



Winter Flow Variability

Preliminary results and future
recommendations

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Photo courtesy of Aaron Martin, YTFD



Outline

- Components of natural flow regimes in Mediterranean climates
- Winter variable flows 2023: flow components and intended benefits
- Making fish food with disturbance and inundation, a refresher
- Preliminary results of WY2023 winter variable flows implementation
- Technical recommendation for water year 2024



Common components of Mediterranean flow regimes

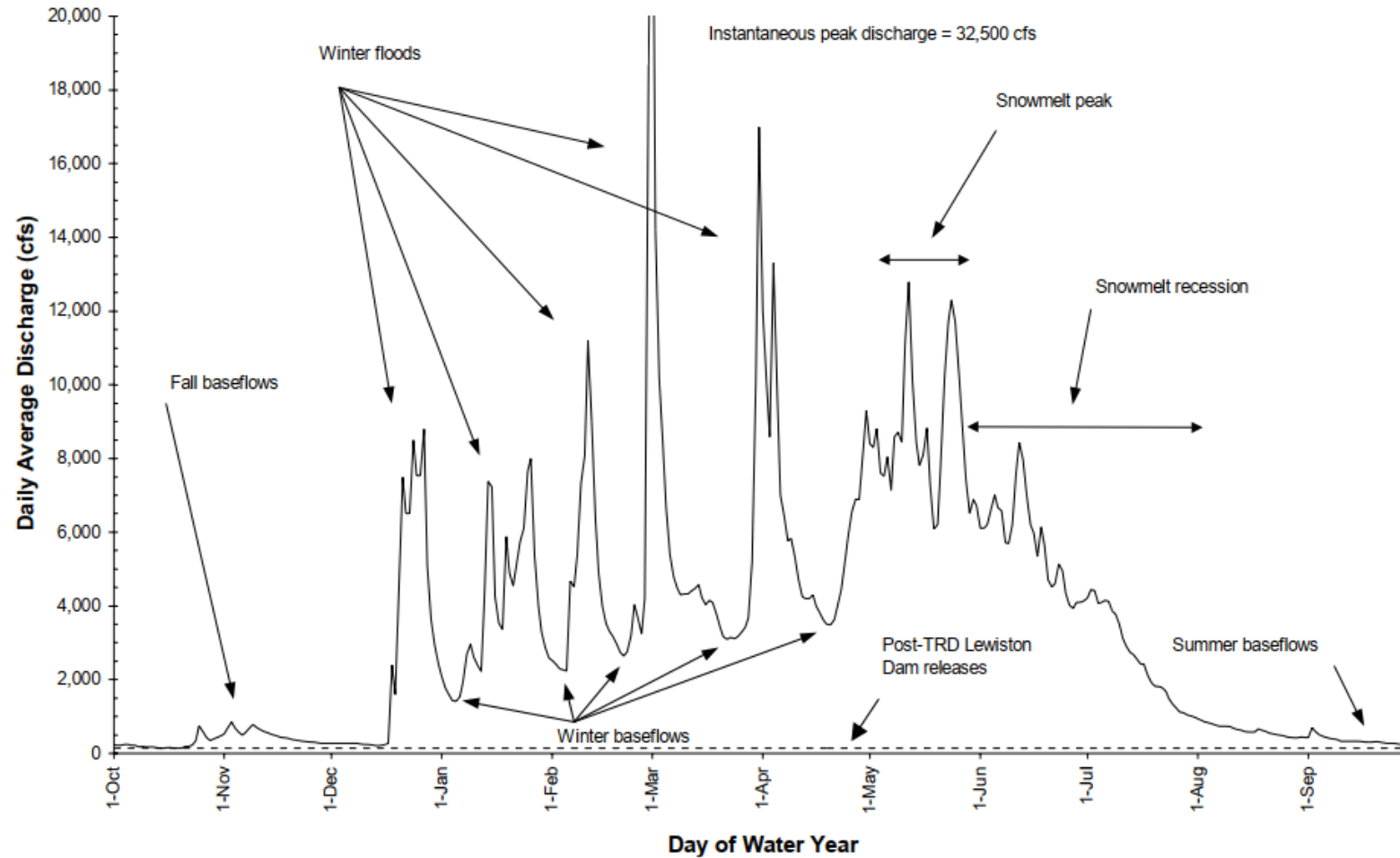
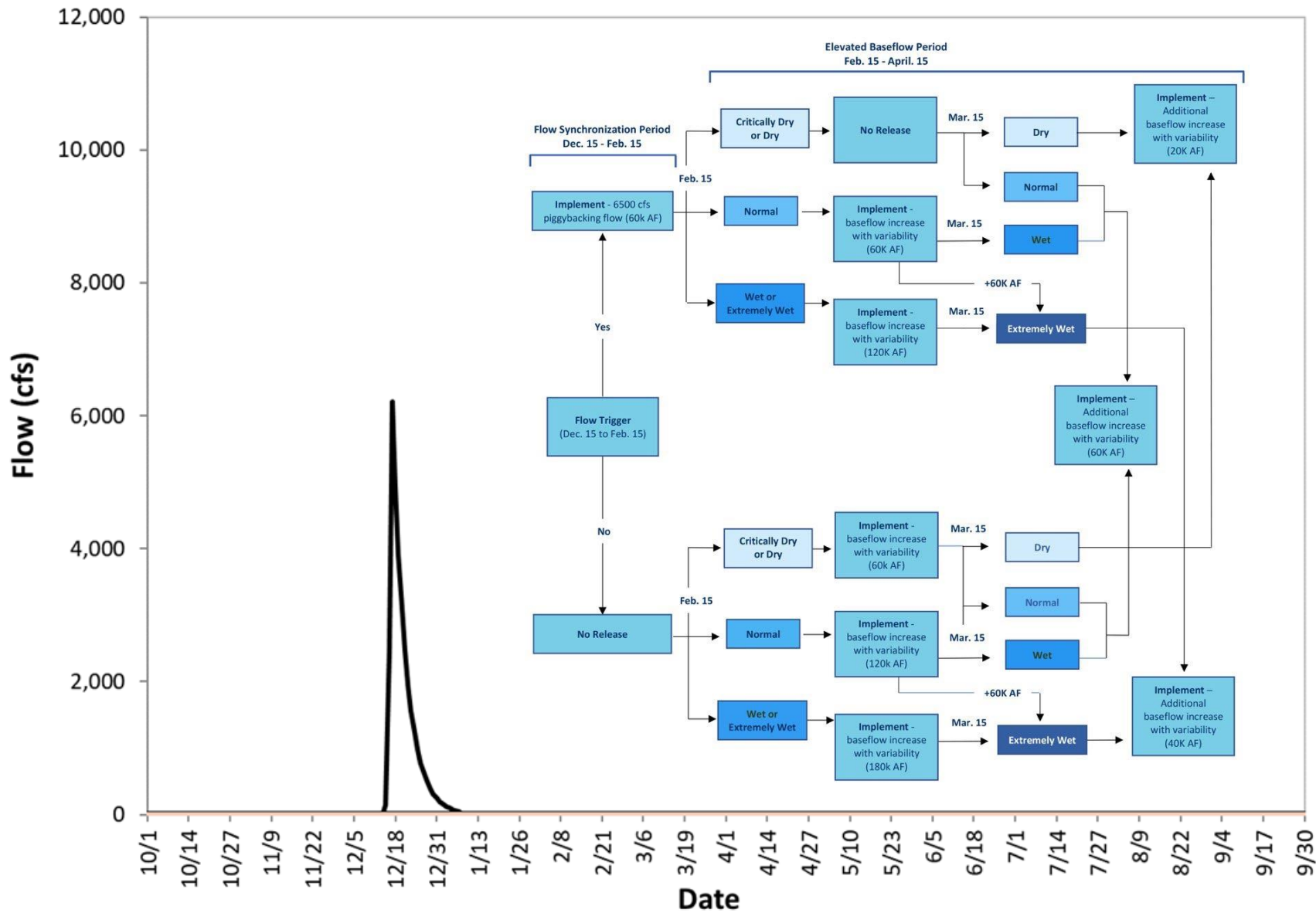


Figure 4.10. Trinity River at Lewiston streamflow hydrograph illustrating hydrograph components typical of a watershed dominated by rainfall and snowmelt runoff (Extremely Wet water year 1941).



Winter Variable Flows 2023



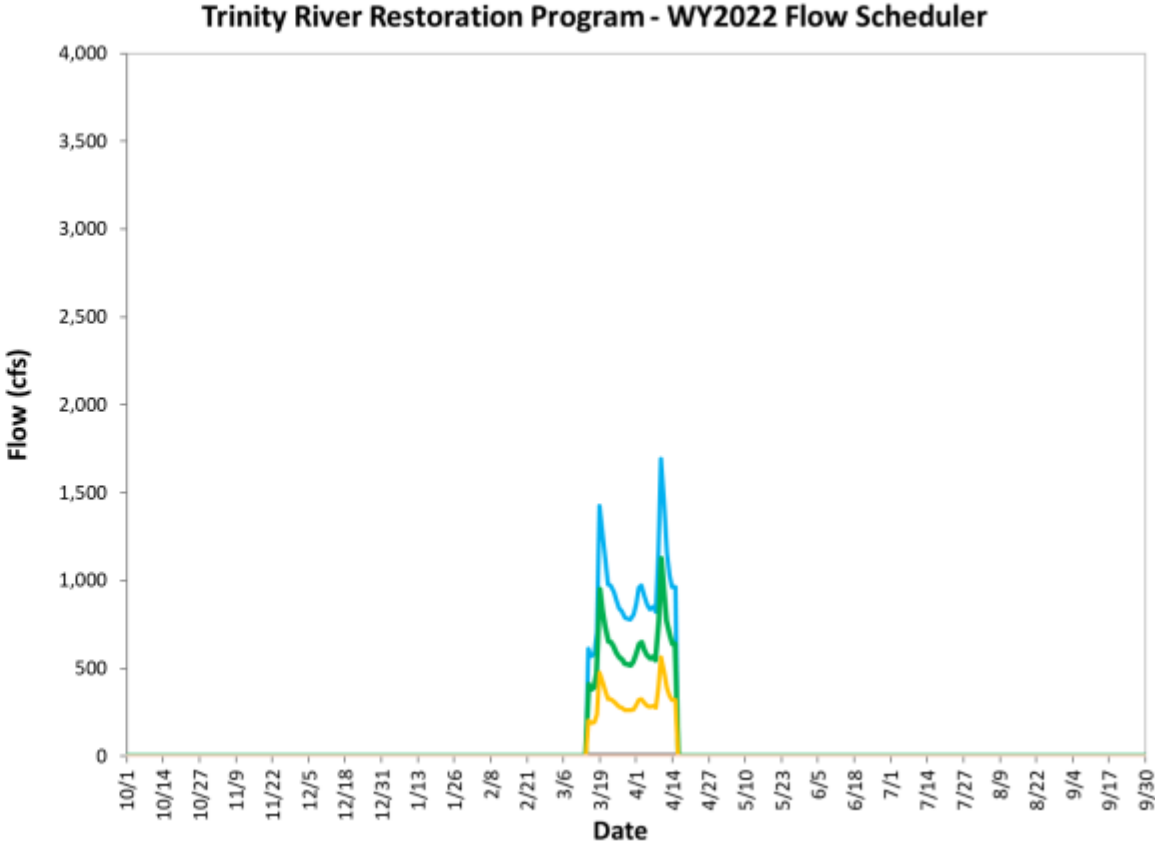
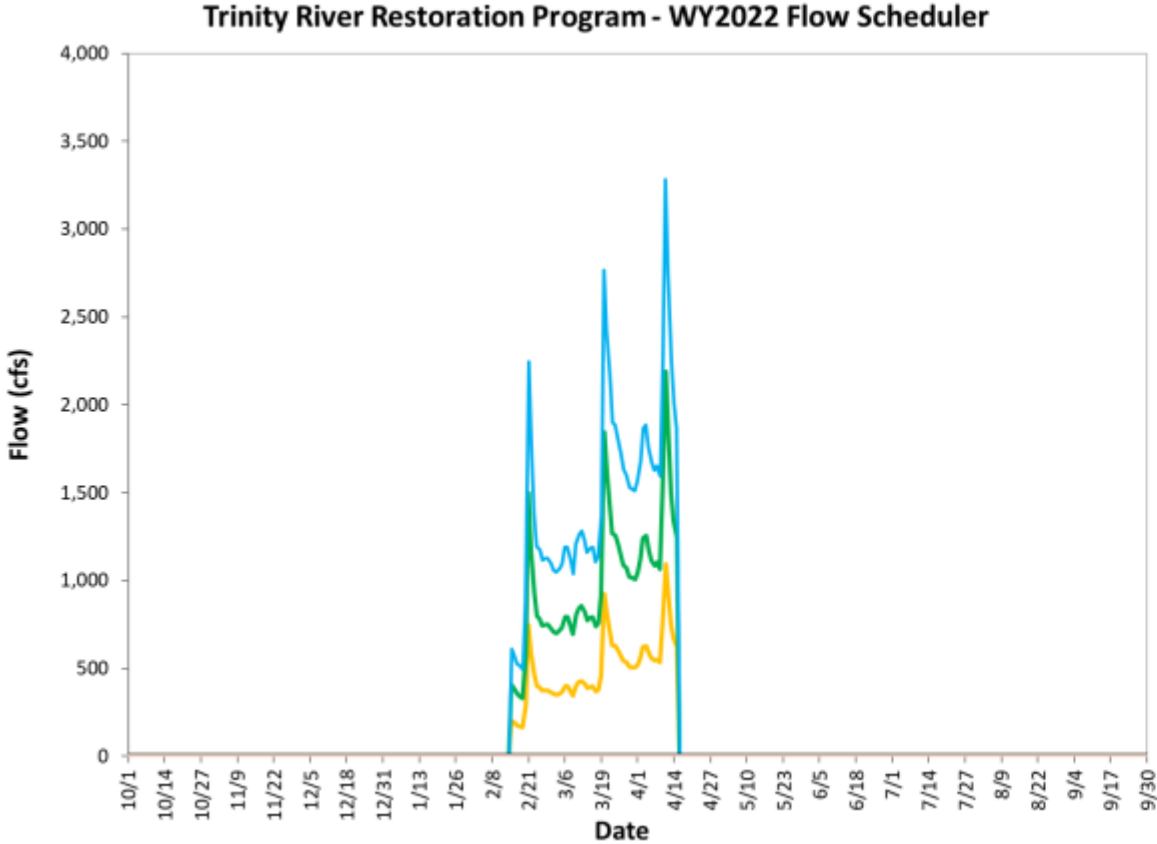
A flow chart and forecasted water year volumes determine winter variable flows

One geomorphic release synchronized with tributaries IF flow trigger met

15 Dec – 15 Feb



Winter Variable Flows 2023



Varying volumes, determined by forecasts, released as elevated winter baseflows in two periods:

15 Feb to 15 April

15 March to 15 April



Winter Variable Flows – intended benefits

- Improved juvenile salmonid growth due to food and temperature
- Promote earlier emigration to improve survival in lower Klamath
- Expand spawning habitat
- Improve conditions for frogs and turtles
- Meet geomorphic objectives more efficiently
- Redistribute tributary sediments onto floodplains



