APPENDIX E. EXPANDED LFA RESULTS

This appendix supports the Limiting Factors Analysis for Lower Trinity River Chinook salmon (*Oncorhynchus tshawytscha*) prepared for the Trinity River Restoration Program. It provides model output figures from the Trinity River Chinook life-cycle model and limiting factors analysis developed for this project. Figures are organized by the life-stage blocks used in Section 9 of the main report.

Table 1. Test-level synopsis of the 27 diagnostic tests. Class: P = primary, C = compounding, N = non-limiting. Control: In = directly manageable by the Trinity River Restoration Program, Partial = influenceable but not controllable, External = mostly outside Trinity management. Basis: D = data/model-driven, EI = relied substantially on expert interpretation or assumption.

Life Stage	Test	Finding	Class	Control	Conf.	Figure Number (Appx. E)
Adult immigration	Adult Imm. T1	Improved Klamath–Trinity immigration and routing survival increased escapement but did not achieve the recovery target alone.	C	Partial	Med.	1-2
Adult immigration	Adult Imm. T2	Spring-run holding habitat was non-limiting under current conditions; effects appeared mainly under no-harvest or higher-escapement scenarios.	N	In	Low–Med.	3-4
Adult immigration	Adult Imm. T3	Spawning capacity was compounding and became more limiting under large reductions; hatchery-origin spawner allocation had small effects.	C	In	Med.	5-11
Adult immigration	Adult Imm. T4	Best-plausible immigration improved escapement but did not meet the target; rearing capacity was the most sensitive Trinity-managed capacity.	C	In/Partial	Med.	12-15
Spawning	Spawning T1	Mirrors Adult Imm. T1: improved migration survival increased returns but did not resolve the spawner shortfall.	C	Partial	Med.	1-2
Spawning	Spawning T2	Mirrors Adult Imm. T2: spring-run holding habitat did not constrain total adult escapement under current conditions.	N	In	Low–Med.	3-4
Spawning	Spawning T3	Mirrors Adult Imm. T3: spawning capacity was compounding and could become primary under large reductions.	C	In	Med.	5-11
Spawning	Spawning T4	Mirrors Adult Imm. T4: remaining limitation shifted toward Trinity-managed habitat, especially rearing capacity.	C	In/Partial	Med.	12-15
Incubation	Incub. T1	Best combined incubation survival increased fry production and	C	In	Med.	16-17

Life Stage	Test	Finding	Class	Control	Conf.	Figure Number (Appx. E)
		escapement but did not reach the recovery target alone.				
Incubation	Incub. T2	Coarse gravel became limiting by reducing female redd-construction success; interpretation is limited by reach-scale substrate data gaps.	C	In/Partial	Low–Med.	18-19
Incubation	Incub. T3	Fine sediment had little effect at moderate levels but substantially reduced escapement at high to extreme levels.	C	In/Partial	Low–Med.	20-21
Incubation	Incub. T4	Hydrologic disturbance was non-limiting under stable to minor conditions but episodic under moderate to extreme disturbance.	N/epis.	Partial	Med.	22
Incubation	Incub. T5	Maternal thiamine deficiency was generally non-limiting except under moderate to severe deficiency.	N/epis.	External	Low–Med.	23-26
Incubation	Incub. T6	Best plausible incubation increased juvenile outmigrant abundance and escapement but remained insufficient to reach the target alone.	C	In	Med.	27-29
Rearing	Rearing T1	Rearing capacity controlled emigration timing and size; large capacity reductions substantially reduced escapement.	C	In	Med–High	30-36
Rearing	Rearing T2	Sustained early food increased escapement but did not reach the target; shorter food-limited periods had little effect.	C	In/Partial	Med.	37-38
Rearing	Rearing T3	Cool or optimal temperatures improved production; rapid warming reduced escapement and highlighted size-survival tradeoffs.	C	In/Partial	Med.	39-41
Rearing	Rearing T4	Baseline Trinity production exceeded targets when downstream and ocean survival were favorable, indicating primary systemwide downstream and marine constraints rather than insufficient Trinity production alone.	P	Partial/Ext.	Med–High	42-43
Rearing	Rearing T5	Hatchery release timing changed natural-origin migrant size distribution but had little effect on long-term escapement.	N	In	Low	44-46
Rearing	Rearing T6	Flow and habitat can influence emigration size and timing, which can influence downstream survival and escapement.	C	In	Low	47-50
Outmigration	Outmig. T1	Large losses occurred from the Trinity through Klamath, estuary, and	C/P	Partial	Med.	51-52

Life Stage	Test	Finding	Class	Control	Conf.	Figure Number (Appx. E)
		ocean entry; larger fish survived better.				
Outmigration	Outmig. T2	Klamath flow, temperature, and disease scenarios produced wide escapement differences and strong episodic effects.	C/epis.	Partial	Med.	53-54
Outmigration	Outmig. T3	Test whether increased Trinity production can offset downstream mortality under limiting conditions (Untestable with final model structure).	N/A	N/A	N/A	N/A
Ocean	Ocean T1	Ocean harvest was primary; reducing ocean harvest produced large escapement increases and could exceed the target.	P	External	Med–High	55-56
Ocean	Ocean T2	Favorable early marine and ocean-entry conditions substantially increased escapement; highest-probability systemwide factor.	P	External	High	57-58
Ocean	Ocean T3	Freshwater production to ocean entry showed major attrition, especially through the Klamath corridor, with strong size-dependent survival.	C/P	Partial	Med.	59-60
Ocean	Ocean T4	Nested limiting-factor scenario shows that coordinated improvements across ocean, Klamath River, and Trinity River conditions increased modeled escapement from baseline to 68,035 adults.	P/C	Mixed	Med.	61

Adult immigration and holding

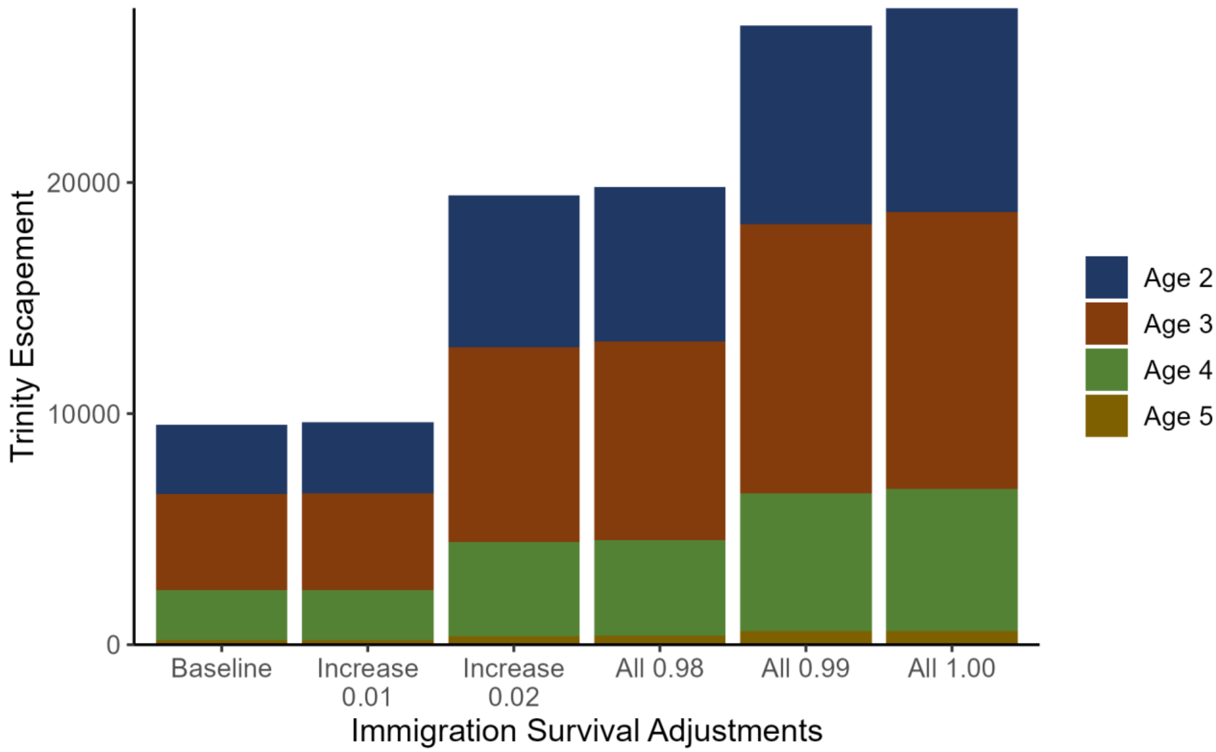

Figure 1. Ten-year average modeled Trinity River Chinook escapement under six immigration survival scenarios for simulation years 40–50. Scenarios adjusted Klamath and Trinity immigration survival for spring and fall runs, holding habitat survival, and straying from the Trinity River to the Klamath River. Baseline survival values ranged from 0.95 to 0.98; other scenarios increased survival by 0.01 or 0.02 increments or set all values to 0.98, 0.99, or 1.00. All other model parameters were held constant.

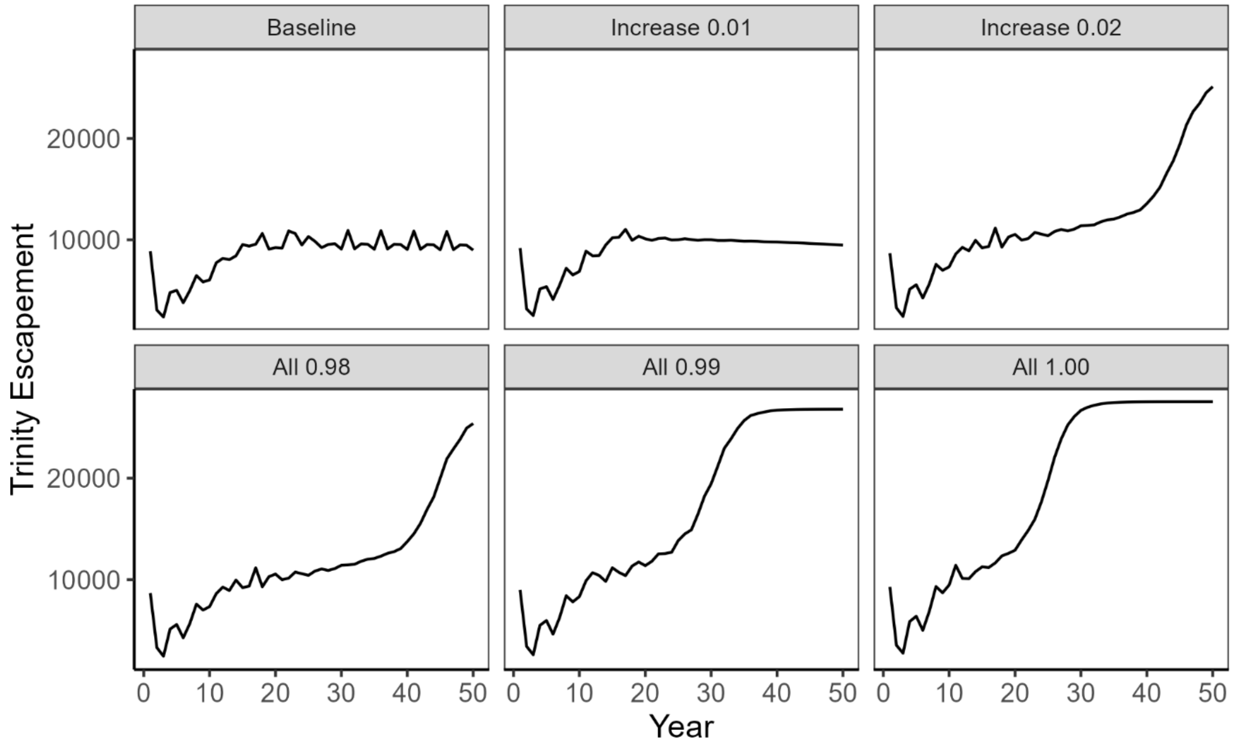

Figure 1. Time series of modeled Trinity River Chinook escapement under six immigration survival scenarios. Scenarios adjusted Klamath immigration survival (spring and fall runs), Trinity immigration survival (spring and fall runs), holding habitat survival, and straying rate from the Trinity to the Klamath. Baseline survivals ranged from 0.95–0.98 across parameters; subsequent scenarios incrementally increased all survivals by 0.01 and 0.02, or set all survivals to a uniform 0.98, 0.99, or 1.00. All other model parameters were held constant.

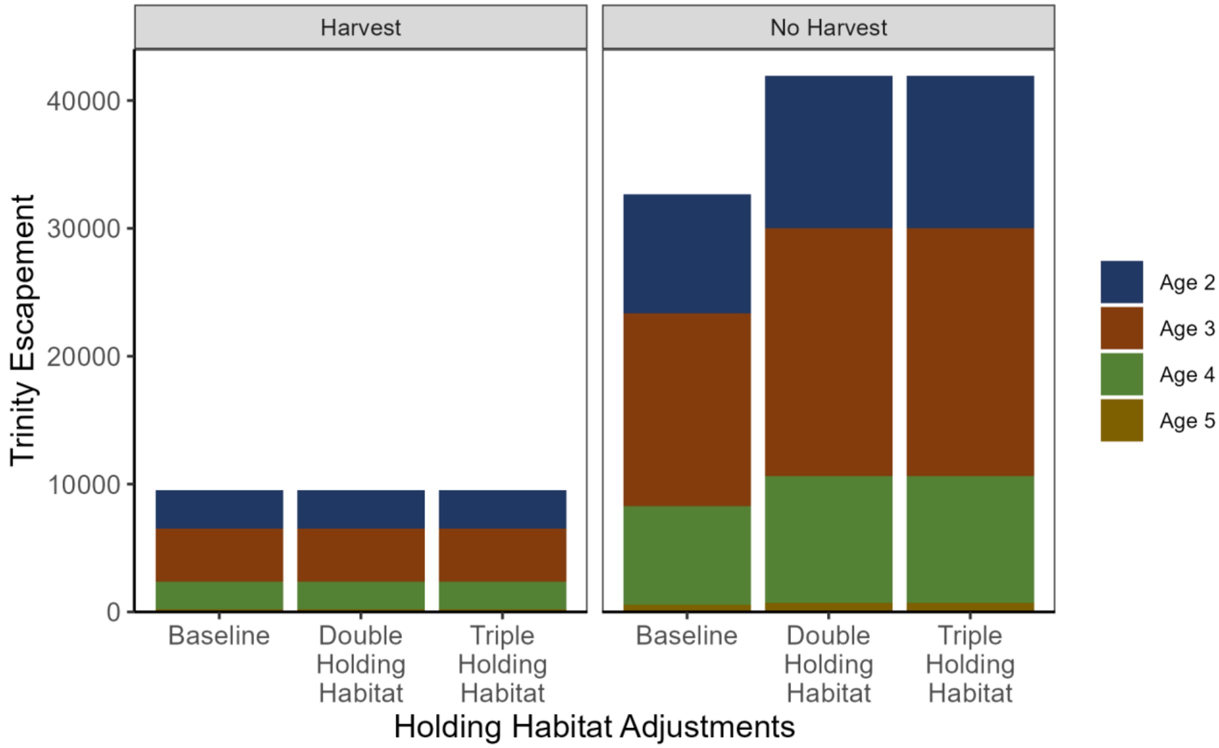

Figure 3. Ten-year average modeled Trinity River Chinook escapement under six holding habitat capacity scenarios for simulation years 40–50, with and without in-river harvest. Baseline holding habitat supports 10,000 adults; alternative scenarios double or triple holding capacity. Each scenario was run with baseline in-river harvest rates and with in-river harvest set to zero. All other model parameters were held constant.

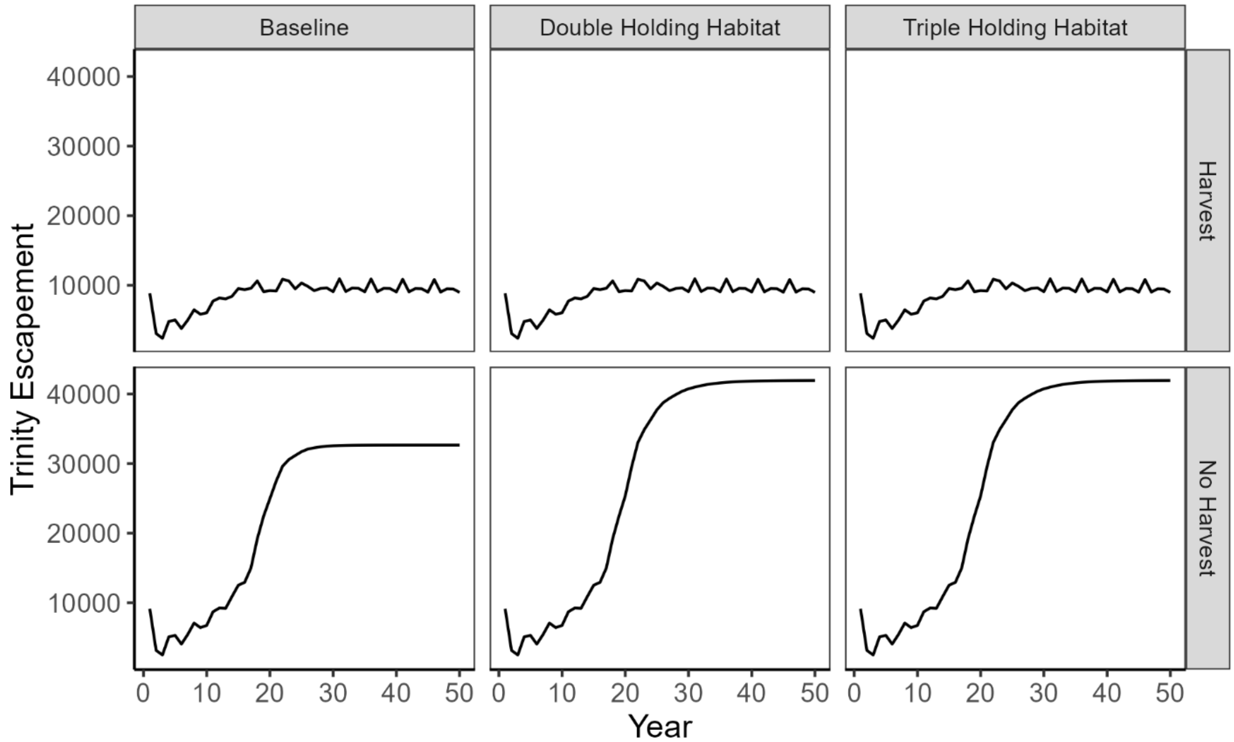

Figure 2. Time series of modeled Trinity River Chinook escapement under six holding habitat capacity scenarios, with and without in-river harvest. Baseline holding habitat supports 10,000 adults; scenarios double and triple the number of adults the holding habitat can support. Two versions of these scenarios were run; one includes baseline in-river harvest rates, and the other sets in-river harvest to zero. All other model parameters were held constant.

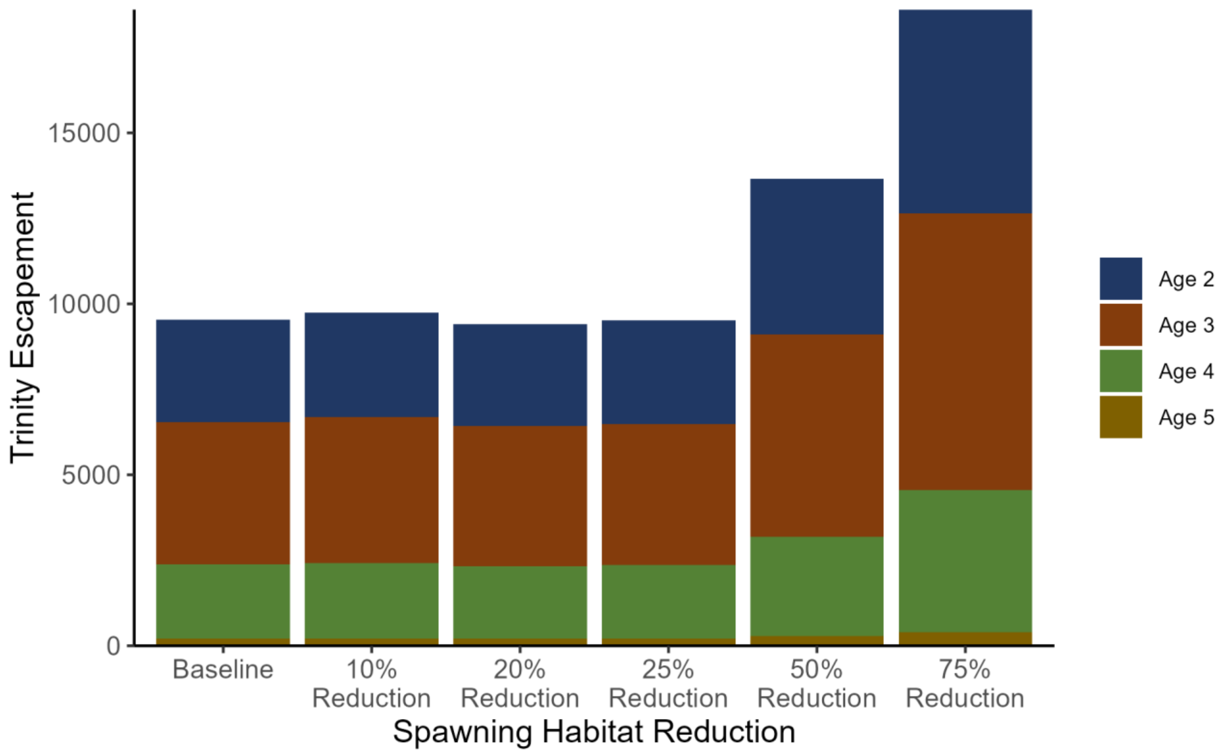

Figure 3. Ten-year average (simulation years 40-50) of modeled Trinity River Chinook escapement under six spawning habitat capacity scenarios. Baseline spawning habitat consists of 350,000m2 with 10% of the habitat in model reach 1, 40% in model reach 2, and 50% in model reach 3. Scenarios reduce the total amount of spawning habitat by 10, 20, 25, 50, and 75 percent. All other model parameters were held constant.

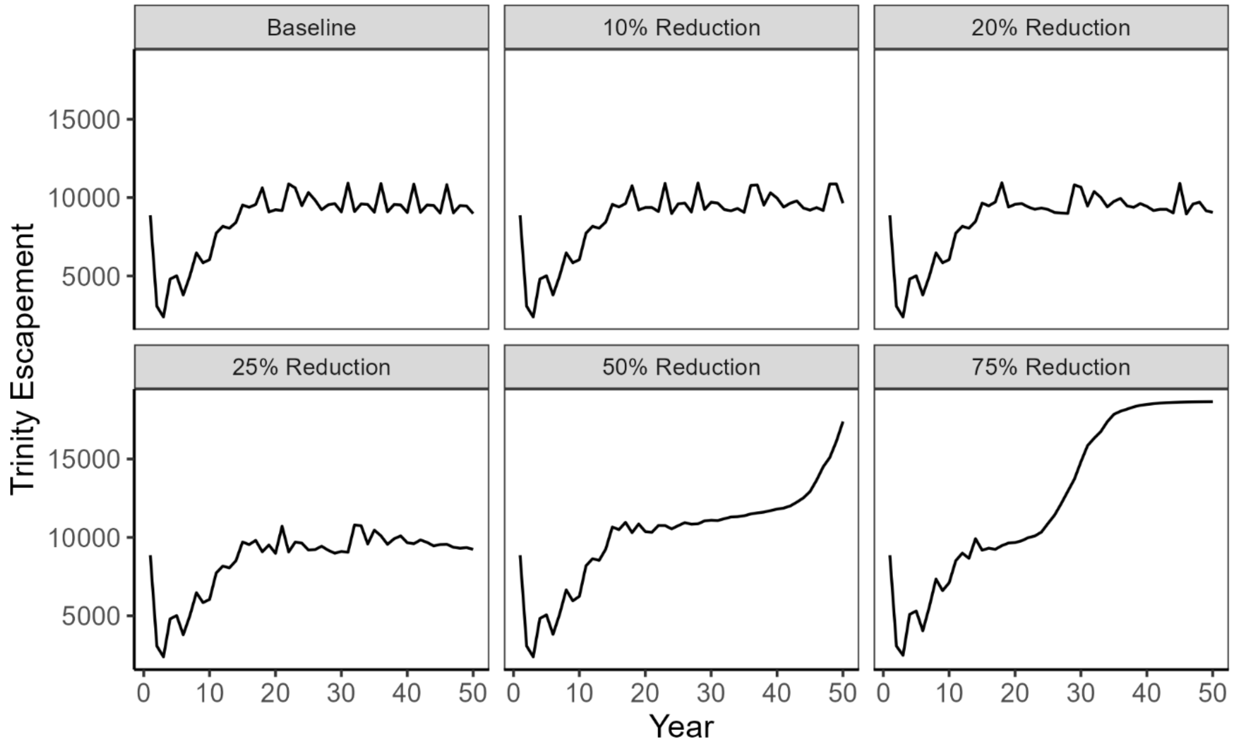

Figure 4. Time series of modeled Trinity River Chinook escapement under six spawning habitat capacity scenarios. Baseline spawning habitat consists of 350,000m2 with 10% of the habitat in model reach 1, 40% in model reach 2, and 50% in model reach 3. Scenarios reduce the total amount of spawning habitat by 10, 20, 25, 50, and 75 percent. All other model parameters were held constant.

