



Functional River Analysis

Eric Peterson (TRRP/USBR) and Seth Naman (NMFS)

Plus: Justin Alvarez (HVT), Kyle De Juilio (YT), Chris Laskodi (TRRP/YT), Ken Lindke (CDFW), Dave Gaeuman (YT geomorphology), Smokey Pitman (ARS/HVT geomorphology), Todd Buxton (TRRP/USBR geomorphology)



Draft Supplemental Environmental Impact Statement, Trinity River Division, Long-Term Operation

- Updates NEPA coverage for river flows and reservoir management
- Joint-Leads: HVT and YT participated in development (plus CDFW, USFWS, TC)
- Collaborating agency review completed
- Public draft pending
- No Action (2000 ROD) plus 6 Alternatives
 - one analyzed with two models to span Adaptive Management
- CalSim3 modeling incorporated Reservoir Management Release
 - AKA “Safety of Dams” releases (SOD)
 - Analysis presented here covers both with and without



Alternatives Cheat-Sheet

No Action Alt (NAA): the classic ROD 2000

1. **Water Quality:** 340 TAF / no min pool
2. **Multiagency:** A: Decision Tree, B: Realtime / min pool 1200-900-750 TAF
3. **Modified Natural (Oscillation):** WY shifted / min pool 1200-900-750 TAF
4. **Risk informed:** Alt 2 with 15% cut multi-year drought / min pool 750
5. ***Removed***
6. **Trinity County:** ROD 2000+holdover / min pool 1500-1300-1100-1000-900-825-750 TAF
7. **Maximum Flow:** 70% of inflow released / min pool 750 / low baseflows

Reference Flow: Salmon River at Somes Bar, climate adjusted hydrology (SRaSBadj)

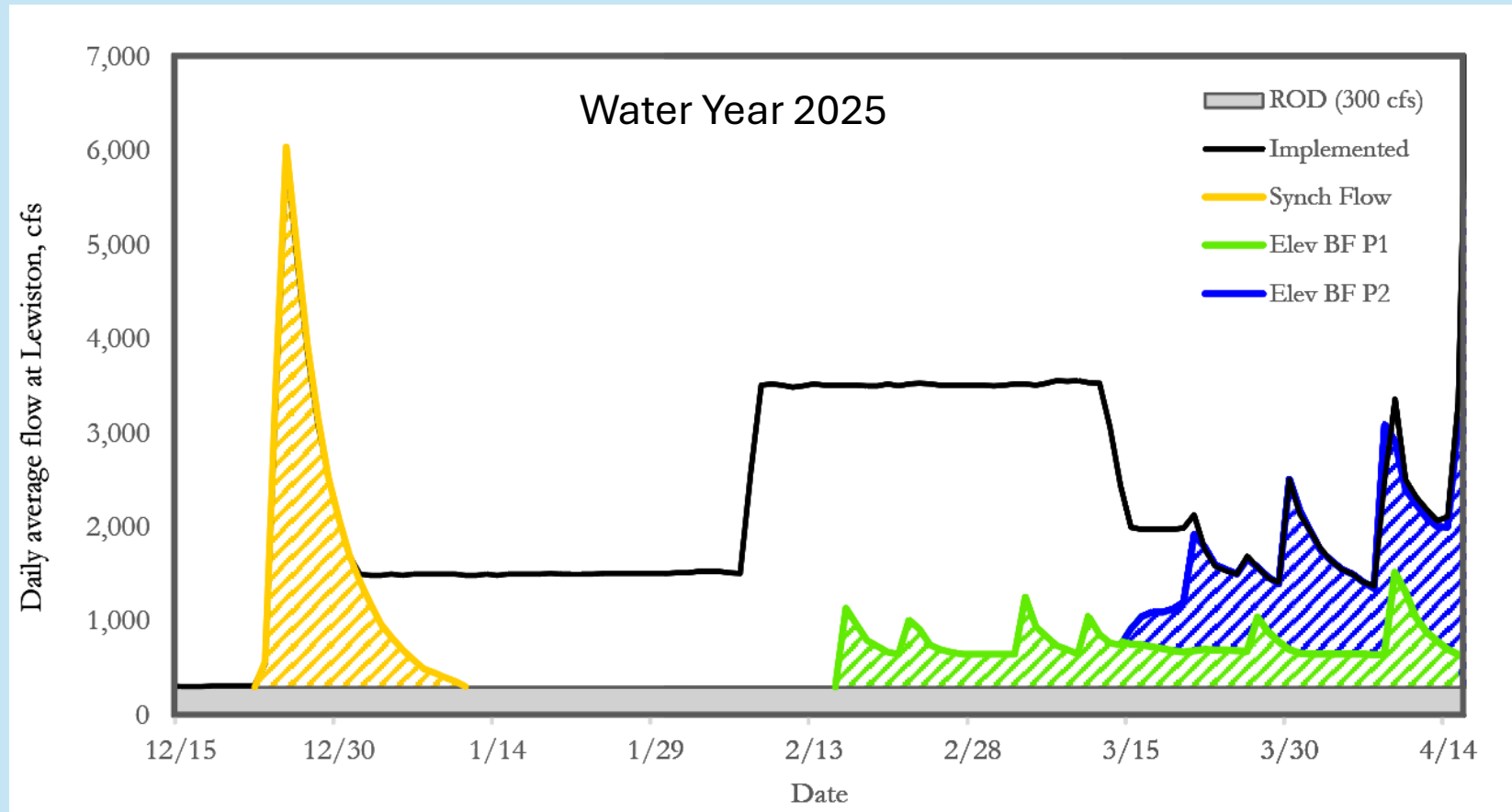




Safety of Dams Releases... are they relevant?

SOD rate since the ROD: **15%**
(proactive actions)

CalSim3: **33%**

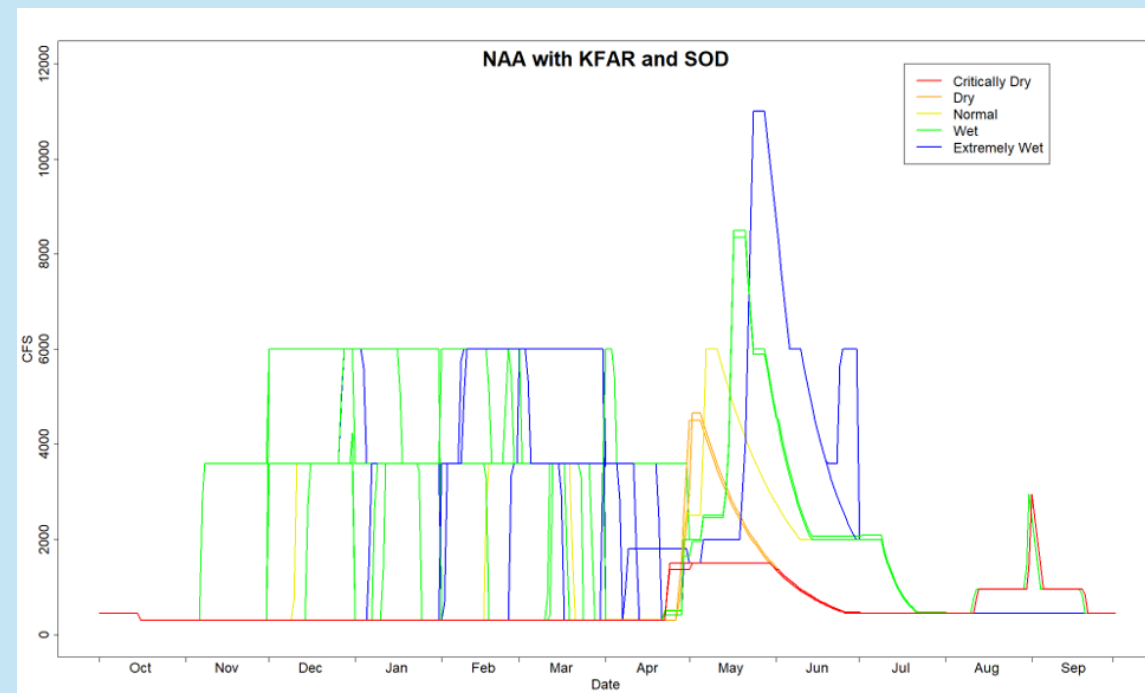
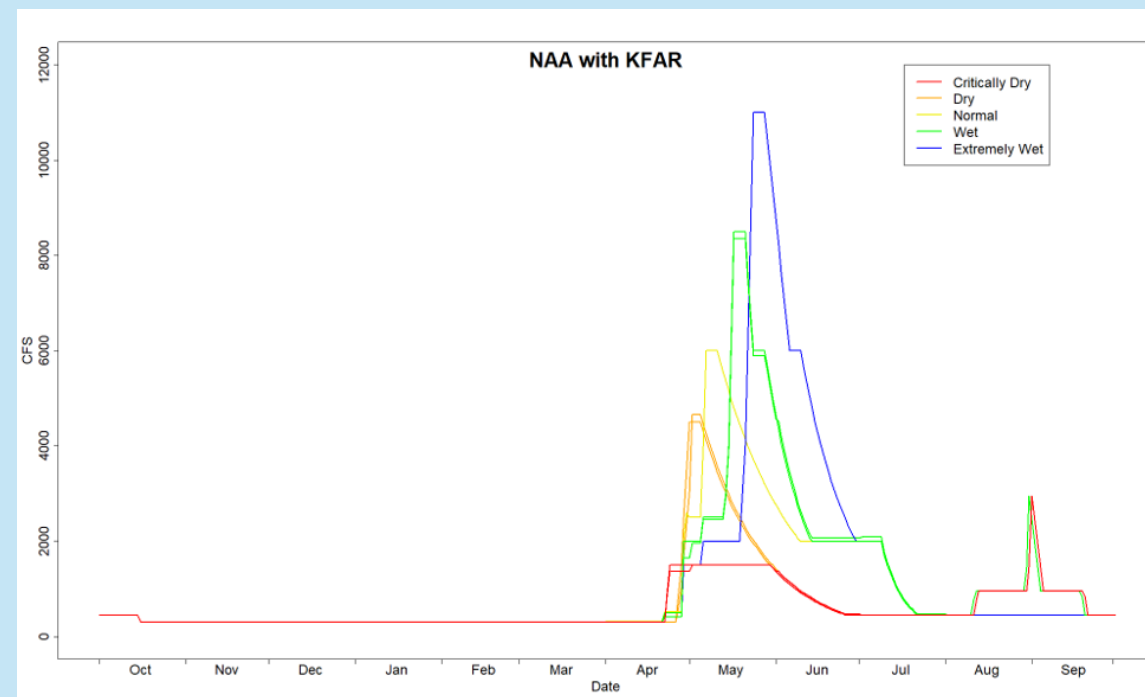




SEIS No Action Alt

ROD 2000

- ROD water volumes
- 600 TAF planning minimum pool
- 300/450 baseflows
- Restoration flows start Apr 15
- FAR retained (all except Alt 1)
- Ramping rates, 11k cfs max retained for all alternatives
- CalSim3: SOD 33% of years, 7.4 MAF over 40 years