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- Promote earlier emigration to improve survival in lower Klamath
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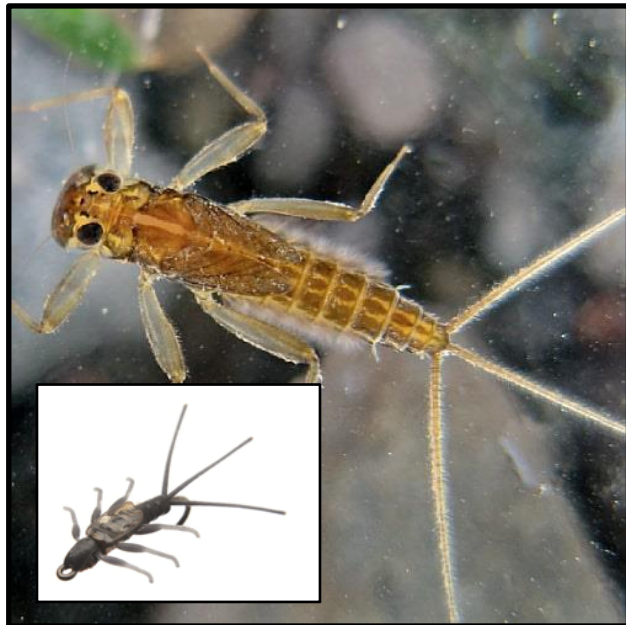




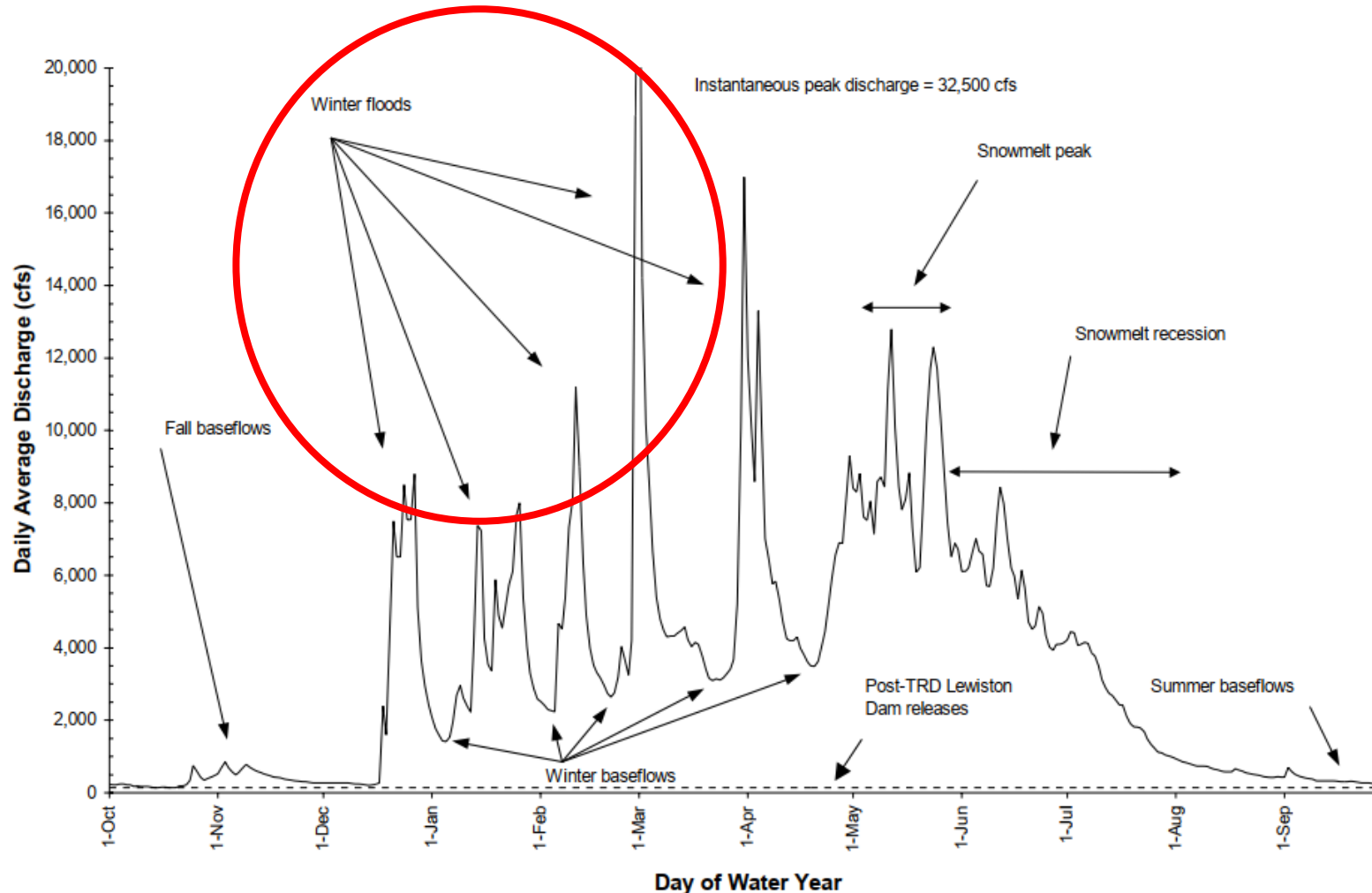
Floodplain inundation

Bed disturbance

Fish food vs. non-fish food



Common components of Mediterranean flow regimes



Winter floods

- Geomorphic processes (bedload movement, channel migration, fine sediment transport and floodplain delivery)
- **Disturbance** promotes seasonally appropriate foodweb development
- Contribute to elevated baseflows



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Disturbance: physical process and biological response

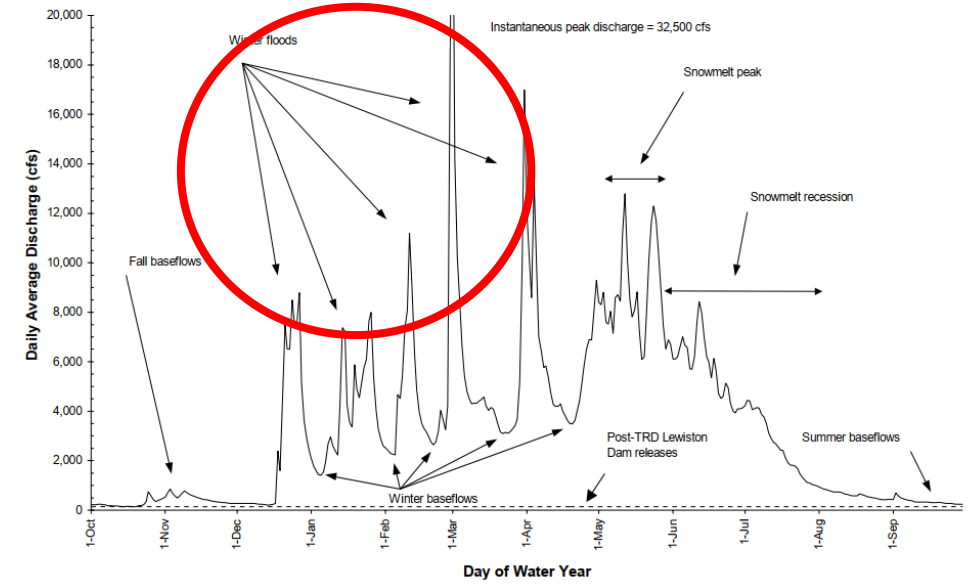
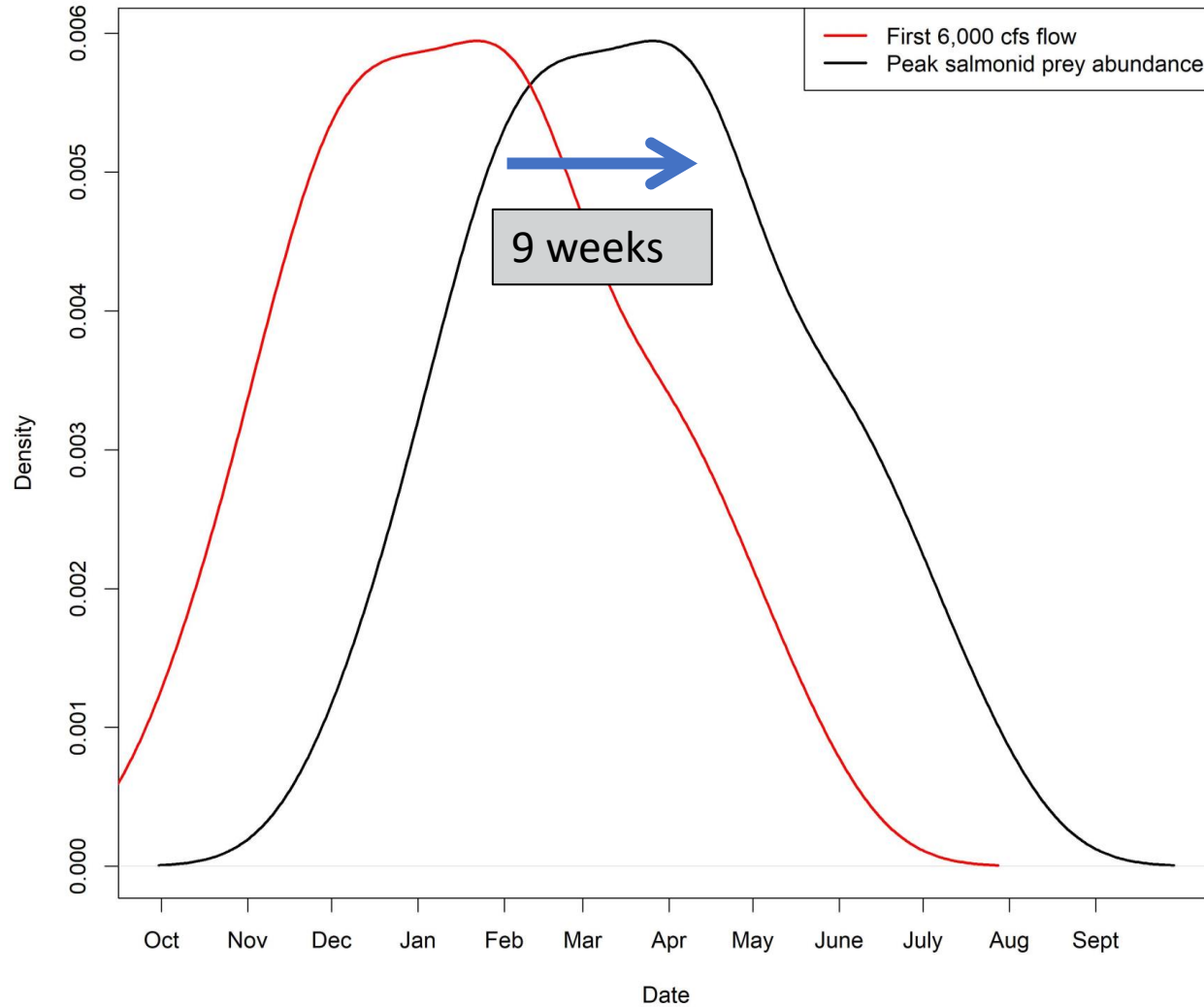
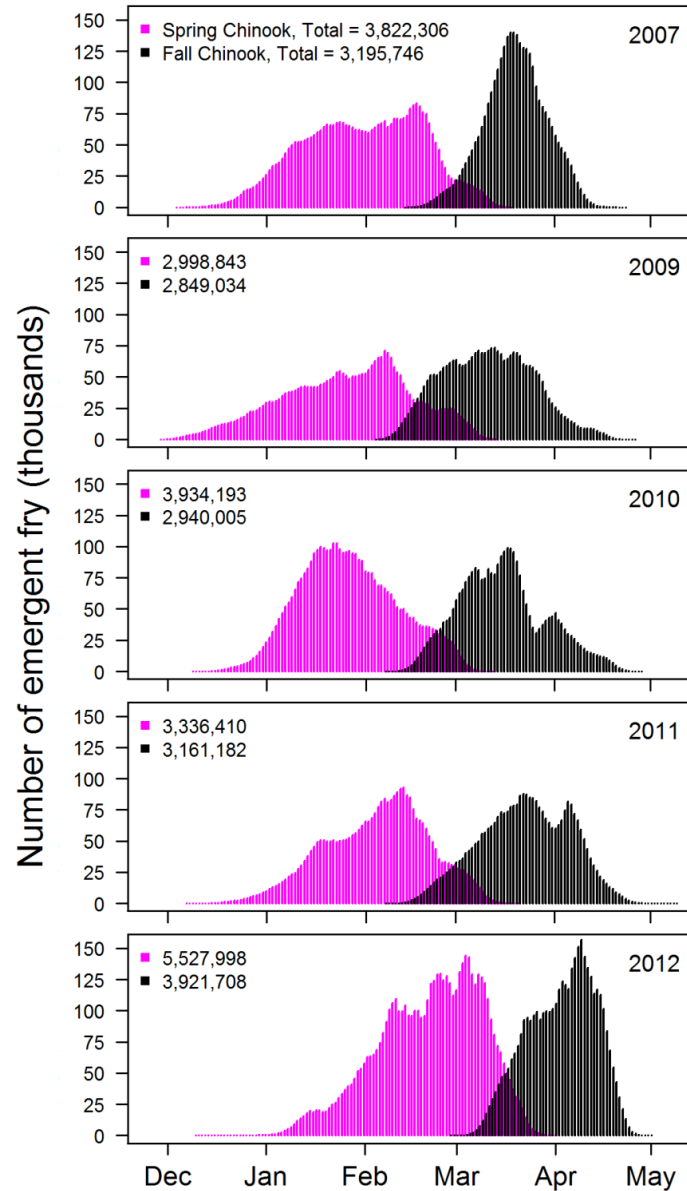


