

Restoring Functional Flows in the Sacramento River – Chinook Salmon Survival in Relation to Spring Pulse Flows



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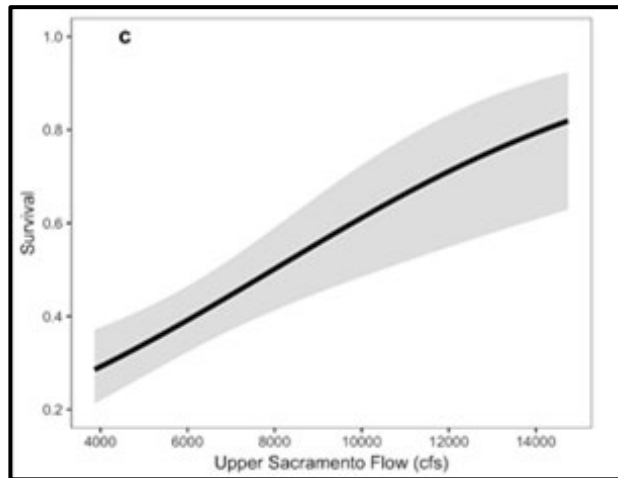


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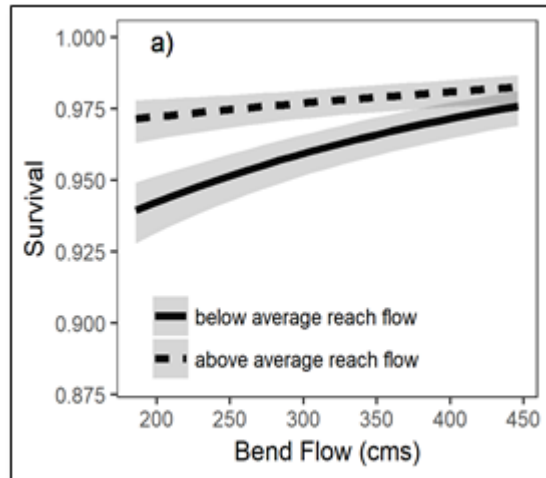
Spring Pulse Flows: Tributary method of delivering environmental flows for Healthy Rivers and Landscapes

Why spring pulse flows?

- Previous research suggests spring pulse flows may be beneficial for outmigration survival



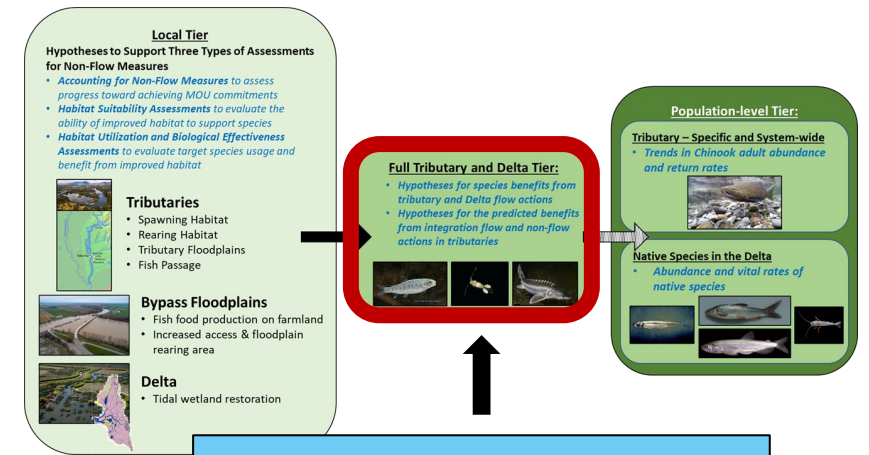
Notch et al. 2020. EBF



Henderson et al. 2019. CJFAS

What are some uncertainties?

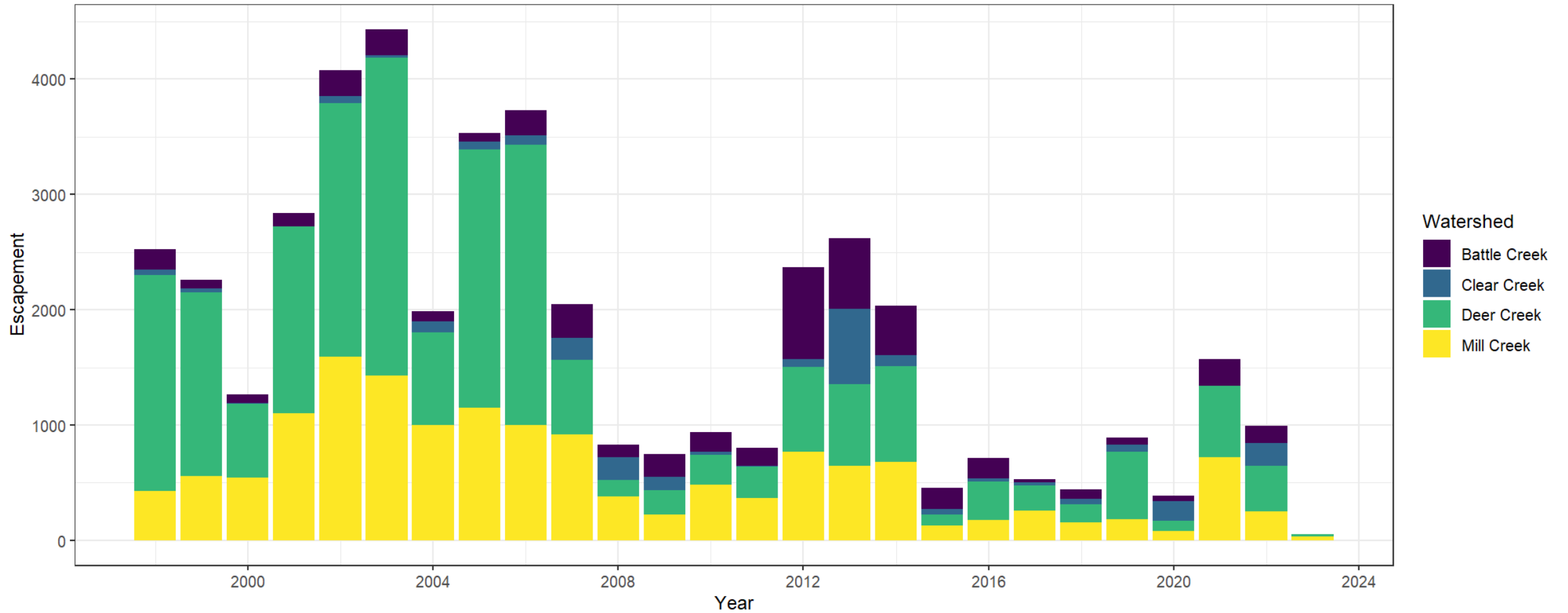
- When are spring pulse flows most beneficial?
- How do they interact with water temperature and other environmental factors?
- Is there a lasting benefit into the Delta?



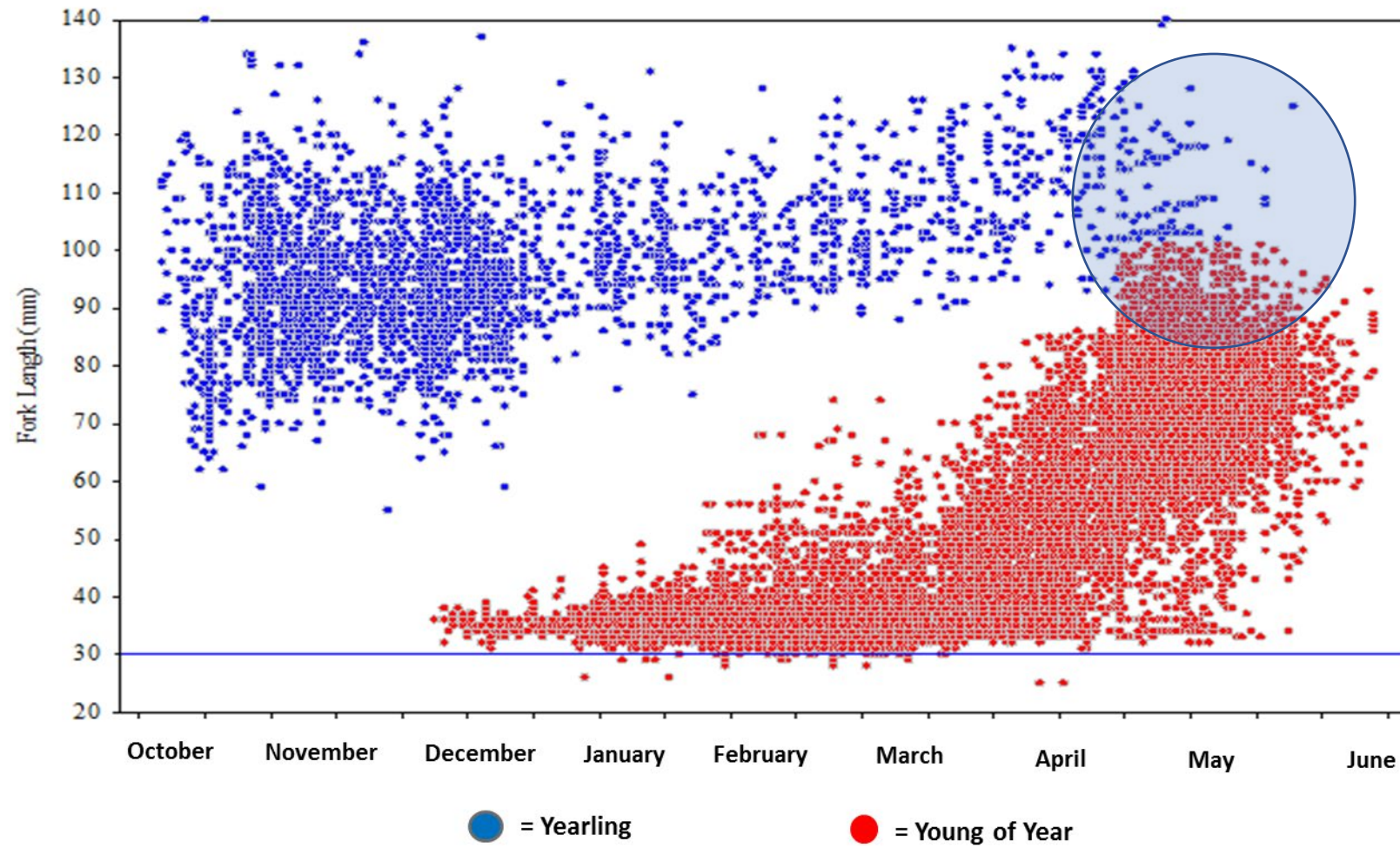
HRL Science Plan:
What are the hypothesized outcomes of providing spring pulse flows for juvenile salmonids?

