Appendix F, Modeling

Attachment F.5 Interactive Object-oriented Simulation Model

F.5.1 Model Overview

The Interactive Object-Oriented Simulation (IOS) Model is composed of six model stages defined by a specific spatiotemporal context and are arranged sequentially to account for the entire life cycle of winter-run Chinook salmon, from eggs to returning spawners. In sequential order, the IOS Model stages are listed below (Figure F.5-1).

1. **Spawning,** which models the number and temporal distribution of eggs deposited in the gravel at the spawning grounds in the upper Sacramento River between Red Bluff Diversion Dam and Keswick Dam as a function of water Temperatures in April and May.
2. **Early Development,** which models the effect of temperature on maturation timing and mortality of eggs incubating in the gravel.
3. **Fry Rearing,** which models the relationship between temperature and mortality of fry during the river rearing period in the upper Sacramento River between Red Bluff Diversion Dam and Keswick Dam.
4. **River Migration,** which estimates mortality of migrating smolts in the Sacramento River between Red Bluff and the Delta as a function of river flow.
5. **Delta Passage,** which models the effect of flow, routing, and exports on the survival of smolts migrating through the Delta to San Francisco Bay.
6. **Ocean Survival,** which estimates the effect of natural mortality, ocean harvest, and ocean conditions to predict survival and spawning returns by age.

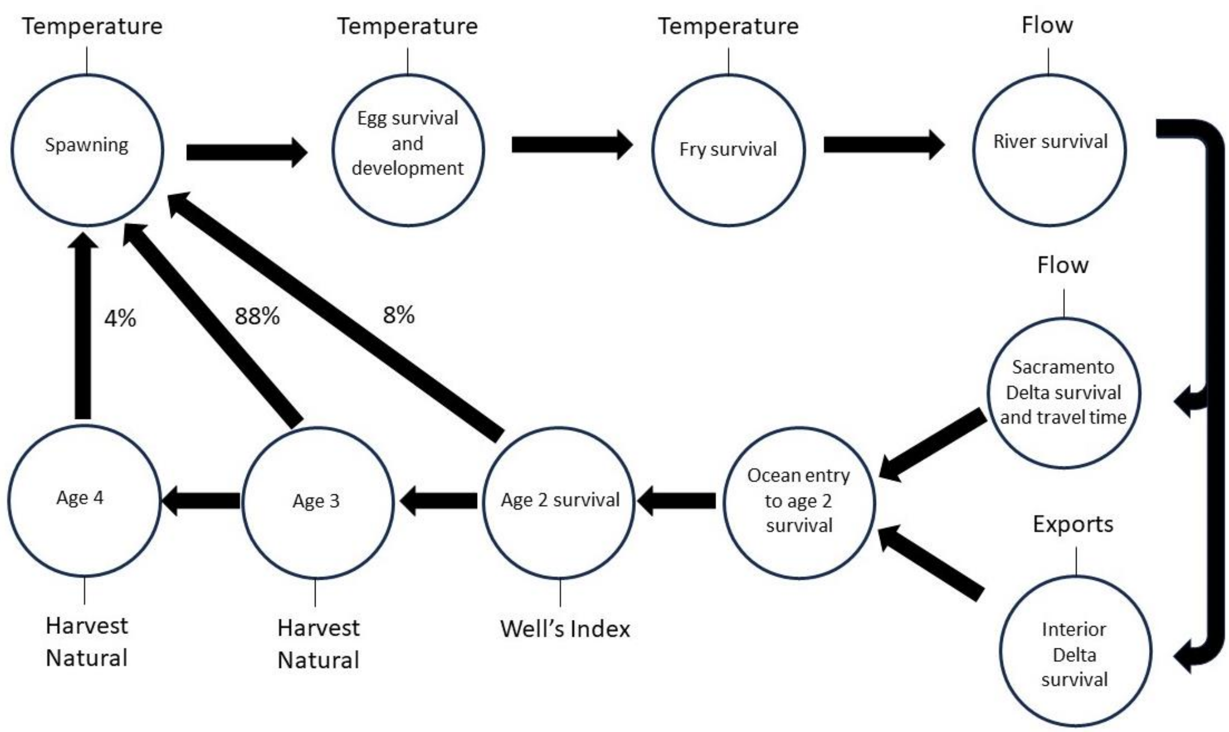


Figure F.5-1. Conceptual Diagram of the IOS Model Stages and Environmental Influences on Survival and Development of Winter-Run Chinook Salmon at Each Stage

F.5.2 Model Development

F.5.2.1 Methods

F.5.2.1.1 Stages

Spawning

For the first four simulation years, the model is seeded with 5,000 spawners, of which 3,088 are female based on the wild male to female ratio of spawners from CDFW carcass survey reports. In each subsequent simulation year, the number of female spawners is determined by the model's probabilistic simulation of survival to this life stage.

To ensure that developing fish experience the correct environmental conditions during each year, spawn timing is determined by a function of water temperatures in April and May as described by Jennings and Hendrix (2020). Eggs deposited on a particular date are treated as cohorts that experience temperature on a daily time step during the early development stage. The daily number of female spawners is calculated by multiplying the predicted daily proportion of spawners by the total Jolly-Seber estimate of female spawners (Poytress and Carillo 2010).

(Equation 1) $$S_d = P_d S_{JS}$$

where, S_d is the daily number of female spawners, P_d is the daily proportion of total spawners and S_{JS} is the total Jolly-Seber estimate of female spawners.

The model accounts for the time difference between egg deposition and carcass observations by backing up egg deposition by 14 days relative to the spawning distribution (Niemela pers. comm.).

To obtain estimates of expected juvenile production, a Ricker stock-recruitment curve (Ricker 1975) was fit between the winter run Juvenile Production Index (JPI) (estimated by rotary screw–trap sampling at Red Bluff Diversion Dam) and the number of female spawners (from USFWS carcass surveys) for years 1996–1999 and 2002–2017:

(Equation 2) $$R = \alpha S e^{-\beta S} + \varepsilon$$

where α is a parameter that describes recruitment rate, and β is a parameter that measures the level of density dependence.

The density-dependent parameter (β) did not differ significantly from 0 ($t = 1.662$, $p = 0.114$)), indicating that the relationships between emergent fry and female spawners was linear (density-independent). Therefore, β was removed from the equation and a linear version of the stock-recruitment relationship was estimated. The number of female spawners explained 90% of the variation in fry production ($F_{1,19} = 173$, $p<0.001$) in the data, so the value of α was taken from the regression:

(Equation 3) $$R = 1027*S$$

In the IOS Model, this linear relationship is used to predict values for mean fry production along with the confidence intervals for the predicted values. These values are then used to define a normal probability distribution, which is randomly sampled to determine the annual fry production. Although the Ricker model accounts for mortality during egg incubation, additional mortality was imposed at temperatures higher than those experienced during the years used to construct the Ricker model (described in the *Early Development* section).

Early Development

Data from three laboratory studies were used to estimate the relationship between temperature, egg mortality, and development time (Murray and McPhail 1988; Beacham and Murray 1989; U.S. Fish and Wildlife Service 1999). Using data from these experiments, a relationship was constructed between maturation time and water temperature. First *maturation time* (days) was converted to a *daily maturation rate* (1/day):

(Equation 4) $$\textit{daily maturation rate} = \textit{maturation time}^{-1}$$

A significant linear relationship between maturation rate and water temperature was detected using linear regression. Daily water temperature explained 99% of the variation in *daily maturation rate* (F =2188; df =1,15; p<0.001):

(Equation 5) $$\textit{daily maturation rate} = 0.00058 * Temp\ (°F) - 0.018$$

In the IOS Model, the daily mean maturation rate of the incubating eggs is predicted from daily water temperatures using a linear function; the predicted mean maturation rate, along with the confidence intervals of the predicted values, is used to define a normal probability distribution, which then is randomly sampled to determine the daily maturation rate. A cohort of eggs accumulates a percentage of total maturation each day from the above equation until 100% maturation is reached.

Data from experimental work (U.S. Fish and Wildlife Service 1999) was used to parameterize the relationship between temperature and mortality of developing winter-run Chinook salmon eggs. Predicted proportional mortality over the entire incubation period was converted to a daily mortality rate to apply these temperature effects in the IOS Model. This conversion was used to calculate daily mortality using the methods described by Bartholow and Heasley (2006):

(Equation 6) $$\textit{mortality} = 1-(1-\textit{total mortality})^{(1/\textit{development time})}$$

where *total mortality* is the predicted mortality over the entire incubation period observed for a particular water temperature and *development time* was the time to develop from fertilization to emergence.

Limited sample size in the USFWS study (1999) did not allow a statistically valid test for effects of temperature on mortality (e.g., a general additive model) to be performed. However, the following exponential relationship was fitted between observed *daily mortality* and observed water temperatures (U.S. Fish and Wildlife Service 1999) to provide the required values for the IOS Model:

(Equation 7) $$\textit{daily mortality} = 1.38 * 10^{-15} e^{(0.503 * Temp)}$$

Equation 7 yields the following graphic (Figure F.5-2), which indicates that proportional daily egg mortality increases rapidly with only small changes in water temperature. For example, within the predominant water temperature range found in model scenarios (55°F to 60°F), proportional daily mortality increases over ten-fold (~0.001 at 55°F to ~0.018 at 60°F).

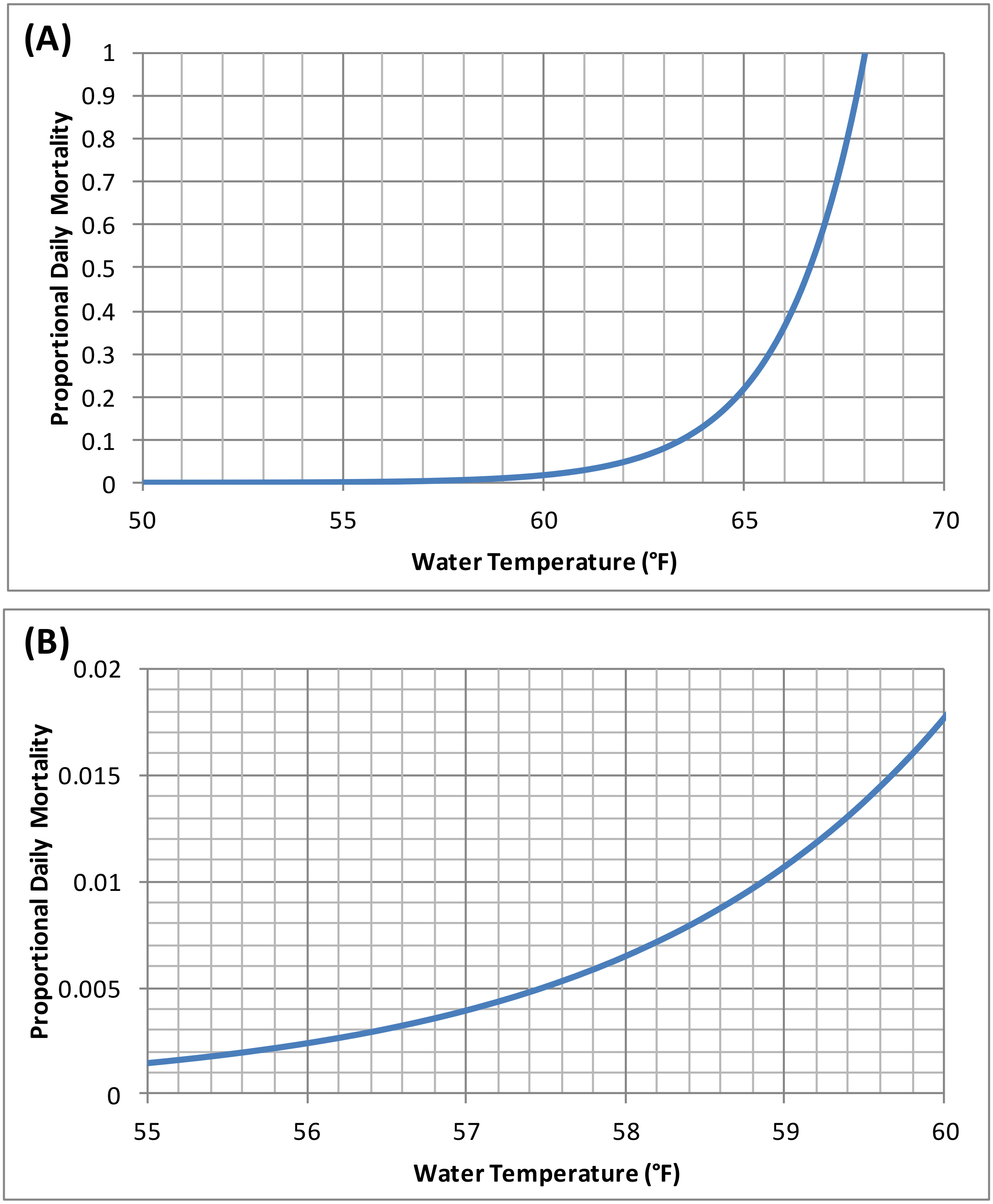


Figure F.5-2. Relationship between Proportional Daily Mortality of Winter-Run Chinook Salmon Eggs and Water Temperature (Equation 7) for (A) the Entire Temperature Range, and (B) the Predominant Range Found in Model Scenarios

In the IOS Model, mean daily mortality rates of the incubating eggs are predicted from weighted mean daily water temperature at Keswick Dam and Balls Ferry where temperatures are weighted by a 10-year average distribution of winter run redds between these two locations. The predicted mean mortality rate, along with the confidence intervals of the predicted values, is used to define a normal probability distribution, which then is randomly sampled to determine the daily egg mortality rate.

Fry Rearing

Data from USFWS (1999) was used to model fry mortality during rearing as a function of water temperature. To acquire predicted values for the model, the following exponential relationship was fitted between observed daily mortality and observed water temperatures (U.S. Fish and Wildlife Service 1999):

(Equation 8) $$daily\ mortality = 3.92*10\text{-}12e\ (0.349*Temp)$$

Equation 8 yields the following graphic (Figure F.5-3), which indicates that proportional daily fry mortality increases rapidly with only small changes in water temperature. For example, within the predominant water temperature range found in model scenarios (55°F to 60°F), proportional daily mortality increases over five-fold (~0.001 at 55°F to ~0.005 at 60°F). This indicates that, although fry mortality is highly sensitive to changes in water temperature, this sensitivity is not as great as that of egg mortality within the predominant range observed in the model scenarios in focus.

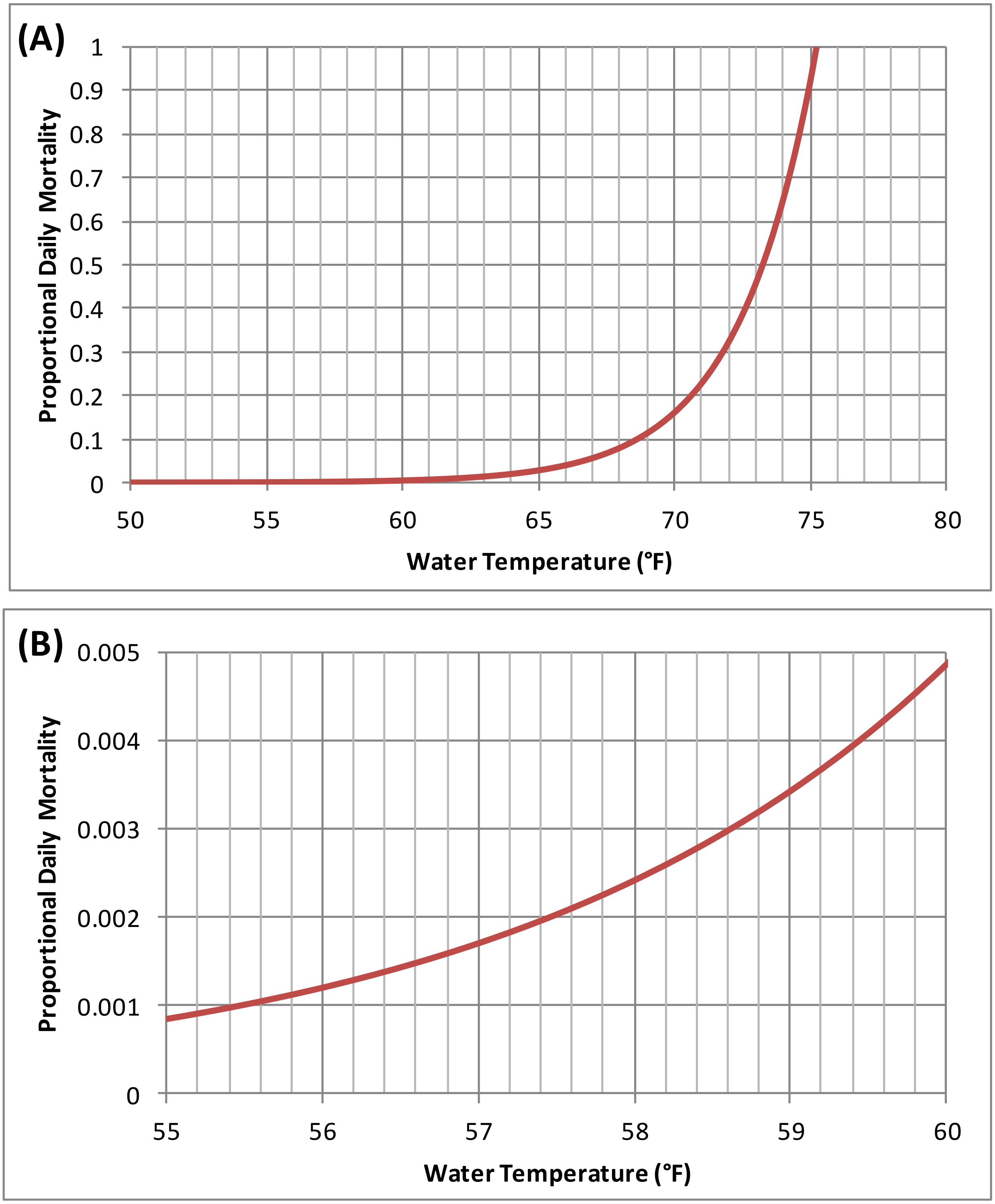


Figure F.5-3. Relationship between Proportional Daily Mortality of Winter-Run Chinook Salmon Fry and Water Temperature (Equation 8) for (A) the Entire Temperature Range, and (B) the Predominant Range Found in Model Scenarios

Each day the mean proportional mortality of the rearing fish is predicted from the daily water temperature using the above exponential relationship; the predicted mean mortality, along with the confidence intervals of the predicted values, is used to define a normal probability distribution, which then is randomly sampled to determine the daily mortality of the rearing fish. Temperature mortality is applied to rearing fry for 60 days, which is the approximate time required for fry to transition into smolts (U.S. Fish and Wildlife Service 1999) and enter the *River Migration* stage. All fish migrating through the Delta are assumed to be smolts.

River Migration

Survival of smolts between Red Bluff Diversion Dam and Fremont Weir is estimated as a function of flow at Bend Bridge (Figure F.5-4). The flow-survival relationship in this reach was modeled using 7 years of releases of winter run smolts from Livingston Stone hatchery that were implanted with JSATS transmitters (total of 2,912 tagged fish detected at Red Bluff). Mortality in this stage is applied on the day fish pass Red Bluff with the specific value estimated based on flow at Bend Bridge. Smolts are delayed from entering the next model stage to account for travel time. Mean travel time (20 days) is used along with the standard error (3.6 days) to define a normal probability distribution, which is randomly sampled to provide estimates of the total travel time of migrating smolts.