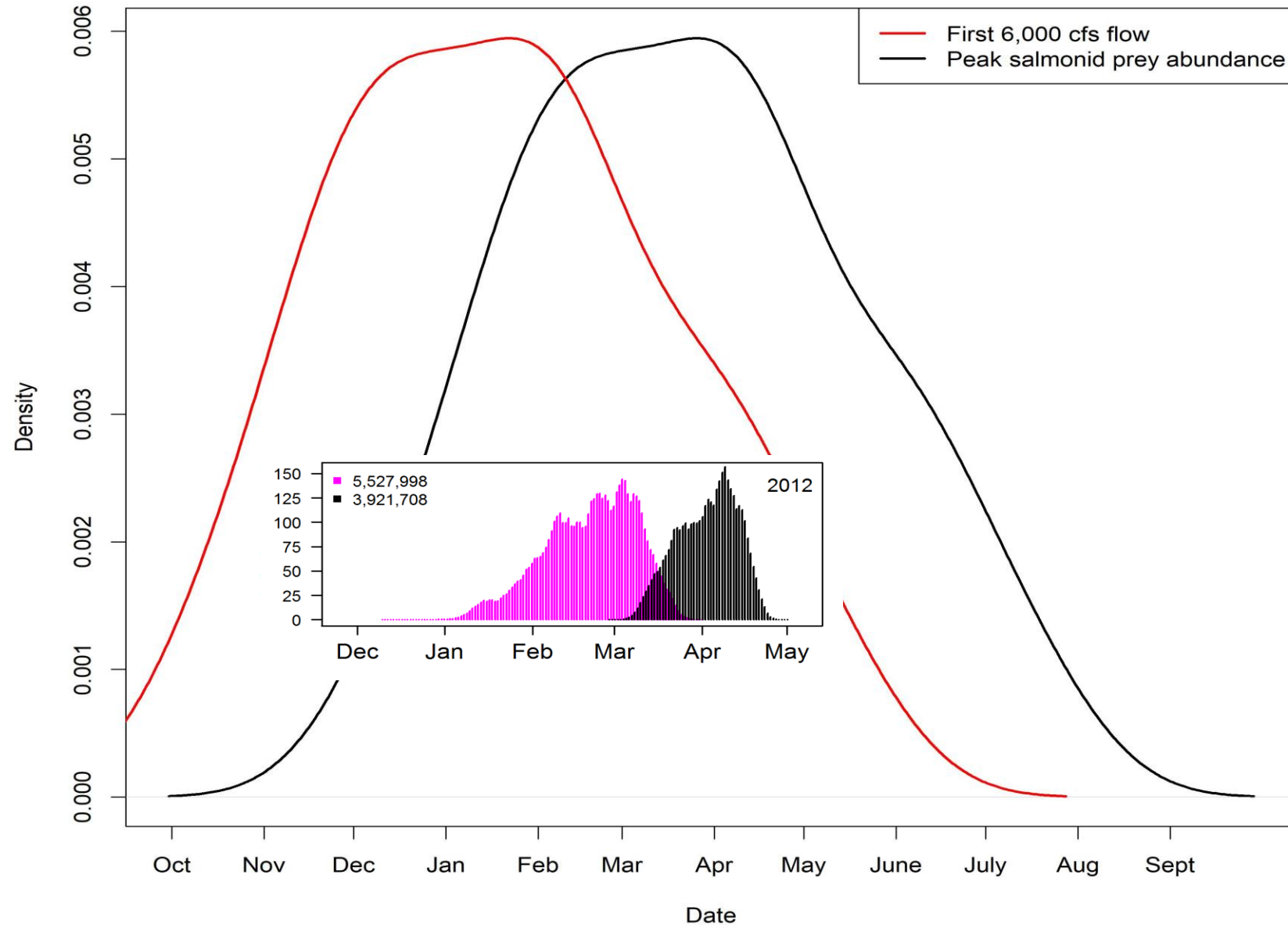
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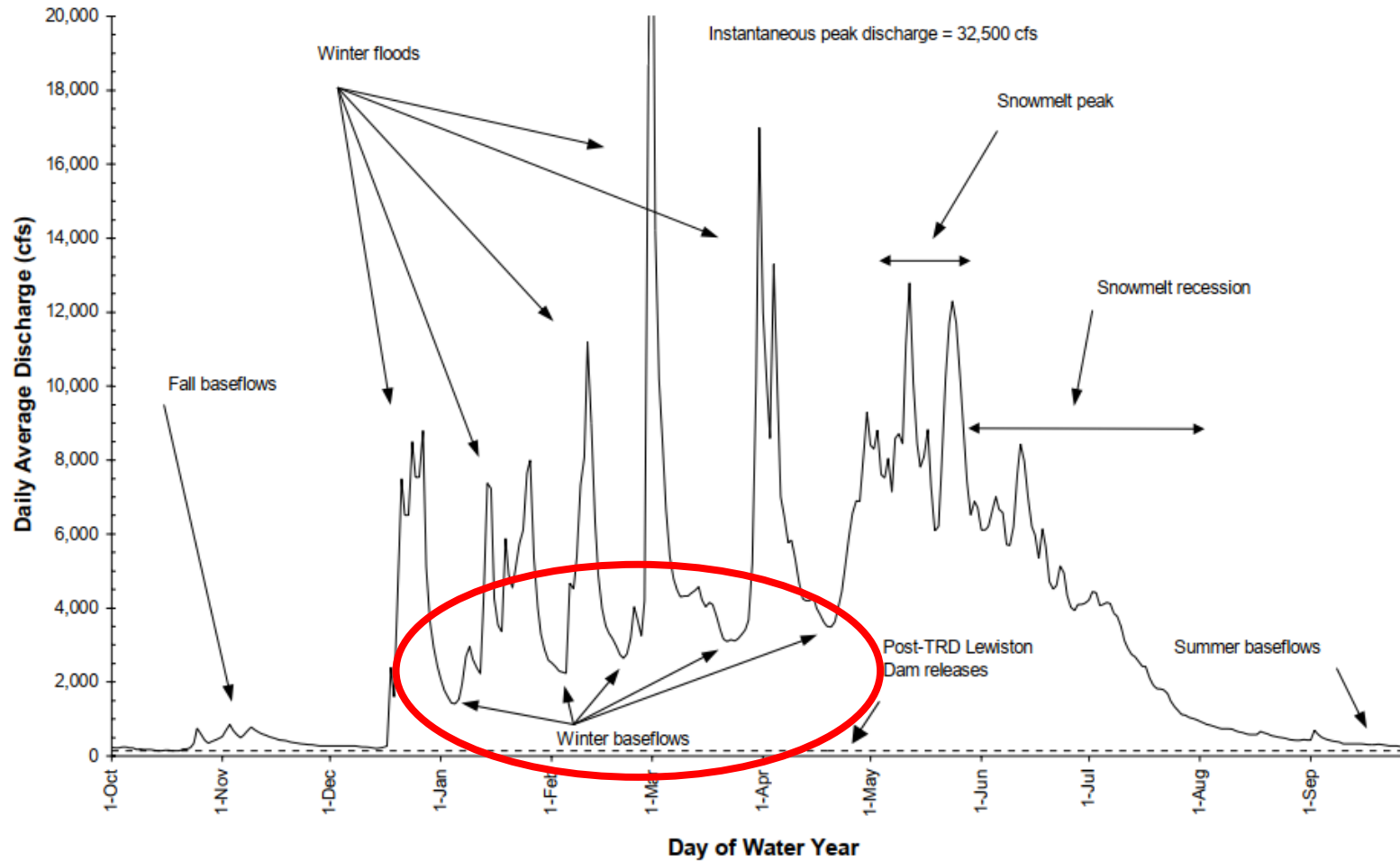
Emergence timing and increasing abundance



Disturbance: physical process and biological response



Inundation: physical process and biological response



Winter baseflows

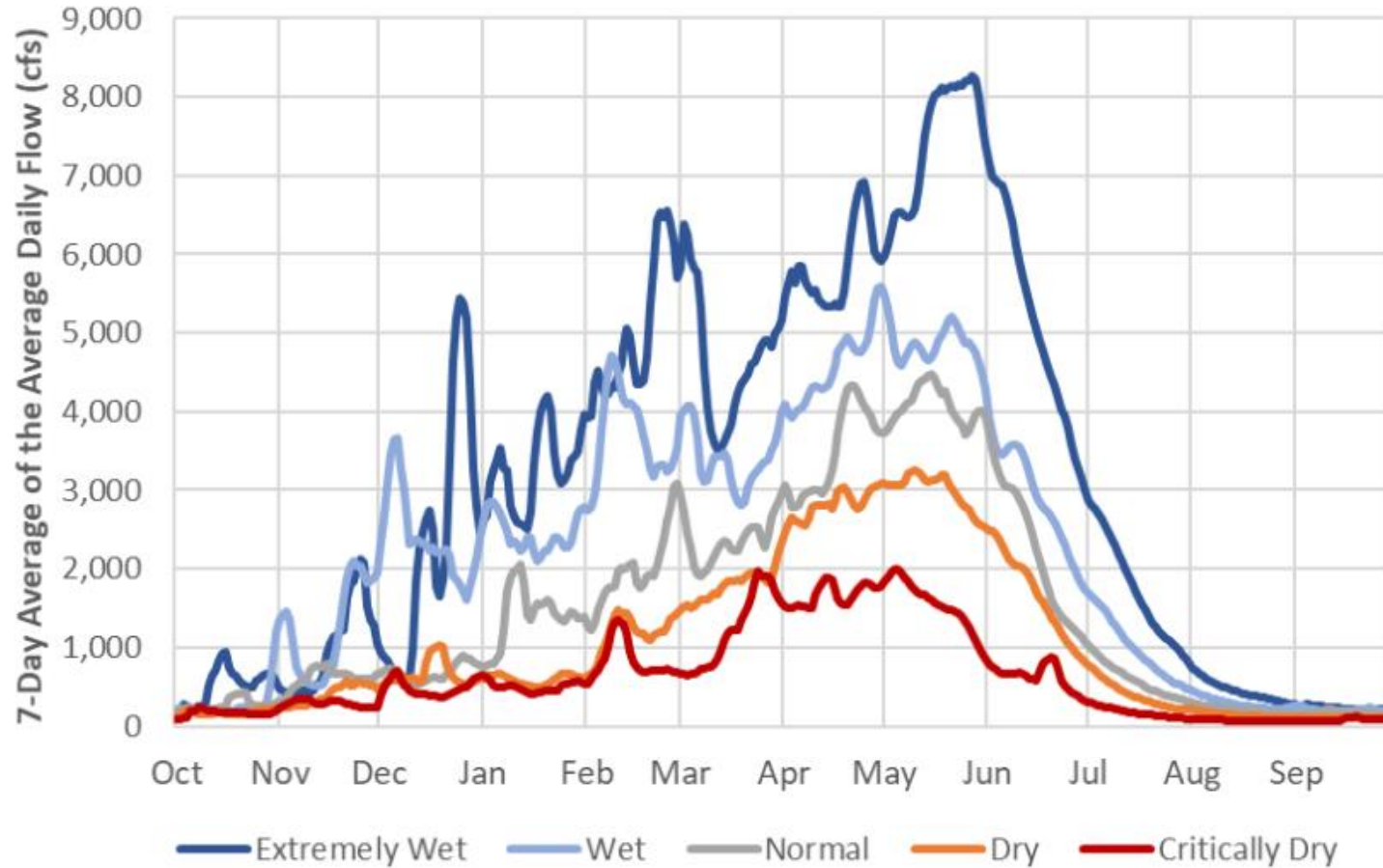
- **Inundation** Increases wetted area, space and habitat to reduce competition and predation
- lateral habitat expansion (basal food web development translates up to fish)
- Expansion of foodscape

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Inundation: physical process and biological response

7-Day Average of the Daily Average (7DADA) Flow by Water Year Type
Trinity River near Lewiston (USGS 11525500), water years 1912 - 1960



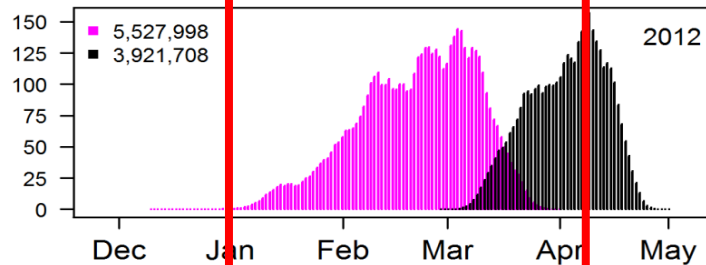
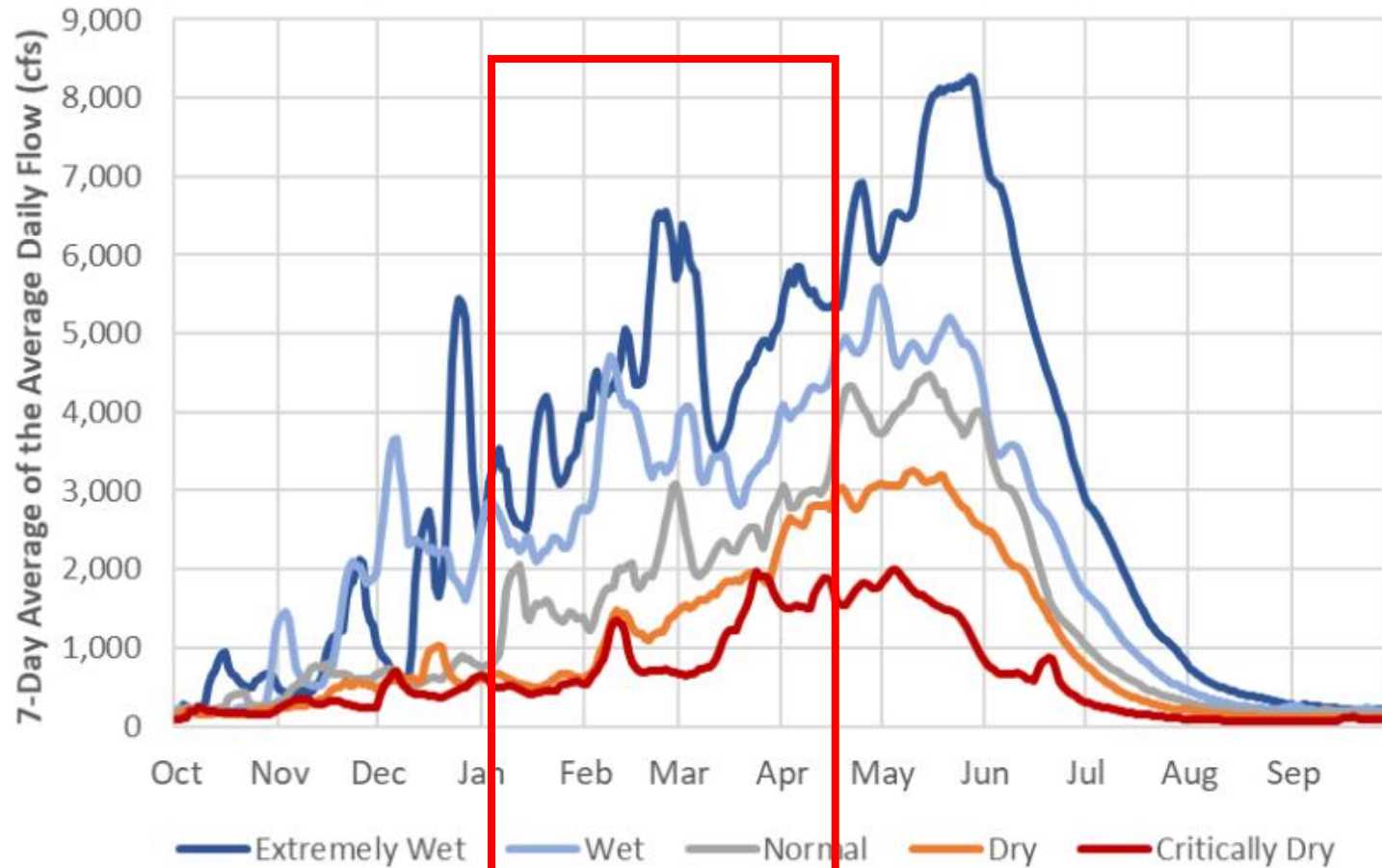
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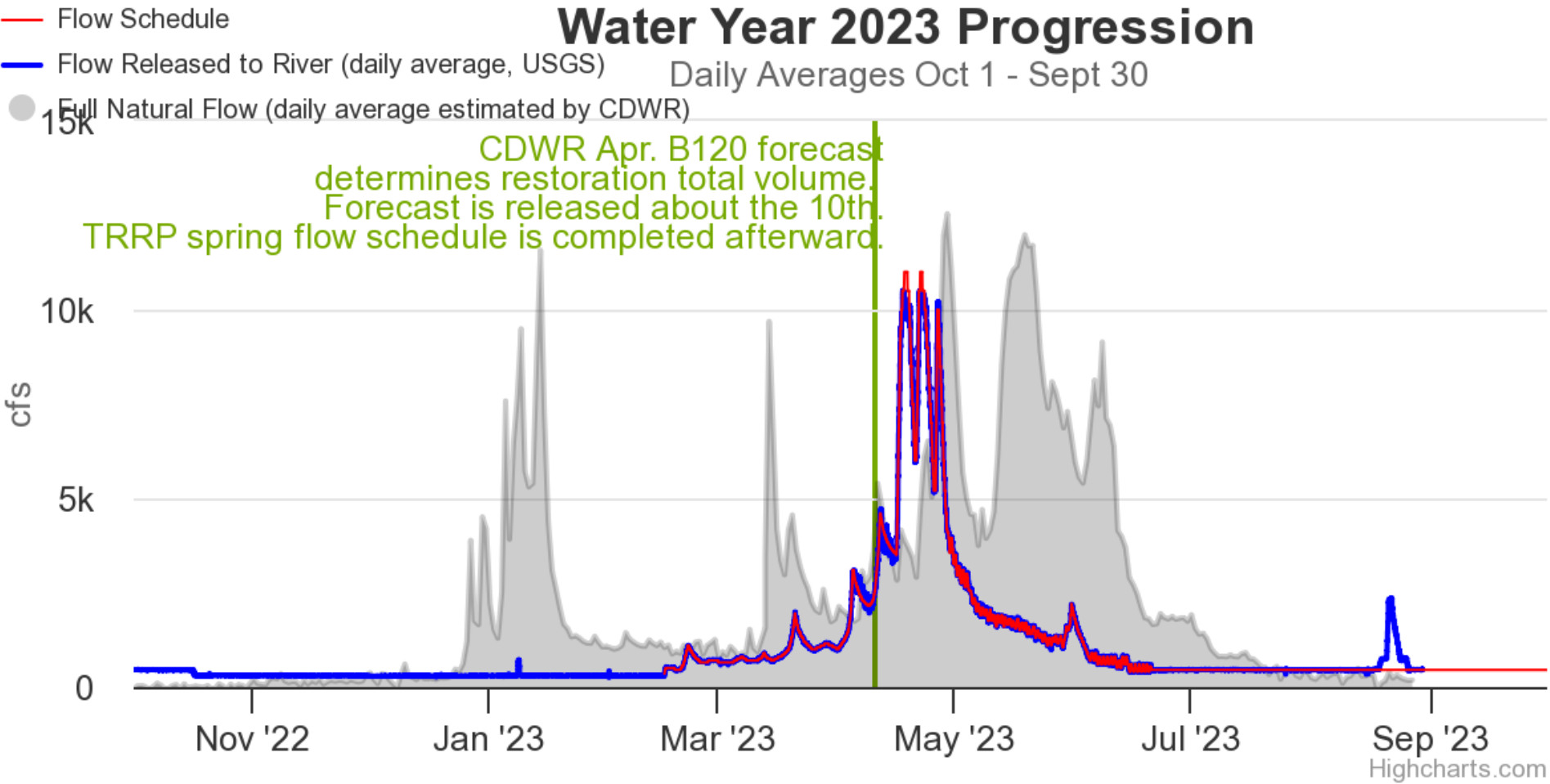


