BUREAU OF RECLAMATION

Water Year 2024 Seasonal Report for Old and Middle River Flow Management

Appendix H- Winter-Run Chinook Salmon Cohort Report (Brood Year 2023)

Cover Photo: Male Chinook Salmon on Clear Creek (Credit: Brandon Honig, USFWS)

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Background

Sacramento River winter-run Chinook salmon (Oncorhynchus tshawytscha; WRCS) are a federal- and state- listed endangered species. Adults typically arrive in the Upper Sacramento in December-January, with spawning occurring in the Upper Sacramento River and its tributaries between April and August, and redds beginning to form in June. Juveniles begin to enter the Delta in the Fall, when Old and Middle River (OMR) Flow Management Season starts. This summary describes select biological metrics for the upstream life stages of WRCS, providing context for observations in the Delta during OMR Flow Management Season.

Water year 2023 was designated as wet for the Sacramento Valley based on unimpaired Sacramento Valley runoff and was a Tier 1 year for the duration of water temperature management season (Sufficient volume of cold water to target 53.5°F or lower starting May 15 through October 31). See the 2023 Shasta Coldwater Pool Management Seasonal Report (USBR 2024) for additional background about environmental and biological conditions

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Escapement

Escapement estimates represent the number of adult WRCS that successfully migrated from the ocean upstream to natural spawning habitat or to the hatchery, and that are potentially able to spawn. Escapement does not take into account pre-spawn mortality (Azat and Killam 2024). Estimates are summarized on GrandTab from escapement survey data collected by the California Department of Fish and Wildlife (CDFW), including numerous methodologies such as carcass and aerial redd surveys, video surveys, and snorkel surveys. For BY 2023, Sacramento River system-wide WR Chinook salmon survival (escapement) was 2,482. This value is lower than the 10-year average escapement value of 4,807, and lower than the previous four years.