Science Plan Metric	Prediction	Example Covariates
Outmigration rate	↑	Water temp, DO, turbidity, day length
Survival to tributary mouth	↑	

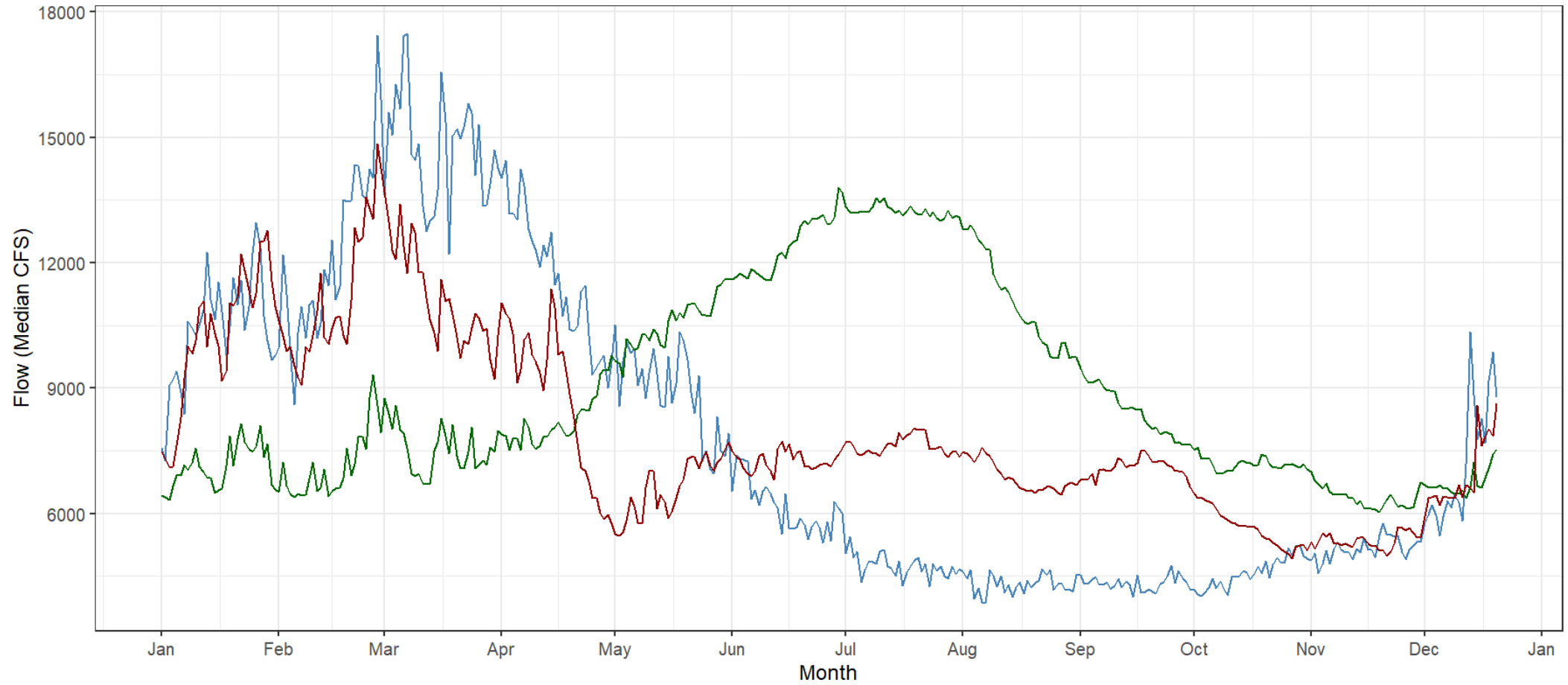
Sacramento River Spring-run Chinook Salmon Escapement 1998-2023



Spreading the Risk: Juvenile Spring-Run Outmigration Across Time

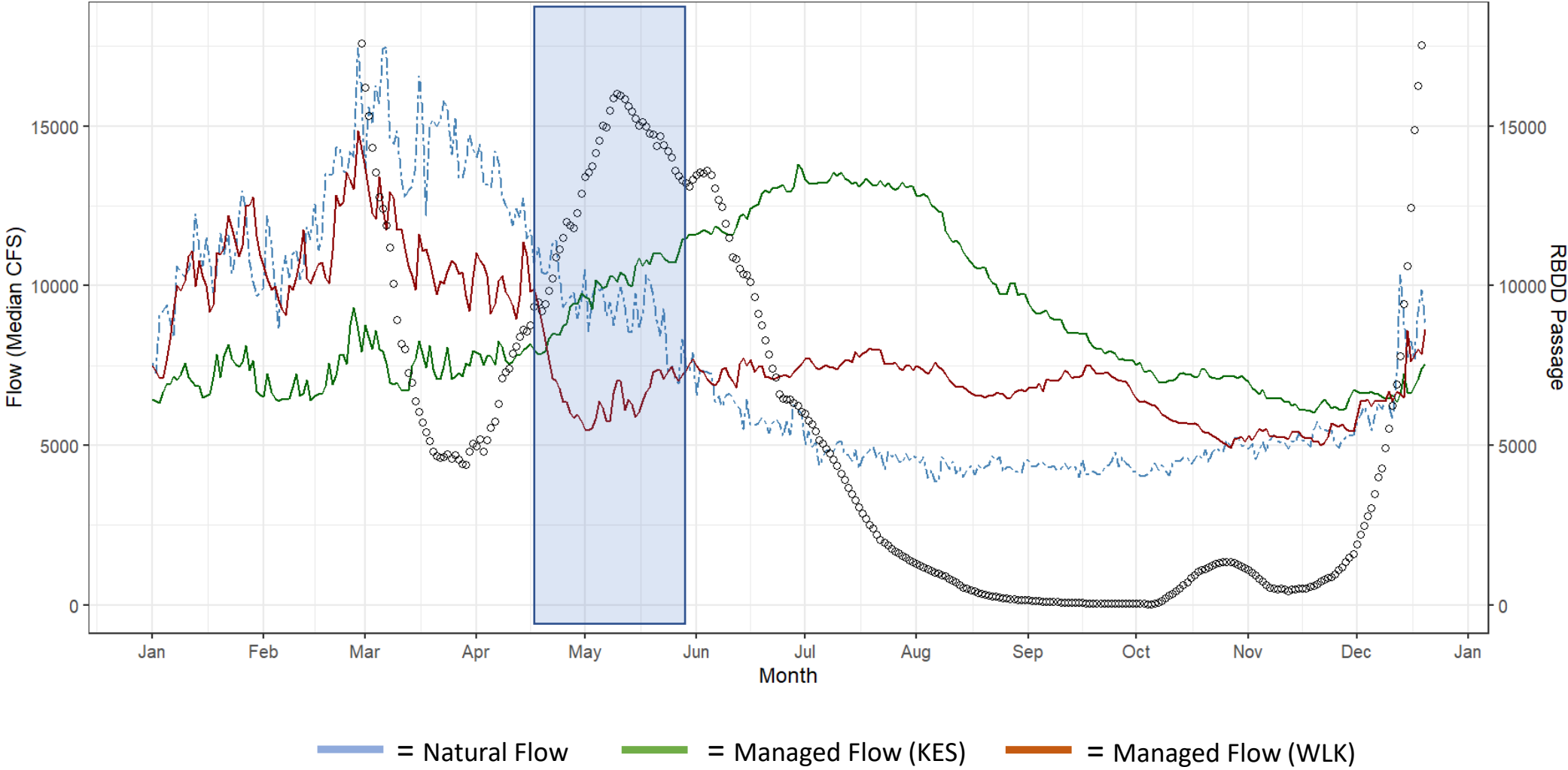


Sacramento River Natural vs. Managed Median Flow (1995-Present)



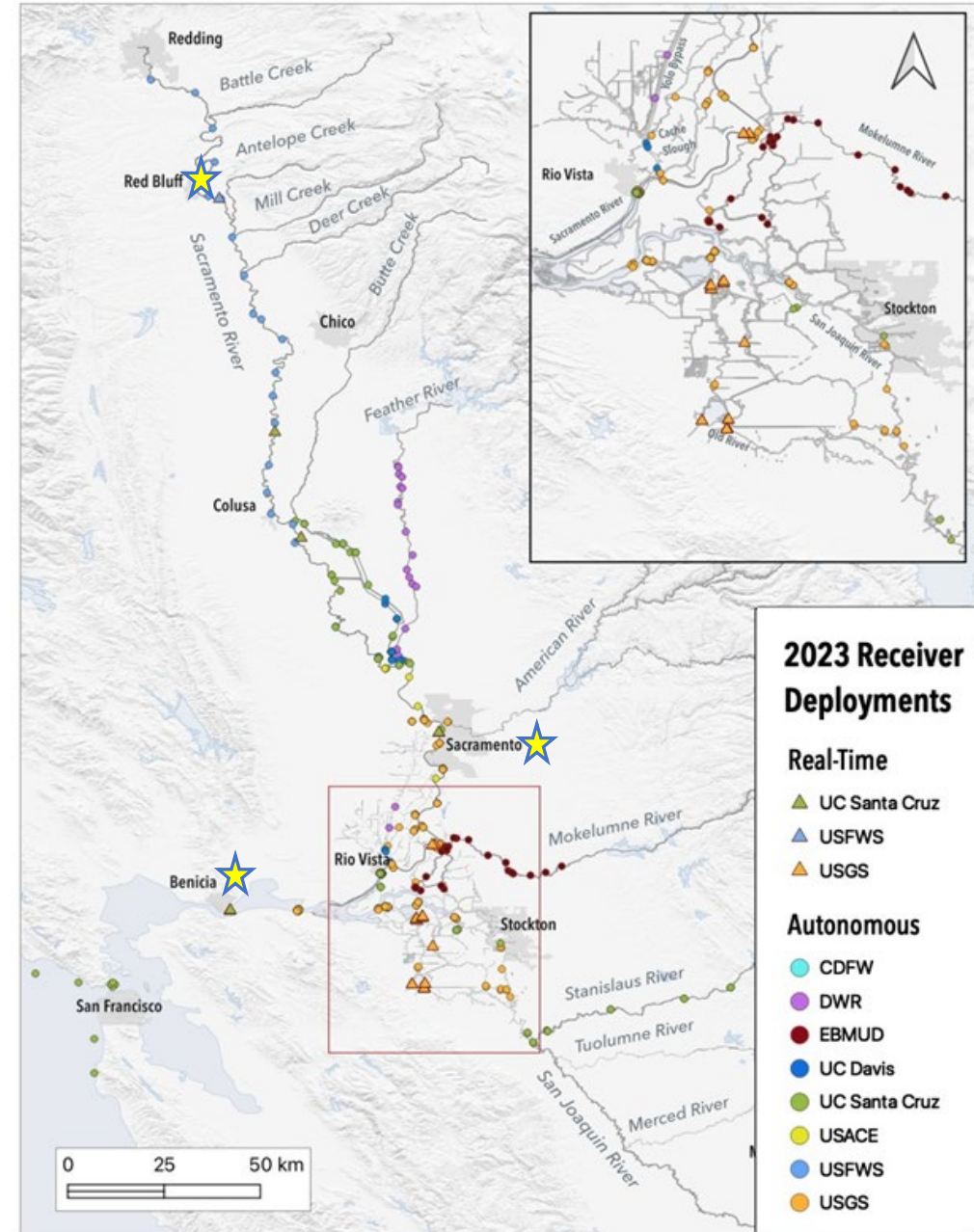
— = Natural Flow — = Managed Flow (KES) — = Managed Flow (WLK)

Sacramento River natural/managed median flow (1995-2021) vs. RBDD fish passage (2006-2019)

