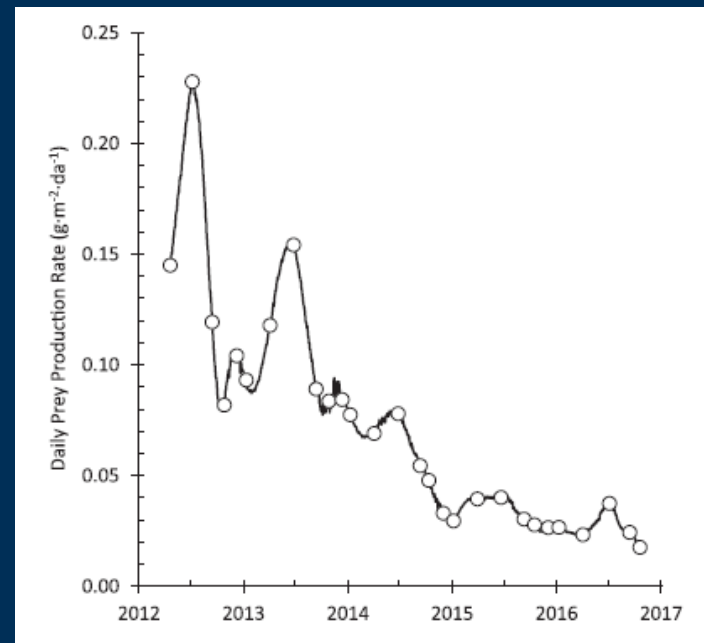
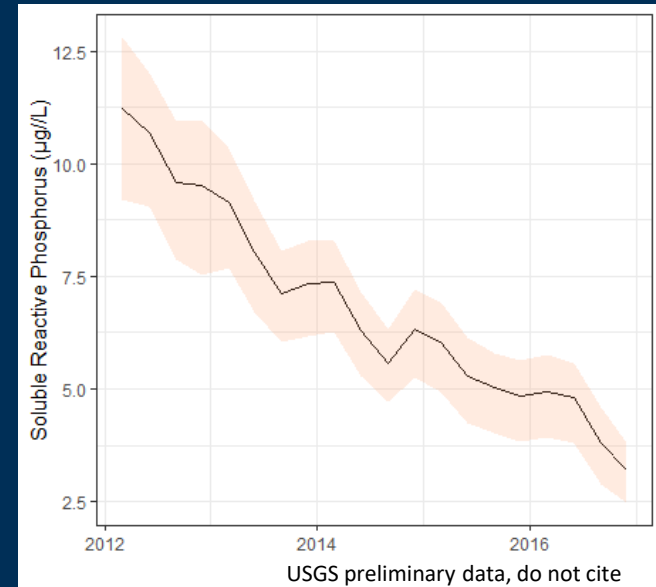
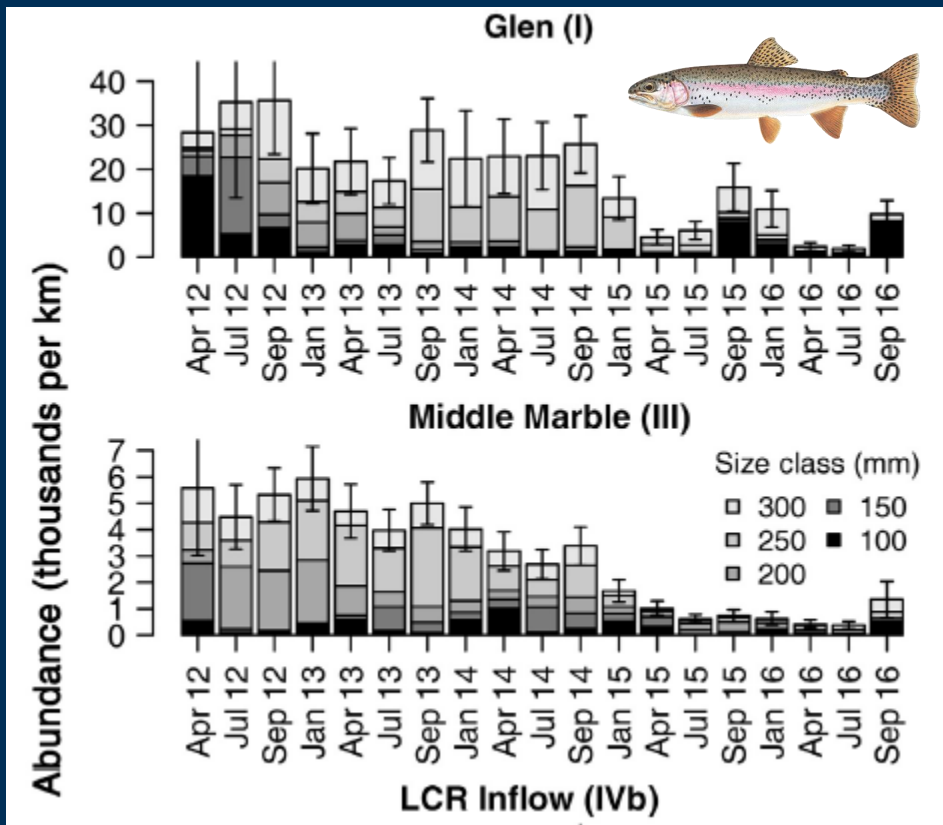
Soluble reactive phosphorus (SRP) is the most biologically available form of phosphorus to plants and microbes.

