

Outmigration Survival of Chinook Salmon Smolts in the Sacramento River



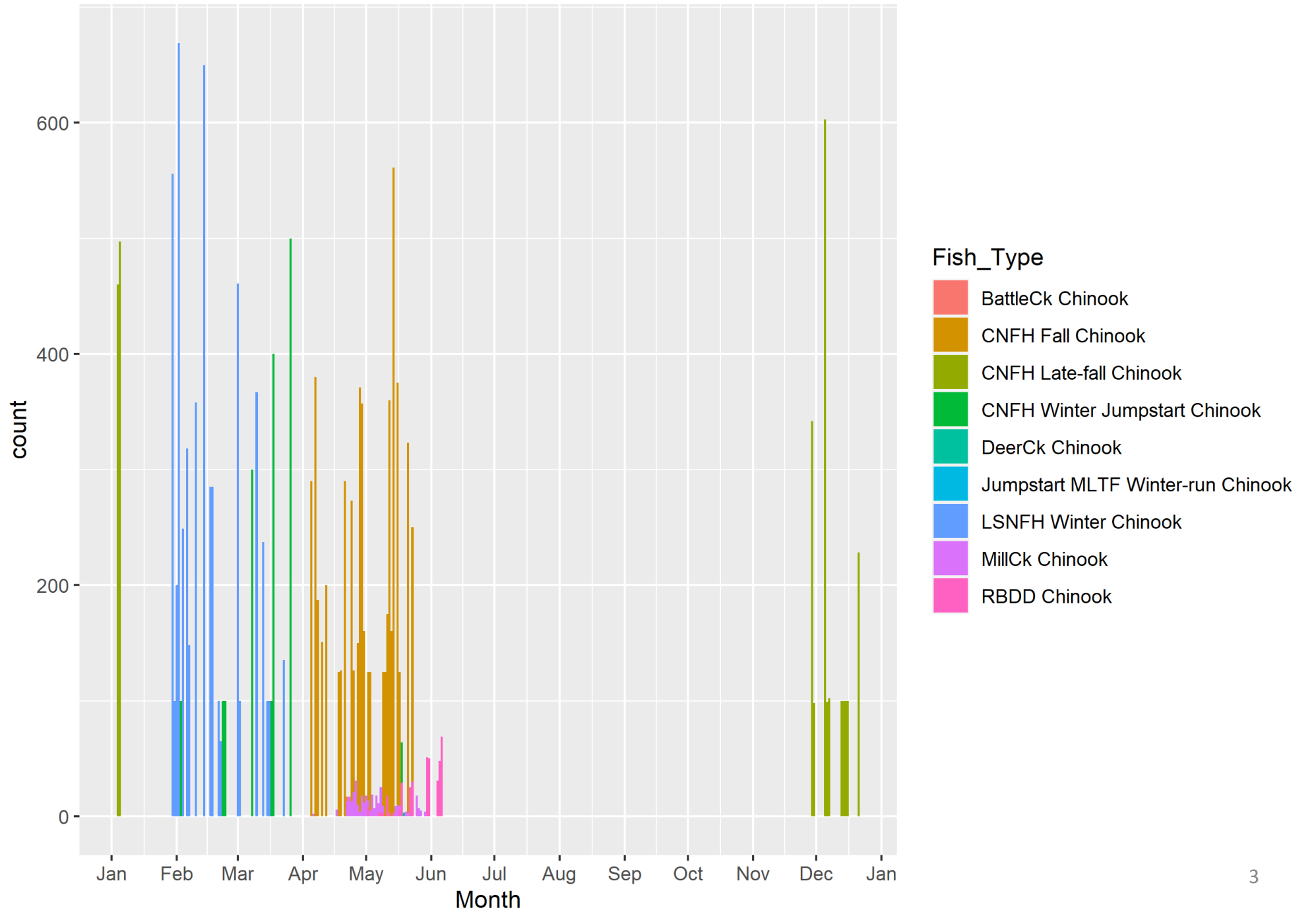
Jeremy Notch
UC Santa Cruz in affiliation with NOAA Fisheries