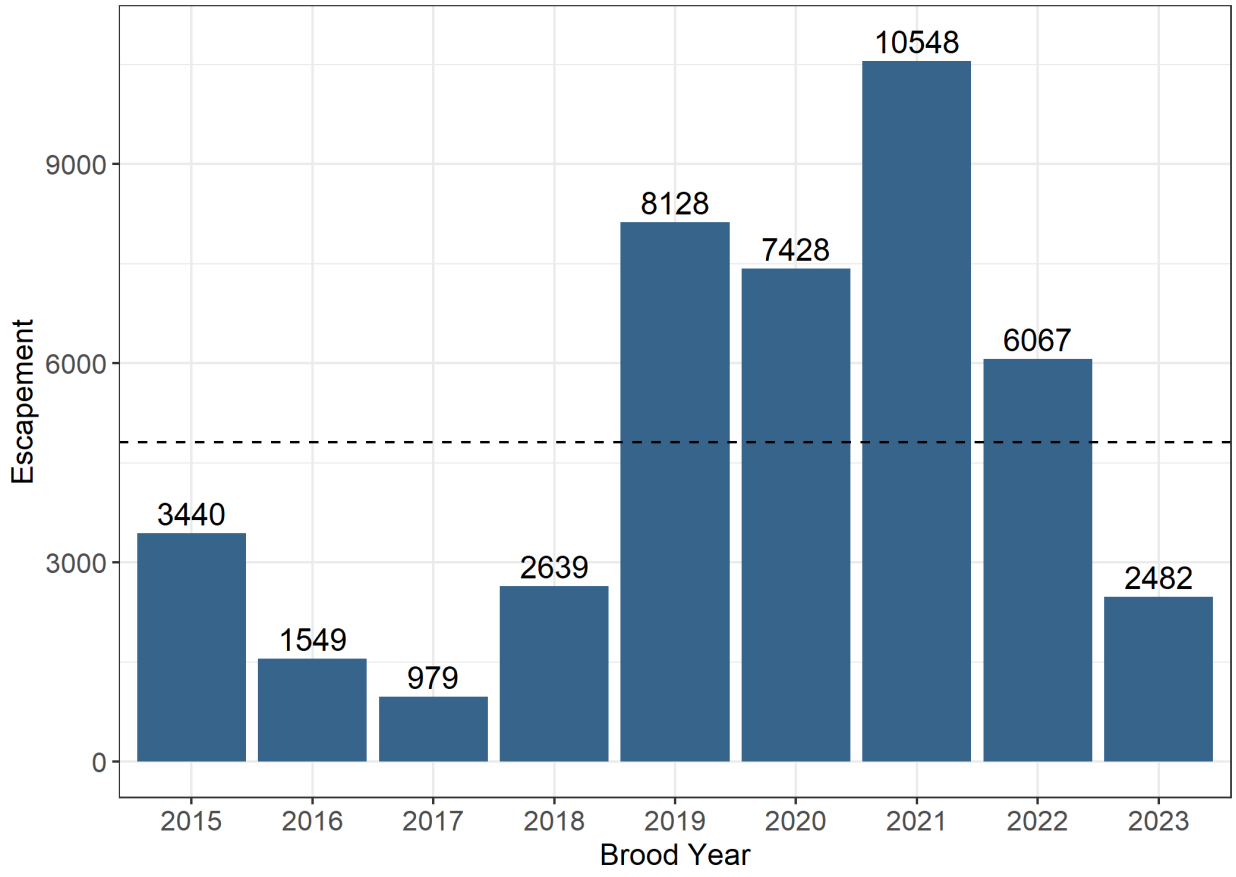

Figure 1. Winter-Run Chinook salmon Escapement Estimates, Brood Years 2014-2023. Winter-run escapement estimates are based on data from CDFW GrandTab (Azat 2024). Horizontal line indicates the 10-year average JPI.

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Juvenile Production Index

The Juvenile Production Index (JPI) is based on the number of fry-equivalents at Red Bluff Diversion Dam (RBDD) and takes into account the response of fish to environmental conditions during spawning, egg incubation and outmigration, and that occur upstream of RBDD (NMFS 2024). For BY 2023, WR Chinook salmon JPI was 1,458,089 (Figure 2). This value was estimated on December 31, 2023 and will subsequently undergo adjustment for seasonal totals at RBDD. The JPI value is slightly higher than the 10-year average value of 1.33 million, and higher than the JPI from the two previous years. Estimates from BY 2022 and 2023 are obtained from National Marine Fisheries Service (NMFS) JPE letters, and estimates from previous brood years are obtained from the United States Fish and Wildlife Service (USFWS) Red Bluff Fish and Wildlife Office.