Increasing and elevated winter baseflows

- Begins Dec-Feb
- habitat expansion in space
- expansion of foodscape
- coincident with fry emergence
- habitat and food continue to expand as fry abundance increases

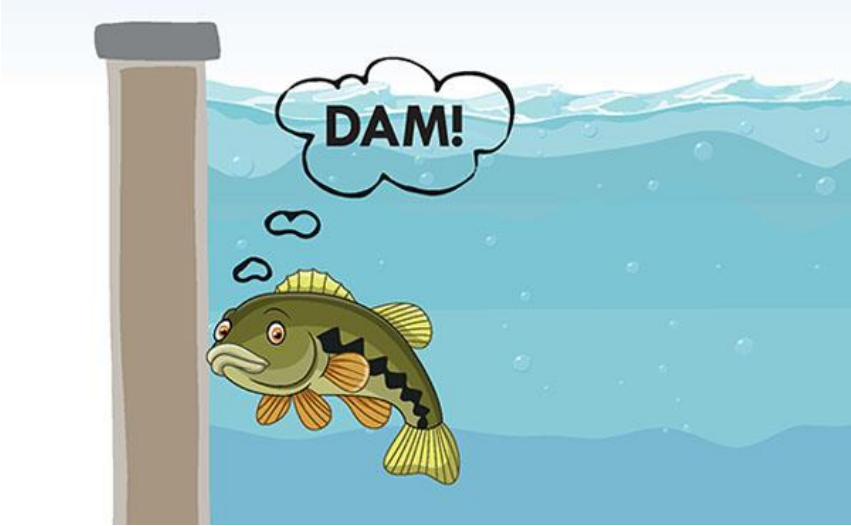
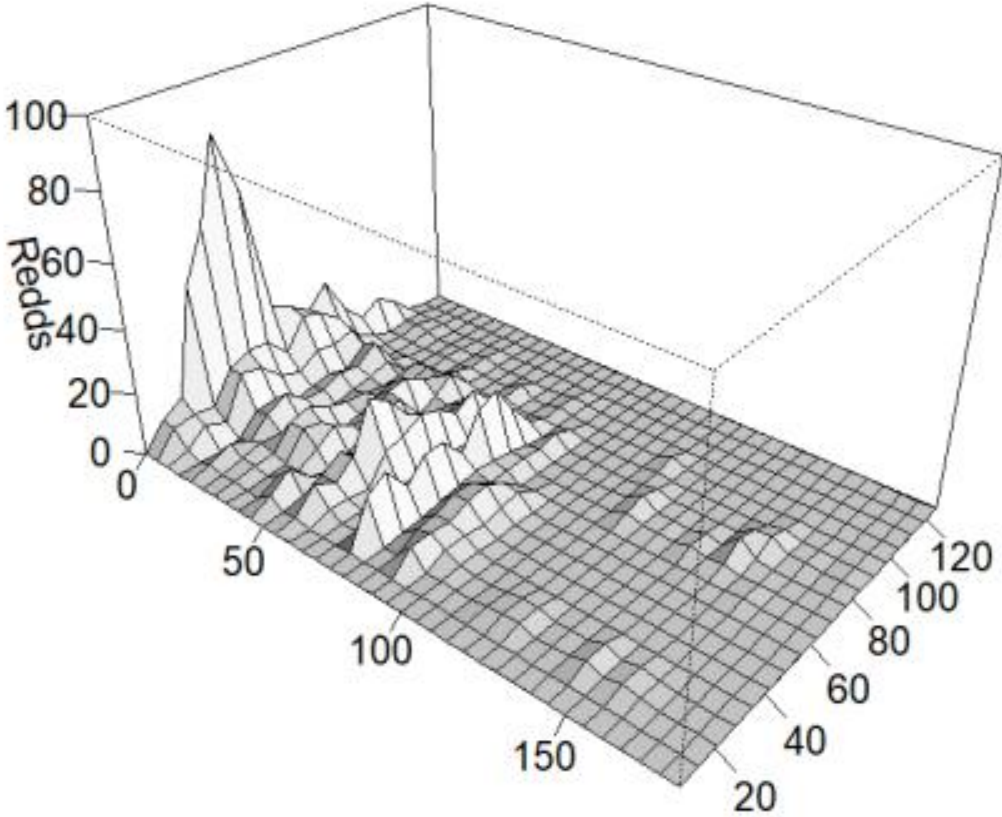


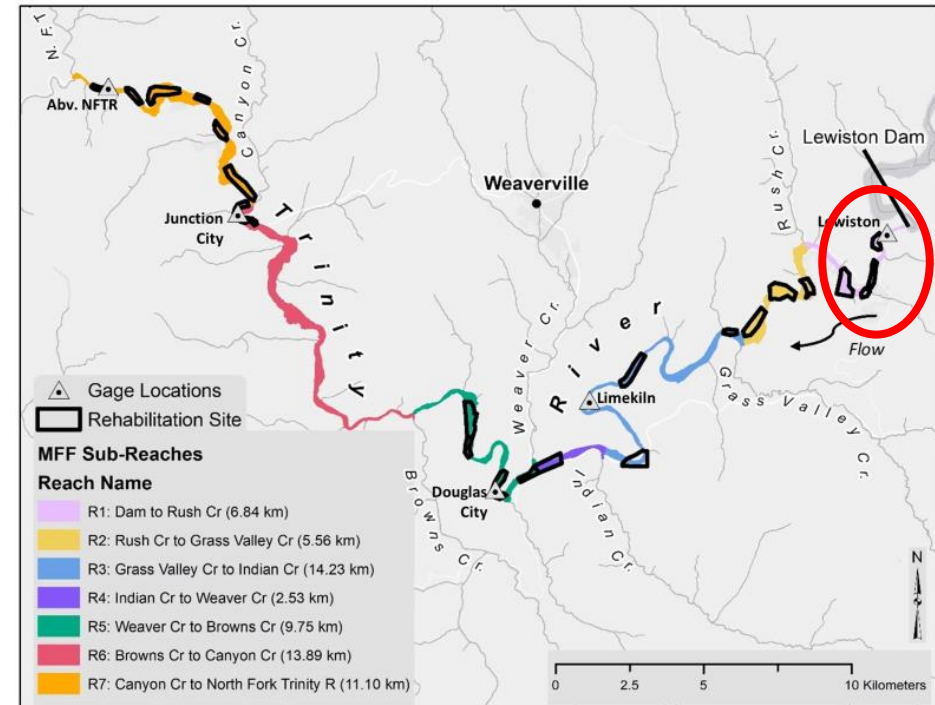
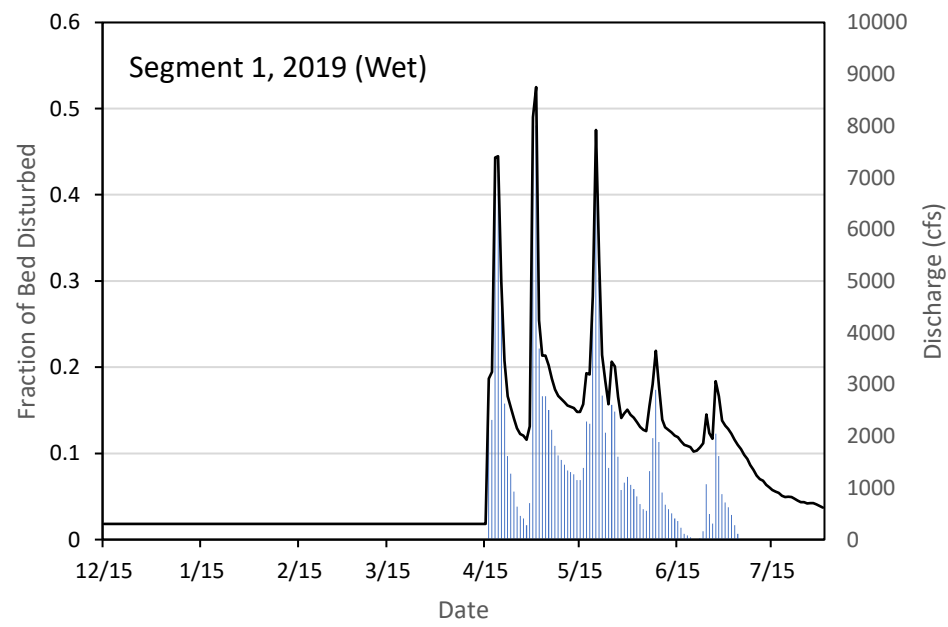
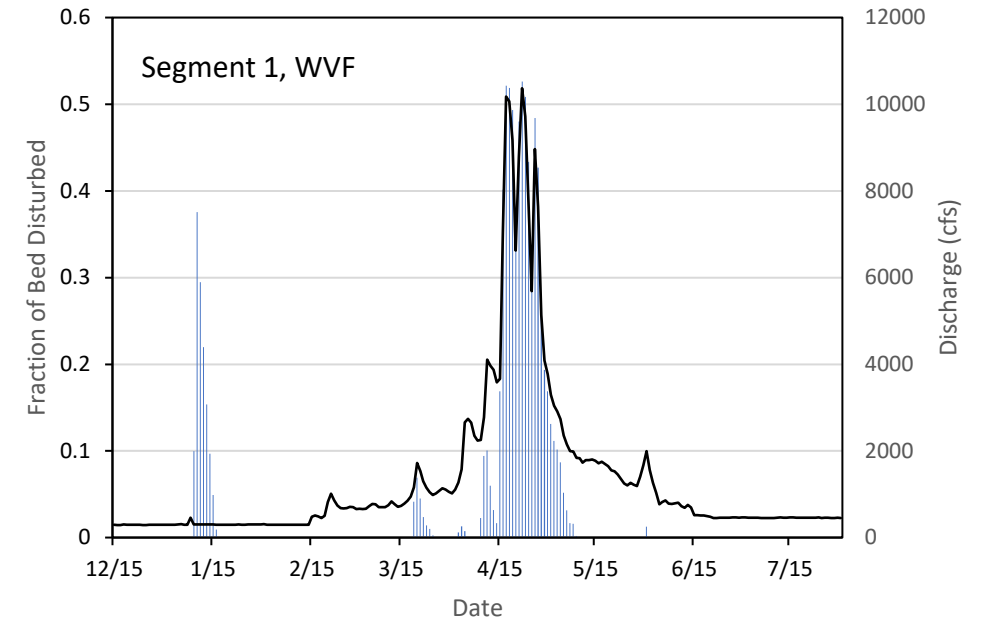
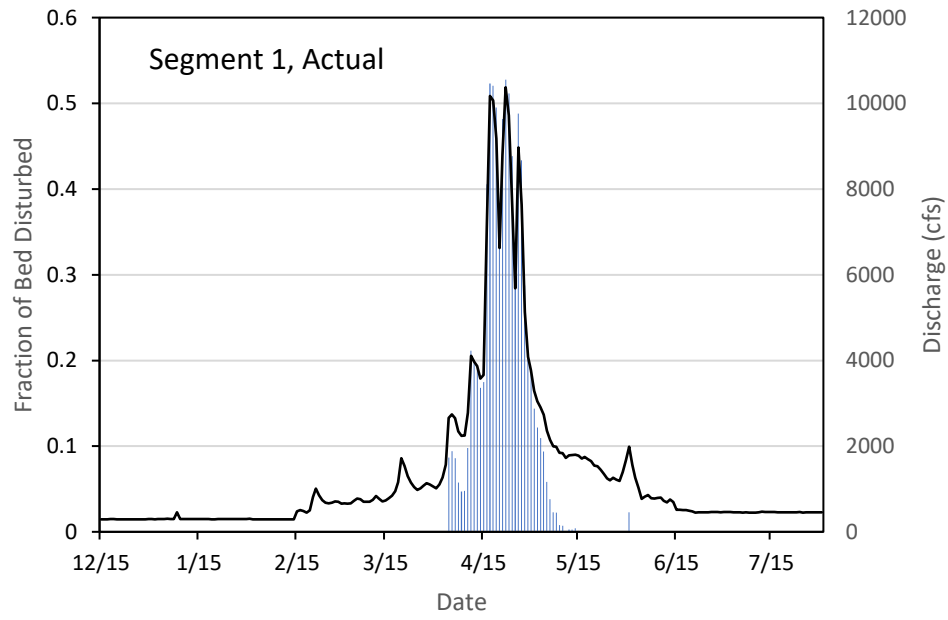
New flow management 2023



