

A photograph of a rocky shoreline with plastic waste. The foreground is filled with dark, wet rocks and pebbles. In the background, a large, dark, mossy log or rock formation sits in the water. The water is calm, reflecting the light. The overall scene suggests environmental pollution in a natural setting.

TRRP Limiting Factors Analysis

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Recap and Discussion Points

Pinnix et al. 2022 (Outmigrant Synthesis)

Gaugh et al. 2024 (Spawner Synthesis)

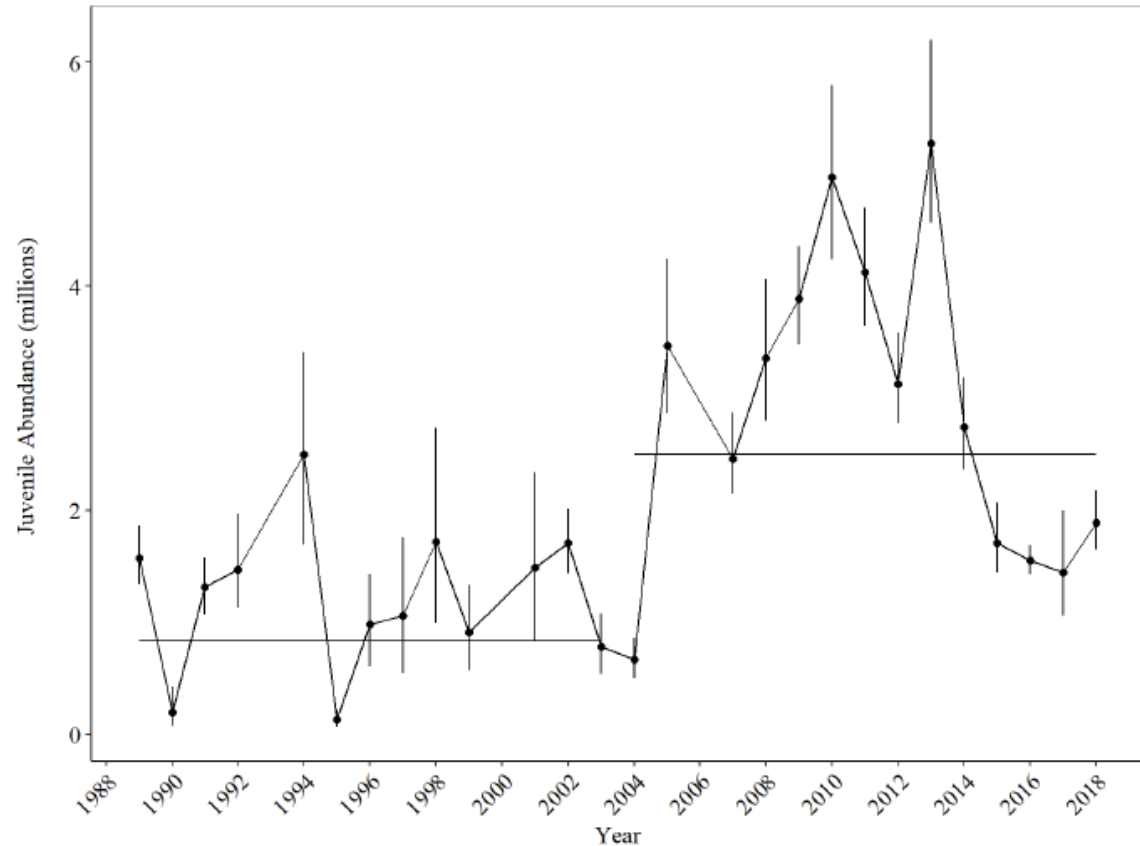


Figure 4. Juvenile Chinook Salmon abundance (in millions) at the Willow Creek trap site from 1989-2018. Horizontal lines indicate mean juvenile abundance (in millions) prior to and following the identified change point of 2004. Error bars indicate 95% credible intervals around juvenile abundance estimates.

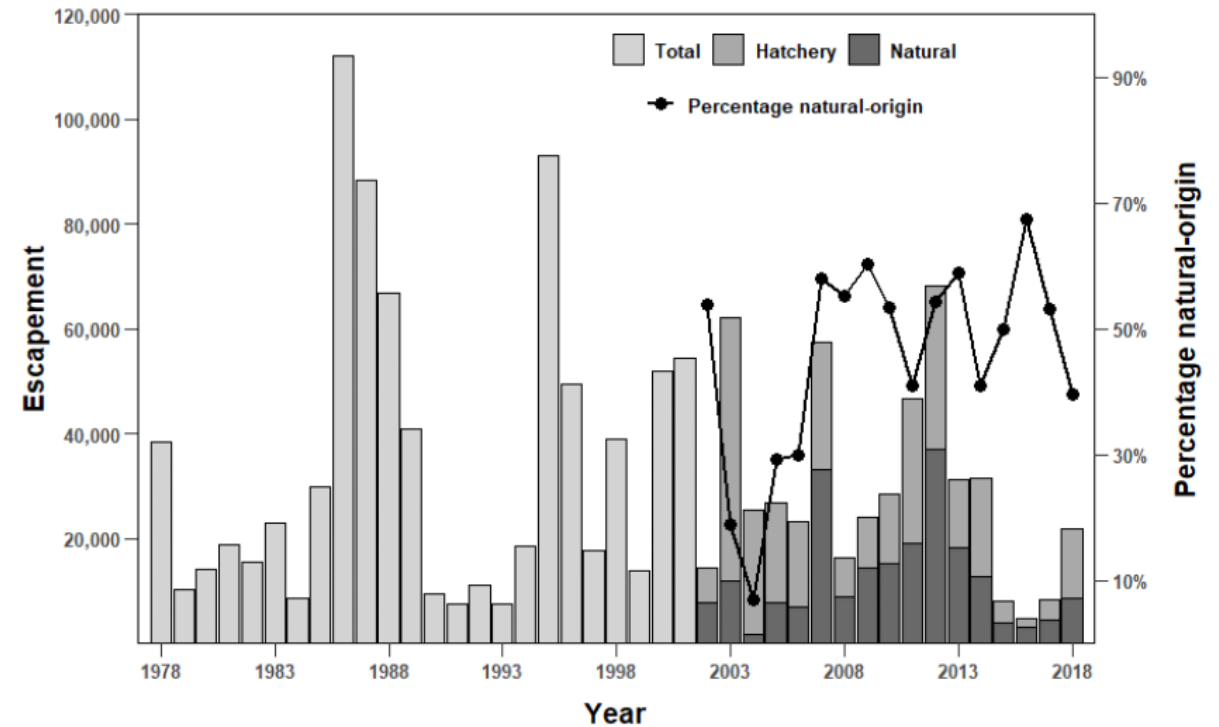


Figure 2. Time series of fall-run Chinook Salmon returning to natural spawning grounds and Trinity River Hatchery from 1978 to 2018. Natural- and hatchery-origin fish were not estimated separately before 2002, so only total escapements are provided for those years.