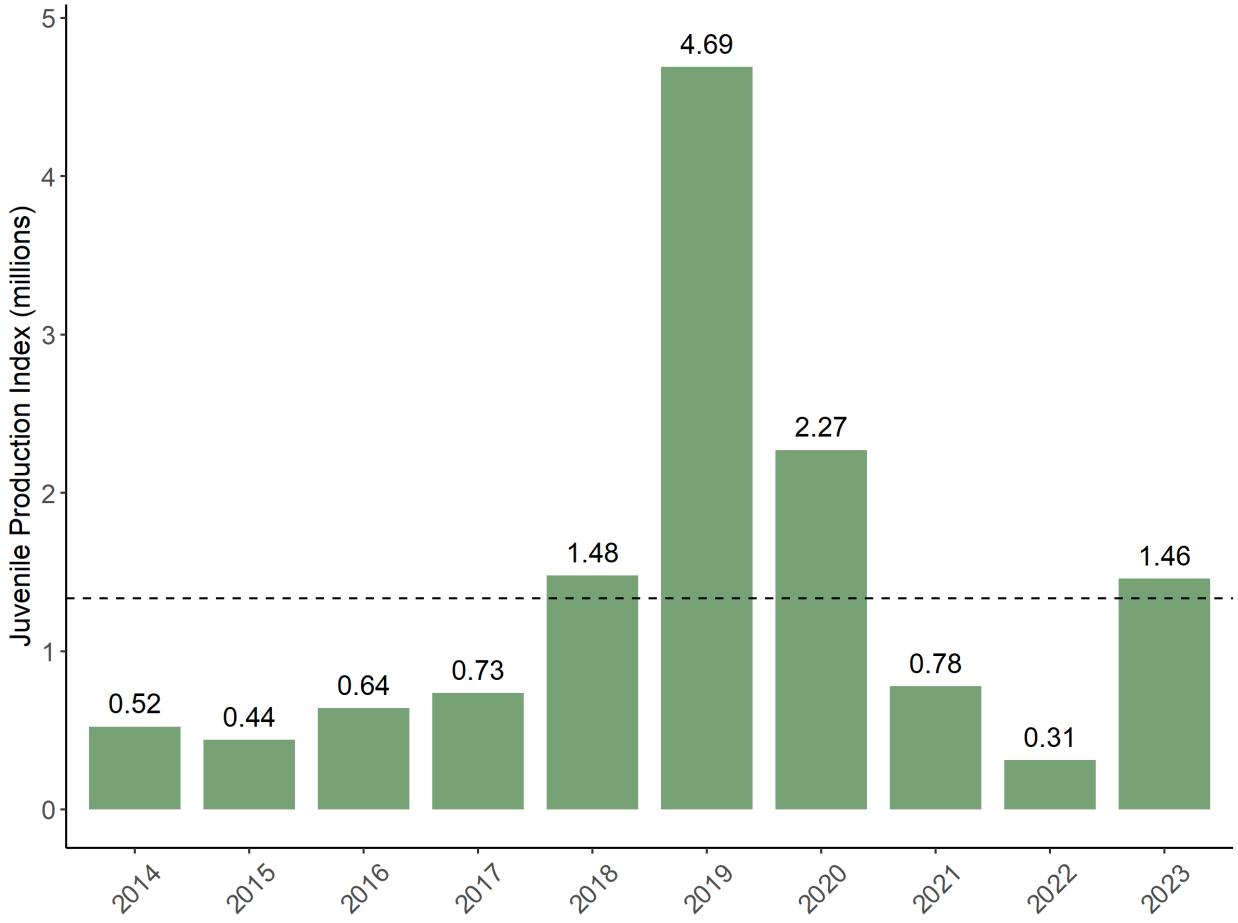

Figure 2. Winter-run Chinook salmon Juvenile Production Index, Brood Years 2014-2023. Estimates from 2022 and 2023 are preliminary and from the NMFS JPE letters, while other estimates are from USFWS. Horizontal line indicates the 10-year average JPI.

Egg-to-Fry Survival and Temperature-Dependent Mortality

Egg-to-fry (ETF) survival describes the survival rate from egg deposition to fry emergence and migration to RBDD rotary screw traps. Estimates are based on the estimated number of spawning females; estimated fecundity of the females derived from egg takes at Livingston Stone National Fish Hatchery (LSNFH), and the estimated number of fry equivalents passing RBDD derived from emigration monitoring using rotary screw traps at that location. Each year, a preliminary estimate is developed in the NMFS JPE letter, which is finalized later in the spring/summer. In BY 2023, preliminary ETF Survival was estimated to be 24.94%, which was greater than the 10-year average of 16.8% (Figure 3).