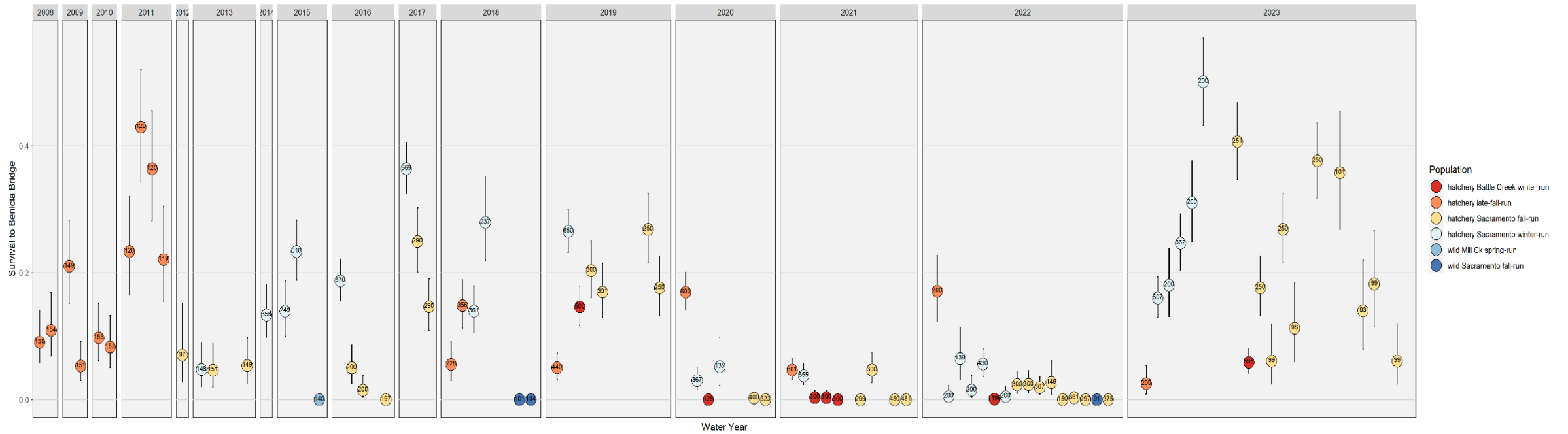


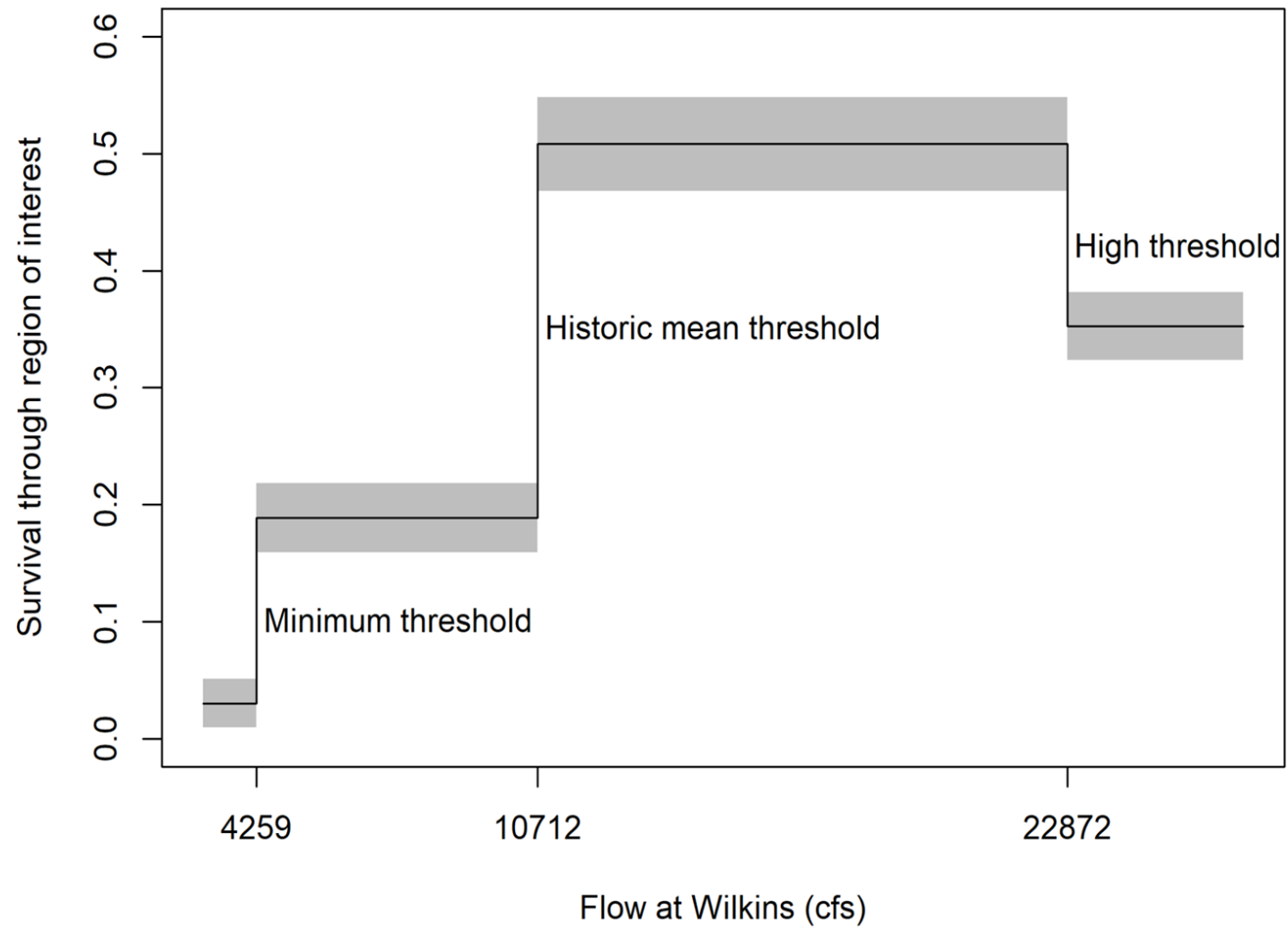
JSATS – Juvenile Salmon Acoustic Telemetry System

- Minimum fish size > 80mm, 6.0 g
- Unique ID for each tag, pings every 5 seconds for up to 40 days
- Fish released the morning after surgery to allow for complete recovery



Sacramento River Juvenile Salmon Outmigration Survival to Benicia (2008 – 2023)





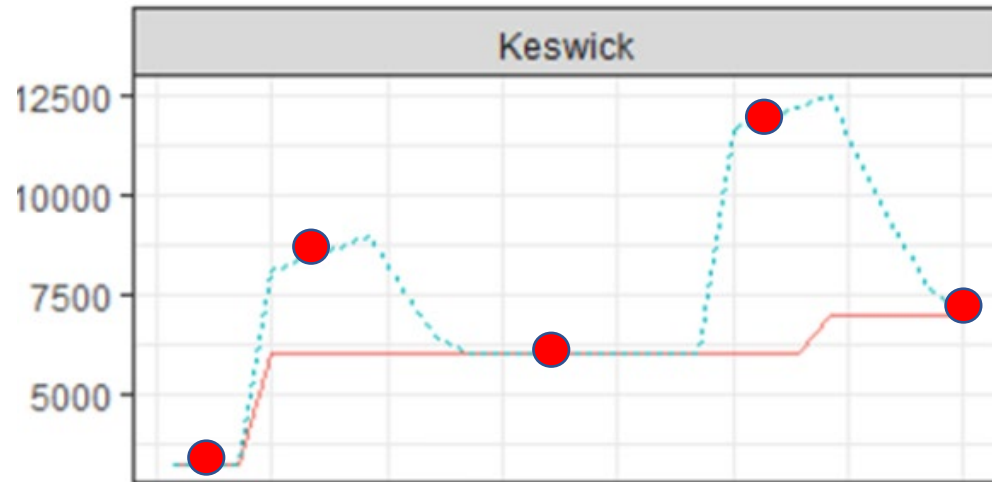
Upper Sacramento Scheduling Team

- CDFW, DWR, NMFS, BOR, SWCB, USFWS, SRSC
- Annual Pulse Flow Operation Plan

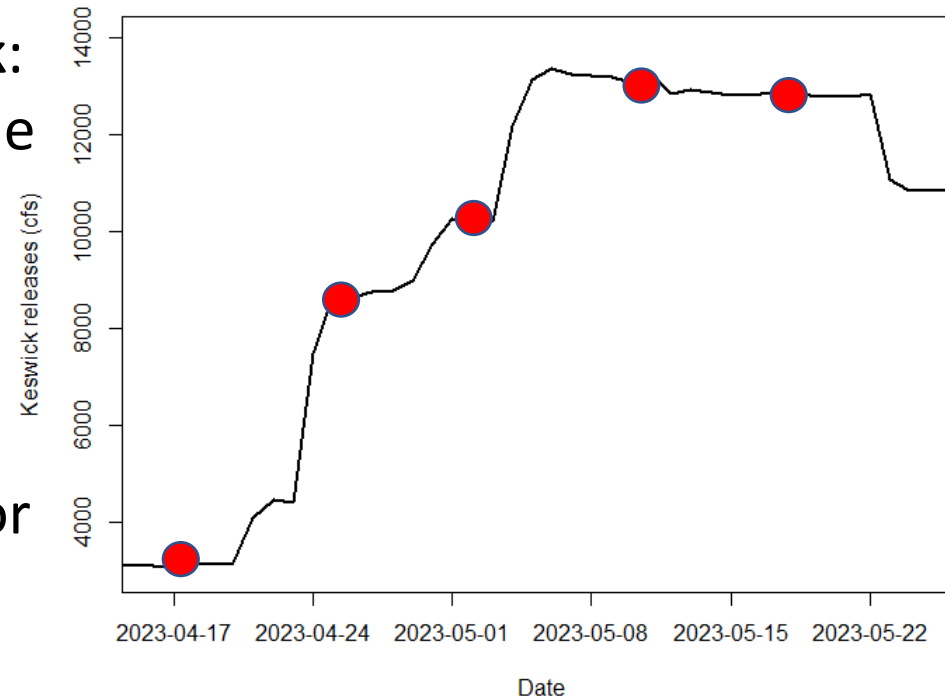
Assess various scenarios with these constraints:

- **Shasta May 1st storage: > 4 MAF**
- Pulse(s) of length of 2, 3, or 4 days
- Of a magnitude to result in 11,000 cfs at Wilkins Slough
- Occurring in April and/or May
- Single or multiple pulses
- Total Volume: < 150 TAF
- 15% ramp-down rates

Planned 2023 pulses and release groups, vs reality



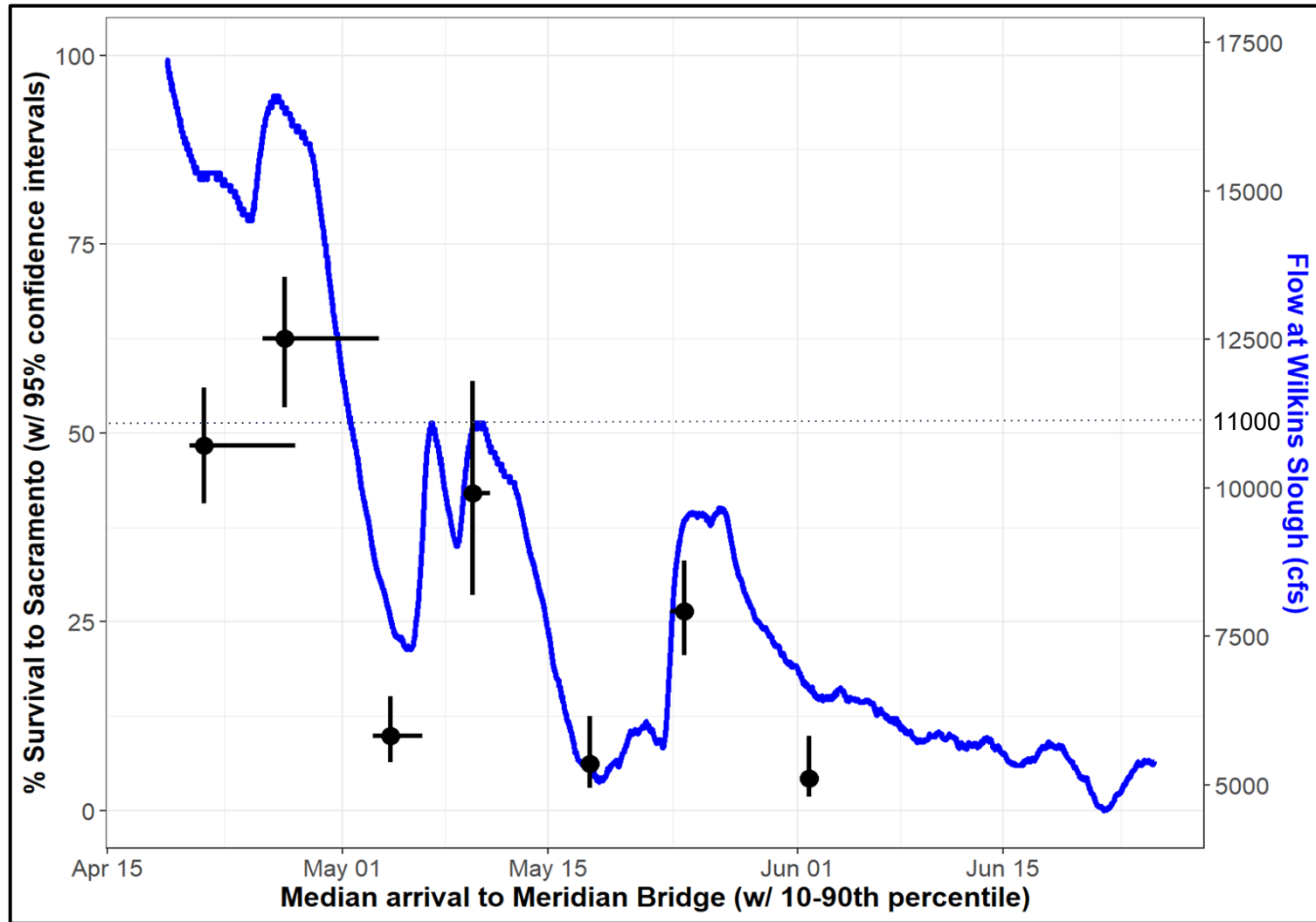
- **Mother nature reality check:** storage management became a necessity, no drop in flows for “control” treatment groups, but good survival across the board.
- Bad for learning, but good for fish!