Pinnix et al. 2022 (Outmigrant Synthesis)

Thomas Gast Assoc. 202_ (Outmigrant Timing Synthesis)

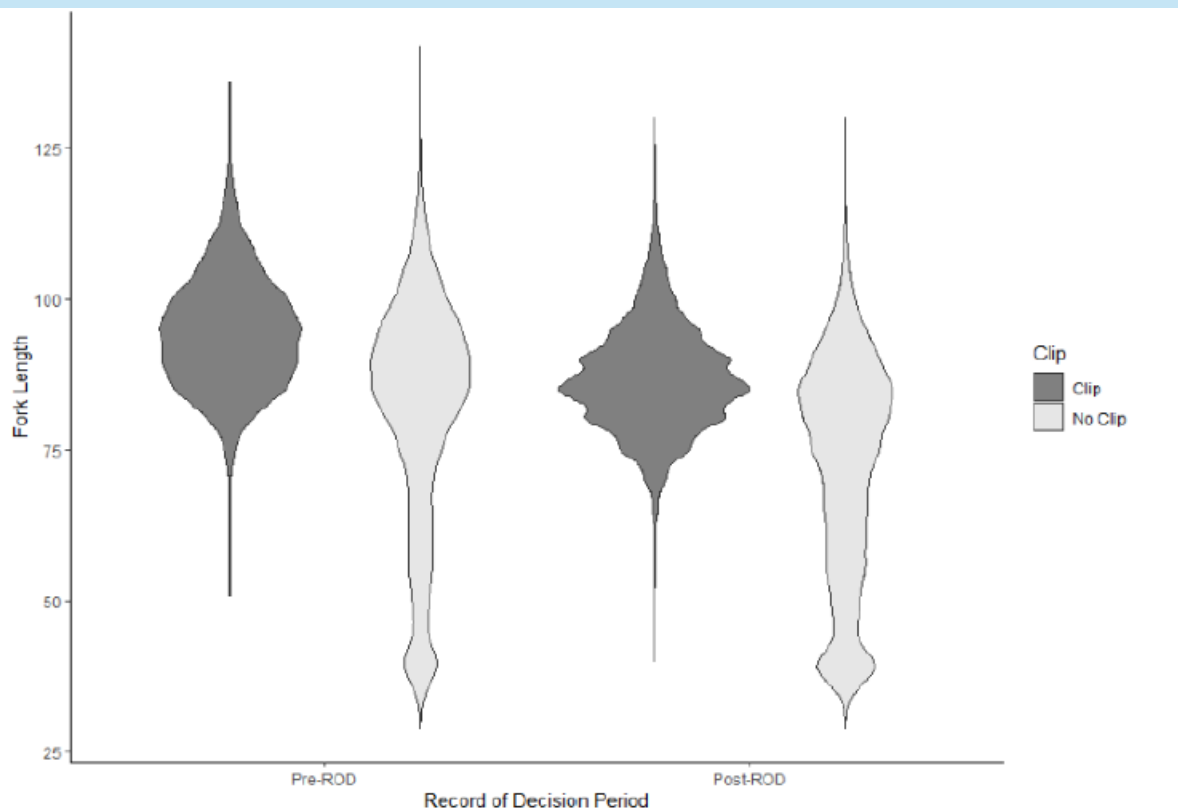


Figure 11. Violin plots of juvenile Chinook Salmon fork length (FL, mm) for adipose fin clipped hatchery fish (Clip) and non-adipose fin clipped fish (No Clip), which may be natural or hatchery origin, for both pre- Record of Decision (ROD, 1993-2003) and post-ROD (2004-2018) periods.