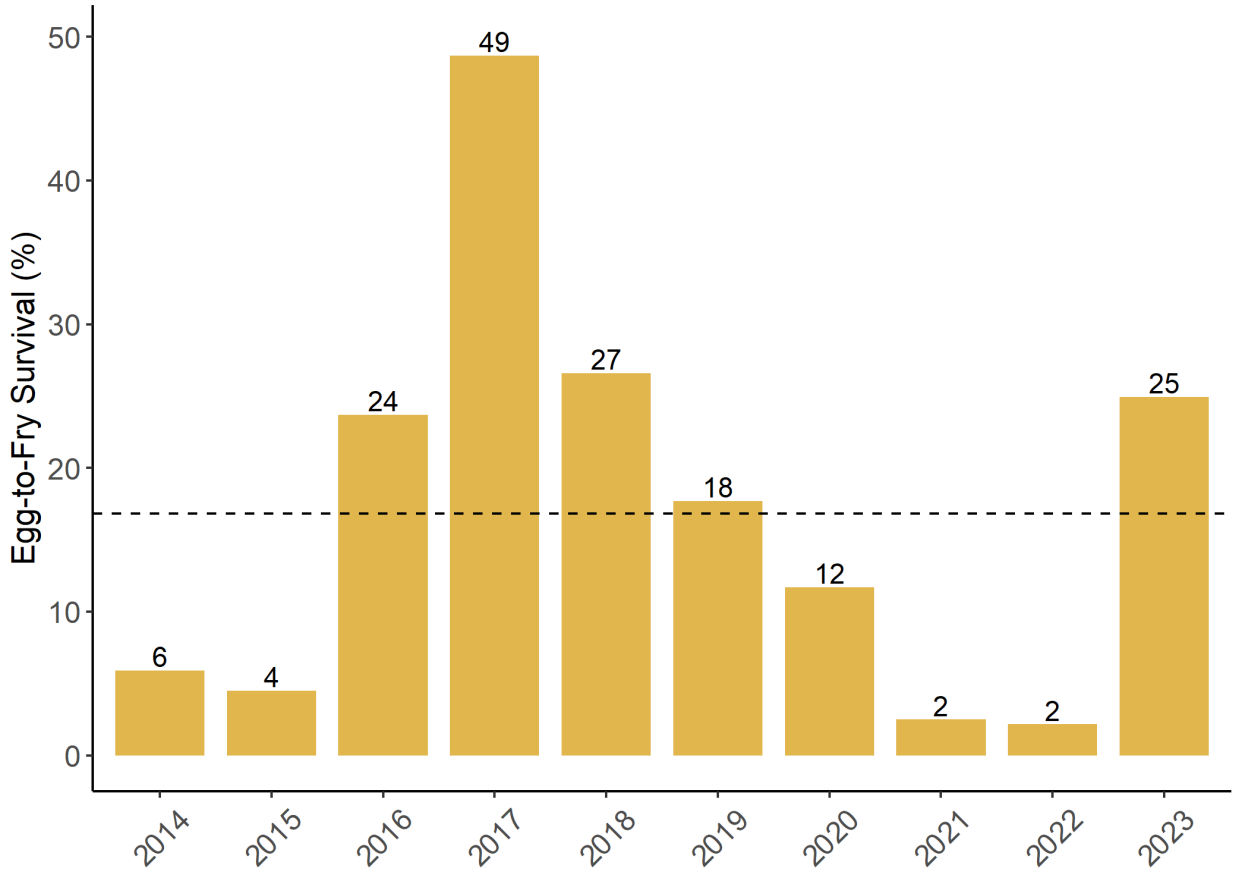

Figure 3. Winter-run Chinook salmon Egg-to-Fry Survival, Brood Years 2014-2023. Horizontal dashed line indicates the 10-year average JPI.

Temperature-dependent mortality (TDM) is a modeled estimate that describes mortality at the egg stage that can occur due to water temperature. The water temperature exceeded the Sacramento River above Clear Creek (CCR) compliance target of 53.5°F on 1 day between March and October of 2023, at a temperature of 53.6°F (Figure 4). TDM estimates are used for in-season planning of temperature management actions and as a performance metric. TDM estimates depend on redd location, incubation timing, and water temperature data within the winter-run spawning habitat of the Sacramento River. The TDM hindcast estimate was 2% for BY 2023, which was lower than the 10-year average of 27.4% (Figure 5). For more information on TDM seasonal hindcast assumptions, refer to Shasta Cold Water Pool Seasonal Report (USBR 2024).