New flow management 2023

Chinook Salmon redds





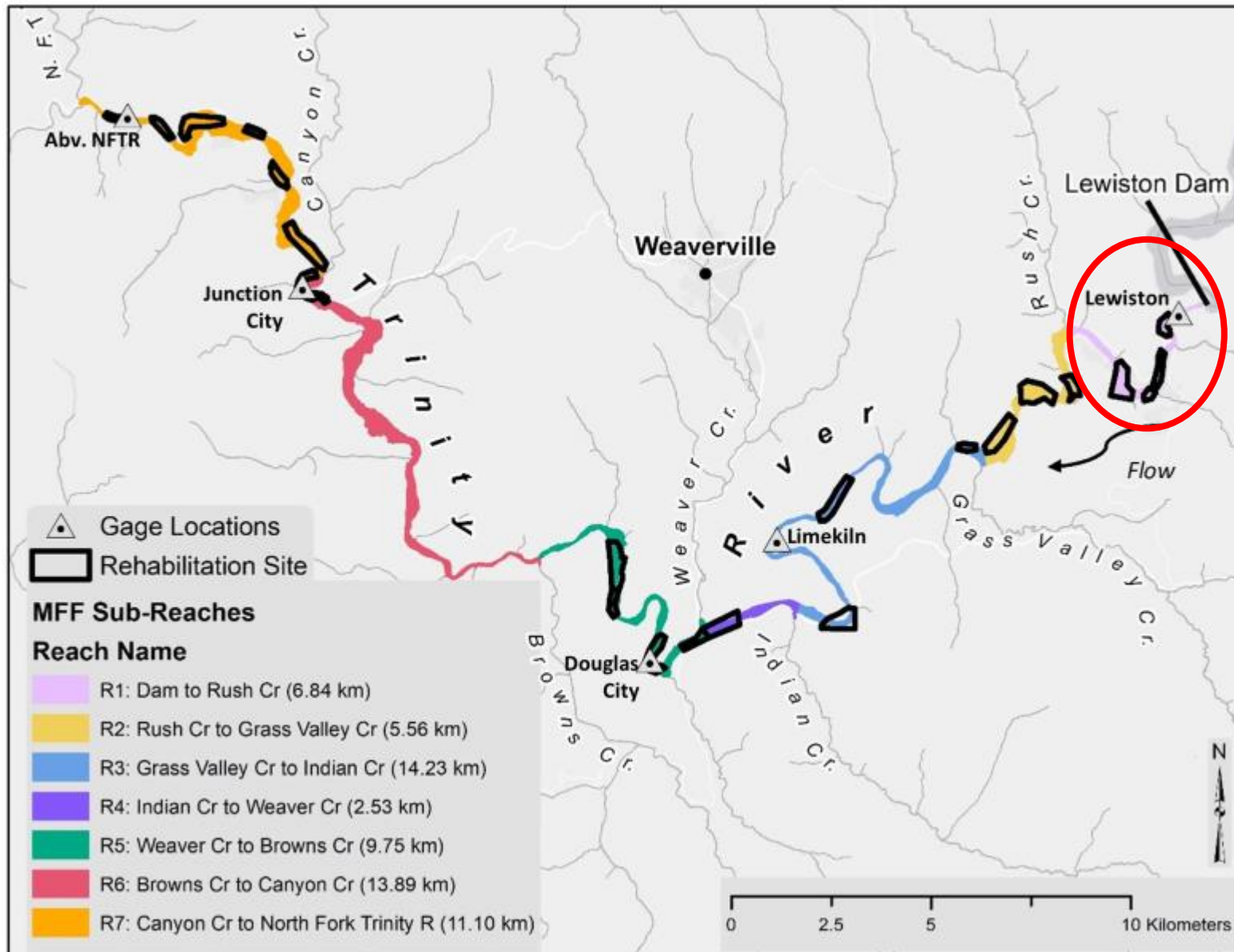
Preliminary Data: Do Not Cite

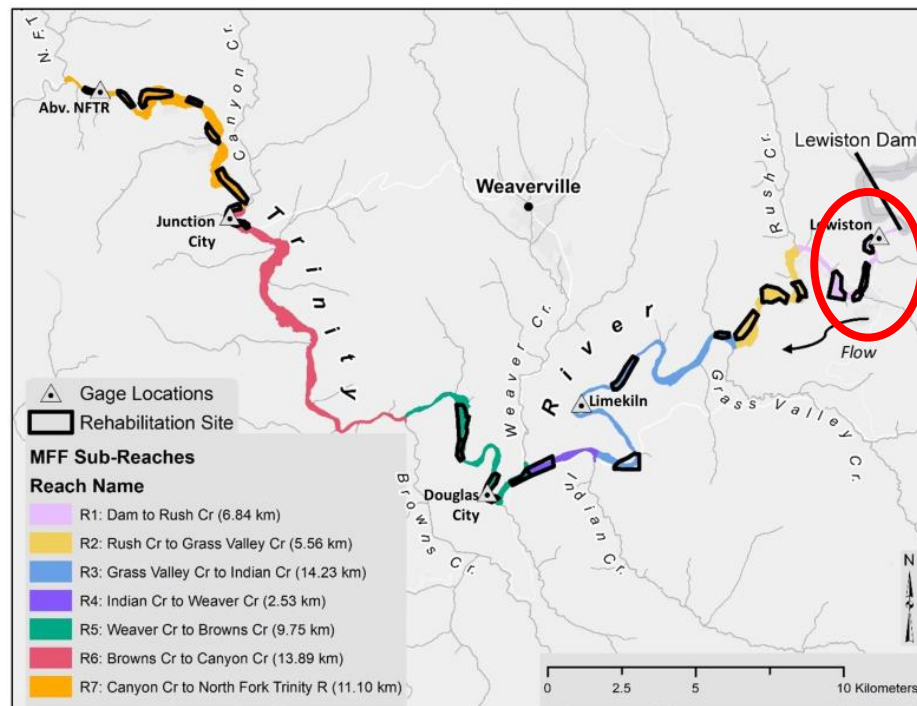
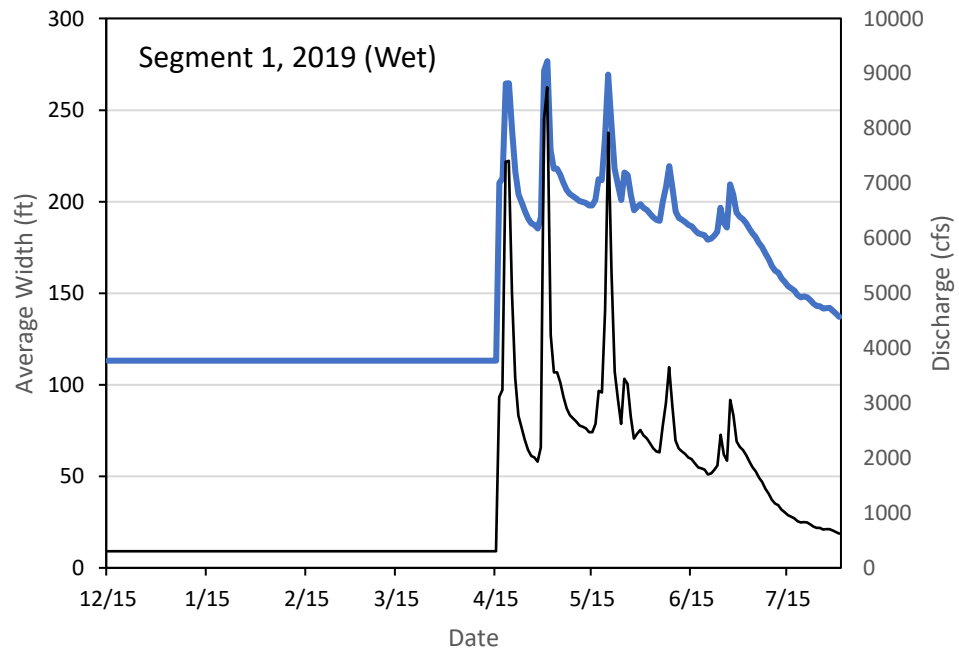
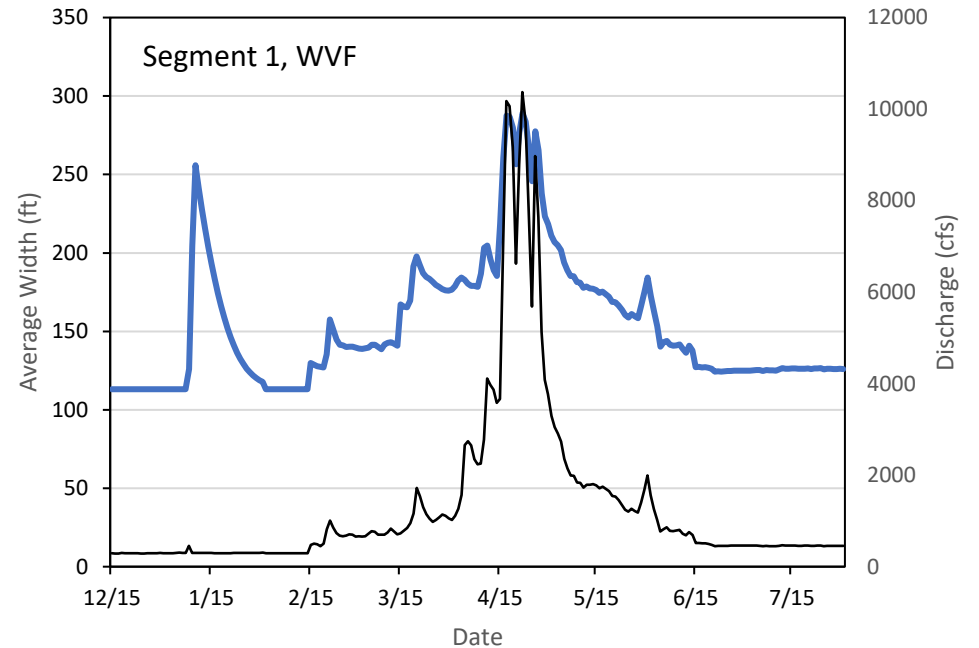
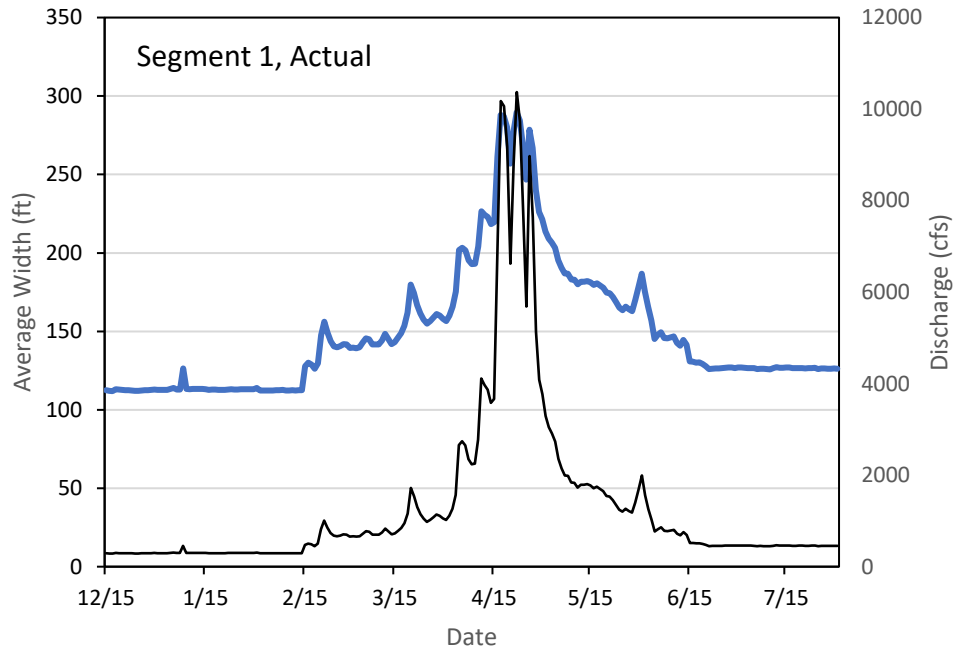