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.



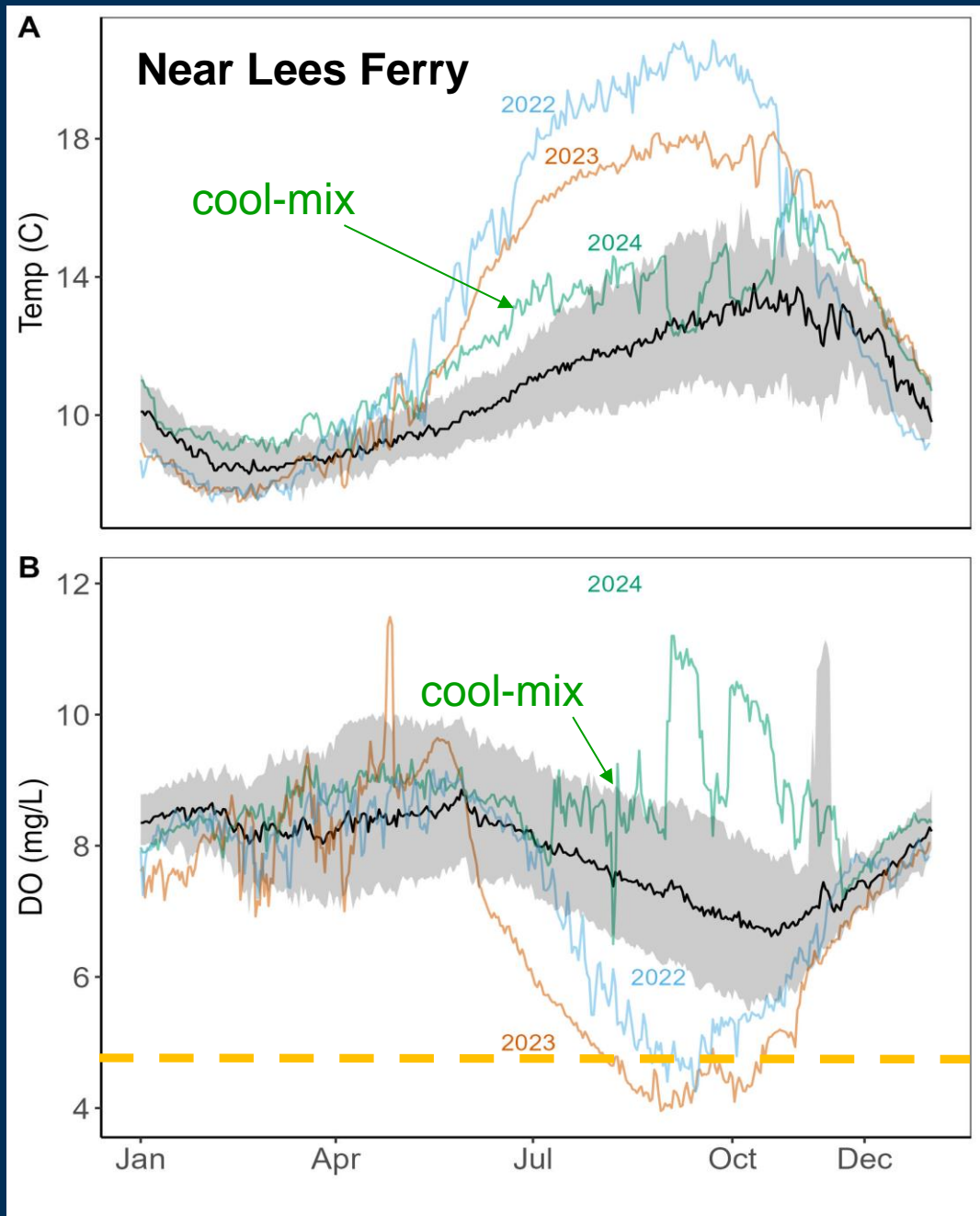
Prey Production and Trout Decline with Phosphorous