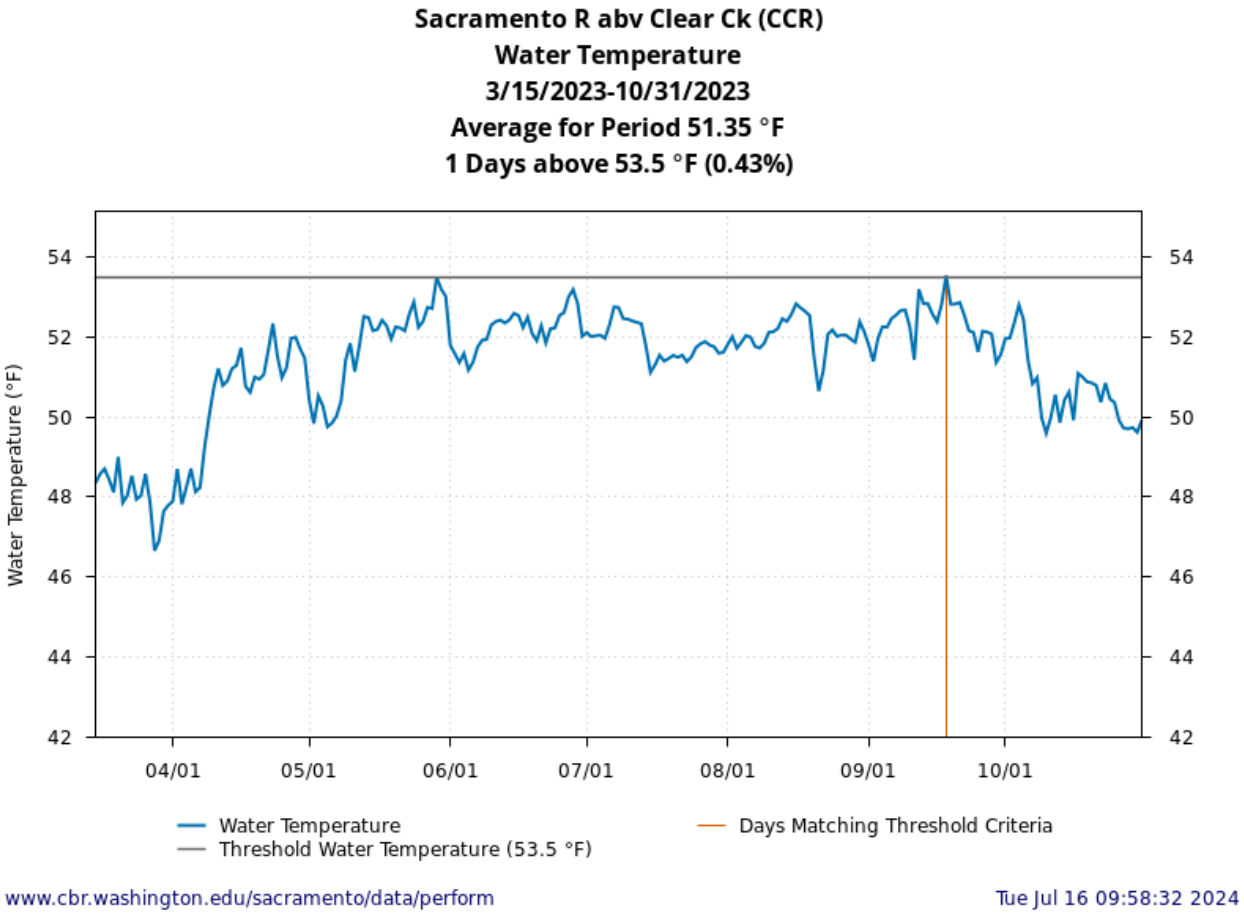

Figure 4. Water Temperature at Sacramento River above Clear Creek, March – October 2023. The horizontal line marks the temperature compliance threshold. Plot created by University of Washington on SacPAS (www.cbr.washington.edu/sacramento/data/perform).

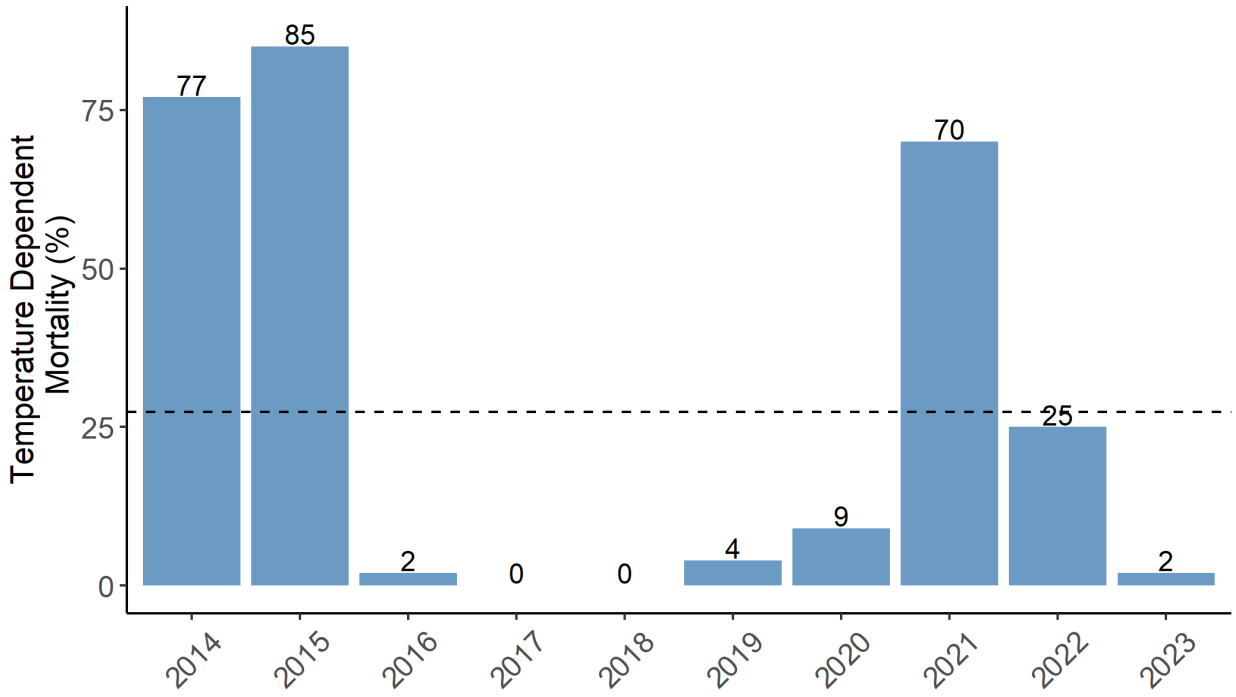

Figure 5. Winter-run Chinook salmon Temperature Dependent Mortality (TDM) Hindcast Estimate, Brood Years 2014-2023. Horizontal dashed line indicates the 10-year average TDM.