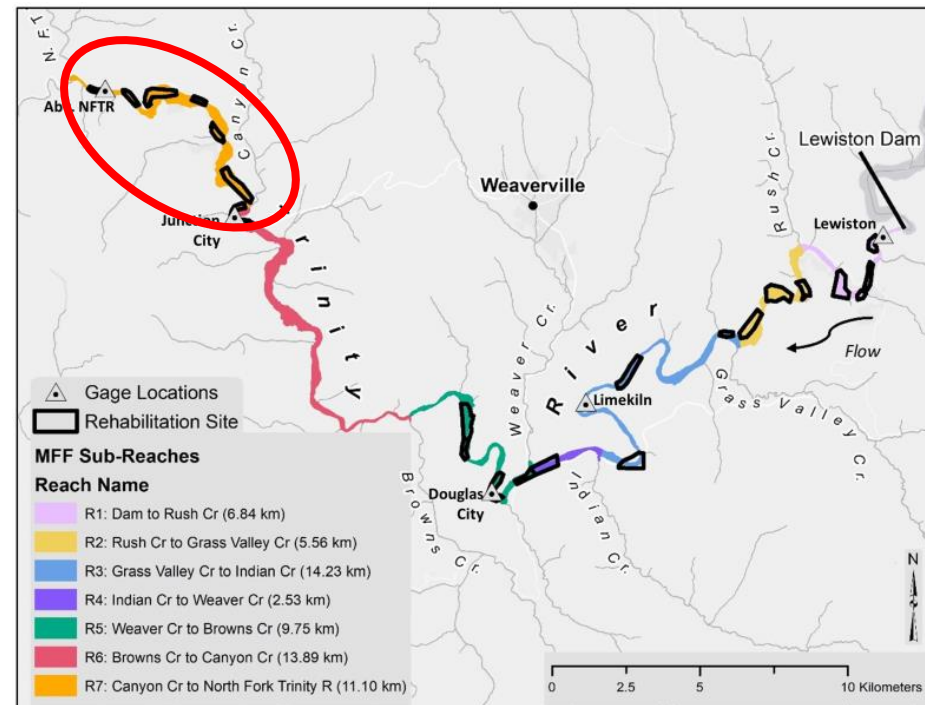
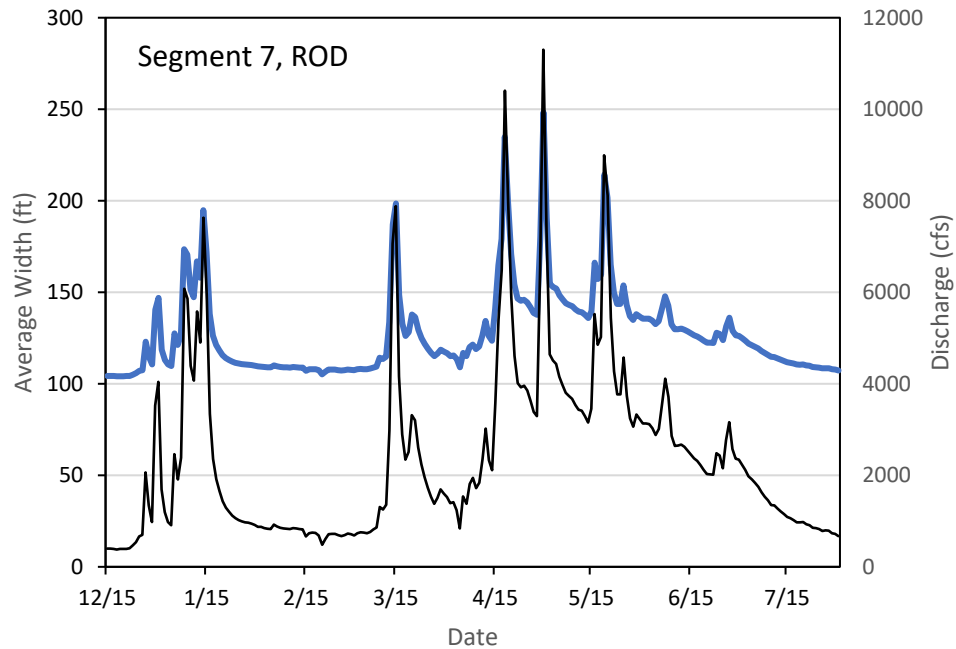
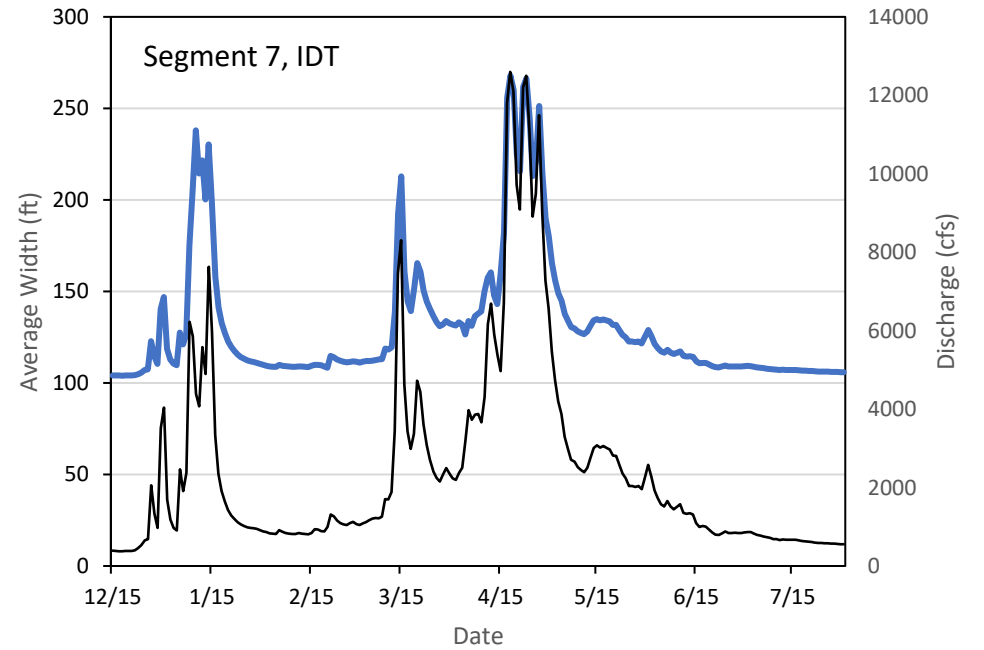
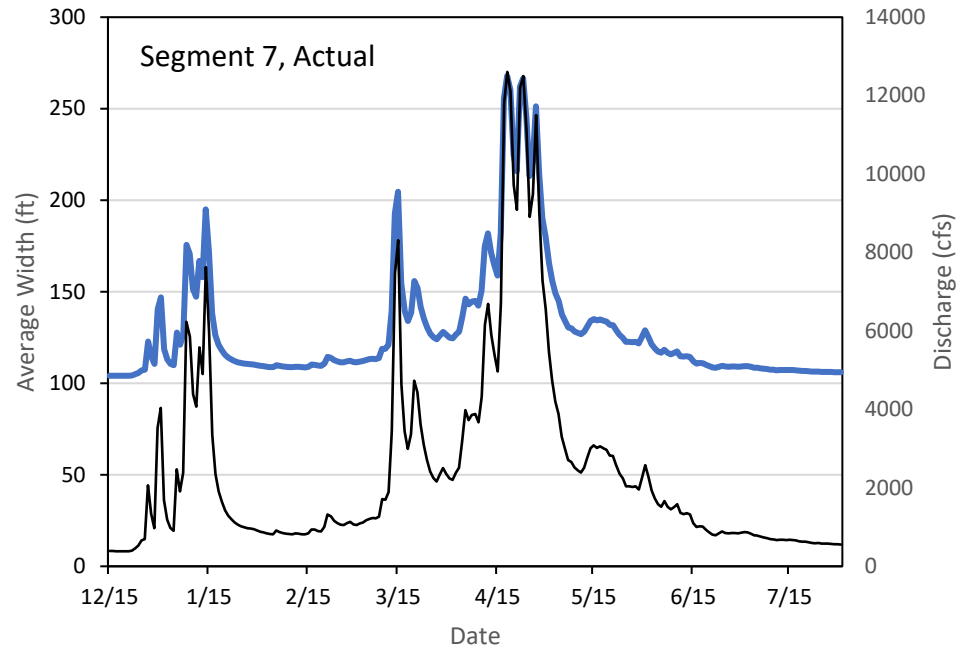
Fine Sediment



Winter Variable Flows: Inundation







Floodplain Macroinvertebrate Sampling to Assess Juvenile Salmonid Food Resources

- Benthic macroinvertebrates (BMIs) are the main food resource for juvenile salmonids.
- This research explored the impact of floodplain inundation on the availability of this food resource.
- Samples collected using .09 m² hess sampler pictured here.
- Samples were taken in areas suitable for juvenile salmonid habitat.
- Juveniles were often observed in these areas



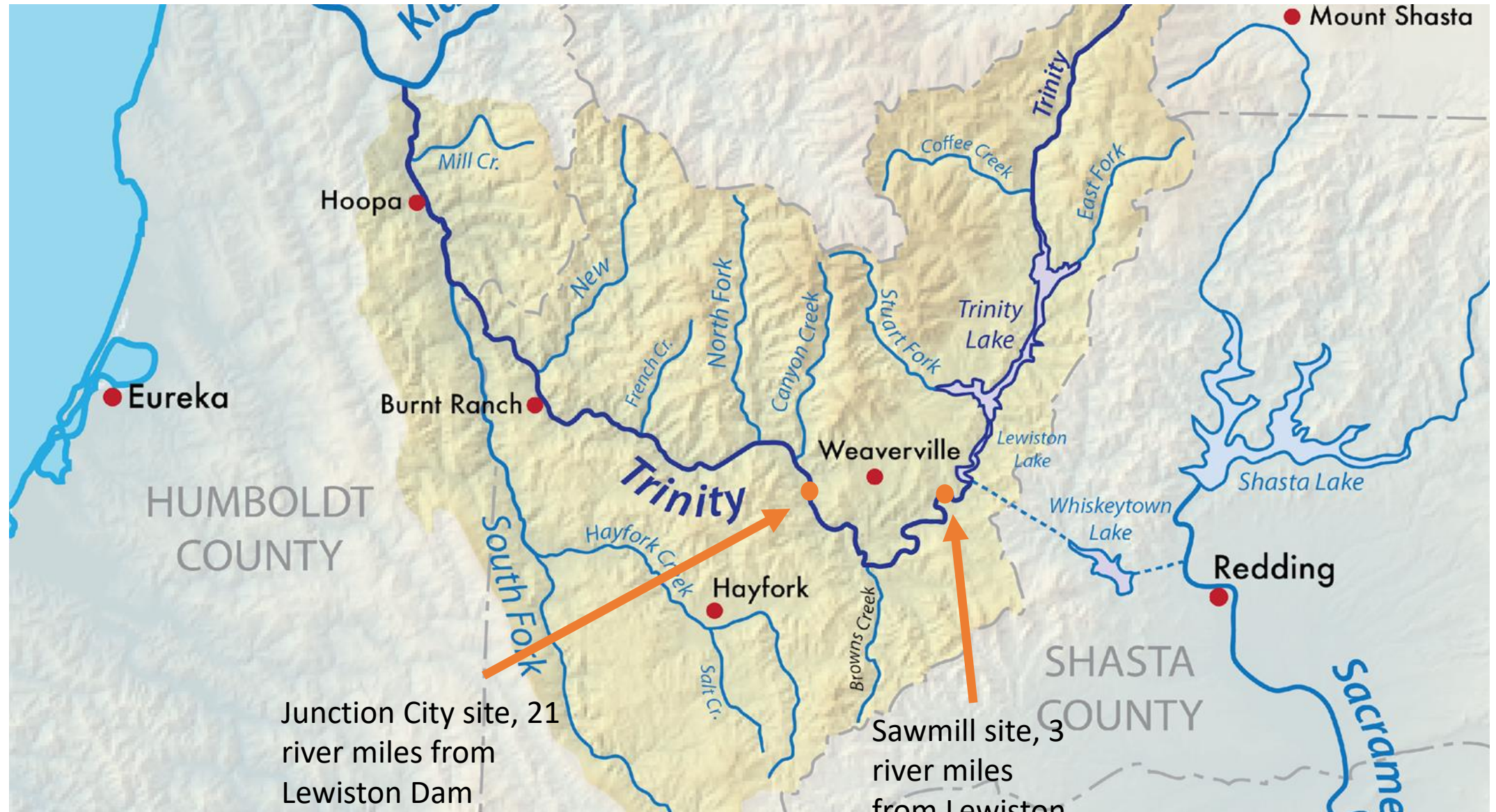
Photo by Ben King



Photo by Ben King



Study Sites: Sawmill and Junction City



https://commons.wikimedia.org/wiki/File:Trinity_CA_watershed_map.png

Fish Food



Chironomidae

Baetidae

Photos by Ben

Non-food



Pteronarcyidae

Photo by Ben

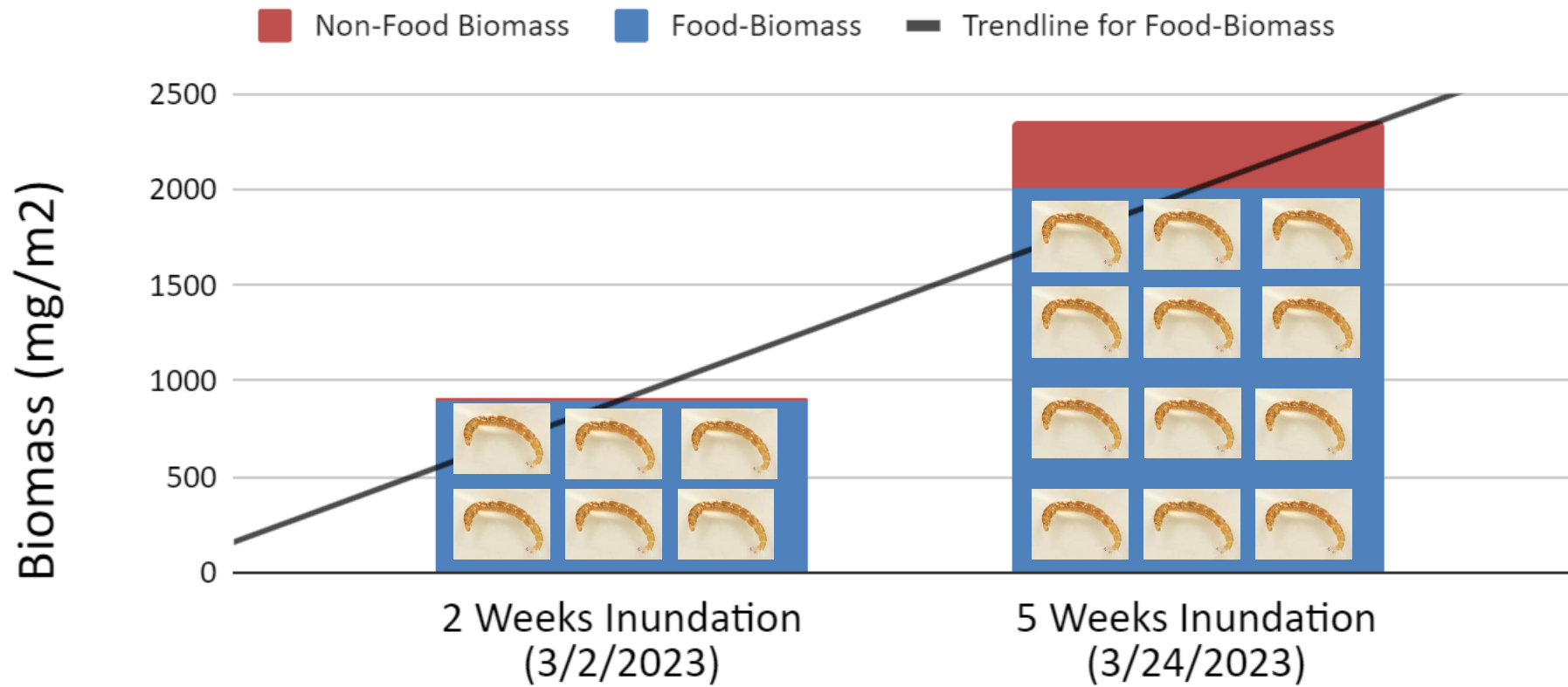
Limnephilidae

- **“Fish food”** invertebrates consisted of organisms such as midge flies (Chironomidae) and baetid mayflies (upper left), as well as many other small, soft-bodied invertebrates
- **“Non-food”** invertebrates included those that are:
 - Too large, such as larval salmonflies (third from the left)
 - Unpalatable, such as armored caddisfly larva (far right) or snails
 - Unavailable - such as burrowing invertebrates