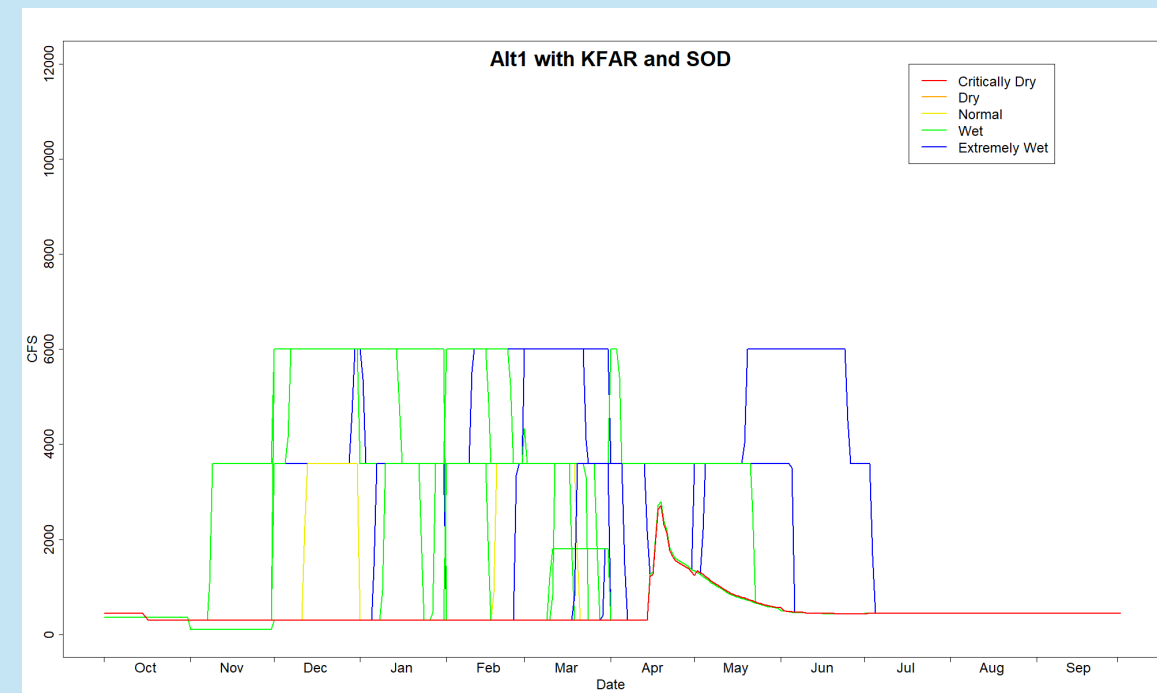
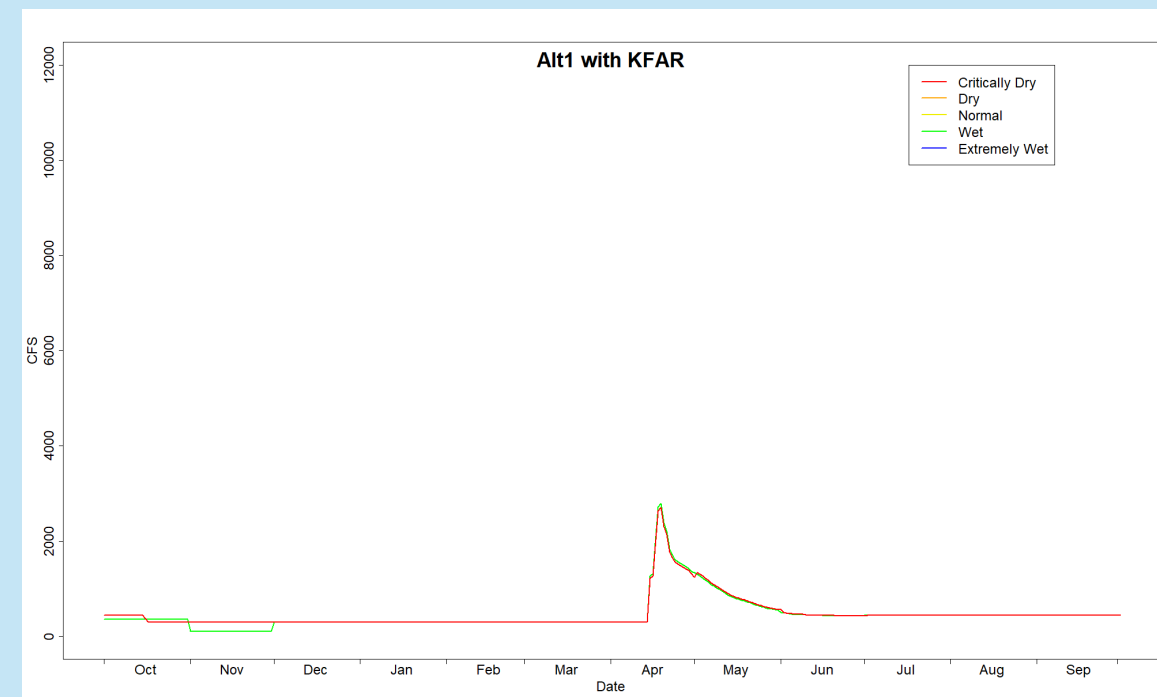


SEIS Alternative 1

Water Quality Control Plan

Legal minimums and WO 90-5

- 340,000 AF
- *NO* planning minimum pool
- 300/450 baseflows (249,000 AF)
 - Violated twice due to deadpool
- Restoration flows start Apr 15
 - (subject to AM)
- No FAR
- Ramping rates, 11k cfs max retained for all alternatives
- CalSim3: SOD 30% of years, 6.7 MAF over 40 years





SEIS Alternative 2

Multi-Agency Deliberation

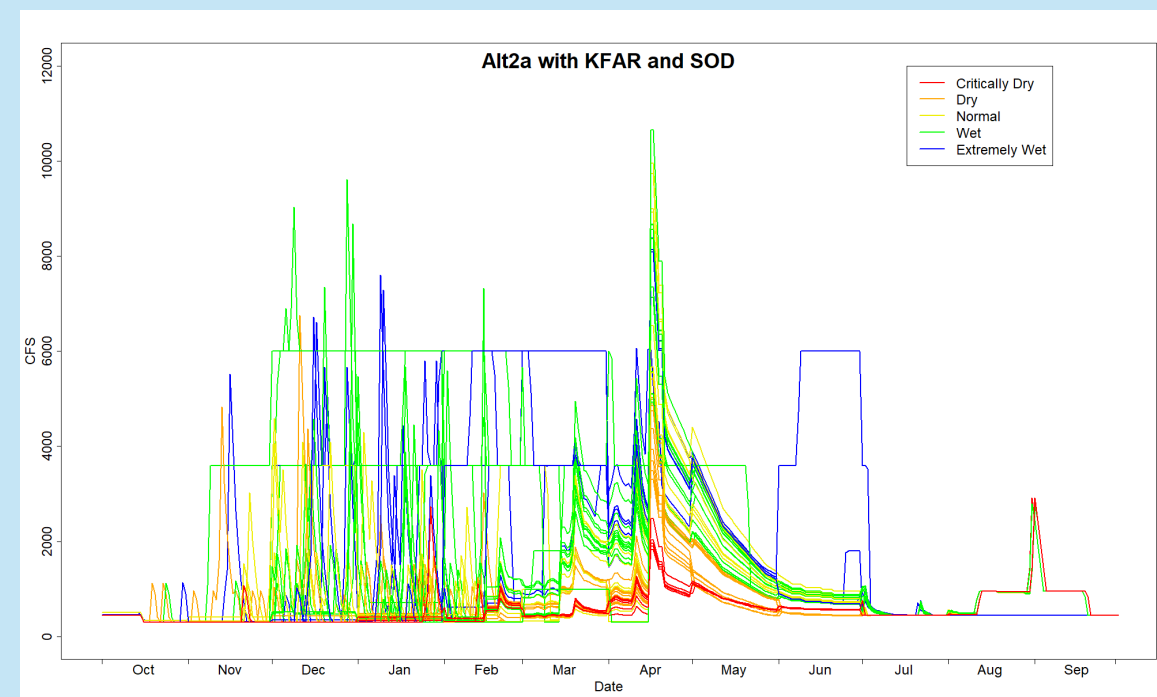
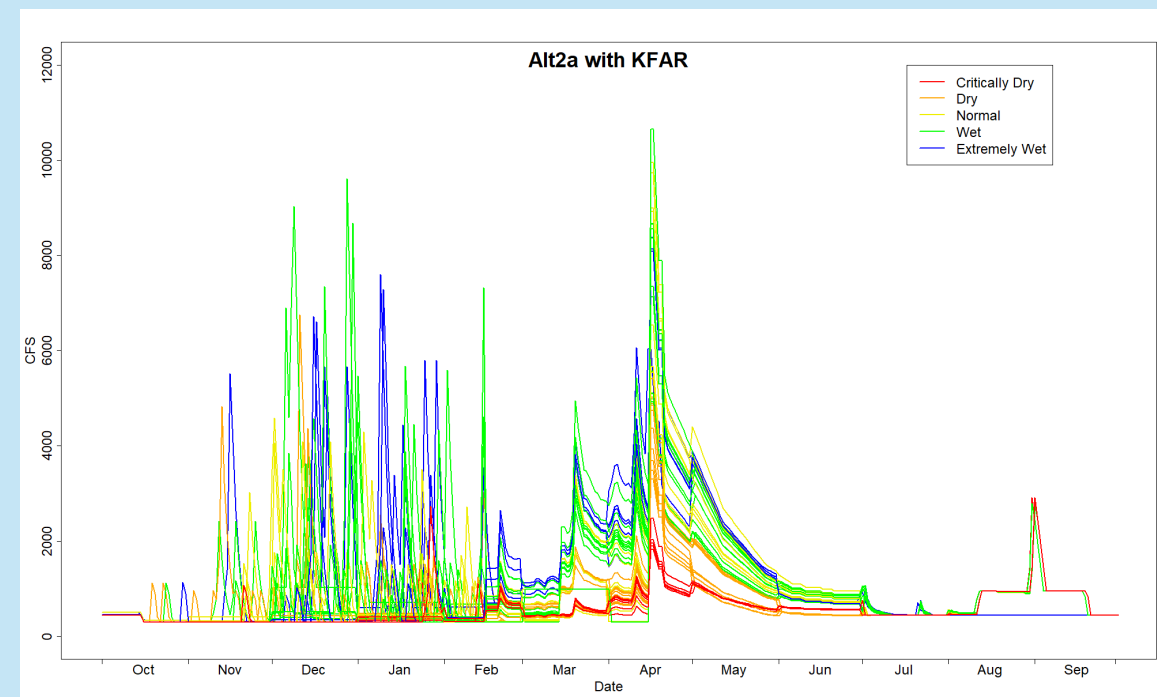
- Multi-Agency Deliberation
 - HVD, YT, NMFS, CDFW, USFWS, USBR
- Objectives:
 - Shift flows earlier in the season
 - Align dam releases with surrounding hydrology specific to each water year
- Broad Adaptive Management to achieve, represented by two methods (A and B)



SEIS Alternative 2 (a)

Multi-Agency Deliberation

- ROD water volumes
- 1200-900-750 TAF planning minimum pools
- 300/450 baseflows
 - (subject to AM)
- Restoration flows start October,
 - trigger based
- CalSim3: SOD 33% of years, 5.3 MAF over 40 years

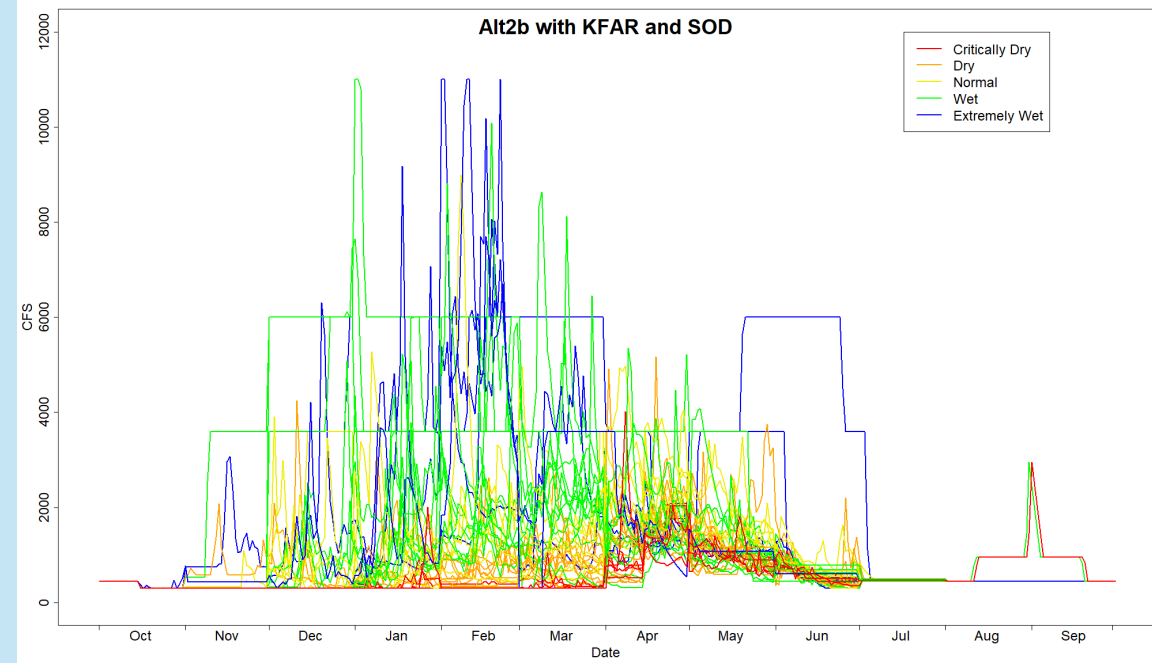
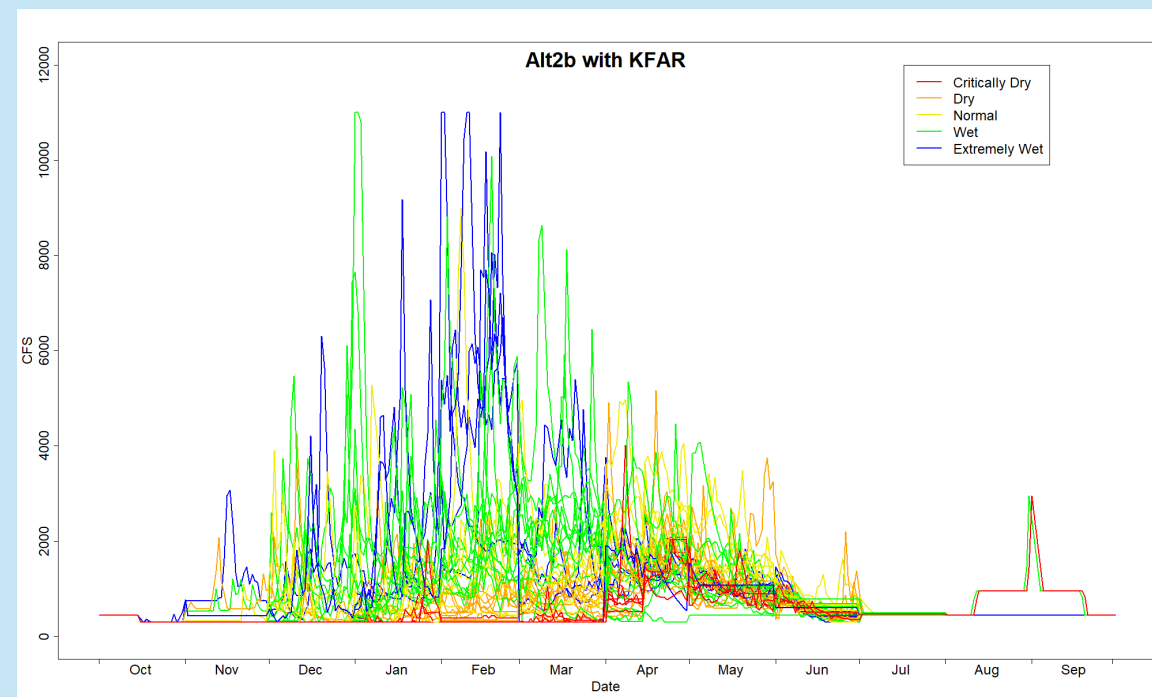