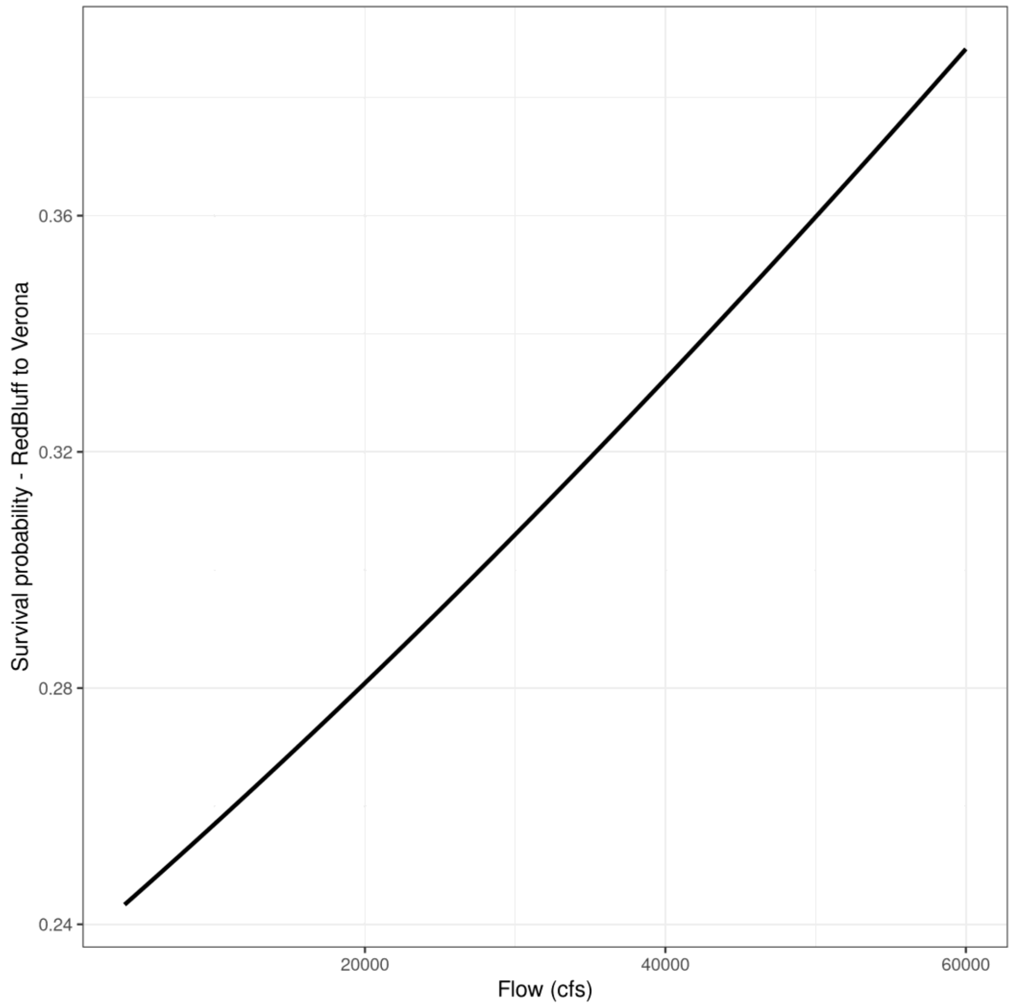
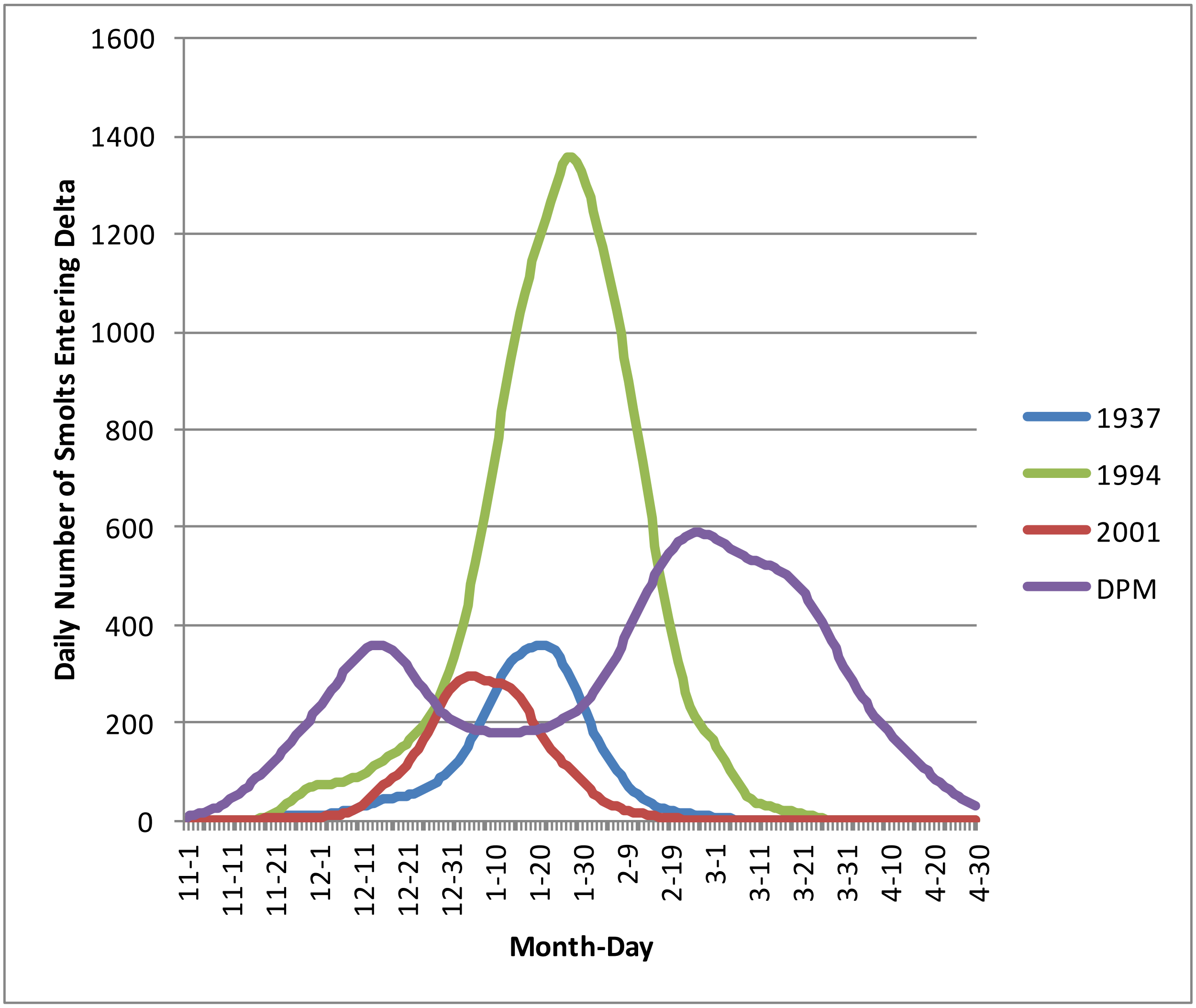


Figure F.5-4. Relationship between flow at Bend Bridge and the probability of winter run smolt survival between Red Bluff and the first Delta Passage reach at Verona. This relationship includes smolts that entered the Yolo Bypass and those that remained in the Sacramento River.

Delta Passage

Winter-run Chinook salmon passage through the Delta within IOS is modeled with the Delta Passage Model (DPM), which is described fully in Appendix I OMR, Attachment I.6) Note that there is one difference between the implementation of the DPM in IOS and the standalone DPM. The timing of winter-run entry into the Delta is a function of upstream fry/egg rearing and river migration so timing changes annually, in contrast to the fixed nature of Delta entry for the standalone DPM. Also, the IOS entry distribution is a unimodal term that tends to peak between the bimodal peaks of the standalone DPM entry distribution (Figure F.5-5). As each cohort of smolts exits the final reaches of the Delta (Sac4 and the interior Delta), the cohorts accumulate until all cohorts from that year have exited the Delta. After all cohorts have arrived, they all enter the *Ocean Survival* model as a single cohort and the model begins applying mortality on an annual time step.



DPM: purple line, fixed bimodal distribution.
IOS in 1937: blue line, an average peak of January 21.
IOS in 1994: green line, a late peak of January 28.
IOS in 2001: red line, an early peak of January 4.
IOS data are from scenario ALT9_LLT of the BDCP EIR/EIS.

Figure F.5-5. Winter-Run Chinook Salmon Smolt Delta Entry Distributions Assumed under the Delta Passage Model Compared with Entry Distributions for IOS in 1937, 1994, and 2001

Ocean Survival

As described by Zeug et al. (2012), this model stage uses a set of equations for smolt-to-age-2 mortality, winter mortality, ocean harvest, and spawning returns to predict yearly survival and escapement numbers (i.e., individuals exiting the ocean to spawn). Certain values during the ocean survival life stage were fixed constant among model scenarios. Ocean survival model-stage elements are listed in Table F.5-1 and discussed below.

Table F.5-1. Functions and Environmental Variables Used in the Ocean Survival Stage of the IOS Model

Model Element	**Environmental Variable**	**Value**
Smolt-age 2 mortality	None	Uniform random variable between 94% and 98%
Age 2 ocean survival	Wells' Index of Ocean productivity	Equation 13
Age 3 ocean survival	None	Equation 14
Age 4 ocean survival	None	Equation 15
Age 3 harvest	None	Fixed at 17.5%
Age 4 harvest	None	Fixed at 45%

Relying on ocean harvest, mortality, and returning spawner data from Grover et al. (2004), a uniformly distributed random variable between 94% and 98% mortality was applied for winter-run Chinook salmon from ocean entry to age 2 and functional relationships were developed to predict ocean survival and returning spawners for age 2 (8%), age 3 (88%), and age 4 (4%), assuming that 100% of individuals that survive to age 4 return for spawning. In the IOS Model, ocean survival to age 2 is given by:

(Equation 13) $$A_2 = A_i(1\text{-}M_2)(1\text{-}M_w)(1\text{-}H_2)(1\text{-}S_{r2})*W$$

Survival to age 3 is given by:

(Equation 14) $$A_3 = A_2(1\text{-}M_w)(1\text{-}H_3)(1\text{-}S_{r3})$$

And survival to age 4 is given by:

(Equation 15) $$A_4 = A_3(1\text{-}M_w)(1\text{-}H_4)$$

where A_i is initial abundance at ocean entry (from the DPM stage), $A_{2,3,4}$ are abundances at ages 2–4, $H_{2,3,4}$ are harvest percentages at ages 2–4 represented by uniform distributions bounded by historical harvest levels, M_2 is smolt-to-age-2 mortality, M_w is winter mortality for ages 2–4, and $S_{r2,r3}$ are returning spawner percentages at age 2 and age 3.

Harvest mortality is represented by a uniform distribution that is bounded by historical levels of harvest. Age 2 survival is multiplied by a scalar W that corresponds to the value of Wells Index of ocean productivity. This metric was shown to significantly influence over-winter survival of age 2 fish (Wells et al. 2007). The value of Wells Index is a normally distributed random variable that is resampled each year of the simulation. In the analysis, the following values from Grover et al. (2004) were used: H_2 = 0%, H_3 = 0-39%, H_4 = 0-74%, M_2 = 94-98%, M_w = 20%, S_{r2} = 8%, and S_{r3} = 96%.

Adult fish designated for return to the spawning grounds are assumed to be 65% female and are assigned a pre-spawn mortality of 5% to determine the final number of female returning spawners (Snider et al. 2001).

F.5.2.1.2 Time Step

The IOS Model operates on a daily time step, advancing the age of each cohort/life stage and thus tracking their numerical fate throughout the different stages of the life cycle. Some variables (e.g., annual mortality estimates) are randomly sampled from a distribution of values and are applied once per year. Although a daily time step is implemented for the Delta Passage component of IOS, flow inputs that rely on CALSIM outputs (i.e., all flows except flows at Fremont Weir) are based on monthly modeling and are assumed to be constant within a particular month. In addition, for the ocean phase of the life cycle, the model operates on an annual time step by applying annual survival estimates to each ocean cohort.

F.5.2.1.3 Model Inputs

Delta flows and export flow into SWP and CVP pumping plants were modeled using monthly flow output from CALSIM 3, with the monthly average flow in a particular month being applied to all days within that month, as described above. A separate set of flow inputs was developed for each of the scenarios, based on the CALSIM 3 flow predictions for each scenario across the entire1922 2021 prediction record. Flows into the Yolo Bypass over Fremont Weir were based on disaggregated monthly CALSIM 3 data based on historical patterns of variability. Temperature data for the Sacramento River was obtained from the Sacramento River Water Quality Model (SRWQM) developed by the Bureau of Reclamation (Reclamation). The nodes in the CALSIM 3 and SRWQM models that were used to provide flow and temperature data for specific reaches in the Sacramento River and Delta are shown in Table F.5-2.

Table F.5-2. IOS Reaches and Associated Channels from CALSIM 3 and SRWQM Models

IOS Reach	DSM2 Output Location	SRWQM
Spawning-Rearing Reach	–	Weighted average of Keswick and Balls Ferry temperatures based on spawning distribution
River Migration	Bend Bridge	
Sac1	rsac155	–
Sac2	rac128	–
Sac3	rsac123	–
Sac4	rsac101	–
SS	slsbt011	–
Geo/DCC	Dcc+georg_sl	–
Interior Delta	Total_exports	–

F.5.2.1.4 Model Outputs

Four model outputs are used to determine differences among model scenarios.

- **Egg survival:** The Sacramento River between Keswick Dam and the Red Bluff Diversion Dam provides egg incubation habitat for winter-run Chinook salmon. Water temperature has a large effect on the survival of Chinook salmon during the egg incubation period by controlling mortality as well as development rate. Temperatures in this reach are partially controlled by releases of cold water from Shasta Reservoir and ambient weather conditions.
- **Fry survival:** The Sacramento River between Keswick Dam and Red Bluff Diversion Dam provides rearing habitat for juvenile winter-run Chinook salmon. Water temperature can have a large effect on the survival of Chinook salmon during the fry rearing stage by controlling mortality and development rate. Temperatures in this reach are partially controlled by releases of cold water from Shasta Reservoir and ambient weather conditions.
- **River migration survival:** The Sacramento River between Red Bluff Diversion Dam and Fremont Weir is a migration route for juvenile winter-run Chinook salmon. Flow magnitude at the Bend Bridge station influences survival and travel time in this reach. Flows at Bend Bridge are partially controlled by releases from Shasta and Keswick Reservoirs.
- **Through-Delta survival:** The Delta between the Fremont Weir on the Sacramento River and Chipps Island is a migration route for juvenile winter-run Chinook salmon. Flow magnitude in different reaches of the Delta influences survival and travel time and entrainment into alternative migration routes with different survival probabilities.
- **Escapement:** Each year of the IOS Model simulation, escapement is calculated as the combined number of 2-, 3-, and 4-year-old fish that leave the ocean and migrate back into the Sacramento River to spawn between Keswick Dam and the Red Bluff Diversion Dam. These numbers are influenced by the combination of all previous life stages and the functional relationships between environmental variables and survival rates.

F.5.2.2 Assumptions / Uncertainty

F.5.2.2.1 Model Limitations and Assumptions

The following model limitations and assumptions should be recognized when interpreting results.

1. Other important ecological relationships likely exist but quantitative relationships are not available for integration into IOS (e.g., the interaction among flow, turbidity, and predation). To the extent that these unrepresented relationships are important and alter IOS outcomes, each alternative considered is assumed to be affected in the same way.
2. For relationships that are represented in IOS, operational alternatives considered are not assumed to alter those underlying functional relationships.
3. There is a specific range of environmental conditions (temperature, flow, exports, and ocean productivity) under which functional relationships were derived. These functional relationships are assumed to hold true for the environmental conditions in the scenarios considered.
4. Differential growth because of different environmental conditions (e.g., river temperature) and subsequent potential differences in survival and other factors are not directly included in the model. Differences in survival related to growth are indirectly included to an unknown extent in flow-survival, temperature-survival, and ocean productivity-survival relationships.
5. Juvenile winter-run Chinook salmon migrating through the Delta all are assumed to be smolts that are not rearing in the Delta.

F.5.2.2.2 Model Sensitivity and Influence of Environmental Variables

Zeug et al. (2012) examined the sensitivity of the previous IOS model estimates of escapement to its input parameter values, with input parameters being the functional relationships between environmental inputs and biological outputs. Although revisions have been undertaken to IOS since that time, particularly the river survival function, the main points from their analysis are still likely to be valid.

Zeug et al. (2012) found that escapement of different age classes was sensitive to different input parameters (Table F.5-3). Escapement of age-2 fish (which compose 8% of the total returning fish in a given cohort) was most sensitive to smolt-to-age-2-survival and water year when considering either independent or interactive effects of these parameters, and there was also sensitivity to river migration survival when considering interactive effects of this parameter with other parameters. Escapement of age-3 fish (which compose 88% of the total returning fish in a given cohort) was sensitive to several input parameters when considering the independent effects of these parameters but was sensitive to through-Delta survival alone when considering first-order interactions between parameters. Escapement of age-4 fish (which compose 4% of the total returning fish in a given cohort) was sensitive to nearly all input parameters when considering the independent effects of these parameters, but was not sensitive to any of the parameters when considering first-order interactions between parameters (Zeug et al. 2012).

Zeug et al. (2012) also explored how uncertainty in model parameter estimates influences model output by increasing by 10–50% the variation around the mean of selected parameters that could be addressed by management actions (egg survival, fry-to-smolt survival, river migration survival, Delta survival, age-3 harvest, and age-4 harvest). They found that model output was robust to parameter uncertainty and that age-3 and age-4 harvest had the greatest coefficients of variation as a result of the uniform distribution of these parameters. Zeug et al. (2012) noted that there are limitations in the data used to inform certain parameters in the model that may be ecologically relevant but that are not sensitive in the current IOS configuration: river survival is a good example because it is based on a three-year field study of relatively low-flow conditions that does not cover the range of potential conditions that may be experienced by downstream-migrating juvenile Chinook salmon.

To understand the influence of environmental parameter inputs on escapement estimates from IOS, Zeug et al. (2012) performed three sets of simulations of a baseline condition and either a 10% increase or a 10% decrease in river flow, exports, water temperature (on the Sacramento River at Bend Bridge; see above), and ocean productivity (i.e., Wells Index; see above). They found that only 10% changes in temperature produced a statistically significant change in escapement; a 10% increase in temperature produced a far greater reduction in escapement (>95%) than a 10% decrease in temperature gave an increase in escapement (>10%). Zeug et al. (2012) suggested that the lack of significant changes in escapement with 10% changes of flow, exports, and ocean productivity may reflect the fact that these variables' relationships within the model were based on observational studies with large error estimates associated with the responses. In contrast, temperature functions were parameterized with data from controlled experiments with small error estimates. Also, Zeug et al. (2012) noted that water temperatures within the winter-run Chinook salmon spawning and rearing area are close to the upper tolerance limit for the species; therefore, even small changes have the potential to significantly affect the population.

Table F.5-3. Sobol' Sensitivity Indices (Standard Deviation in Parentheses) for Each Age Class of Returning Spawners Based on 1,000 Monte Carlo Iterations, Conducted to Test Sensitivity of IOS Input Parameters by Zeug et al. (2012)

Input Parameter	Age 2		Age 3		Age 4	
	Main Index (Effect Independent of Other Input Parameters)	**Total Index (Effect Accounting for First-Order Interactions with Other Input Parameters)**	**Main Index (Effect Independent of Other Input Parameters)**	**Total Index (Effect Accounting for First-Order Interactions with Other Input Parameters)**	**Main Index (Effect Independent of Other Input Parameters)**	**Total Index (Effect Accounting for First-Order Interactions with Other Input Parameters)**
Water year	0.300 [a] (0.083)	0.306 [a] (0.079)	0.181 [a] (0.091)	0.150 (0.091)	0.073 (0.067)	0.012 (0.065)
Egg survival	0.030 (0.016)	-0.006 (0.016)	0.222 [a] (0.081)	-0.021 (0.081)	0.102 [a] (0.044)	-0.072 (0.044)
Fry-to-smolt survival	0.039 (0.020)	-0.009 (0.020)	0.166 (0.090)	0.091 (0.092)	0.079 [a] (0.017)	-0.071 (0.017)
River migration survival	0.007 (0.034)	0.135 [a] (0.034)	0.164 (0.084)	0.062 (0.085)	0.079 (0.018)	-0.07 (0.018)
Delta survival	0.010 [a] (0.002)	-0.009 (0.002)	0.404 [a] (0.180)	0.643 [a] (0.177)	0.313 [a] (0.134)	-0.009 (0.132)
Smolt to age 2 survival	0.734 [a] (0.118)	0.454 [a] (0.113)	0.015 (0.016)	-0.006 (0.016)	0.057 [a] (0.017)	-0.052 (0.017)
Ocean productivity	0.003 (0.009)	0.009 (0.009)	0.034 [a] (0.015)	-0.034 (0.015)	0.061 [a] (0.030)	-0.048 (0.029)
Age 3 harvest	N/A	N/A	0.029 [a] (0.001)	-0.028 (0.001)	1.48 [a] (0.306)	0.188 (0.293)
Age 4 harvest	N/A	N/A	N/A	N/A	0.055 [a] (0.003)	-0.054 (0.003)

Source: Zeug et al. 2012.

[a] Index value was statistically significant at α=0.05.

F.5.2.3 Code and Data Repository

Analysis files for the IOS input data and analysis are available upon request.

F.5.3 Results

F.5.3.1 EIS Results

F.5.3.1.1 Egg Survival

Under Alt1 in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0% lower compared to the NAA (Figure F.5-6 and Table F.5-4).

Under Alt2 With TUCP Without VA in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0% lower compared to the NAA.

Under Alt3 in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0.02% lower compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.06% higher to 0% lower compared to the NAA.

Under Alt1 in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.1% higher to 0% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.1% higher to 0.04% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.08% higher to 0.03% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.06% higher to 0.03% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.06% higher to 0.15% lower compared to the NAA.

Under Alt3 in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.1% higher to 0.01% lower compared to the NAA.

Under Alt4 in Below Normal water years, mean predicted egg survival of winter-run Chinook salmon is lower than NAA, ranging from 0.02% higher to 0.19% lower compared to the NAA.