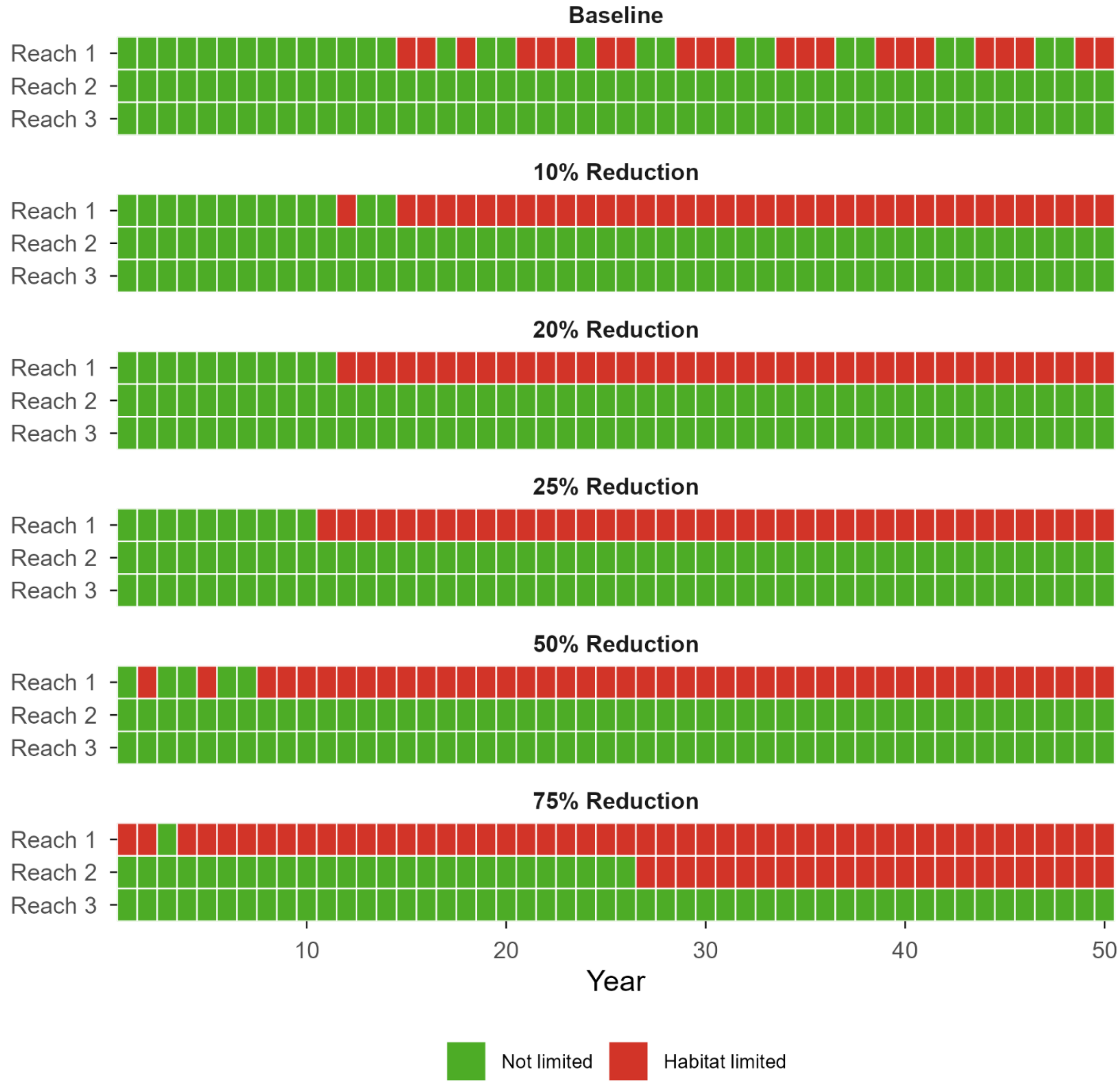

Figure 5. Spawning habitat limitation by year and reach under six spawning habitat capacity scenarios. Baseline spawning habitat consists of 350,000 m² with 10% in Reach 1, 40% in Reach 2, and 50% in Reach 3. Scenarios reduce total spawning habitat by 10%, 20%, 25%, 50%, and 75% relative to baseline. Green indicates habitat is not limiting and red indicates habitat is limiting for a given year and reach. All other model parameters were held constant.

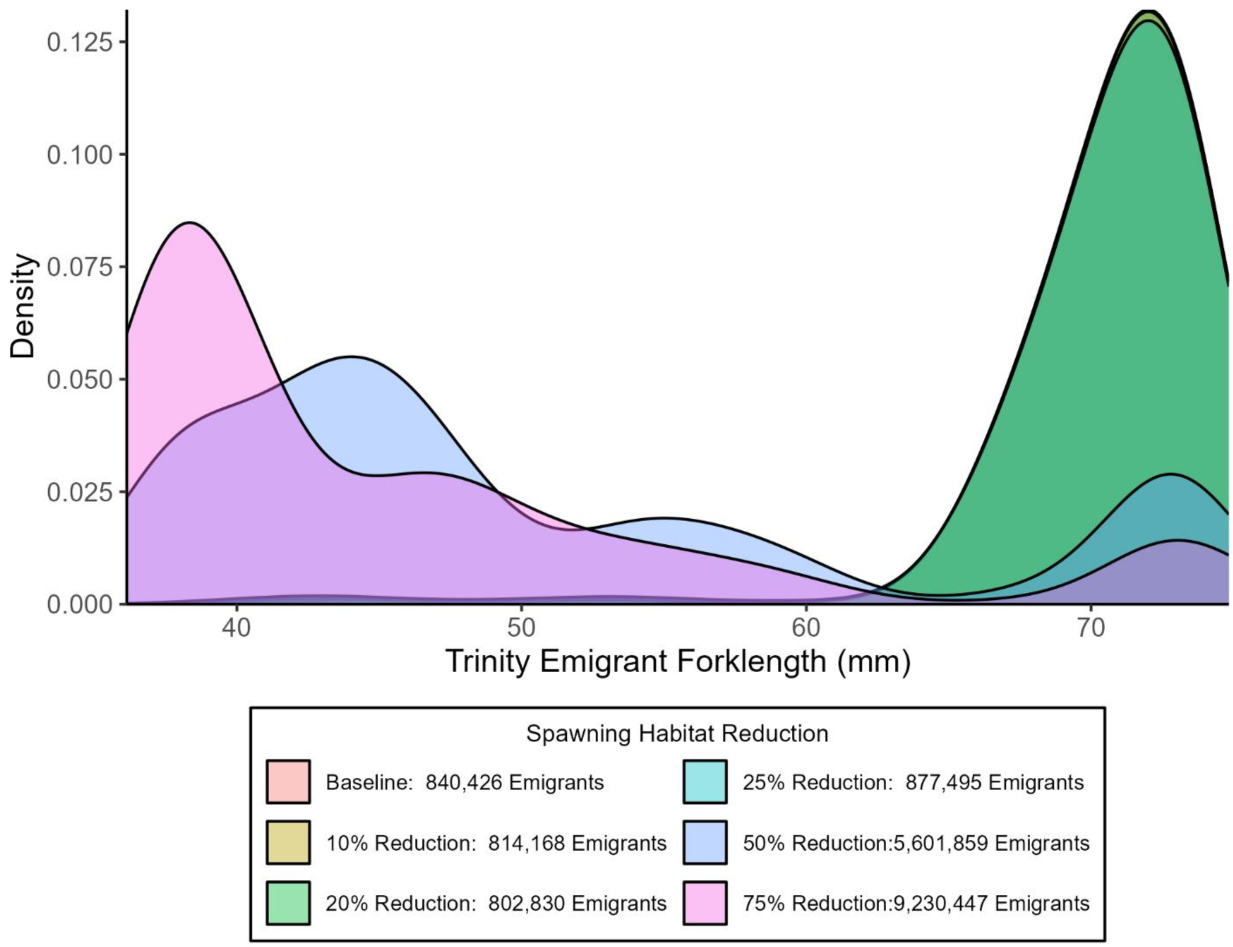

Figure 6. Density distribution of Trinity River Chinook emigrant size under six spawning habitat capacity scenarios for the final simulation year. Baseline spawning habitat consists of 350,000 m² with 10% in Reach 1, 40% in Reach 2, and 50% in Reach 3. Scenarios reduce total spawning habitat by 10%, 20%, 25%, 50%, and 75% relative to baseline. Total emigrating fish per scenario are shown in the legend. All other model parameters were held constant.

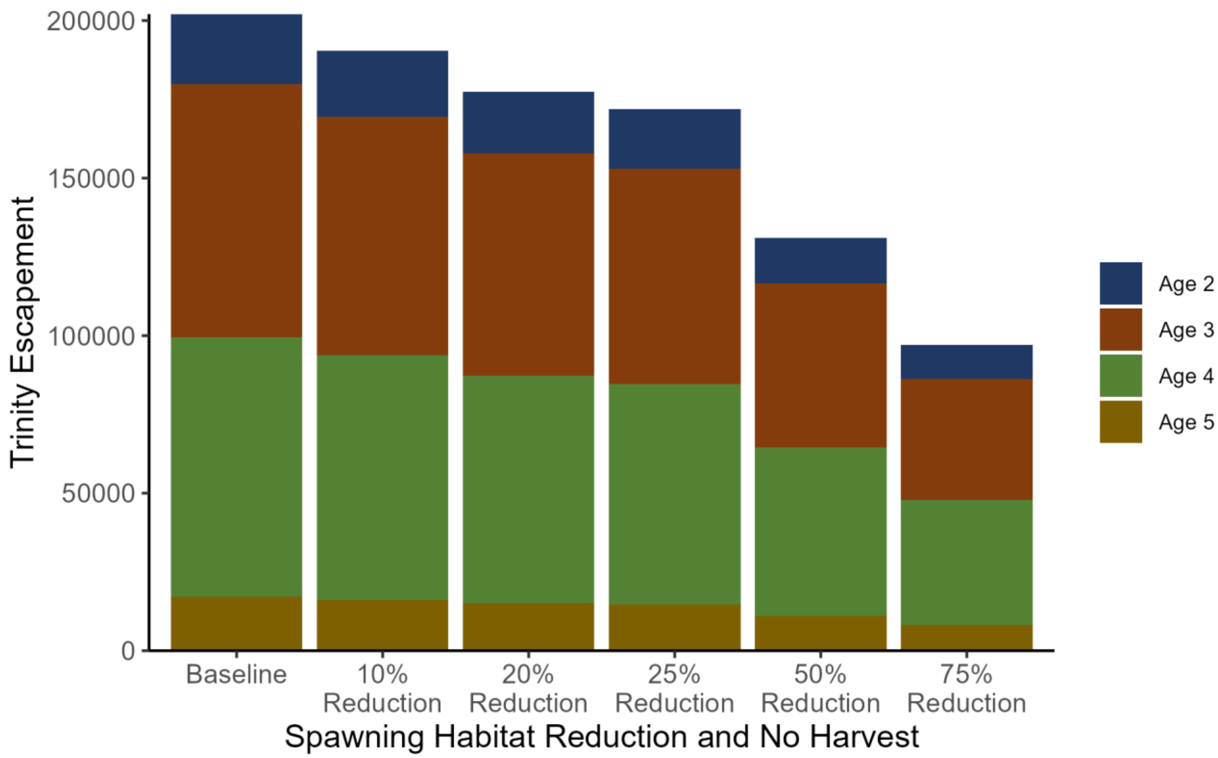

Figure 7. Ten-year average (simulation years 40-50) of modeled Trinity River Chinook escapement under six spawning habitat capacity scenarios where ocean and in-river harvest are both 0. Baseline spawning habitat consists of 350,000m2 with 10% of the habitat in model reach 1, 40% in model reach 2, and 50% in model reach 3. Scenarios reduce the total amount of spawning habitat by 10, 20, 25, 50, and 75 percent. All other model parameters were held constant.

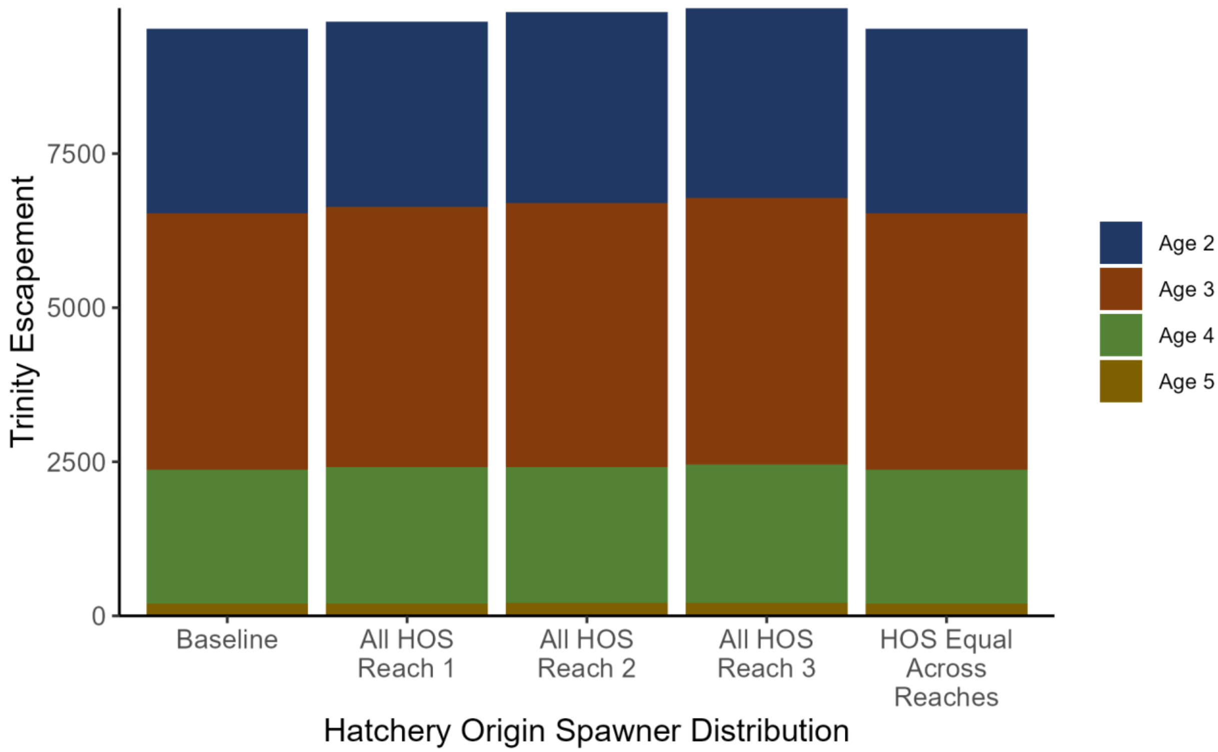

Figure 8. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five hatchery-origin natural spawner distribution scenarios. The baseline distribution assigns 82% of hatchery-origin spawners to Reach 1, 18% to Reach 2, and 0% to Reach 3. Alternative scenarios concentrate all hatchery-origin spawners in Reach 1, Reach 2, or Reach 3 individually, or distribute them equally across all three reaches. All other model parameters were held constant.

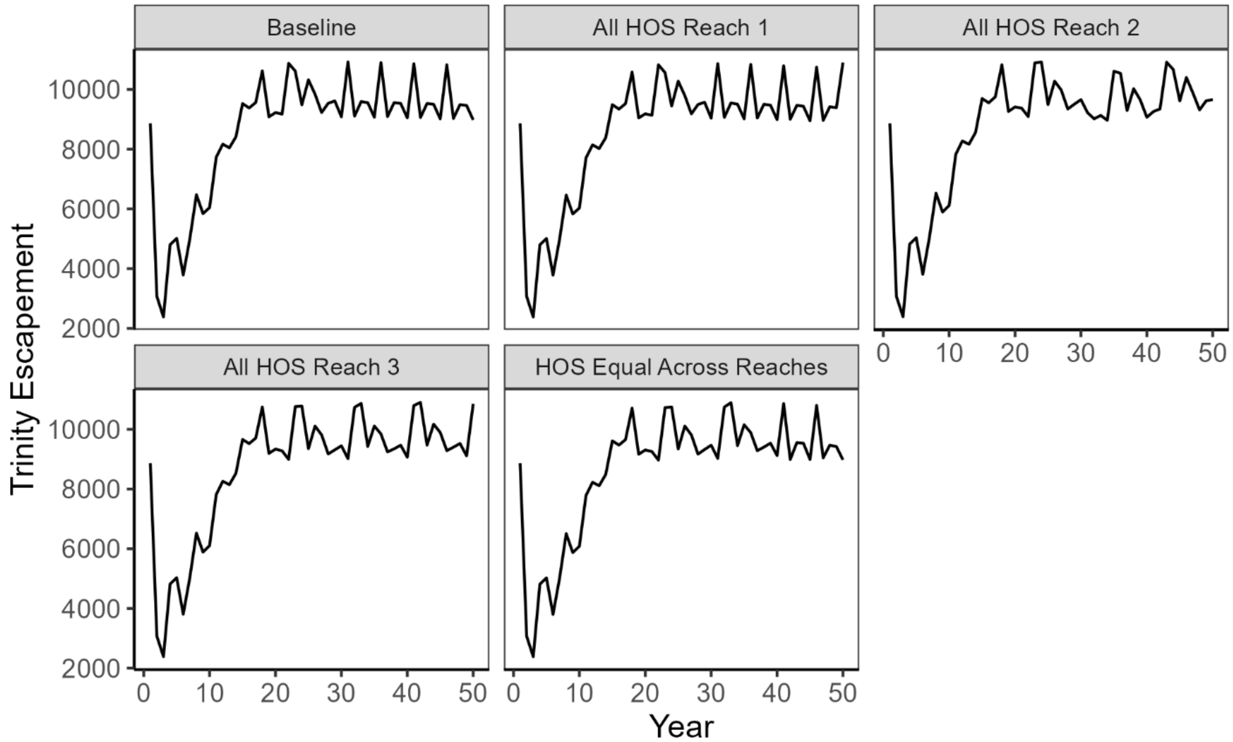

Figure 9. Time series of modeled Trinity River Chinook escapement under five hatchery-origin natural spawner distribution scenarios. The baseline distribution assigns 82% of hatchery-origin spawners to Reach 1, 18% to Reach 2, and 0% to Reach 3. Alternative scenarios concentrate all hatchery-origin spawners in Reach 1, Reach 2, or Reach 3 individually, or distribute them equally across all three reaches. All other model parameters were held constant.

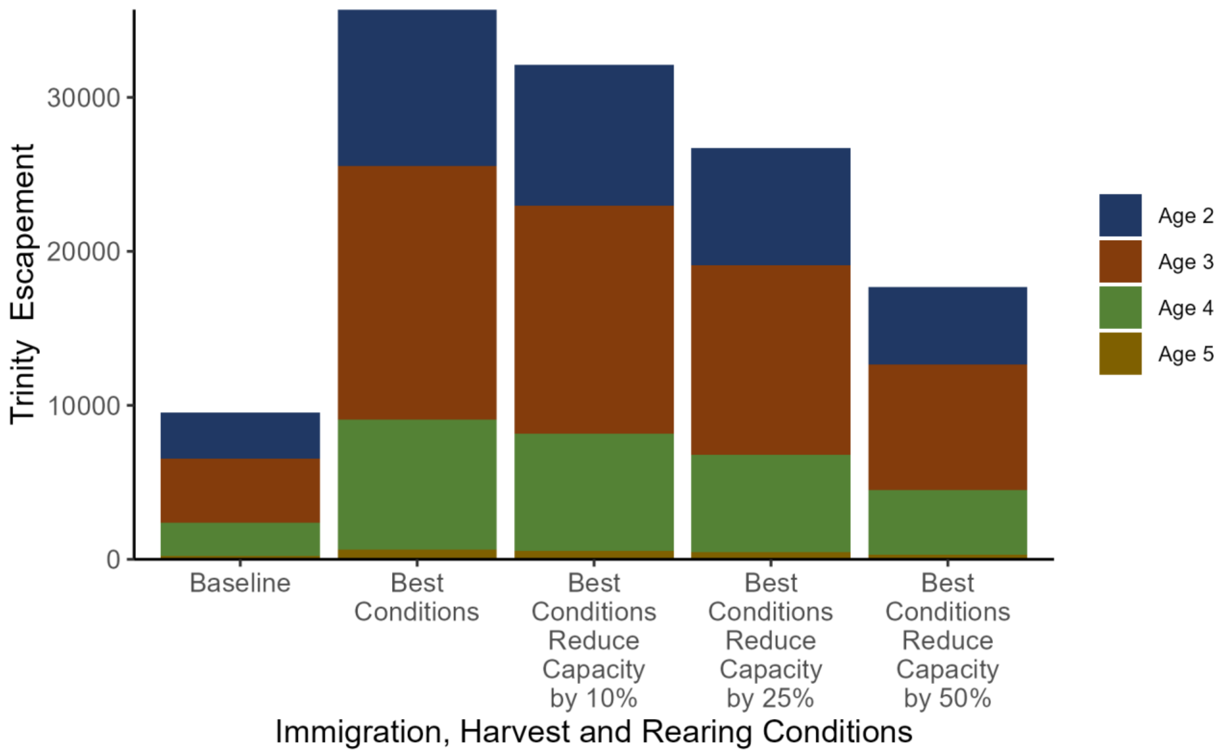

Figure 10. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five immigration and habitat scenarios. The baseline scenario uses baseline Klamath and Trinity immigration survival, baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish), and baseline in-river harvest rates. The best conditions scenario sets all immigration survivals and straying rates to 1.00, reduces harvest to 0.03 across all age classes, and retains baseline habitat capacities. The remaining three scenarios apply best conditions while simultaneously reducing rearing, spawning, and holding habitat capacities by 10%, 25%, and 50% relative to baseline. All other model parameters were held constant.

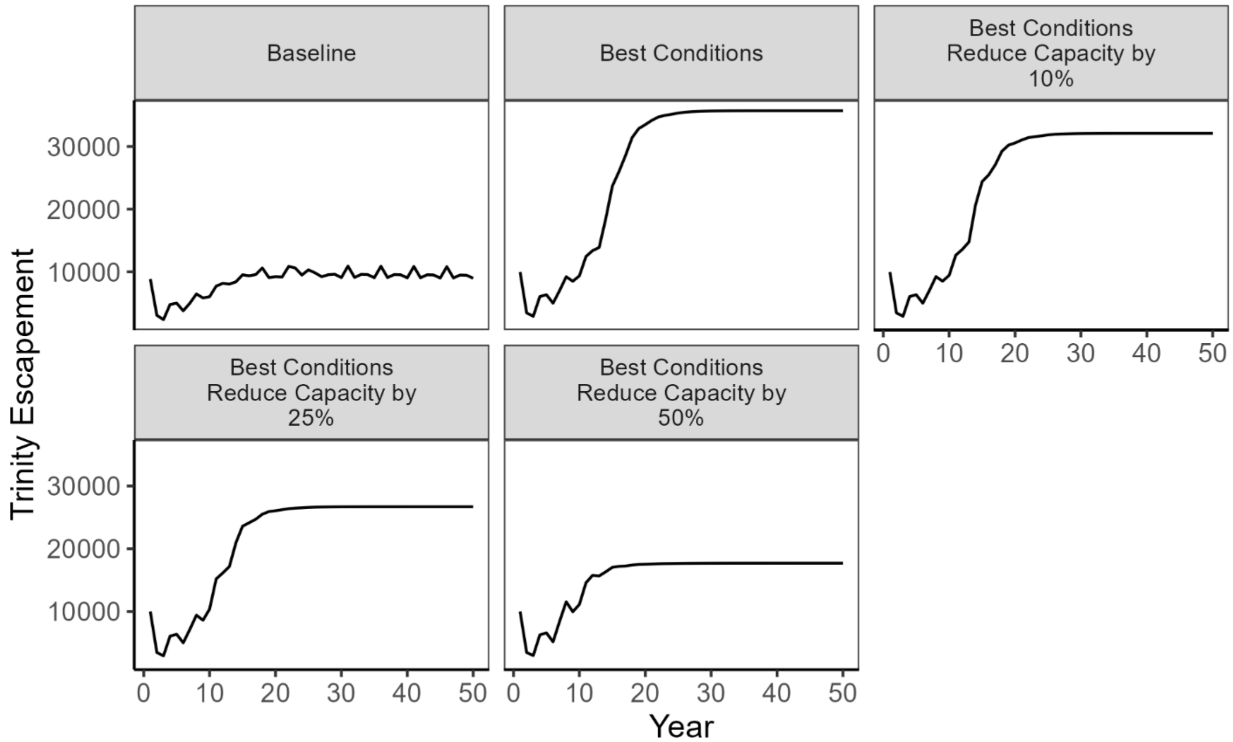

Figure 11. Time series of modeled Trinity River Chinook escapement under five immigration and habitat scenarios. The baseline scenario uses baseline Klamath and Trinity immigration survival, baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish), and baseline in-river harvest rates. The best conditions scenario sets all immigration survivals and straying rates to 1.00, reduces harvest to 0.03 across all age classes, and retains baseline habitat capacities. The remaining three scenarios apply best conditions while simultaneously reducing rearing, spawning, and holding habitat capacities by 10%, 25%, and 50% relative to baseline. All other model parameters were held constant.

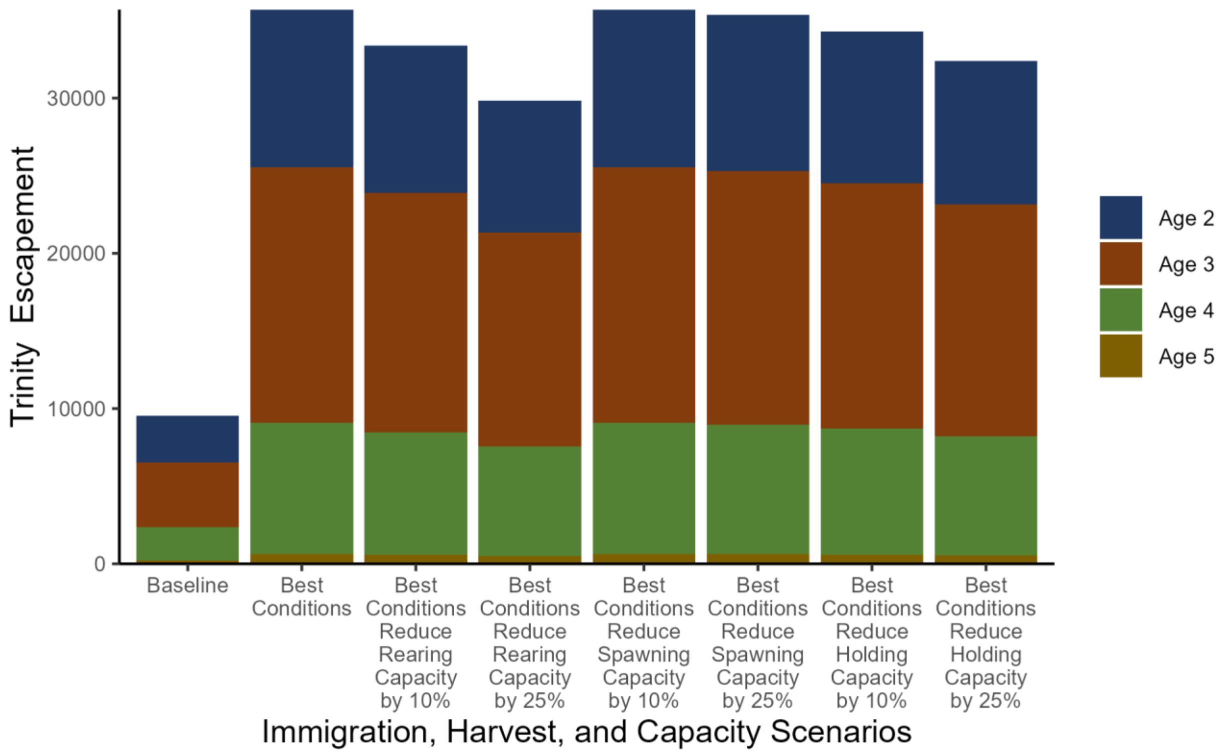

Figure 12. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under eight immigration and habitat scenarios. The baseline scenario uses baseline Klamath and Trinity immigration survival, baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish), and baseline in-river harvest rates. The best conditions scenario sets all immigration survivals and straying rates to 1.00, reduces harvest to 0.03 across all age classes, and retains baseline habitat capacities. The remaining three scenarios apply best conditions while simultaneously reducing rearing, spawning, and holding habitat capacities individually by 10% and 25% relative to baseline. All other model parameters were held constant.

