APPENDIX D. CALIBRATION AND TUNING

This appendix supports the Limiting Factors Analysis for Lower Trinity River Chinook salmon (*Oncorhynchus tshawytscha*) prepared for the Trinity River Restoration Program. The analysis applies the general method of Hamilton and Murphy (2018), which uses a life-cycle framework to organize potential limiting factors by life stage, identify hypothesized drivers and causes, and evaluate the data needed to parameterize and test those hypotheses. This appendix describes the calibration and tuning steps used to ensure the model represents current conditions for Trinity River Chinook salmon.

Calibration and Tuning Checkpoints

The model was tuned and calibrated so that baseline conditions closely matched observed Trinity River natural-origin escapement, emigration abundance, and smolt-to-adult return (SAR) rates; these calibration checkpoints are summarized in Table 1.

Table 1. Calibration checkpoints used to compare observed Trinity River Chinook salmon data with modeled baseline conditions.

Calibration Checkpoint	Observed Period	Observed Mean	Observed Median	Modeled Baseline	Notes
Natural-origin escapement	2015–2021	9,877	10,088	9,529 mean escapement	Spring- and fall-run natural-origin jack and adult escapement combined.
Age-0 emigration abundance	2015–2021, excluding 2020	1,004,389	886,754	872,910 mean emigrants	Willow Creek rotary screw trap estimates; 2020 excluded because of known data-collection issues.
Smolt-to-adult return rate	Brood years 2010–2016	0.008	0.006	0.009 mean and median SAR	Modeled value summarized over the last 10 complete simulated brood years.

Trinity River annual escapement data were drawn from the 2023–2024 Trinity River Basin Salmon and Steelhead Monitoring Project Annual Report (Kier et al. 2025; Appendices 4 and 8). From 2015 through 2021, annual natural-origin jack and adult escapement in the Trinity River, across both runs combined, ranged from 5,523 individuals in 2016 to 15,115 individuals in 2018. Median escapement was 10,088 individuals, and mean escapement was 9,877 individuals. After tuning and calibration, the model produces a mean escapement of 9,529 individuals over the last 10 years of the simulation with baseline inputs.

Emigration abundance was calibrated using estimates for age-0 natural-origin Chinook salmon at the Willow Creek rotary screw trap (RST), drawn from Appendix B of the *Long-Term Analyses of Estimates of Abundance of Juvenile Chinook Salmon on the Trinity River, 1989–2018* (Pinnix et al. 2022). Calibration data were taken from 2015 through 2021, with 2020 excluded because of known data-collection issues. Within this period, emigration abundance ranged from 520,135 individuals in 2021 to 1,832,183 individuals in 2018. Median abundance was 886,754 individuals, and mean abundance was 1,004,389 individuals. After tuning and calibration, the model produces a mean emigration abundance of 872,910 individuals over the last 10 years of the simulation with baseline conditions.

The final calibration checkpoint was the SAR rate by brood year. Calculating SAR required separating escapement by natural origin and age class. Spring- and fall-run natural-origin escapement were drawn from the escapement data described above (Kier et al. 2025; Appendices 4 and 8). Age-class structure for spring-run Chinook salmon was calculated using returns to the Trinity River Hatchery, while age-class structure for fall-run Chinook salmon was determined using Table 5 from the Klamath River fall-run Chinook salmon age-specific escapement, river harvest, and run-size estimate reports for escapement years 2012 through 2021, covering brood years 2010 through 2016 (KRTT 2013–2022). Brood year was then calculated from escapement year and age class at return. Smolt abundance data used in the SAR calculation came from Appendix B of Pinnix et al. (2022). After merging the escapement and emigration datasets by brood year, SAR was calculated as escapement divided by emigrating smolts for each brood year. For brood years 2010 through 2016, the median observed SAR was 0.006, and the mean was 0.008. After tuning and calibration, the model produces a mean and median SAR of 0.009 over the last 10 complete brood years simulated (model brood years 37–46) with baseline conditions.

During tuning and calibration, model parameters were iteratively adjusted until output converged on these three empirical checkpoints.

Calibration and Tuning Methods

Because of uncertainty and known overestimation in habitat-capacity data for holding pools, spawning habitat, and rearing habitat, the model was initially tuned and calibrated so that habitat was not limiting. Once the model produced expected results, holding, spawning, and rearing habitat capacities were reduced to more realistic values. Some parameters were known with confidence and were not altered during tuning and calibration.

To achieve the escapement, emigration, and SAR estimates described above, several parameters were adjusted during tuning and calibration. Klamath River immigration survival was slightly decreased for fall-run Chinook salmon, while Trinity River immigration survival was increased for spring-run Chinook salmon. The egg-to-fry survival multiplier for egg quality at ages 3 and 4 was slightly decreased. The fine-sediment and hydrologic-disturbance egg-to-fry survival multipliers were both decreased, but only for Reach 1. Incubation survival was also slightly decreased. Base rearing survival in the Trinity River was adjusted with caution because this rate is applied weekly and the model is highly sensitive to small changes in its value. Klamath River

emigration exposure survival by entry timing and size was decreased across all size classes and entry-timing combinations. Ocean-entry survival was greatly decreased for smaller size classes, and ocean adult survival was also decreased.

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