Under Alt1 in Critical water years, mean predicted egg survival of winter-run Chinook salmon is lower than NAA, ranging from 31.33% higher to 86.35% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 368.01% higher to 0.28% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 143.16% higher to 93.22% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 170.7% higher to 93.71% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 157.93% higher to 93.05% lower compared to the NAA.

Under Alt3 in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 437.17% higher to 0.64% lower compared to the NAA.

Under Alt4 in Critical water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 311.9% higher to 21.58% lower compared to the NAA.

Under Alt1 in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.45% higher to 0% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.31% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.45% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.38% higher to 0.05% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.31% higher to 0% lower compared to the NAA.

Under Alt3 in Dry water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.43% higher to 0% lower compared to the NAA.

Under Alt4 in Dry water years, mean predicted egg survival of winter-run Chinook salmon is lower than NAA, ranging from 0.37% higher to 0.24% lower compared to the NAA.

Under Alt1 in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt3 in Wet water years, mean predicted egg survival of winter-run Chinook salmon is higher than NAA, ranging from 0.04% higher to 0% lower compared to the NAA.

Under Alt4 in Wet water years, mean predicted egg survival of winter-run Chinook salmon is lower than NAA, ranging from 0.04% higher to 0.33% lower compared to the NAA.

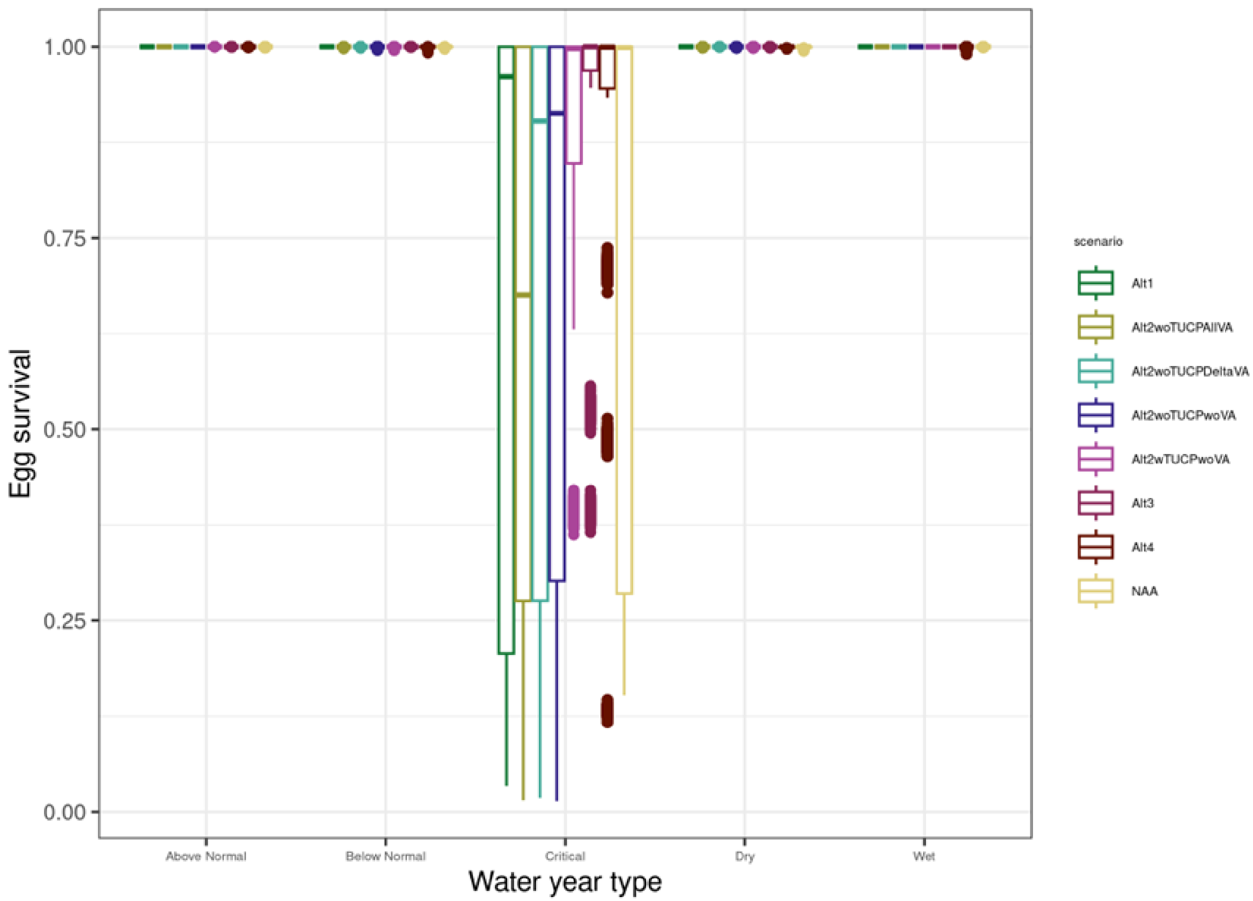


Figure F.5-6. Boxplots showing predicted winter-run Chinook egg survival by water year type.

Table F.5-4. Predicted mean annual winter-run Chinook egg survival by water year type. Difference from NAA shown in parenthesis.

Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Above Normal	1	1.000 (0.01%)	1.000 (0.01%)	1.000 (0.01%)	1.000 (0.01%)	1.000 (0.01%)	1.000(0.01%)	1.000 (0.01%)
Below Normal	1	1.000 (0.02%)	1.000 (0.01%)	1.000 (0.00%)	1.000 (0.01%)	1.000 (0.01%)	1.000 (0.02%)	1.000 (-0.01%)
Critical	0.698	0.661 (-5.26%)	0.907 (29.87%)	0.682 (-2.23%)	0.673 (-3.63%)	0.664 (-4.94%)	0.922 (32.06%)	0.882 (26.34%)
Dry	1	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.03%)	1.000 (0.04%)	1.000 (-0.00%)
Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.01%)

Under Alt1, mean annual predicted egg survival of winter-run Chinook salmon is on average lower than NAA (-1.66%), ranging from 31.33% higher in 1931 to 86.35% lower in 1934 compared to the NAA for winter-run Chinook salmon (Figure F.5-7 and Table F.5-5).

Under Alt2 With TUCP Without VA, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (12.85%), ranging from 368.01% higher in 2014 to 0.28% lower in 1992 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Delta VA, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (0.73%), ranging from 143.16% higher in 2014 to 93.22% lower in 2015 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Systemwide VA, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (0.93%), ranging from 170.7% higher in 2014 to 93.71% lower in 2015 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Without VA, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (1.09%), ranging from 157.93% higher in 1933 to 93.05% lower in 2015 compared to the NAA for winter-run Chinook salmon.

Under Alt3, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (13.75%), ranging from 437.17% higher in 2014 to 0.64% lower in 1992 compared to the NAA for winter-run Chinook salmon.

Under Alt4, mean annual predicted egg survival of winter-run Chinook salmon is on average higher than NAA (10.38%), ranging from 311.9% higher in 1933 to 21.58% lower in 1977 compared to the NAA for winter-run Chinook salmon.

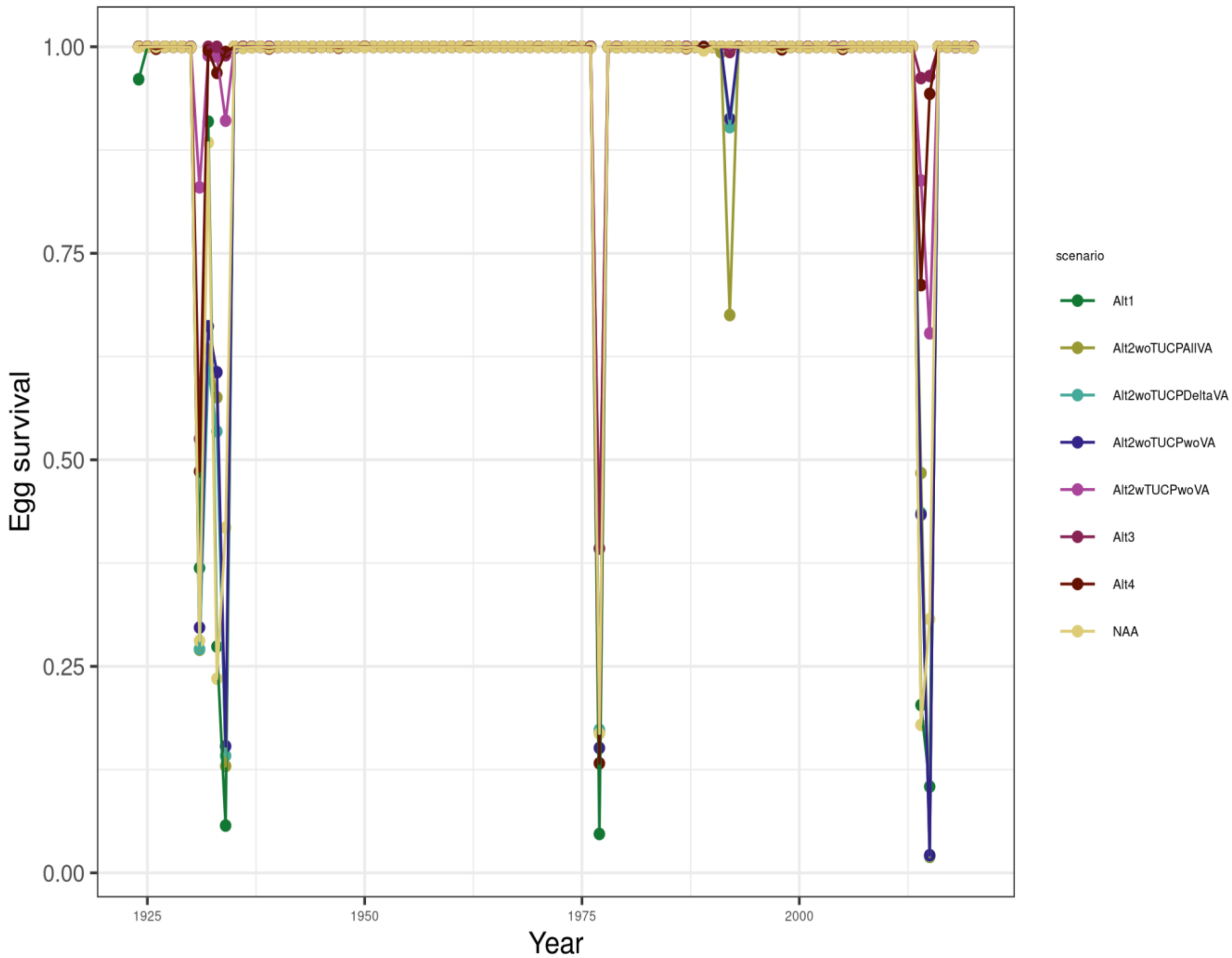


Figure F.5-7. Predicted mean annual winter-run Chinook egg survival.

Table F.5-5. Predicted mean annual winter-run Chinook egg survival. Difference from NAA shown in parenthesis.

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1923	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1924	Critical	1	0.960 (-3.91%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)
1925	Dry	1	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)
1926	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	0.998 (-0.24%)
1927	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1928	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1929	Critical	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1930	Dry	0.999	1.000 (0.07%)	0.999 (0.01%)	1.000 (0.06%)	1.000 (0.06%)	0.999 (-0.05%)	1.000 (0.07%)	0.999 (0.00%)
1931	Critical	0.281	0.369 (31.33%)	0.830 (195.53%)	0.297 (5.82%)	0.271 (-3.52%)	0.271 (-3.60%)	0.525 (87.10%)	0.486 (73.06%)
1932	Critical	0.884	0.909 (2.87%)	0.989 (11.96%)	0.662 (-25.10%)	0.612 (-30.78%)	0.634 (-28.29%)	1.000 (13.16%)	0.996 (12.67%)
1933	Critical	0.235	0.274 (16.49%)	0.988 (320.29%)	0.606 (157.93%)	0.535 (127.46%)	0.576 (144.99%)	1.000 (325.36%)	0.968 (311.90%)
1934	Critical	0.418	0.057 (-86.35%)	0.910 (117.92%)	0.153 (-63.30%)	0.142 (-65.97%)	0.129 (-69.05%)	0.990 (137.00%)	0.994 (137.96%)
1935	Below Normal	1	1.000 (0.00%)	1.000 (-0.02%)	0.999 (-0.15%)	1.000 (-0.01%)	1.000 (0.00%)	1.000 (-0.01%)	1.000 (0.00%)
1936	Below Normal	0.999	1.000 (0.10%)	1.000 (0.10%)	0.999 (0.03%)	1.000 (0.08%)	0.999 (-0.03%)	1.000 (0.10%)	0.999 (0.02%)
1937	Below Normal	0.999	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	0.999 (0.00%)
1938	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1939	Dry	0.999	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	0.998 (-0.11%)
1940	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.02%)	1.000 (0.00%)
1941	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1942	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1943	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1944	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.05%)
1945	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1946	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1947	Dry	1	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	0.999 (-0.10%)
1948	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1949	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1950	Dry	1	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)
1951	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1952	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1953	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1954	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1955	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1956	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1957	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1958	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.02%)
1959	Below Normal	1	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (0.02%)	1.000 (-0.00%)
1960	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1961	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1962	Dry	0.999	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.05%)
1963	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1964	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1965	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1966	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1967	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1968	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1969	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1970	Wet	1	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)
1971	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1972	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1973	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1974	Wet	1	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.04%)
1975	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1976	Critical	0.999	1.000 (0.12%)	1.000 (0.12%)	1.000 (0.12%)	1.000 (0.10%)	1.000 (0.12%)	1.000 (0.12%)	0.999 (0.07%)
1977	Critical	0.169	0.047 (-72.11%)	0.392 (132.13%)	0.151 (-10.40%)	0.173 (2.49%)	0.171 (1.36%)	0.393 (132.58%)	0.133 (-21.58%)
1978	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1979	Dry	0.999	1.000 (0.07%)	1.000 (0.04%)	1.000 (0.04%)	1.000 (0.03%)	0.999 (0.01%)	1.000 (0.07%)	0.999 (0.01%)
1980	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1981	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1982	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1983	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1984	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1985	Below Normal	0.999	1.000 (0.06%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.02%)	1.000 (0.03%)	1.000 (0.06%)	0.999 (-0.01%)
1986	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1987	Dry	0.999	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	1.000 (0.10%)	0.998 (-0.07%)
1988	Critical	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.01%)	1.000 (0.00%)	1.000 (0.00%)
1989	Dry	0.996	1.000 (0.45%)	0.999 (0.31%)	0.999 (0.31%)	1.000 (0.45%)	0.999 (0.38%)	1.000 (0.43%)	0.999 (0.37%)
1990	Critical	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1991	Critical	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	0.993 (-0.67%)	1.000 (0.00%)	1.000 (0.00%)
1992	Critical	1	0.997 (-0.33%)	0.997 (-0.28%)	0.912 (-8.75%)	0.902 (-9.76%)	0.675 (-32.47%)	0.994 (-0.64%)	1.000 (0.00%)
1993	Above Normal	0.999	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)
1994	Critical	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1995	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1996	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
1997	Wet	1	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)	1.000 (0.03%)
1998	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	0.997 (-0.33%)
1999	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2000	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2001	Dry	0.999	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.05%)	1.000 (0.05%)	1.000 (0.06%)	0.999 (-0.02%)
2002	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2003	Above Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2004	Above Normal	0.999	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	0.999 (0.02%)
2005	Below Normal	0.999	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	1.000 (0.06%)	0.997 (-0.19%)
2006	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2007	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2008	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2009	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.02%)
2010	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2011	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2012	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2013	Dry	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (-0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2014	Critical	0.179	0.203 (13.54%)	0.838 (368.01%)	0.433 (142.02%)	0.435 (143.16%)	0.485 (170.70%)	0.962 (437.17%)	0.711 (296.77%)
2015	Critical	0.307	0.104 (-66.08%)	0.653 (112.57%)	0.021 (-93.05%)	0.021 (-93.22%)	0.019 (-93.71%)	0.965 (213.83%)	0.943 (206.81%)
2016	Below Normal	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2017	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2018	Below Normal	1	1.000 (0.01%)	0.999 (-0.04%)	0.999 (-0.04%)	1.000 (-0.03%)	1.000 (-0.01%)	1.000 (0.01%)	1.000 (0.01%)
2019	Wet	1	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)	1.000 (0.00%)
2020	Dry	0.999	1.000 (0.08%)	1.000 (0.07%)	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	1.000 (0.08%)	0.999 (-0.02%)

F.5.3.1.2 Fry Rearing Survival

Under Alt1 in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.31% lower to 2.89% lower compared to the NAA (Figure F.5-8 and Table F.5-6).

Under Alt2 With TUCP Without VA in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.32% higher to 2.27% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.34% higher to 2.35% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.37% higher to 1.77% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.33% higher to 2.38% lower compared to the NAA.

Under Alt3 in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.45% higher to 0.32% lower compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.12% higher to 0.83% lower compared to the NAA.

Under Alt1 in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.98% higher to 3.15% lower compared to the NAAUnder Alt2 With TUCP Without VA in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 1.96% higher to 1.08% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.8% higher to 2.83% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 1.59% higher to 1.82% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.7% higher to 4.43% lower compared to the NAA.

Under Alt3 in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 1.66% higher to 0.24% lower compared to the NAA.

Under Alt4 in Below Normal water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 1.29% higher to 1.16% lower compared to the NAA.

Under Alt1 in Critical water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 162.38% higher to 89.69% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 699.65% higher to 6.26% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 311.53% higher to 97.8% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 341.56% higher to 98.07% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 310.33% higher to 97.46% lower compared to the NAA.

Under Alt3 in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 969.23% higher to 7.98% lower compared to the NAA.

Under Alt4 in Critical water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 539.66% higher to 35.33% lower compared to the NAA.

Under Alt1 in Dry water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 1.28% higher to 2.61% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Dry water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 2.62% higher to 2.95% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Dry water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 2.44% higher to 4.04% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Dry water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 2.84% higher to 3.11% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Dry water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 2.64% higher to 2.81% lower compared to the NAA.

Under Alt3 in Dry water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 2.95% higher to 7.39% lower compared to the NAA.

Under Alt4 in Dry water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 3.57% higher to 2.8% lower compared to the NAA.

Under Alt4 in Dry water years, mean predicted fry survival of winter-run Chinook salmon is higher than NAA, ranging from 3.08% higher to 1.27% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.27% higher to 0.9% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.27% higher to 0.93% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.26% higher to 0.99% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.37% higher to 0.95% lower compared to the NAA.

Under Alt3 in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.26% higher to 0.49% lower compared to the NAA.

Under Alt4 in Wet water years, mean predicted fry survival of winter-run Chinook salmon is lower than NAA, ranging from 0.05% higher to 1.71% lower compared to the NAA.

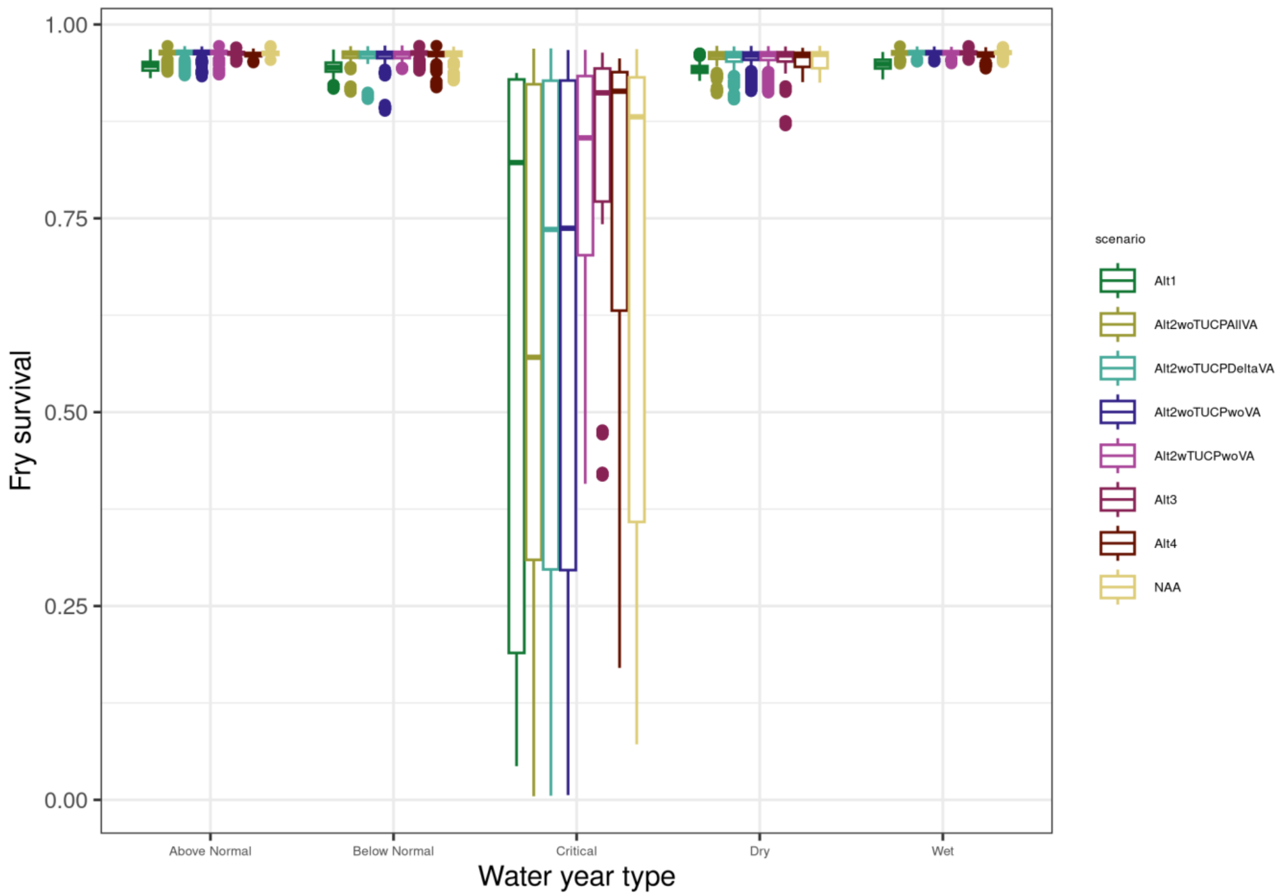


Figure F.5-8. Boxplots showing predicted winter-run Chinook fry survival by water year type.