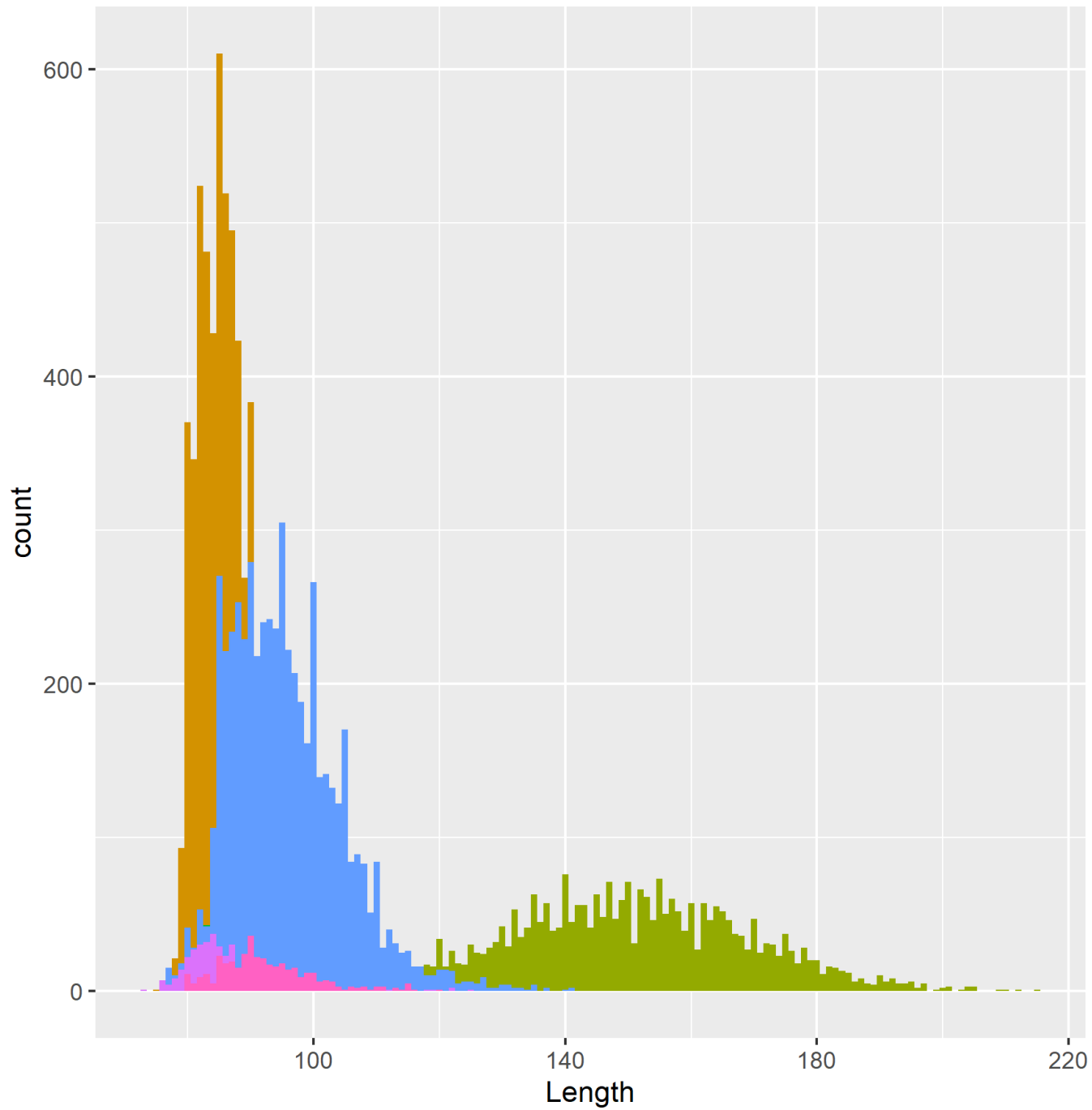


Presentation Overview

- Overview of acoustic tagging and receiver deployments in the Central Valley (2012-Present)
- Outmigration survival to Benicia Bridge across years and environmental conditions
- Outmigration survival through the Sacramento River