Korman et al. 2021

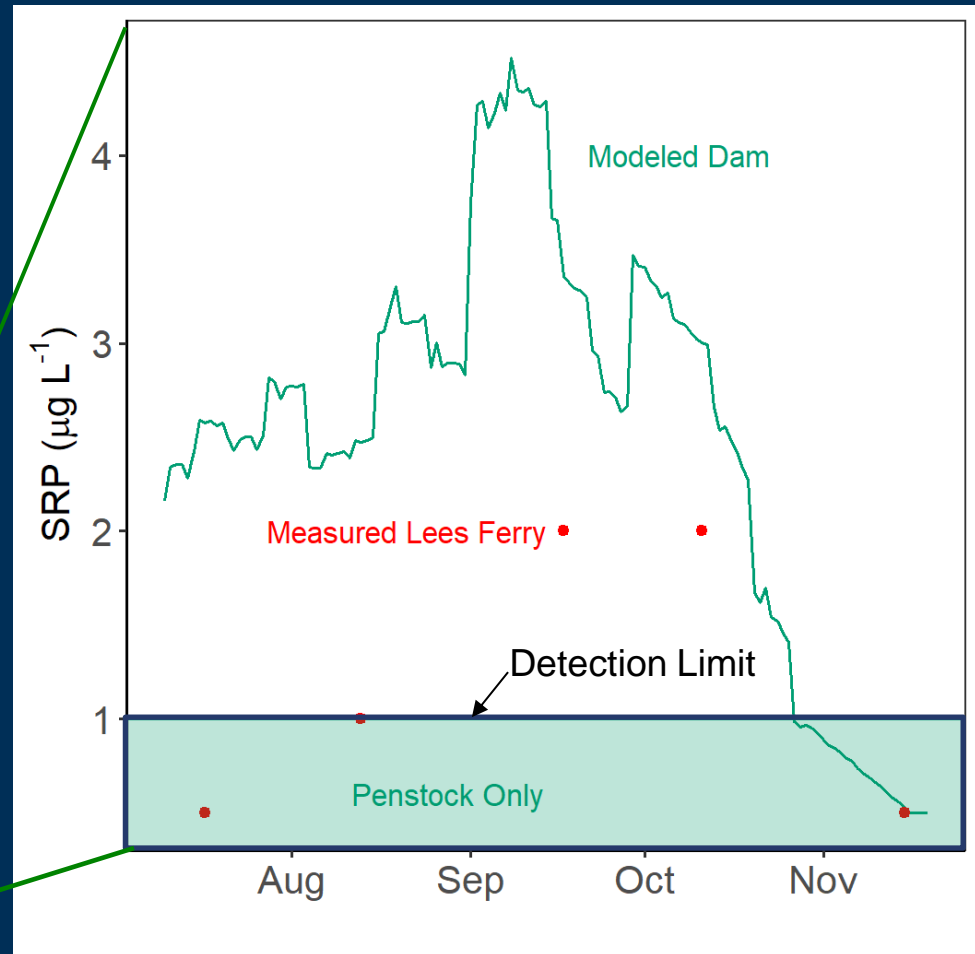
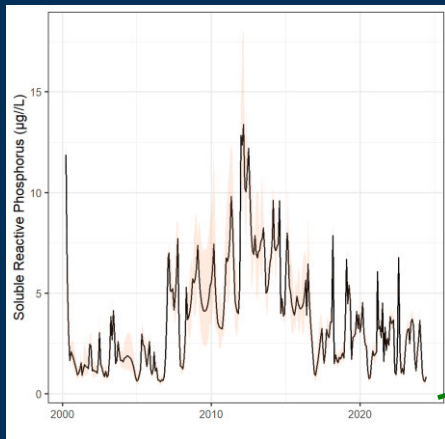
Water Quality

- Low survival corresponding to warm temperatures, low dissolved oxygen (fall 2023)
- Coolmix may have offset potential temperature and dissolved oxygen effects