Table F.5-6. Predicted mean annual winter-run Chinook fry survival by water year type. Difference from NAA shown in parenthesis.

Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Above Normal	0.963	0.947 (-1.65%)	0.962 (-0.11%)	0.962 (-0.12%)	0.961 (-0.15%)	0.962 (-0.10%)	0.963 (-0.03%)	0.961 (-0.17%)
Below Normal	0.959	0.944 (-1.53%)	0.961 (0.15%)	0.957 (-0.25%)	0.956 (-0.33%)	0.959 (-0.05%)	0.962 (0.27%)	0.958 (-0.08%)
Critical	0.652	0.610 (-6.35%)	0.794 (21.92%)	0.613 (-5.89%)	0.609 (-6.47%)	0.591 (-9.25%)	0.832 (27.69%)	0.782 (19.97%)
Dry	0.955	0.942 (-1.34%)	0.955 (0.01%)	0.955 (-0.02%)	0.955 (-0.07%)	0.957 (0.16%)	0.954 (-0.16%)	0.955 (-0.03%)
Wet	0.964	0.949 (-1.56%)	0.963 (-0.03%)	0.963 (-0.03%)	0.963 (-0.03%)	0.963 (-0.05%)	0.963 (-0.03%)	0.961 (-0.30%)

Under Alt1, mean annual predicted fry survival of winter-run Chinook salmon is on average lower than NAA (-1.54%), ranging from 162.38% higher in 2015 to 89.69% lower in 1935 compared to the NAA for winter-run Chinook salmon (Figure F.5-9 and Table F.5-7).

Under Alt2 With TUCP Without VA, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (11.79%), ranging from 699.65% higher in 2015 to 6.26% lower in 1993 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Delta VA, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (0.84%), ranging from 311.53% higher in 2015 to 97.8% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Systemwide VA, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (0.92%), ranging from 341.56% higher in 2015 to 98.07% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Without VA, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (1.06%), ranging from 310.33% higher in 2015 to 97.46% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt3, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (15.84%), ranging from 969.23% higher in 2015 to 7.98% lower in 1993 compared to the NAA for winter-run Chinook salmon.

Under Alt4, mean annual predicted fry survival of winter-run Chinook salmon is on average higher than NAA (9.59%), ranging from 539.66% higher in 2015 to 35.33% lower in 1978 compared to the NAA for winter-run Chinook salmon.

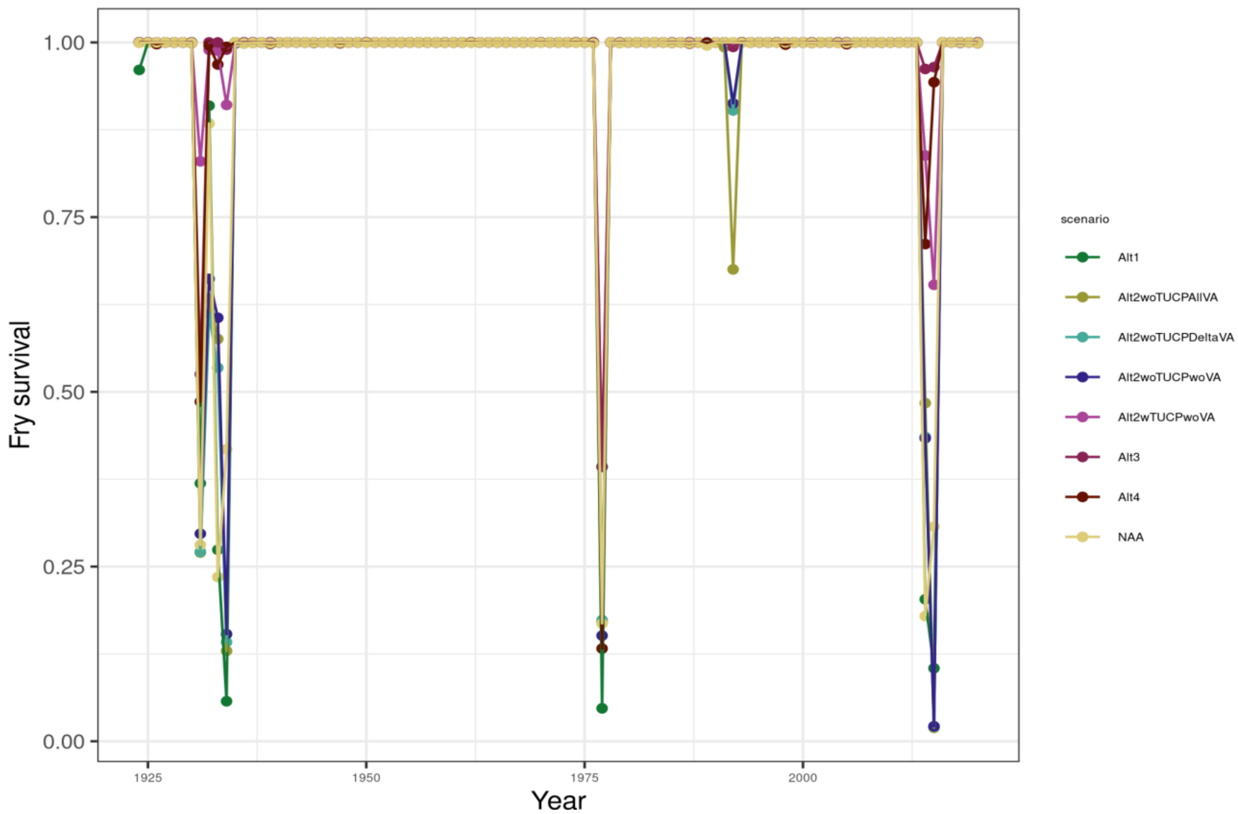


Figure F.5-9. Predicted mean annual winter-run Chinook fry survival.

Table F.5-7. Predicted mean annual winter-run Chinook fry survival. Difference from NAA shown in parenthesis.

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1924	Below Normal	0.962	0.947 (-1.59%)	0.961 (-0.20%)	0.960 (-0.21%)	0.960 (-0.22%)	0.961 (-0.12%)	0.963 (0.11%)	0.961 (-0.18%)
1925	Critical	0.897	0.822 (-8.37%)	0.944 (5.26%)	0.921 (2.71%)	0.922 (2.79%)	0.907 (1.09%)	0.929 (3.60%)	0.945 (5.32%)
1926	Dry	0.955	0.935 (-2.13%)	0.963 (0.78%)	0.961 (0.63%)	0.960 (0.49%)	0.959 (0.40%)	0.960 (0.50%)	0.953 (-0.21%)
1927	Dry	0.936	0.942 (0.55%)	0.942 (0.63%)	0.939 (0.24%)	0.938 (0.15%)	0.955 (1.97%)	0.958 (2.31%)	0.943 (0.71%)
1928	Wet	0.964	0.954 (-1.02%)	0.967 (0.25%)	0.967 (0.25%)	0.966 (0.24%)	0.966 (0.19%)	0.965 (0.05%)	0.963 (-0.08%)
1929	Above Normal	0.961	0.941 (-2.16%)	0.939 (-2.27%)	0.938 (-2.38%)	0.939 (-2.35%)	0.944 (-1.77%)	0.966 (0.45%)	0.962 (0.05%)
1930	Critical	0.937	0.929 (-0.88%)	0.945 (0.80%)	0.931 (-0.68%)	0.933 (-0.52%)	0.938 (0.01%)	0.942 (0.48%)	0.947 (0.98%)
1931	Dry	0.961	0.937 (-2.54%)	0.962 (0.10%)	0.958 (-0.31%)	0.958 (-0.34%)	0.961 (-0.01%)	0.917 (-4.58%)	0.955 (-0.66%)
1932	Critical	0.384	0.429 (11.60%)	0.702 (82.61%)	0.328 (-14.58%)	0.309 (-19.48%)	0.309 (-19.57%)	0.474 (23.33%)	0.551 (43.50%)
1933	Critical	0.614	0.635 (3.39%)	0.837 (36.32%)	0.499 (-18.80%)	0.473 (-22.97%)	0.486 (-20.80%)	0.909 (47.91%)	0.843 (37.21%)
1934	Critical	0.358	0.411 (14.87%)	0.829 (131.82%)	0.519 (45.19%)	0.495 (38.33%)	0.510 (42.46%)	0.915 (155.69%)	0.742 (107.47%)
1935	Critical	0.43	0.044 (-89.69%)	0.718 (66.96%)	0.144 (-66.44%)	0.100 (-76.72%)	0.088 (-79.45%)	0.828 (92.42%)	0.827 (92.28%)
1936	Below Normal	0.934	0.937 (0.35%)	0.952 (1.96%)	0.893 (-4.43%)	0.907 (-2.83%)	0.917 (-1.82%)	0.949 (1.66%)	0.923 (-1.16%)
1937	Below Normal	0.957	0.934 (-2.41%)	0.965 (0.84%)	0.962 (0.54%)	0.965 (0.80%)	0.961 (0.45%)	0.961 (0.42%)	0.958 (0.14%)
1938	Below Normal	0.961	0.950 (-1.16%)	0.964 (0.29%)	0.965 (0.41%)	0.963 (0.18%)	0.966 (0.56%)	0.966 (0.55%)	0.966 (0.52%)
1939	Wet	0.964	0.944 (-2.02%)	0.965 (0.14%)	0.965 (0.18%)	0.966 (0.19%)	0.965 (0.18%)	0.965 (0.18%)	0.958 (-0.61%)
1940	Dry	0.942	0.932 (-1.10%)	0.923 (-2.01%)	0.924 (-1.94%)	0.924 (-1.98%)	0.934 (-0.89%)	0.873 (-7.39%)	0.931 (-1.18%)
1941	Above Normal	0.959	0.940 (-2.03%)	0.952 (-0.72%)	0.952 (-0.75%)	0.948 (-1.15%)	0.950 (-0.92%)	0.956 (-0.32%)	0.958 (-0.09%)
1942	Wet	0.964	0.950 (-1.39%)	0.965 (0.16%)	0.965 (0.17%)	0.966 (0.19%)	0.966 (0.20%)	0.965 (0.10%)	0.962 (-0.19%)
1943	Wet	0.962	0.946 (-1.65%)	0.962 (0.04%)	0.962 (0.03%)	0.962 (0.04%)	0.962 (0.03%)	0.961 (-0.02%)	0.961 (-0.08%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1944	Wet	0.965	0.938 (-2.79%)	0.964 (-0.12%)	0.964 (-0.09%)	0.963 (-0.19%)	0.963 (-0.22%)	0.965 (0.02%)	0.961 (-0.46%)
1945	Dry	0.929	0.941 (1.28%)	0.954 (2.62%)	0.954 (2.64%)	0.952 (2.40%)	0.956 (2.84%)	0.941 (1.27%)	0.963 (3.57%)
1946	Dry	0.964	0.950 (-1.42%)	0.964 (0.04%)	0.964 (0.03%)	0.964 (0.04%)	0.964 (0.03%)	0.965 (0.10%)	0.964 (0.04%)
1947	Below Normal	0.964	0.955 (-0.93%)	0.963 (-0.01%)	0.963 (-0.01%)	0.963 (-0.08%)	0.963 (-0.05%)	0.964 (0.03%)	0.963 (-0.03%)
1948	Dry	0.964	0.941 (-2.42%)	0.960 (-0.46%)	0.960 (-0.46%)	0.955 (-0.97%)	0.960 (-0.49%)	0.956 (-0.89%)	0.937 (-2.80%)
1949	Dry	0.967	0.943 (-2.49%)	0.964 (-0.31%)	0.964 (-0.34%)	0.963 (-0.37%)	0.964 (-0.31%)	0.952 (-1.56%)	0.964 (-0.35%)
1950	Dry	0.962	0.941 (-2.17%)	0.961 (-0.02%)	0.961 (-0.07%)	0.962 (0.02%)	0.962 (-0.00%)	0.962 (0.07%)	0.959 (-0.22%)
1951	Dry	0.964	0.959 (-0.56%)	0.965 (0.05%)	0.965 (0.03%)	0.965 (0.06%)	0.965 (0.04%)	0.963 (-0.10%)	0.964 (-0.00%)
1952	Above Normal	0.963	0.955 (-0.85%)	0.964 (0.08%)	0.964 (0.08%)	0.964 (0.08%)	0.964 (0.07%)	0.963 (0.04%)	0.963 (-0.01%)
1953	Wet	0.964	0.956 (-0.86%)	0.964 (-0.01%)	0.964 (-0.01%)	0.964 (-0.01%)	0.964 (0.01%)	0.964 (-0.00%)	0.964 (-0.05%)
1954	Above Normal	0.964	0.953 (-1.11%)	0.964 (0.05%)	0.964 (0.04%)	0.965 (0.10%)	0.964 (-0.01%)	0.963 (-0.04%)	0.963 (-0.05%)
1955	Above Normal	0.966	0.947 (-1.95%)	0.966 (-0.05%)	0.966 (0.01%)	0.966 (-0.03%)	0.967 (0.06%)	0.964 (-0.22%)	0.963 (-0.36%)
1956	Dry	0.961	0.943 (-1.81%)	0.966 (0.56%)	0.966 (0.57%)	0.966 (0.54%)	0.966 (0.55%)	0.967 (0.61%)	0.963 (0.23%)
1957	Wet	0.964	0.955 (-0.84%)	0.964 (0.03%)	0.964 (0.02%)	0.964 (-0.00%)	0.963 (-0.01%)	0.964 (0.01%)	0.964 (0.01%)
1958	Below Normal	0.963	0.955 (-0.82%)	0.964 (0.05%)	0.964 (0.07%)	0.964 (0.11%)	0.964 (0.05%)	0.963 (-0.01%)	0.963 (-0.00%)
1959	Wet	0.966	0.940 (-2.70%)	0.963 (-0.28%)	0.963 (-0.29%)	0.963 (-0.28%)	0.963 (-0.30%)	0.964 (-0.19%)	0.949 (-1.71%)
1960	Below Normal	0.964	0.940 (-2.48%)	0.963 (-0.15%)	0.963 (-0.14%)	0.963 (-0.16%)	0.964 (-0.09%)	0.964 (-0.02%)	0.961 (-0.33%)
1961	Dry	0.964	0.945 (-1.96%)	0.967 (0.31%)	0.967 (0.27%)	0.967 (0.29%)	0.967 (0.32%)	0.966 (0.21%)	0.965 (0.12%)
1962	Dry	0.963	0.953 (-1.10%)	0.964 (0.10%)	0.964 (0.07%)	0.964 (0.07%)	0.964 (0.05%)	0.964 (0.08%)	0.963 (-0.01%)
1963	Dry	0.963	0.958 (-0.51%)	0.963 (0.03%)	0.964 (0.04%)	0.963 (0.02%)	0.963 (0.03%)	0.963 (0.02%)	0.963 (-0.01%)
1964	Wet	0.964	0.953 (-1.18%)	0.966 (0.14%)	0.966 (0.13%)	0.966 (0.15%)	0.966 (0.12%)	0.965 (0.05%)	0.965 (0.05%)
1965	Dry	0.966	0.948 (-1.92%)	0.966 (0.01%)	0.967 (0.03%)	0.967 (0.04%)	0.966 (-0.02%)	0.966 (-0.01%)	0.965 (-0.10%)
1966	Wet	0.965	0.959 (-0.61%)	0.966 (0.07%)	0.966 (0.07%)	0.966 (0.06%)	0.966 (0.05%)	0.965 (0.01%)	0.965 (-0.01%)
1967	Below Normal	0.965	0.952 (-1.27%)	0.964 (-0.03%)	0.965 (0.00%)	0.965 (0.00%)	0.965 (0.01%)	0.965 (0.04%)	0.964 (-0.01%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1968	Wet	0.964	0.952 (-1.29%)	0.964 (0.00%)	0.964 (0.00%)	0.964 (-0.02%)	0.964 (-0.03%)	0.964 (-0.07%)	0.963 (-0.09%)
1969	Below Normal	0.967	0.946 (-2.09%)	0.967 (0.07%)	0.967 (0.06%)	0.967 (0.07%)	0.967 (0.09%)	0.965 (-0.20%)	0.965 (-0.12%)
1970	Wet	0.965	0.958 (-0.69%)	0.965 (0.03%)	0.965 (0.04%)	0.965 (0.02%)	0.965 (0.03%)	0.963 (-0.14%)	0.965 (-0.01%)
1971	Wet	0.965	0.952 (-1.32%)	0.965 (-0.02%)	0.965 (-0.05%)	0.965 (0.02%)	0.965 (-0.02%)	0.964 (-0.13%)	0.964 (-0.16%)
1972	Wet	0.964	0.958 (-0.63%)	0.964 (-0.03%)	0.964 (0.01%)	0.964 (-0.03%)	0.964 (-0.05%)	0.964 (0.03%)	0.964 (0.02%)
1973	Below Normal	0.964	0.962 (-0.25%)	0.965 (0.12%)	0.966 (0.14%)	0.965 (0.11%)	0.966 (0.14%)	0.965 (0.06%)	0.965 (0.08%)
1974	Above Normal	0.964	0.961 (-0.31%)	0.965 (0.08%)	0.965 (0.10%)	0.965 (0.09%)	0.964 (-0.01%)	0.964 (0.02%)	0.964 (0.04%)
1975	Wet	0.962	0.943 (-1.94%)	0.964 (0.20%)	0.964 (0.19%)	0.965 (0.27%)	0.964 (0.22%)	0.961 (-0.11%)	0.956 (-0.60%)
1976	Above Normal	0.961	0.951 (-1.08%)	0.964 (0.32%)	0.964 (0.33%)	0.964 (0.28%)	0.964 (0.28%)	0.960 (-0.09%)	0.962 (0.12%)
1977	Critical	0.962	0.933 (-3.04%)	0.963 (0.00%)	0.963 (0.01%)	0.964 (0.15%)	0.964 (0.12%)	0.949 (-1.44%)	0.951 (-1.20%)
1978	Critical	0.265	0.106 (-59.96%)	0.410 (54.33%)	0.196 (-26.18%)	0.200 (-24.63%)	0.192 (-27.56%)	0.420 (58.23%)	0.172 (-35.33%)
1979	Above Normal	0.96	0.946 (-1.46%)	0.962 (0.18%)	0.961 (0.06%)	0.961 (0.06%)	0.961 (0.08%)	0.962 (0.21%)	0.959 (-0.12%)
1980	Dry	0.942	0.944 (0.27%)	0.961 (2.06%)	0.962 (2.15%)	0.965 (2.44%)	0.964 (2.34%)	0.963 (2.26%)	0.959 (1.88%)
1981	Above Normal	0.961	0.942 (-1.94%)	0.964 (0.30%)	0.964 (0.32%)	0.964 (0.34%)	0.964 (0.37%)	0.961 (0.06%)	0.960 (-0.10%)
1982	Dry	0.962	0.944 (-1.85%)	0.956 (-0.64%)	0.957 (-0.57%)	0.953 (-0.99%)	0.957 (-0.57%)	0.956 (-0.62%)	0.964 (0.22%)
1983	Wet	0.962	0.953 (-0.93%)	0.962 (-0.01%)	0.963 (0.05%)	0.963 (0.06%)	0.962 (0.02%)	0.962 (-0.06%)	0.962 (0.04%)
1984	Wet	0.963	0.943 (-2.10%)	0.958 (-0.52%)	0.958 (-0.49%)	0.959 (-0.44%)	0.958 (-0.54%)	0.962 (-0.13%)	0.961 (-0.26%)
1985	Wet	0.965	0.957 (-0.82%)	0.965 (0.07%)	0.965 (0.05%)	0.965 (0.06%)	0.965 (0.04%)	0.964 (-0.04%)	0.965 (0.00%)
1986	Below Normal	0.966	0.943 (-2.44%)	0.964 (-0.28%)	0.964 (-0.26%)	0.964 (-0.27%)	0.964 (-0.24%)	0.964 (-0.20%)	0.965 (-0.18%)
1987	Wet	0.961	0.944 (-1.76%)	0.960 (-0.02%)	0.960 (-0.02%)	0.962 (0.13%)	0.961 (0.05%)	0.961 (-0.00%)	0.956 (-0.50%)
1988	Dry	0.965	0.944 (-2.23%)	0.959 (-0.57%)	0.959 (-0.60%)	0.959 (-0.64%)	0.961 (-0.41%)	0.963 (-0.23%)	0.960 (-0.47%)
1989	Critical	0.932	0.933 (0.02%)	0.898 (-3.68%)	0.899 (-3.55%)	0.940 (0.80%)	0.886 (-4.99%)	0.957 (2.67%)	0.933 (0.00%)
1990	Dry	0.961	0.939 (-2.35%)	0.964 (0.28%)	0.964 (0.28%)	0.965 (0.32%)	0.965 (0.32%)	0.964 (0.29%)	0.953 (-0.87%)
1991	Critical	0.93	0.929 (-0.13%)	0.934 (0.50%)	0.930 (-0.01%)	0.929 (-0.12%)	0.924 (-0.64%)	0.948 (1.93%)	0.937 (0.81%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1992	Critical	0.881	0.895 (1.58%)	0.923 (4.75%)	0.899 (2.03%)	0.919 (4.32%)	0.844 (-4.24%)	0.912 (3.52%)	0.933 (5.87%)
1993	Critical	0.911	0.839 (-7.91%)	0.854 (-6.26%)	0.737 (-19.05%)	0.736 (-19.22%)	0.571 (-37.32%)	0.838 (-7.98%)	0.914 (0.36%)
1994	Above Normal	0.962	0.940 (-2.35%)	0.964 (0.22%)	0.964 (0.20%)	0.964 (0.20%)	0.964 (0.15%)	0.962 (-0.05%)	0.959 (-0.37%)
1995	Critical	0.953	0.931 (-2.34%)	0.930 (-2.48%)	0.929 (-2.54%)	0.919 (-3.57%)	0.928 (-2.60%)	0.943 (-1.02%)	0.939 (-1.52%)
1996	Wet	0.964	0.947 (-1.83%)	0.965 (0.09%)	0.965 (0.08%)	0.966 (0.14%)	0.965 (0.09%)	0.965 (0.08%)	0.958 (-0.61%)
1997	Wet	0.965	0.938 (-2.77%)	0.956 (-0.90%)	0.956 (-0.95%)	0.956 (-0.93%)	0.956 (-0.99%)	0.960 (-0.49%)	0.964 (-0.10%)
1998	Wet	0.964	0.955 (-0.92%)	0.965 (0.18%)	0.965 (0.16%)	0.965 (0.18%)	0.965 (0.15%)	0.964 (0.05%)	0.963 (-0.04%)
1999	Wet	0.965	0.941 (-2.42%)	0.958 (-0.74%)	0.959 (-0.62%)	0.959 (-0.58%)	0.958 (-0.68%)	0.961 (-0.40%)	0.960 (-0.53%)
2000	Wet	0.961	0.950 (-1.15%)	0.961 (0.05%)	0.961 (0.04%)	0.961 (0.02%)	0.961 (0.01%)	0.961 (0.04%)	0.961 (-0.01%)
2001	Above Normal	0.964	0.936 (-2.89%)	0.966 (0.16%)	0.966 (0.17%)	0.966 (0.19%)	0.966 (0.19%)	0.964 (-0.02%)	0.956 (-0.83%)
2002	Dry	0.964	0.947 (-1.72%)	0.956 (-0.81%)	0.957 (-0.77%)	0.957 (-0.76%)	0.957 (-0.74%)	0.956 (-0.84%)	0.963 (-0.13%)
2003	Below Normal	0.963	0.945 (-1.91%)	0.965 (0.15%)	0.965 (0.18%)	0.965 (0.15%)	0.965 (0.13%)	0.963 (-0.02%)	0.961 (-0.21%)
2004	Above Normal	0.964	0.950 (-1.47%)	0.966 (0.24%)	0.966 (0.25%)	0.967 (0.27%)	0.966 (0.23%)	0.964 (-0.05%)	0.962 (-0.25%)
2005	Above Normal	0.967	0.948 (-1.90%)	0.967 (-0.01%)	0.966 (-0.02%)	0.966 (-0.03%)	0.966 (-0.02%)	0.964 (-0.32%)	0.964 (-0.30%)
2006	Below Normal	0.967	0.945 (-2.23%)	0.956 (-1.08%)	0.956 (-1.09%)	0.957 (-1.05%)	0.957 (-1.03%)	0.965 (-0.24%)	0.964 (-0.33%)
2007	Wet	0.963	0.949 (-1.48%)	0.966 (0.27%)	0.965 (0.20%)	0.965 (0.23%)	0.965 (0.23%)	0.963 (0.03%)	0.962 (-0.16%)
2008	Below Normal	0.964	0.941 (-2.36%)	0.960 (-0.46%)	0.960 (-0.43%)	0.961 (-0.35%)	0.960 (-0.46%)	0.966 (0.21%)	0.962 (-0.28%)
2009	Dry	0.937	0.931 (-0.65%)	0.940 (0.33%)	0.941 (0.37%)	0.947 (1.01%)	0.950 (1.35%)	0.965 (2.95%)	0.938 (0.12%)
2010	Dry	0.93	0.931 (0.08%)	0.932 (0.16%)	0.932 (0.13%)	0.936 (0.55%)	0.933 (0.29%)	0.952 (2.34%)	0.936 (0.62%)
2011	Below Normal	0.961	0.951 (-1.08%)	0.964 (0.29%)	0.964 (0.29%)	0.965 (0.37%)	0.965 (0.39%)	0.962 (0.10%)	0.961 (-0.04%)
2012	Wet	0.965	0.945 (-1.99%)	0.966 (0.17%)	0.966 (0.18%)	0.966 (0.17%)	0.966 (0.17%)	0.966 (0.11%)	0.960 (-0.48%)
2013	Below Normal	0.961	0.936 (-2.57%)	0.953 (-0.79%)	0.954 (-0.79%)	0.954 (-0.78%)	0.955 (-0.64%)	0.962 (0.14%)	0.963 (0.19%)
2014	Dry	0.944	0.940 (-0.46%)	0.917 (-2.95%)	0.918 (-2.81%)	0.906 (-4.04%)	0.915 (-3.11%)	0.950 (0.60%)	0.943 (-0.11%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2015	Critical	0.072	0.189 (162.38%)	0.577 (699.65%)	0.296 (310.33%)	0.297 (311.53%)	0.318 (341.56%)	0.771 (969.23%)	0.461 (539.66%)
2016	Critical	0.245	0.128 (-47.83%)	0.452 (84.37%)	0.006 (-97.46%)	0.005 (-97.80%)	0.005 (-98.07%)	0.745 (203.75%)	0.630 (157.11%)
2017	Below Normal	0.931	0.940 (0.98%)	0.946 (1.63%)	0.938 (0.70%)	0.909 (-2.42%)	0.946 (1.59%)	0.945 (1.50%)	0.943 (1.29%)
2018	Wet	0.957	0.945 (-1.27%)	0.960 (0.27%)	0.961 (0.37%)	0.960 (0.26%)	0.960 (0.26%)	0.960 (0.26%)	0.957 (0.02%)
2019	Below Normal	0.951	0.921 (-3.15%)	0.954 (0.36%)	0.954 (0.35%)	0.954 (0.35%)	0.951 (0.08%)	0.958 (0.73%)	0.944 (-0.74%)
2020	Wet	0.965	0.933 (-3.26%)	0.960 (-0.45%)	0.960 (-0.45%)	0.957 (-0.84%)	0.960 (-0.48%)	0.965 (-0.02%)	0.948 (-1.70%)
2021	Dry	0.956	0.931 (-2.61%)	0.955 (-0.02%)	0.956 (-0.00%)	0.955 (-0.02%)	0.956 (0.09%)	0.945 (-1.10%)	0.947 (-0.89%)