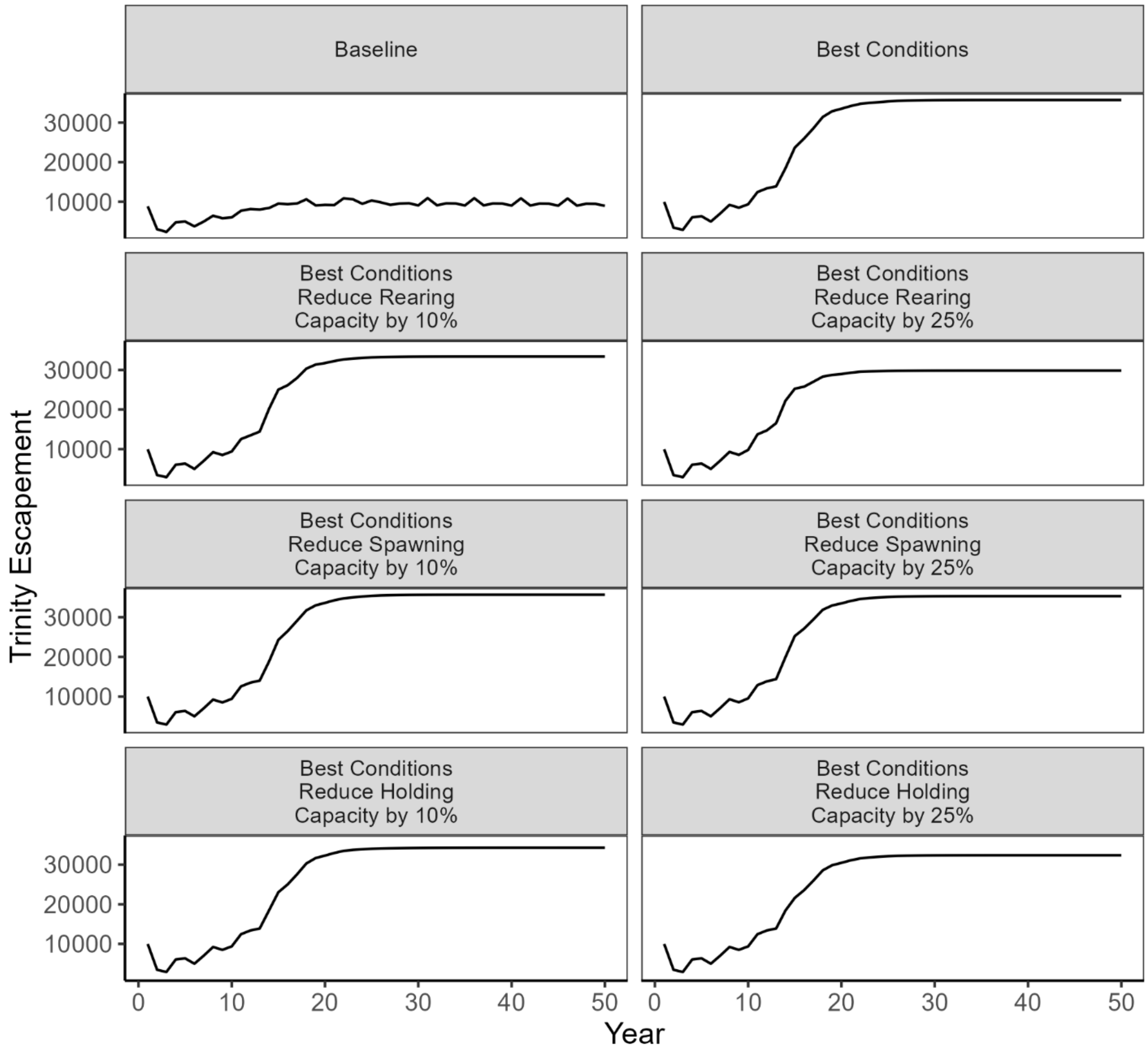

Figure 13. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under eight immigration and habitat scenarios. The baseline scenario uses baseline Klamath and Trinity immigration survival, baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish), and baseline in-river harvest rates. The best conditions scenario sets all immigration survivals and straying rates to 1.00, reduces harvest to 0.03 across all age classes, and retains baseline habitat capacities. The remaining three scenarios apply best conditions while simultaneously reducing rearing, spawning, and holding habitat capacities individually by 10% and 25% relative to baseline. All other model parameters were held constant.

Egg incubation

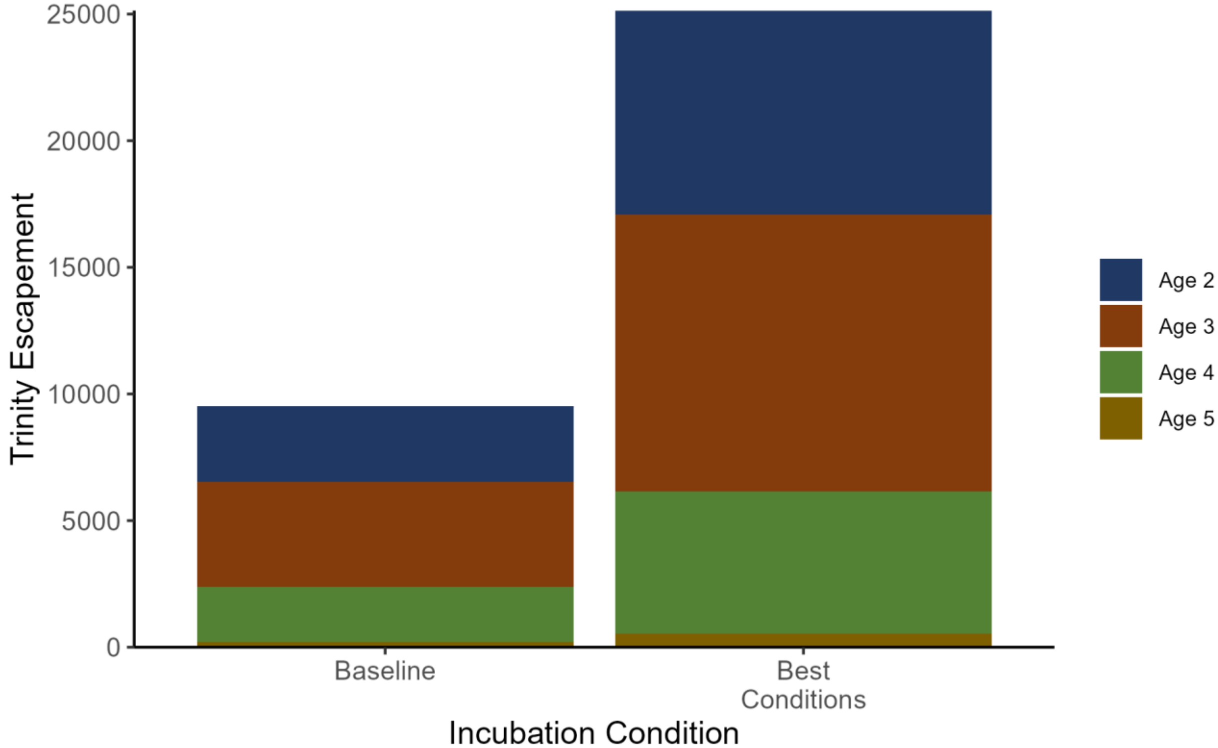

Figure 14. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under two incubation survival scenarios. The baseline scenario uses observed incubation conditions including fine sediment survival (0.95 in Reach 1, 1.00 in Reaches 2–3), hydrologic disturbance survival (0.95 in Reach 1, 1.00 in Reaches 2–3), and incubation temperature survival of 0.92 across all reaches. The best-conditions scenario sets fine sediment, hydrologic disturbance, and incubation temperature survival to 1.00 across all reaches. Gravel size and thiamine conditions were held at baseline in both scenarios. All other model parameters were held constant.

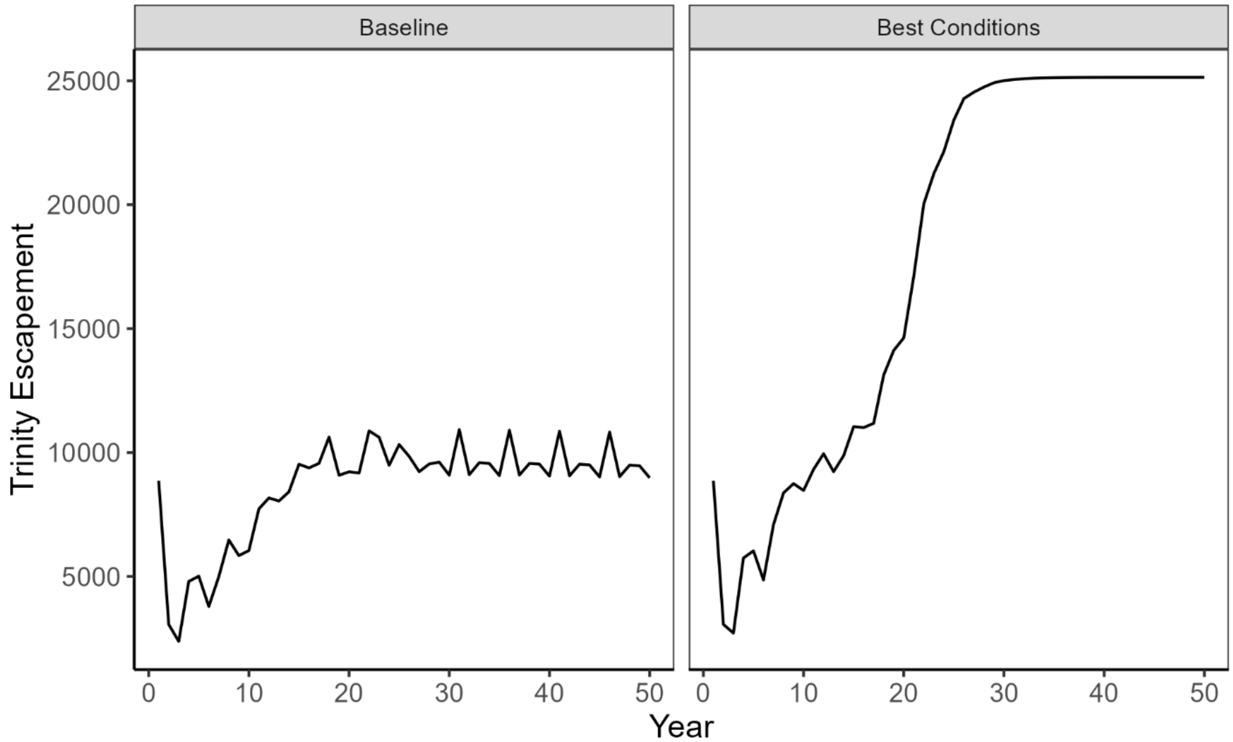

Figure 15. Time series of modeled Trinity River Chinook escapement under two incubation survival scenarios. The baseline scenario uses observed incubation conditions including fine sediment survival (0.95 in Reach 1, 1.00 in Reaches 2–3), hydrologic disturbance survival (0.95 in Reach 1, 1.00 in Reaches 2–3), and incubation temperature survival of 0.92 across all reaches. The best-conditions scenario sets fine sediment, hydrologic disturbance, and incubation temperature survival to 1.00 across all reaches. Gravel size and thiamine conditions were held at baseline in both scenarios. All other model parameters were held constant.

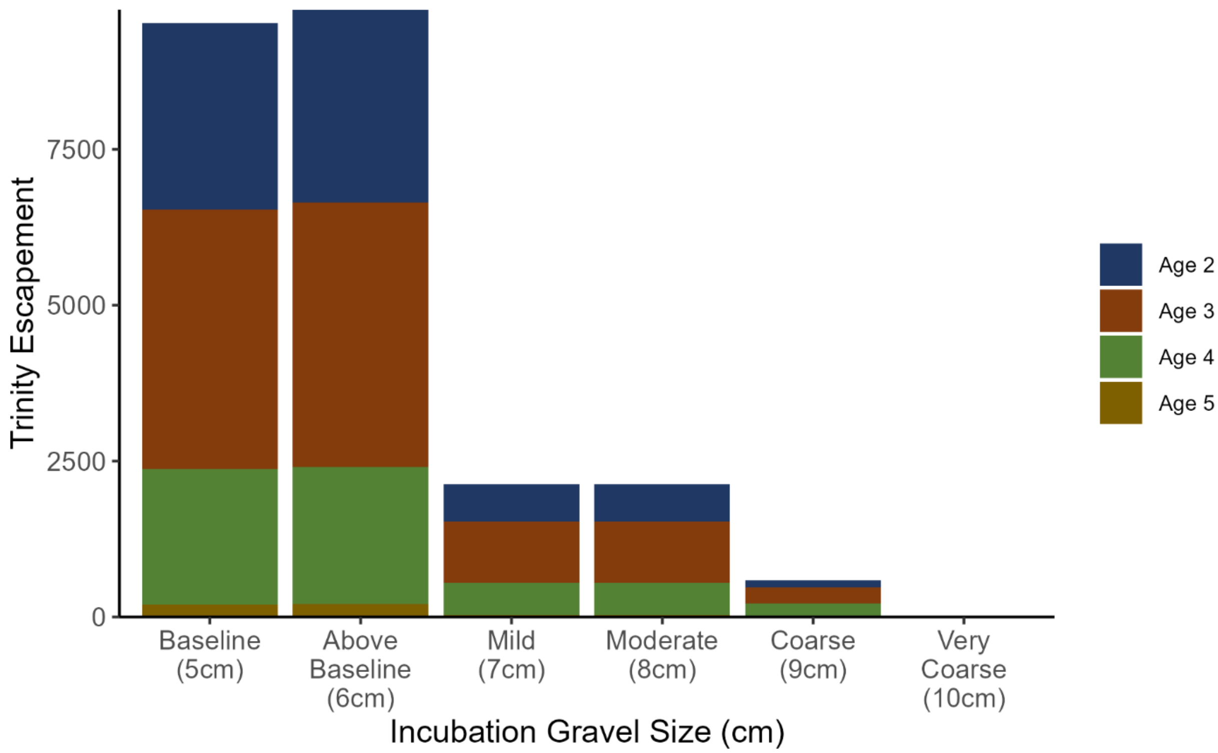

Figure 16. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six incubation gravel scenarios. The baseline scenario uses 5 cm gravel across all model reaches. Subsequent scenarios increase gravel size in 1 cm increments up to 10 cm, which decreases egg-to-fry survival by model reach. All other model parameters were held constant.

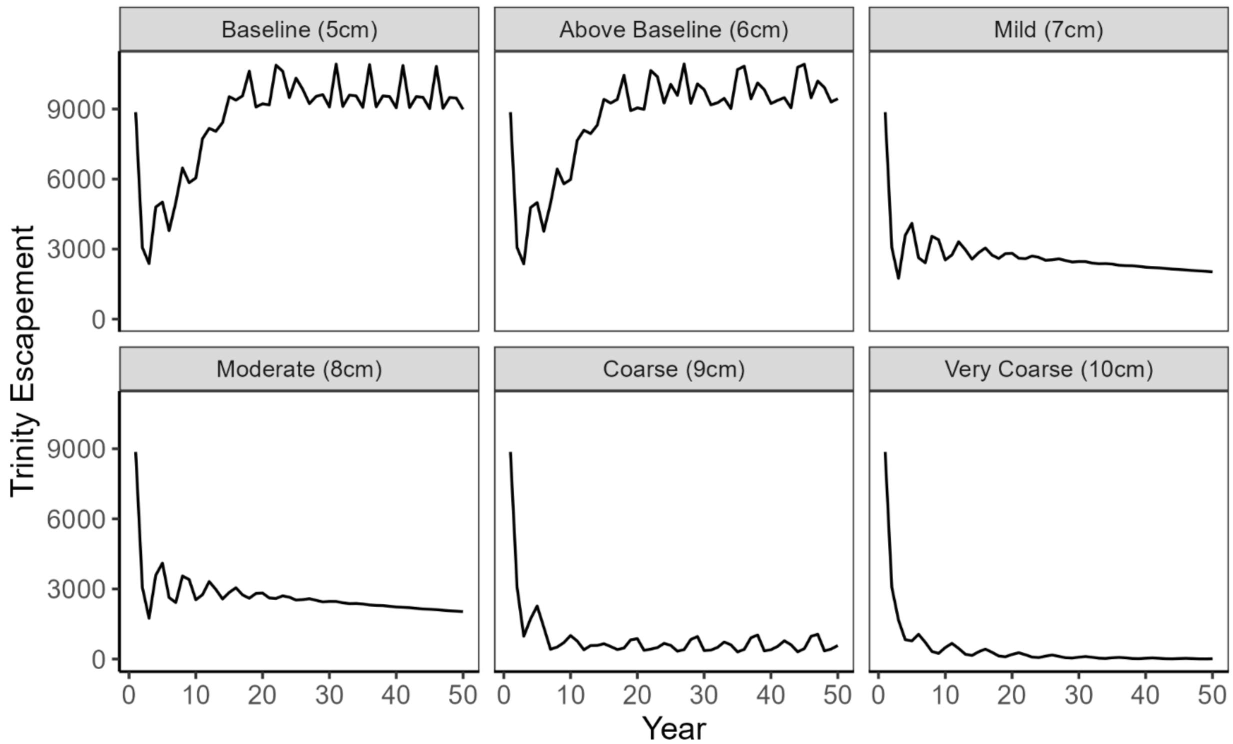

Figure 17. Time series of modeled Trinity River Chinook escapement under six incubation gravel scenarios. The baseline scenario uses 5 cm gravel across all model reaches. Subsequent scenarios increase gravel size in 1 cm increments up to 10 cm, which decreases egg-to-fry survival by model reach. All other model parameters were held constant.

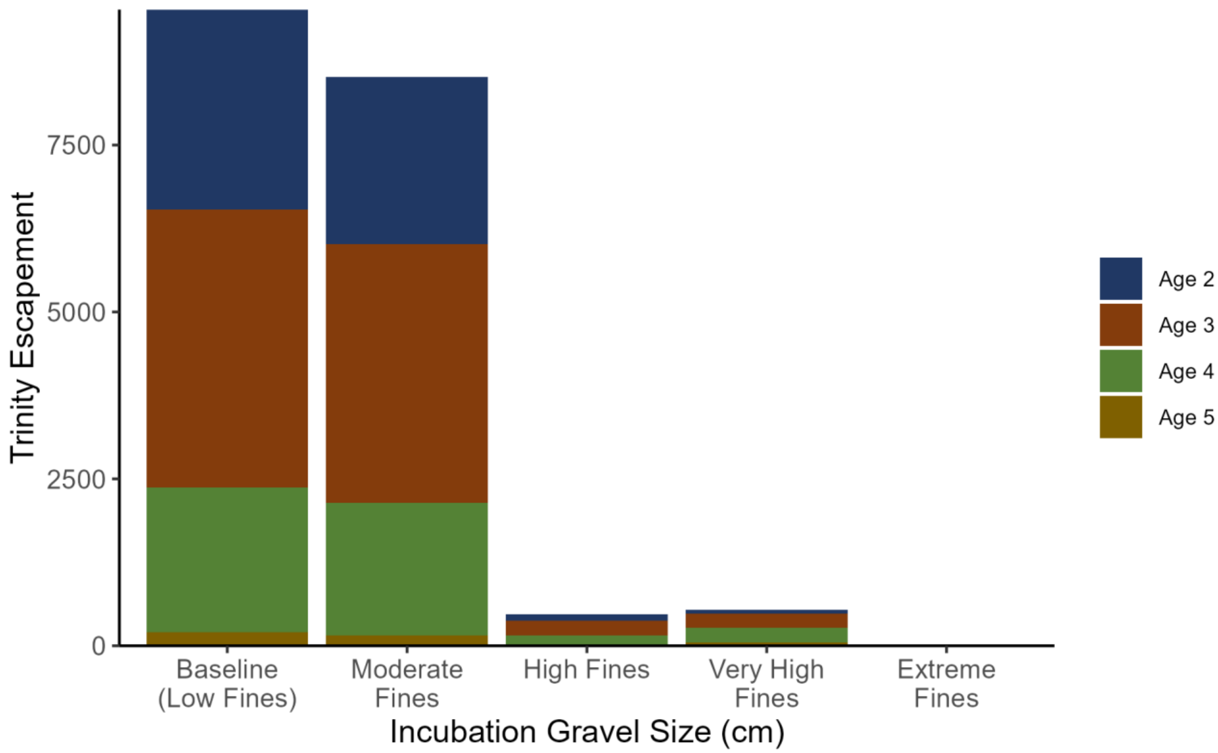

Figure 18. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five incubation fine sediment scenarios. The baseline scenario uses low fine-sediment conditions, with egg-to-fry survival of 0.95 in Reach 1 and 1.00 in Reaches 2 and 3. Subsequent scenarios increase fine sediment content, reducing egg-to-fry survival to 0.80, 0.40, 0.10, and 0.01 across all reaches. All other model parameters were held constant.

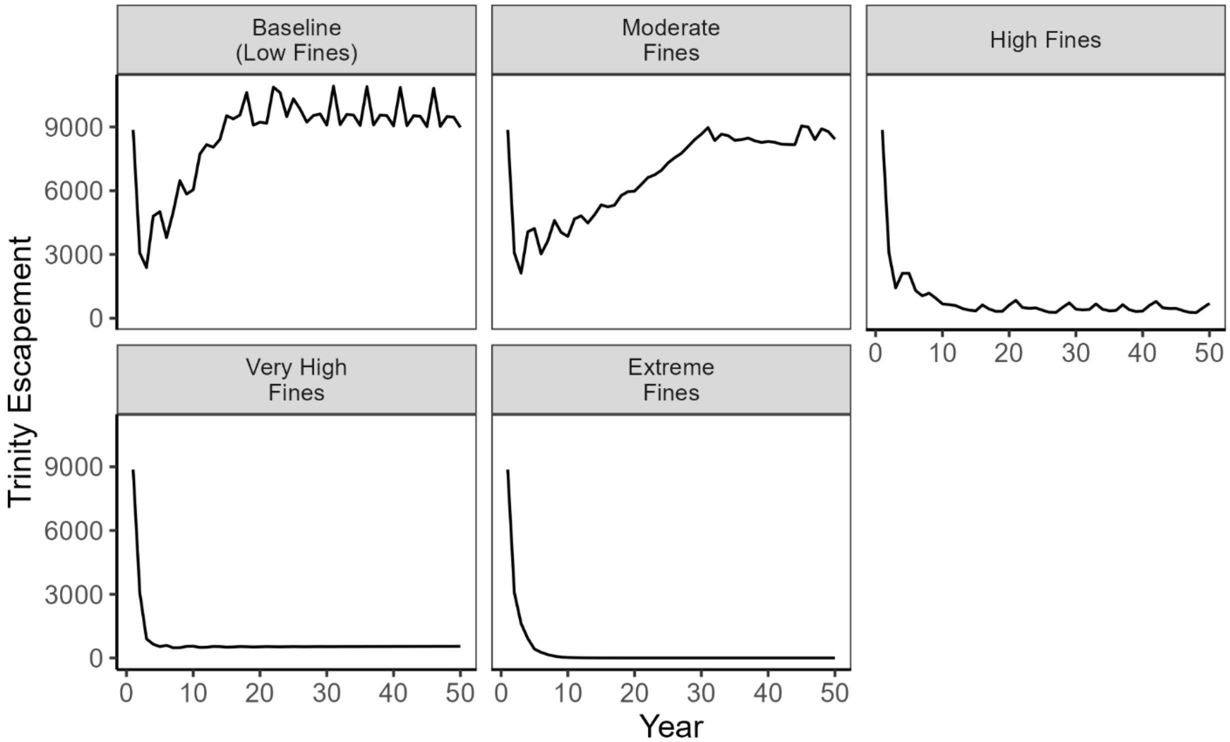

Figure 19. Time series of modeled Trinity River Chinook escapement under five incubation fine sediment scenarios. The baseline scenario uses low fine-sediment conditions, with egg-to-fry survival of 0.95 in Reach 1 and 1.00 in Reaches 2 and 3. Subsequent scenarios increase fine sediment content, reducing egg-to-fry survival to 0.80, 0.40, 0.10, and 0.01 across all reaches. All other model parameters were held constant.

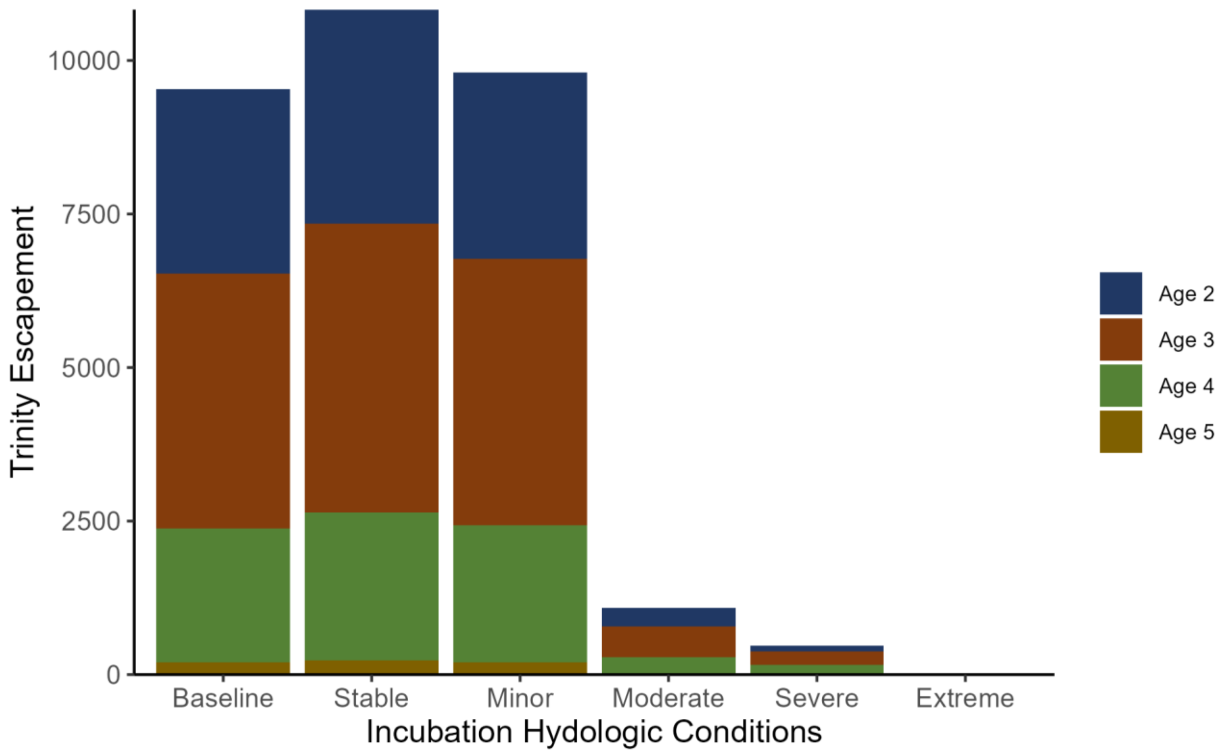

Figure 20. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six incubation hydrologic disturbance scenarios. The baseline scenario reflects stable to minor disturbance conditions with egg-to-fry survival of 0.95 in Reach 1 and 1.00 in Reaches 2 and 3. Subsequent scenarios range from fully stable conditions (survival = 1.00 across all reaches) to increasing disturbance levels, reducing egg-to-fry survival to 0.90, 0.64, 0.40, and 0.01. All other model parameters were held constant.