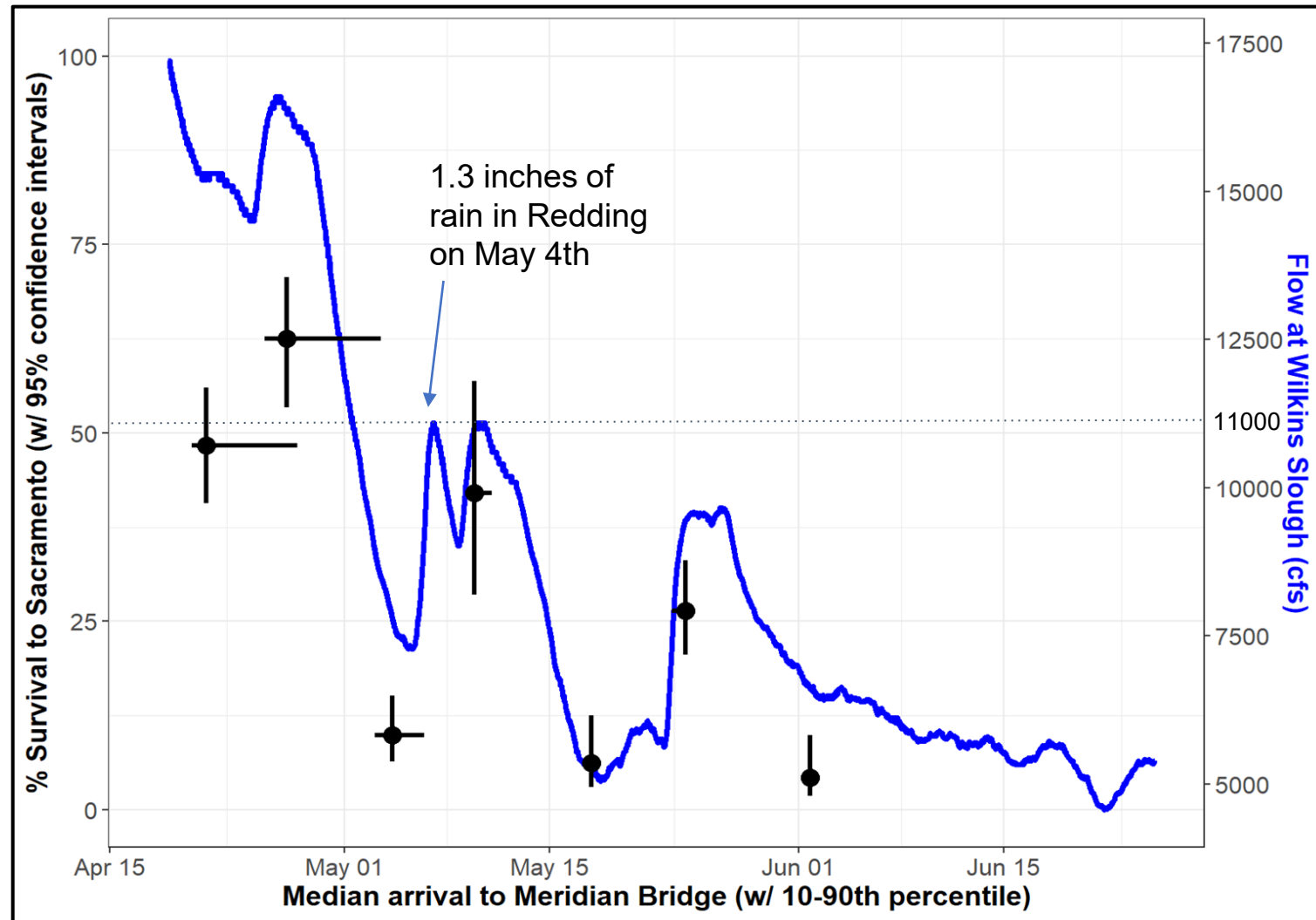
2024: Three 4-day Spring Pulses out of Keswick