F.5.3.1.3 River-Migration Survival

Under Alt1 in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.15% higher to 1.56% lower compared to the NAA (Figure F.5-10 and Table F.5-8).

Under Alt2 With TUCP Without VA in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.58% higher to 0.65% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.41% higher to 0.8% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.94% higher to 0.87% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.85% higher to 0.66% lower compared to the NAA.

Under Alt3 in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.44% higher to 0.96% lower compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.45% higher to 0.37% lower compared to the NAA.

Under Alt1 in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.9% higher to 0.59% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.68% higher to 0.43% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is lower than NAA, ranging from 0.77% higher to 1.96% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is lower than NAA, ranging from 0.82% higher to 1.92% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is lower than NAA, ranging from 0.69% higher to 1.91% lower compared to the NAA.

Under Alt3 in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 3.23% higher to 0.58% lower compared to the NAA.

Under Alt4 in Below Normal water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 3.07% higher to 0.18% lower compared to the NAA.

Under Alt1 in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.66% higher to 0.7% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.69% higher to 0.47% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.91% higher to 0.77% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.5% higher to 0.26% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.88% higher to 0.32% lower compared to the NAA.

Under Alt3 in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.65% higher to 0.54% lower compared to the NAA.

Under Alt4 in Critical water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.98% higher to 0.17% lower compared to the NAA.

Under Alt1 in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is lower than NAA, ranging from 0.56% higher to 1.14% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 1.65% higher to 0.1% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 1.48% higher to 0.1% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 1.45% higher to 0.11% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 1.59% higher to 0.06% lower compared to the NAA.

Under Alt3 in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 1.19% higher to 0.79% lower compared to the NAA.

Under Alt4 in Dry water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 0.71% higher to 0.67% lower compared to the NAA.

Under Alt1 in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 2.68% higher to 2.9% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 5.2% higher to 0.37% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 4.07% higher to 0.56% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 5.32% higher to 0.38% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 5.67% higher to 0.37% lower compared to the NAA.

Under Alt3 in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 7.95% higher to 0.79% lower compared to the NAA.

Under Alt4 in Wet water years, mean predicted river-migration survival of winter-run Chinook salmon is higher than NAA, ranging from 4.04% higher to 1.75% lower compared to the NAA.

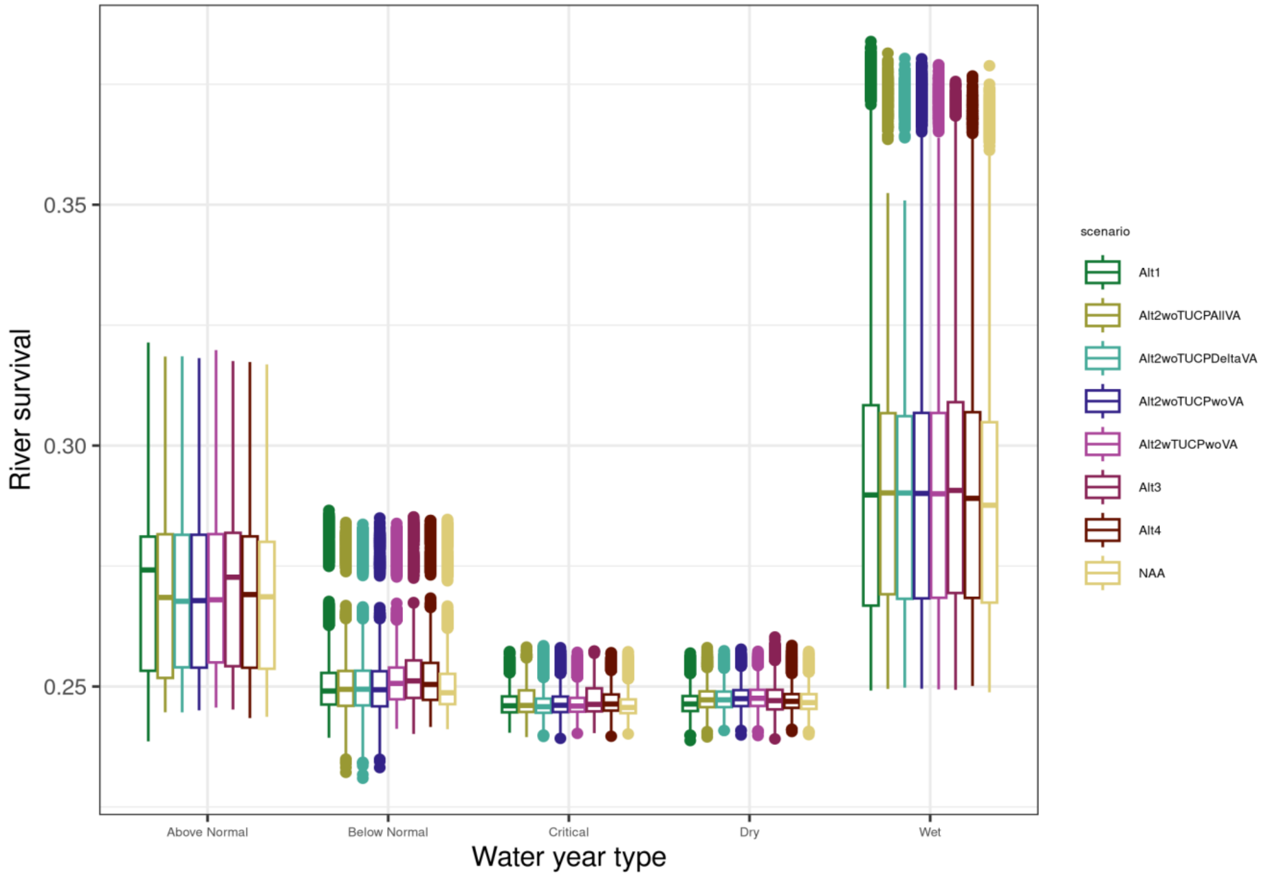


Figure F.5-10. Boxplots showing predicted winter-run Chinook river migration survival by water year type.

Table F.5-8. Predicted mean annual winter-run Chinook river migration survival by water year type. Difference from NAA shown in parenthesis.

Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Above Normal	0.268	0.270 (0.60%)	0.270 (0.42%)	0.270 (0.39%)	0.269 (0.32%)	0.269 (0.35%)	0.270 (0.66%)	0.270 (0.41%)
Below Normal	0.253	0.253 (0.14%)	0.254 (0.38%)	0.253 (-0.04%)	0.253 (-0.02%)	0.253 (0.00%)	0.254 (0.55%)	0.254 (0.42%)
Critical	0.247	0.247 (0.07%)	0.247 (0.07%)	0.247 (0.20%)	0.247 (0.07%)	0.247 (0.29%)	0.247 (0.30%)	0.247 (0.23%)
Dry	0.247	0.247 (-0.17%)	0.248 (0.30%)	0.248 (0.28%)	0.247 (0.18%)	0.248 (0.21%)	0.248 (0.20%)	0.247 (0.08%)
Wet	0.292	0.292 (0.24%)	0.294 (0.71%)	0.294 (0.70%)	0.293 (0.52%)	0.294 (0.72%)	0.295 (0.99%)	0.293 (0.43%)

Under Alt1, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.13%), ranging from 2.68% higher in 1984 to 2.9% lower in 1995 compared to the NAA for winter-run Chinook salmon (Figure F.5-11 and Table F.5-9).

Under Alt2 With TUCP Without VA, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.41%), ranging from 5.2% higher in 2017 to 0.65% lower in 1954 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Delta VA, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.24%), ranging from 4.07% higher in 2017 to 1.96% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Systemwide VA, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.35%), ranging from 5.32% higher in 2017 to 1.92% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Without VA, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.35%), ranging from 5.67% higher in 2017 to 1.91% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt3, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.58%), ranging from 7.95% higher in 2017 to 0.96% lower in 1940 compared to the NAA for winter-run Chinook salmon.

Under Alt4, mean annual predicted river-migration survival of winter-run Chinook salmon is on average higher than NAA (0.31%), ranging from 4.04% higher in 1927 to 1.75% lower in 1995 compared to the NAA for winter-run Chinook salmon.

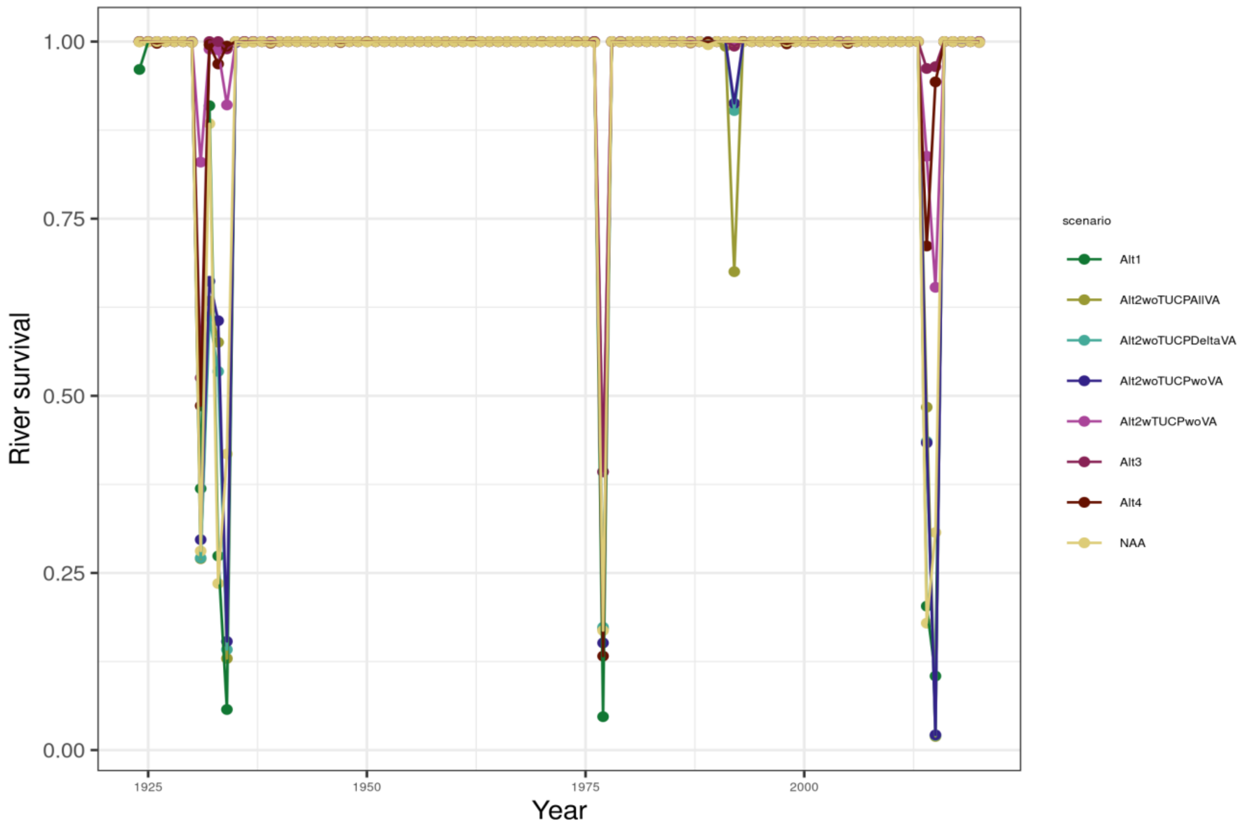


Figure F.5-11. Predicted mean annual winter-run Chinook river migration survival.

Table F.5-9. Predicted mean annual winter-run Chinook river migration survival. Difference from NAA shown in parenthesis.