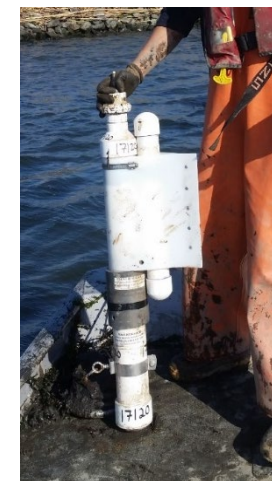


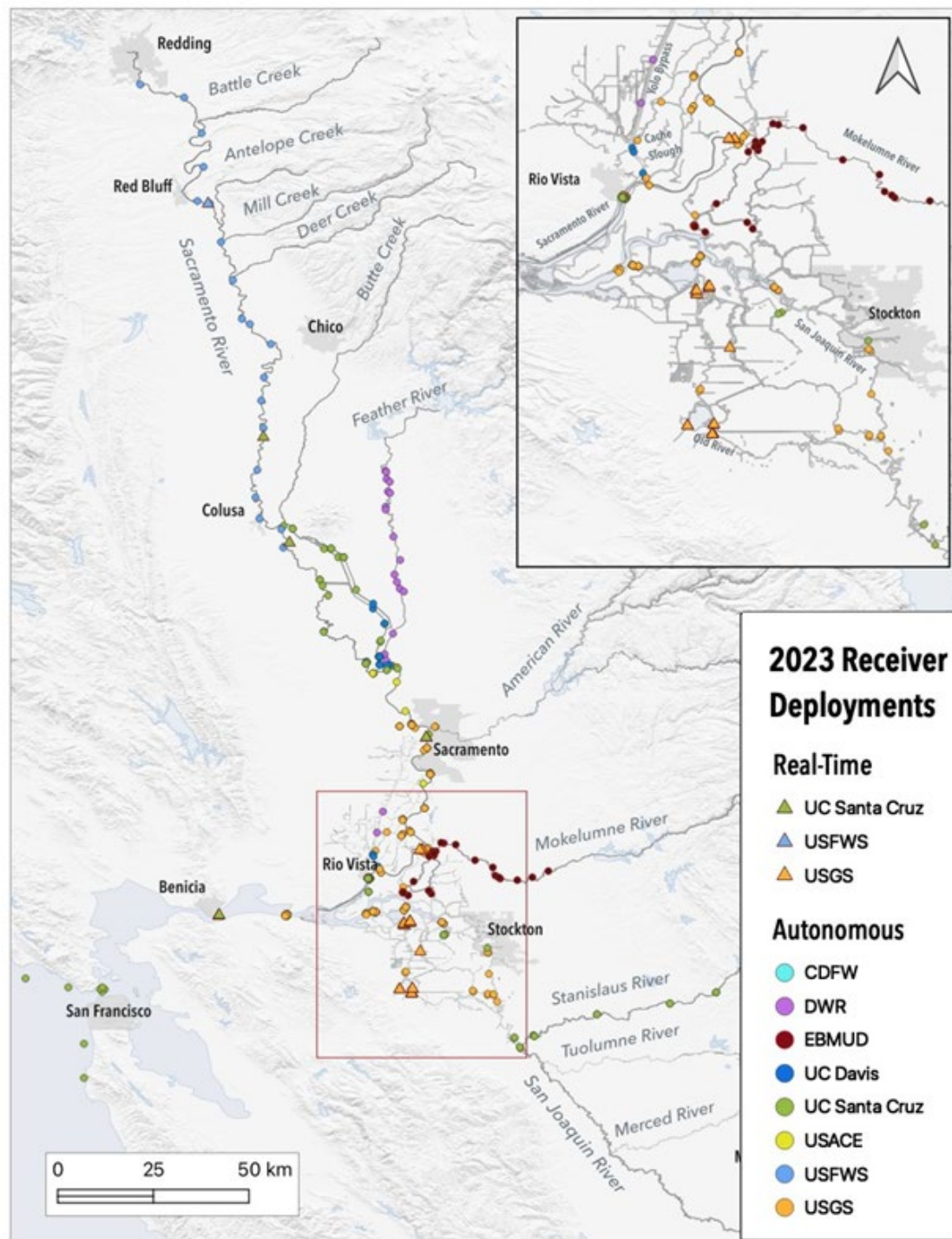


Juvenile Salmon Acoustic Telemetry System (JSATS)

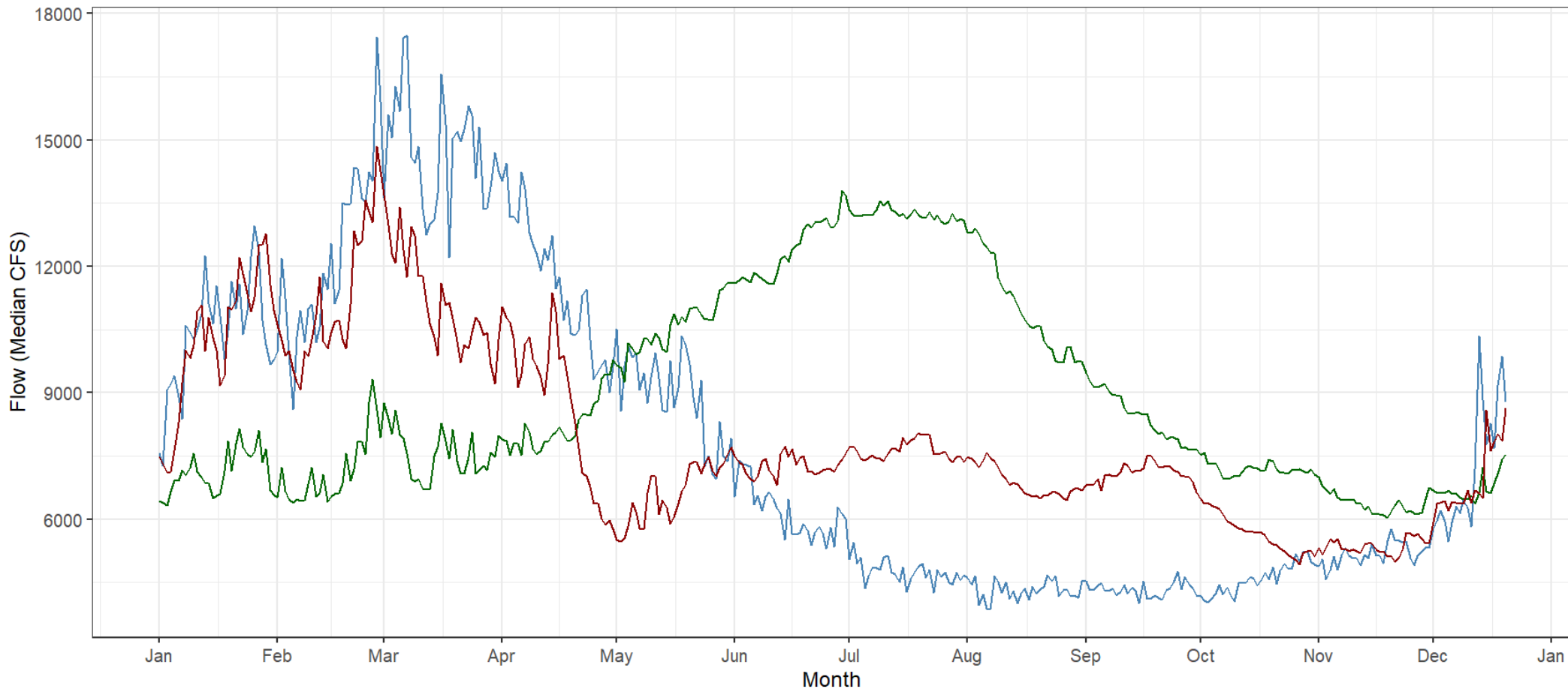


- Acoustic tag weight of 0.2 or 0.3 grams, can tag fish as small as 6 grams, 80mm fork length
- Tag battery life of 35 – 150 days depending on ping rate interval and battery type (3, 5, 10 seconds ping rate)
- Detections from autonomous (ATS, Lotek, Teknologics) and ATS real-time receivers at over 100 unique locations allow reach-specific survival estimates throughout the Central Valley.
- Over 35,000 fish acoustic tagged in the Central Valley since 2012, and ~17,000 tagged and released into the upper Sacramento River