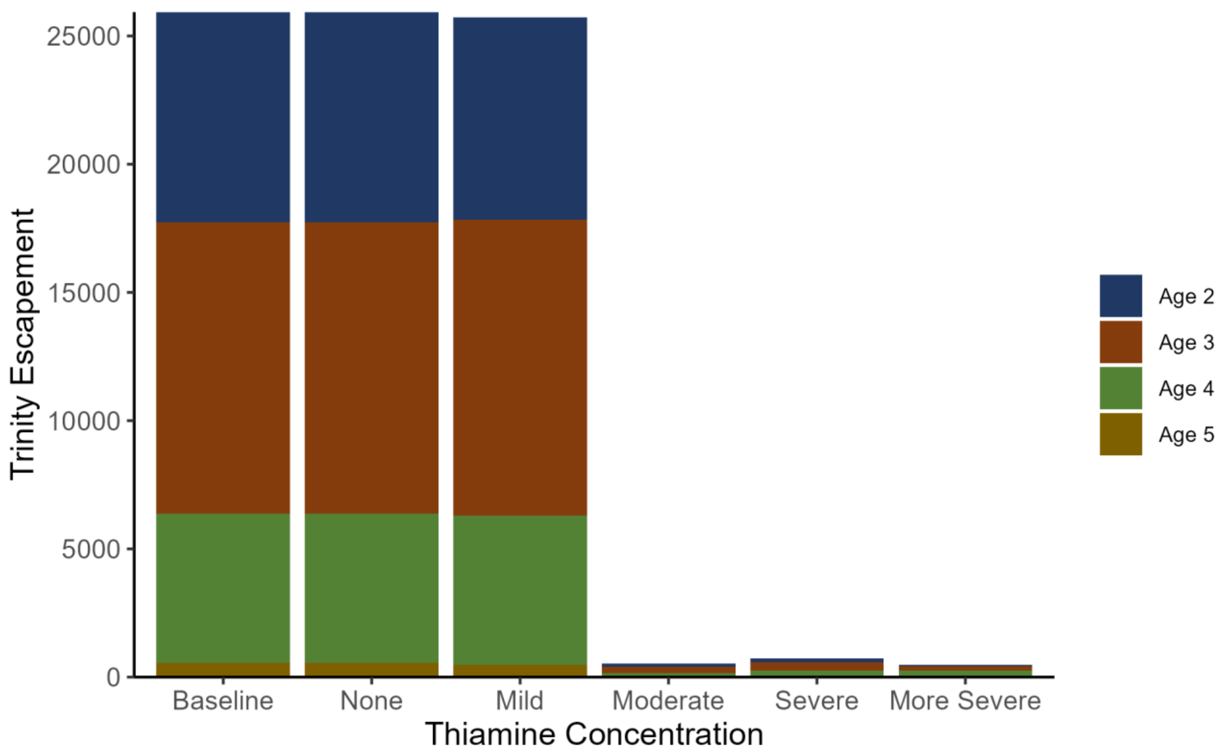

Figure 21. Ten-year average (simulation years 65-75) of modeled Trinity River Chinook escapement under six thiamine deficiency scenarios. The baseline scenario assumes no thiamine deficiency with egg-to-fry survival of 1.00. Subsequent scenarios increase thiamine deficiency severity from mild to more severe, reducing egg-to-fry survival to 0.85, 0.60, 0.40, and 0.10. All other model parameters were held constant.

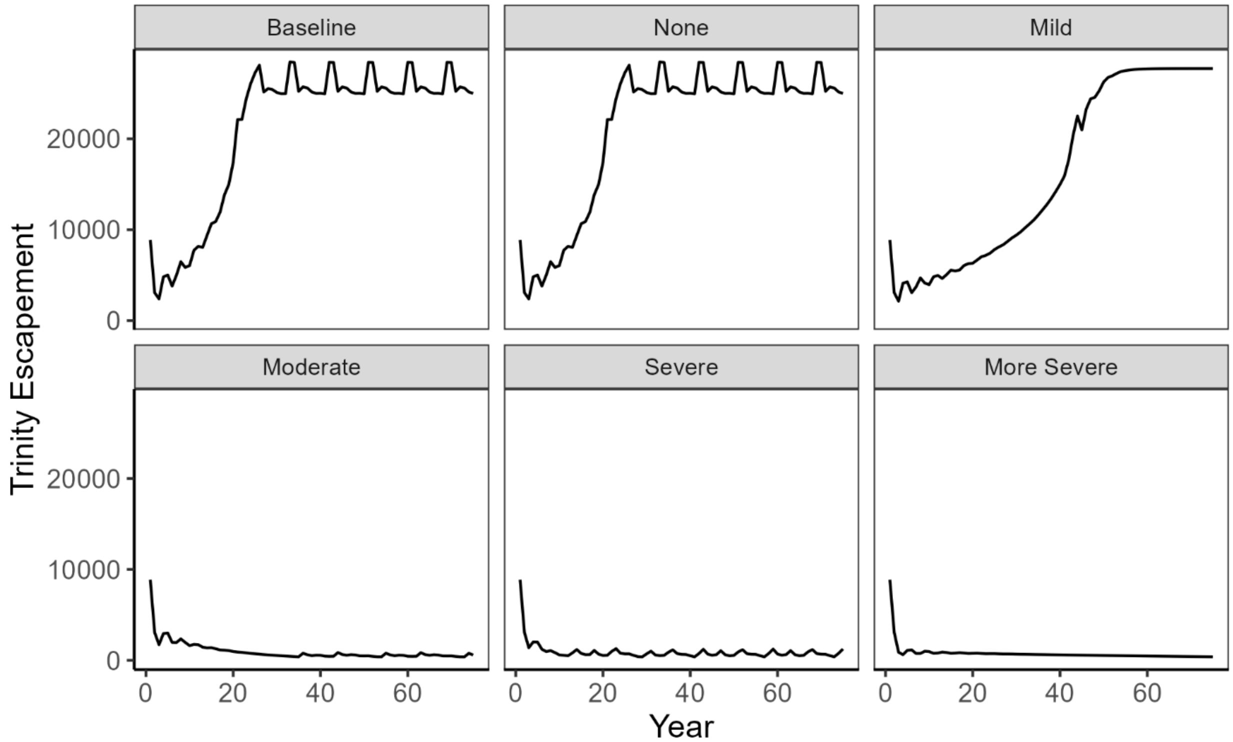

Figure 22. Time series of modeled Trinity River Chinook escapement under six thiamine deficiency scenarios. The baseline scenario assumes no thiamine deficiency with egg-to-fry survival of 1.00. Subsequent scenarios increase thiamine deficiency severity from mild to more severe, reducing egg-to-fry survival to 0.85, 0.60, 0.40, and 0.10. All other model parameters were held constant.

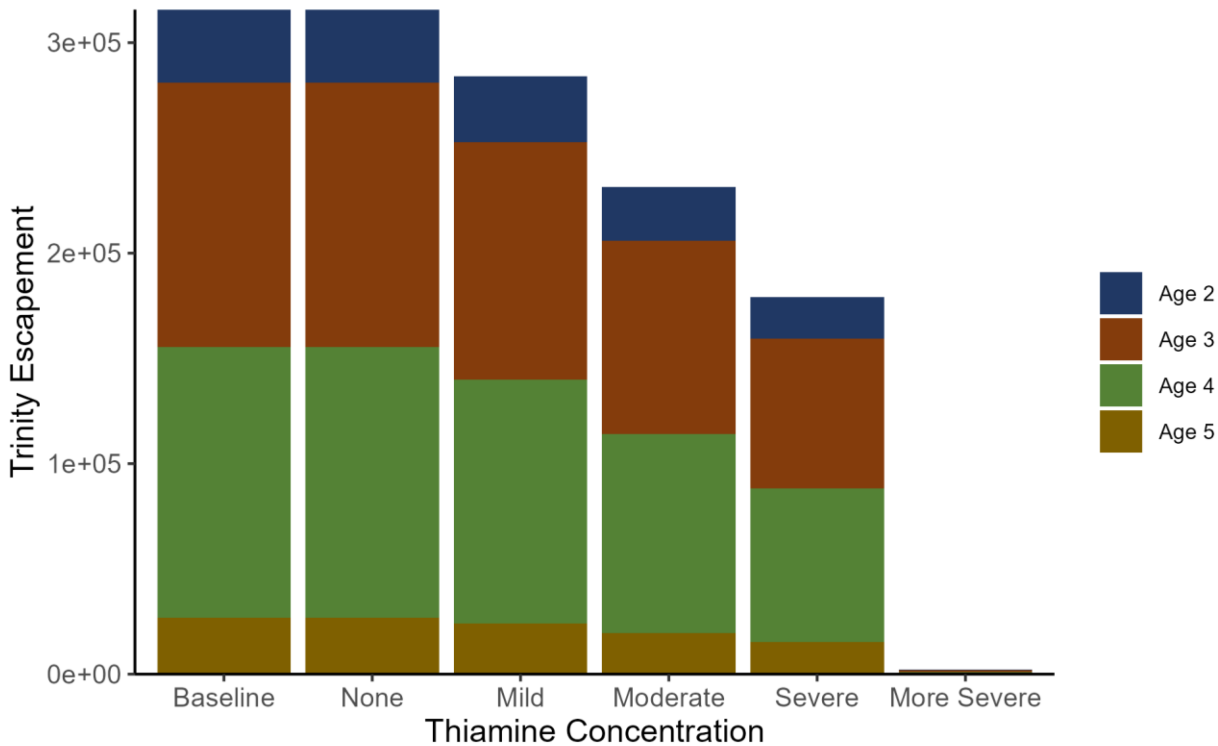

Figure 23. Ten-year average (simulation years 65–75) of modeled Trinity River Chinook escapement under six thiamine deficiency scenarios with no in river or ocean harvest. The baseline scenario assumes no thiamine deficiency with egg-to-fry survival of 1.00. Subsequent scenarios increase thiamine deficiency severity from mild to more severe, reducing egg-to-fry survival to 0.85, 0.60, 0.40, and 0.10. All other model parameters were held constant.

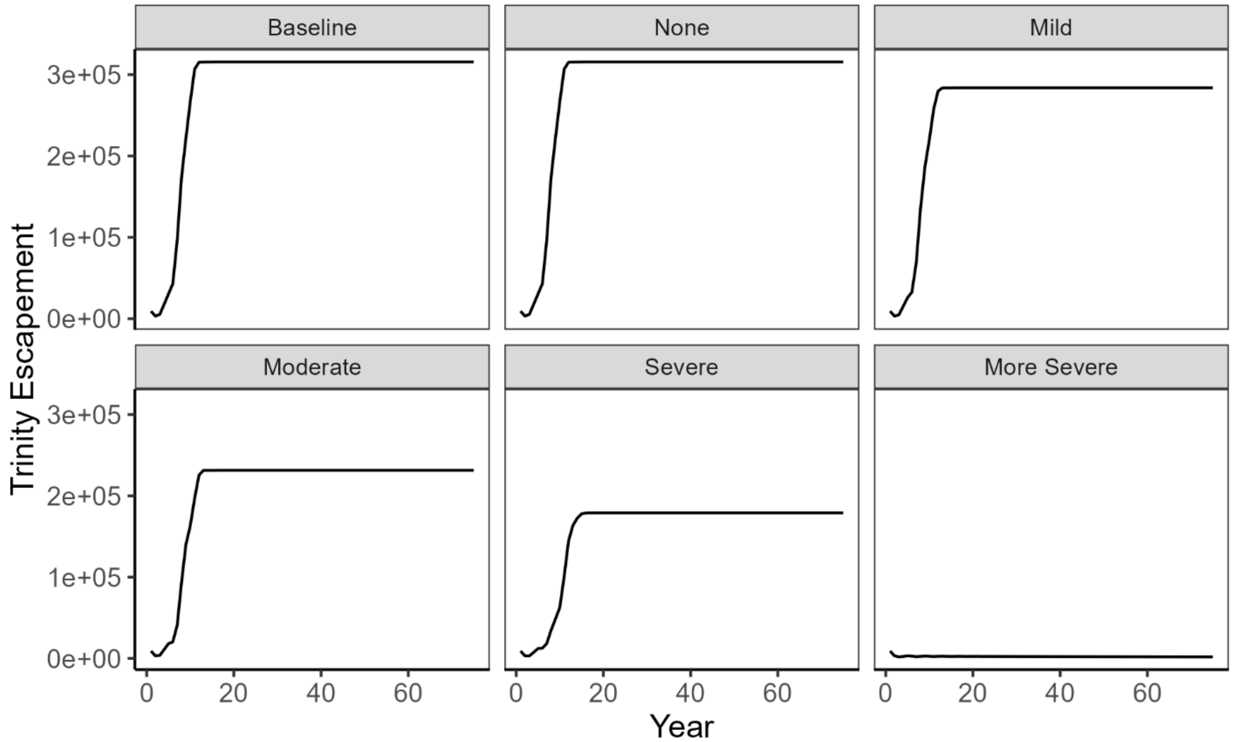

Figure 24. Time series of modeled Trinity River Chinook escapement under six thiamine deficiency scenarios with no ocean or in river harvest. The baseline scenario assumes no thiamine deficiency with egg-to-fry survival of 1.00. Subsequent scenarios increase thiamine deficiency severity from mild to more severe, reducing egg-to-fry survival to 0.85, 0.60, 0.40, and 0.10. All other model parameters were held constant.

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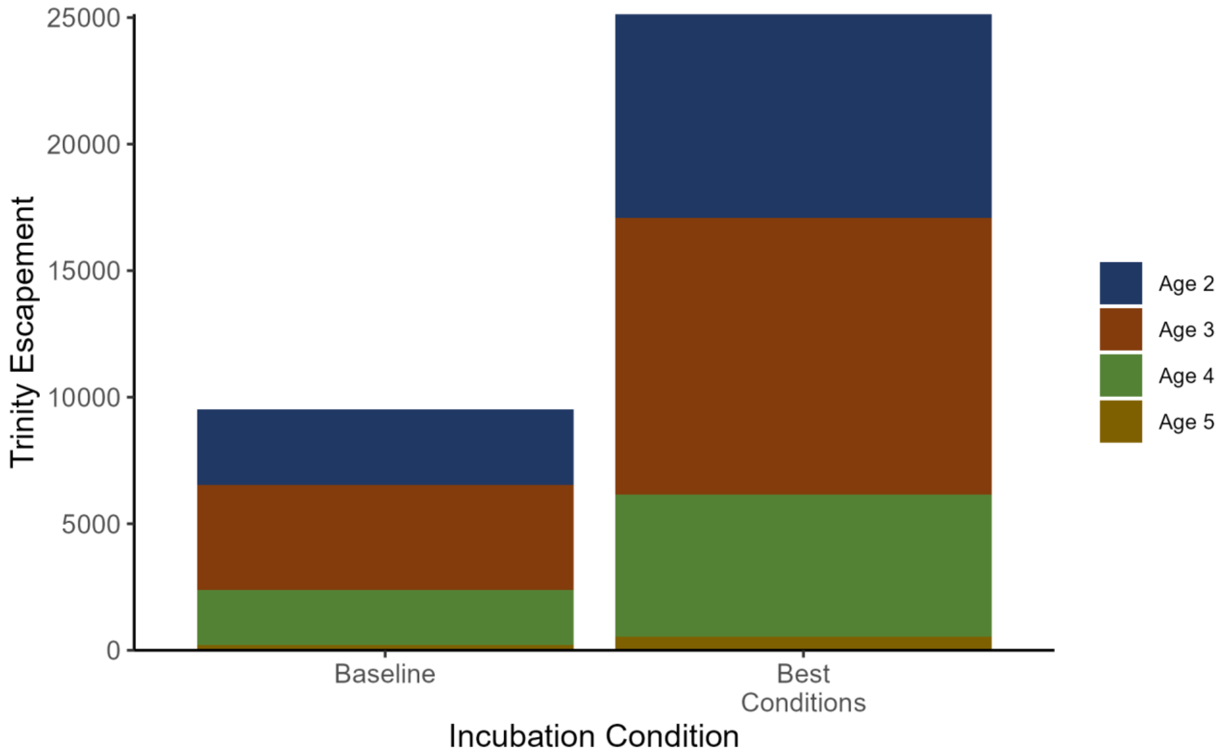

Figure 25. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under two incubation survival scenarios. The baseline scenario uses observed incubation conditions including fine sediment survival (0.95 in Reach 1, 1.00 in Reaches 2–3), hydrologic disturbance survival (0.95 in Reach 1, 1.00 in Reaches 2–3), and incubation temperature survival of 0.92 across all reaches. The best conditions scenario sets fine sediment, hydrologic disturbance, and incubation temperature survival to 1.00 across all reaches. Gravel size and thiamine conditions were held at baseline in both scenarios. All other model parameters were held constant.

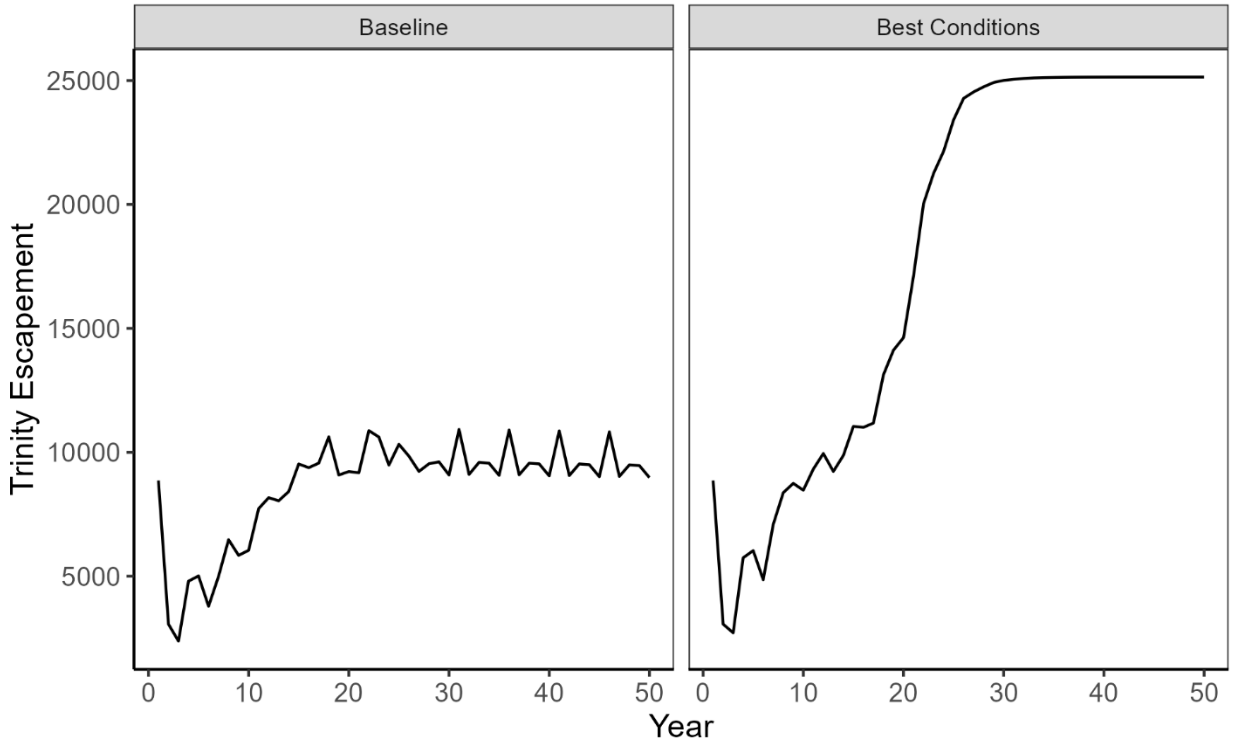

Figure 26. Time series of modeled Trinity River Chinook escapement under two incubation survival scenarios. The baseline scenario uses observed incubation conditions including fine sediment survival (0.95 in Reach 1, 1.00 in Reaches 2–3), hydrologic disturbance survival (0.95 in Reach 1, 1.00 in Reaches 2–3), and incubation temperature survival of 0.92 across all reaches. The best conditions scenario sets fine sediment, hydrologic disturbance, and incubation temperature survival to 1.00 across all reaches. Gravel size and thiamine conditions were held at baseline in both scenarios. All other model parameters were held constant.

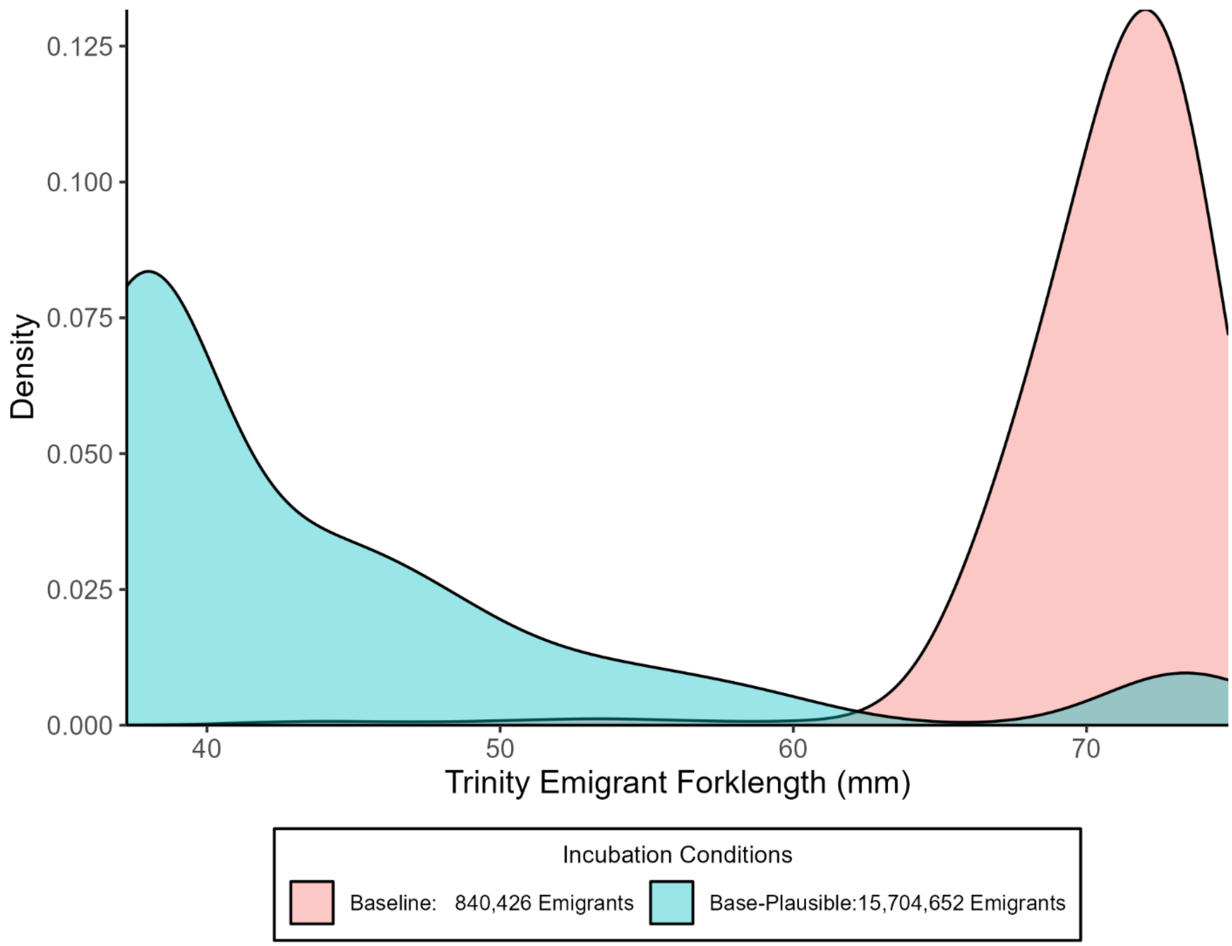

Figure 27. Density distribution of Trinity River Chinook emigrant size under two incubation survival scenarios. The baseline scenario uses observed incubation conditions including fine sediment survival (0.95 in Reach 1, 1.00 in Reaches 2–3), hydrologic disturbance survival (0.95 in Reach 1, 1.00 in Reaches 2–3), and incubation temperature survival of 0.92 across all reaches. The best conditions scenario sets fine sediment, hydrologic disturbance, and incubation temperature survival to 1.00 across all reaches. Gravel size and thiamine conditions were held at baseline in both scenarios. All other model parameters were held constant.

Juvenile Rearing

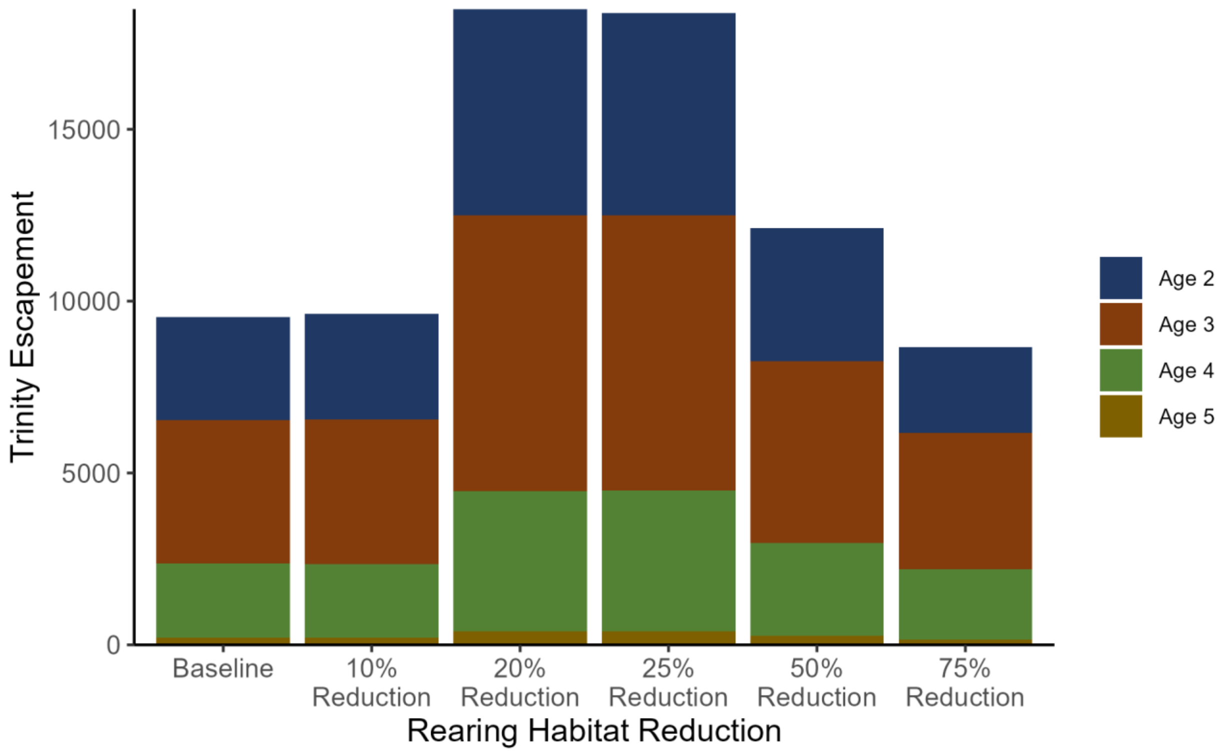

Figure 28. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six rearing habitat capacity scenarios. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. All other model parameters were held constant.