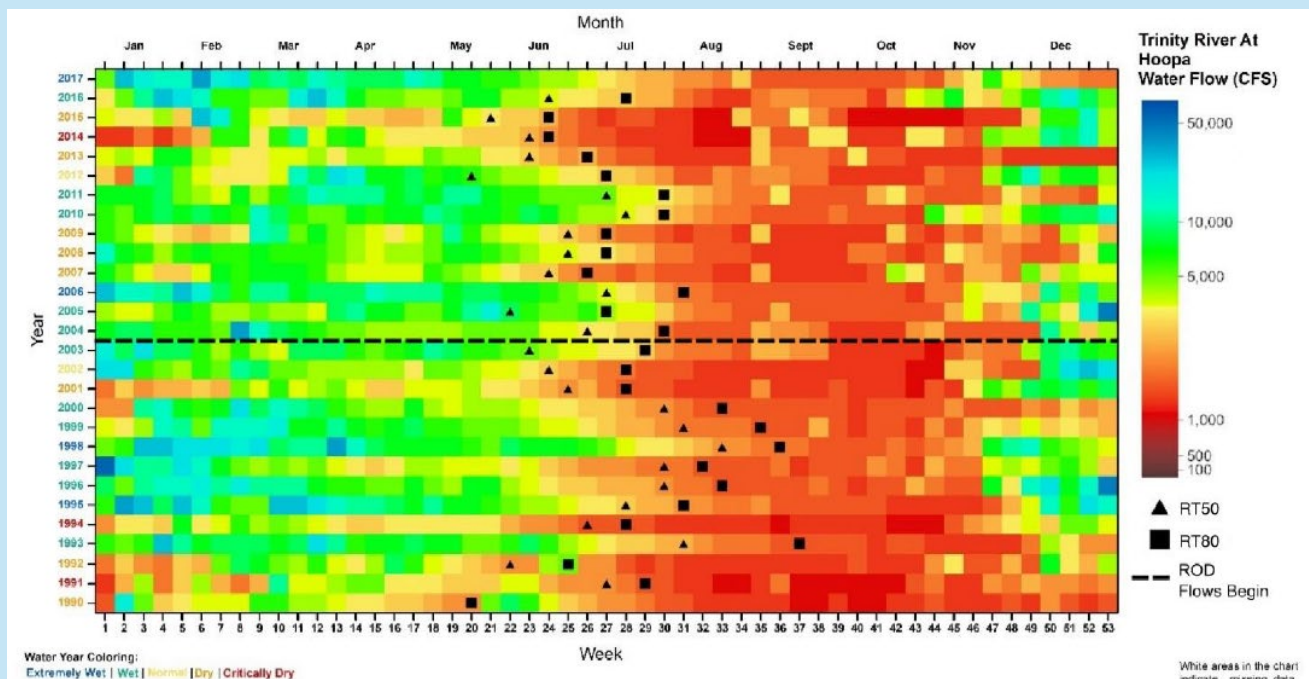
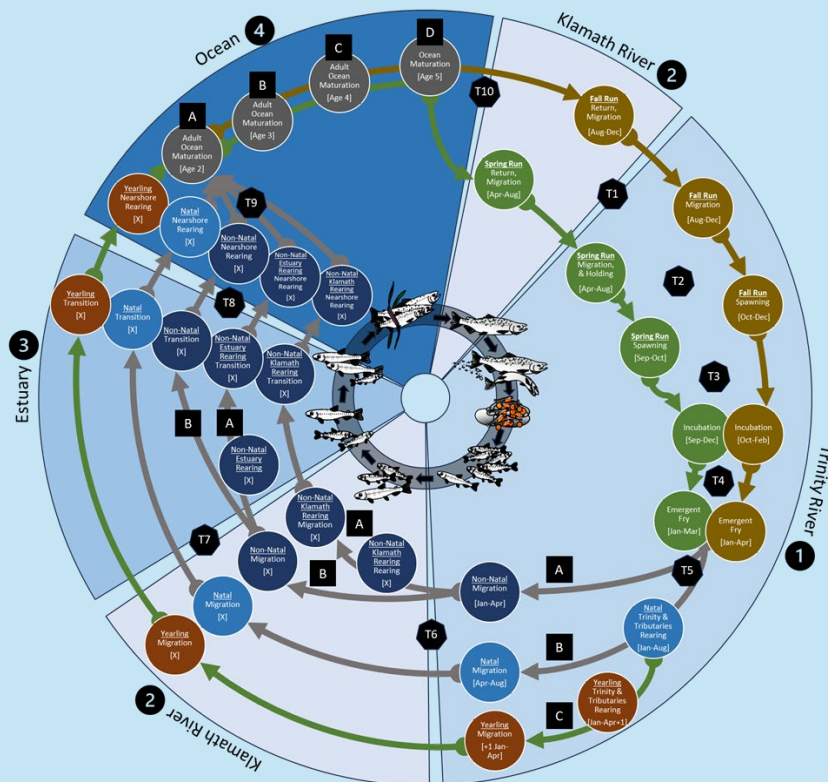


Figure 3. River flow at Hoopa, USGS Gage 11530000, 1990-2017. The year labels are colored to show water year types.

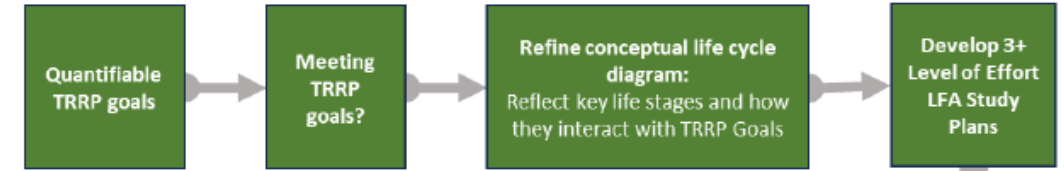
Cramer Fish Sciences (CFS) Study Plan

- Life Cycle Model (LCM)

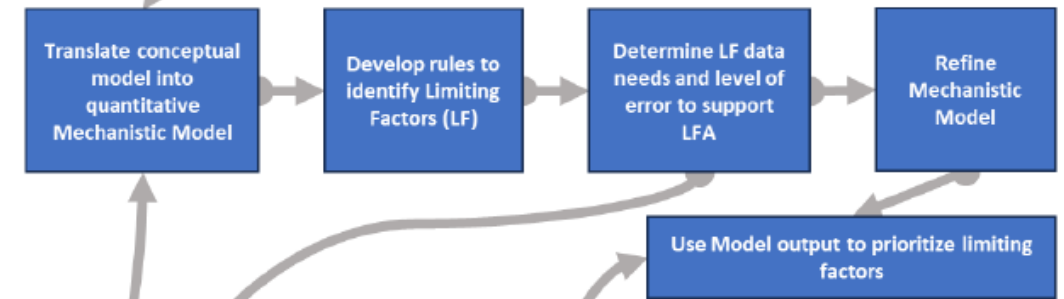


TRRP
Adaptive Management

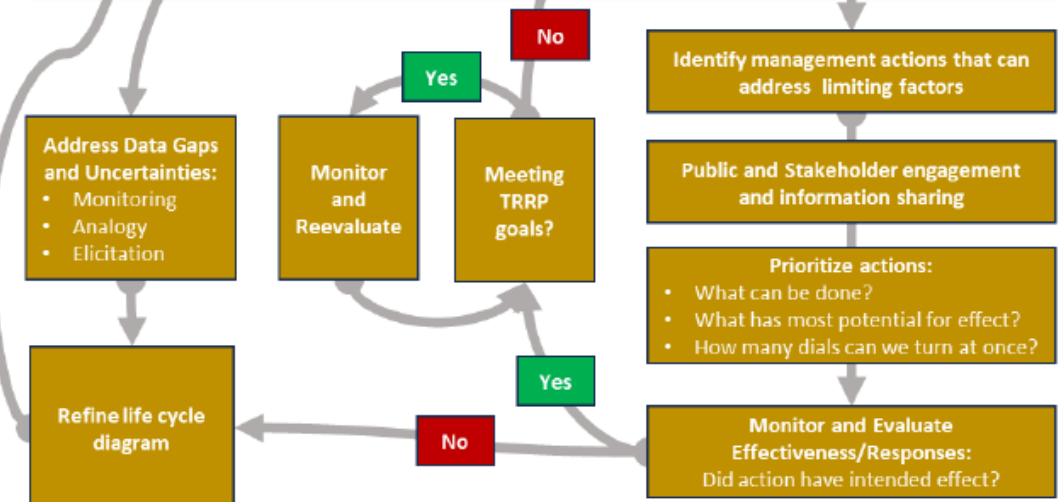
Phase 1: Draft LFA Study Plans



Phase 2: Select and Conduct LFA



Phase 3: Application and Adaptive Management





Conducting the LFA

CFS and Trinity Advisory Group (TAG)