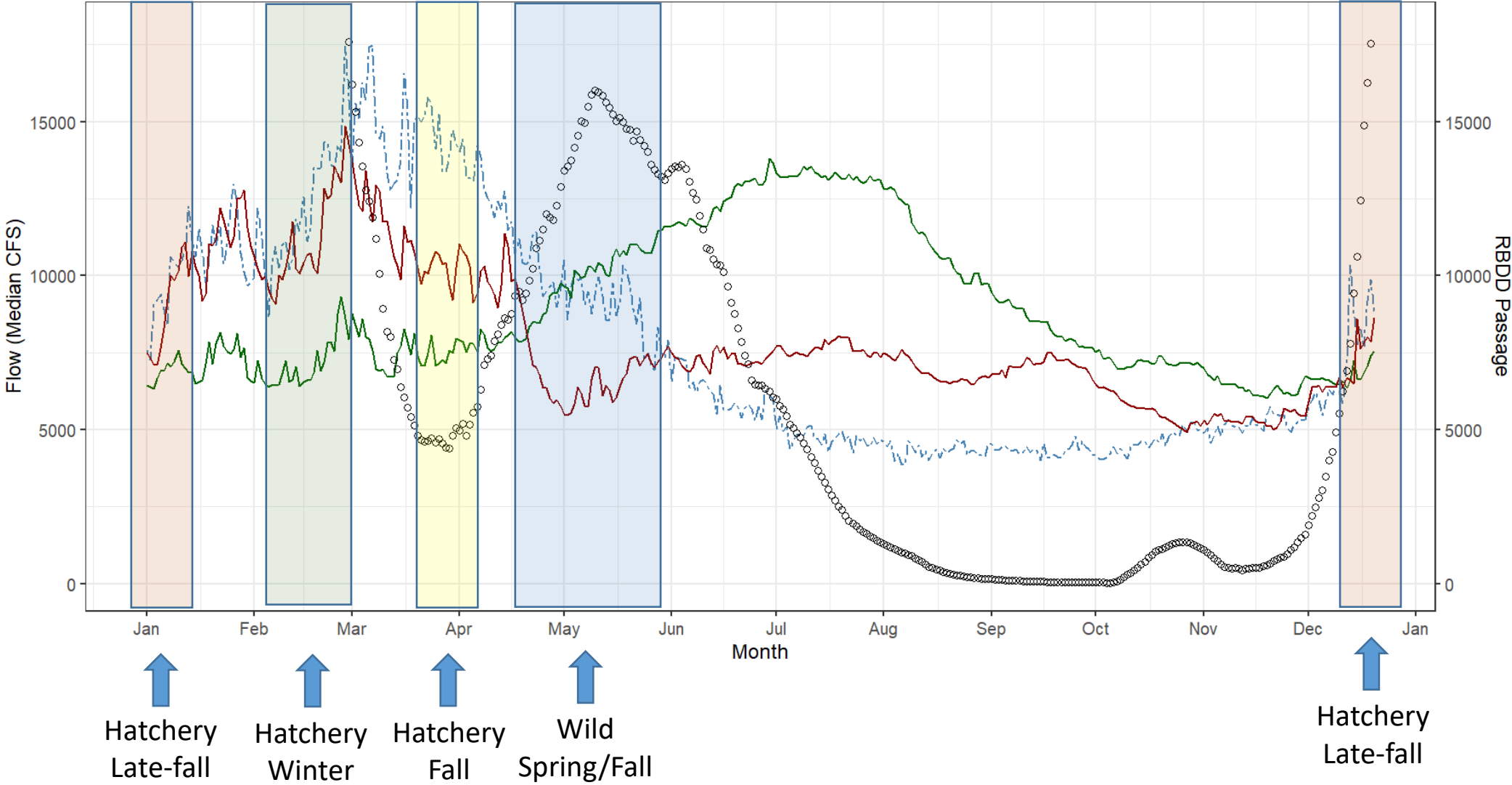


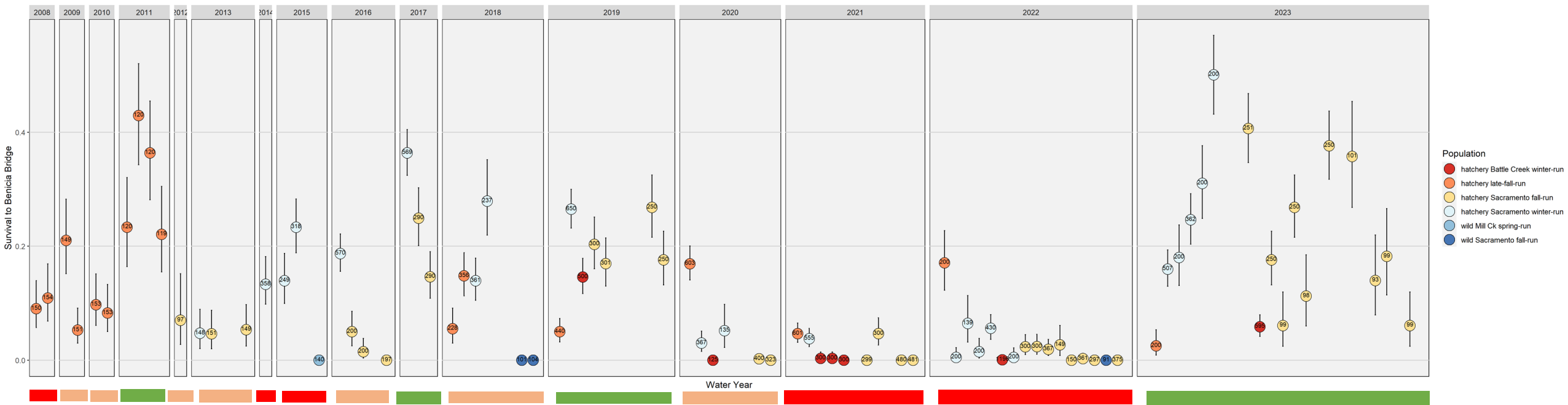


Sacramento River natural vs. managed median flow (1995-2021) Flow = Natural, Bend, Wilkins