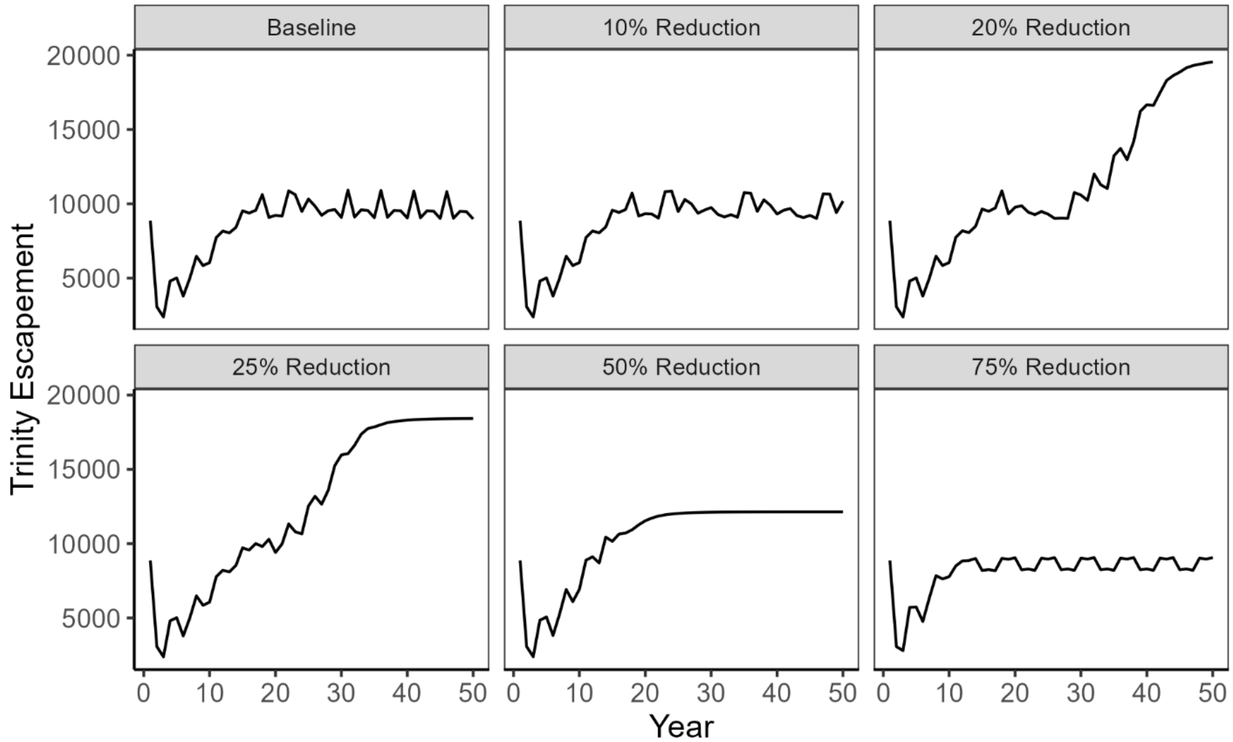

Figure 29. Time series of modeled Trinity River Chinook escapement under six rearing habitat capacity scenarios. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. All other model parameters were held constant.

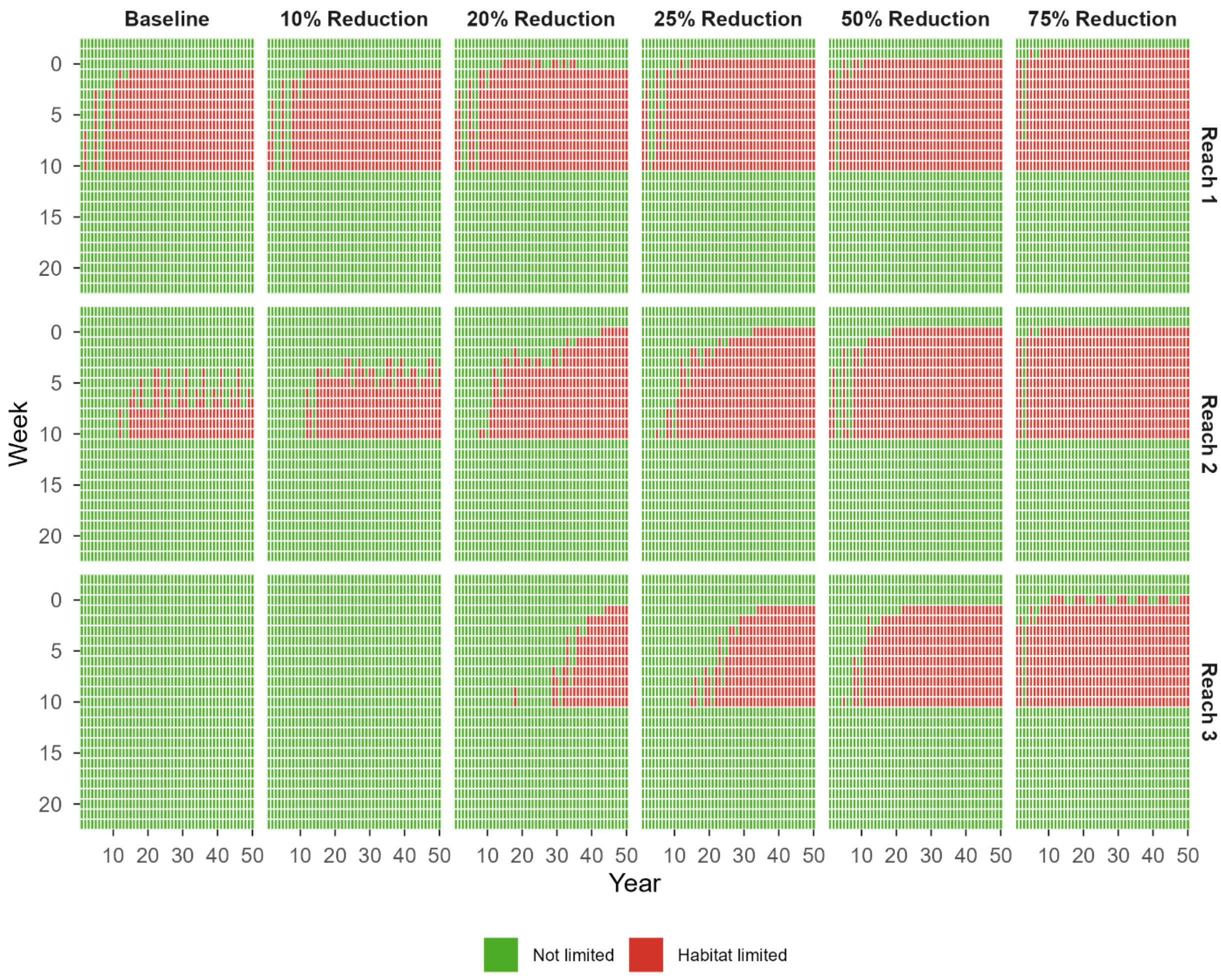

Figure 30. Rearing habitat limitation by year, week, and reach under six rearing habitat capacity scenarios. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. Green indicates habitat is not limiting and red indicates habitat is limiting for a given year and reach. All other model parameters were held constant.

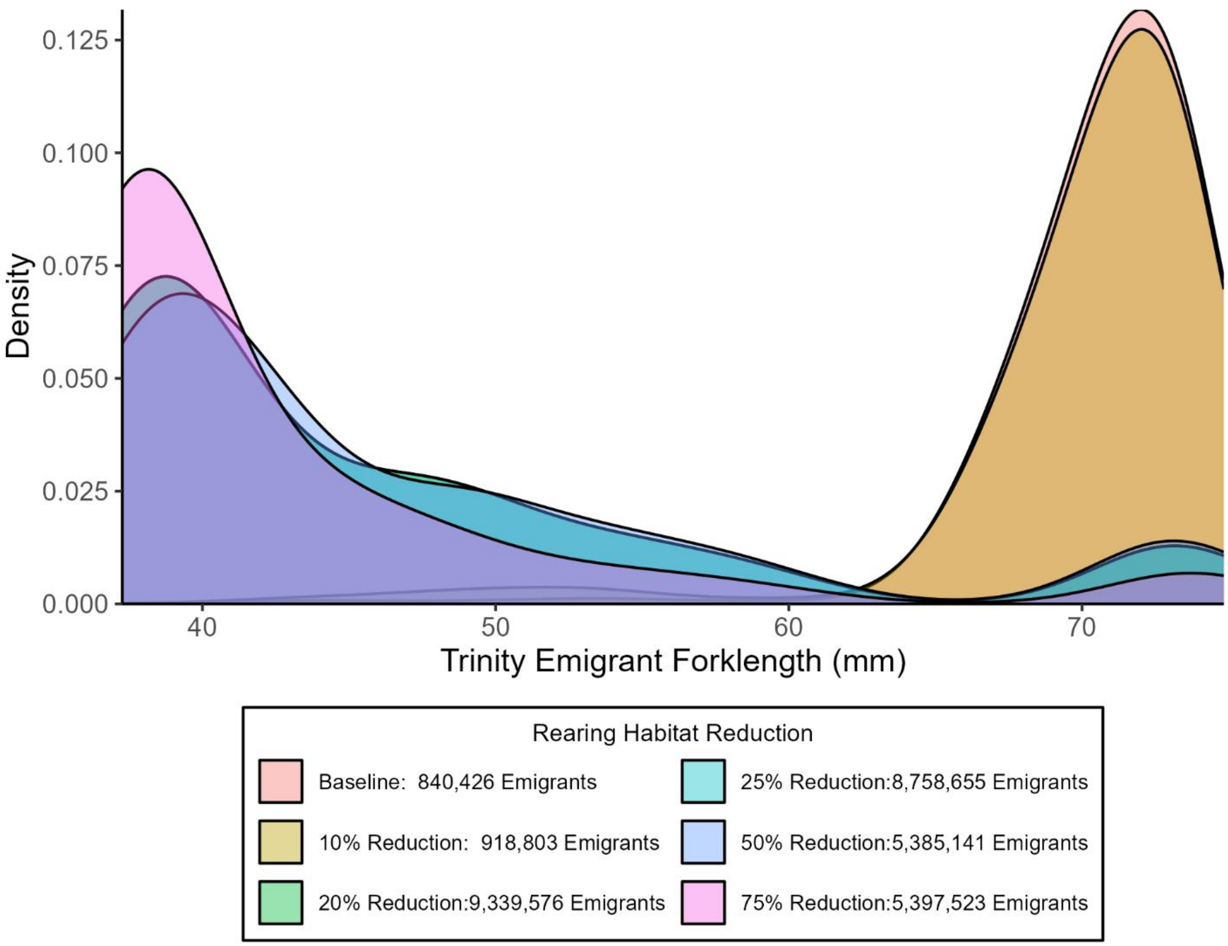

Figure 31. Density distribution of Trinity River Chinook emigrant size under six rearing habitat capacity scenarios. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. All other model parameters were held constant.

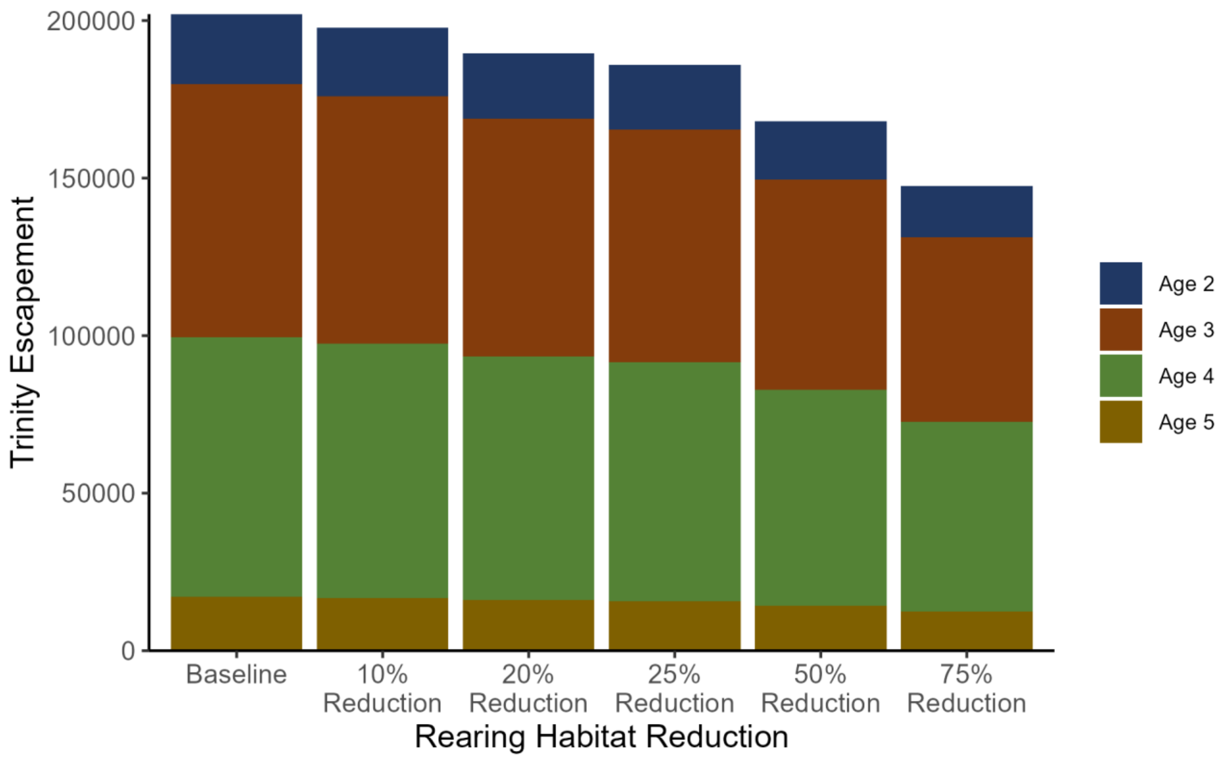

Figure 32. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six rearing habitat capacity scenarios with no in-river or ocean harvest impacts. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. All other model parameters were held constant.

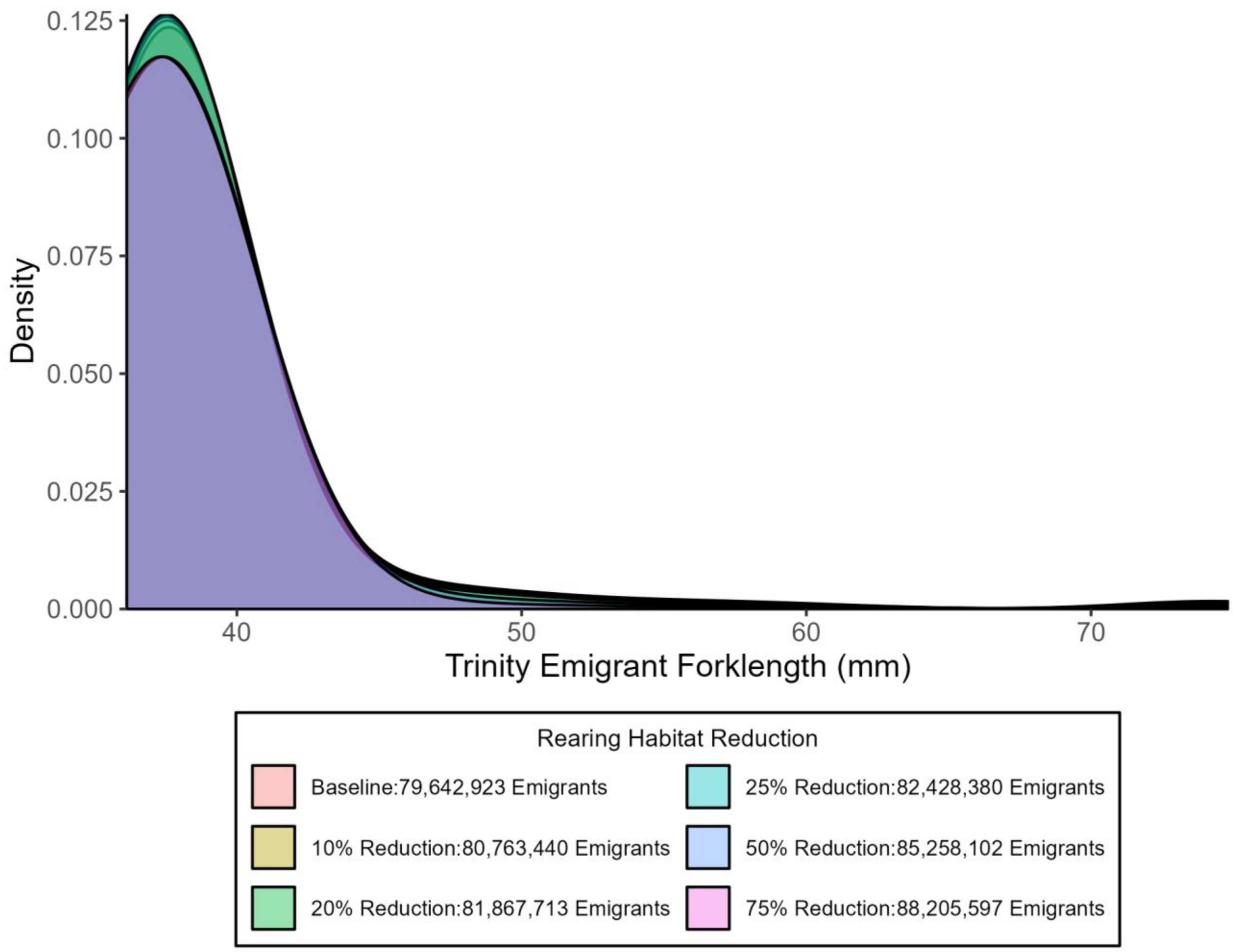

Figure 33. Density distribution of Trinity River Chinook emigrant size under six rearing habitat capacity scenarios with no in-river or ocean harvest impacts. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. All other model parameters were held constant.

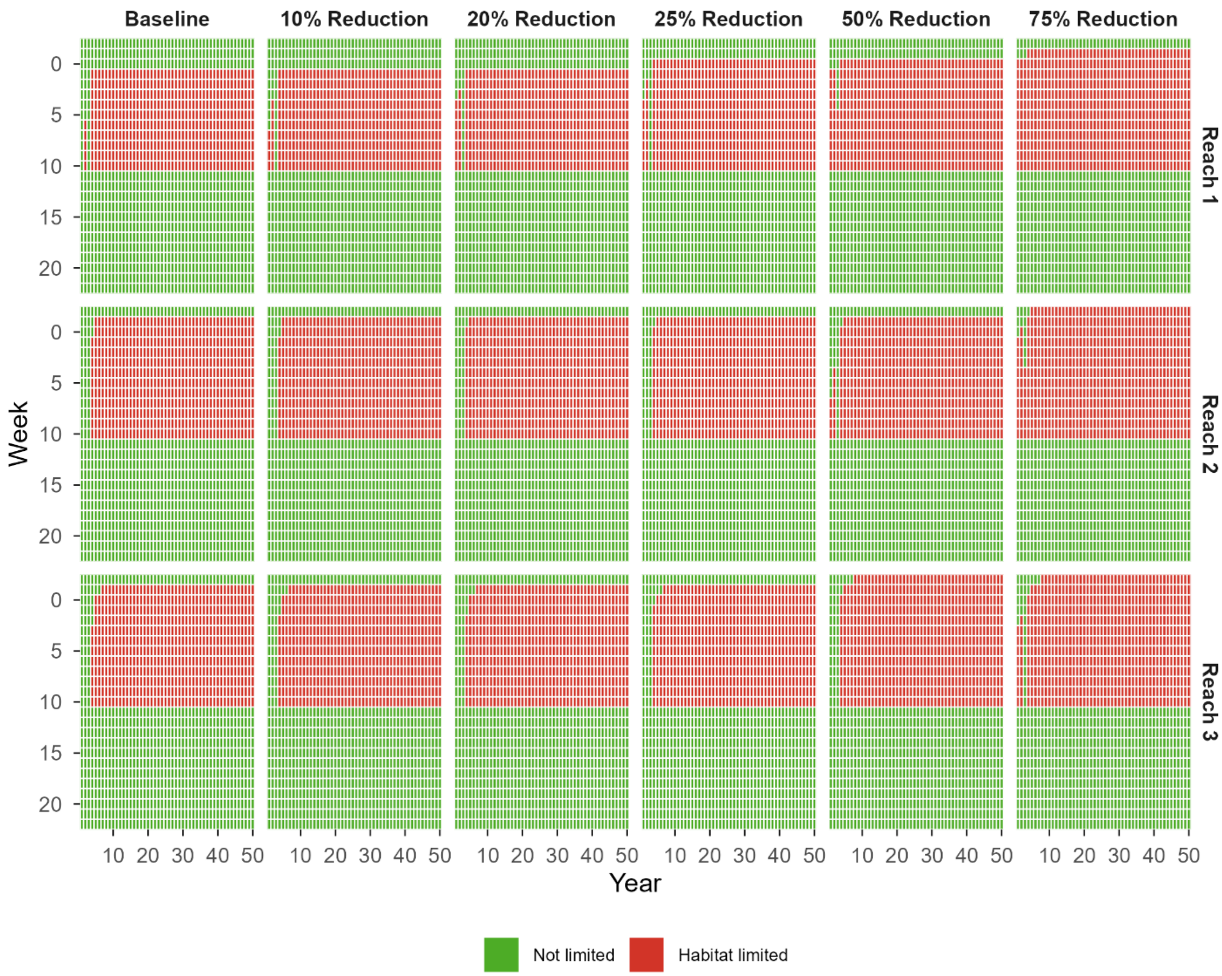

Figure 34. Rearing habitat limitation by year, week, and reach under six rearing habitat capacity scenarios. The baseline scenario uses baseline rearing capacity by reach and flow condition. Subsequent scenarios reduce rearing capacity by 10%, 20%, 25%, 50%, and 75% relative to baseline. Green indicates habitat is not limiting and red indicates habitat is limiting for a given year and reach. All other model parameters were held constant.

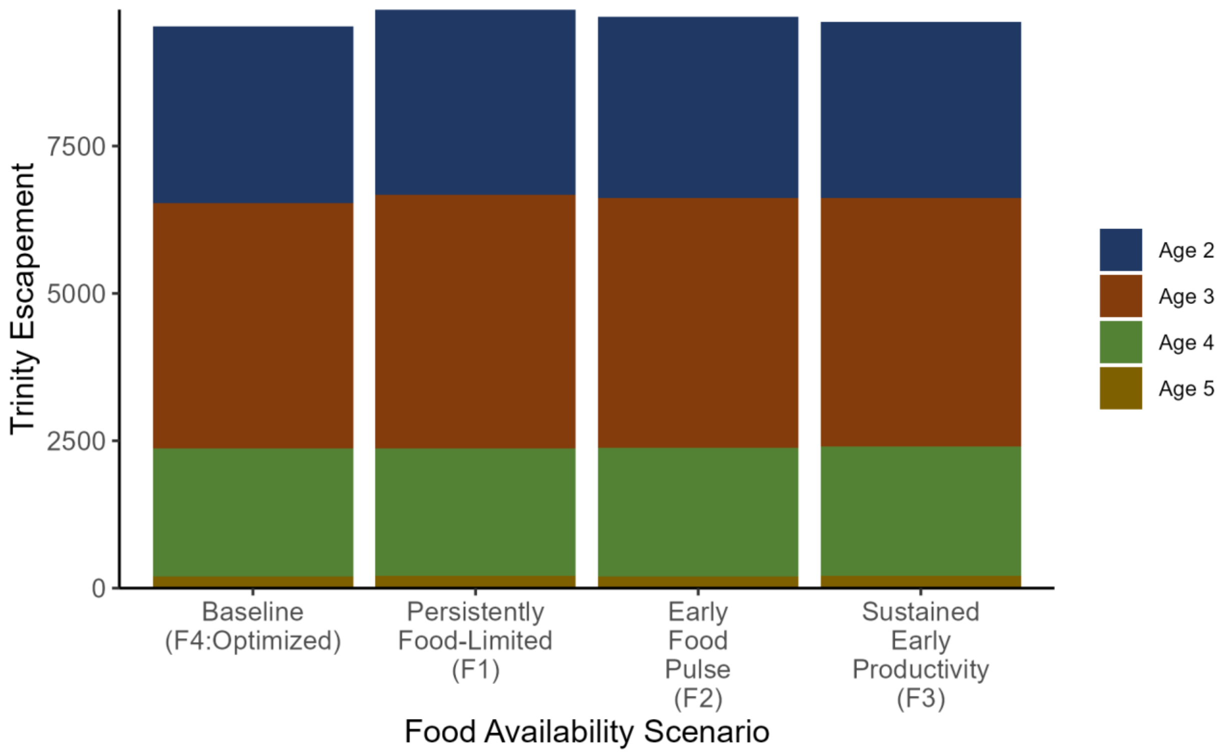

Figure 35. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under four food availability scenarios. Scenarios vary the timing and duration of sufficient versus limited food availability across all three model reaches throughout the rearing season. The baseline scenario includes 6 weeks of sufficient food availability preceded and followed by periods of limited availability. Alternative scenarios reduce sufficient food availability to 5 or 3 weeks or limit food availability for the entire rearing season. All other model parameters were held constant.