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1924	Critical	0.244	0.244 (0.14%)	0.245 (0.35%)	0.245 (0.24%)	0.245 (0.31%)	0.245 (0.16%)	0.244 (0.04%)	0.245 (0.15%)
1925	Dry	0.246	0.245 (-0.34%)	0.248 (0.64%)	0.247 (0.19%)	0.247 (0.19%)	0.246 (0.09%)	0.247 (0.35%)	0.246 (0.08%)
1926	Dry	0.246	0.245 (-0.33%)	0.247 (0.26%)	0.247 (0.24%)	0.247 (0.30%)	0.247 (0.14%)	0.246 (0.03%)	0.247 (0.35%)
1927	Wet	0.258	0.260 (0.95%)	0.267 (3.59%)	0.267 (3.49%)	0.264 (2.24%)	0.269 (4.21%)	0.268 (3.72%)	0.268 (4.04%)
1928	Above Normal	0.249	0.249 (-0.17%)	0.250 (0.34%)	0.250 (0.34%)	0.249 (0.07%)	0.249 (0.12%)	0.250 (0.30%)	0.249 (0.08%)
1929	Critical	0.245	0.245 (-0.19%)	0.245 (0.09%)	0.245 (0.11%)	0.245 (0.14%)	0.245 (0.08%)	0.245 (0.12%)	0.245 (0.06%)
1930	Dry	0.247	0.246 (-0.10%)	0.247 (0.31%)	0.247 (0.33%)	0.247 (0.33%)	0.248 (0.36%)	0.250 (1.19%)	0.247 (0.30%)
1931	Critical	0.246	0.246 (0.02%)	0.246 (0.03%)	0.246 (0.16%)	0.246 (0.12%)	0.246 (0.10%)	0.246 (-0.00%)	0.246 (0.17%)
1932	Critical	0.251	0.251 (0.11%)	0.251 (0.03%)	0.251 (0.33%)	0.251 (0.22%)	0.251 (0.24%)	0.251 (0.30%)	0.251 (0.34%)
1933	Critical	0.245	0.244 (-0.05%)	0.245 (0.09%)	0.244 (-0.32%)	0.244 (-0.35%)	0.244 (-0.26%)	0.245 (0.13%)	0.245 (-0.01%)
1934	Critical	0.245	0.245 (0.07%)	0.247 (0.69%)	0.246 (0.38%)	0.246 (0.36%)	0.246 (0.33%)	0.247 (0.75%)	0.247 (0.61%)
1935	Below Normal	0.246	0.246 (-0.08%)	0.253 (2.68%)	0.245 (-0.45%)	0.245 (-0.48%)	0.245 (-0.36%)	0.253 (2.88%)	0.252 (2.53%)
1936	Below Normal	0.25	0.250 (-0.07%)	0.251 (0.57%)	0.251 (0.50%)	0.251 (0.55%)	0.251 (0.48%)	0.252 (0.88%)	0.250 (0.04%)
1937	Below Normal	0.245	0.244 (-0.28%)	0.246 (0.22%)	0.245 (-0.06%)	0.246 (0.20%)	0.245 (-0.09%)	0.245 (0.16%)	0.245 (0.09%)
1938	Wet	0.278	0.277 (-0.44%)	0.282 (1.53%)	0.281 (1.22%)	0.281 (1.15%)	0.280 (0.82%)	0.283 (1.76%)	0.280 (0.84%)
1939	Dry	0.247	0.244 (-1.14%)	0.247 (0.15%)	0.247 (0.19%)	0.247 (0.16%)	0.248 (0.26%)	0.245 (-0.79%)	0.245 (-0.67%)
1940	Above Normal	0.257	0.255 (-0.85%)	0.257 (-0.16%)	0.257 (-0.16%)	0.257 (-0.21%)	0.257 (-0.01%)	0.255 (-0.96%)	0.258 (0.07%)
1941	Wet	0.303	0.307 (1.49%)	0.306 (1.11%)	0.306 (1.16%)	0.304 (0.44%)	0.305 (0.77%)	0.301 (-0.79%)	0.305 (0.78%)
1942	Wet	0.297	0.295 (-0.70%)	0.298 (0.31%)	0.298 (0.35%)	0.298 (0.33%)	0.298 (0.32%)	0.297 (-0.01%)	0.298 (0.06%)
1943	Wet	0.279	0.280 (0.52%)	0.279 (0.14%)	0.279 (0.14%)	0.279 (0.17%)	0.279 (0.18%)	0.279 (0.02%)	0.279 (0.02%)
1944	Dry	0.245	0.245 (0.13%)	0.245 (0.08%)	0.245 (0.10%)	0.245 (0.08%)	0.245 (0.11%)	0.245 (0.08%)	0.245 (0.22%)
1945	Dry	0.246	0.248 (0.56%)	0.247 (0.33%)	0.247 (0.32%)	0.247 (0.24%)	0.247 (0.36%)	0.246 (0.12%)	0.248 (0.71%)
1946	Below Normal	0.281	0.283 (0.54%)	0.280 (-0.43%)	0.280 (-0.43%)	0.280 (-0.46%)	0.280 (-0.44%)	0.282 (0.21%)	0.282 (0.11%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1947	Dry	0.244	0.244 (-0.04%)	0.244 (-0.04%)	0.244 (-0.01%)	0.244 (-0.10%)	0.244 (-0.02%)	0.244 (-0.22%)	0.245 (0.13%)
1948	Dry	0.246	0.247 (0.50%)	0.249 (1.41%)	0.249 (1.40%)	0.246 (0.06%)	0.246 (0.16%)	0.248 (1.17%)	0.245 (-0.06%)
1949	Dry	0.245	0.245 (-0.06%)	0.245 (-0.10%)	0.245 (-0.06%)	0.245 (-0.06%)	0.245 (-0.10%)	0.244 (-0.44%)	0.245 (-0.08%)
1950	Dry	0.246	0.246 (-0.21%)	0.246 (0.08%)	0.247 (0.12%)	0.247 (0.13%)	0.247 (0.26%)	0.246 (-0.16%)	0.247 (0.10%)
1951	Above Normal	0.28	0.280 (-0.04%)	0.280 (-0.01%)	0.280 (0.02%)	0.280 (-0.02%)	0.280 (0.04%)	0.280 (0.12%)	0.279 (-0.05%)
1952	Wet	0.287	0.290 (0.84%)	0.289 (0.48%)	0.289 (0.52%)	0.289 (0.48%)	0.289 (0.47%)	0.291 (1.39%)	0.289 (0.50%)
1953	Above Normal	0.312	0.317 (1.46%)	0.314 (0.61%)	0.314 (0.62%)	0.314 (0.59%)	0.314 (0.33%)	0.313 (0.23%)	0.313 (0.19%)
1954	Above Normal	0.27	0.275 (1.90%)	0.268 (-0.65%)	0.268 (-0.66%)	0.268 (-0.80%)	0.269 (-0.34%)	0.274 (1.36%)	0.269 (-0.37%)
1955	Dry	0.249	0.248 (-0.13%)	0.249 (0.04%)	0.249 (0.00%)	0.249 (0.13%)	0.249 (0.11%)	0.250 (0.39%)	0.249 (0.07%)
1956	Wet	0.344	0.345 (0.42%)	0.346 (0.64%)	0.346 (0.62%)	0.346 (0.57%)	0.347 (0.99%)	0.346 (0.54%)	0.347 (1.01%)
1957	Below Normal	0.246	0.245 (-0.59%)	0.246 (-0.24%)	0.245 (-0.34%)	0.245 (-0.49%)	0.245 (-0.52%)	0.246 (-0.11%)	0.246 (0.07%)
1958	Wet	0.288	0.286 (-0.68%)	0.290 (0.68%)	0.290 (0.72%)	0.290 (0.72%)	0.290 (0.72%)	0.288 (0.02%)	0.288 (0.05%)
1959	Below Normal	0.258	0.259 (0.39%)	0.259 (0.39%)	0.258 (0.32%)	0.258 (0.22%)	0.259 (0.37%)	0.258 (0.18%)	0.257 (-0.18%)
1960	Dry	0.246	0.245 (-0.19%)	0.248 (0.80%)	0.248 (0.80%)	0.246 (0.32%)	0.247 (0.45%)	0.246 (-0.03%)	0.247 (0.56%)
1961	Dry	0.25	0.248 (-0.71%)	0.250 (0.25%)	0.250 (0.30%)	0.250 (0.03%)	0.250 (0.24%)	0.251 (0.37%)	0.249 (-0.31%)
1962	Dry	0.251	0.250 (-0.38%)	0.252 (0.29%)	0.252 (0.27%)	0.252 (0.22%)	0.252 (0.31%)	0.253 (0.60%)	0.252 (0.13%)
1963	Wet	0.253	0.253 (-0.09%)	0.253 (0.03%)	0.253 (0.03%)	0.253 (0.03%)	0.253 (0.04%)	0.253 (0.07%)	0.253 (0.13%)
1964	Dry	0.248	0.248 (-0.14%)	0.248 (-0.00%)	0.248 (0.08%)	0.248 (0.05%)	0.248 (-0.01%)	0.250 (0.86%)	0.247 (-0.32%)
1965	Wet	0.307	0.309 (0.59%)	0.307 (0.16%)	0.307 (0.13%)	0.308 (0.27%)	0.308 (0.45%)	0.308 (0.26%)	0.307 (0.04%)
1966	Below Normal	0.264	0.264 (0.27%)	0.263 (-0.15%)	0.263 (-0.10%)	0.263 (-0.07%)	0.263 (-0.07%)	0.264 (0.24%)	0.264 (0.22%)
1967	Wet	0.268	0.269 (0.12%)	0.269 (0.18%)	0.269 (0.17%)	0.269 (0.28%)	0.269 (0.36%)	0.271 (1.05%)	0.268 (0.04%)
1968	Below Normal	0.251	0.251 (-0.07%)	0.252 (0.26%)	0.252 (0.25%)	0.252 (0.28%)	0.252 (0.35%)	0.252 (0.15%)	0.251 (0.06%)
1969	Wet	0.314	0.313 (-0.57%)	0.317 (0.86%)	0.317 (0.83%)	0.317 (0.91%)	0.318 (1.02%)	0.319 (1.58%)	0.314 (0.04%)
1970	Wet	0.368	0.376 (2.16%)	0.372 (1.03%)	0.372 (1.07%)	0.372 (1.10%)	0.372 (1.04%)	0.368 (-0.00%)	0.368 (0.08%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1971	Wet	0.284	0.288 (1.47%)	0.285 (0.40%)	0.285 (0.33%)	0.284 (0.15%)	0.284 (0.22%)	0.287 (1.23%)	0.286 (0.89%)
1972	Below Normal	0.246	0.247 (0.25%)	0.246 (0.05%)	0.246 (0.06%)	0.246 (0.02%)	0.246 (0.03%)	0.248 (0.87%)	0.247 (0.14%)
1973	Above Normal	0.283	0.283 (0.08%)	0.284 (0.26%)	0.283 (0.18%)	0.283 (0.10%)	0.284 (0.30%)	0.283 (-0.10%)	0.283 (0.05%)
1974	Wet	0.344	0.345 (0.26%)	0.345 (0.12%)	0.345 (0.10%)	0.344 (-0.10%)	0.345 (0.16%)	0.345 (0.24%)	0.344 (-0.02%)
1975	Above Normal	0.248	0.251 (1.11%)	0.249 (0.19%)	0.249 (0.15%)	0.249 (0.15%)	0.249 (0.15%)	0.249 (0.22%)	0.251 (1.13%)
1976	Critical	0.246	0.247 (0.66%)	0.246 (-0.10%)	0.246 (-0.10%)	0.246 (0.03%)	0.246 (-0.10%)	0.246 (0.10%)	0.248 (0.98%)
1977	Critical	0.245	0.246 (0.24%)	0.246 (0.25%)	0.246 (0.39%)	0.246 (0.21%)	0.247 (0.49%)	0.252 (2.65%)	0.247 (0.55%)
1978	Above Normal	0.248	0.244 (-1.56%)	0.250 (0.75%)	0.249 (0.56%)	0.250 (0.60%)	0.250 (0.59%)	0.253 (1.80%)	0.248 (0.07%)
1979	Dry	0.246	0.245 (-0.30%)	0.246 (0.17%)	0.246 (0.18%)	0.246 (0.17%)	0.246 (0.10%)	0.245 (-0.48%)	0.246 (-0.03%)
1980	Above Normal	0.279	0.284 (2.00%)	0.286 (2.58%)	0.287 (2.85%)	0.286 (2.41%)	0.287 (2.94%)	0.286 (2.44%)	0.286 (2.45%)
1981	Dry	0.247	0.247 (-0.16%)	0.248 (0.15%)	0.248 (0.14%)	0.248 (0.16%)	0.248 (0.15%)	0.248 (0.22%)	0.247 (-0.02%)
1982	Wet	0.289	0.290 (0.34%)	0.290 (0.14%)	0.290 (0.15%)	0.290 (0.29%)	0.290 (0.25%)	0.290 (0.24%)	0.291 (0.63%)
1983	Wet	0.298	0.297 (-0.22%)	0.300 (0.50%)	0.299 (0.47%)	0.299 (0.45%)	0.299 (0.48%)	0.298 (-0.12%)	0.298 (0.03%)
1984	Wet	0.285	0.292 (2.68%)	0.284 (-0.37%)	0.284 (-0.37%)	0.284 (-0.31%)	0.284 (-0.38%)	0.285 (0.10%)	0.287 (0.98%)
1985	Below Normal	0.248	0.249 (0.31%)	0.248 (-0.01%)	0.248 (0.01%)	0.248 (-0.05%)	0.248 (-0.05%)	0.249 (0.18%)	0.249 (0.14%)
1986	Wet	0.26	0.253 (-2.74%)	0.262 (0.78%)	0.262 (0.68%)	0.262 (0.78%)	0.262 (0.82%)	0.261 (0.29%)	0.258 (-0.95%)
1987	Dry	0.247	0.245 (-0.51%)	0.251 (1.65%)	0.251 (1.59%)	0.250 (1.48%)	0.250 (1.45%)	0.246 (-0.08%)	0.247 (-0.05%)
1988	Critical	0.254	0.252 (-0.70%)	0.254 (0.06%)	0.254 (0.02%)	0.252 (-0.57%)	0.254 (0.03%)	0.254 (0.15%)	0.253 (-0.17%)
1989	Dry	0.246	0.246 (-0.15%)	0.246 (0.07%)	0.246 (0.02%)	0.246 (0.10%)	0.246 (0.03%)	0.246 (0.11%)	0.246 (-0.04%)
1990	Critical	0.245	0.246 (0.32%)	0.245 (0.11%)	0.246 (0.16%)	0.246 (0.38%)	0.245 (0.09%)	0.246 (0.12%)	0.246 (0.31%)
1991	Critical	0.246	0.245 (-0.11%)	0.246 (-0.02%)	0.248 (0.78%)	0.244 (-0.77%)	0.252 (2.50%)	0.249 (1.16%)	0.247 (0.56%)
1992	Critical	0.244	0.244 (-0.05%)	0.244 (0.05%)	0.244 (-0.07%)	0.244 (0.03%)	0.244 (-0.00%)	0.244 (0.01%)	0.244 (-0.00%)
1993	Above Normal	0.254	0.254 (-0.14%)	0.256 (0.56%)	0.255 (0.15%)	0.255 (0.14%)	0.252 (-0.87%)	0.256 (0.55%)	0.255 (0.07%)
1994	Critical	0.245	0.247 (0.64%)	0.246 (0.06%)	0.245 (0.03%)	0.245 (0.02%)	0.245 (-0.01%)	0.245 (0.03%)	0.246 (0.05%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1995	Wet	0.3	0.291 (-2.90%)	0.303 (1.07%)	0.303 (0.78%)	0.299 (-0.56%)	0.303 (0.97%)	0.308 (2.70%)	0.295 (-1.75%)
1996	Wet	0.265	0.263 (-0.61%)	0.265 (0.31%)	0.267 (0.70%)	0.266 (0.31%)	0.266 (0.46%)	0.266 (0.45%)	0.264 (-0.10%)
1997	Wet	0.327	0.331 (0.95%)	0.327 (-0.08%)	0.327 (-0.02%)	0.328 (0.04%)	0.327 (0.00%)	0.328 (0.00%)	0.328 (0.14%)
1998	Wet	0.301	0.307 (2.05%)	0.303 (0.67%)	0.302 (0.58%)	0.302 (0.52%)	0.302 (0.34%)	0.311 (3.63%)	0.307 (2.09%)
1999	Wet	0.266	0.265 (-0.54%)	0.268 (0.49%)	0.267 (0.27%)	0.267 (0.33%)	0.267 (0.43%)	0.267 (0.16%)	0.265 (-0.39%)
2000	Above Normal	0.259	0.263 (1.83%)	0.261 (0.87%)	0.261 (0.91%)	0.261 (0.89%)	0.261 (0.87%)	0.260 (0.69%)	0.260 (0.60%)
2001	Dry	0.247	0.248 (0.36%)	0.247 (0.11%)	0.247 (0.05%)	0.247 (0.07%)	0.247 (0.14%)	0.247 (0.19%)	0.247 (0.24%)
2002	Below Normal	0.275	0.278 (0.90%)	0.275 (0.12%)	0.276 (0.15%)	0.276 (0.27%)	0.277 (0.58%)	0.275 (0.11%)	0.276 (0.28%)
2003	Above Normal	0.281	0.280 (-0.25%)	0.281 (-0.03%)	0.281 (-0.03%)	0.281 (-0.05%)	0.281 (0.01%)	0.282 (0.36%)	0.280 (-0.18%)
2004	Above Normal	0.269	0.275 (2.15%)	0.269 (0.15%)	0.269 (0.11%)	0.269 (0.18%)	0.269 (0.22%)	0.273 (1.60%)	0.272 (1.23%)
2005	Below Normal	0.251	0.251 (-0.17%)	0.251 (0.08%)	0.251 (0.07%)	0.251 (0.04%)	0.251 (0.00%)	0.251 (0.01%)	0.251 (0.08%)
2006	Wet	0.309	0.311 (0.69%)	0.310 (0.31%)	0.310 (0.30%)	0.309 (0.08%)	0.309 (0.15%)	0.309 (0.19%)	0.309 (0.07%)
2007	Below Normal	0.249	0.251 (0.80%)	0.250 (0.08%)	0.250 (0.06%)	0.250 (0.16%)	0.250 (0.09%)	0.249 (0.04%)	0.250 (0.24%)
2008	Dry	0.25	0.248 (-0.64%)	0.250 (0.11%)	0.250 (0.12%)	0.250 (-0.05%)	0.249 (-0.11%)	0.249 (-0.33%)	0.249 (-0.36%)
2009	Dry	0.244	0.244 (-0.07%)	0.245 (0.34%)	0.245 (0.35%)	0.245 (0.33%)	0.244 (0.16%)	0.245 (0.29%)	0.245 (0.36%)
2010	Below Normal	0.249	0.248 (-0.09%)	0.251 (0.72%)	0.250 (0.69%)	0.251 (0.77%)	0.251 (0.82%)	0.252 (1.20%)	0.250 (0.43%)
2011	Wet	0.26	0.257 (-1.13%)	0.259 (-0.20%)	0.259 (-0.19%)	0.259 (-0.16%)	0.259 (-0.26%)	0.260 (0.03%)	0.260 (0.08%)
2012	Below Normal	0.246	0.245 (-0.23%)	0.246 (-0.04%)	0.246 (-0.03%)	0.246 (0.17%)	0.246 (0.12%)	0.244 (-0.58%)	0.246 (0.01%)
2013	Dry	0.254	0.253 (-0.11%)	0.254 (0.08%)	0.254 (0.20%)	0.254 (0.05%)	0.255 (0.35%)	0.256 (0.97%)	0.255 (0.56%)
2014	Critical	0.247	0.247 (0.01%)	0.246 (-0.08%)	0.247 (0.14%)	0.246 (-0.04%)	0.247 (-0.00%)	0.246 (-0.20%)	0.246 (-0.10%)
2015	Critical	0.253	0.253 (0.16%)	0.251 (-0.47%)	0.255 (0.88%)	0.255 (0.91%)	0.255 (0.77%)	0.251 (-0.54%)	0.252 (-0.06%)
2016	Below Normal	0.247	0.247 (0.15%)	0.251 (1.85%)	0.242 (-1.91%)	0.242 (-1.96%)	0.242 (-1.92%)	0.255 (3.23%)	0.254 (3.07%)
2017	Wet	0.281	0.283 (0.92%)	0.295 (5.20%)	0.297 (5.67%)	0.292 (4.07%)	0.296 (5.32%)	0.303 (7.95%)	0.288 (2.58%)
2018	Below Normal	0.246	0.247 (0.26%)	0.247 (0.53%)	0.247 (0.49%)	0.247 (0.53%)	0.247 (0.59%)	0.246 (-0.07%)	0.246 (-0.03%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2019	Wet	0.253	0.253 (-0.13%)	0.253 (0.05%)	0.253 (-0.01%)	0.253 (-0.01%)	0.253 (0.01%)	0.258 (1.96%)	0.254 (0.47%)
2020	Dry	0.248	0.248 (0.14%)	0.248 (-0.04%)	0.248 (-0.05%)	0.248 (-0.04%)	0.248 (-0.05%)	0.249 (0.36%)	0.248 (0.07%)
2021	Critical	0.245	0.244 (-0.08%)	0.245 (0.01%)	0.245 (0.04%)	0.245 (0.06%)	0.245 (0.14%)	0.245 (0.04%)	0.245 (0.23%)

F.5.3.1.4 Through-Delta survival

Under Alt1 in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 2.61% higher to 37.05% lower compared to the NAA (Figure F.5-12 and Table F.5-10).

Under Alt2 With TUCP Without VA in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 22.52% higher to 0.85% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 2.44% higher to 4.61% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 2.87% higher to 4.79% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 2.44% higher to 9.4% lower compared to the NAA.

Under Alt3 in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 29.84% higher to 0.91% lower compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 2.1% higher to 22.7% lower compared to the NAA.

Under Alt1 in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 4.96% higher to 40.49% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 9.71% higher to 1.74% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 6.11% higher to 43.67% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 7.09% higher to 44.32% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 5.02% higher to 43.58% lower compared to the NAA.

Under Alt3 in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 20.78% higher to 1.5% lower compared to the NAA.

Under Alt4 in Below Normal water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 8.12% higher to 5.44% lower compared to the NAA.

Under Alt1 in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 3.39% higher to 14.91% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 6.66% higher to 36.12% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 6.21% higher to 31.76% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 15.71% higher to 33.44% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 6.98% higher to 31.87% lower compared to the NAA.