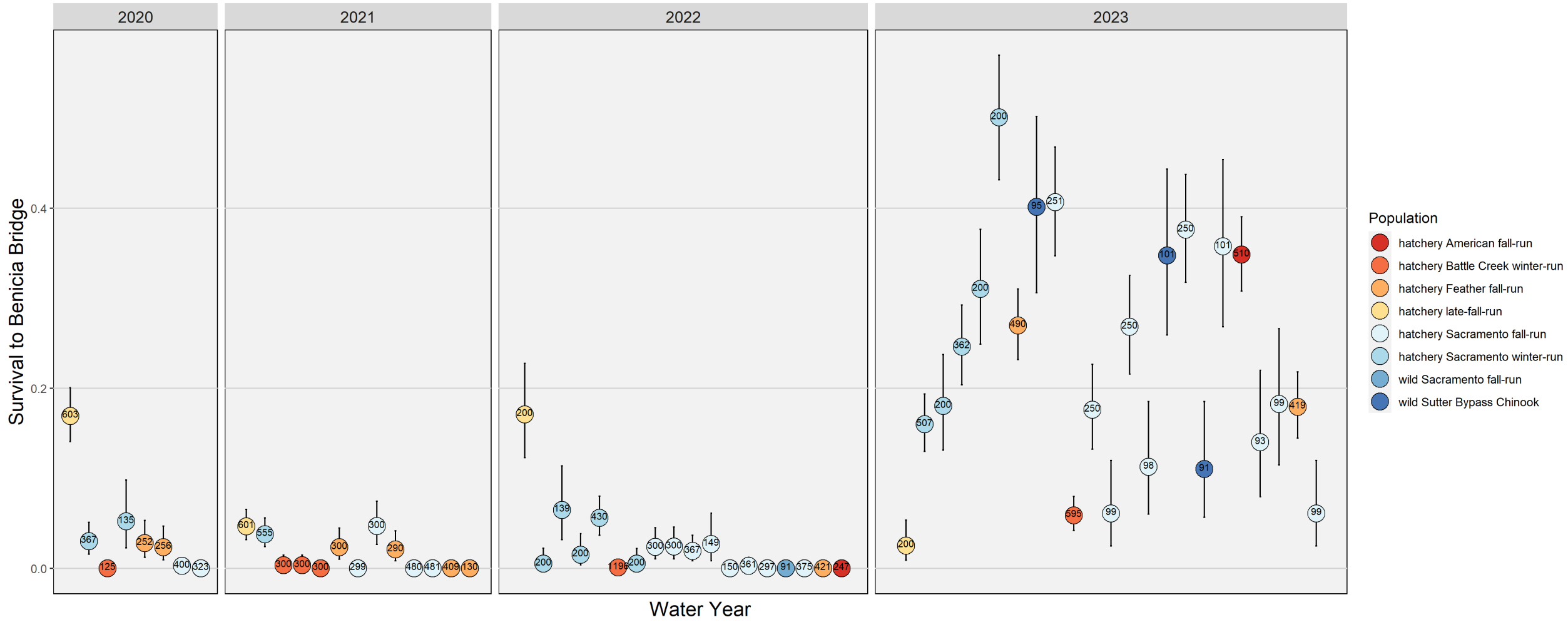


Sacramento River natural/managed median flow (1995-2021) vs. RBDD fish passage (2006-2019)