Preliminary Results: Sawmill sampling site

Contribution of "Food" and "Non-Food" to Biomass

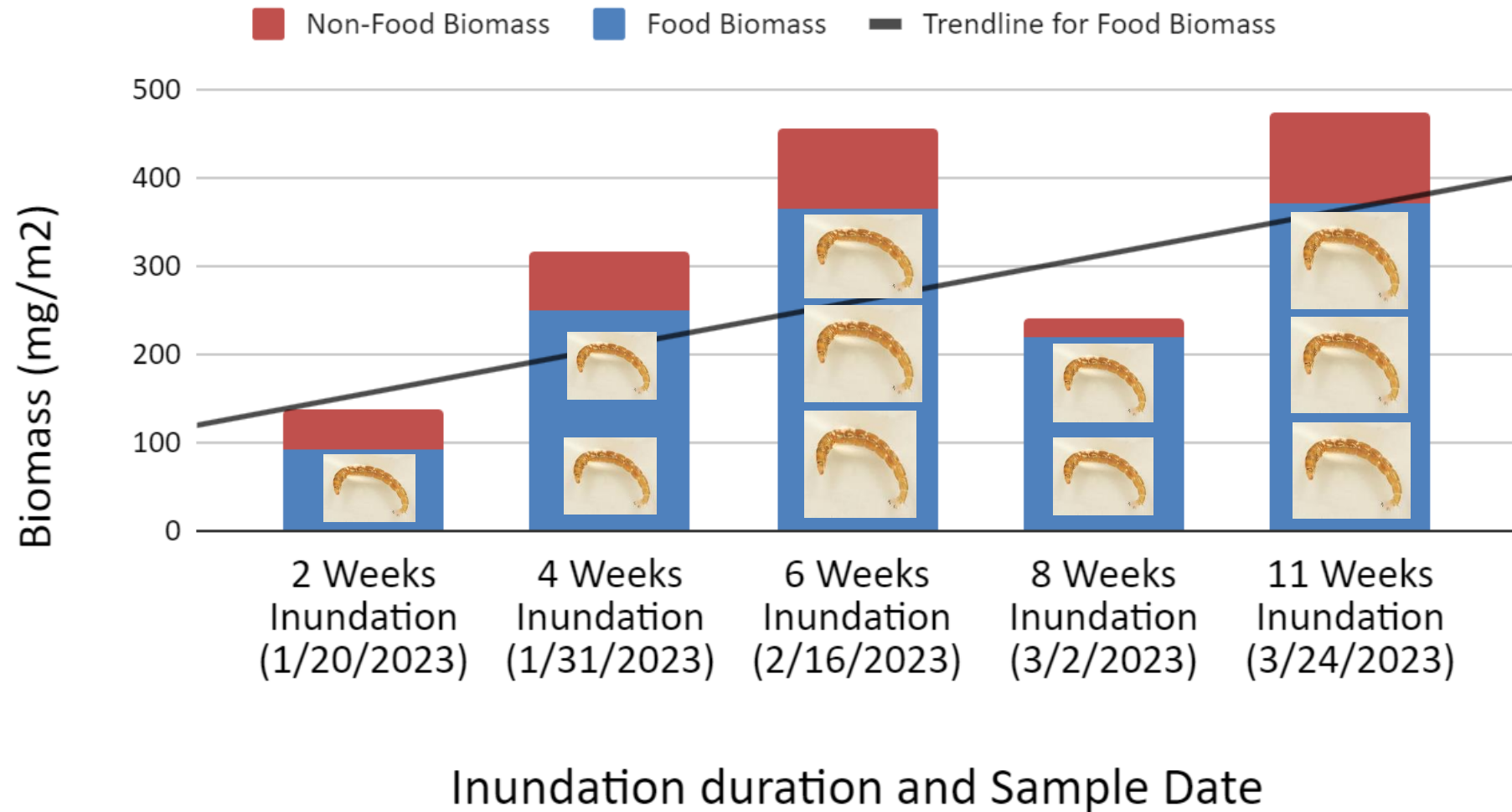


Inundation Duration and Sample Date

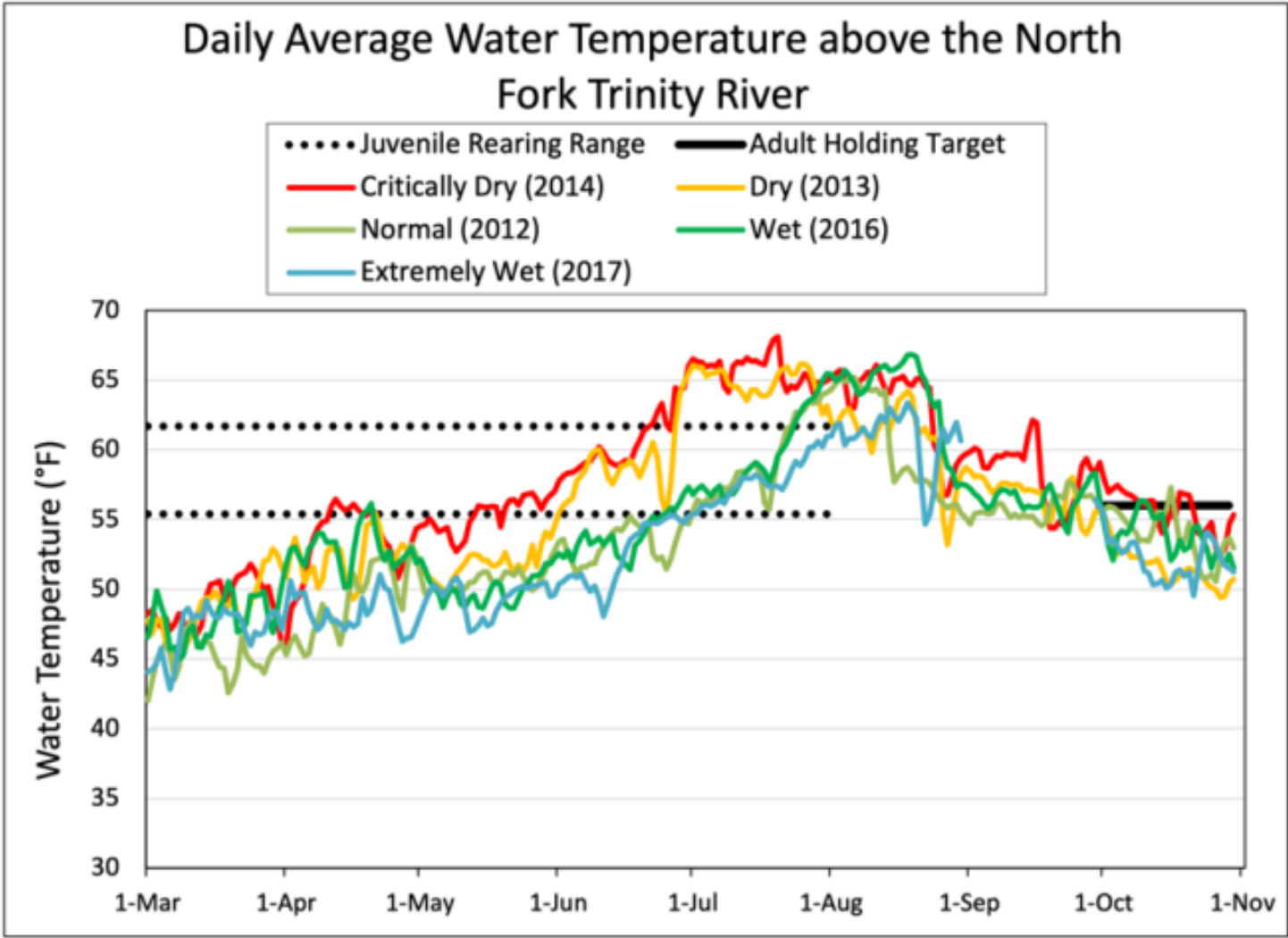


Preliminary Results: Junction City Sampling Site

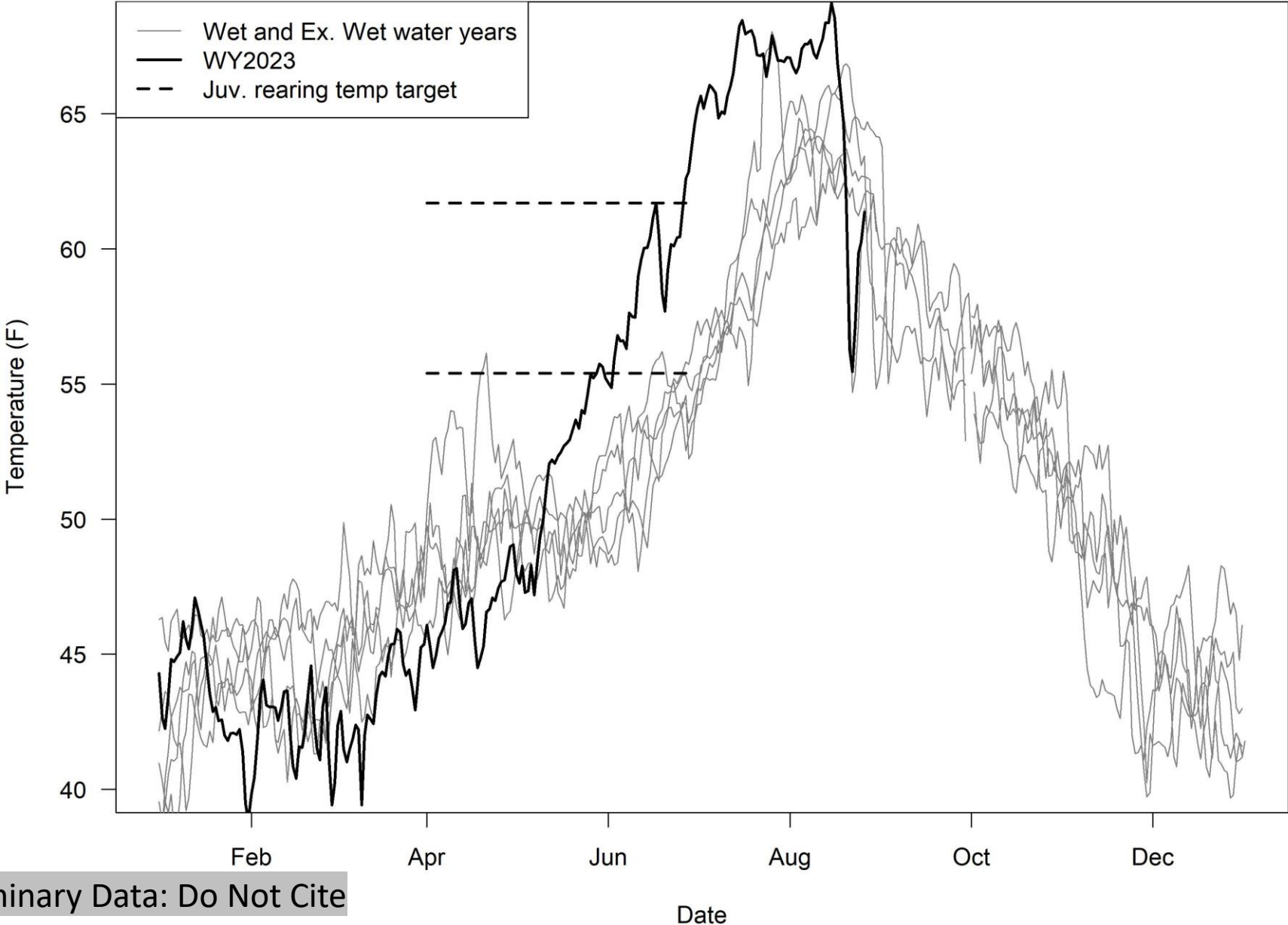
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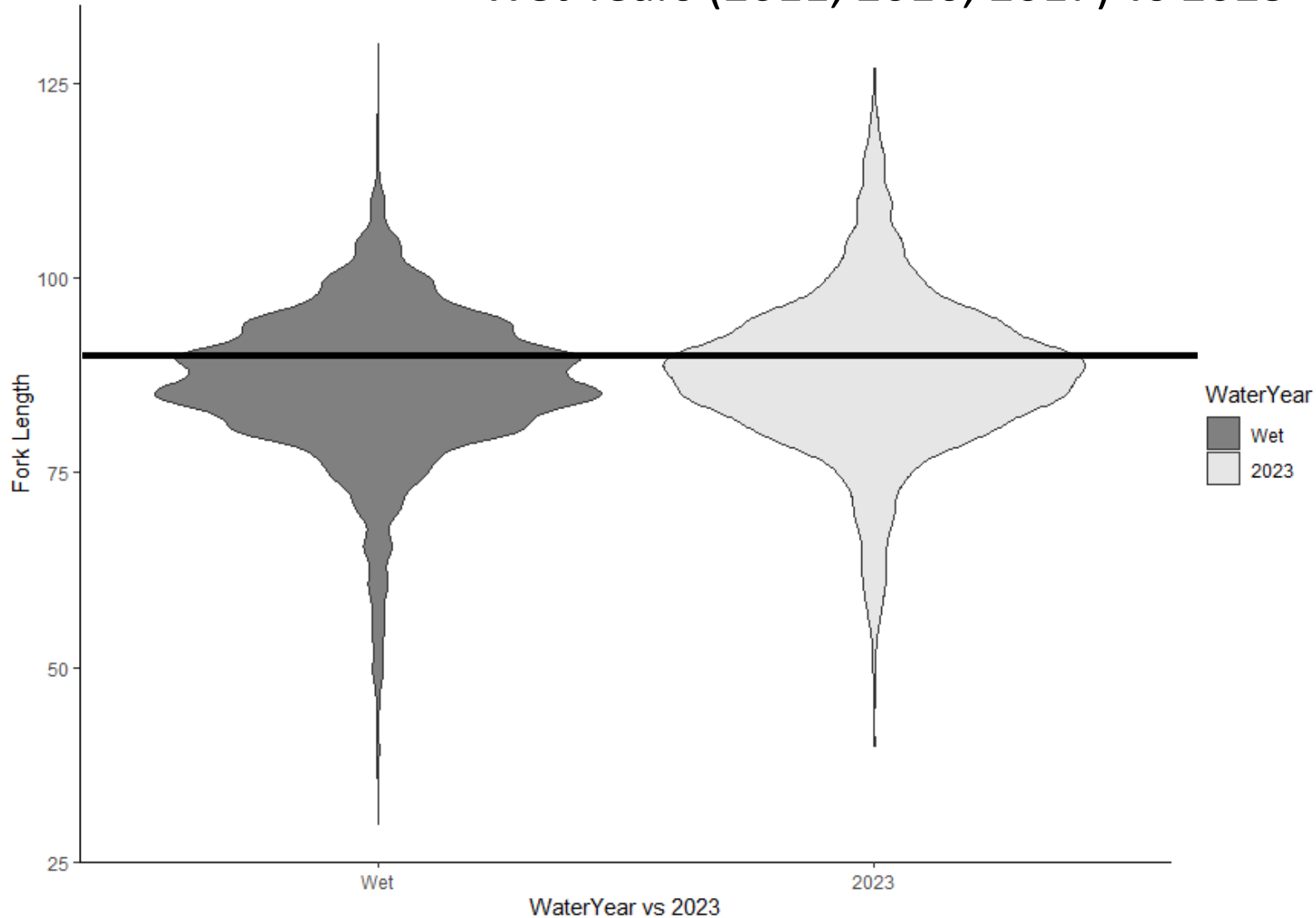
Temperatures, food and growth