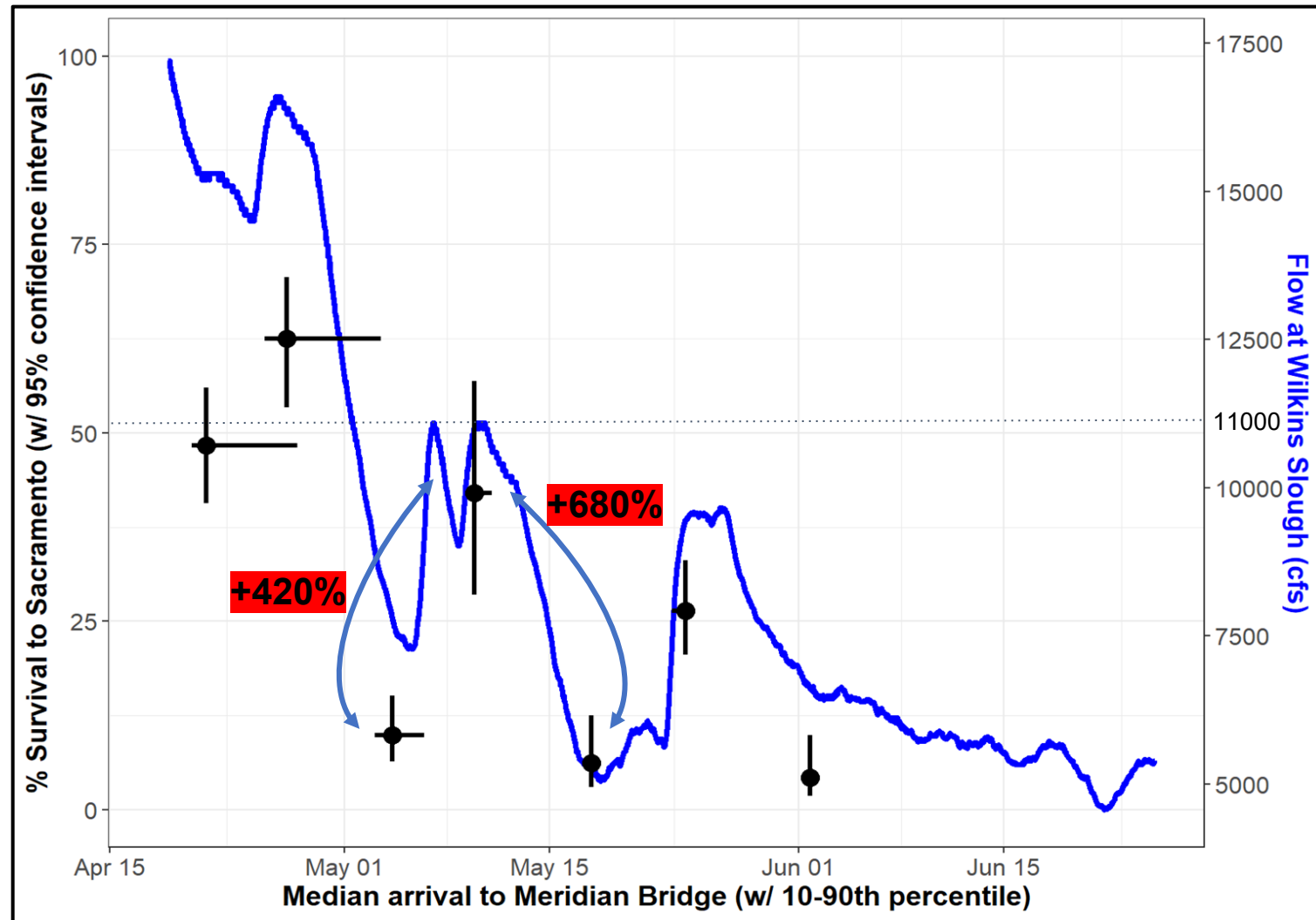
Survival to Sacramento



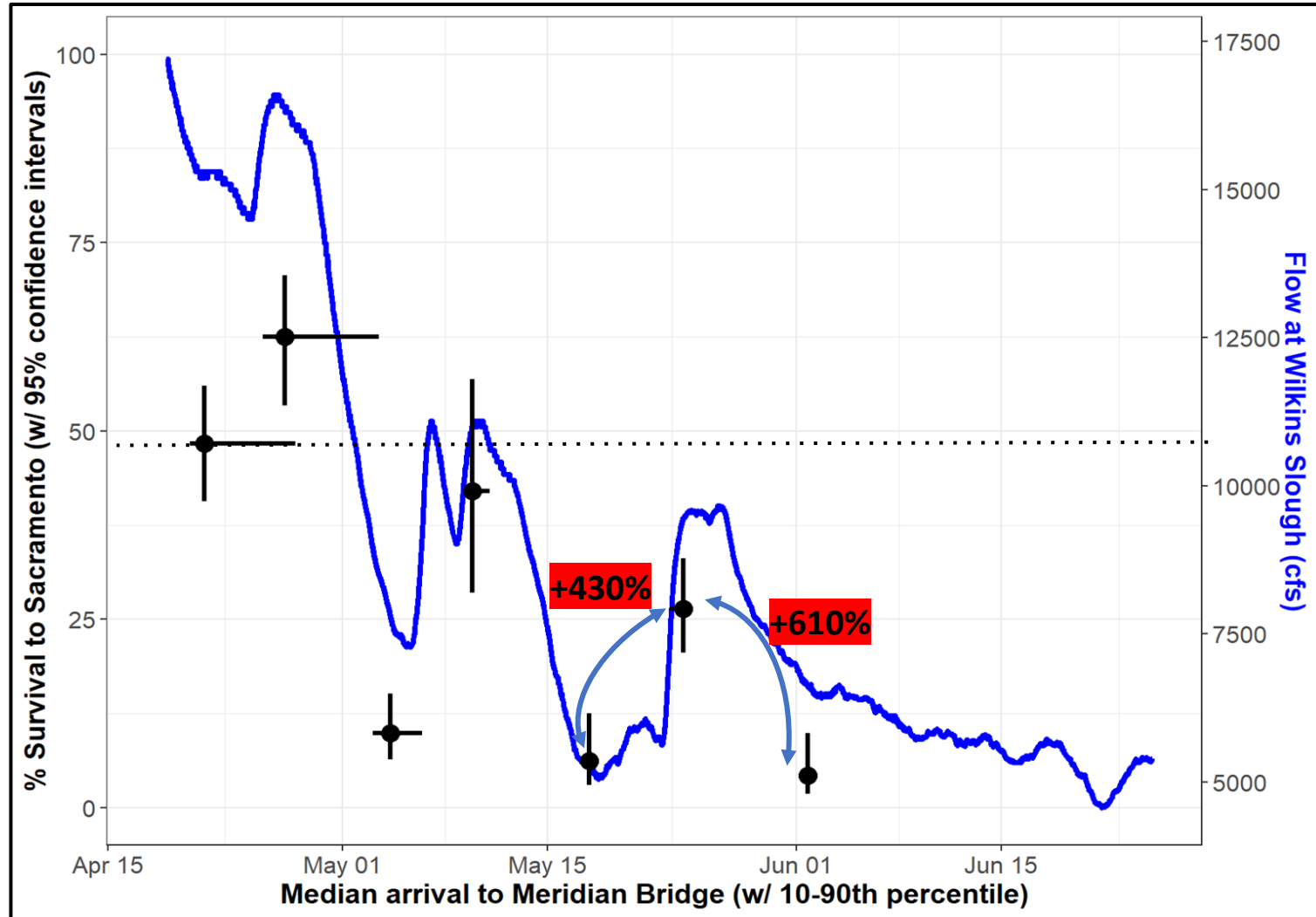
Survival to Sacramento



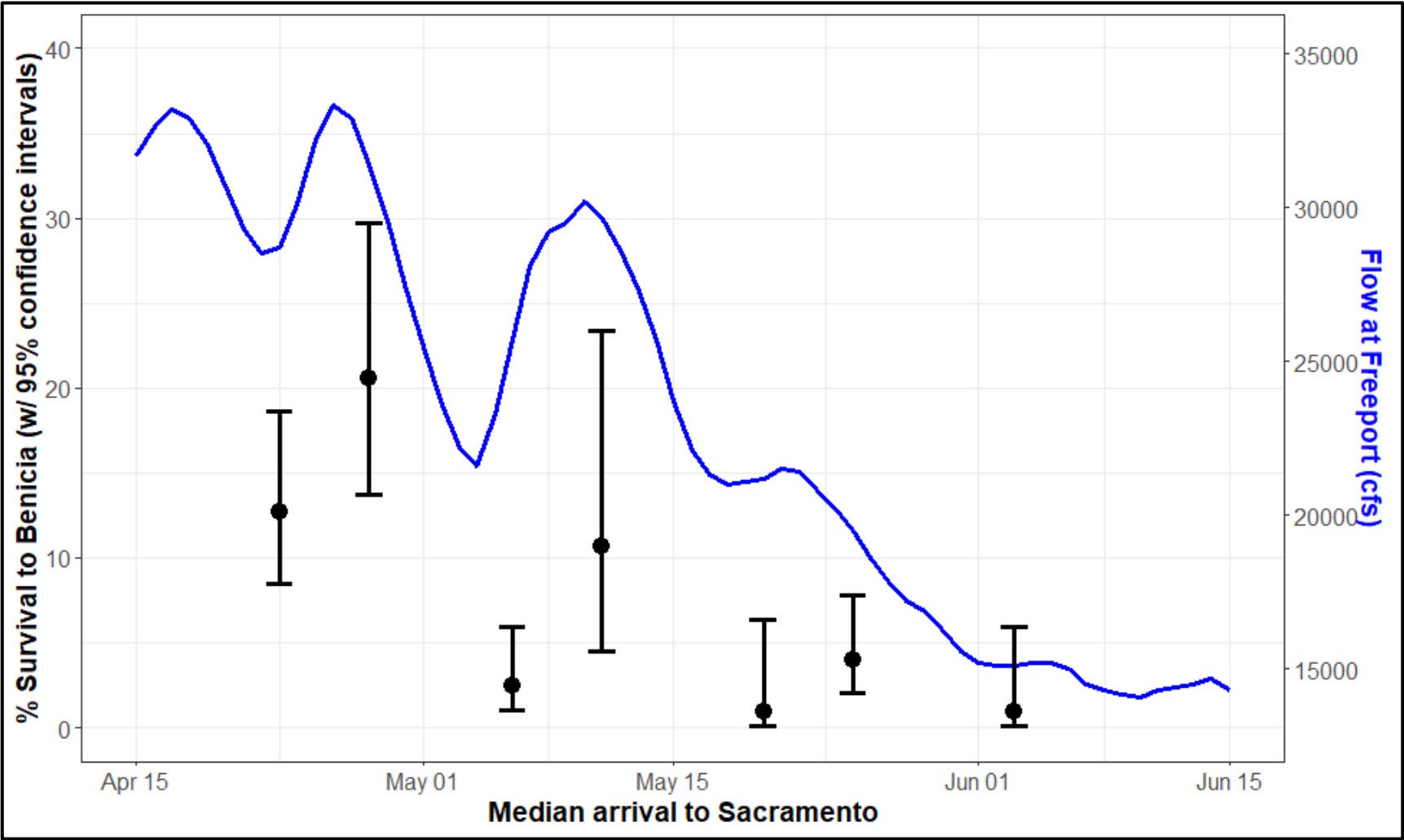
Survival to Sacramento



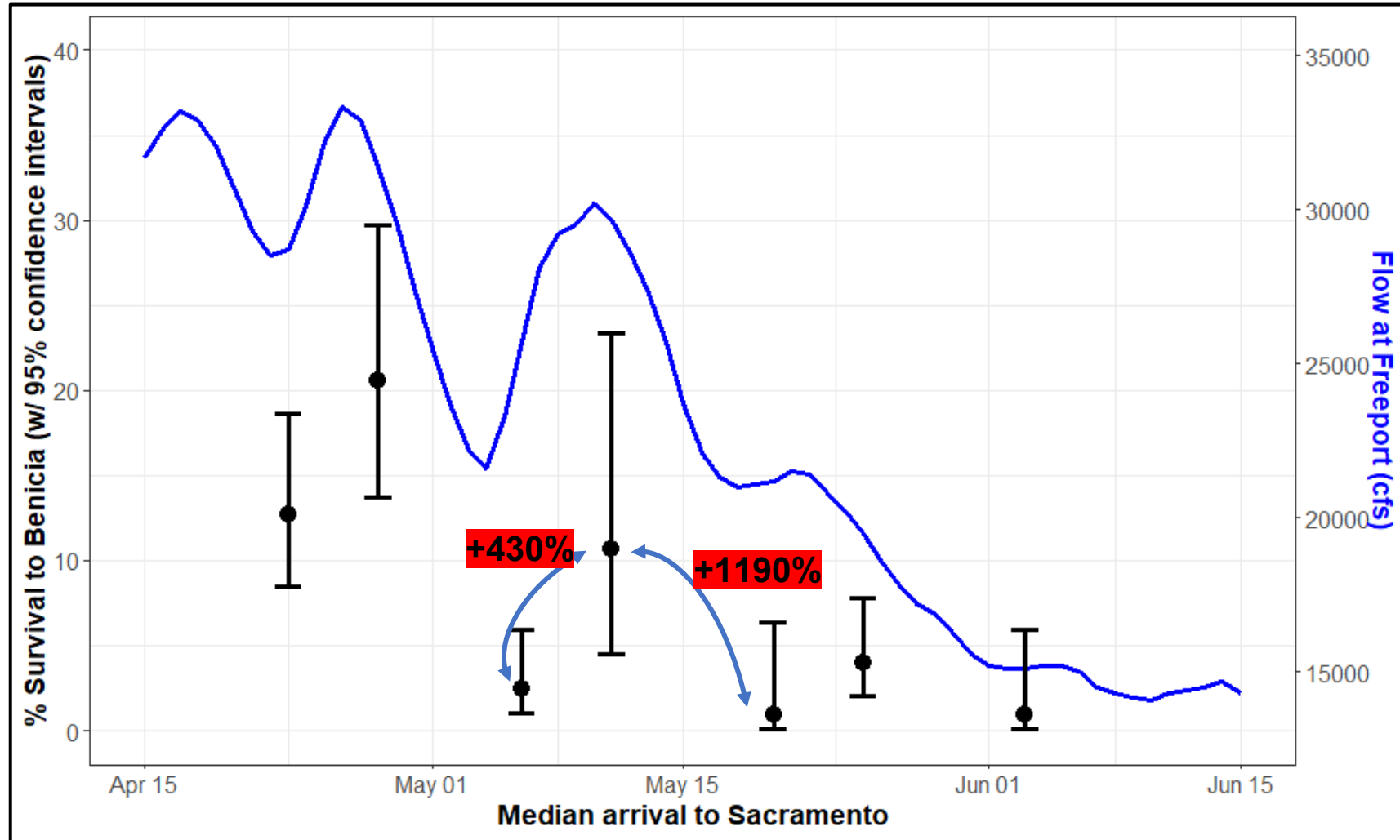
Survival to Sacramento



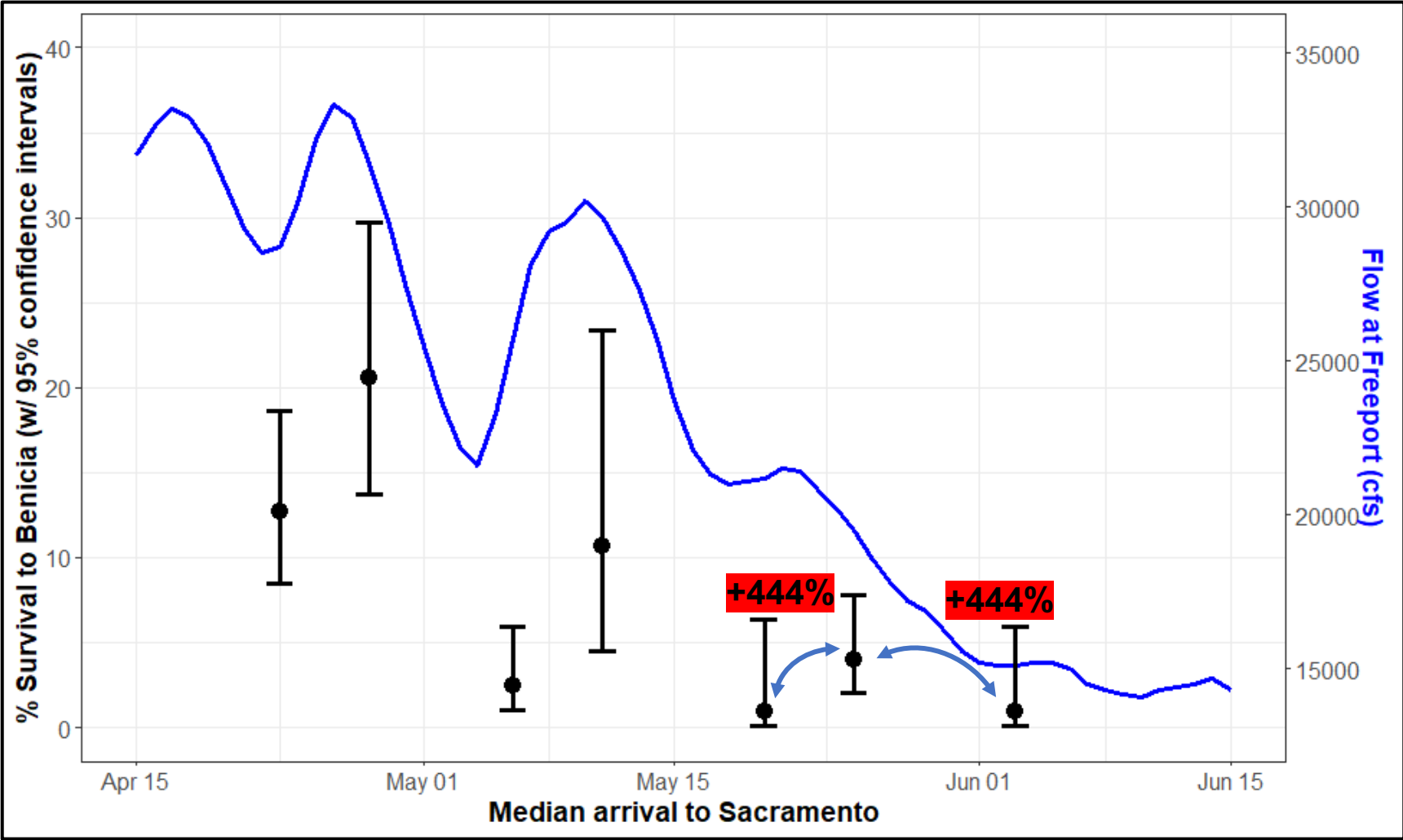
Survival to Benicia



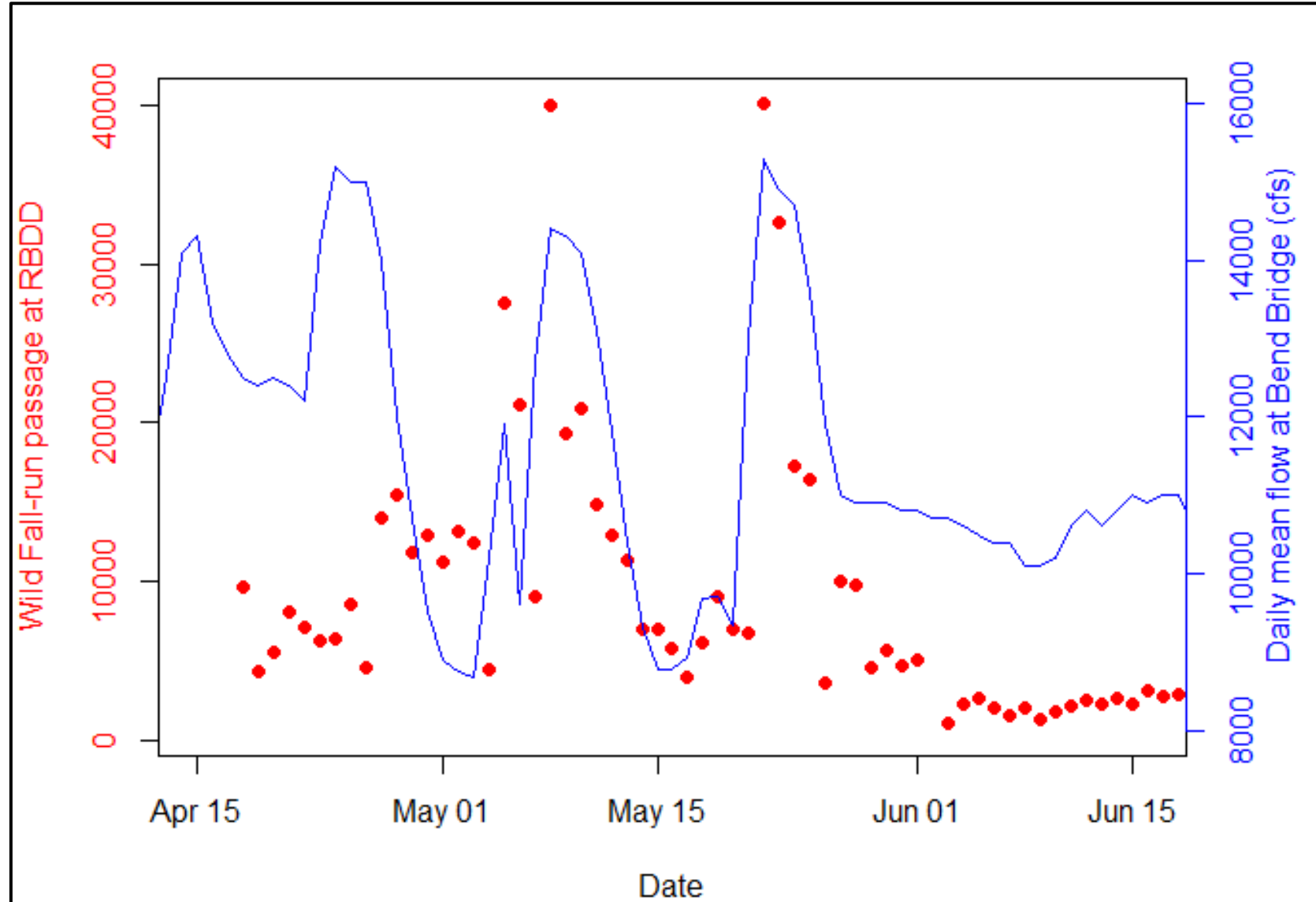
Survival to Benicia



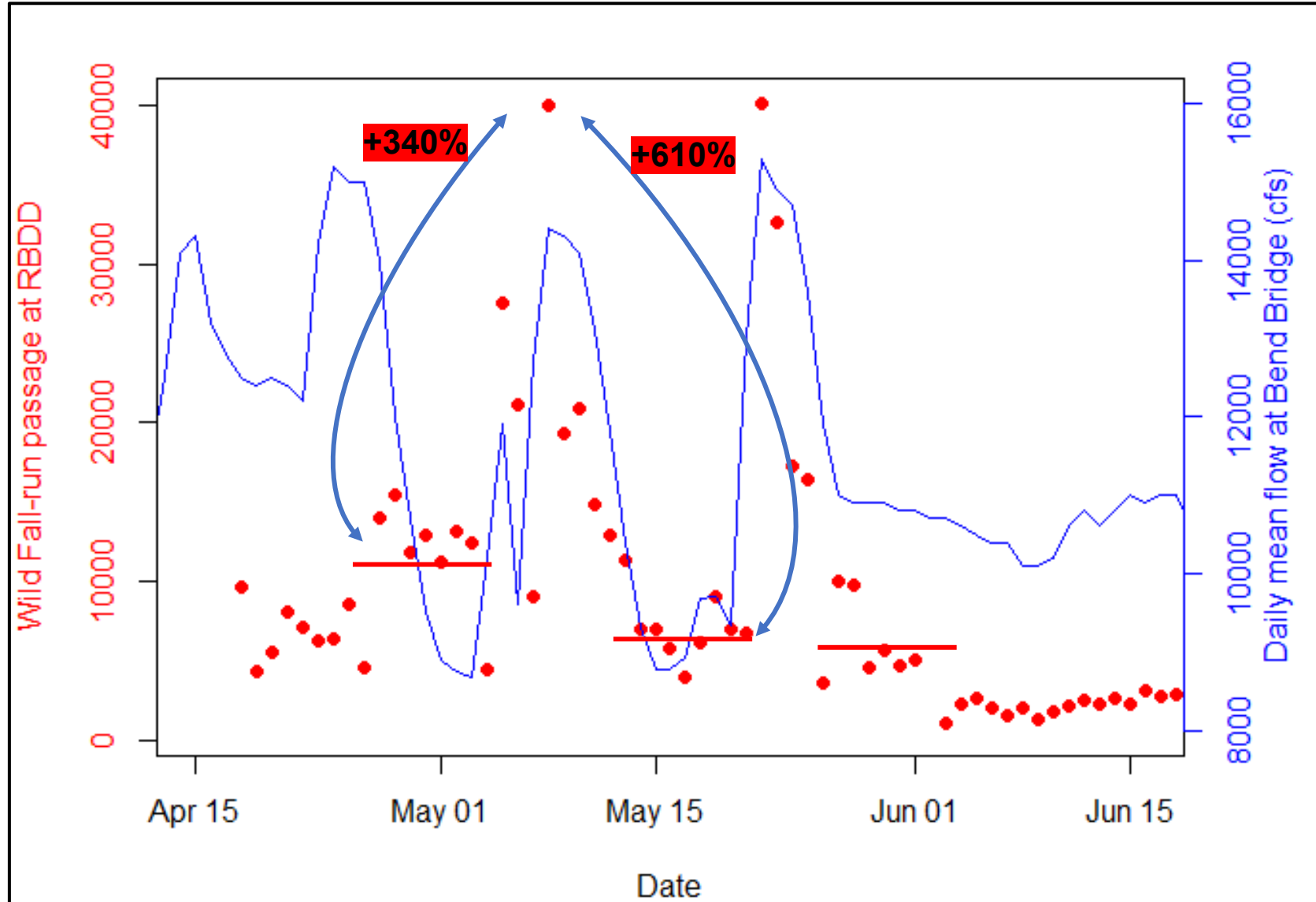
Survival to Benicia



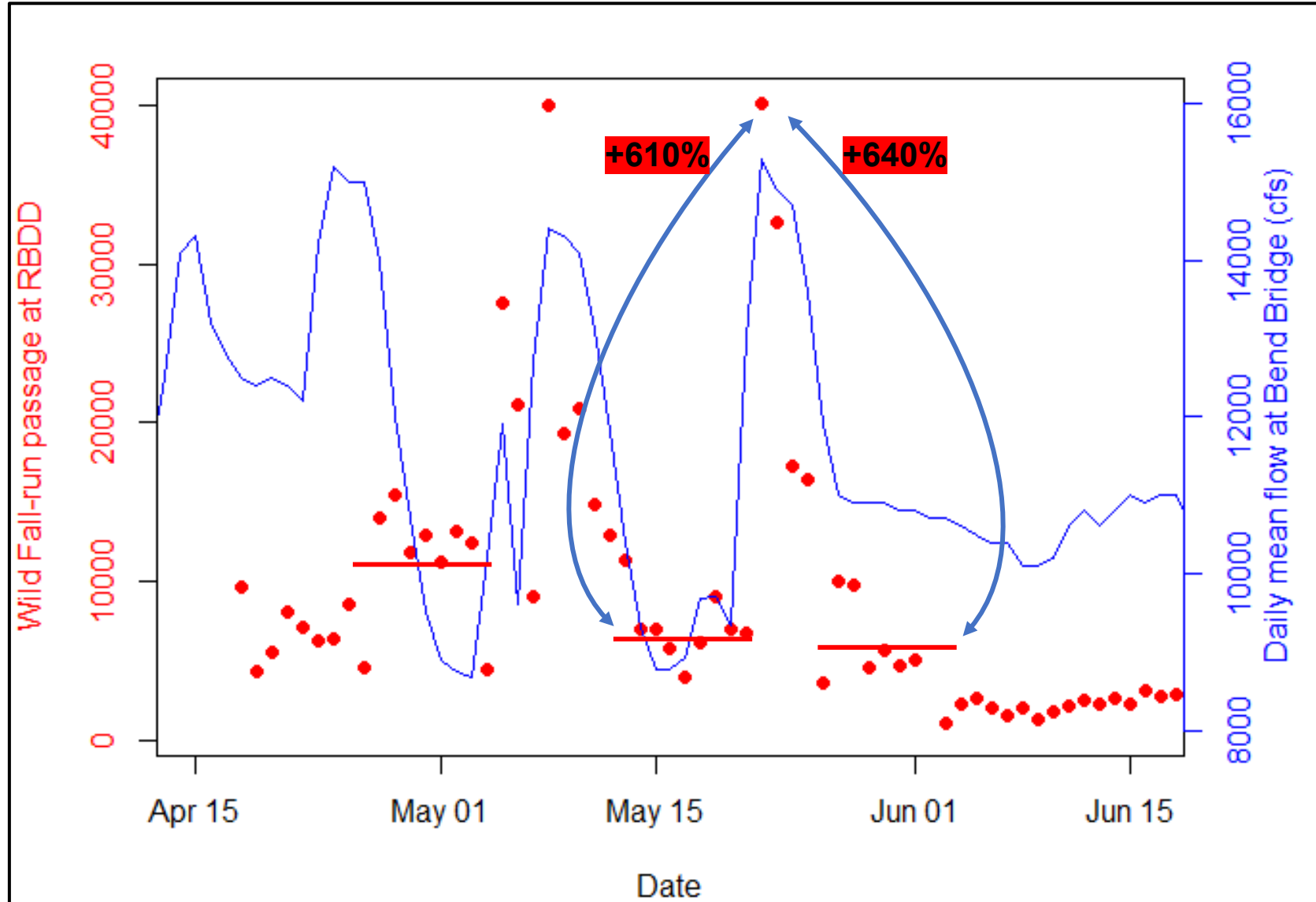
Fish Passage at Red Bluff