- Per contract, TAG up to 10 advisors
 - IDT core members (8)
 - Ken Lindke standing in for the State
 - Kurt Fausch representing the SAB
 - Scott McBain
- Numerous rounds of gathering data and perspective from Program scientists (well beyond the TAG)
- Iterative discussions on spatial structure, data interpretation, ...
- Review of Life Cycle Model, including transitions, data sources
- Life Cycle Model workshop (held June 20th)
- Review of draft report (completed July 24th)
- Presentation of final results (Special TMC August 20th)



Limiting Factors Analysis for Trinity River Chinook salmon downstream of Lewiston Dam (*Oncorhynchus tshawytscha*) Using the Hamilton and Murphy Method

Technical Memorandum Prepared for:

Trinity River Restoration Program

Prepared by:

Joseph Merz, Kai Ross, Kiera McNeely, Jason Hall

Cramer Fish Sciences

August 2026

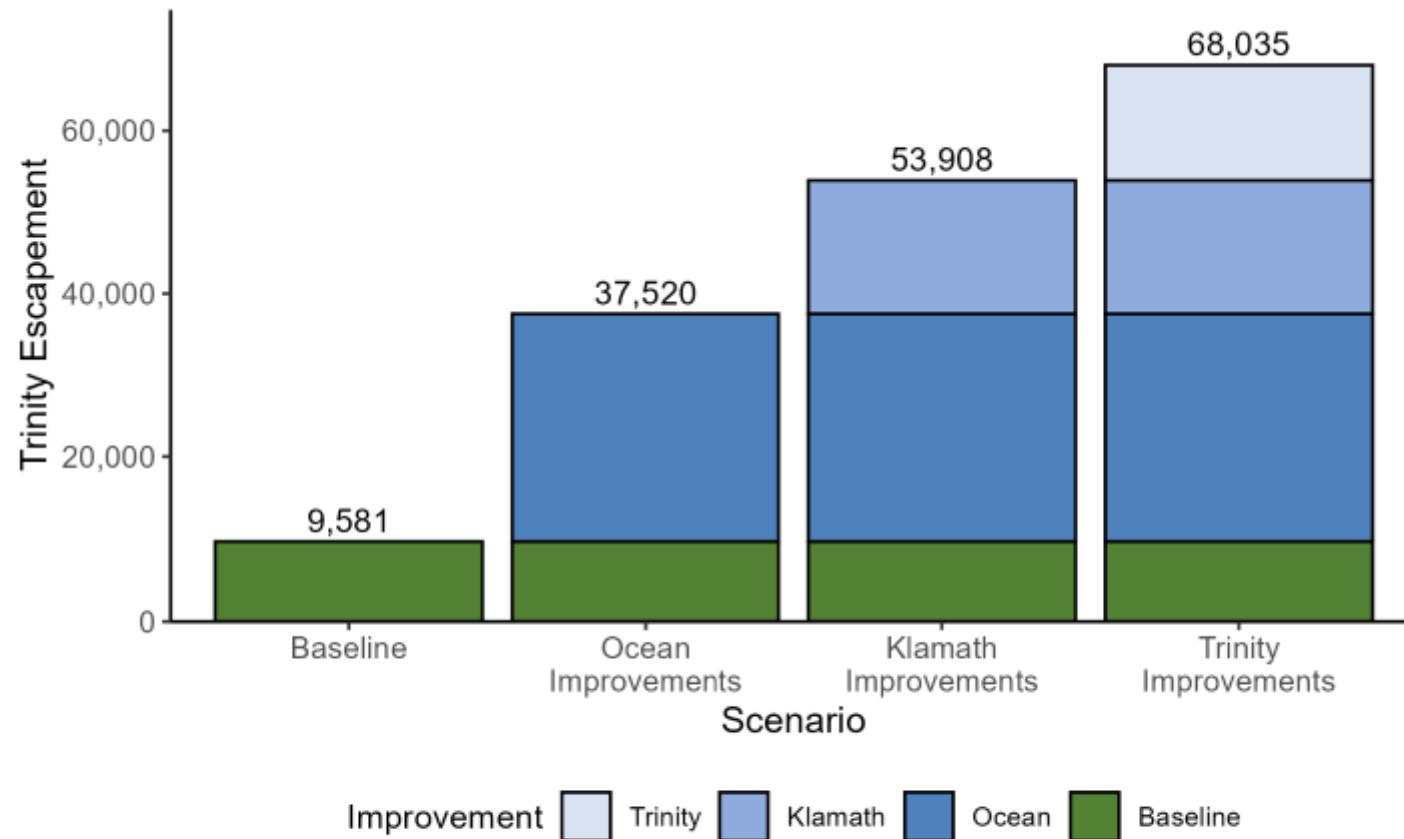


Figure 4. Modeled mean Trinity River pre-spawn adult escapement under nested limiting-factor scenarios. Bars show cumulative changes from baseline conditions (green), ocean improvements (dark blue), Klamath River improvements (blue), and Trinity River improvements (light blue). Baseline escapement represents mean annual pre-spawn escapement across the baseline simulation period.

Table 6. Prioritization of data gaps and uncertainties to inform future monitoring and refinement of the life cycle model and limiting factors analysis. See Table 1 for hypotheses.