SEIS Alternative 2 (b)

Multi-Agency Deliberation

- ROD water volumes
- 1200-900-750 TAF planning minimum pools
- 300/450 baseflows
 - (subject to AM)
- Restoration flows start October
 - real-time from unimpaired streamgauge
- CalSim3: SOD 30% of years, 4.0 MAF over 40 years

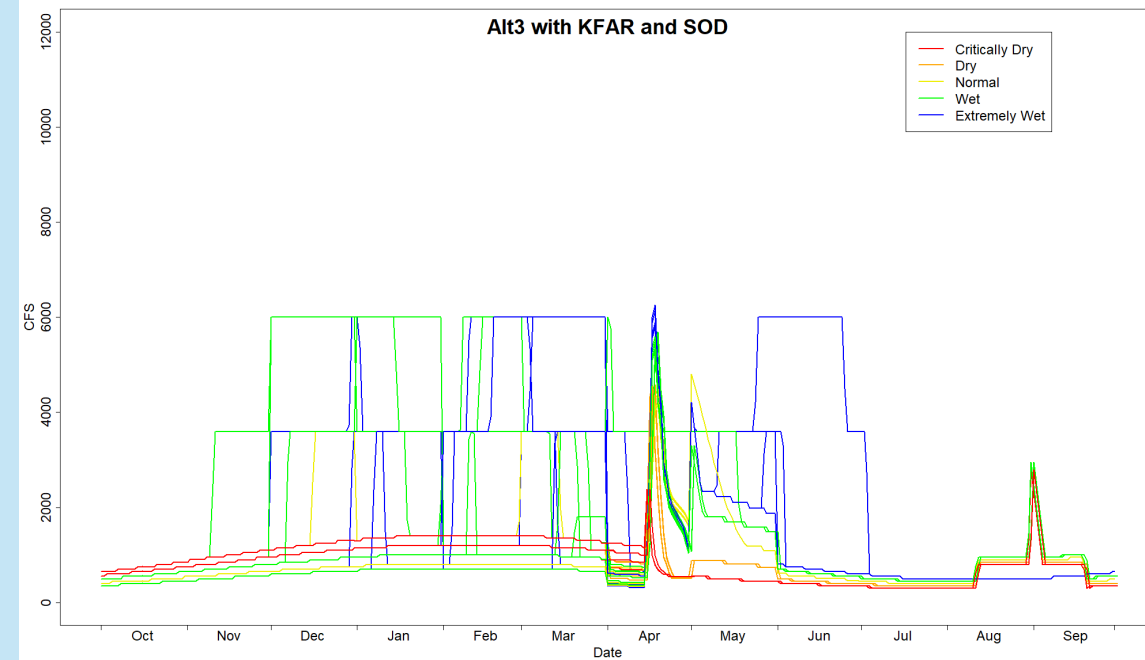
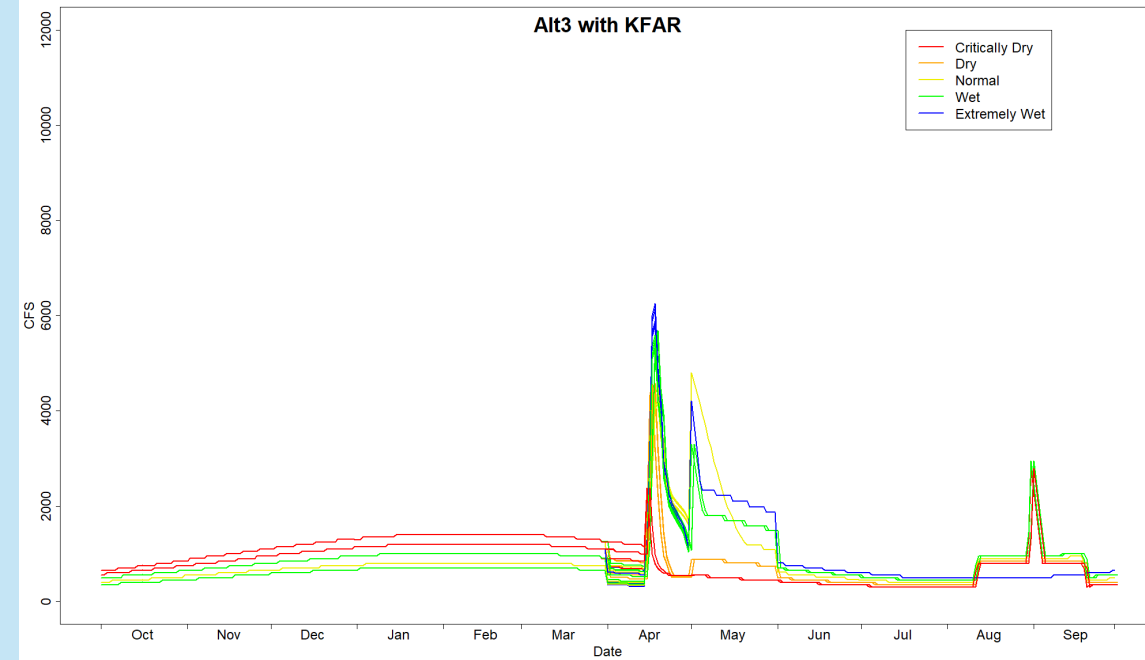




SEIS Alternative 3

Modified Natural Hydrology

- ROD water volumes REDISTRIBUTED April to April
- 1200-900-750 TAF planning minimum pools
- Oscillating summer baseflows
 - 300-500 in summer
- Restoration flows start Apr 15
 - (subject to AM)
- CalSim3: SOD 33% of years, 5.3 MAF over 40 years

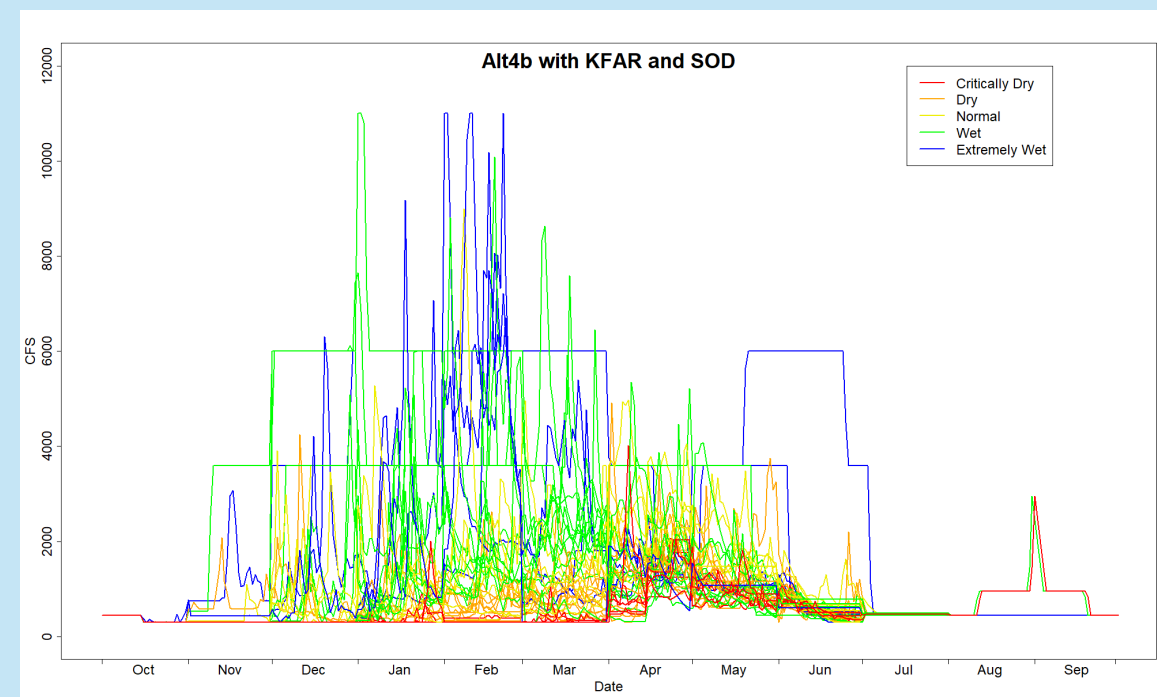
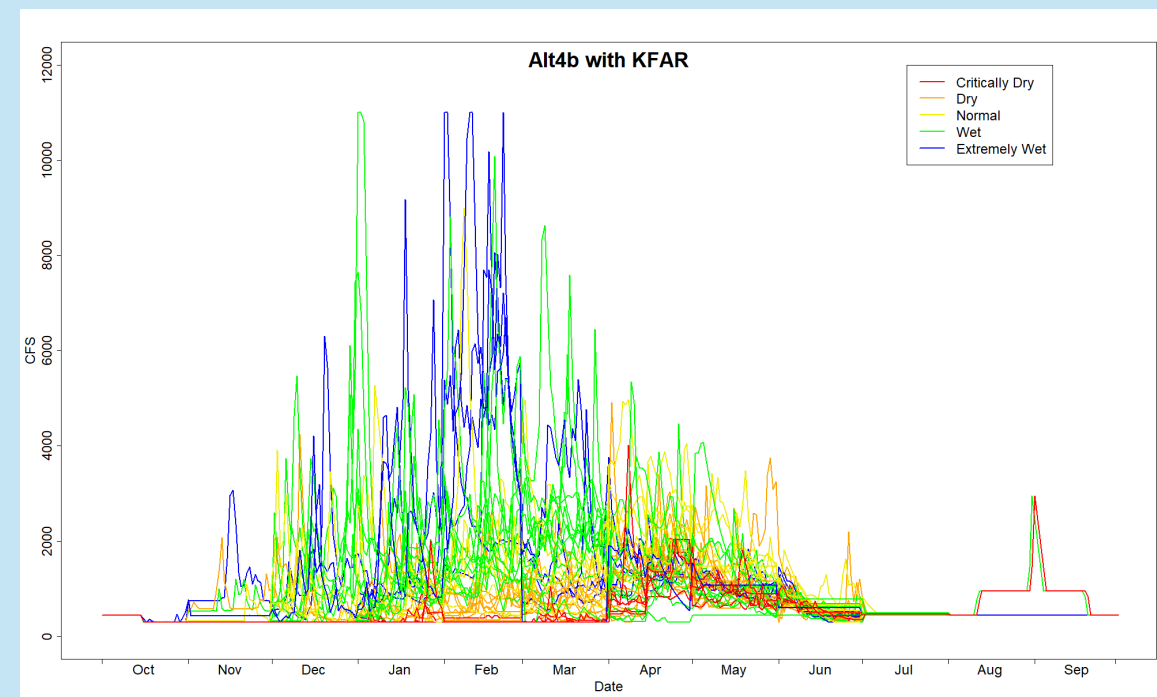




SEIS Alternative 4 (b)

Risk-Informed Operations

- ROD water volumes, REDUCED 15% during ongoing drought years and in the first normal or wetter year
- 750 TAF planning minimum pool
- Otherwise identical to Alt 2 (a and b)
- 300/450 baseflows
 - (subject to AM)
- Restoration flows start October
- CalSim3: SOD 28% of years, 4.1 MAF over 40 years