Under Alt3 in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 18.49% higher to 27.78% lower compared to the NAA.

Under Alt4 in Critical water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 10.1% higher to 36.12% lower compared to the NAA.

Under Alt1 in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 4.07% higher to 11.4% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 14.02% higher to 1.53% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 14.55% higher to 1.43% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 14.42% higher to 1.8% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 14.03% higher to 1.71% lower compared to the NAA.

Under Alt3 in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 19.18% higher to 3.85% lower compared to the NAA.

Under Alt4 in Dry water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 12.96% higher to 5.06% lower compared to the NAA.

Under Alt1 in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is lower than NAA, ranging from 2.91% higher to 9.15% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 8.44% higher to 1.35% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 6.51% higher to 1.47% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 8.28% higher to 2.02% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 8.58% higher to 1.3% lower compared to the NAA.

Under Alt3 in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 10.67% higher to 0.61% lower compared to the NAA.

Under Alt4 in Wet water years, mean predicted through-Delta survival of winter-run Chinook salmon is higher than NAA, ranging from 7.6% higher to 2.57% lower compared to the NAA.

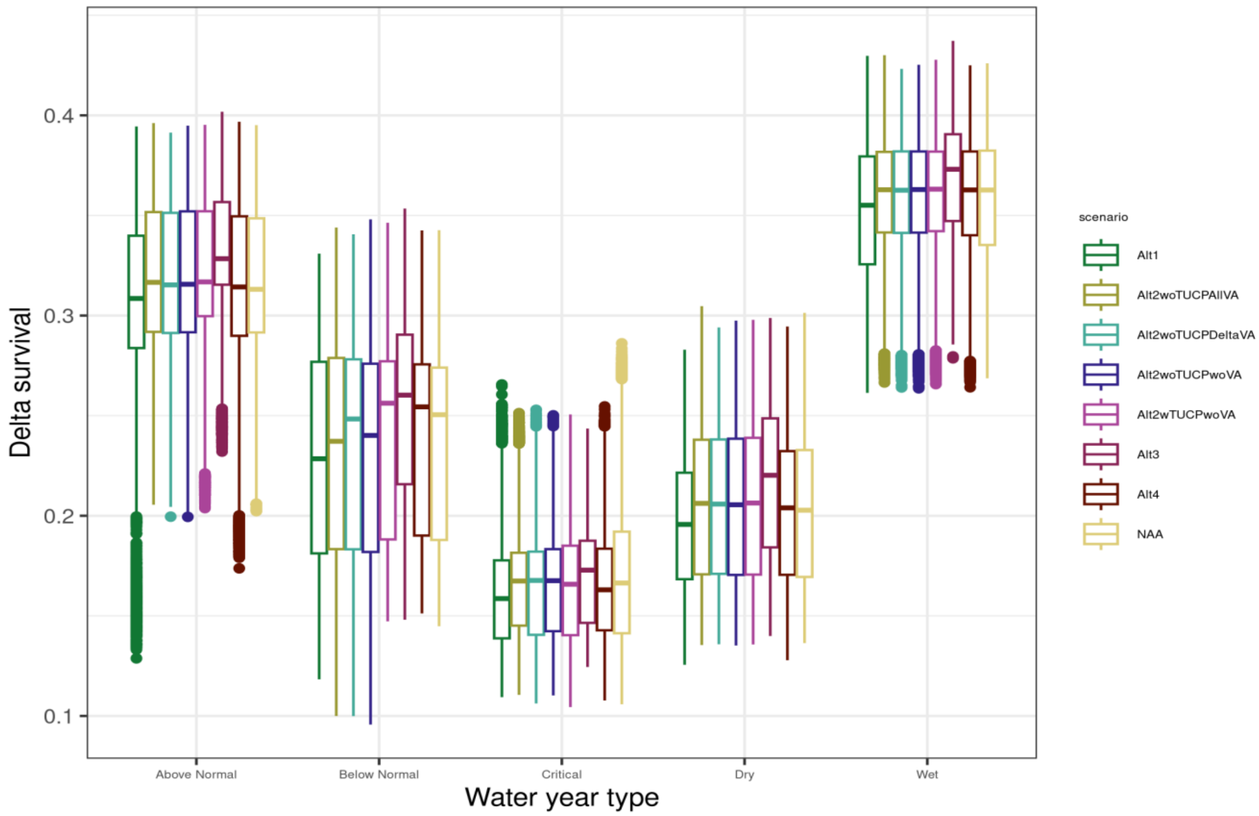


Figure F.5-12. Boxplots showing predicted winter-run Chinook through-Delta survival by water year type.

Table F.5-10. Predicted mean annual winter-run Chinook through-Delta survival by water year type. Difference from NAA shown in parenthesis.

Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Above Normal	0.313	0.300 (-4.05%)	0.319 (1.97%)	0.313 (-0.02%)	0.314 (0.17%)	0.314 (0.39%)	0.331 (5.57%)	0.309 (-1.32%)
Below Normal	0.238	0.226 (-4.89%)	0.241 (1.51%)	0.230 (-3.03%)	0.231 (-2.78%)	0.230 (-3.15%)	0.253 (6.43%)	0.240 (0.92%)
Critical	0.173	0.163 (-5.75%)	0.168 (-2.89%)	0.169 (-2.00%)	0.166 (-4.14%)	0.169 (-1.92%)	0.172 (-0.13%)	0.168 (-2.84%)
Dry	0.204	0.197 (-3.51%)	0.209 (2.44%)	0.209 (2.46%)	0.209 (2.24%)	0.209 (2.24%)	0.216 (6.07%)	0.205 (0.56%)
Wet	0.356	0.350 (-1.62%)	0.358 (0.43%)	0.358 (0.40%)	0.357 (0.31%)	0.357 (0.31%)	0.368 (3.35%)	0.357 (0.30%)

Under Alt1, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average lower than NAA (-3.48%), ranging from 4.96% higher in 1957 to 40.49% lower in 1935 compared to the NAA for winter-run Chinook salmon (Figure F.5-13 and Table F.5-11).

Under Alt2 With TUCP Without VA, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average higher than NAA (0.96%), ranging from 22.52% higher in 1978 to 36.12% lower in 2015 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Delta VA, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average lower than NAA (-0.28%), ranging from 14.55% higher in 1945 to 43.67% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Systemwide VA, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average higher than NAA (0.05%), ranging from 15.71% higher in 1991 to 44.32% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Without VA, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average higher than NAA (0.03%), ranging from 14.03% higher in 1945 to 43.58% lower in 2016 compared to the NAA for winter-run Chinook salmon.

Under Alt3, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average higher than NAA (4.81%), ranging from 29.84% higher in 1978 to 27.78% lower in 2015 compared to the NAA for winter-run Chinook salmon.

Under Alt4, mean annual predicted through-Delta survival of winter-run Chinook salmon is on average lower than NAA (-0.1%), ranging from 12.96% higher in 1945 to 36.12% lower in 2015 compared to the NAA for winter-run Chinook salmon.

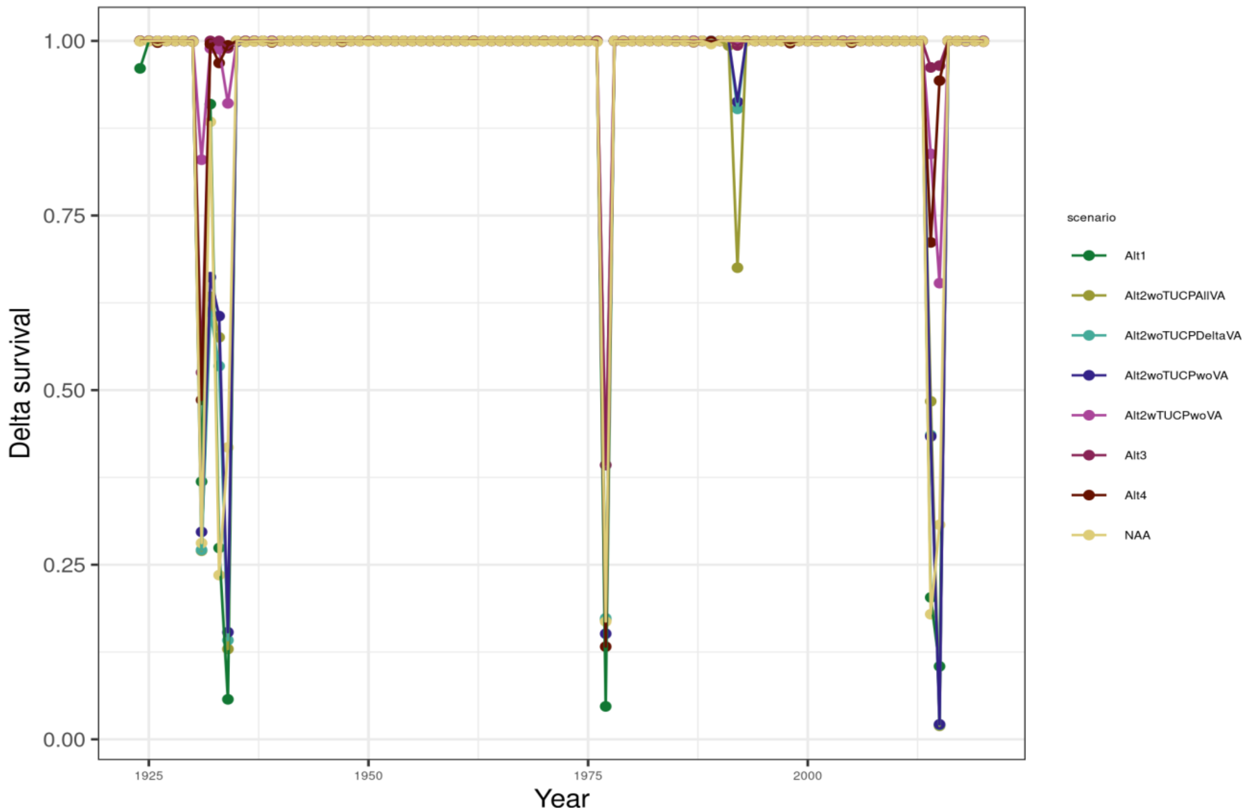


Figure F.5-13. Predicted mean annual winter-run Chinook through-Delta survival.

Table F.5-11. Predicted mean annual winter-run Chinook through-Delta survival. Difference from NAA shown in parenthesis.