Temperatures, food and growth



Fork Length of juvenile Chinook Salmon at Willow Creek Wet Years (2011, 2016, 2017) vs 2023



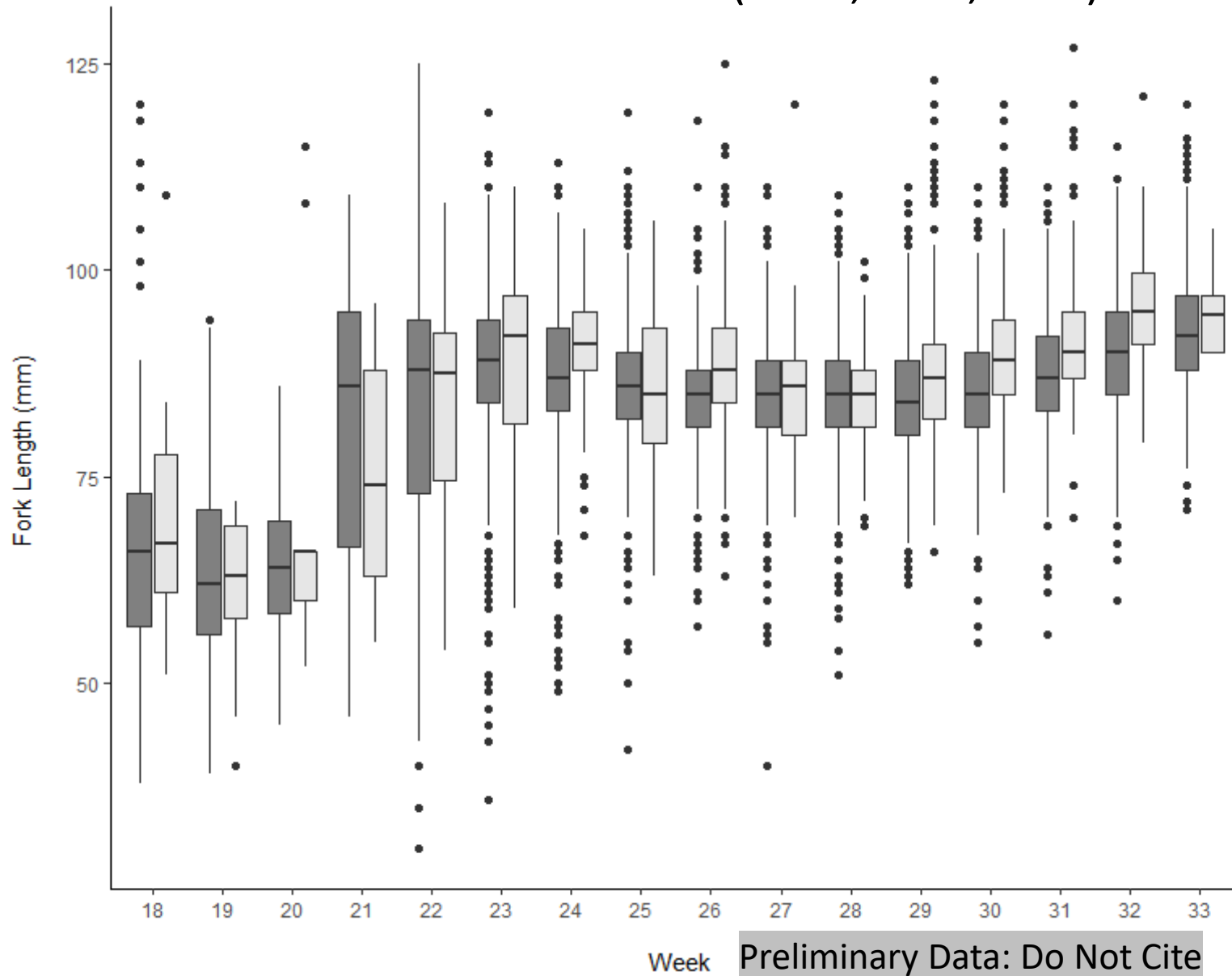
	F-Value	P-value
Year	89.86	< 0.001

Mean Fork Length is significantly larger in 2023 compared to other wet years



Preliminary Data: Do Not Cite

Fork Length of juvenile Chinook Salmon at Willow Creek Wet Years (2011,2016,2017) vs 2023



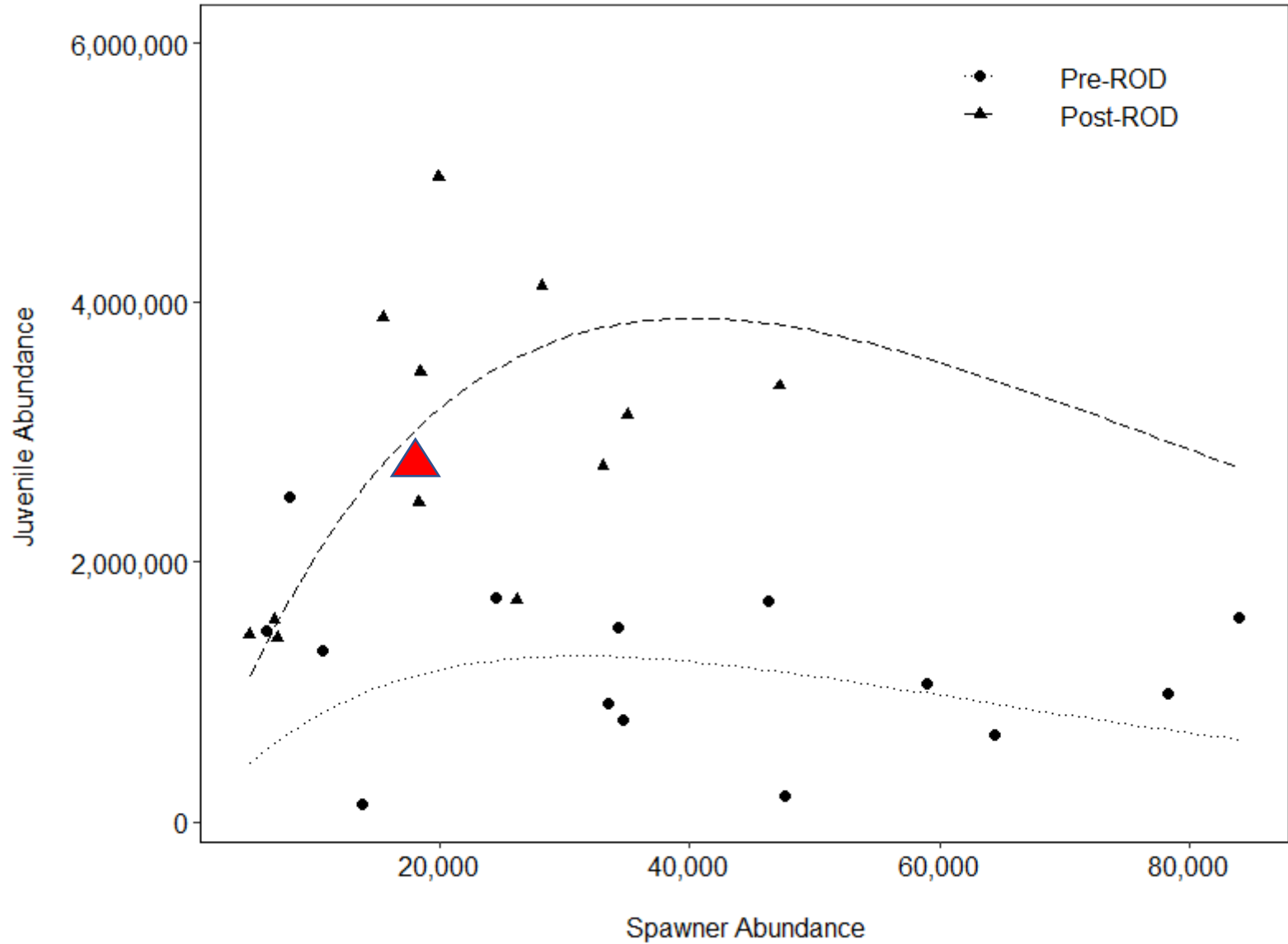
	F-Value	P-value
Year	108.4	< 0.001
Week	3203.0	< 0.001

Significant Year and week effect, Fork Length is significantly larger in most weeks in 2023 compared to other wet years.



Preliminary Data: Do Not Cite

Stock Recruit Relationship – (2023 [▲] Included)



Preliminary Data: Do Not Cite



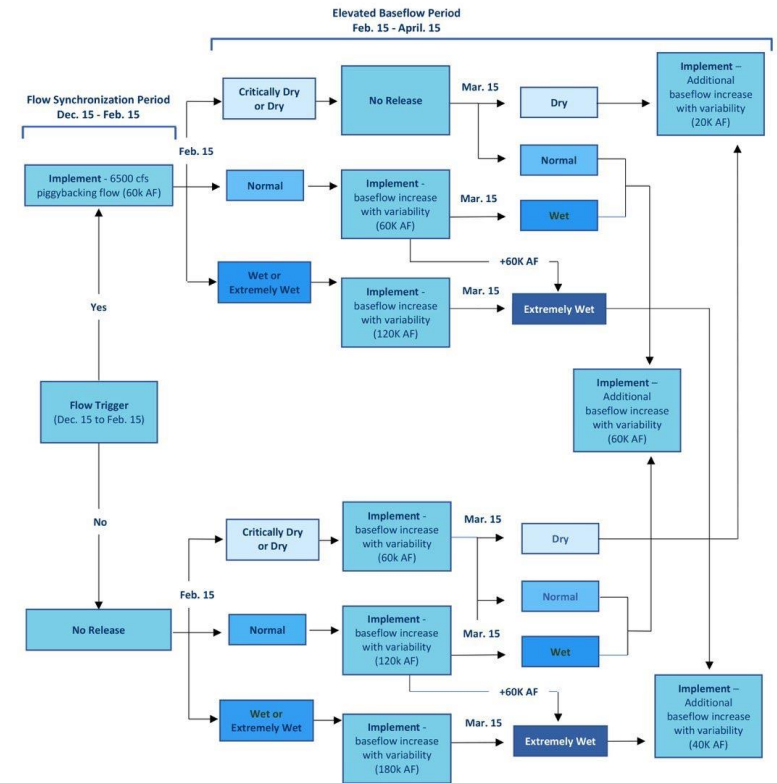
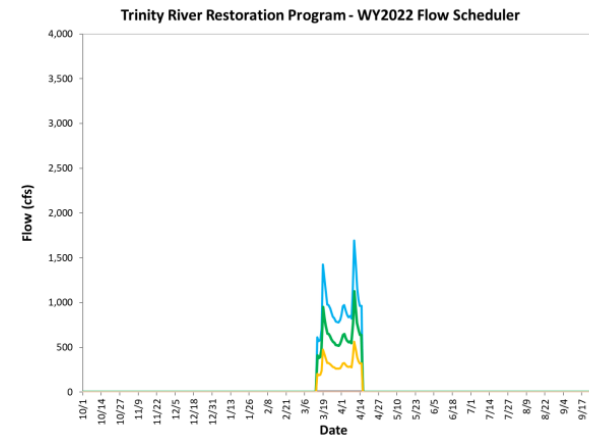
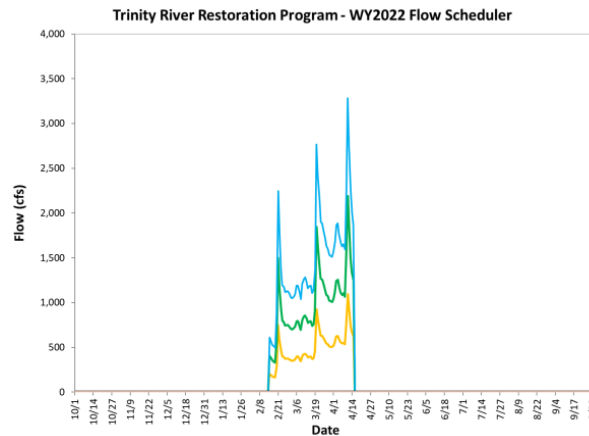
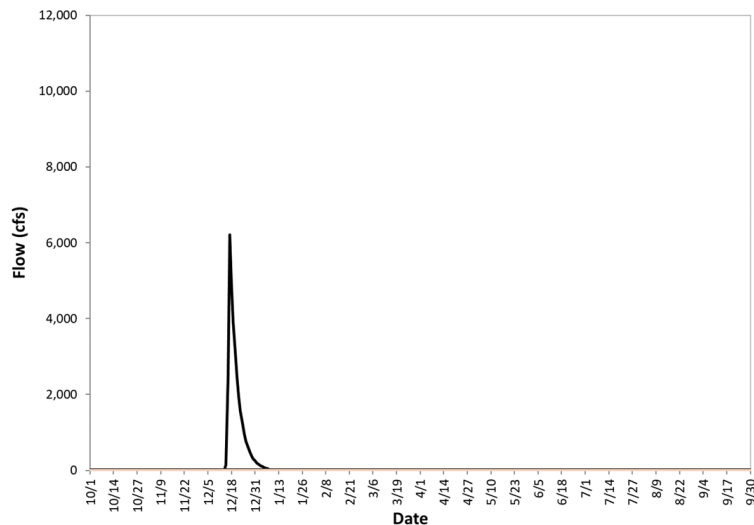
Water year 2023 summary

- No synchronized flow despite a trigger event
- Elevated baseflow Feb-April (**Inundation**) grew food!
- Improved temperature conditions for growth
- Fish response! Larger fork length compared to similar previous years



Flow WG & IDT Technical Recommendation

- Repeat of WVF approved by TMC Dec. '22 and implemented WY2023
- Synchronized 6,500 cfs flow with 4,500 cfs forecasted at NF Dec-Feb
- Elevated baseflow Feb-Apr w/ volume based on Feb B120
- Additional baseflow Mar-Apr based on Mar B120



Trout Unlimited Website:

“Most major river systems, of course, now have dams and water diversion infrastructure on them and cannot replicate unimpaired flow conditions. However, the science of river ecology and hydrology affirms that, in the absence of unimpaired flow conditions, *mimicking the natural variability in river flows is essential to support wildlife species such as salmon and steelhead* that have evolved to those ecosystems and to take advantage of the natural variability of those systems.

Link: [Functional streamflows key to recovering salmon and steelhead | Trout Unlimited](#)

Questions?

Kenneth.Lindke@Wildlife.ca.gov



Table 3-2. ROD water volumes and the percent shifted prior to April 15 under the Winter Flow Project for each water year type.

Water Year Type	ROD Water Volume (af)	ROD Volume Shifted to Winter Period under Winter Flow Project (af)	Percent ROD Volume Shifted to Winter Period
Critically Dry	369,000	60,000	16%
Dry	453,000	80,000	18%
Normal	647,000	120,000	19%
Wet	701,000	180,000	26%
Extremely Wet	815,000	220,000	27%