SEIS Alternative 5

name

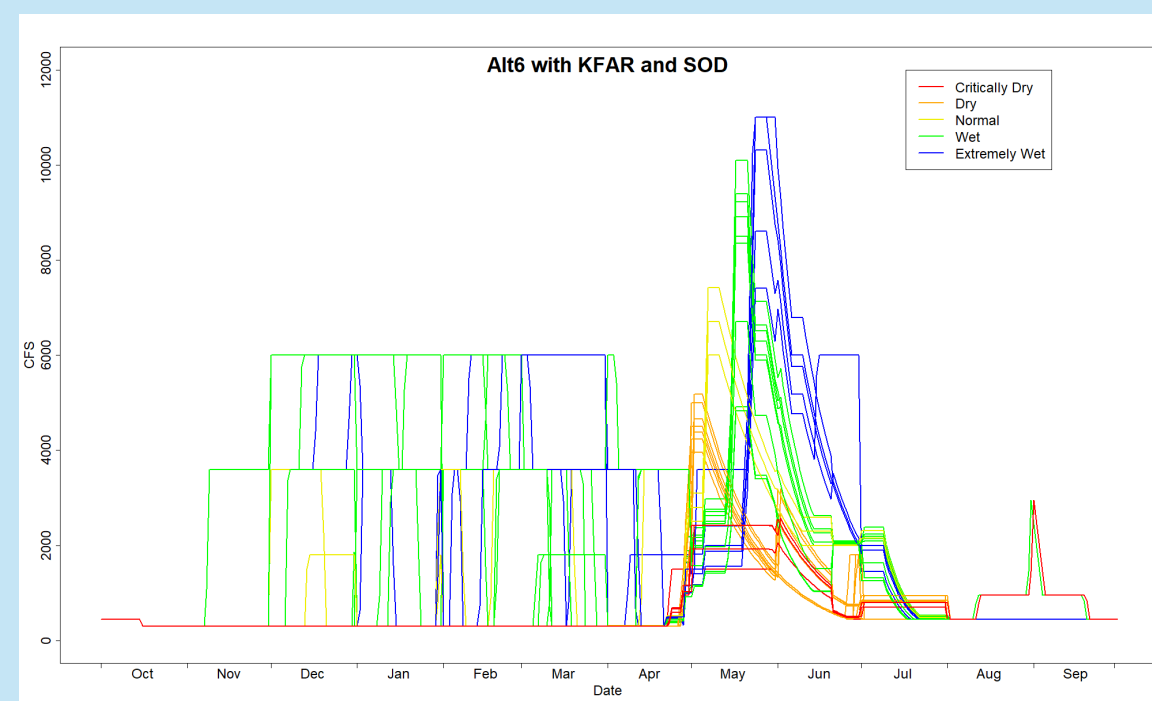
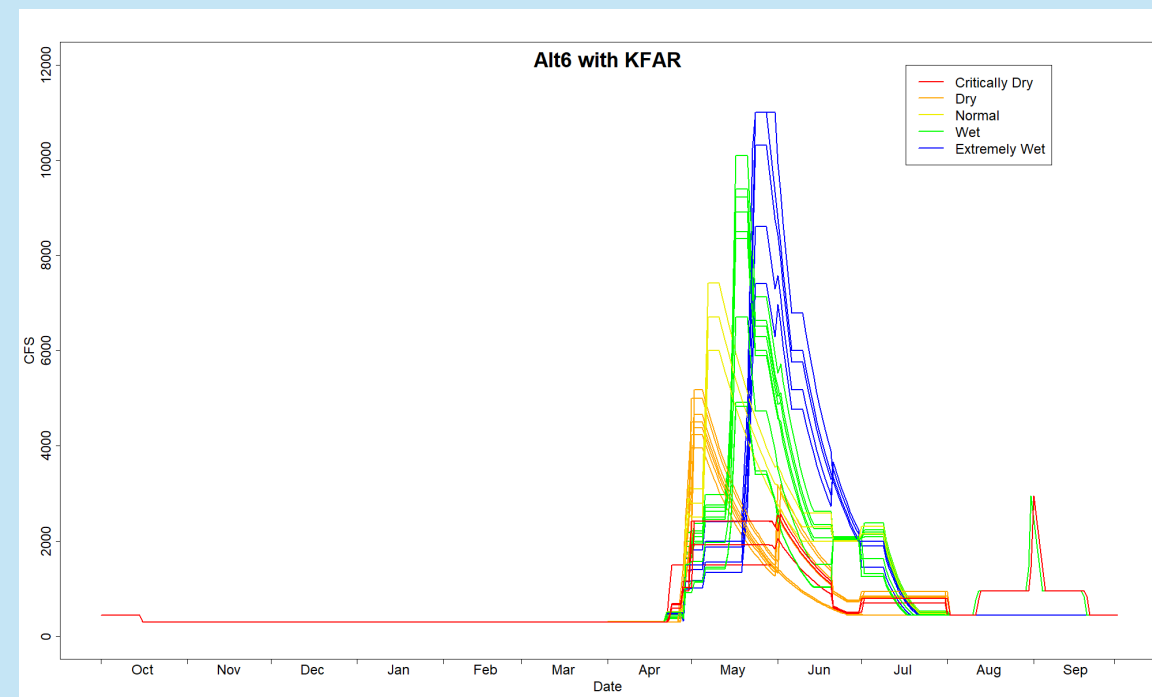
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SEIS Alternative 6

Trinity County

- ROD water volumes except 200 TAF when a Wet or Extremely Wet year follows a missed end-of-September storage, released over subsequent 3 years
- 1500-1300-1100-1000-900-825-750 TAF planning minimum pool
- 300/450 baseflows
- Restoration flows start April 15
- CalSim3: SOD 60% of years, 8.9 MAF over 40 years

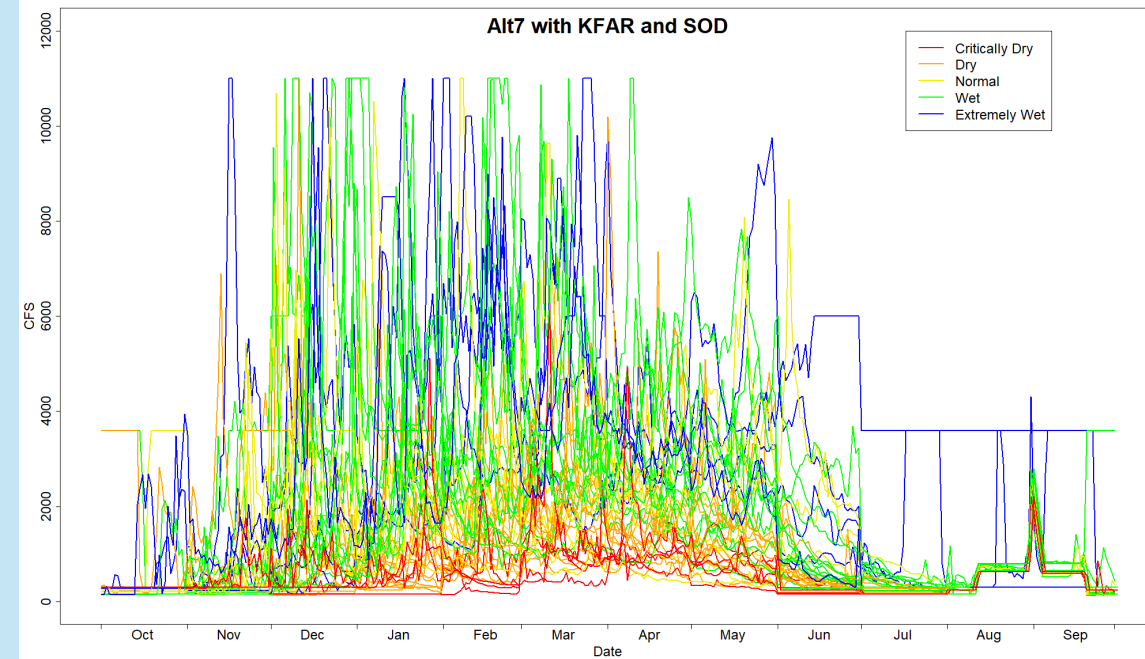
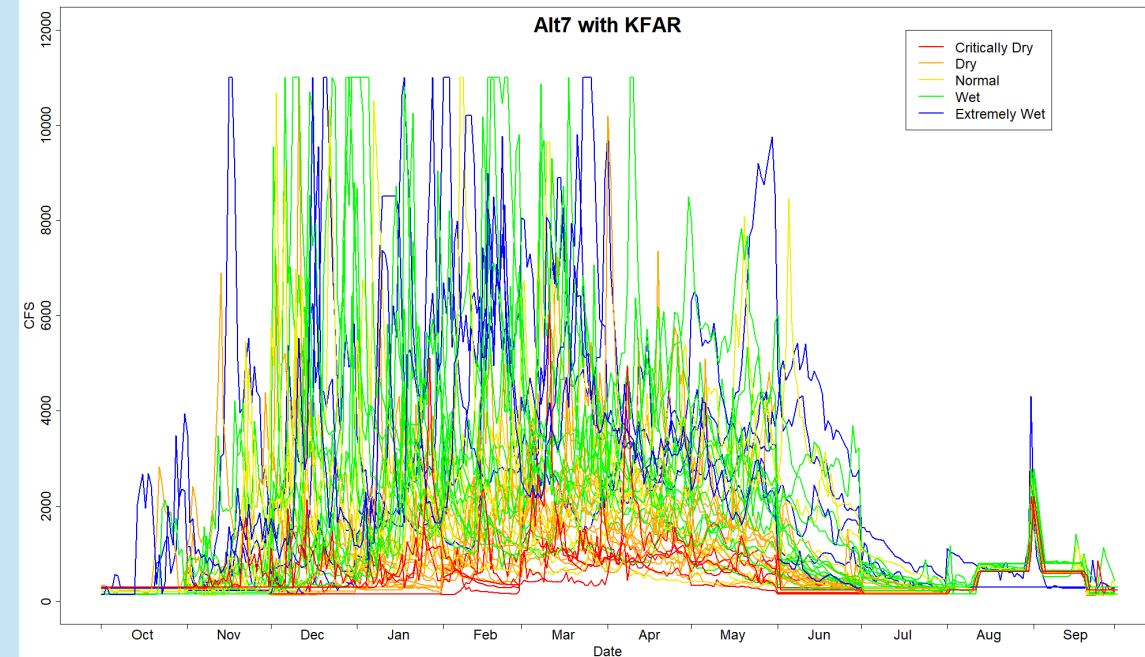




SEIS Alternative 7

Maximum Flow

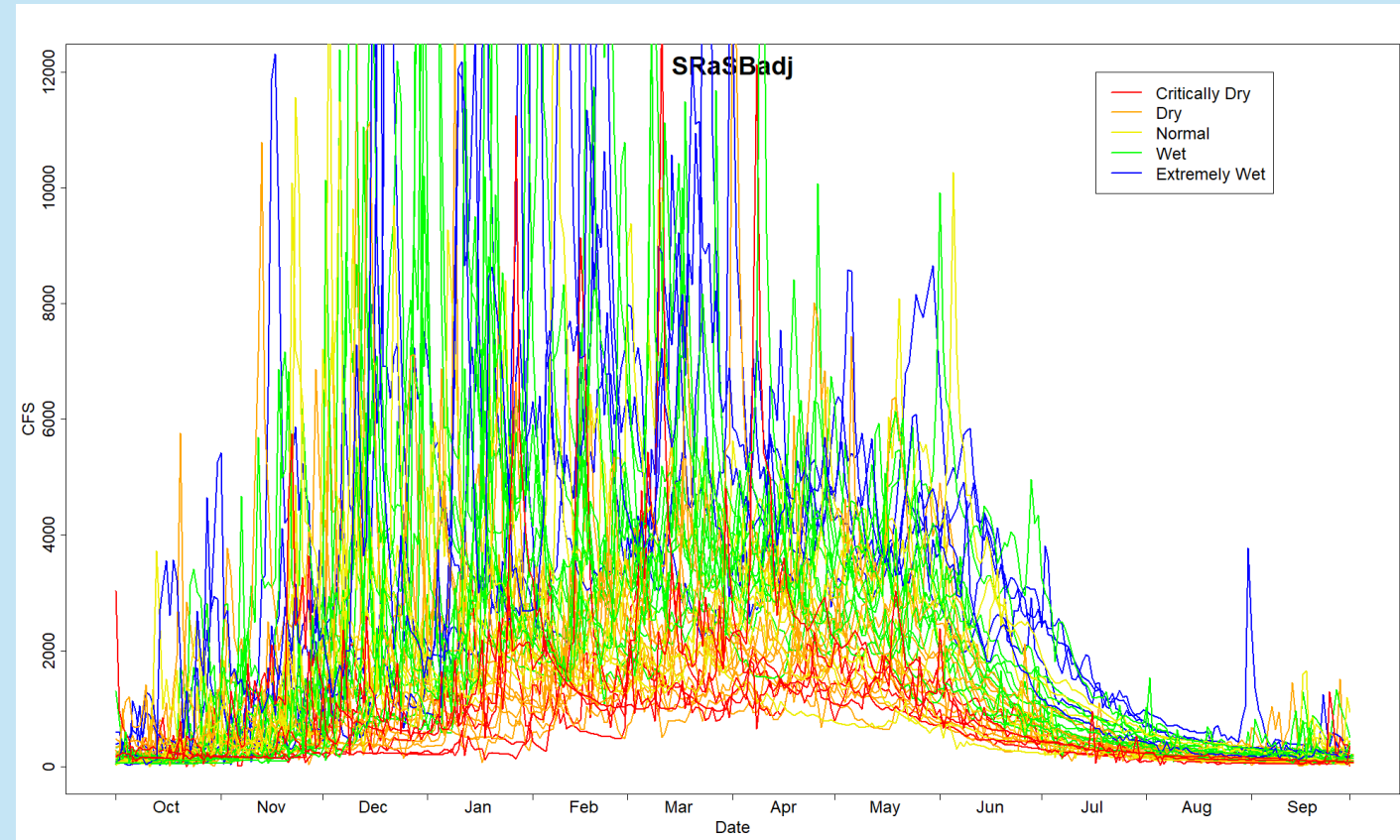
- ~70% of inflows released
- 750 TAF planning minimum pool
- 300/450 baseflows reducing as low as 100 cfs at 750 TAF
- Restoration flows start October
 - real-time from unimpaired streamgauge
- CalSim3: SOD 18% of years, 1.5 MAF over 40 years





Reference Natural Flow

- Salmon River at Somes Bar
 - Climate adjusted to 2022 +/- 15 conditions
 - [as are hydrographs for all alternatives]
- Not CalSim3 / No SOD models





How to analyze the effects of these Alternatives?

- Many, many modeling and analysis exercises in the DSEIS!
- Toward our interest in restoring the river for salmonids...
 - Water temperature models
 - Flow-based Coho population model
 - Flow-based Chinook (S3) used, largely for analyzing effects on Orcas.