The estimates for temperature-dependent mortality, egg-to-fry survival, and unattributed mortality (which represents other mortality factors upstream of RBDD) for BY 2014 – 2023 are shown as point estimates and do not incorporate uncertainty (Figure 6). Uncertainty in these point estimates include the abundance of fry equivalents passing Red Bluff, variation in fecundity of spawning females, viability of eggs, and temperature and background mortality rates. The unattributed mortality occurs during the egg incubation and free swimming life stages, while the temperature-dependent egg mortality is estimated only when eggs are in the gravel. There may be water temperature impacts outside of the egg incubation life stage. When temperature-dependent egg mortality was lower, there may be additional mortality from other sources.

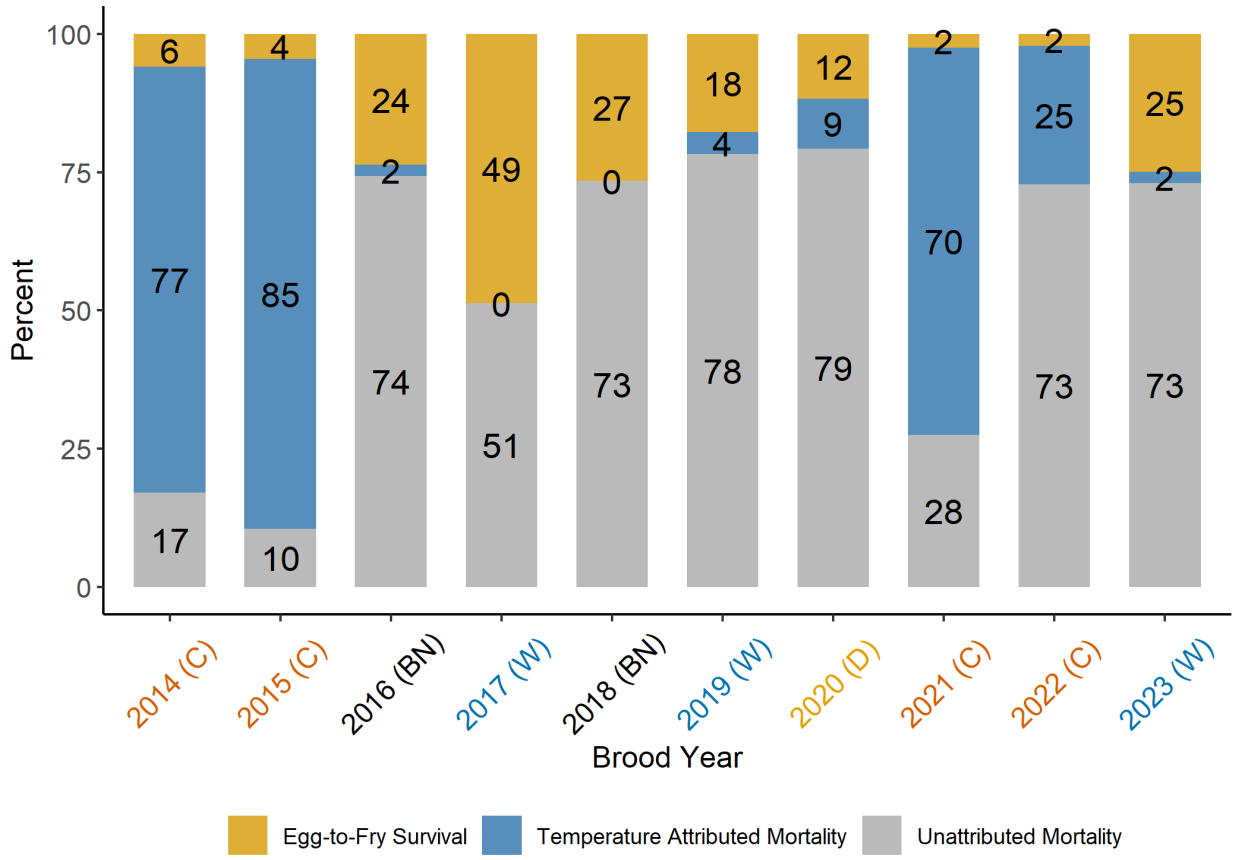

Figure 6. Winter-run Chinook salmon temperature attributed mortality (i.e., temperature-dependent egg mortality; %; in blue), unattributed mortality (%; in gray), and egg-to-fry survival (%; in yellow) for BY 2014 through 2023. Temperature dependent mortality (i.e., temperature attributed mortality) estimates obtained from NOAA-Southwest Fisheries Science Center and are based on the Martin Model. Final egg-to-fry survival for BY 2014 to 2021 were provided by USFWS. Preliminary egg-to-fry survival estimates for BY 2022 and 2023 obtained from the NMFS Juvenile Production Estimate letters. Unattributed mortality (which represents other mortality factors upstream of RBDD) was derived from subtracting temperature attributed mortality from total mortality