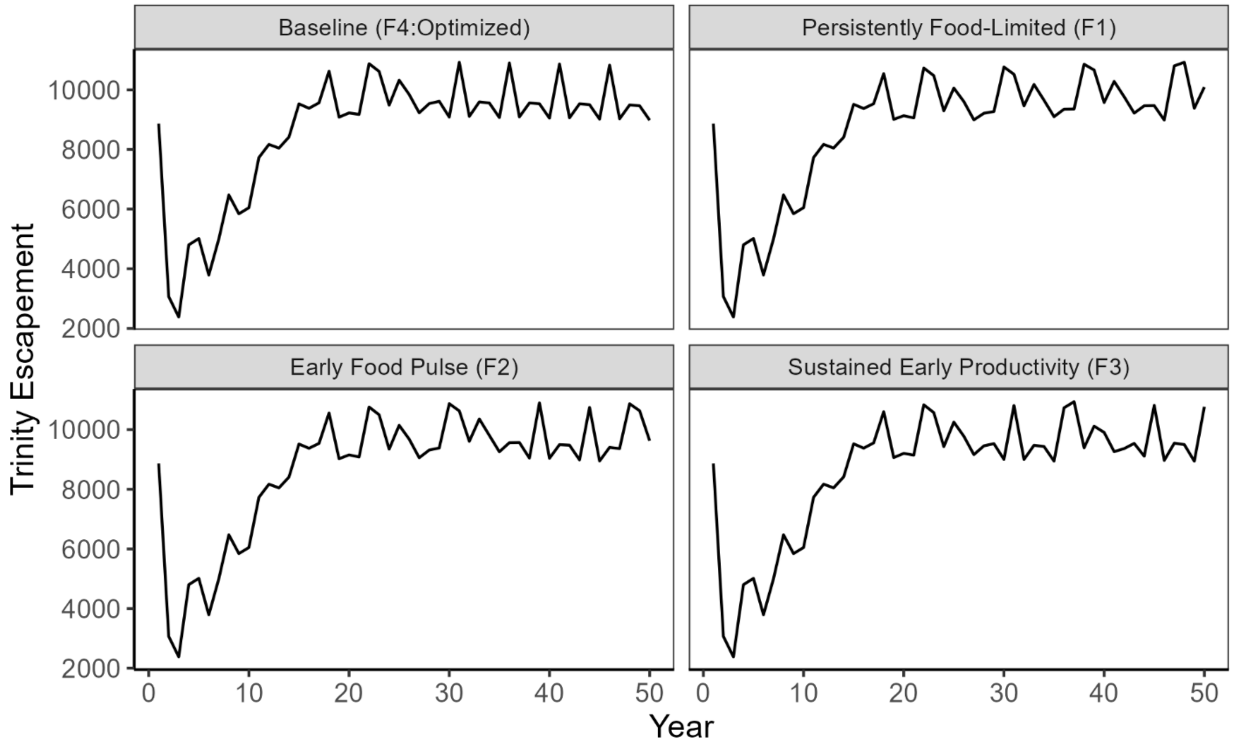

Figure 36. Time series of modeled Trinity River Chinook escapement under four food availability scenarios. Scenarios vary the timing and duration of sufficient versus limited food availability across all three model reaches throughout the rearing season. The baseline scenario includes 6 weeks of sufficient food availability preceded and followed by periods of limited availability. Alternative scenarios reduce sufficient food availability to 5 or 3 weeks or limit food availability for the entire rearing season. All other model parameters were held constant.

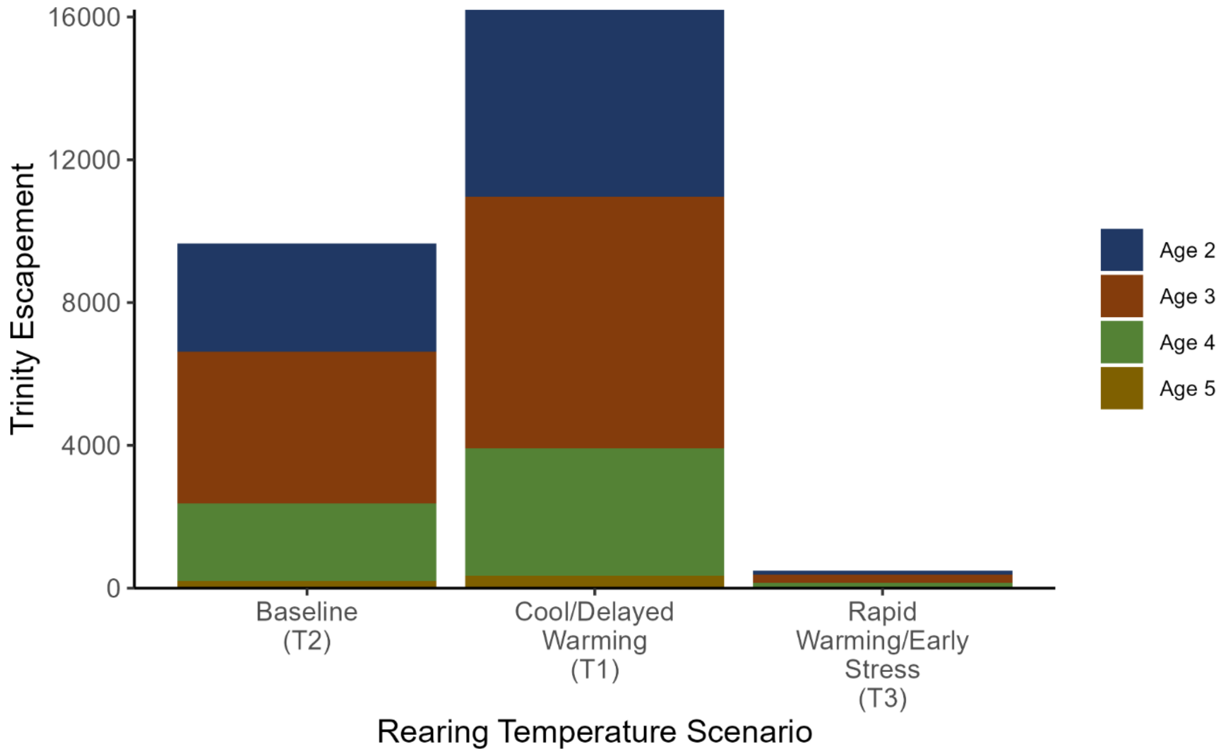

Figure 37. Ten-year average (simulation years 90–100) of modeled Trinity River Chinook escapement under three rearing temperature scenarios. Scenarios vary the timing and duration of cold, optimal, transitional, warm, and stress temperature conditions throughout the rearing season, each affecting juvenile 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.

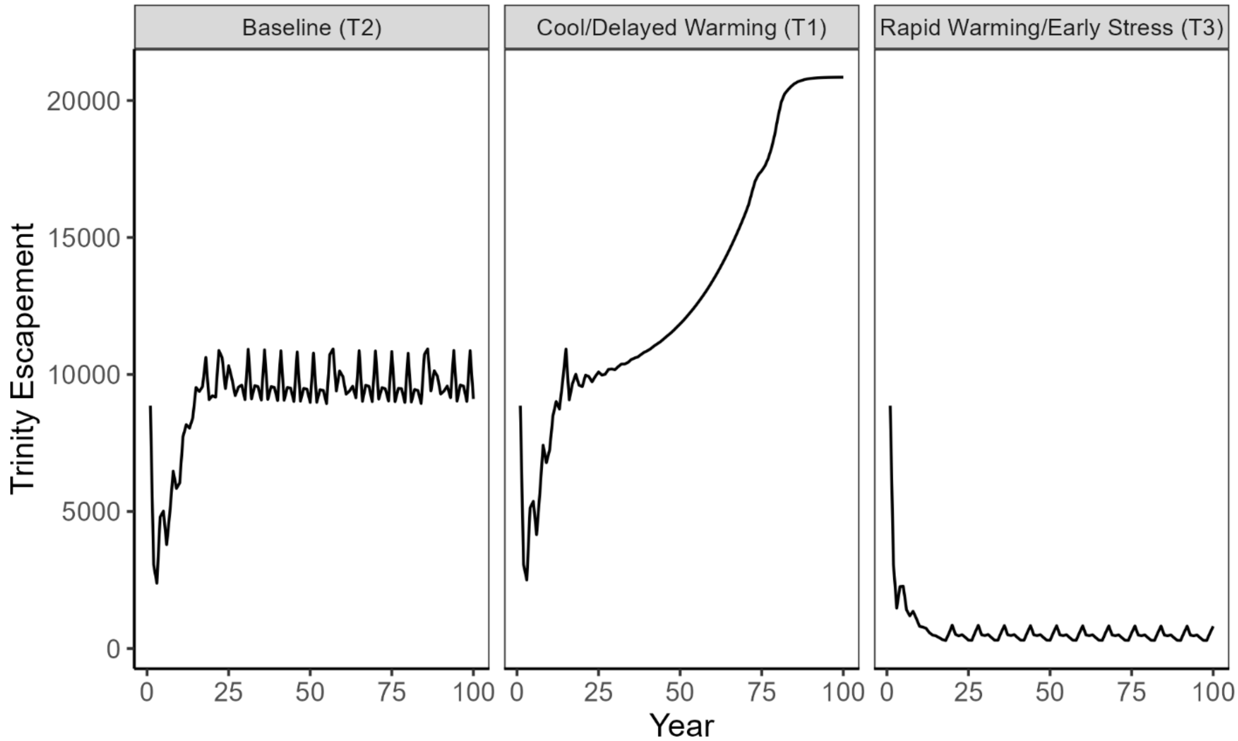

Figure 38. Time series of modeled Trinity River Chinook escapement under three rearing temperature scenarios. Scenarios vary the timing and duration of cold, optimal, transitional, warm, and stress temperature conditions throughout the rearing season, each affecting juvenile growth and survival rates. 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.

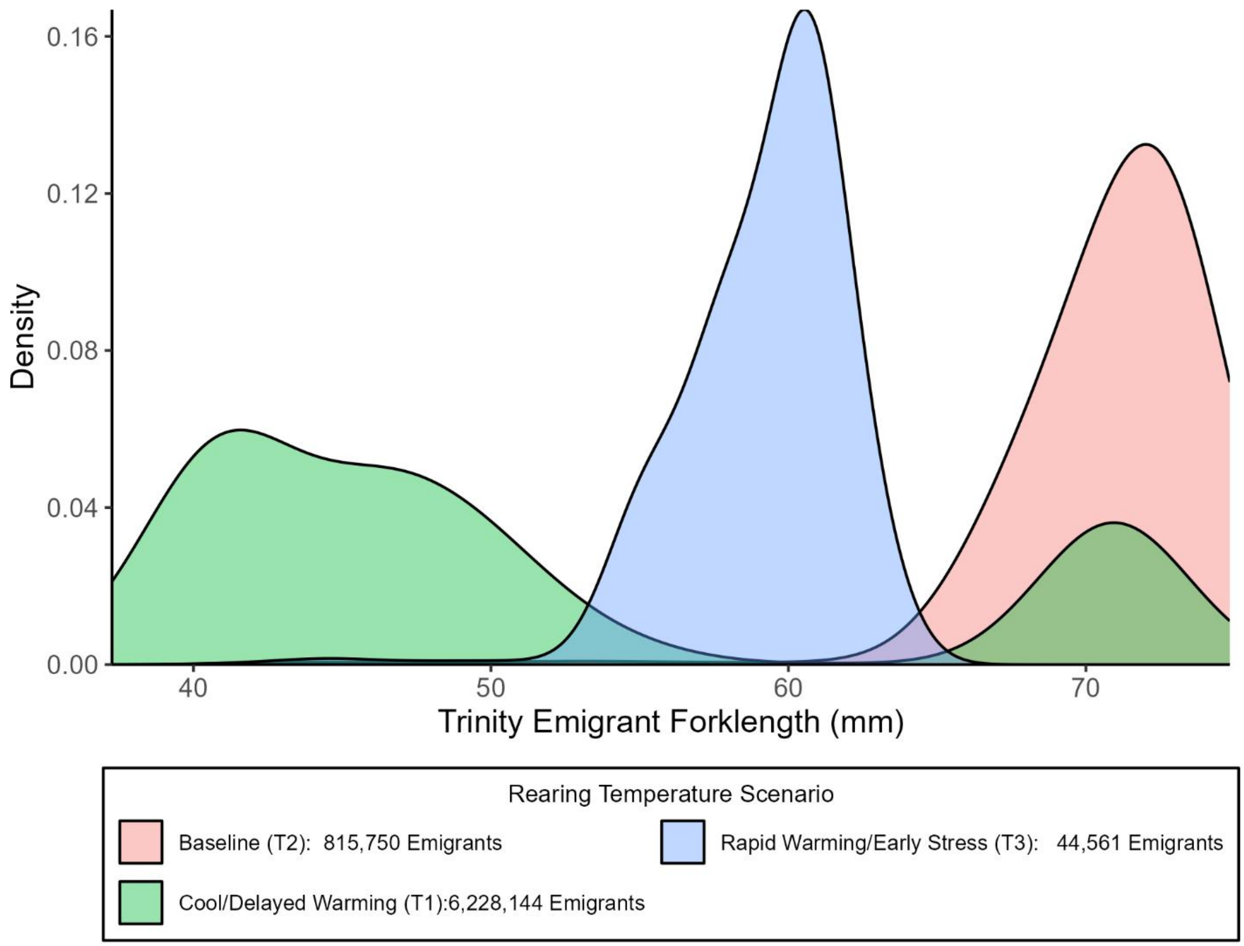

Figure 39. Density distribution of Trinity River Chinook emigrant size under three rearing temperature scenarios. Scenarios vary the timing and duration of cold, optimal, transitional, warm, and stress temperature conditions throughout the rearing season, each affecting juvenile growth and survival rates. 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.

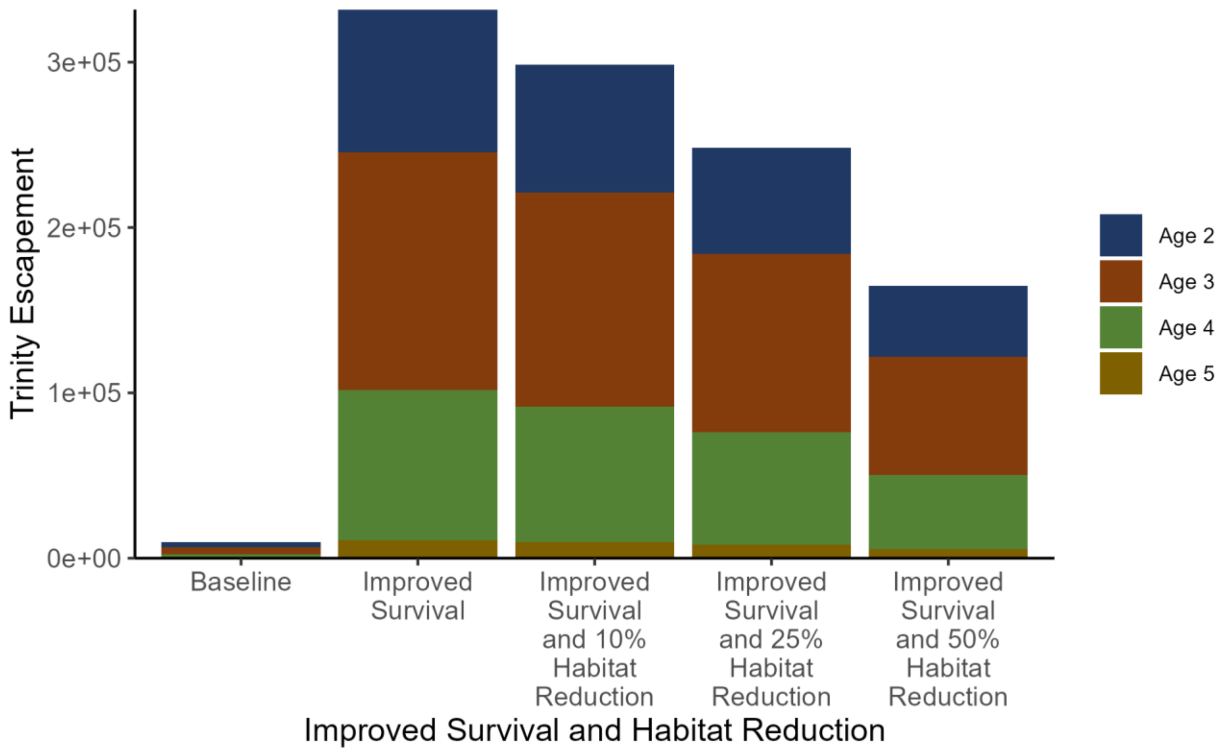

Figure 40. Ten-year average (simulation years 90–100) of modeled Trinity River Chinook escapement under five scenarios. The baseline scenario uses observed emigration and immigration survival rates and baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish). The improved survival scenario increases emigration and immigration survivals and environmental conditions while retaining baseline habitat capacities. Subsequent scenarios apply improved survivals while reducing all habitat capacities by 10%, 25%, and 50%. All other model parameters were held constant.

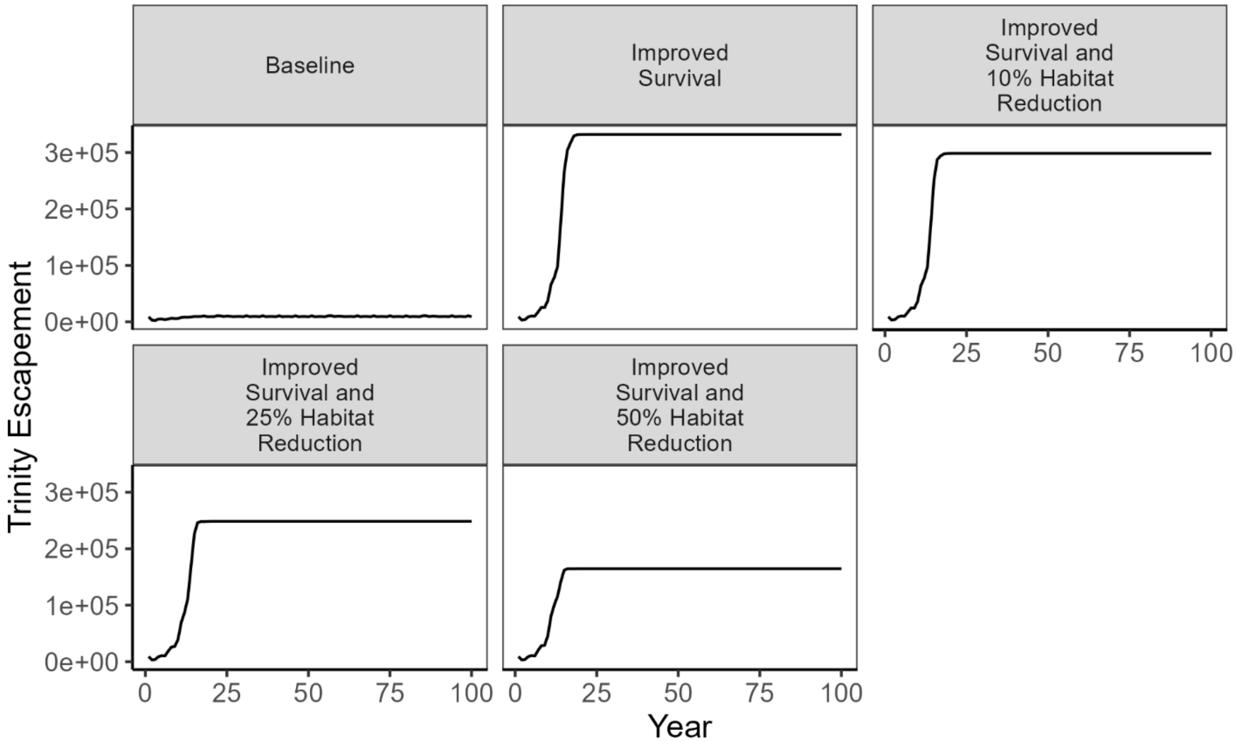

Figure 41. Time series of modeled Trinity River Chinook escapement under five scenarios. The baseline scenario uses observed emigration and immigration survival rates and baseline habitat capacities (rearing: 300,000 m², spawning: 350,000 m², holding: 10,000 fish). The improved survival scenario increases emigration and immigration survivals and environmental conditions while retaining baseline habitat capacities. Subsequent scenarios apply improved survivals while reducing all habitat capacities by 10%, 25%, and 50%. All other model parameters were held constant.

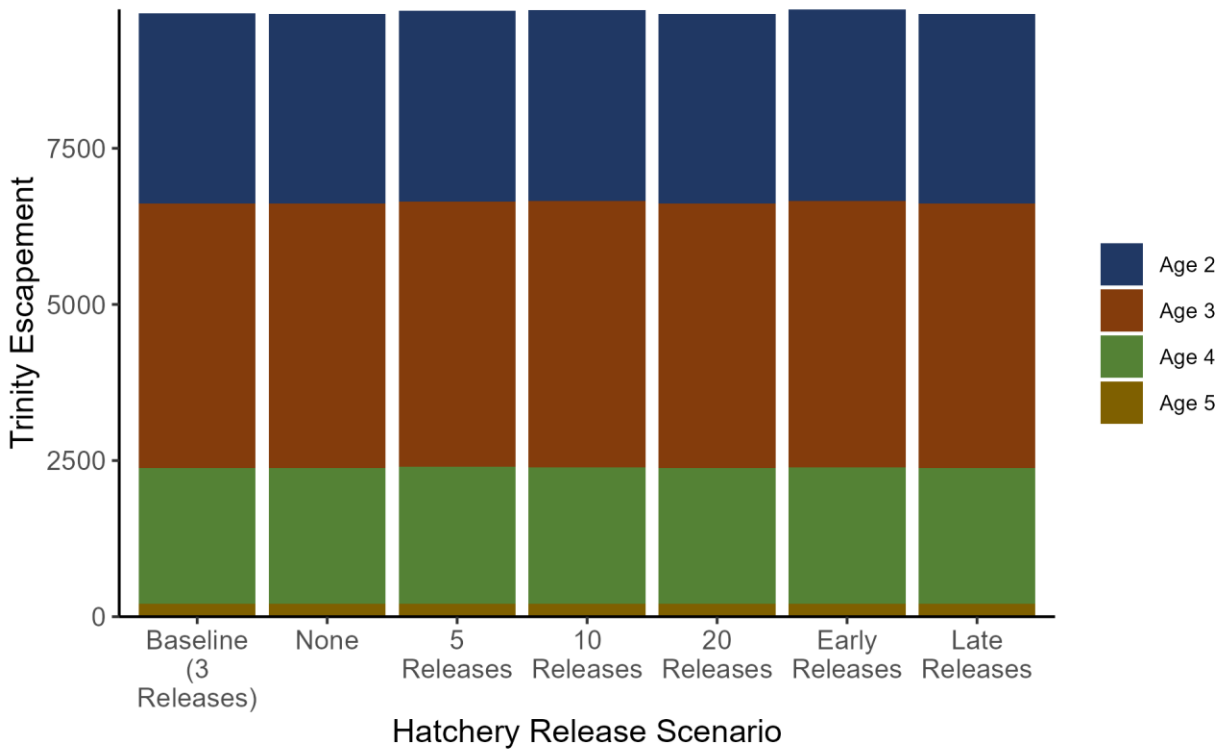

Figure 42. Ten-year average (simulation years 90–100) of modeled Trinity River Chinook escapement under seven hatchery release schedule scenarios. The baseline scenario consists of three releases totaling 2,000 fish across weeks 5–16. Additional scenarios include no hatchery releases, and increased release schedules of 5, 10, and 20 releases totaling 50,000, 151,000, and 317,000 fish respectively, distributed across reaches and the rearing season. Two additional scenarios test the timing effect by concentrating 22 releases of approximately 440,000 fish early in the season (weeks −2 through 10) or late in the season (weeks 13–22). All other model parameters were held constant.

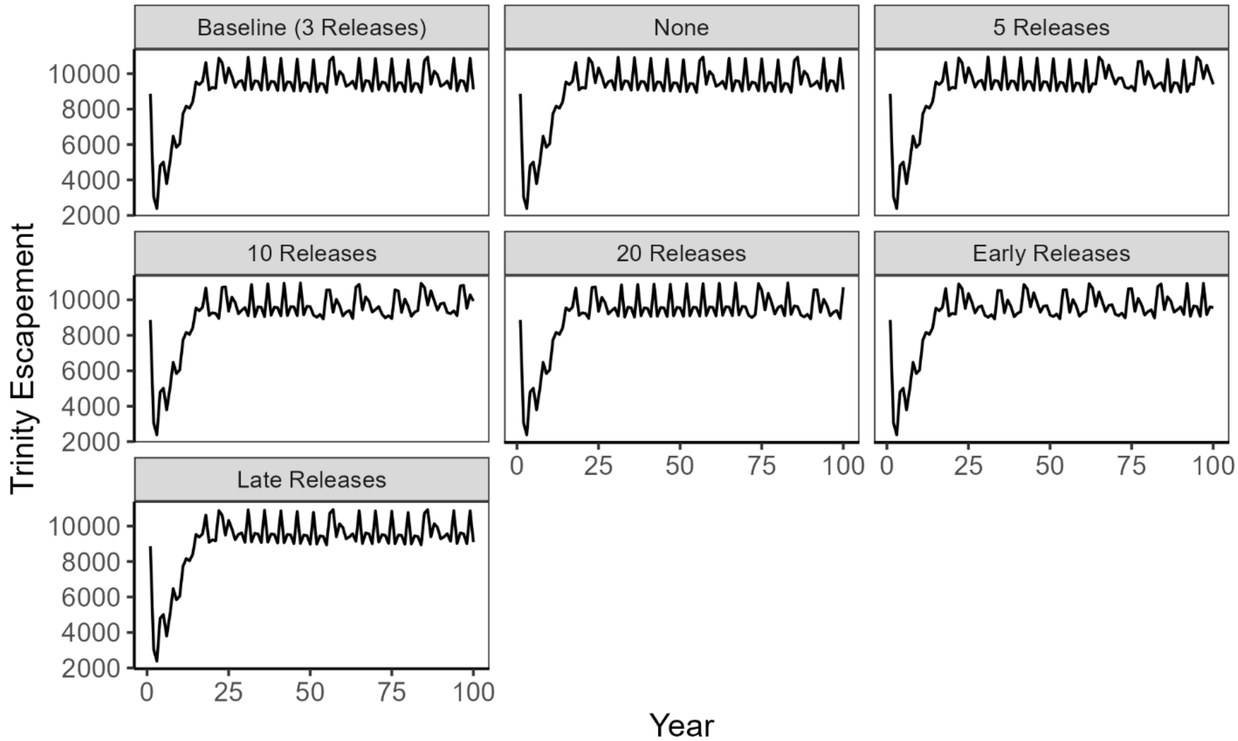

Figure 43. Time series of modeled Trinity River Chinook escapement under seven hatchery release schedule scenarios. The baseline scenario consists of three releases totaling 2,000 fish across weeks 5–16. Additional scenarios include no hatchery releases, and increased release schedules of 5, 10, and 20 releases totaling 50,000, 151,000, and 317,000 fish respectively, distributed across reaches and the rearing season. Two additional scenarios test the timing effect by concentrating 22 releases of approximately 440,000 fish early in the season (weeks −2 through 10) or late in the season (weeks 13–22). All other model parameters were held constant.