Fish Passage at Red Bluff

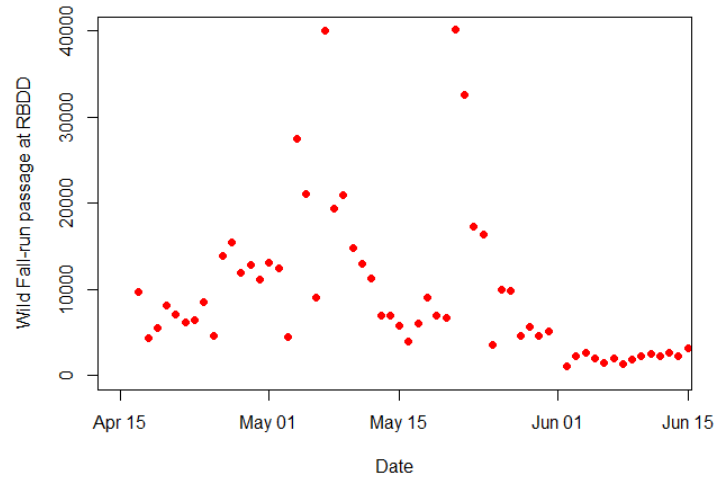


Fish Passage at Red Bluff

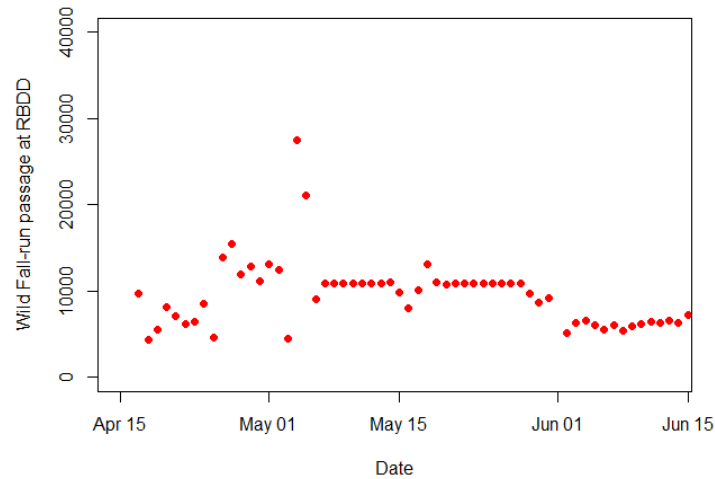


Preliminary assessment of pulse efficacy

- Survivors to Benicia with latter 2 pulses, from 4/15 to 6/15

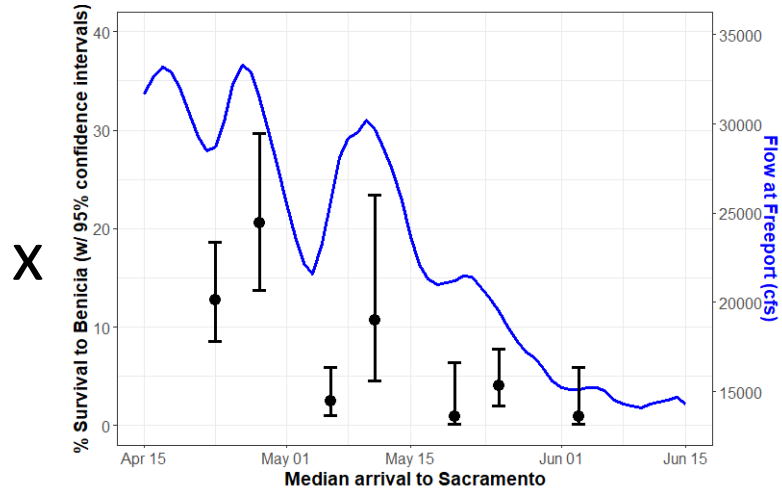
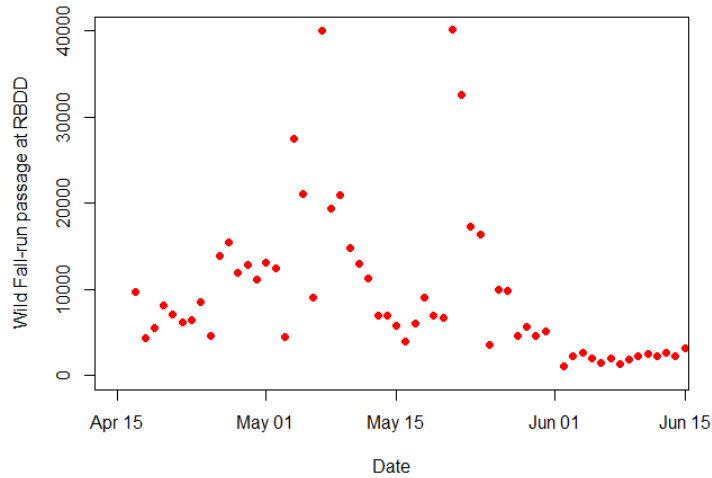


- Survivors to Benicia without latter 2 pulses, from 4/15 to 6/15

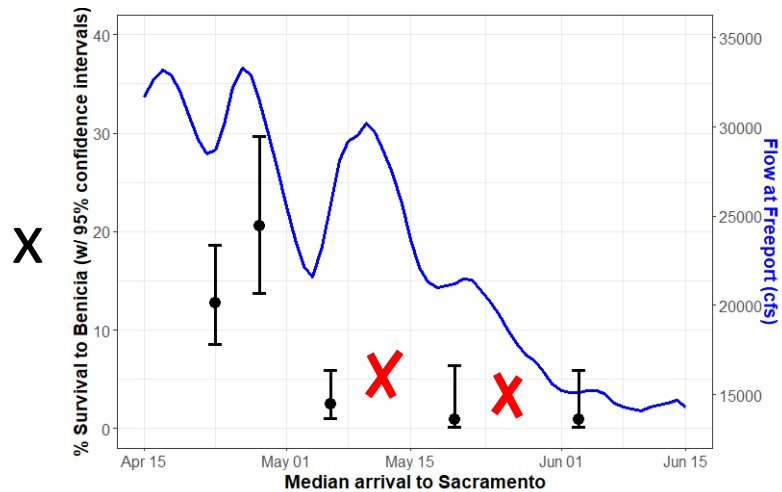
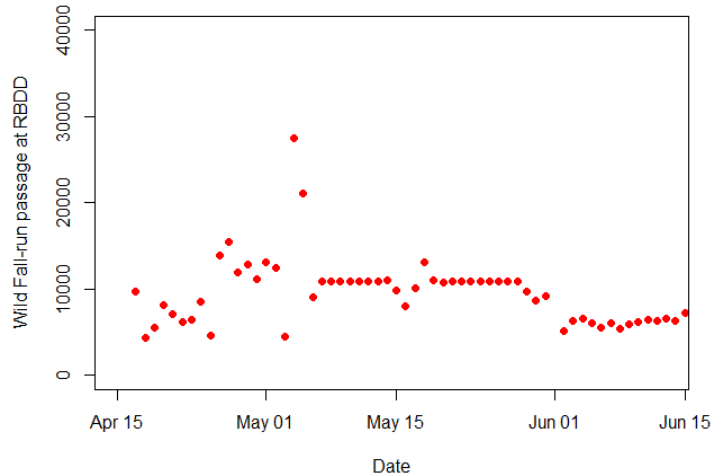


Preliminary assessment of pulse efficacy