Hatchery Winter-Run Survival

Acoustic Telemetry

To obtain estimates of survival and improve abundance estimates, USFWS implants acoustic transmitters into juvenile LSNFH WRCS and tracks survival through the Delta. In February 16, 2024, 581 fish were released at Bonnyview Boat Ramp on the Sacramento River. Survival estimates are calculated using the Cormack Jolly-Seber method. Preliminary through-Delta Survival for BY 2023 was 68.6% (95% CI: 61.7-74.8%), which was above the 5-year average of 50.0% (Figure 7). Survival to Benicia Bridge East Span was 26.3% (95% CI: 22.8-30.0%), which was above the 6-year average of 14.1% (Figure 7). For additional information about each year's tagging results and final estimates can be found at: CalFishTrack. The final report is anticipated by Fall 2025.

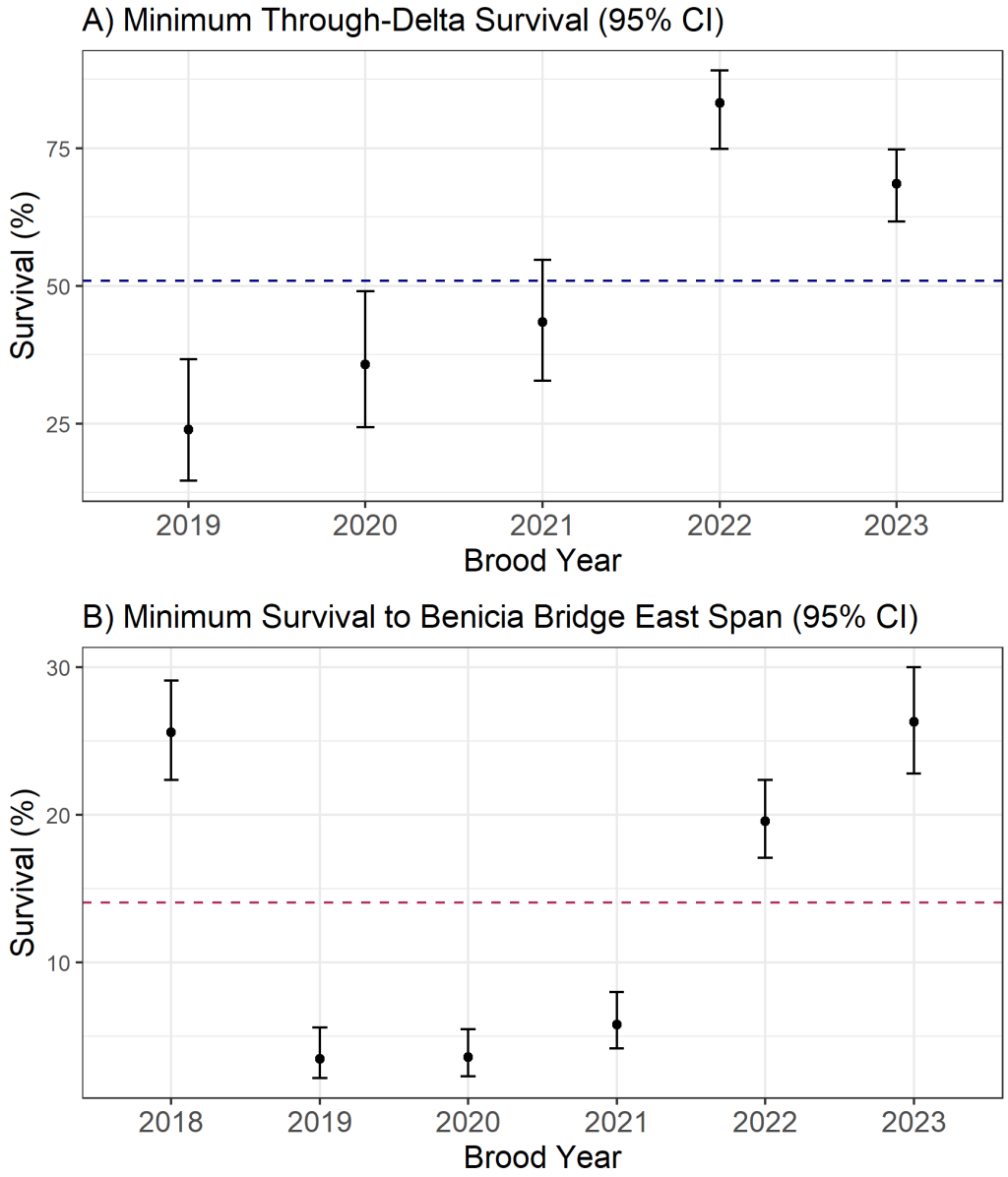

Figure 7. Preliminary Hatchery WRCS Survival and 95% Confidence Interval Estimates for A) Through-Delta Survival and B) Survival to Benicia Bridge East Span. Estimates from CalFishTrack.