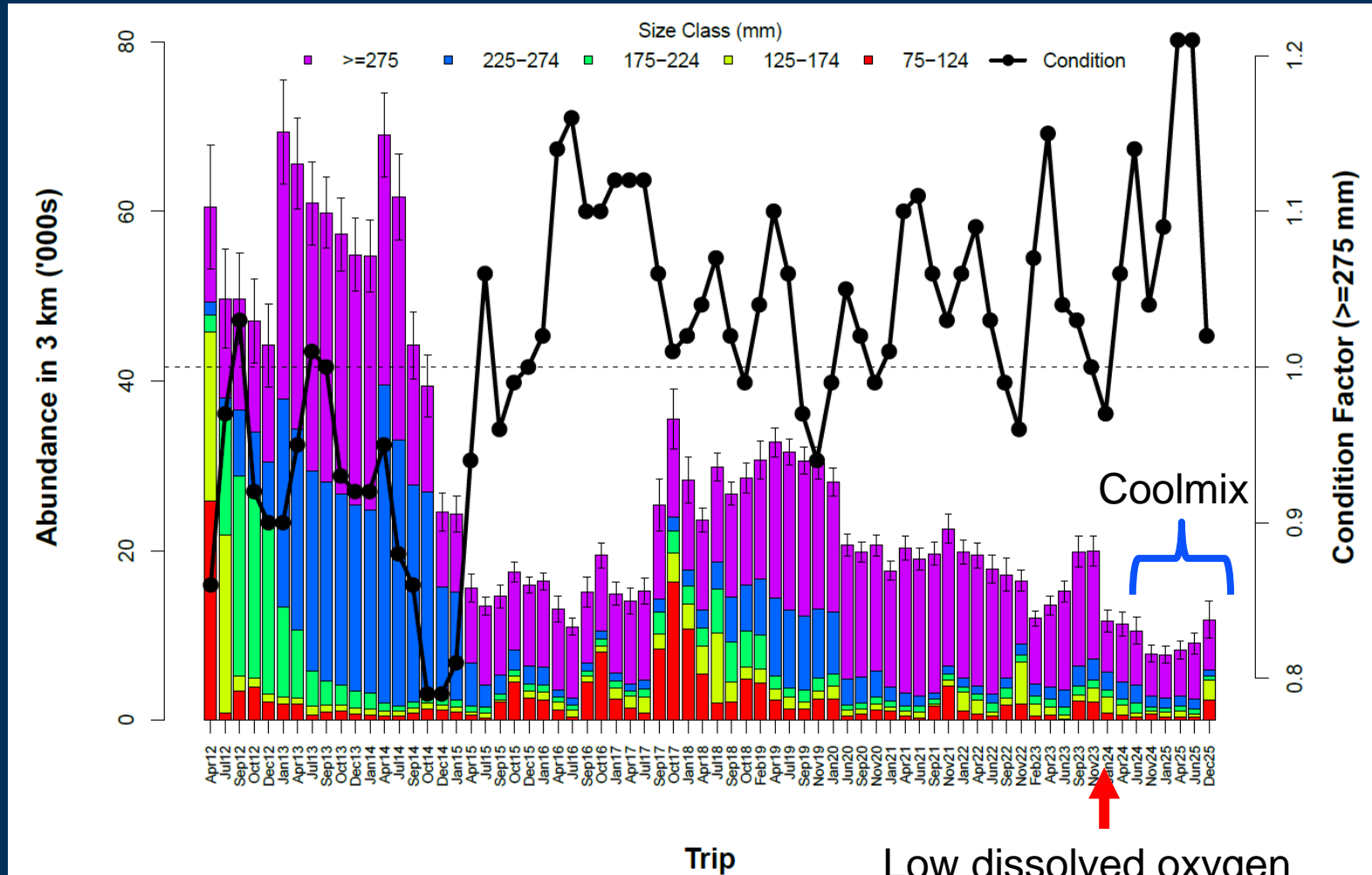


Coolmix and Water Quality

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



Rainbow Trout Abundance – Glen Canyon Site 1C



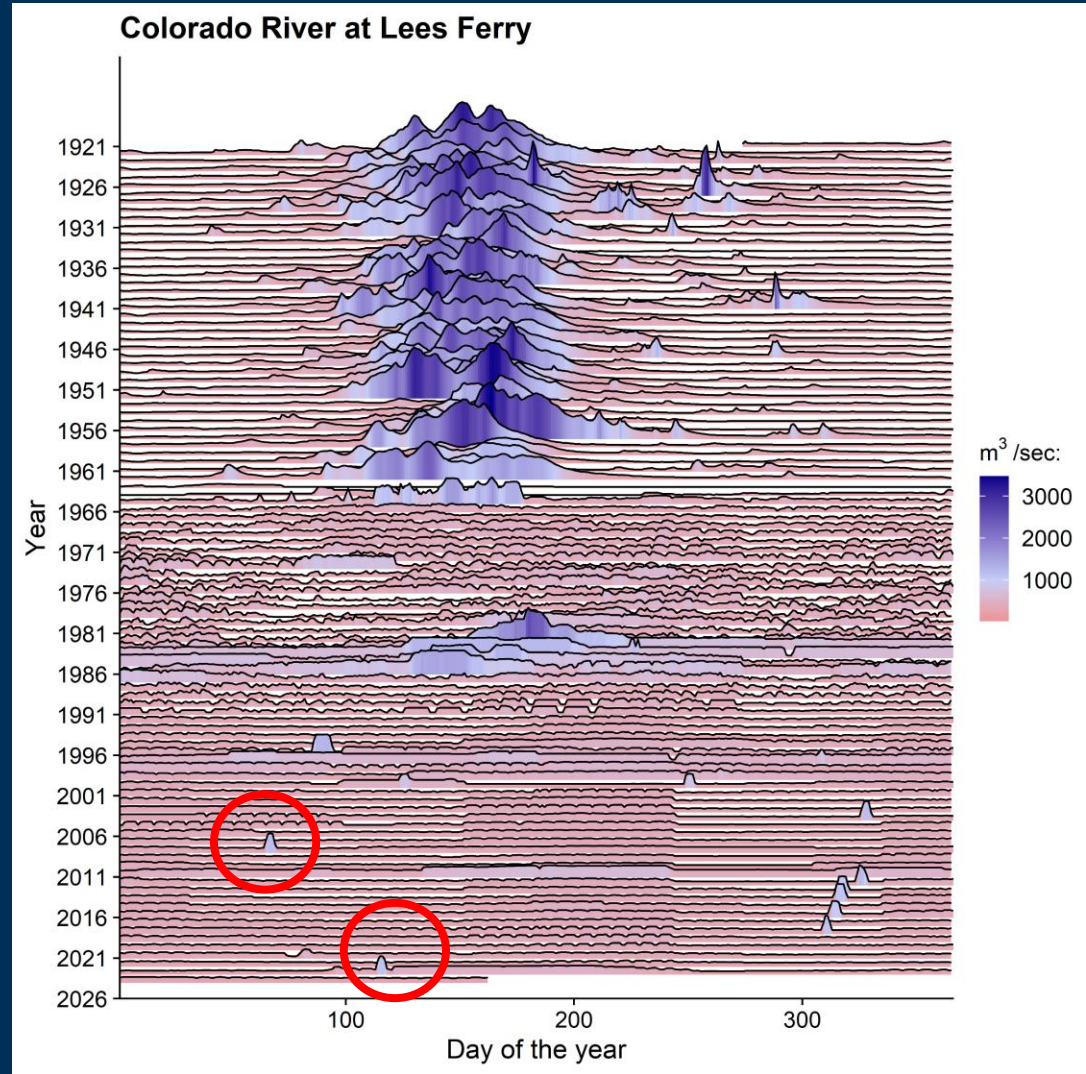
Low dissolved oxygen
and reduced survival

Preliminary unpublished data, do not cite



Flow History - Overview

- Are we applying flow experiments at the appropriate magnitude?
- Constraints:
 - Engineering
 - Minimize lost hydropower revenue
 - Impacts timing
 - Reduces magnitude
 - Few replicates
 - Risk tolerance?
 - E.g., few spring HFEs =



Summary

- **Flow experiments can have an influence on fish populations – but outcomes may be unexpected or counter to goals**
 - **Effects are indirect or subtle and difficult to detect**
- **Constraints on flow design may limit learning**
- **Evidence indicates temperature and water quality effects likely override those of flow**
- **Next steps:**
 - **Value of information analysis (Project H and J)**
 - **Prioritize future research**
 - **Rank potential management actions to improve the fishery**
 - **Reproductive condition, dissolved oxygen, coolmix effects analyses (ongoing)**
 - **Knowledge assessment workshops (TBD)**

Questions?

Acknowledgements
Funded by:



DAVID HERASIMTSCHUK

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References

- Healy, B.D., Yackulic, C.B., and Schelly, R.C., 2022, Impeding access to tributary spawning habitat and releasing experimental fall-timed floods increases brown trout immigration into a dam's tailwater: *Canadian Journal of Fisheries and Aquatic Sciences*, v. 80, no. 3, p. 614-627.
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