- Survivors to Benicia with latter 2 pulses, from 4/15 to 6/15

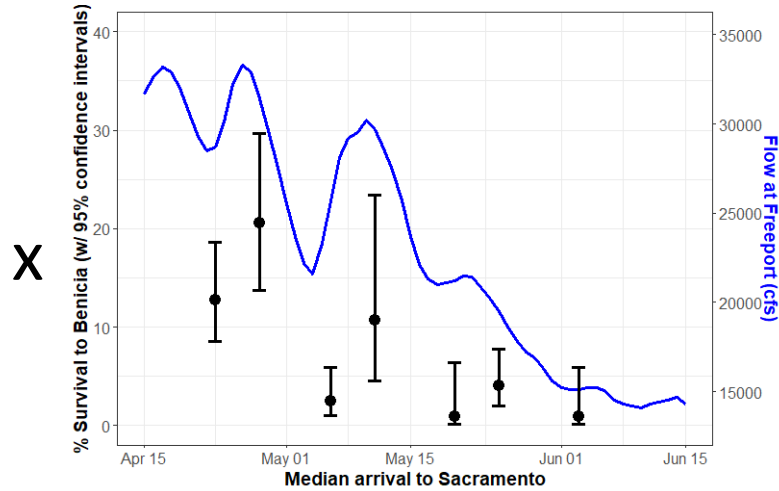
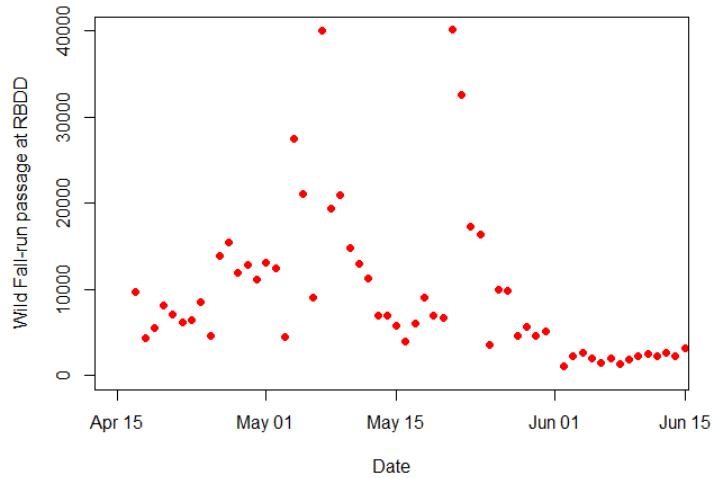


- Survivors to Benicia without latter 2 pulses, from 4/15 to 6/15



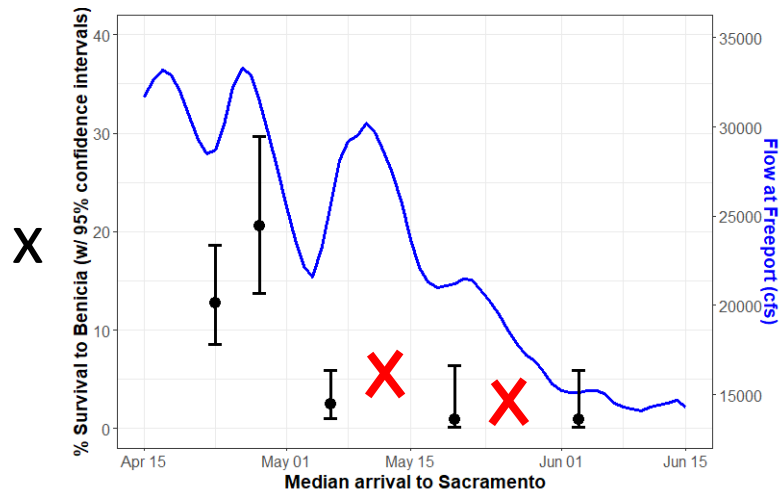
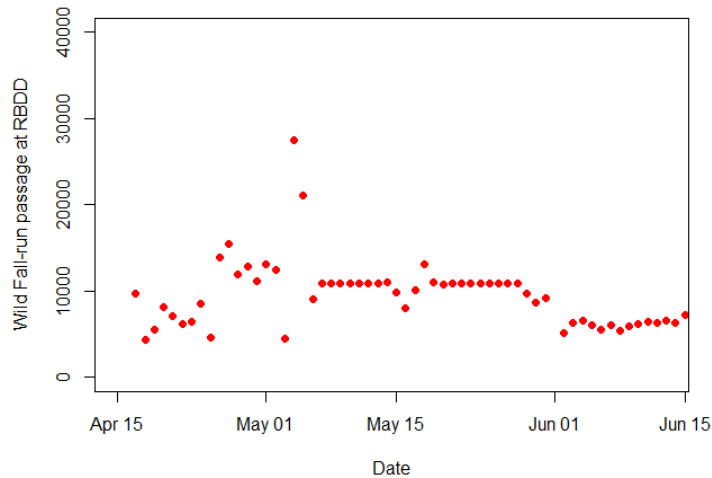
Preliminary assessment of pulse efficacy

- Survivors to Benicia with latter 2 pulses, from 4/15 to 6/15



= 40086

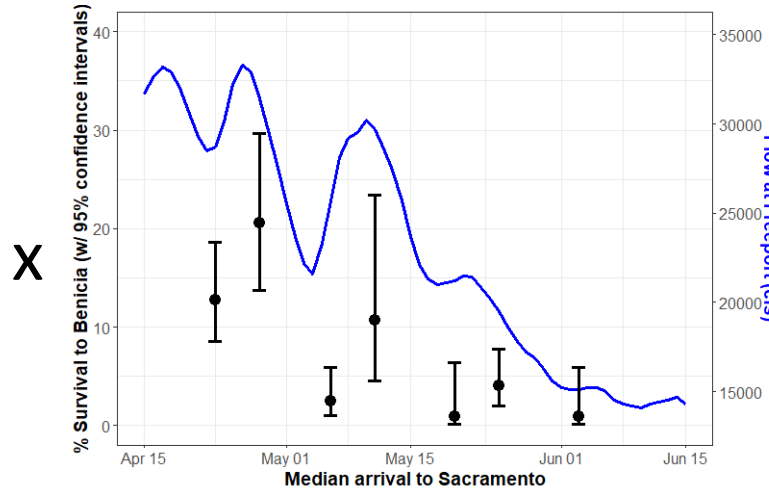
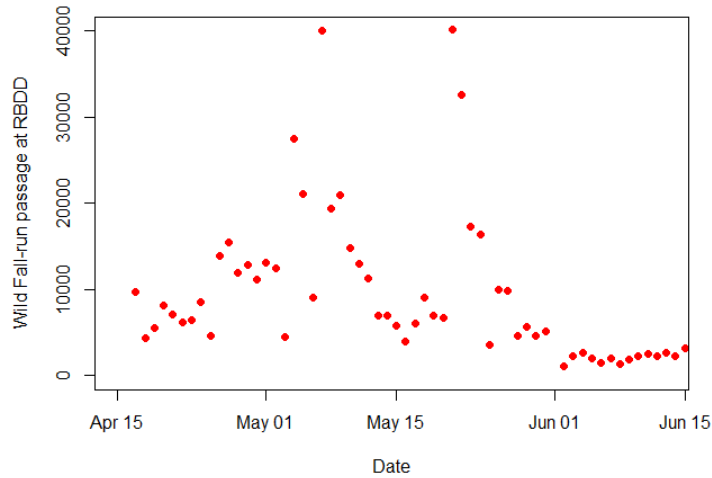
- Survivors to Benicia without latter 2 pulses, from 4/15 to 6/15