STARS Survival Model

STARS stands for the 'San Francisco Bay Delta Survival, Travel time, and Routing Simulation'. It is a series of simulations that predicts late-fall and winter-run through delta survival and routing based on environmental covariates and relationships developed in past telemetry studies. The simulation tool is available on: https://www.cbr.washington.edu/shiny/STARS/.

Data from the STARS model were downloaded for all available water years (2018-2024) and graphed to aid in visualizing year-to-year comparisons of survival and routing. For the purpose of this document the WY is the BY+1 so WY 2024 would represent BY 2023. Predicted through-delta survival in WY 2024 appears higher than recent years, particularly during those months of peak outmigration (Jan-Mar), with the exception of 2019 (Figure 8). This pattern also holds true with interior delta routing probability which is negatively correlated with through delta survival. As illustrated in Figure 8, through-delta survival and interior delta survival is highest in those months and years in which routing probability into the interior delta is lowest.

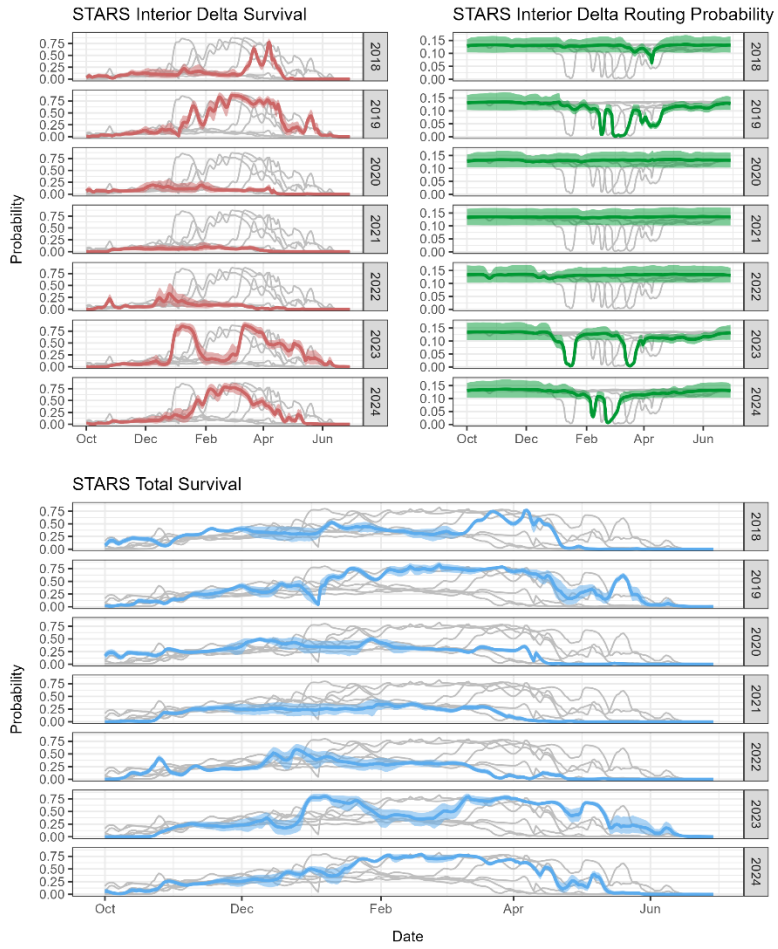

Figure 8. Predicted interior delta survival (top left), interior delta routing (top right), and predicted overall survival (bottom) of winter-run from the STARS model derived from analysis of telemetry results of hatchery-origin winter-run Chinook Salmon over a five-year period. Facets and blue lines represent individual years with the grey lines representing all years from WY 2018-2024.

References

Azat, J. and Killam, D. (2024). GrandTab 2024.05.20 California Central Valley Chinook Escapement Database Report. California Department of Fish and Wildlife.

National Marine Fisheries Service (NMFS). (2024). 2023 Juvenile Production Estimate Letter. https://www.fisheries.noaa.gov/s3/2024-01/jpe-letter-2023.pdf

United States Bureau of Reclamation (USBR). 2024. Shasta Cold Water Pool Seasonal Report. In preparation.