*These models all have an inherent assumption:
a static river channel*

Thus, the importance of analyzing...
Attributes of a ~~Healthy~~ Functional River



Joint-Leads team

- Justin Alvarez (HVT)
- Kyle De Juilio (YT)
- Seth Naman (NMFS)
- Eric Peterson (TRRP/USBR)
- Chris Laskodi (TRRP/YT)
- Ken Lindke (CDFW)
- Dave Gaeuman (YT geomorphology)
- Smokey Pitman (ARS/HVT geomorphology)
- Todd Buxton (TRRP/USBR geomorphology)

9 Attributes

Number	River System Attribute Description	Number	River System Objective Description	River System Objective Threshold	Notes-global change consider the word "every 2-3 years" versus using a ratio the different wording
5	Maintain appropriate grain size distribution in the bedload	1	Maintain appropriate fine sediment storage levels	Fine sediment grain size distribution supports overall geomorphic function and ecosystem health	Grain size distribution not important. Augmentation and Hamilton Pond management affect this. Fines ≤ 2 mm 16-24% in subsurface bulk samples would be the target but there is no way to evaluate this for each alternative. Could be a target for bar area as a surrogate for coarse sediment storage. Map of spatial distribution of bars. Measure of area, not volume but a strong surrogate for bar volume. As of now, do not have a metric (number) for the amount (area) of bars that are good or bad or high or low. Not a good way to evaluate this for each alternative. A hydrograph combined with a transport curve does evaluate this in a theoretical way, but because of hysteresis and other factors would not necessarily be accurate.
		2	Maintain appropriate coarse sediment supply in the mainstem	Ability of combined flow magnitude and duration to achieve spatially appropriate coarse sediment levels for bar formation and replenishment of spawning gravels	Consider moving this to a different river system attribute, and/or rewording. Synchrony in this case could be 1-3 days different, but overall we want to transport tributary sediments as they come into the river and we don't want unnatural buildup of tributary deltas over weeks and riparian berms. at large restoration sites we see channel migration, but in most other areas we do not. Todd says max fishery flow 14000 should be achieved ~10 years. Eric-Very gradual migrations are occurring in some areas, but not at the rate that was theorized in the 1990. See TRRP online maps based on Lidar and multibeam sonar. Difference between 2016 and 2022 models shows the difference. Occurring big time across from Rush Creek delta because the delta is pushing the river there but otherwise not really occurring and not at the speed that was expected. Reword to "Requires mechanical intervention..." Migration is going on at Poker bar and JC, again rate that was hypothesized is lower. No hard numbers on flows and durations that cause channel migration. Have a few data points on
		3	Prevent excessive aggradation of tributary-derived material as it enters the mainstem	Tributary sediments distributed downstream and or maintained by river flows; distribution of delta begins at flows > 6,000 cfs, coarser particles require flows > 14,000 cfs. Correlation with Salmon River above Sommes Bar and Trinity River above Coffee Creek of 0.7 or greater.	
6	Periodic channel migration	1	Channel migrates in alluvial reaches	Requires mechanical intervention	



Attributes of a Functional River

1. Spatially complex channel geomorphology
 - 5 objectives... emergent properties of subsequent attributes
2. Flows are variable and synchronized with tributaries
 - 5 objectives... largely correlations to SRaSB and variation metrics
3. Frequently mobilized channelbed surface at appropriate time synchronized with tributaries to support geomorphic function and ecosystem health (winter months)
 - 2 objectives... threshold based
4. Periodic channelbed scour and fill at appropriate time synchronized with tributaries to support species and ecosystem health (winter months)
 - 3 objectives... threshold based
5. Maintain appropriate grain size distribution in the bedload
 - 3 objectives... CV, correlations, and thresholds
6. Periodic channel migration
 - 1 objective... threshold based
7. Functional floodplain
 - 4 objectives... inundation model, threshold, and correlation
8. Self-sustaining diverse riparian plant communities
 - 5 objectives... correlations and thresholds
9. Water temperature and microhabitat
 - 3 objectives... existing TRRP temperature targets

$\Sigma = 31$ Objectives
Don't worry... I'll just cover a select few.



Annual Thresholds

(for geomorphic change)

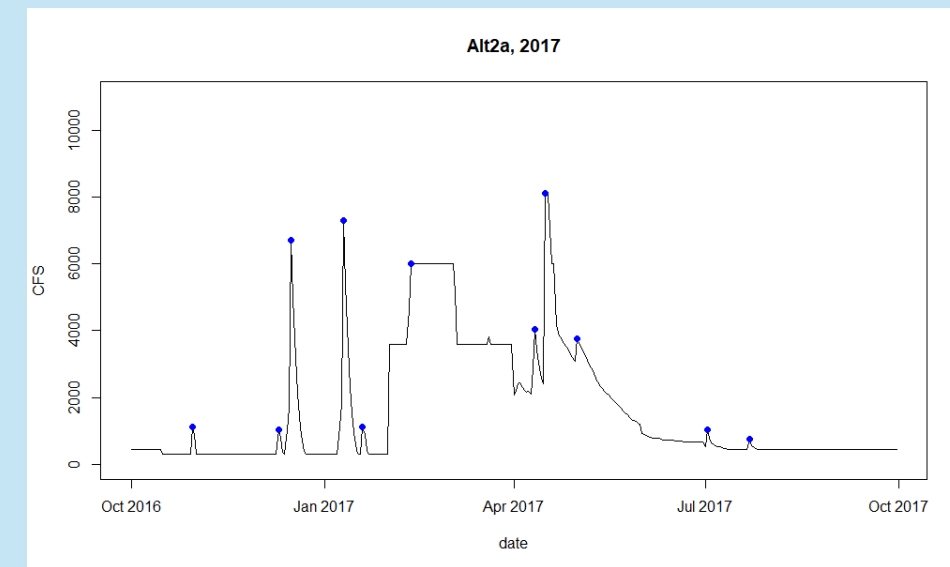
Threshold (cfs)	Metric	NAA	Alt 1	Alt 2a	Alt 2b	Alt 3	Alt 4b	Alt 6	Alt 7	SRaSBadj
<4000	Frequency	13% (13%)	100% (80%)	15% (15%)	38% (35%)	13% (13%)	40% (38%)	15% (15%)	8% (8%)	5% (5%)
4000-5499	Frequency	28% (28%)	0% (3%)	28% (25%)	25% (23%)	65% (63%)	23% (20%)	35% (35%)	15% (15%)	3% (3%)
5500-7999	Frequency	18% (18%)	0% (18%)	18% (20%)	13% (18%)	23% (25%)	15% (20%)	23% (23%)	18% (18%)	15% (15%)
8000-10499	Frequency	30% (30%)	0% (0%)	38% (38%)	15% (15%)	0% (0%)	13% (13%)	23% (23%)	15% (15%)	13% (13%)
>= 10,500	Frequency	13% (13%)	0% (0%)	3% (3%)	10% (10%)	0% (0%)	10% (10%)	5% (5%)	45% (45%)	65% (65%)

Values given as: no-SOD (SOD)



Peak Frequencies

(within years)



	NAA	Alt1	Alt2a	Alt2b	Alt3	Alt4b	Alt6	Alt7	SRaSBadj
Average Peaks per Year of any flow rate	1.875 (2.4)	1 (1.425)	8.575 (8.2)	11.075 (10.225)	2.475 (2.975)	10.825 (9.9)	2.25 (3.15)	17.425 (17.4)	23.25
Average Peaks per Year >= 8000 cfs	0.425 (0.425)	0 (0)	0.4 (0.4)	0.3 (0.3)	0 (0)	0.275 (0.275)	0.275 (0.275)	1.575 (1.575)	2.475

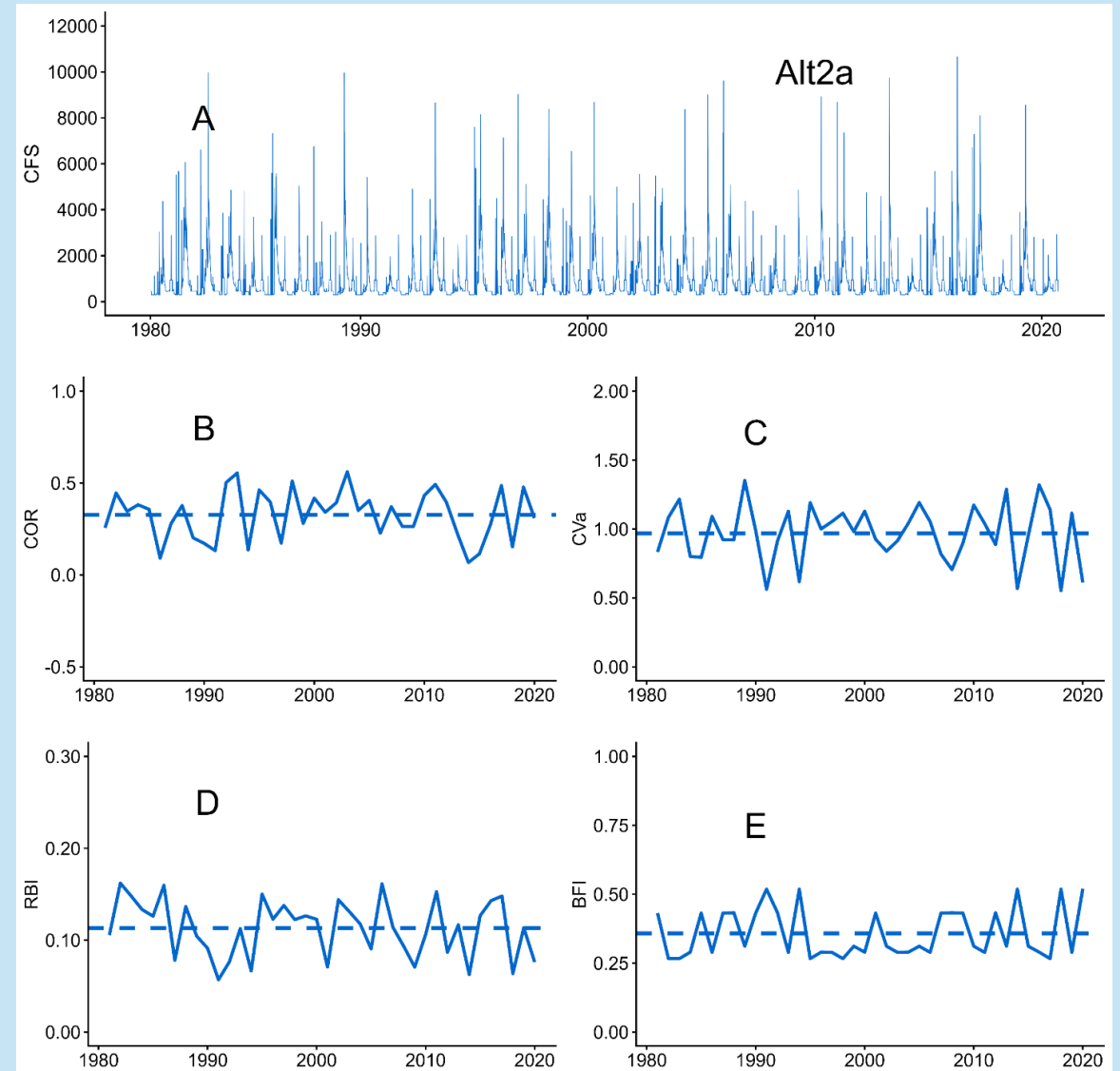
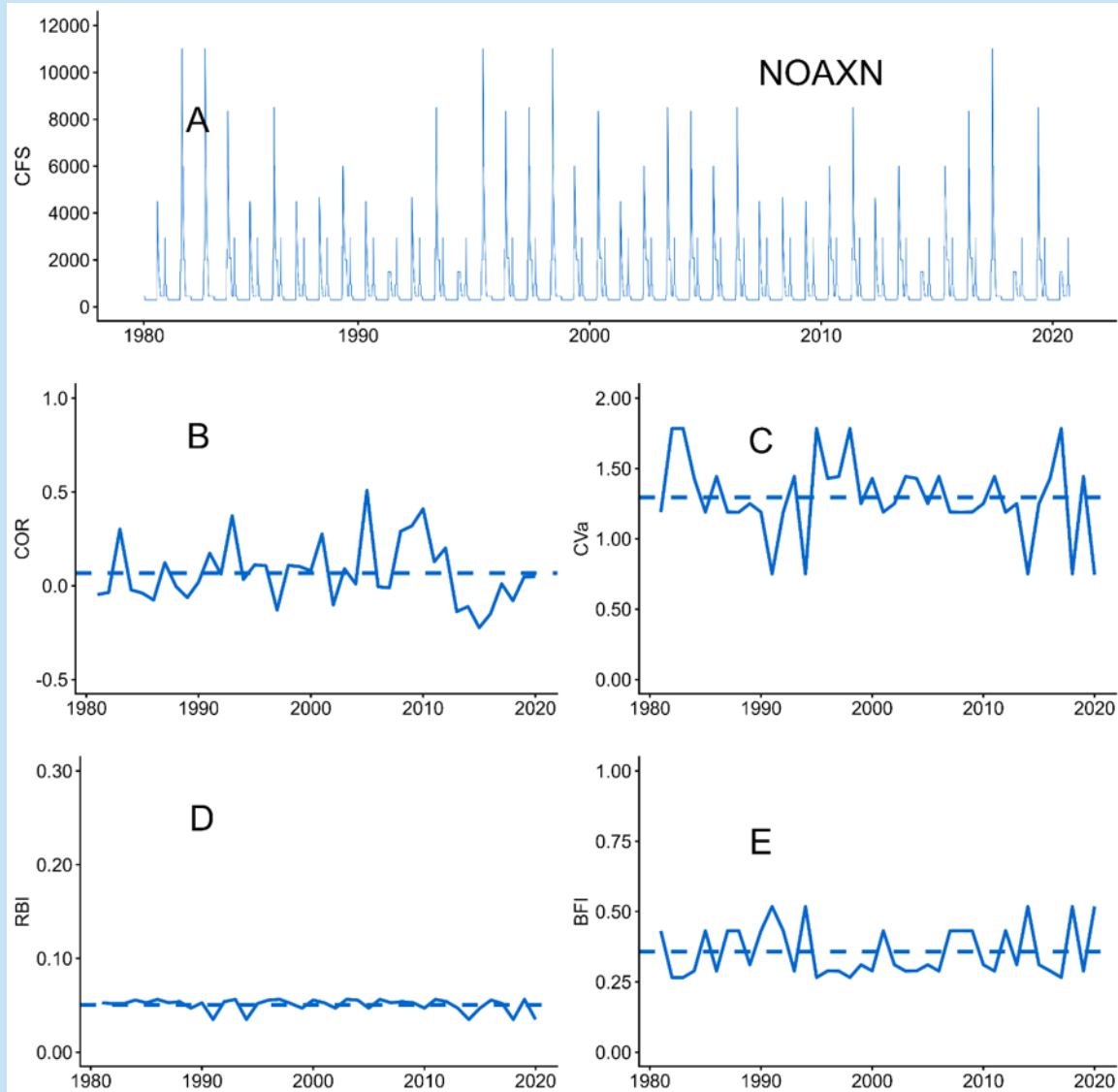