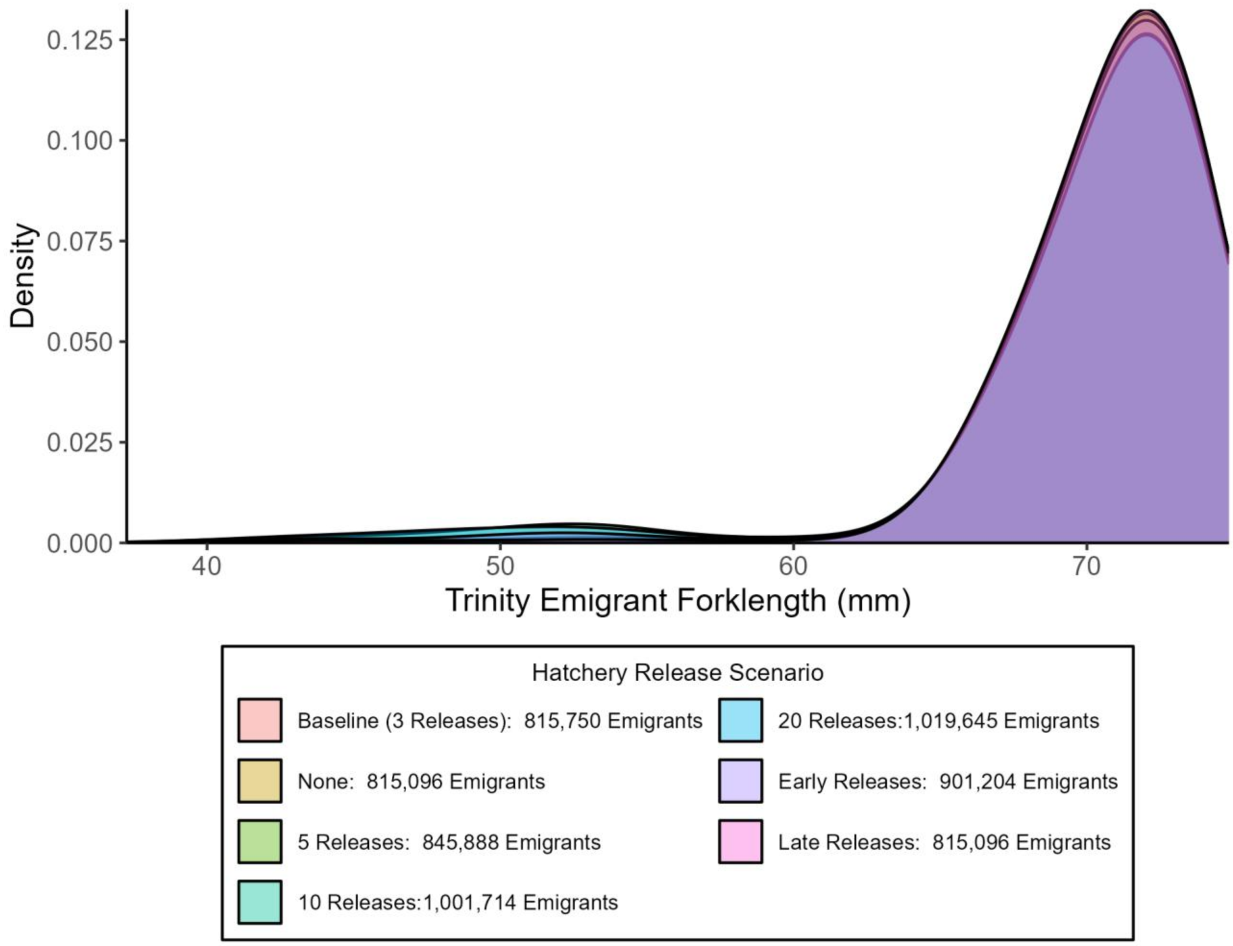

Figure 44. Density distribution of Trinity River Chinook emigrant size under seven hatchery release schedule scenarios. The baseline scenario consists of three releases totaling 2,000 fish across weeks 5–16. Additional scenarios include no hatchery releases, and increased release schedules of 5, 10, and 20 releases totaling 50,000, 151,000, and 317,000 fish respectively, distributed across reaches and the rearing season. Two additional scenarios test the timing effect by concentrating 22 releases of approximately 440,000 fish early in the season (weeks −2 through 10) or late in the season (weeks 13–22). All other model parameters were held constant.

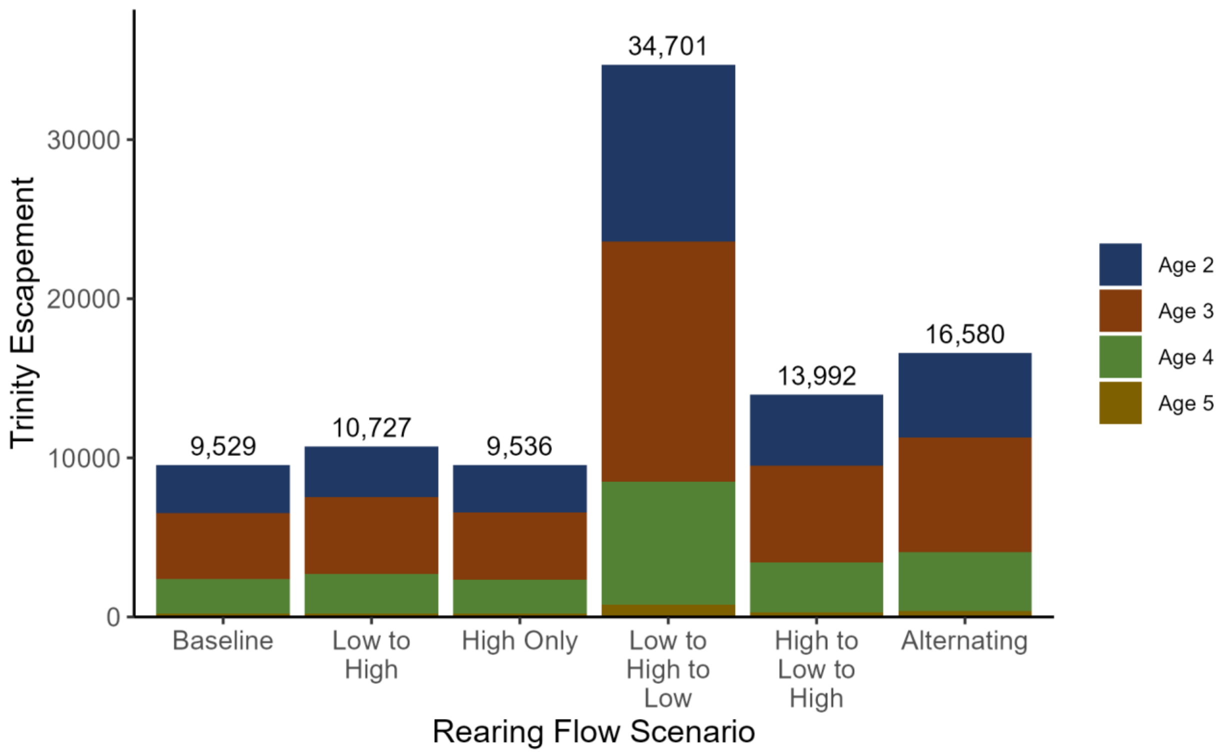

Figure 45. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six rearing flow scenarios differing in weekly flow sequence (Low, Moderate, High) and associated rearing capacity by reach. Baseline uses a fixed capacity with a moderate–high–moderate–low flow pattern; the remaining scenarios use a flow-sensitive capacity (scaled 0.4–1.25 across reaches) under Low to High, High Only, Low to High to Low, High to Low to High, and Alternating flow sequences. All other model parameters were held constant.

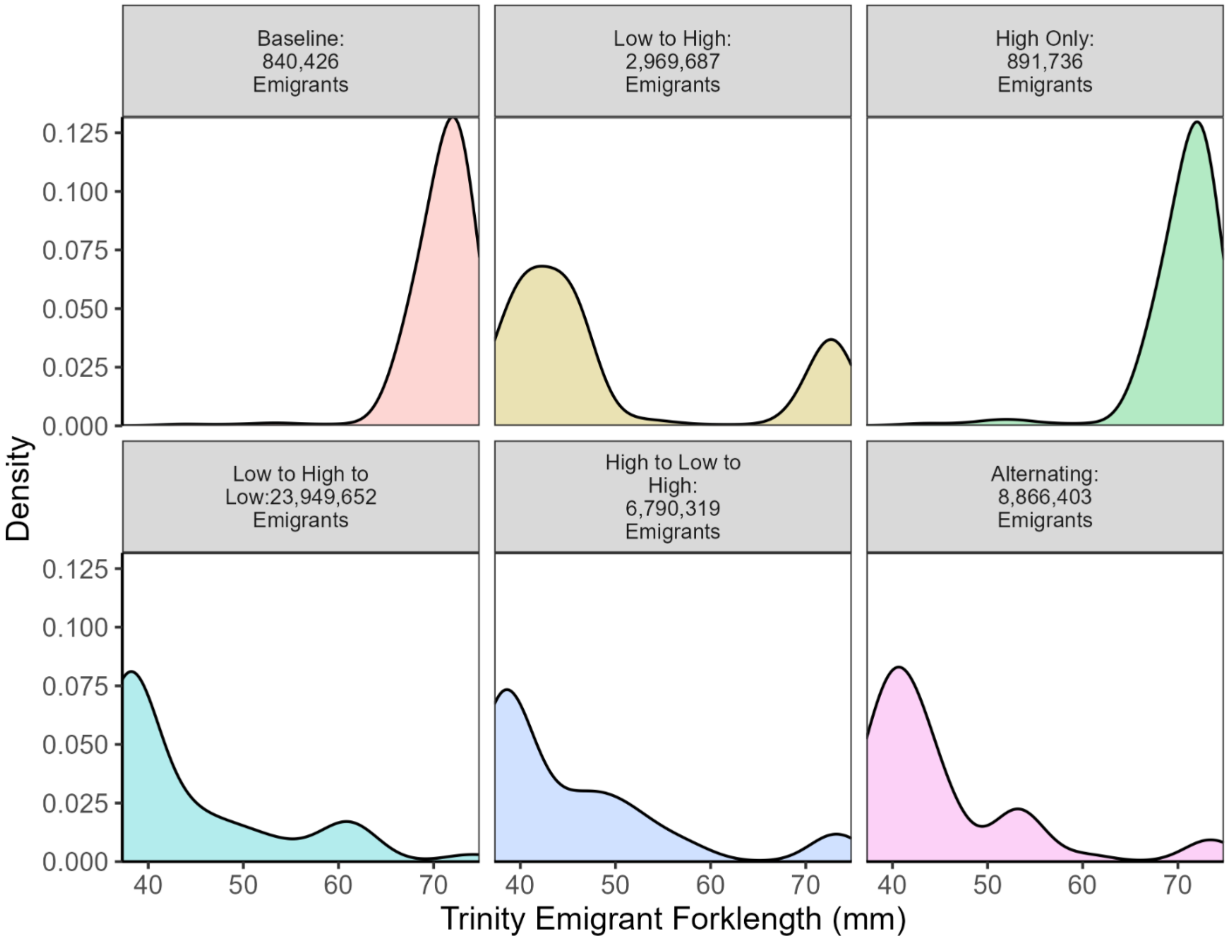

Figure 46. Density distribution of Trinity River Chinook emigrant size escapement under six rearing flow scenarios differing in weekly flow sequence (Low, Moderate, High) and associated rearing capacity by reach. Baseline uses a fixed capacity with a moderate–high–moderate–low flow pattern; the remaining scenarios use a flow-sensitive capacity (scaled 0.4–1.25 across reaches) under Low to High, High Only, Low to High to Low, High to Low to High, and Alternating flow sequences. All other model parameters were held constant.

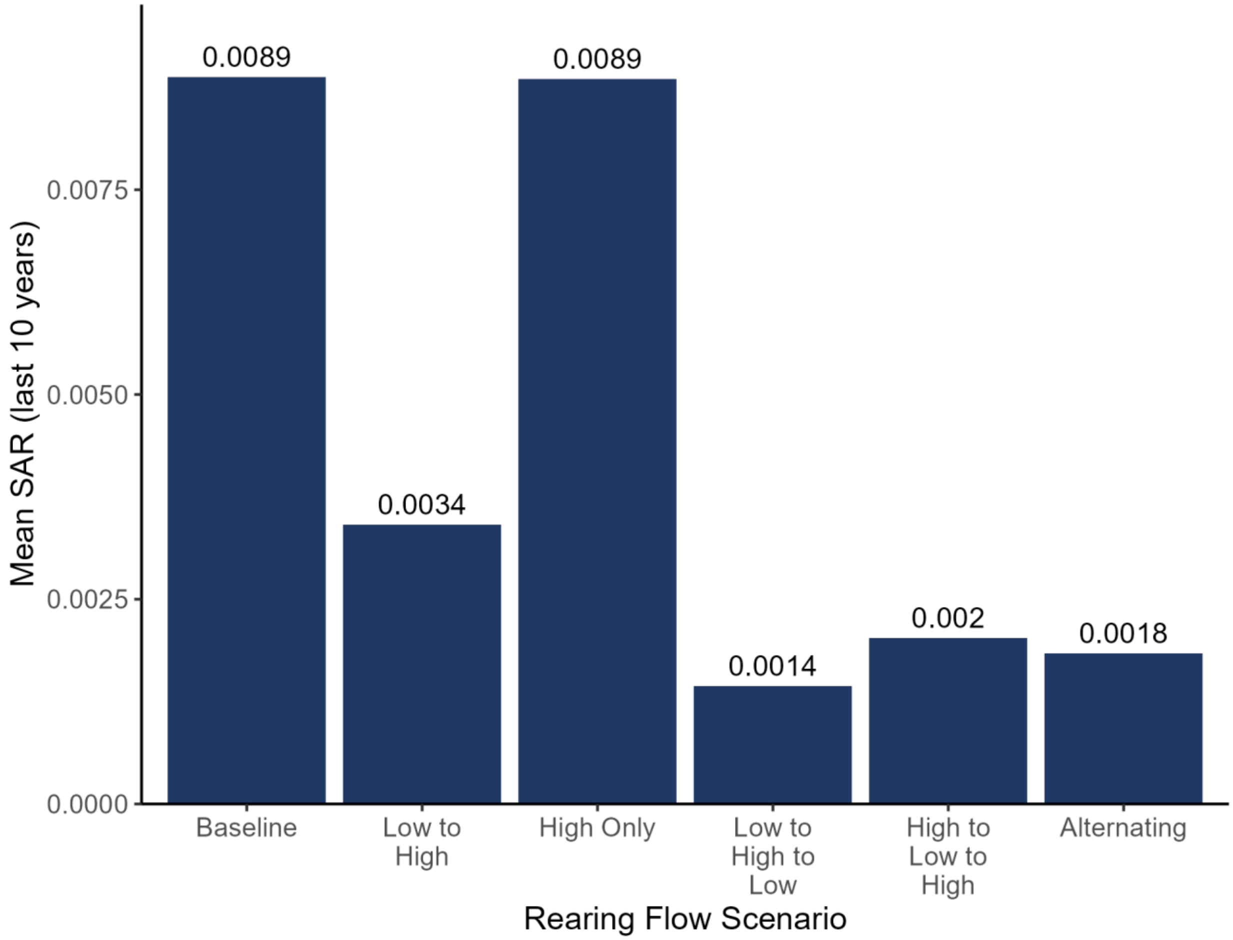

Figure 47. Smolt-to-Adult return ratio of Trinity River Chinook under six rearing flow scenarios differing in weekly flow sequence (Low, Moderate, High) and associated rearing capacity by reach. Baseline uses a fixed capacity with a moderate–high–moderate–low flow pattern; the remaining scenarios use a flow-sensitive capacity (scaled 0.4–1.25 across reaches) under Low to High, High Only, Low to High to Low, High to Low to High, and Alternating flow sequences. All other model parameters were held constant.

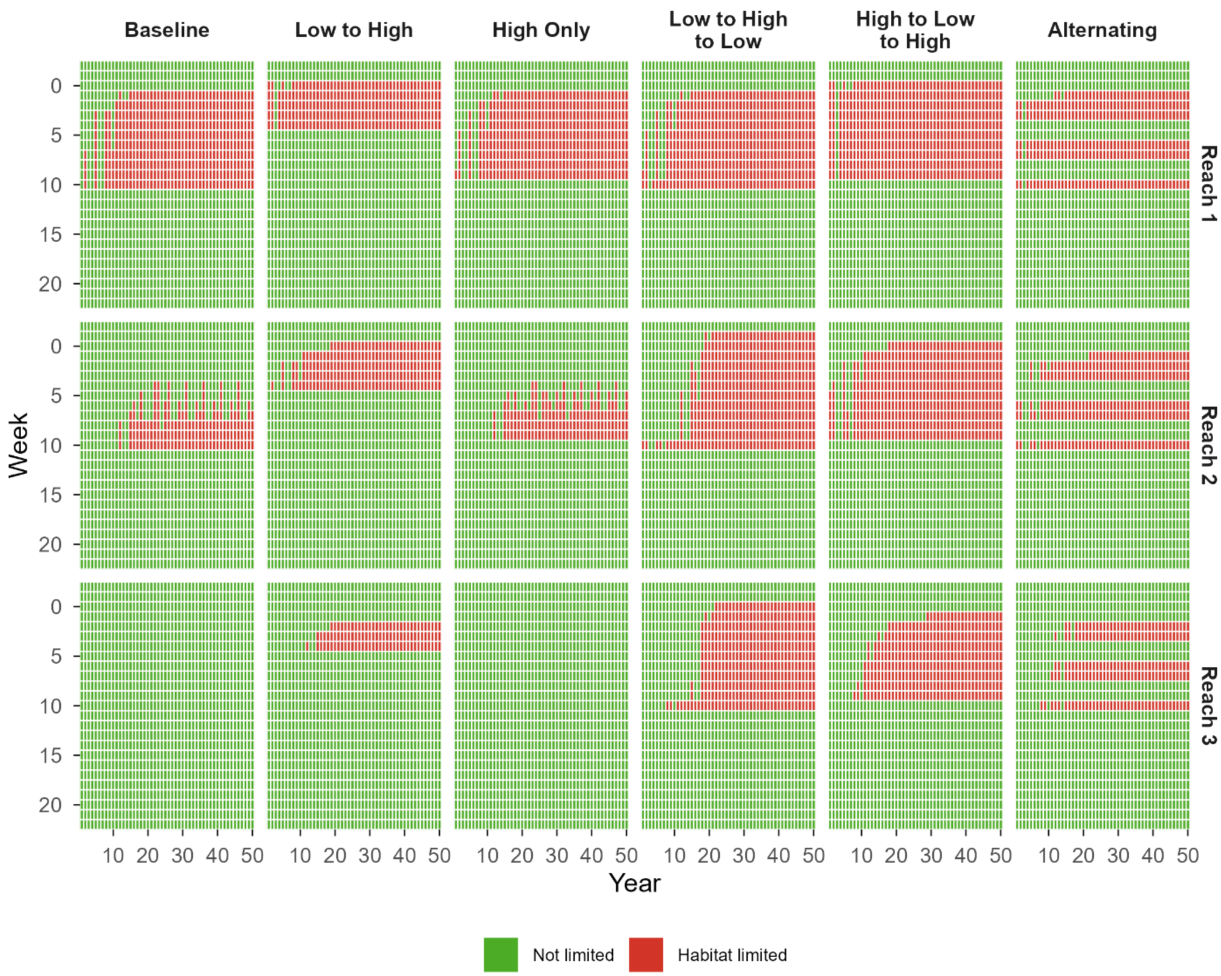

Figure 48. Rearing habitat limitation by year, week, and reach under six rearing habitat flow scenarios. Baseline uses a fixed capacity with a moderate–high–moderate–low flow pattern; the remaining scenarios use a flow-sensitive capacity (scaled 0.4–1.25 across reaches) under Low to High, High Only, Low to High to Low, High to Low to High, and Alternating flow sequences. All other model parameters were held constant.

Outmigration, estuary, and early marine survival

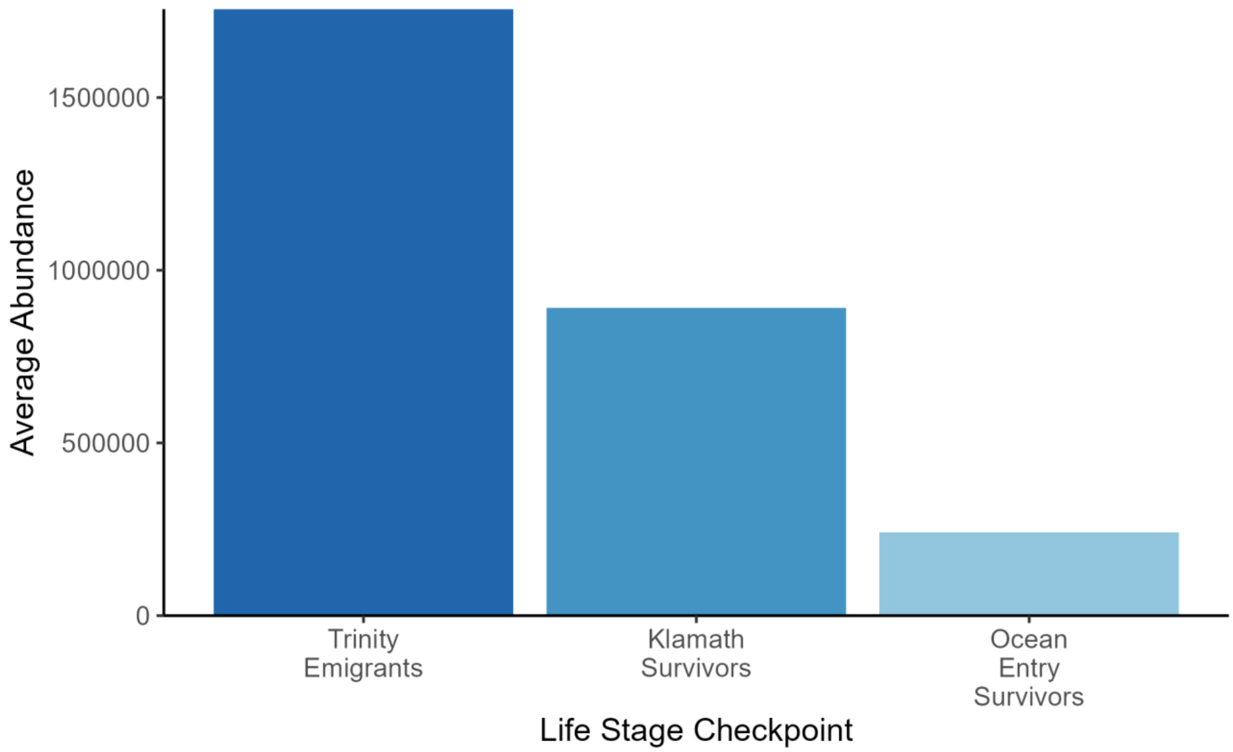

Figure 49. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook abundance at three life stage checkpoints under baseline conditions. Trinity Emigrants represent fish that survived Trinity River immigration and entered the Klamath River, Klamath Survivors represent fish that completed Klamath River migration and reached ocean entry, and Ocean Entry Survivors represent fish that survived ocean entry to age 2. All other model parameters were held constant.

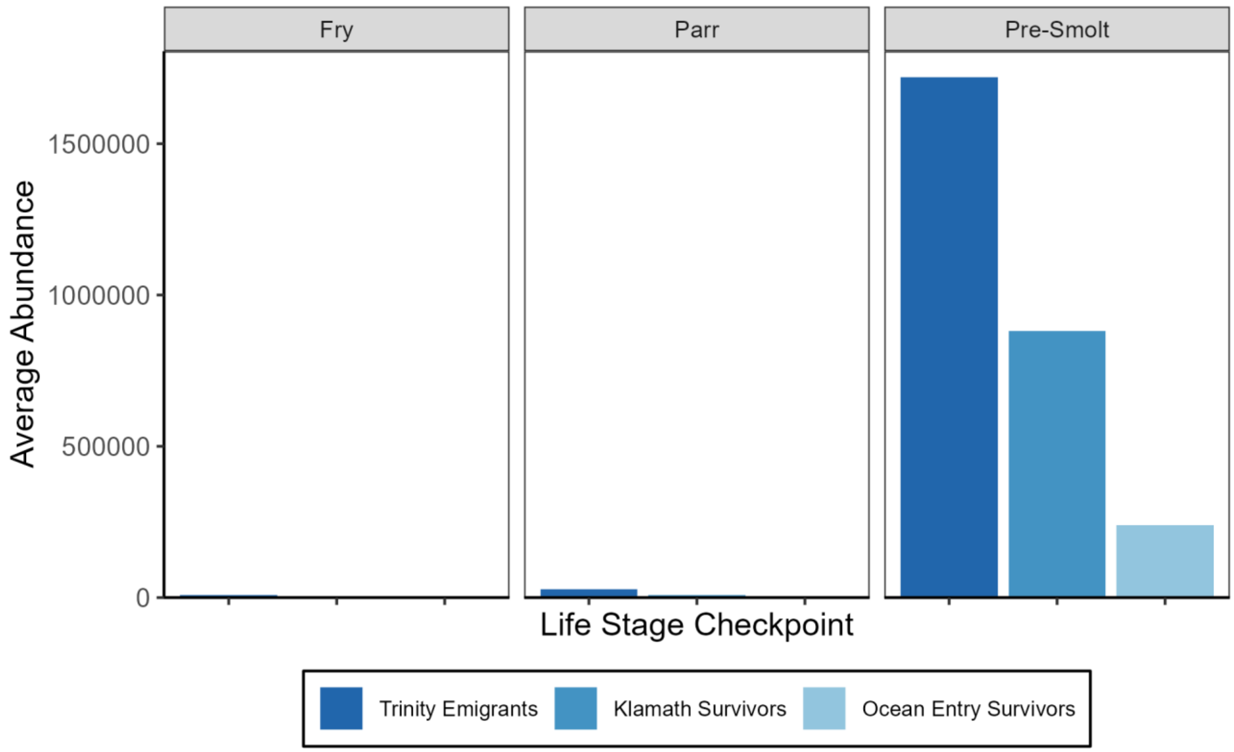

Figure 50. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook abundance at three life stage checkpoints under baseline conditions, stratified by emigrating size class (fry, parr, and pre-smolt). Trinity Emigrants represent fish that survived Trinity River immigration and entered the Klamath River, Klamath Survivors represent fish that completed Klamath River migration and reached ocean entry, and Ocean Entry Survivors represent fish that survived ocean entry to age 2. All other model parameters were held constant.