Priority Tier	Life Stage	Key Data Gap / Uncertainty	Affected Hypotheses (Table 1)	Why it Matters for LFA Diagnosis	Recommended Action
Tier 1	Juvenile rearing	Empirical rearing capacity, density dependence, growth, survival	H ₉ –H ₁₁	Strongest Trinity-managed lever; current estimates drive model sensitivity but are weakly constrained	Direct field studies + capacity calibration
Tier 1	Outmigration (Trinity–Klamath)	Survival rates, size-selective mortality, migration timing; lack of traps below confluence	H ₁₂ –H ₁₃ , H ₁₈ –H ₁₉	Major uncertainty in where mortality occurs and how size/timing affects survival	Install/expand monitoring (RSTs, tagging)
Tier 1	Estuary & early marine	Trinity-origin identification, survival, growth, residence time	H ₁₂ –H ₁₃ , H ₁₅	Prevents separation of Trinity vs Klamath mortality; limits core systemwide diagnosis	Stock ID methods + estuary survival studies
Tier 2	Juvenile life history	Proportion and survival of naturally produced yearlings (1+ fish)	H ₉ , H ₁₁ , H ₁₇	Limits understanding of life-history diversity and carryover effects	Targeted yearling monitoring + tagging
Tier 2	Incubation & emergence	Spatial distribution of coarse substrate, fine sediment, egg-to-fry survival	H ₅ –H ₈	Drives spawning-to-emergence survival but currently based on coarse assumptions	Reach-scale habitat mapping + survival studies
Tier 2	Cross-stage processes	Carryover effects linking size, timing, and condition across stages	H ₁₆ –H ₁₇	Limits integration of life-cycle dynamics and tradeoffs central to the LFA	Integrated tagging + life-cycle studies
Tier 3	Ocean & harvest	Trinity-specific tag data, stock composition, harvest attribution	H ₁₄ –H ₁₅	Reduces precision in identifying ocean vs harvest effects	Improved stock-specific tagging and modeling
Tier 3	Outmigration conditions	Flow–temperature–disease interactions in Klamath corridor	H ₁₂ , H ₁₅	High variability and episodic mortality not fully resolved	Coordinated basin monitoring + modeling
Tier 4	Spawning	Reach-scale spawning capacity	H ₄	Affects density dependence but only	Habitat surveys + finer-scale





Appendix B

Table 20. Conceptual example of how the weeks of emergence would map to calendar weeks assuming typical peak emergence in March.

Relative Week	Approx. Calendar Timing
-2	late February
-1	early March
0	mid-March
+4	mid-April
+8	mid-May
+12	mid-June
+16	mid-July
+18	late July
+20	early August
+22	mid-August

Appendix B



Table 23. Weekly trajectories of temperature that can be used to simulate different seasonal patterns of temperature in the Trinity River for each model reach. The default or baseline temperature trajectory is T2.

Trajectory Name	Relative Week Range	Dominant Temperature Category	Ecological Interpretation
Cool / Delayed warming (T1)	-2 to -1	<13–16 °C (Cold)	Prolonged cool conditions; strong rearing incentive; delayed migration
	+0 to +9	13–16 °C (Optimal)	Extended optimal growth window
	+10 to +12	17–19 °C (Transitional)	Gradual warming; migration pressure increases late
	+13 to +14	18–20 °C (Warm)	Late-season warming; residual migration tail, limited growth
	+15 to +22	>20 °C (Stress)	Thermal Stress; residual migration tail, limited growth
Nominal / Gradual warming (T2)	-2 to -1	<13–16 °C	Typical emergence under cool to optimal conditions
	0 to +9	13–16 °C	Extended optimal growth and rearing window
	+10 to +12	17–18 °C	Transitional warming; mixed rearing and migration
	+13 to +14	18–20 °C	Increasing thermal stress; sustained outmigration
	+15 to +22	>20 °C	Late-season warm conditions; migration favored, limited growth
Rapid warming / Early stress (T3)	-2 to +1	13–16 °C	Short optimal window post-emergence
	+2 to +4	17–18 °C → 18–20 °C	Rapid loss of growth benefit
	+5 to +22	>20 °C	Strong thermal stress; compressed migration window