Correlations to SRaSBadj (similarity to natural)

Correlation Time Period	NAA	Alt 1	Alt 2a	Alt 2b	Alt 3	Alt 4b	Alt 6	Alt 7
Year-Round (Attr. 5.3, 7.1, 8.1, 8.2, 8.3)	0.09 (0.35)	0.07 (0.39)	0.36 (0.51)	0.72 (0.69)	0.26 (0.47)	0.72 (0.67)	0.07 (0.38)	0.89 (0.86)
Fall to Spring (October through March) (Attr. 2.3)	-0.21 (0.43)	-0.19 (0.38)	0.47 (0.55)	0.81 (0.74)	0.31 (0.48)	0.81 (0.72)	-0.21 (0.48)	0.89 (0.88)
Snowmelt Peak (April through May) (Attr. 2.4, 7.2)	0.05 (0.1)	0 (0.22)	0.27 (0.29)	0.36 (0.48)	0.19 (0.26)	0.35 (0.46)	0.03 (0.12)	0.87 (0.87)
Mobilization Period (December through February) (Attr. 3.1, 3.2, 4.1, 4.2, 4.3)	NA (0.4)	NA (0.35)	0.45 (0.51)	0.84 (0.73)	0.09 (0.41)	0.84 (0.71)	NA (0.44)	0.87 (0.86)
Winter (January through March) (Attr. 7.2)	NA (0.4)	NA (0.32)	0.28 (0.45)	0.79 (0.74)	0.04 (0.4)	0.80 (0.71)	NA (0.43)	0.85 (0.84)

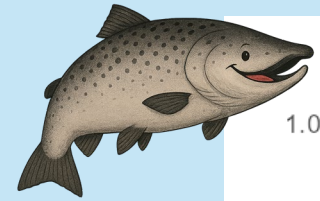


Graphical representations can capture interannual variation

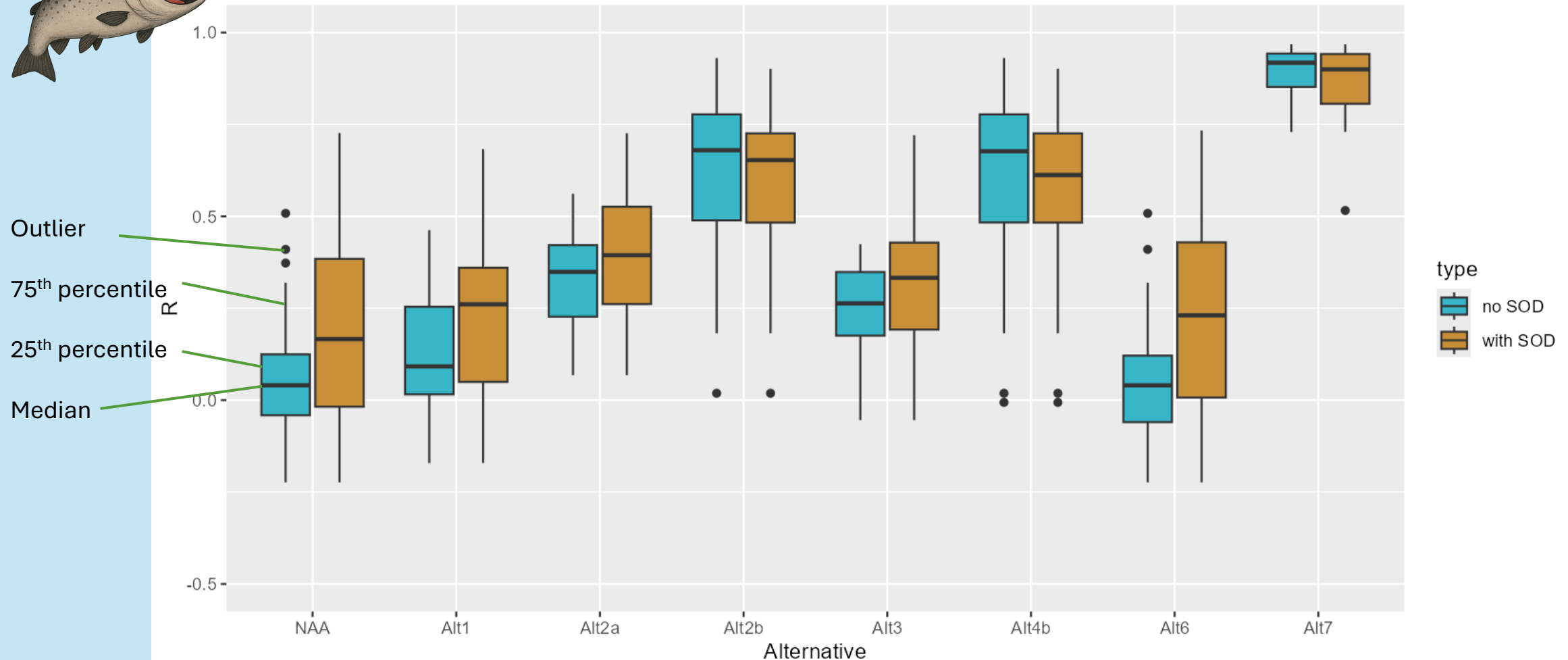


Correlations to SRaSBadj (graphical)

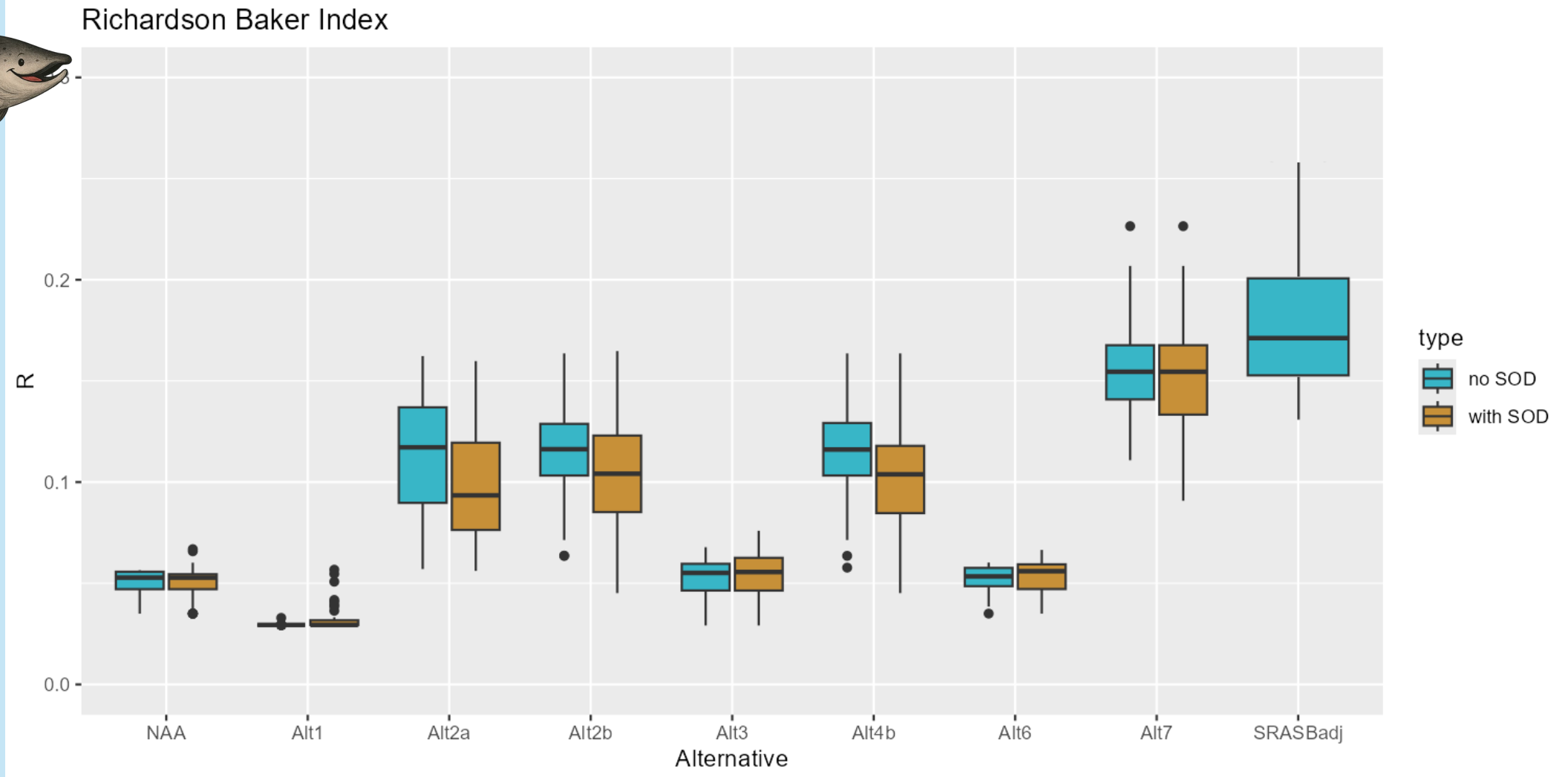
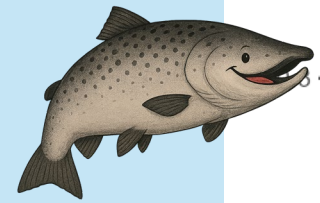
median, first quartile (25th percentile), third quartile (75th percentile), and outliers



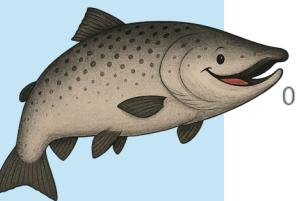
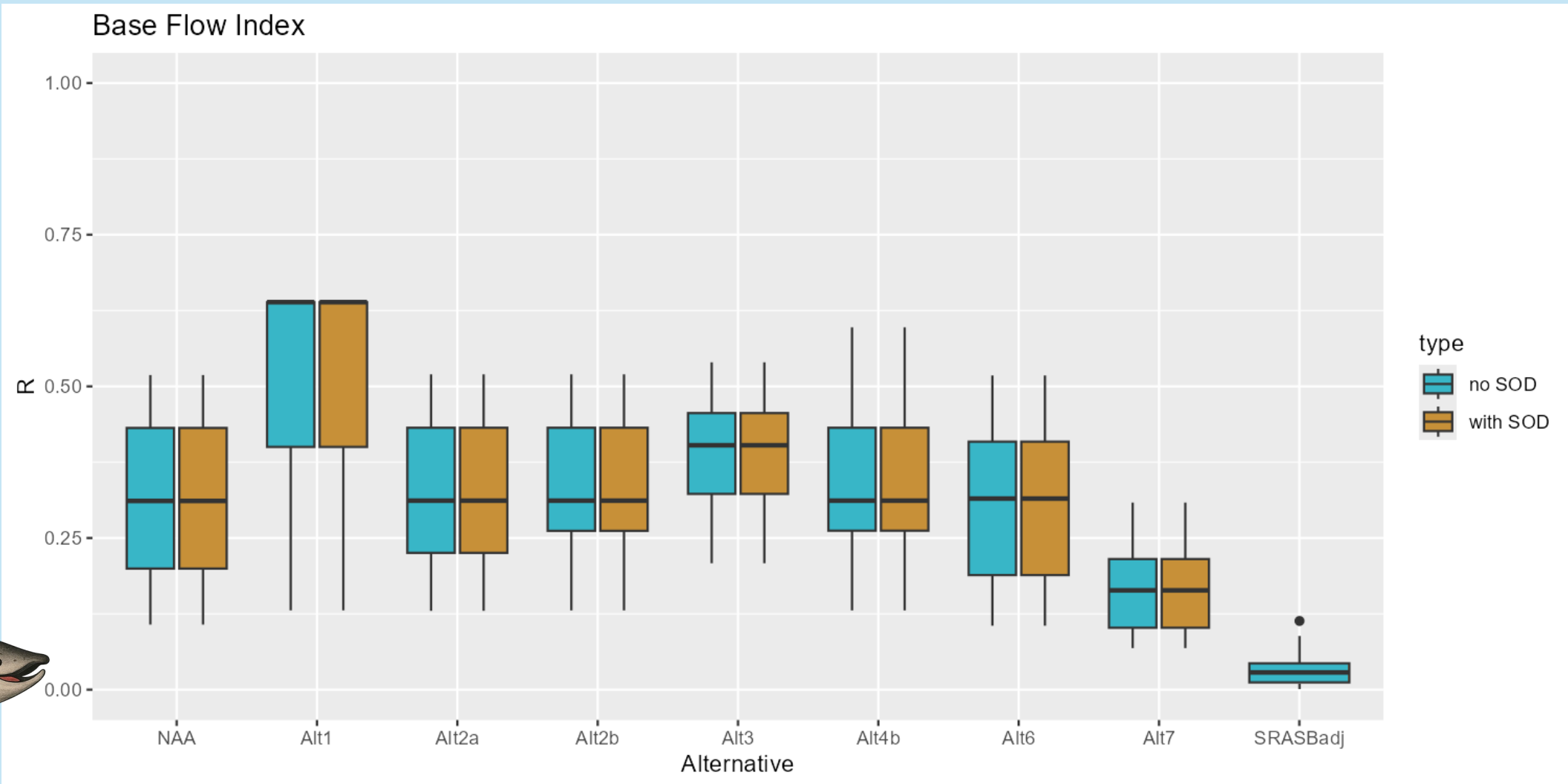
Correlations with SRaSBadj Year-Round