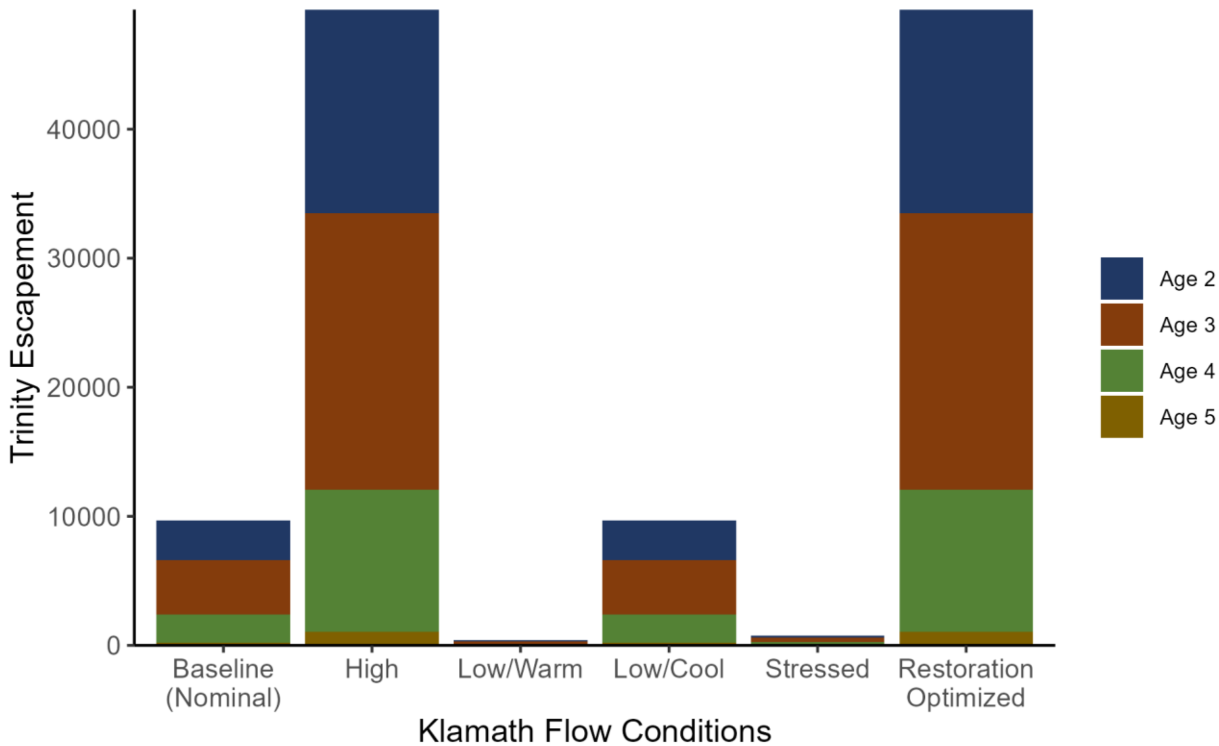

Figure 51. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under six Klamath River flow condition scenarios. Flow conditions influence temperature and disease survival of emigrating juveniles, ranging from stressed conditions with extreme temperatures and high disease mortality to restoration-optimized conditions with cool temperatures and no disease mortality. All other model parameters were held constant.

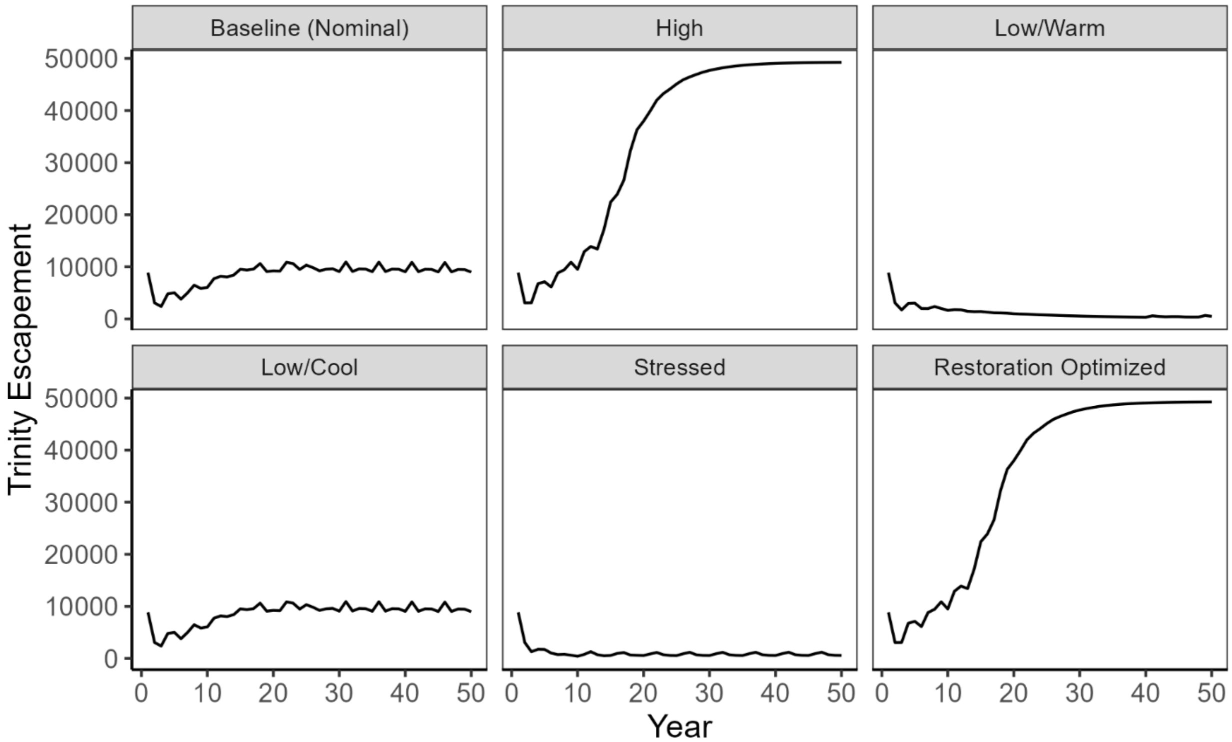

Figure 52. Time series of modeled Trinity River Chinook escapement under six Klamath River flow condition scenarios. Flow conditions influence temperature and disease survival of emigrating juveniles, ranging from stressed conditions with extreme temperatures and high disease mortality to restoration-optimized conditions with cool temperatures and no disease mortality. All other model parameters were held constant.

Ocean maturation and survival

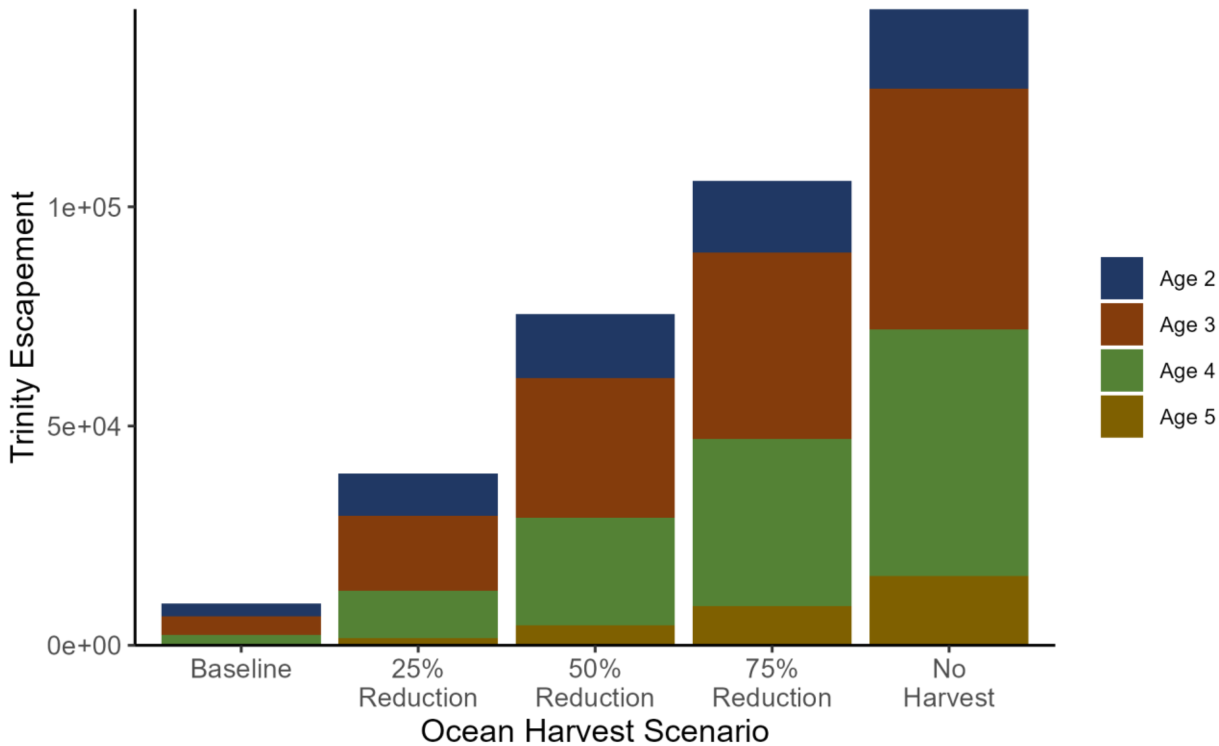

Figure 53. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five ocean harvest scenarios. Baseline harvest is then reduced by 25, 50, 75, and 100% for the other scenarios. All other model parameters were held constant. The baseline ocean harvest for each age 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.

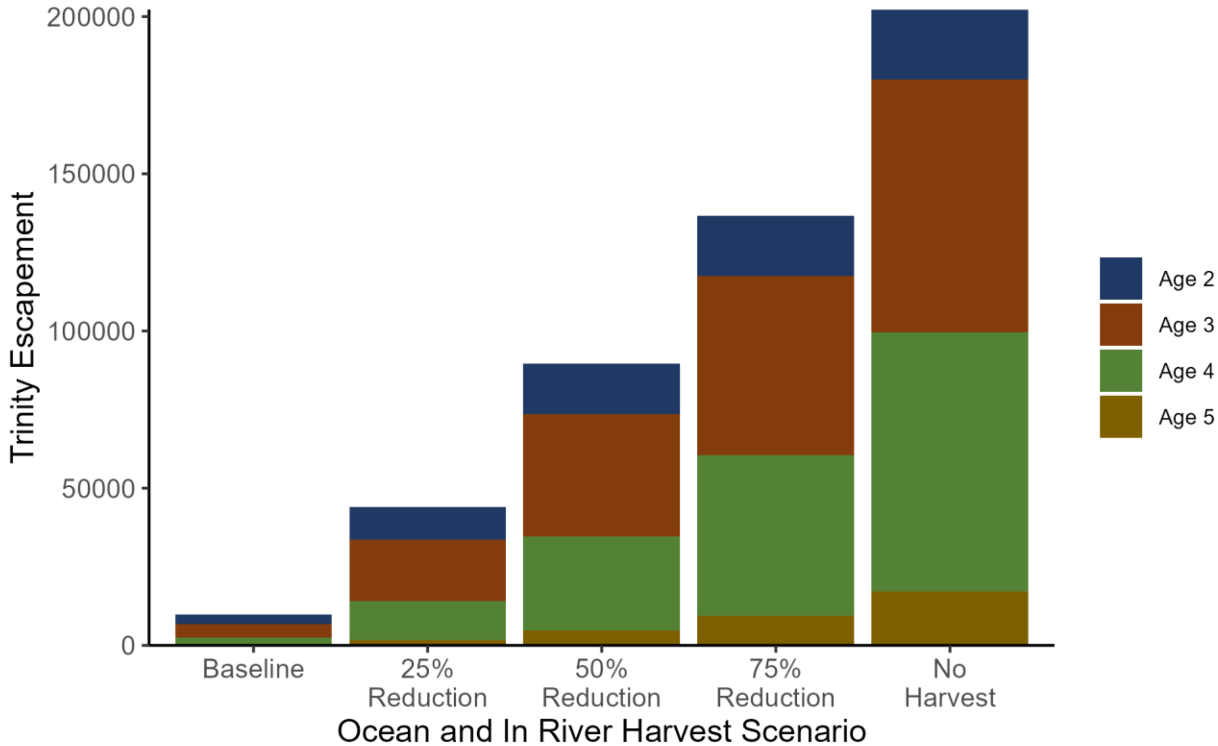

Figure 54. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under five ocean and in-river harvest scenarios. Baseline harvest is then reduced by 25, 50, 75, and 100% for the other scenarios. All other model parameters were held constant. The baseline harvest for each 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. The baseline in-river harvest impacts for each age class are as follows: Age 2 is 20%, Age 3 is 33%, Age 4 is 33%, and Age 5 is 10%.

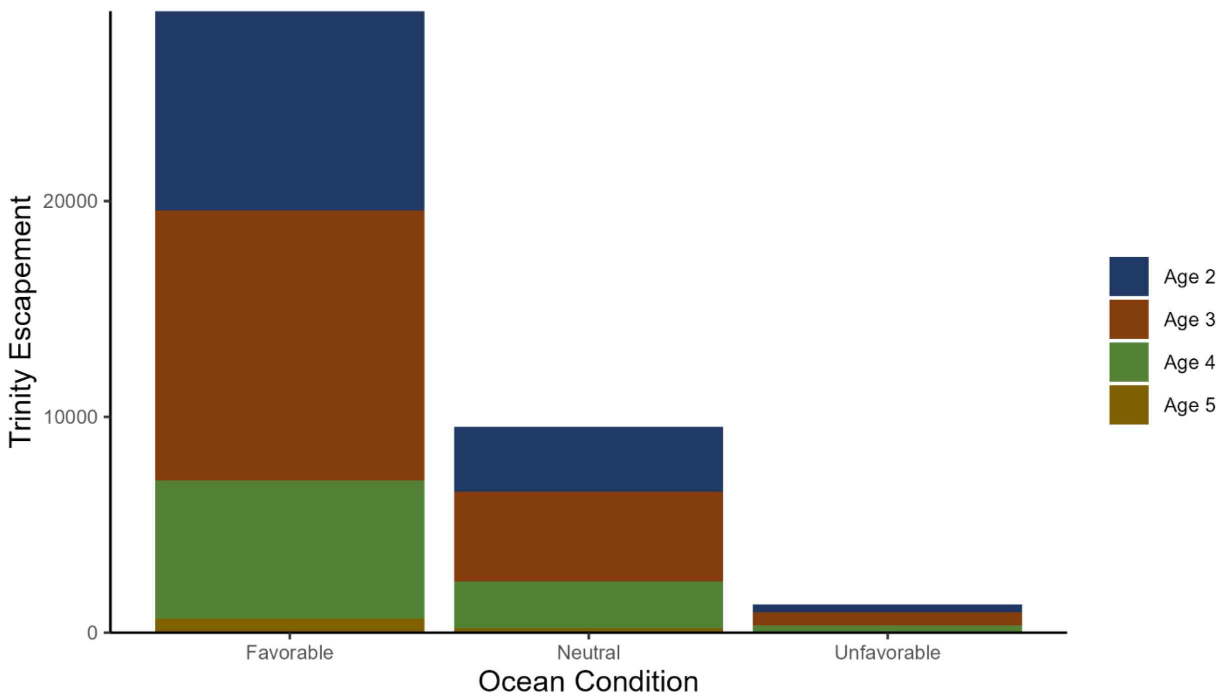

Figure 55. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook escapement under three ocean condition scenarios. Baseline ocean condition is Favorable. Ocean condition affects ocean entry survival regardless of entry timing and size. All other model parameters were held constant.

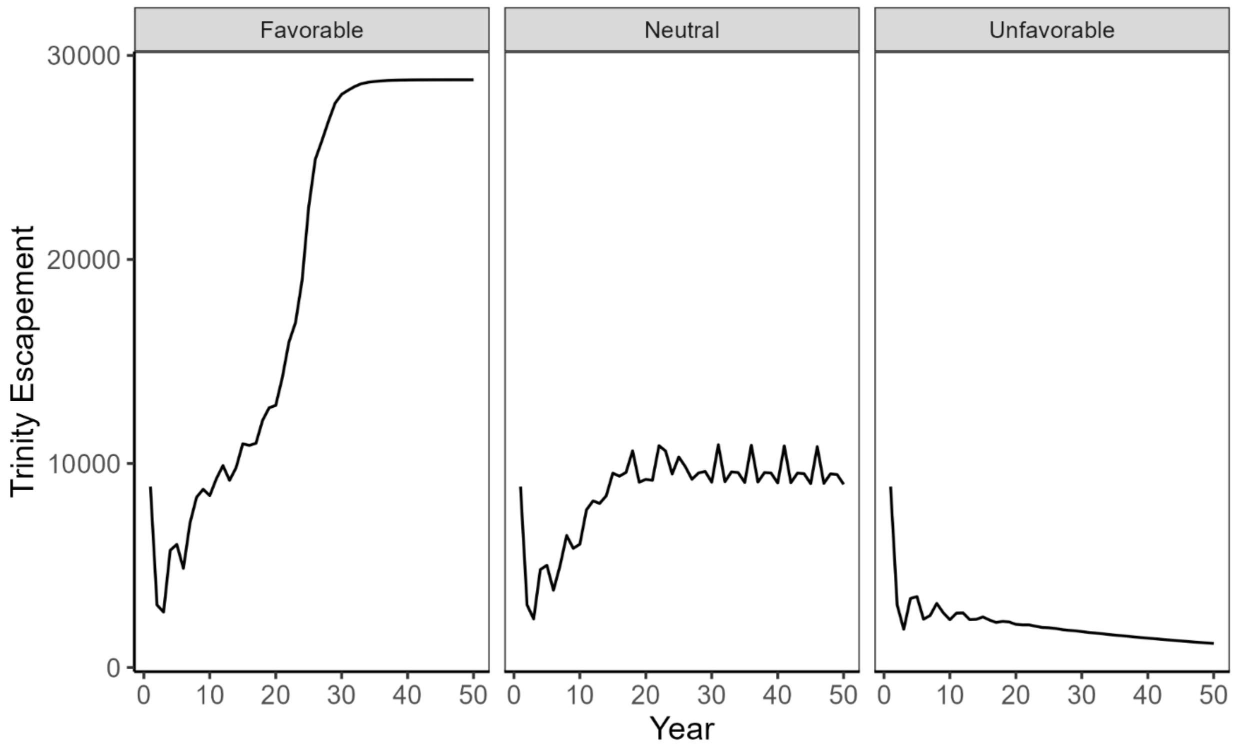

Figure 56. Time series of modeled Trinity River Chinook escapement under three ocean condition scenarios. Baseline ocean condition is Favorable. Ocean condition affects ocean entry survival regardless of entry timing and size. All other model parameters were held constant.

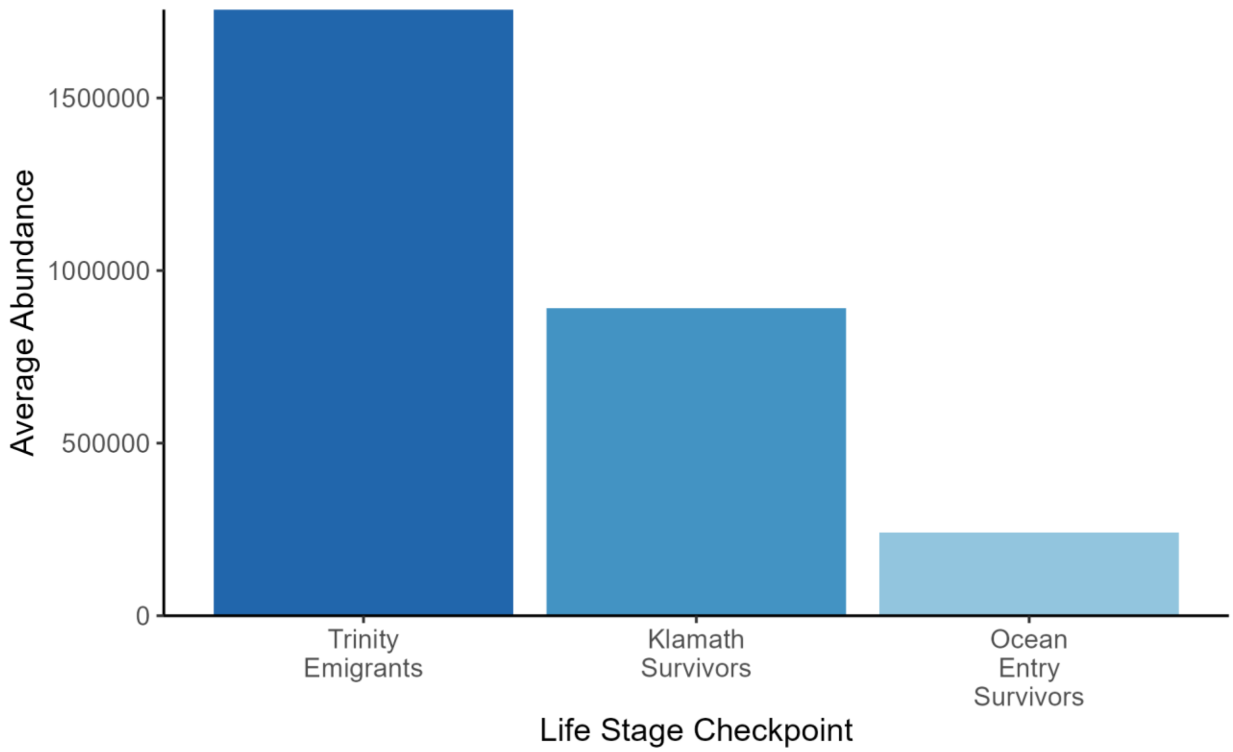

Figure 57. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook abundance at three life stage checkpoints under baseline conditions. Trinity Emigrants represent fish that survived Trinity River immigration and entered the Klamath River, Klamath Survivors represent fish that completed Klamath River migration and reached ocean entry, and Ocean Entry Survivors represent fish that survived ocean entry to age 2. All other model parameters were held constant.

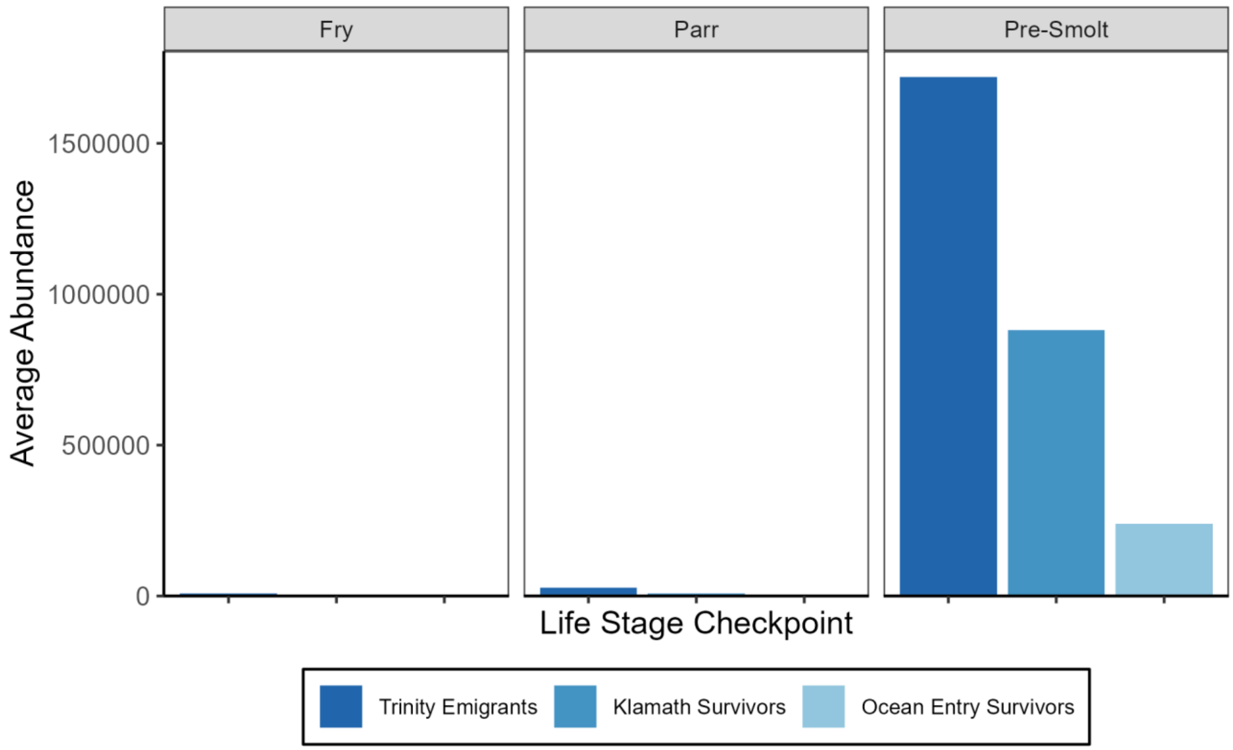

Figure 58. Ten-year average (simulation years 40–50) of modeled Trinity River Chinook abundance at three life stage checkpoints under baseline conditions, stratified by emigrating size class (fry, parr, and pre-smolt). Trinity Emigrants represent fish that survived Trinity River immigration and entered the Klamath River, Klamath Survivors represent fish that completed Klamath River migration and reached ocean entry, and Ocean Entry Survivors represent fish that survived ocean entry to age 2. All other model parameters were held constant.

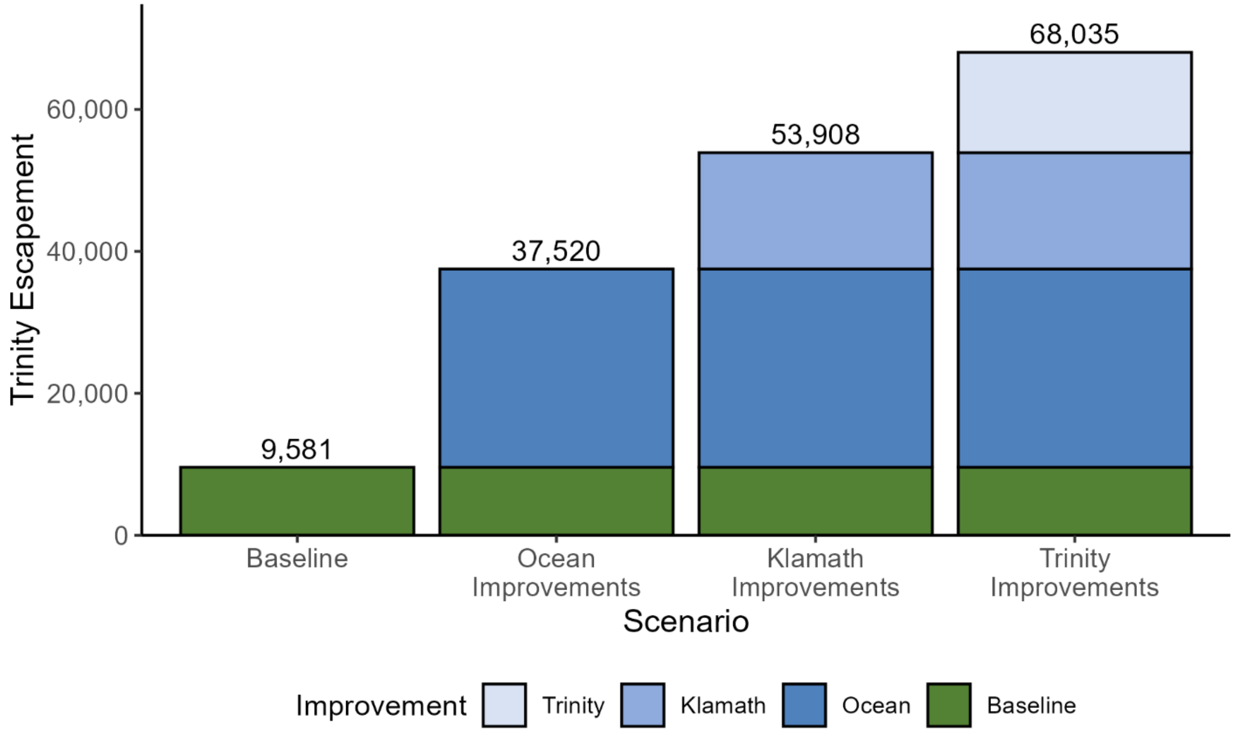

Figure 59. Trinity River escapement under four management scenarios showing cumulative contributions from baseline conditions (green), ocean improvements (dark blue), Klamath River improvements (blue), and Trinity River improvements (light blue).