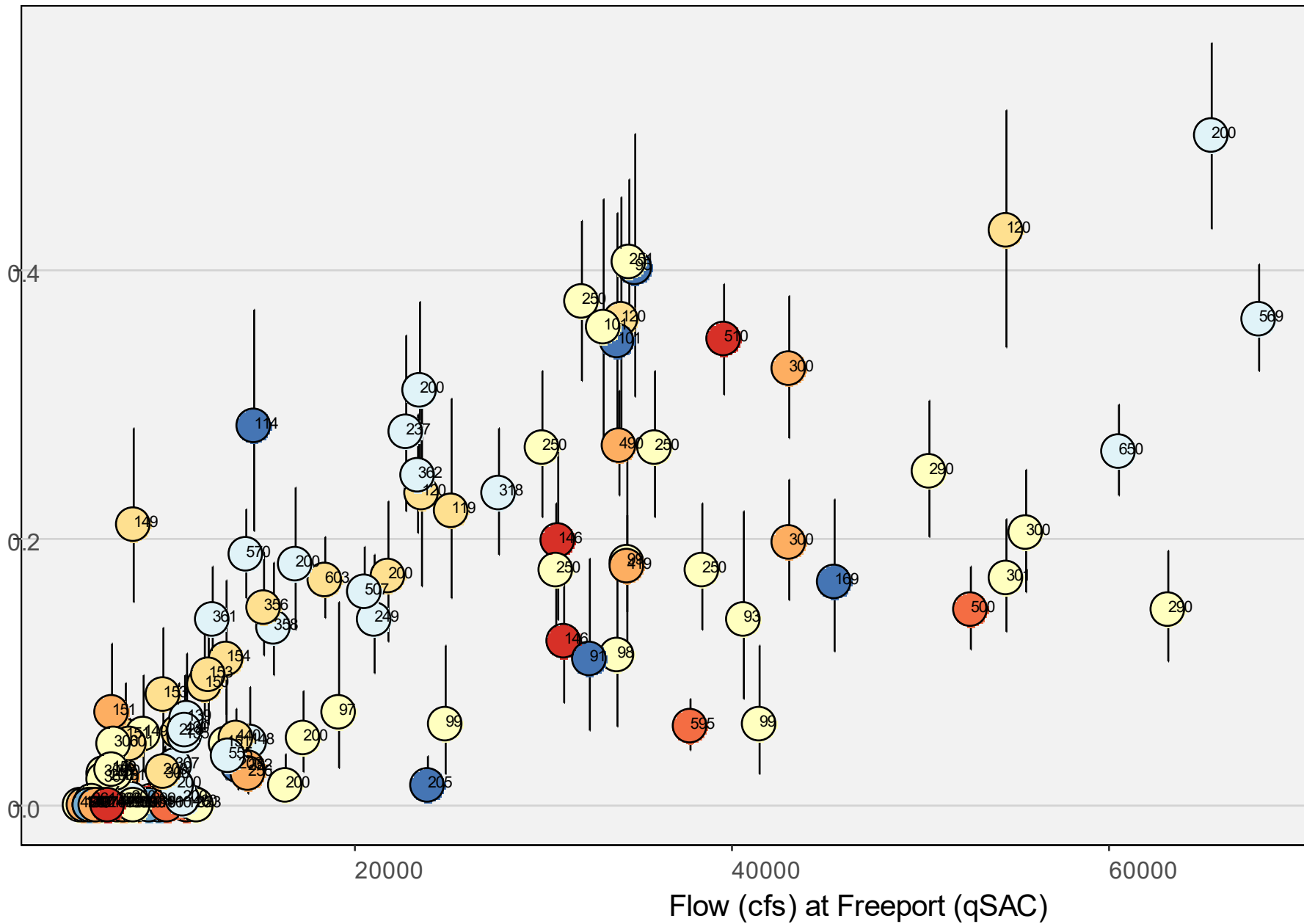




■ = Critically Dry
■ = Dry/Below Normal
■ = Wet



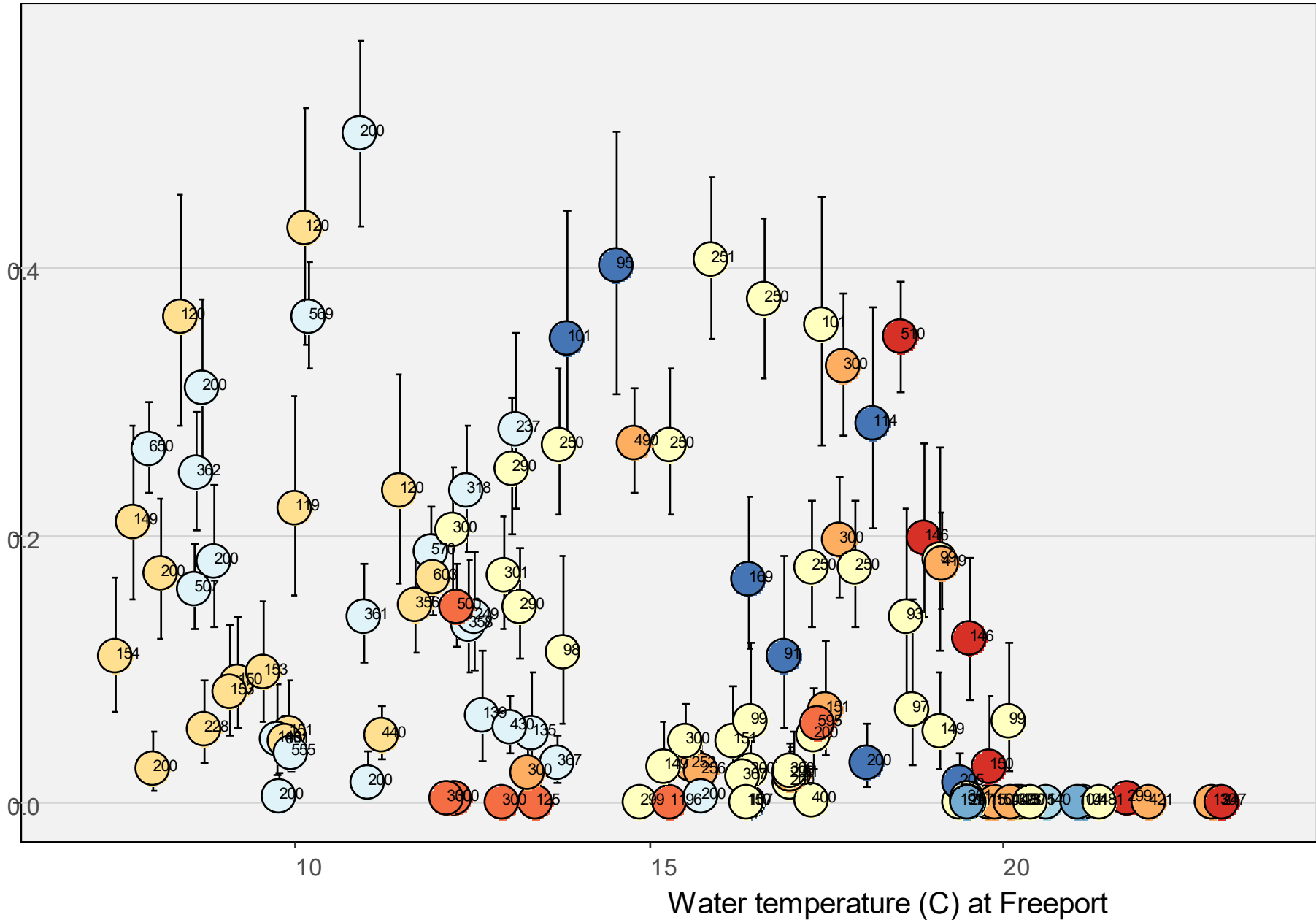
Survival to Benicia Bridge



Population

- hatchery American fall-run
- hatchery Battle Creek winter-run
- hatchery Feather fall-run
- hatchery late-fall-run
- hatchery Sacramento fall-run
- hatchery Sacramento winter-run
- wild Mill Ck spring-run
- wild Sacramento fall-run
- wild Sutter Bypass Chinook