= 26596

Preliminary assessment of pulse efficacy

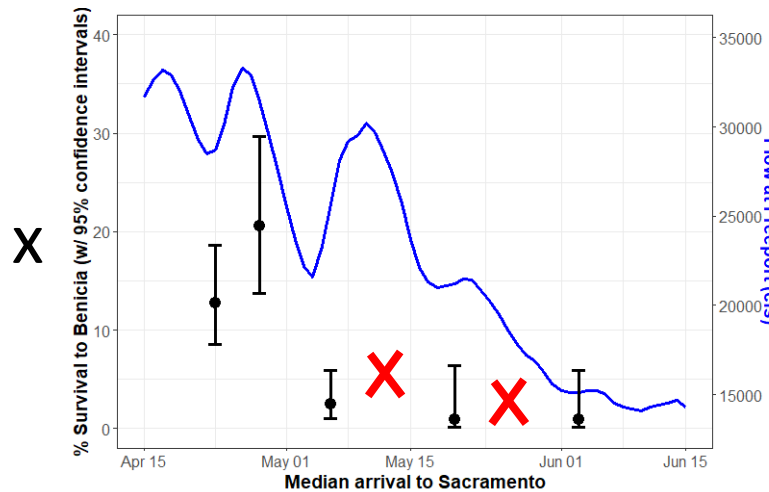
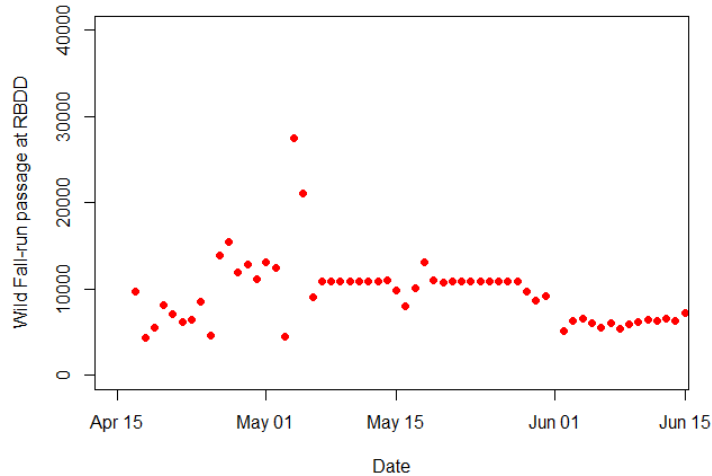
- Survivors to Benicia with latter 2 pulses, from 4/15 to 6/15



X

= 40086

- Survivors to Benicia without latter 2 pulses, from 4/15 to 6/15



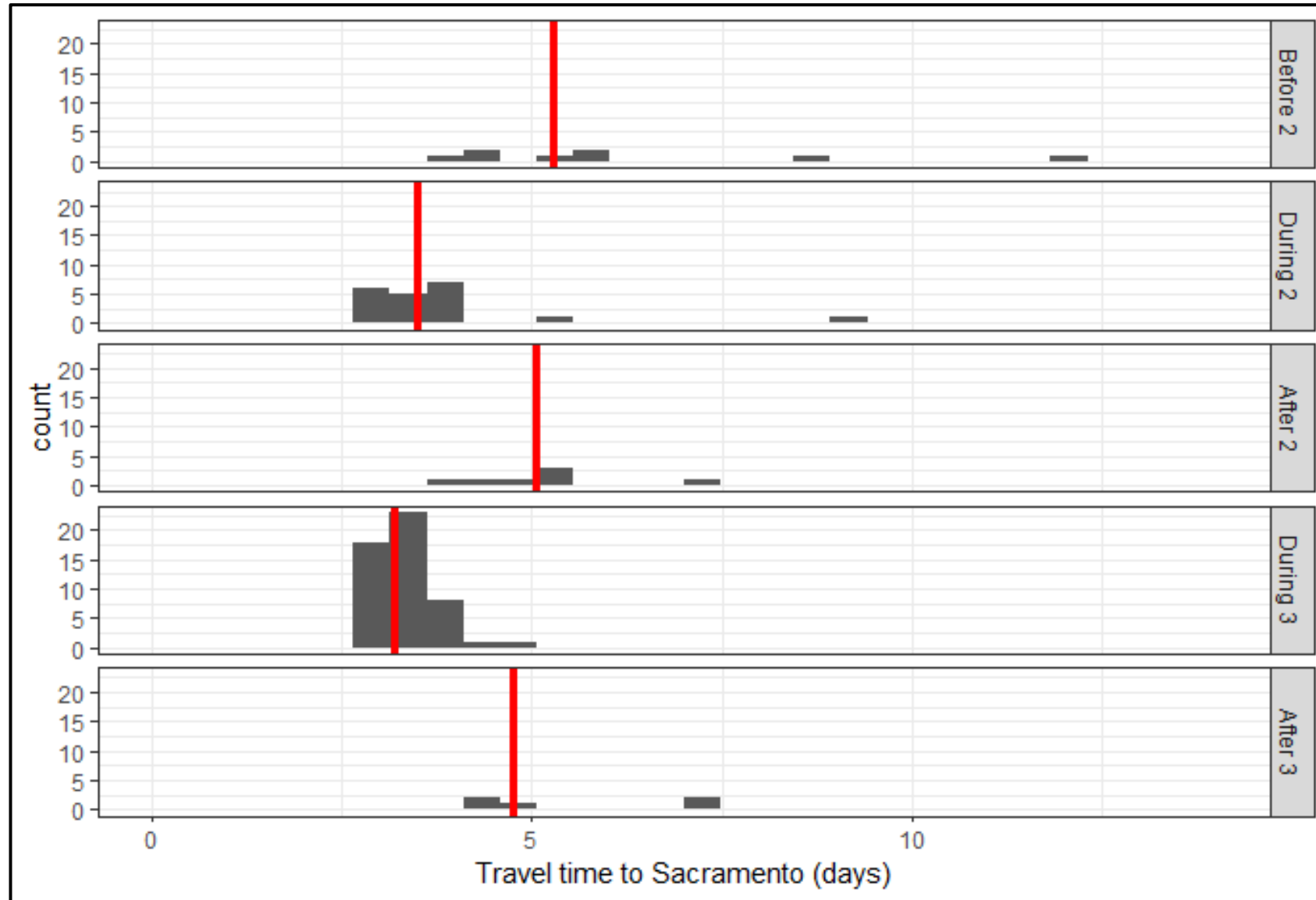
X

= 26596

+50.1%



Mechanisms for increased survival – faster travel



Conclusions

- Pulses increased the number of daily migrants over baseflow conditions by up to 640%
- Pulses increased survival over baseflow conditions by 420-680% to Sacramento
- Estimated increase of 50% of overall survivors to Benicia during late-spring period
- Total water cost ~150TAF
- Decreasing efficacy of pulses to boost survival as season progressed
 - Could be due increasing water temperatures
 - Could be due to missing 11,000 cfs goal

Acknowledgements

- Coleman National Fish Hatchery
- USFWS Red Bluff Field Office
- CDFW Red Bluff Field Office
- Santa Cruz NOAA Fisheries
- Funding provided by U.S. Bureau of Reclamation

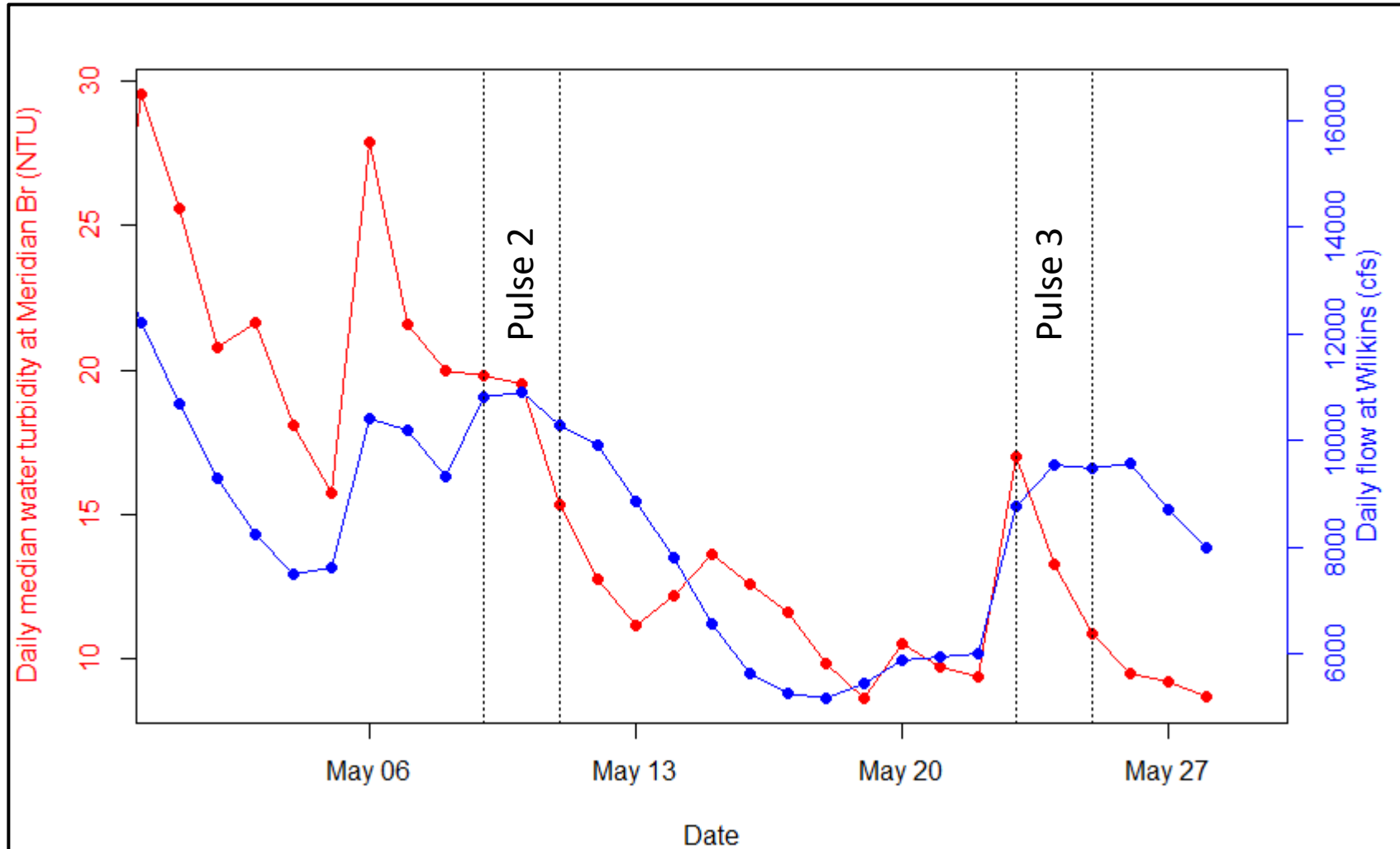


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Questions?



Mechanisms for increased survival – increased turbidity



Mechanisms for increased survival – decreased water temperatures