Appendix E

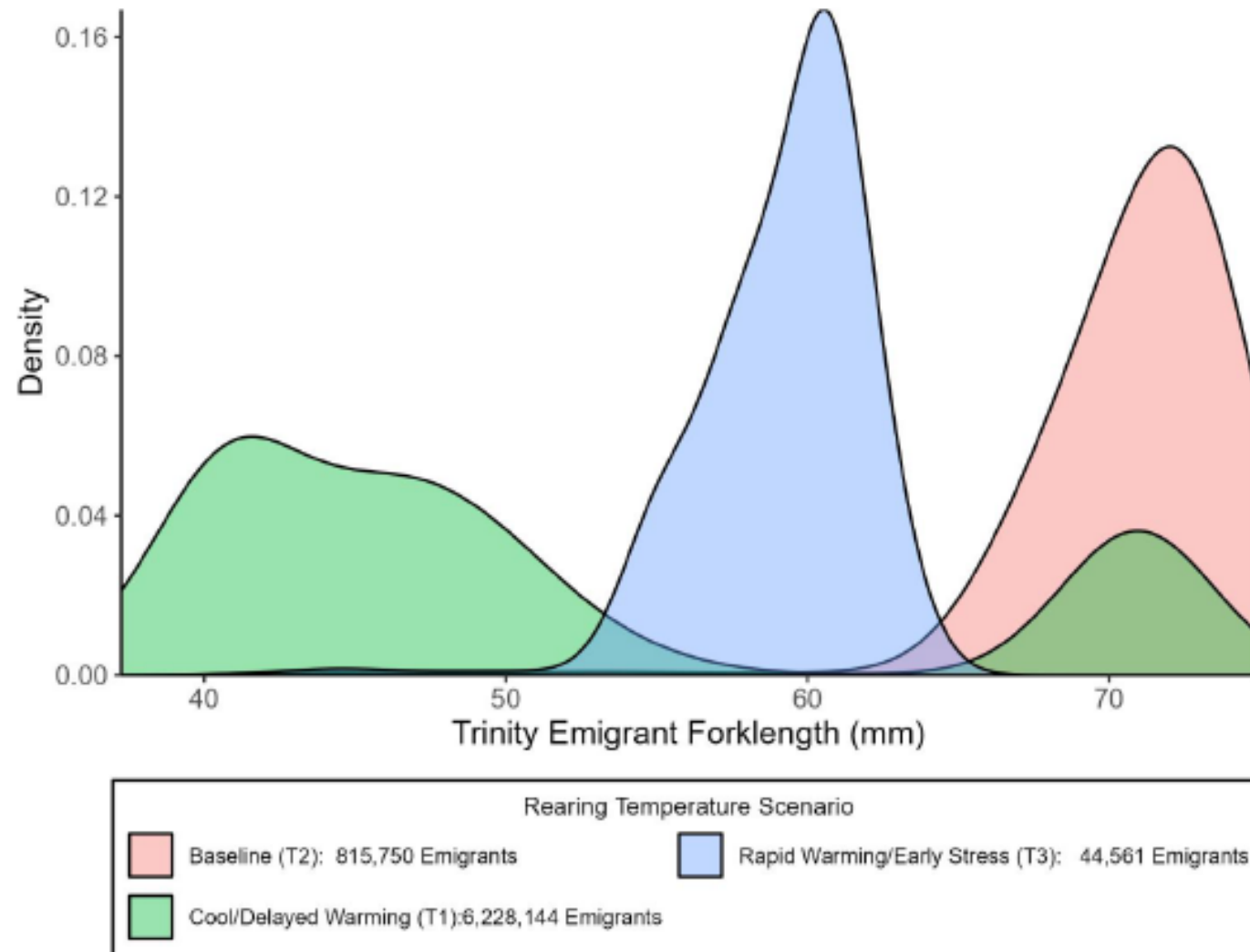


Figure 39. Density distribution of Trinity River Chinook emigrant size under three rearing temperature scenarios. Scenarios vary the timing and duration of cold, optimal, transitional, warm, and stress temperature conditions throughout the rearing season, each affecting juvenile growth and survival rates. The baseline scenario includes 10 weeks of optimal temperatures followed by periods of transitional, warm, and stress conditions. The cooler scenario (T1) extends cold and optimal periods, while the warmer scenario (T3) reduces optimal conditions to 4 weeks with 18 weeks of stress temperatures. All other model parameters were held constant.

Appendix E

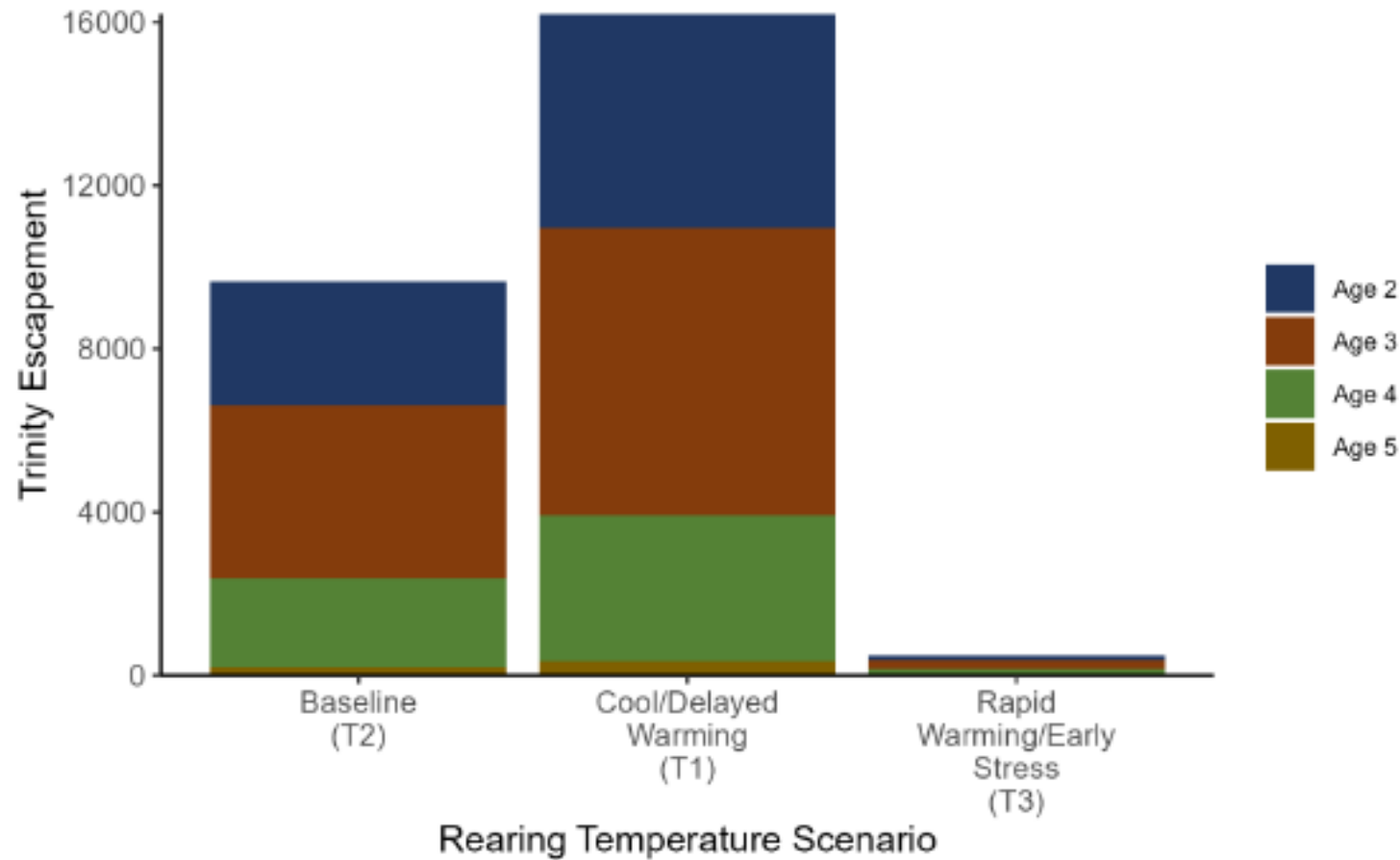


Figure 37. Ten-year average (simulation years 90–100) of modeled Trinity River Chinook escapement under three rearing temperature scenarios. Scenarios vary the timing and duration of cold, optimal, transitional, warm, and stress temperature conditions throughout the rearing season, each affecting juvenile growth and survival rates. The baseline scenario includes 10 weeks of optimal temperatures followed by periods of transitional, warm, and stress conditions. The cooler scenario (T1) extends cold and optimal periods, while the warmer scenario (T3) reduces optimal conditions to 4 weeks with 18 weeks of stress temperatures. All other model parameters were held constant.