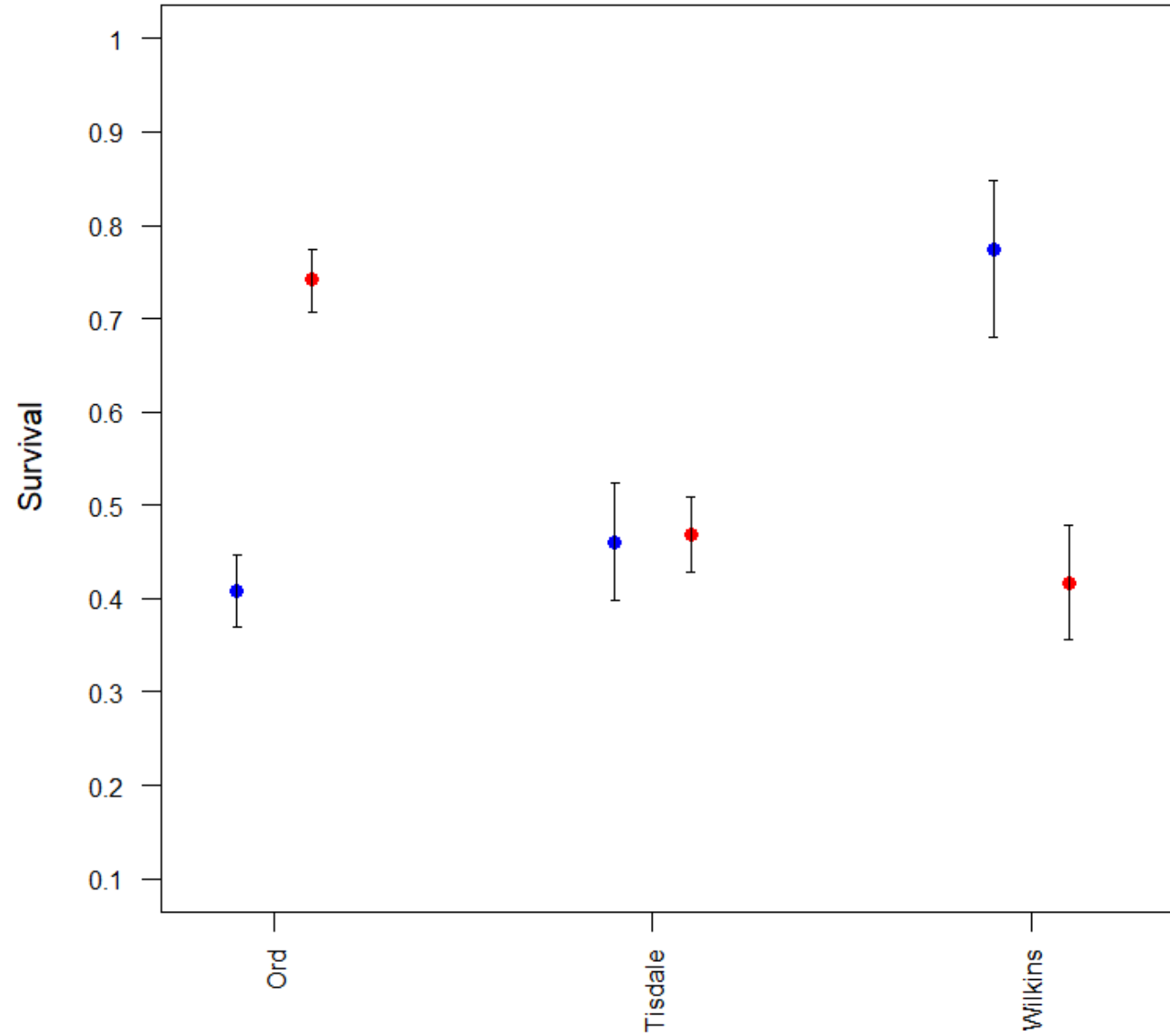
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Wild (blue) - Hatchery (red)