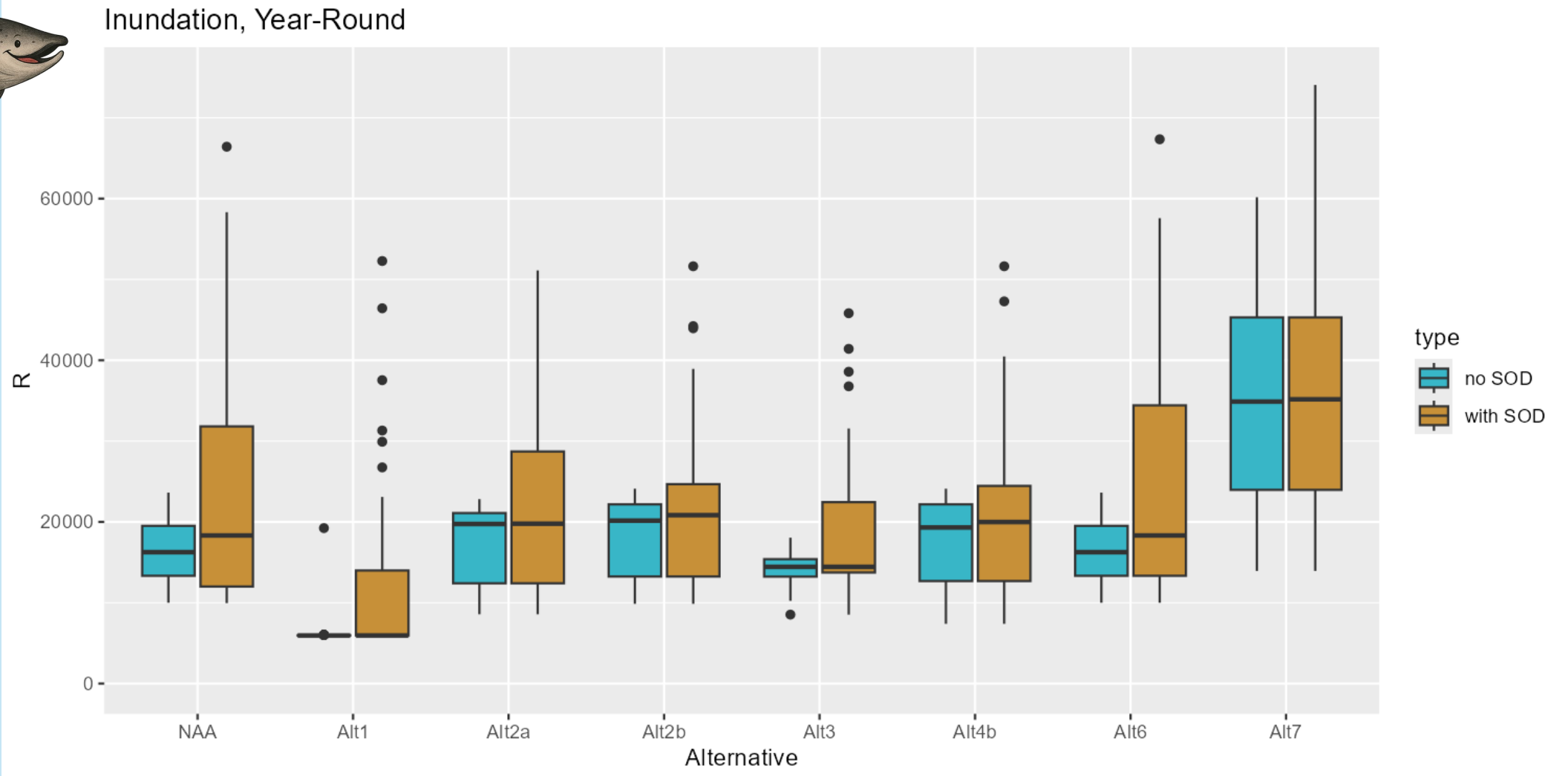
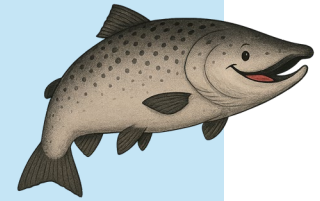
Richardson Baker Index (flashiness)



Baseflow Index (lowest flows compared to highest)

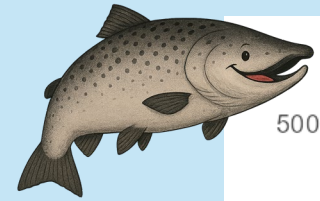


Inundation Duration (7.1 inundate floodplains)

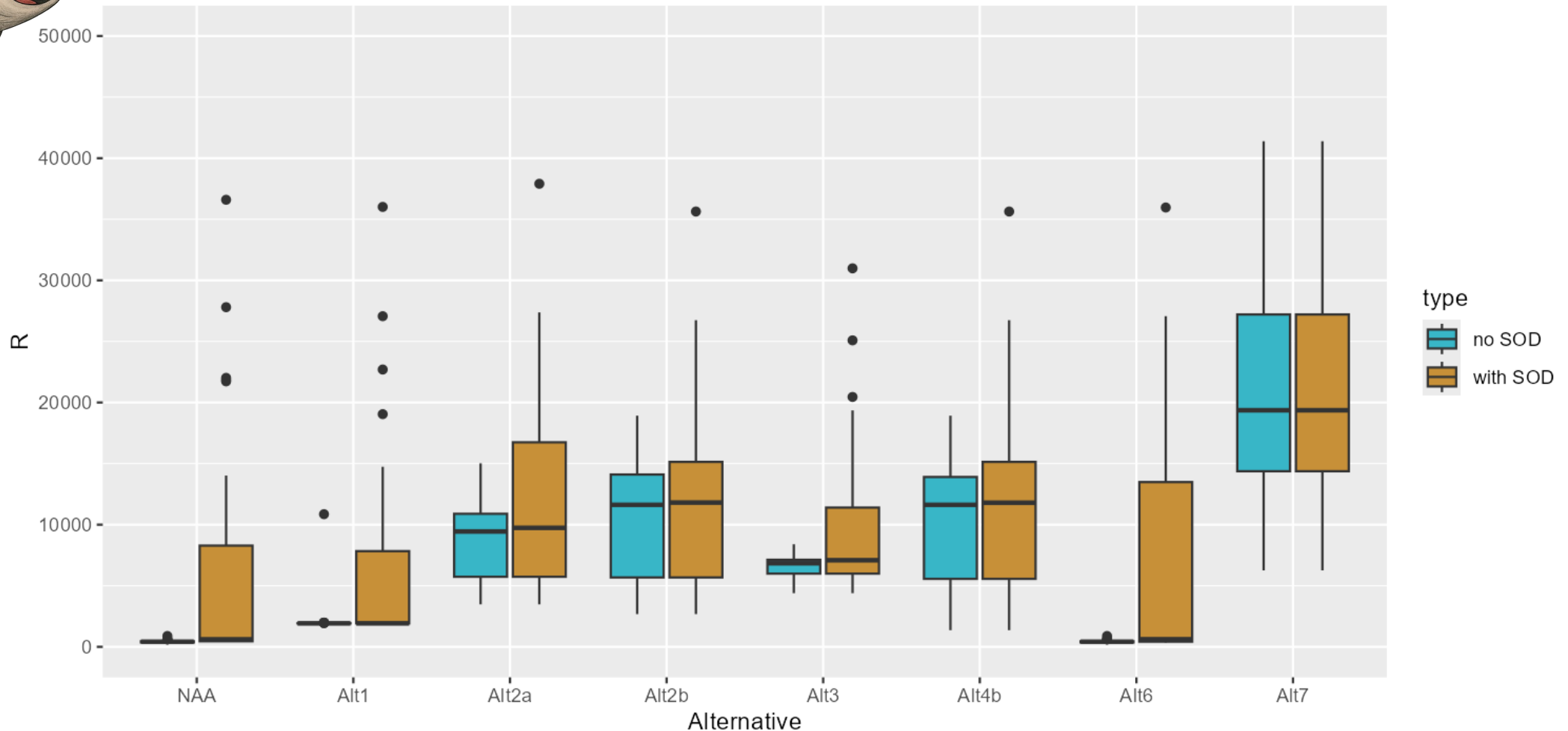


Inundation Duration

(7.3 Inc Habitat, minimize density limits)

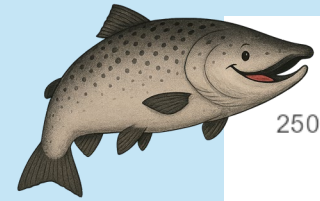


Inundation, January through April

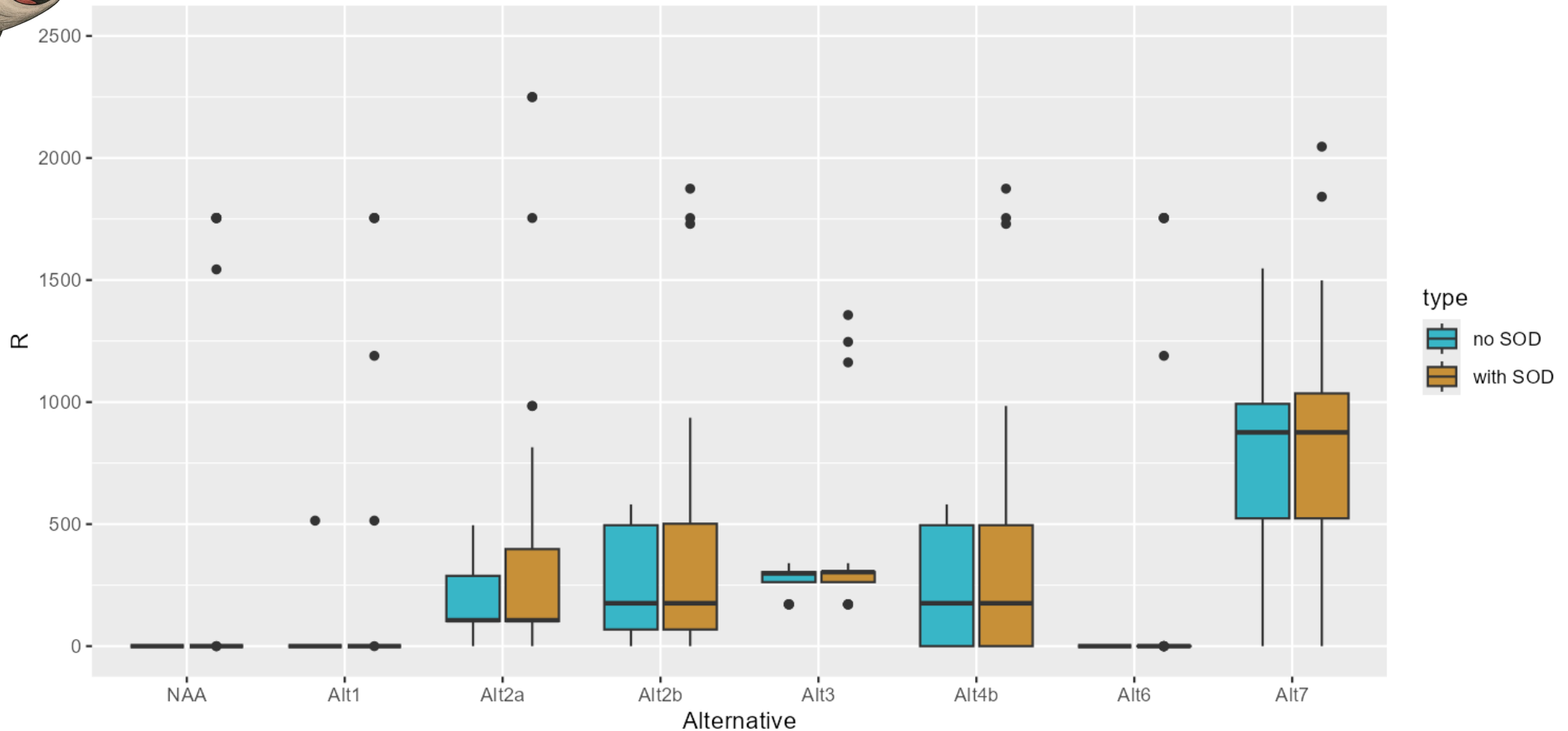


Inundation Duration

(7.4 Establish Foodwebs)