Appendix E

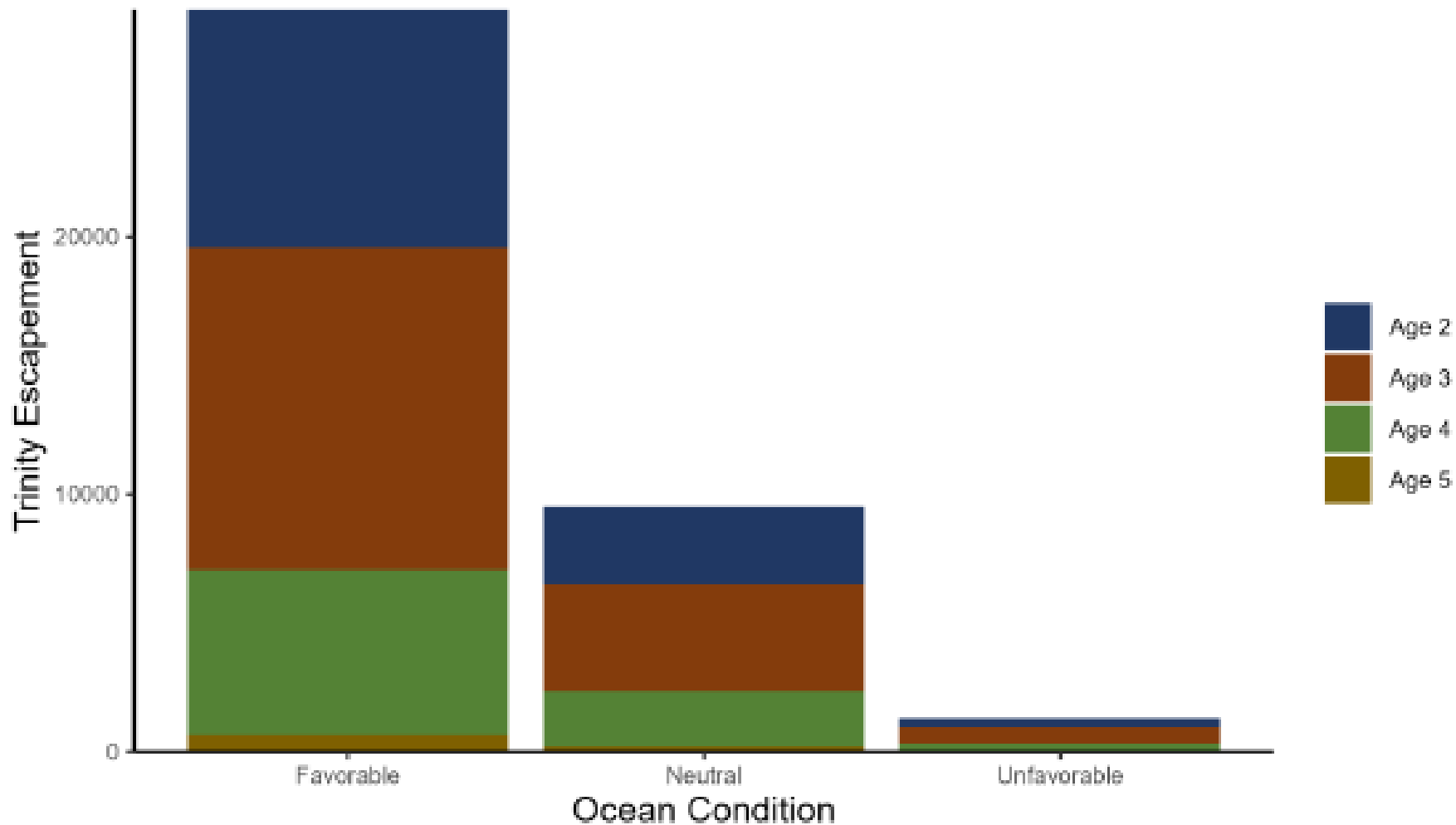


Figure 55. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under three ocean condition scenarios. Baseline ocean condition is Favorable. Ocean condition affects ocean entry survival regardless of entry timing and size. All other model parameters were held constant.