Spring smolt outmigration



Week	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	45.8	47.8	48.3	46.6	47.0	49.7	47.1	50.3	49.9	47.4	40.5
2	46.5	47.7	51.7	48.8	47.1	53.1	48.7	49.7	50.3	49.2	50.1
3	43.9	48.9	52.5	50.8	47.5	52.6	50.6	48.6	51.5	48.9	49.0
4	47.3	49.2	53.4	51.0	47.8	49.2	49.8	49.0	47.8	49.7	47.7
5	49.1	51.4	54.1	48.3	48.0	51.1	52.0	52.9	50.0	48.4	46.9
6	49.9	49.1	54.5	53.3	51.5	55.9	49.7	50.2	52.4	52.3	49.4
7	50.2	53.5	56.6	55.5	50.0	51.4	46.7	51.5	52.1	54.3	49.7
8	51.1	54.6	55.0	53.8	50.0	51.0	47.3	53.9	52.7	52.1	49.6
9	52.3	58.0	56.4	58.4	48.9	50.1	49.3	55.3	54.2	54.3	45.8
10	55.4	54.8	60.0	53.0	49.5	53.9	51.0	55.7	54.5	55.3	48.4
11	56.9	56.3	61.8	53.5	54.5	57.3	50.7	57.0	54.0	58.5	50.3
12	57.2	59.3	63.2	54.5	54.4	56.1	53.2	53.1	56.6	61.9	52.1
13	58.2	59.6	64.3	57.0	53.9	55.8	53.4	56.1	60.6	63.2	50.7
14	61.3	54.2	59.7	63.0	56.9	61.6	55.0	56.6	63.5	63.4	54.2
15	60.2	63.8	63.8	62.5	54.6	58.7	54.0	57.2	64.5	59.7	57.8
16	61.2	68.1	69.2	64.7	54.2	59.2	55.5	64.3	66.3	59.5	58.6
17	65.6	65.6	68.9	63.1	55.7	66.8	62.4	65.2	64.5	65.2	63.0
18	65.3	65.7	68.5	67.1	63.0	65.1	65.5	67.7	69.6	66.9	59.1
19	64.1	67.3	67.3	68.0	63.3	68.0	66.5	65.7	69.7	64.8	56.7
20	67.3	67.5	68.1	70.9	60.9	67.8	64.5	63.9	68.8	71.3	
21	64.6	70.0	71.0	68.2	65.9	68.0	60.7	64.4	69.5	72.9	
22	65.3	71.6	72.4	75.0	66.4	67.6	65.6	71.0	76.5	72.1	
23	70.1	71.7	76.7	73.7	66.1	70.6	67.5	69.2	73.0	74.9	
24	67.5	74.0	77.1	68.8	65.9	70.4	67.1	67.7	74.8	74.9	
25	66.4	70.5	76.9	70.6	73.4	70.1	71.5	66.5	75.4	76.0	
26	65.7	71.0	78.7	74.6	72.1	71.0	69.7	70.9	76.7	78.9	
27	69.7	73.5	76.8	73.4	72.3	69.5	70.2	69.3	75.4	75.7	
28	68.4	73.2	75.6	71.2	72.4	68.1	70.8	69.5	74.4	79.4	
29	68.5	73.2	77.3	70.8	72.0	70.0	72.3	70.4	73.5	79.5	
30	69.6	71.8	76.2	72.3	72.0	70.5	71.6	70.2	71.1	78.7	
31	68.3	73.0	73.6	70.6	71.7	66.1	70.9	71.0	72.7	78.2	
32	67.5	70.2	73.5	69.7	71.0	66.1	70.3	70.7	71.4	77.5	
33	68.5	71.8	73.0	70.0	69.9	68.3	69.0	71.3	69.7	77.1	
34	69.0	72.3	72.9	68.3	69.2	67.2	68.9	68.1	69.5	78.1	
35	69.1	72.2	71.3	65.7	68.5	66.5	69.7	67.5	71.0	76.5	
36	69.2	71.2	68.8	64.8	68.7	67.3	68.0	69.1	71.3	77.6	
37	69.2	70.4	65.0	64.3	67.1	65.2	66.3	66.7	70.6	72.4	
38	66.9	70.9	67.6	63.9	62.3	63.6	64.6	64.1	67.9	68.0	
39	63.0	70.1	66.1	63.6	61.2	64.6	65.3	66.2	66.3	70.6	
40	61.8	67.2	65.4	59.2	59.5	63.3	60.3	66.0	64.3	70.1	
41	59.9	69.0	65.7	60.9	57.9	62.1	59.5	63.9	60.0	68.7	
42	59.9	65.3	62.9	58.9	57.1	59.3	57.8	63.1	59.9	65.8	
43	60.5	63.6	60.9	59.2	59.4	59.7	58.6	63.6	59.3	59.9	
44	57.7	61.1	58.1	57.5	57.8	59.2	53.4	56.9	61.3	56.7	
45	54.6	59.7	54.2	58.3	55.1	56.1	54.9	57.8	57.0	53.6	
46	56.0	60.3	53.7	56.6	55.0	50.1	56.3	52.4	57.1	51.9	
47	53.1	55.4	52.9	52.8	53.5	51.0	55.3	53.5	53.7	50.6	
48	50.3	54.5	48.1	50.0	54.3	54.5	49.7	51.9	54.3	50.5	
49	48.8	55.5	52.9	48.1	49.3	50.8	50.4	50.3	53.6	48.9	
50	42.8	55.6	48.9	49.7	48.4	50.5	53.3	50.2	48.4	47.8	
51	46.1	51.9	48.2	47.0	47.9	52.0	50.0	50.1	47.1	46.6	
52	47.7	53.0	45.7	46.1	48.0	49.8	49.0	48.6	48.3	49.2	
53		48.1	45.1					48.7	48.4		

Adult fall-run return



Conclusions

- Outmigration Survival through the Sacramento River (Release to Benicia) low during dry and critically dry years, high during wet years
 - However, even in dry/critically dry years, well-timed hatchery releases can result in relatively high survival rates

- Variable survival through the Sacramento River
 - In years of low flow, typically less than 20% of tagged fish remaining in Sacramento River prior to Delta entry. In high flow years 20% - 60% survive to the Delta
 - Spring outmigration survival in the upper, middle, lower Sacramento River varies by origin (wild vs hatchery smolts)

- High water temps in the lower Sacramento River in recent years
 - Water temperatures $> 20^{\circ}\text{C}$ (68F) appear to be a survival threshold for outmigrating smolts (and returning adults as well). Much better water conditions in 2023 and 2024 (so far) which is good news!

Questions?



Survival from release to Benicia