Ten-Week Inundation, January through April

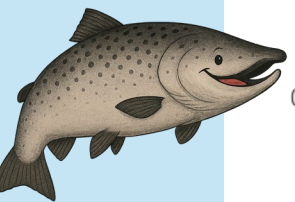
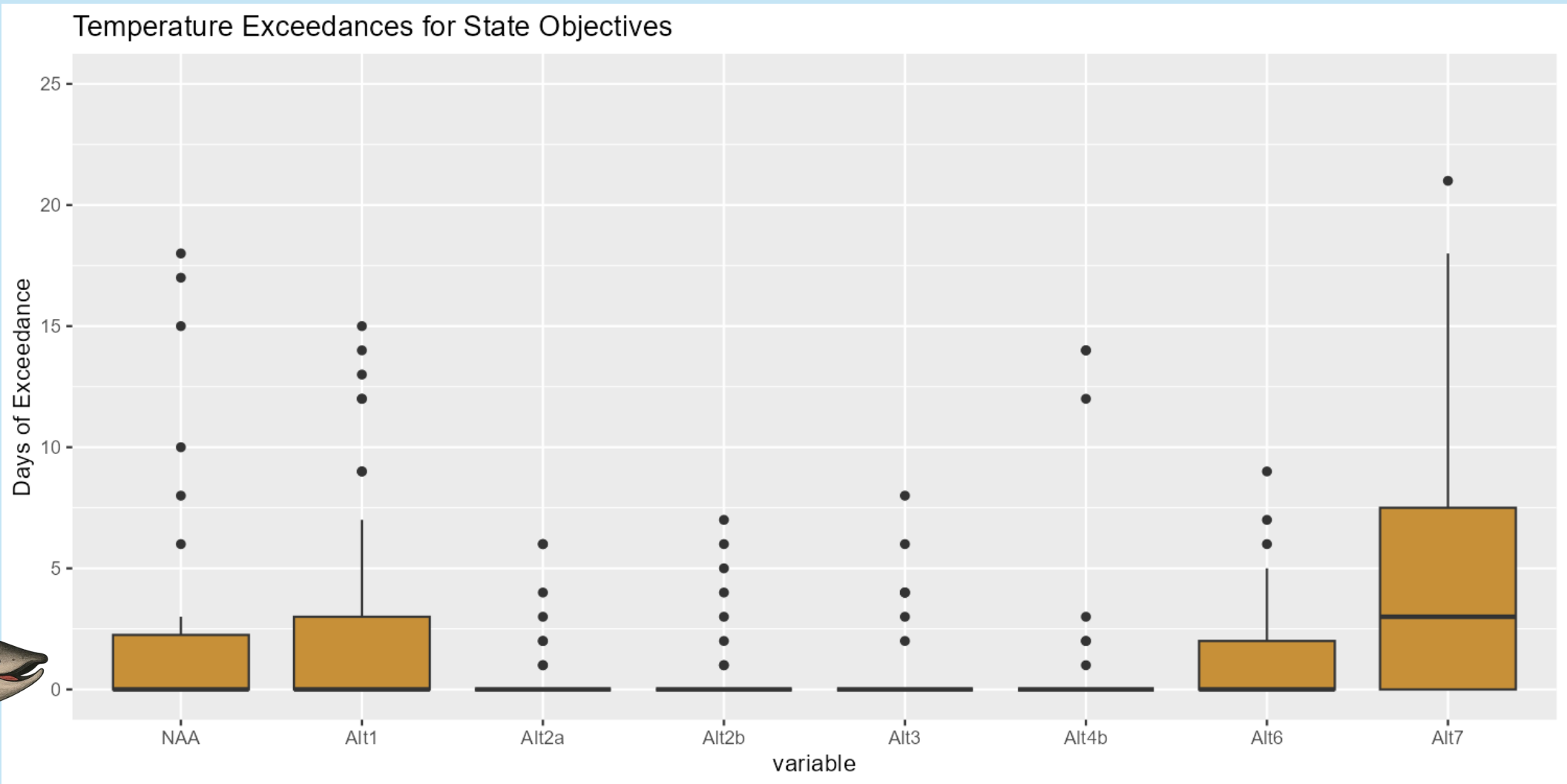




Water Temperatures

(WO 90-5 violations)

Temperature modeling without SOD not available.

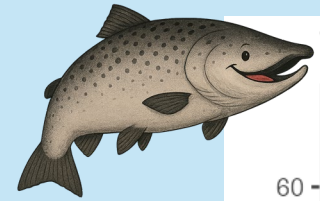




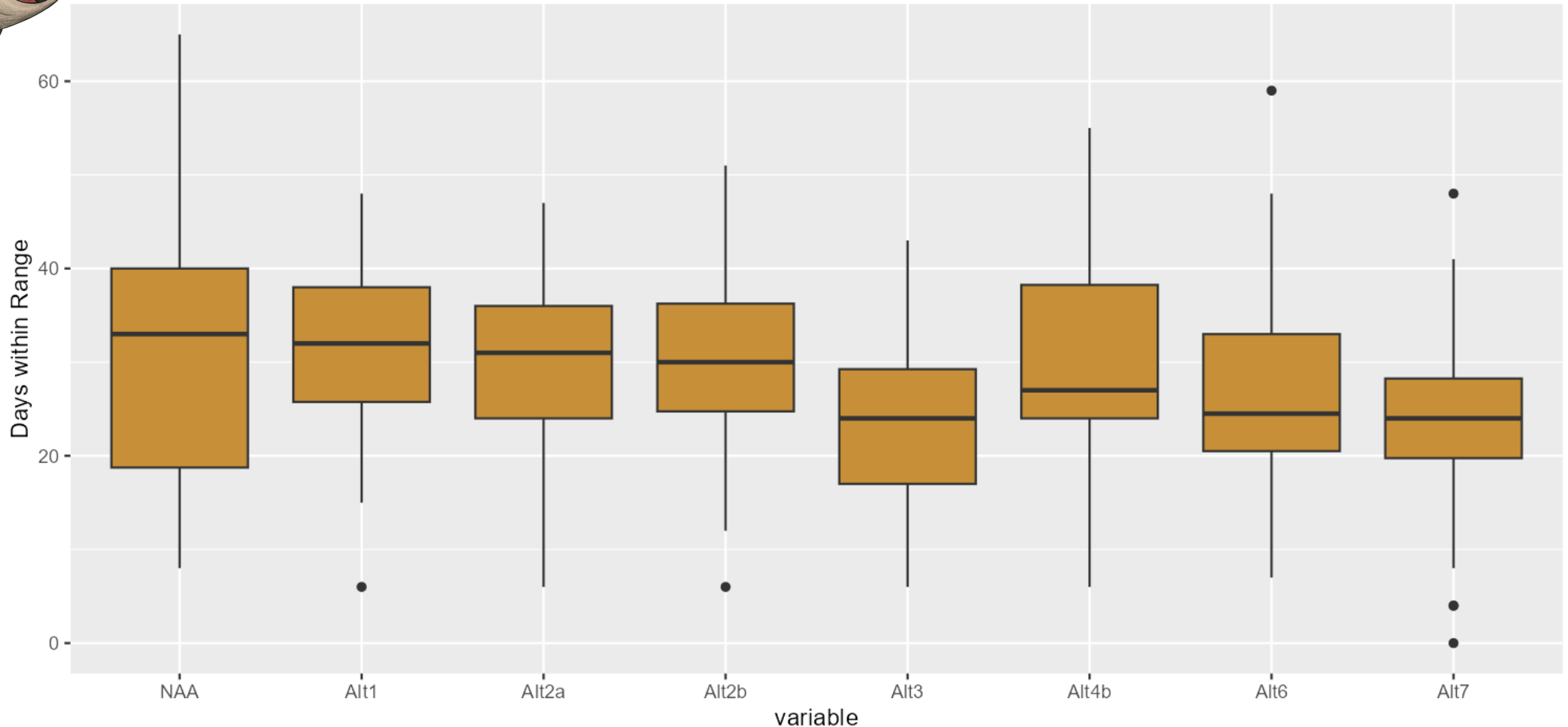
Water Temperatures

(days within 7DADA)

Temperature modeling without SOD not available.



Temperature within Range of Juvenile Objective

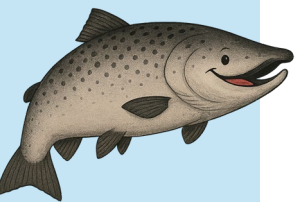
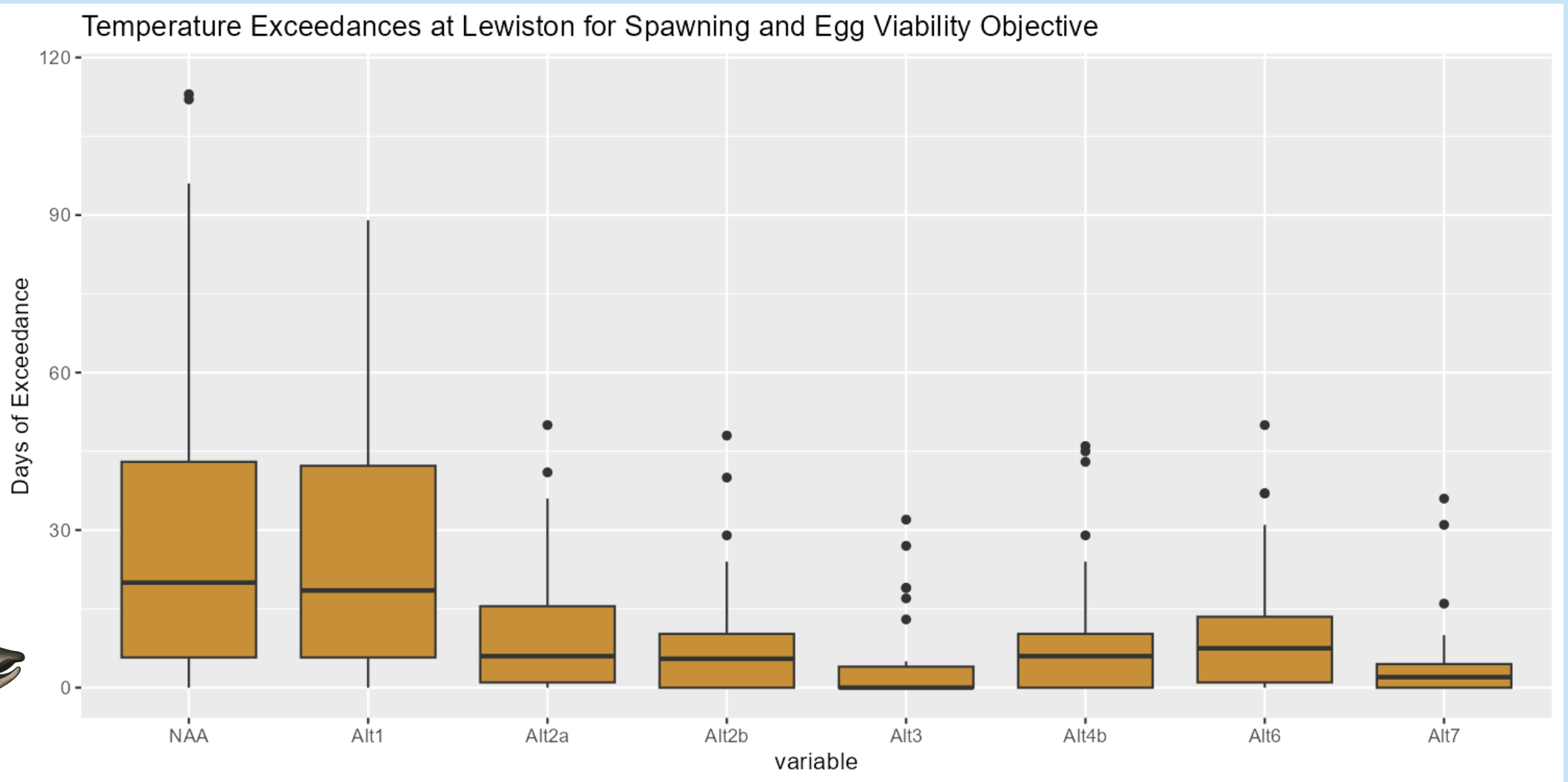




Water Temperatures

(TRRP TRAL target exceedance)

Temperature modeling without SOD not available.





Effects of the No Action Alternative

- Achieves minimal geomorphic function for channel maintenance
- Misses timing for synchronizing with watershed hydraulics
- Misses timing for inundation to benefit salmonid habitat and food webs
- Decent for juvenile temperatures in many years (but not all)



Summary Relative to NAA

Degradation from NAA, or just little improvement

- Alt 1 – almost universally the lowest ranked
- Alt 6 – minimal temperature improvement, otherwise poor performance
- Alt 3 – generally poor, but intriguingly reliable inundation
 - *Something to think about for AM*

Strong improvement over NAA

- Alt 2 (a and b) best overall performance
 - a versus b? Each has benefits.
AM hybrid?
- Alt 4 not quite as good as Alt 2
- Alt 7 great geomorph, great inundation, weak for some temperature metrics.