Appendix E



Ocean maturation and survival

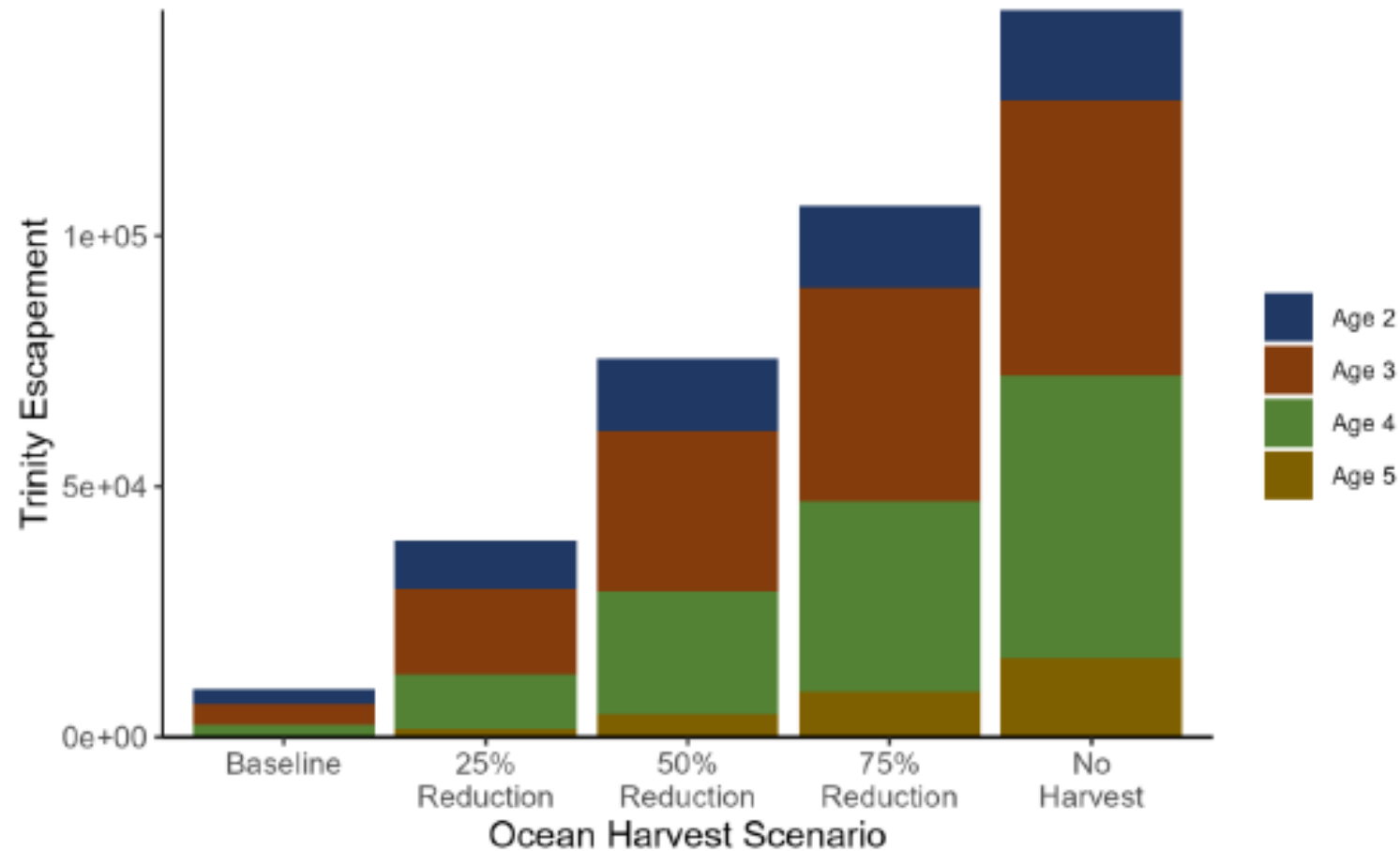
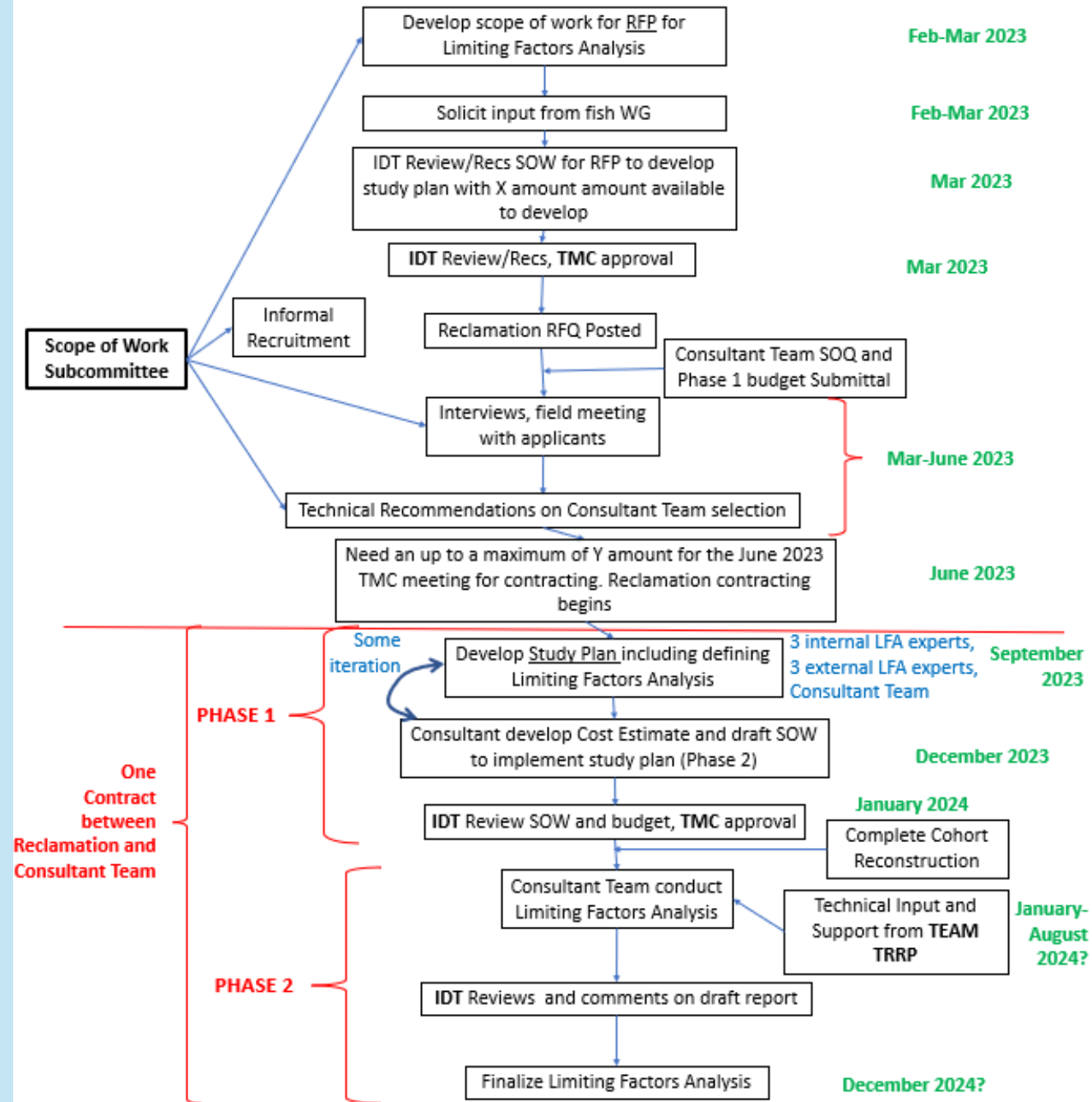


Figure 53. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five ocean harvest scenarios. Baseline harvest is then reduced by 25, 50, 75, and 100% for the other scenarios. All other model parameters were held constant. The baseline ocean harvest for each age class is as follows: Age 2 is 50%, Age 3 is 55%, Age 4 is 50%, and Age 5 is 65%. These are then reduced by 25, 50, 75, and 100 percent.

IDT Planning (early 2023)

Phase 1 (LFA study plan)
Phase 2 (conducting analysis)
→ separate contracts





FY24 Executive Director's Budget Narrative

26 May 2023

FY23 spend-out priorities for surplus funds

A variety of developments have led to an unanticipated surplus of funds this year, though the exact [...]

I propose that the following priorities be approved for allocation of residual FY23 funds:

Limiting Factors Analysis

The Science Plan identified this as a major priority for the program. Understanding why increases in juvenile Chinook production is not resulting in increased adult returns is essential to our ability to adaptively manage our restoration tools in a way that will result in success. The tentative vehicle for funding this task will be a modification to our existing grant with NFWF, who will in turn issue a Request for Proposals to execute the Performance Work Statement (PWS) that has been developed by the Fish WG and IDT. If the PWS and grant modification are completed this year, this should be our highest priority for FY23 funds.

Opportunity for Phase 1

- NFWF for Bid Request
- CFS Responded