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1924	Critical	0.166	0.161 (-2.56%)	0.167 (0.84%)	0.168 (1.45%)	0.168 (1.68%)	0.169 (1.95%)	0.169 (2.32%)	0.163 (-1.38%)
1925	Dry	0.235	0.219 (-6.62%)	0.253 (7.60%)	0.254 (8.02%)	0.255 (8.41%)	0.253 (7.66%)	0.259 (10.33%)	0.228 (-3.08%)
1926	Dry	0.247	0.233 (-5.92%)	0.261 (5.79%)	0.262 (5.92%)	0.259 (4.60%)	0.259 (4.95%)	0.252 (2.03%)	0.255 (3.24%)
1927	Wet	0.326	0.321 (-1.51%)	0.354 (8.44%)	0.354 (8.58%)	0.347 (6.51%)	0.353 (8.28%)	0.348 (6.75%)	0.351 (7.60%)
1928	Above Normal	0.218	0.208 (-4.40%)	0.218 (0.38%)	0.219 (0.56%)	0.219 (0.70%)	0.220 (0.96%)	0.246 (13.14%)	0.222 (2.10%)
1929	Critical	0.17	0.161 (-5.38%)	0.173 (1.77%)	0.174 (2.13%)	0.173 (1.73%)	0.173 (1.92%)	0.183 (7.54%)	0.166 (-2.08%)
1930	Dry	0.233	0.221 (-5.11%)	0.230 (-1.51%)	0.230 (-1.52%)	0.231 (-1.21%)	0.230 (-1.33%)	0.239 (2.43%)	0.229 (-2.02%)
1931	Critical	0.143	0.141 (-1.50%)	0.142 (-0.66%)	0.144 (0.85%)	0.144 (1.06%)	0.145 (1.39%)	0.148 (3.73%)	0.143 (-0.14%)
1932	Critical	0.226	0.203 (-10.38%)	0.234 (3.17%)	0.234 (3.54%)	0.233 (2.86%)	0.234 (3.17%)	0.228 (0.70%)	0.235 (3.82%)
1933	Critical	0.158	0.154 (-2.64%)	0.158 (0.43%)	0.158 (-0.13%)	0.157 (-0.48%)	0.157 (-0.39%)	0.154 (-2.28%)	0.158 (0.38%)
1934	Critical	0.189	0.161 (-14.91%)	0.189 (-0.35%)	0.182 (-3.98%)	0.178 (-6.02%)	0.179 (-5.76%)	0.181 (-4.27%)	0.189 (-0.10%)
1935	Below Normal	0.252	0.150 (-40.49%)	0.249 (-1.38%)	0.211 (-16.27%)	0.205 (-18.58%)	0.201 (-20.25%)	0.248 (-1.50%)	0.238 (-5.44%)
1936	Below Normal	0.323	0.317 (-1.78%)	0.331 (2.27%)	0.330 (2.10%)	0.326 (1.02%)	0.326 (0.95%)	0.334 (3.33%)	0.324 (0.18%)
1937	Below Normal	0.245	0.229 (-6.76%)	0.255 (4.02%)	0.240 (-2.12%)	0.251 (2.26%)	0.238 (-3.16%)	0.248 (1.06%)	0.250 (1.68%)
1938	Wet	0.341	0.324 (-4.88%)	0.350 (2.68%)	0.349 (2.49%)	0.349 (2.53%)	0.344 (0.98%)	0.354 (4.08%)	0.344 (1.13%)
1939	Dry	0.146	0.136 (-6.68%)	0.146 (-0.03%)	0.147 (0.40%)	0.146 (0.22%)	0.147 (0.62%)	0.149 (2.11%)	0.139 (-5.06%)
1940	Above Normal	0.325	0.310 (-4.61%)	0.326 (0.45%)	0.326 (0.33%)	0.324 (-0.15%)	0.328 (1.05%)	0.322 (-0.91%)	0.326 (0.54%)
1941	Wet	0.384	0.379 (-1.43%)	0.386 (0.30%)	0.385 (0.26%)	0.386 (0.38%)	0.385 (0.11%)	0.387 (0.55%)	0.385 (0.05%)
1942	Wet	0.38	0.376 (-1.18%)	0.380 (0.01%)	0.380 (-0.11%)	0.380 (-0.01%)	0.380 (-0.02%)	0.382 (0.55%)	0.380 (-0.01%)
1943	Wet	0.347	0.343 (-1.10%)	0.347 (0.11%)	0.347 (-0.02%)	0.347 (0.08%)	0.346 (-0.06%)	0.352 (1.70%)	0.348 (0.36%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1944	Dry	0.202	0.199 (-1.40%)	0.208 (2.80%)	0.207 (2.41%)	0.207 (2.65%)	0.208 (2.81%)	0.208 (2.80%)	0.202 (-0.01%)
1945	Dry	0.226	0.235 (4.07%)	0.257 (14.02%)	0.257 (14.03%)	0.259 (14.55%)	0.258 (14.42%)	0.263 (16.68%)	0.255 (12.96%)
1946	Below Normal	0.292	0.285 (-2.36%)	0.287 (-1.74%)	0.287 (-1.62%)	0.287 (-1.60%)	0.288 (-1.32%)	0.295 (1.00%)	0.292 (0.23%)
1947	Dry	0.168	0.169 (0.68%)	0.170 (1.19%)	0.171 (1.54%)	0.170 (1.40%)	0.170 (1.39%)	0.189 (12.52%)	0.168 (0.18%)
1948	Dry	0.155	0.159 (2.21%)	0.161 (3.96%)	0.161 (4.01%)	0.153 (-1.39%)	0.154 (-0.81%)	0.173 (11.40%)	0.154 (-0.94%)
1949	Dry	0.164	0.160 (-2.15%)	0.166 (1.55%)	0.166 (1.46%)	0.166 (1.18%)	0.166 (1.71%)	0.157 (-3.76%)	0.164 (0.27%)
1950	Dry	0.281	0.268 (-4.82%)	0.282 (0.30%)	0.282 (0.39%)	0.282 (0.19%)	0.283 (0.45%)	0.281 (-0.22%)	0.281 (-0.01%)
1951	Above Normal	0.364	0.357 (-1.76%)	0.363 (-0.30%)	0.363 (-0.30%)	0.363 (-0.31%)	0.363 (-0.32%)	0.384 (5.51%)	0.363 (-0.18%)
1952	Wet	0.386	0.376 (-2.42%)	0.385 (-0.25%)	0.385 (-0.11%)	0.386 (0.01%)	0.385 (-0.17%)	0.388 (0.61%)	0.385 (-0.08%)
1953	Above Normal	0.311	0.298 (-4.08%)	0.309 (-0.85%)	0.308 (-1.02%)	0.309 (-0.80%)	0.308 (-1.04%)	0.323 (3.83%)	0.314 (1.04%)
1954	Above Normal	0.301	0.299 (-0.53%)	0.301 (-0.11%)	0.300 (-0.41%)	0.299 (-0.55%)	0.302 (0.20%)	0.327 (8.66%)	0.296 (-1.82%)
1955	Dry	0.171	0.176 (3.24%)	0.168 (-1.53%)	0.168 (-1.71%)	0.168 (-1.41%)	0.169 (-1.33%)	0.196 (14.99%)	0.172 (0.69%)
1956	Wet	0.386	0.387 (0.12%)	0.386 (-0.06%)	0.386 (-0.10%)	0.386 (-0.03%)	0.384 (-0.45%)	0.396 (2.56%)	0.385 (-0.36%)
1957	Below Normal	0.176	0.185 (4.96%)	0.181 (2.91%)	0.181 (2.77%)	0.183 (3.81%)	0.183 (3.67%)	0.213 (20.78%)	0.176 (0.09%)
1958	Wet	0.363	0.349 (-3.86%)	0.367 (0.99%)	0.366 (0.80%)	0.366 (0.74%)	0.366 (0.79%)	0.373 (2.70%)	0.363 (-0.07%)
1959	Below Normal	0.285	0.284 (-0.55%)	0.290 (1.63%)	0.289 (1.32%)	0.288 (0.99%)	0.288 (1.04%)	0.309 (8.30%)	0.284 (-0.53%)
1960	Dry	0.22	0.205 (-6.97%)	0.231 (4.94%)	0.230 (4.78%)	0.228 (3.53%)	0.227 (3.31%)	0.243 (10.43%)	0.222 (0.96%)
1961	Dry	0.226	0.200 (-11.40%)	0.226 (0.16%)	0.227 (0.37%)	0.225 (-0.16%)	0.225 (-0.38%)	0.227 (0.67%)	0.219 (-2.90%)
1962	Dry	0.272	0.262 (-3.66%)	0.273 (0.21%)	0.273 (0.23%)	0.273 (0.45%)	0.275 (1.21%)	0.274 (0.51%)	0.270 (-0.97%)
1963	Wet	0.297	0.281 (-5.56%)	0.299 (0.68%)	0.300 (1.00%)	0.298 (0.41%)	0.299 (0.74%)	0.303 (1.95%)	0.296 (-0.38%)
1964	Dry	0.187	0.189 (0.94%)	0.185 (-1.27%)	0.185 (-1.37%)	0.185 (-1.35%)	0.185 (-1.35%)	0.223 (19.18%)	0.186 (-0.52%)
1965	Wet	0.341	0.344 (0.72%)	0.340 (-0.49%)	0.340 (-0.54%)	0.338 (-0.86%)	0.339 (-0.60%)	0.346 (1.28%)	0.341 (-0.16%)
1966	Below Normal	0.256	0.247 (-3.74%)	0.253 (-1.19%)	0.253 (-1.22%)	0.253 (-1.16%)	0.254 (-1.03%)	0.274 (6.72%)	0.257 (0.15%)
1967	Wet	0.347	0.334 (-3.94%)	0.348 (0.23%)	0.348 (0.19%)	0.347 (-0.02%)	0.348 (0.11%)	0.356 (2.47%)	0.348 (0.24%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1968	Below Normal	0.288	0.288 (-0.21%)	0.295 (2.35%)	0.295 (2.28%)	0.295 (2.33%)	0.295 (2.38%)	0.310 (7.64%)	0.292 (1.32%)
1969	Wet	0.385	0.384 (-0.31%)	0.384 (-0.25%)	0.385 (0.15%)	0.385 (0.04%)	0.384 (-0.10%)	0.389 (1.21%)	0.385 (0.10%)
1970	Wet	0.384	0.385 (0.15%)	0.382 (-0.42%)	0.382 (-0.51%)	0.382 (-0.60%)	0.382 (-0.41%)	0.402 (4.82%)	0.384 (0.02%)
1971	Wet	0.298	0.289 (-3.22%)	0.298 (0.06%)	0.299 (0.07%)	0.299 (0.26%)	0.299 (0.26%)	0.330 (10.67%)	0.301 (0.91%)
1972	Below Normal	0.19	0.186 (-2.07%)	0.189 (-0.30%)	0.190 (0.05%)	0.190 (0.03%)	0.190 (0.05%)	0.226 (19.21%)	0.192 (1.40%)
1973	Above Normal	0.378	0.368 (-2.66%)	0.378 (-0.03%)	0.378 (0.11%)	0.379 (0.23%)	0.378 (0.14%)	0.379 (0.38%)	0.378 (-0.03%)
1974	Wet	0.365	0.352 (-3.44%)	0.363 (-0.56%)	0.364 (-0.37%)	0.363 (-0.59%)	0.364 (-0.41%)	0.363 (-0.61%)	0.363 (-0.62%)
1975	Above Normal	0.268	0.263 (-2.17%)	0.272 (1.54%)	0.273 (1.92%)	0.272 (1.44%)	0.274 (1.94%)	0.279 (4.00%)	0.266 (-0.71%)
1976	Critical	0.136	0.134 (-1.65%)	0.134 (-1.84%)	0.134 (-1.91%)	0.134 (-1.59%)	0.133 (-2.20%)	0.140 (3.09%)	0.150 (10.10%)
1977	Critical	0.117	0.121 (3.39%)	0.114 (-2.22%)	0.120 (3.11%)	0.119 (2.01%)	0.120 (2.97%)	0.138 (18.49%)	0.118 (1.29%)
1978	Above Normal	0.252	0.159 (-37.05%)	0.309 (22.52%)	0.228 (-9.40%)	0.240 (-4.61%)	0.240 (-4.79%)	0.327 (29.84%)	0.195 (-22.70%)
1979	Dry	0.239	0.241 (0.92%)	0.243 (1.62%)	0.242 (1.43%)	0.243 (1.62%)	0.243 (1.66%)	0.247 (3.48%)	0.242 (1.22%)
1980	Above Normal	0.368	0.377 (2.61%)	0.372 (1.12%)	0.373 (1.48%)	0.372 (1.13%)	0.374 (1.74%)	0.376 (2.21%)	0.370 (0.74%)
1981	Dry	0.203	0.197 (-2.89%)	0.204 (0.40%)	0.203 (0.15%)	0.203 (0.13%)	0.204 (0.45%)	0.229 (12.92%)	0.206 (1.29%)
1982	Wet	0.372	0.368 (-1.02%)	0.373 (0.36%)	0.372 (0.11%)	0.373 (0.26%)	0.373 (0.23%)	0.384 (3.30%)	0.373 (0.35%)
1983	Wet	0.4	0.402 (0.37%)	0.404 (1.05%)	0.404 (0.99%)	0.404 (0.98%)	0.404 (0.91%)	0.419 (4.68%)	0.402 (0.41%)
1984	Wet	0.316	0.325 (2.91%)	0.315 (-0.43%)	0.315 (-0.40%)	0.315 (-0.38%)	0.315 (-0.33%)	0.336 (6.34%)	0.320 (1.18%)
1985	Below Normal	0.165	0.160 (-2.90%)	0.165 (0.00%)	0.164 (-0.11%)	0.165 (0.07%)	0.166 (0.77%)	0.179 (9.04%)	0.165 (0.59%)
1986	Wet	0.333	0.302 (-9.15%)	0.338 (1.77%)	0.337 (1.41%)	0.338 (1.73%)	0.341 (2.43%)	0.342 (2.86%)	0.324 (-2.57%)
1987	Dry	0.176	0.169 (-4.32%)	0.190 (7.48%)	0.190 (7.52%)	0.189 (7.01%)	0.189 (6.98%)	0.180 (1.98%)	0.176 (-0.11%)
1988	Critical	0.233	0.200 (-14.15%)	0.232 (-0.12%)	0.232 (-0.46%)	0.193 (-17.12%)	0.232 (-0.50%)	0.228 (-2.09%)	0.234 (0.68%)
1989	Dry	0.151	0.150 (-0.30%)	0.154 (2.20%)	0.154 (1.96%)	0.156 (3.27%)	0.151 (0.43%)	0.164 (9.21%)	0.152 (0.84%)
1990	Critical	0.17	0.162 (-4.95%)	0.169 (-0.75%)	0.169 (-0.79%)	0.168 (-0.97%)	0.168 (-1.24%)	0.178 (4.41%)	0.166 (-2.22%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1991	Critical	0.136	0.139 (2.56%)	0.131 (-3.18%)	0.141 (3.73%)	0.131 (-3.84%)	0.157 (15.71%)	0.149 (9.38%)	0.140 (3.27%)
1992	Critical	0.195	0.182 (-6.51%)	0.208 (6.66%)	0.209 (6.98%)	0.207 (6.21%)	0.203 (4.26%)	0.207 (6.11%)	0.201 (3.27%)
1993	Above Normal	0.343	0.332 (-3.40%)	0.347 (1.20%)	0.347 (1.04%)	0.346 (0.87%)	0.345 (0.54%)	0.351 (2.29%)	0.344 (0.09%)
1994	Critical	0.178	0.175 (-2.08%)	0.181 (1.58%)	0.182 (2.10%)	0.182 (1.91%)	0.182 (1.79%)	0.182 (2.20%)	0.178 (-0.14%)
1995	Wet	0.373	0.362 (-3.13%)	0.376 (0.64%)	0.376 (0.64%)	0.374 (0.17%)	0.375 (0.50%)	0.378 (1.13%)	0.371 (-0.51%)
1996	Wet	0.354	0.358 (1.20%)	0.353 (-0.18%)	0.353 (-0.23%)	0.353 (-0.16%)	0.354 (-0.10%)	0.378 (6.90%)	0.360 (1.56%)
1997	Wet	0.377	0.379 (0.46%)	0.372 (-1.35%)	0.373 (-1.20%)	0.372 (-1.47%)	0.372 (-1.37%)	0.389 (3.02%)	0.376 (-0.47%)
1998	Wet	0.398	0.400 (0.31%)	0.400 (0.31%)	0.400 (0.40%)	0.400 (0.44%)	0.399 (0.08%)	0.401 (0.60%)	0.401 (0.62%)
1999	Wet	0.348	0.342 (-1.78%)	0.349 (0.18%)	0.349 (0.10%)	0.348 (0.03%)	0.349 (0.28%)	0.365 (4.93%)	0.345 (-0.91%)
2000	Above Normal	0.307	0.313 (1.81%)	0.315 (2.64%)	0.315 (2.44%)	0.315 (2.44%)	0.316 (2.87%)	0.327 (6.38%)	0.301 (-2.04%)
2001	Dry	0.195	0.184 (-5.68%)	0.199 (1.88%)	0.199 (1.81%)	0.199 (1.78%)	0.199 (1.94%)	0.193 (-1.07%)	0.192 (-1.78%)
2002	Below Normal	0.271	0.276 (1.88%)	0.273 (0.68%)	0.272 (0.51%)	0.275 (1.36%)	0.275 (1.59%)	0.290 (7.10%)	0.273 (0.71%)
2003	Above Normal	0.296	0.288 (-2.83%)	0.297 (0.49%)	0.297 (0.37%)	0.297 (0.25%)	0.296 (0.10%)	0.309 (4.52%)	0.299 (0.87%)
2004	Above Normal	0.34	0.334 (-1.66%)	0.343 (0.98%)	0.343 (0.88%)	0.342 (0.80%)	0.343 (0.96%)	0.347 (2.05%)	0.342 (0.82%)
2005	Below Normal	0.26	0.253 (-2.68%)	0.260 (-0.11%)	0.259 (-0.39%)	0.260 (0.08%)	0.259 (-0.26%)	0.273 (5.12%)	0.259 (-0.34%)
2006	Wet	0.37	0.365 (-1.46%)	0.368 (-0.65%)	0.367 (-0.74%)	0.368 (-0.49%)	0.368 (-0.57%)	0.392 (5.90%)	0.369 (-0.21%)
2007	Below Normal	0.197	0.203 (2.67%)	0.199 (0.73%)	0.200 (1.13%)	0.200 (1.44%)	0.199 (1.07%)	0.215 (9.10%)	0.205 (4.06%)
2008	Dry	0.234	0.217 (-7.23%)	0.231 (-1.34%)	0.231 (-1.29%)	0.230 (-1.43%)	0.230 (-1.80%)	0.253 (8.08%)	0.228 (-2.54%)
2009	Dry	0.173	0.171 (-0.94%)	0.189 (9.32%)	0.190 (9.65%)	0.189 (9.54%)	0.191 (10.24%)	0.201 (16.46%)	0.191 (10.48%)
2010	Below Normal	0.253	0.253 (-0.11%)	0.266 (5.08%)	0.266 (5.02%)	0.269 (6.11%)	0.271 (7.09%)	0.277 (9.46%)	0.262 (3.36%)
2011	Wet	0.282	0.276 (-2.14%)	0.279 (-0.89%)	0.279 (-1.01%)	0.279 (-0.98%)	0.279 (-0.87%)	0.299 (6.02%)	0.279 (-0.93%)
2012	Below Normal	0.16	0.160 (-0.30%)	0.161 (0.34%)	0.161 (0.55%)	0.161 (0.18%)	0.161 (0.40%)	0.160 (-0.38%)	0.161 (0.04%)
2013	Dry	0.227	0.203 (-10.95%)	0.227 (-0.09%)	0.227 (-0.20%)	0.227 (-0.13%)	0.227 (-0.09%)	0.219 (-3.85%)	0.230 (1.17%)
2014	Critical	0.141	0.140 (-0.71%)	0.145 (2.73%)	0.145 (2.72%)	0.145 (2.65%)	0.144 (1.95%)	0.149 (4.96%)	0.139 (-1.68%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2015	Critical	0.263	0.238 (-9.23%)	0.168 (-36.12%)	0.179 (-31.87%)	0.179 (-31.76%)	0.175 (-33.44%)	0.190 (-27.78%)	0.168 (-36.12%)
2016	Below Normal	0.243	0.188 (-22.62%)	0.266 (9.71%)	0.137 (-43.58%)	0.137 (-43.67%)	0.135 (-44.32%)	0.261 (7.40%)	0.262 (8.12%)
2017	Wet	0.401	0.399 (-0.52%)	0.407 (1.42%)	0.406 (1.16%)	0.406 (1.26%)	0.405 (1.04%)	0.412 (2.88%)	0.405 (0.98%)
2018	Below Normal	0.181	0.179 (-1.21%)	0.181 (-0.36%)	0.181 (-0.49%)	0.182 (0.15%)	0.182 (0.38%)	0.186 (2.53%)	0.183 (0.91%)
2019	Wet	0.317	0.312 (-1.56%)	0.313 (-1.28%)	0.312 (-1.30%)	0.312 (-1.31%)	0.310 (-2.02%)	0.340 (7.45%)	0.319 (0.69%)
2020	Dry	0.166	0.162 (-2.25%)	0.164 (-1.38%)	0.164 (-1.29%)	0.165 (-0.64%)	0.165 (-0.82%)	0.174 (4.92%)	0.165 (-0.62%)
2021	Critical	0.142	0.133 (-6.83%)	0.138 (-3.10%)	0.138 (-2.87%)	0.137 (-3.83%)	0.140 (-1.59%)	0.136 (-4.66%)	0.135 (-5.60%)

F.5.3.1.5 Female Escapement

Under Alt1 in Above Normal water years, mean predicted female escapement of winter-run Chinook salmon is lower than NAA, ranging from 0.62% higher to 22.25% lower compared to the NAA (Figure F.5-14 and Table F.5-12).

Under Alt2 With TUCP Without VA in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 25.35% higher to 5.08% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 15.97% higher to 13.38% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is lower than NAA, ranging from 22.61% higher to 21.57% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 22.09% higher to 7.75% lower compared to the NAA.

Under Alt3 in Above Normal water years, mean predicted female escapement of winter-run Chinook salmon is higher than NAA, ranging from 43.64% higher to 4.4% higher compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 12.76% higher to 5.58% lower compared to the NAA.

Under Alt1 in Below Normal water years, mean predicted female escapement of winter-run Chinook salmon is lower than NAA, ranging from 49.2% higher to 60.1% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Below Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 1,298.59% higher to 1.71% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Below Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 303.42% higher to 50.94% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Below Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 339.34% higher to 48.6% lower compared to the NAA.

Under Alt4 in Above Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 12.76% higher to 5.58% lower compared to the NAA.

Under Alt3 in Below Normal water years, mean predicted female escapement of winter-run Chinook salmon is higher than NAA, ranging from 2,745.63% higher to 0% lower compared to the NAA.

Under Alt4 in Below Normal water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 1,020.68% higher to 5.34% lower compared to the NAA.

Under Alt1 in Critical water years, mean predicted female escapement of winter-run Chinook salmon is lower than NAA, ranging from 1.29% higher to 25.38% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Critical water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 363.2% higher to 5.43% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Critical water years, mean predicted female escapement survival of winter-run Chinook salmon is lower than NAA, ranging from 10.21% higher to 36.68% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Critical water years, mean predicted female escapement survival of winter-run Chinook salmon is lower than NAA, ranging from 17.91% higher to 48.99% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Critical water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 16.04% higher to 25.6% lower compared to the NAA.

Under Alt3 in Critical water years, mean predicted female escapement of winter-run Chinook salmon is higher than NAA, ranging from 130.62% higher to 0.01% higher compared to the NAA.

Under Alt4 in Critical water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 144.05% higher to 4.09% lower compared to the NAA.

Under Alt1 in Dry water years, mean predicted female escapement of winter-run Chinook salmon is lower than NAA, ranging from 2.87% lower to 30.68% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Dry water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 110.52% higher to 0.77% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Dry water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 12.09% higher to 22.06% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Dry water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 13.42% higher to 8.62% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Dry water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 16.71% higher to 10.8% lower compared to the NAA.

Under Alt3 in Dry water years, mean predicted female escapement of winter-run Chinook salmon is higher than NAA, ranging from 163.59% higher to 3.21% higher compared to the NAA.

Under Alt4 in Dry water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 24.2% higher to 19.5% lower compared to the NAA.

Under Alt1 in Wet water years, mean predicted female escapement of winter-run Chinook salmon is lower than NAA, ranging from 2.15% lower to 27.39% lower compared to the NAA.

Under Alt2 With TUCP Without VA in Wet water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 176.06% higher to 1.67% lower compared to the NAA.

Under Alt2 Without TUCP Delta VA in Wet water years, mean predicted female escapement survival of winter-run Chinook salmon is lower than NAA, ranging from 8.89% higher to 22.05% lower compared to the NAA.

Under Alt2 Without TUCP Systemwide VA in Wet water years, mean predicted female escapement survival of winter-run Chinook salmon is lower than NAA, ranging from 10.89% higher to 26.7% lower compared to the NAA.

Under Alt2 Without TUCP Without VA in Wet water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 13.02% higher to 22.1% lower compared to the NAA.

Under Alt3 in Wet water years, mean predicted female escapement of winter-run Chinook salmon is higher than NAA, ranging from 538.79% higher to 3.8% higher compared to the NAA.

Under Alt4 in Wet water years, mean predicted female escapement survival of winter-run Chinook salmon is higher than NAA, ranging from 316.86% higher to 6.43% lower compared to the NAA.

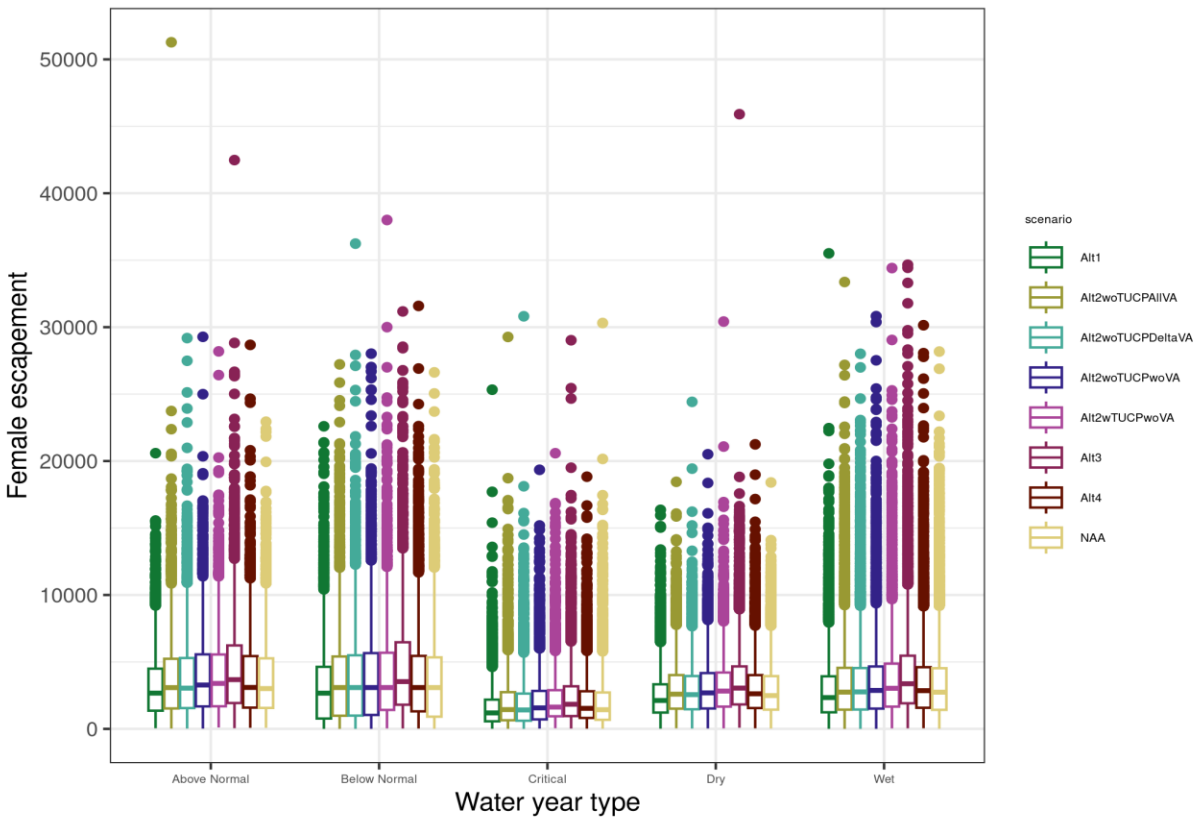


Figure F.5-14. Boxplots showing predicted winter-run Chinook female escapement by water year type.

Table F.5-12. Predicted mean annual winter-run Chinook female escapement by water year type. Difference from NAA shown in parenthesis.

Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Above Normal	3753	3253 (-13.33%)	3989 (6.30%)	3950 (5.26%)	3770 (0.46%)	3745 (-0.20%)	4527 (20.63%)	3840 (2.33%)
Below Normal	3665	3231 (-11.84%)	4063 (10.84%)	3849 (5.00%)	3733 (1.85%)	3718 (1.44%)	4665 (27.28%)	3871 (5.62%)
Critical	2132	1823 (-14.48%)	2299 (7.87%)	2175 (2.06%)	2075 (-2.65%)	2117 (-0.69%)	2491 (16.87%)	2207 (3.52%)
Dry	2888	2454 (-15.05%)	3162 (9.47%)	3045 (5.41%)	2892 (0.12%)	2940 (1.79%)	3499 (21.15%)	2984 (3.30%)
Wet	3490	2965 (-15.04%)	3738 (7.12%)	3582 (2.64%)	3477 (-0.36%)	3478 (-0.35%)	4271 (22.38%)	3567 (2.21%)

Under Alt1, mean annual predicted female escapement of winter-run Chinook salmon is on average lower than NAA (-13.68%), ranging from 49.2% higher in 2017 to 60.1% lower in 1937 compared to the NAA for winter-run Chinook salmon (Figure F.5-15 and Table F.5-13).

Under Alt2 With TUCP Without VA, mean annual predicted female escapement survival of winter-run Chinook salmon is on average higher than NAA (43.23%), ranging from 1,298.59% higher in 2017 to 5.43% lower in 1993 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Delta VA, mean annual predicted female escapement survival of winter-run Chinook salmon is on average higher than NAA (2.92%), ranging from 303.42% higher in 2017 to 50.94% lower in 1937 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Systemwide VA, mean annual predicted female escapement survival of winter-run Chinook salmon is on average higher than NAA (4.28%), ranging from 339.34% higher in 2017 to 48.99% lower in 1995 compared to the NAA for winter-run Chinook salmon.

Under Alt2 Without TUCP Without VA, mean annual predicted female escapement survival of winter-run Chinook salmon is on average higher than NAA (7.21%), ranging from 285.67% higher in 2017 to 47.25% lower in 1937 compared to the NAA for winter-run Chinook salmon.

Under Alt3, mean annual predicted female escapement of winter-run Chinook salmon is on average higher than NAA (71.38%), ranging from 2,745.63% higher in 2017 to 0% lower in 1924 compared to the NAA for winter-run Chinook salmon.

Under Alt4, mean annual predicted female escapement survival of winter-run Chinook salmon is on average higher than NAA (29.86%), ranging from 1,020.68% higher in 2017 to 19.5% lower in 1980 compared to the NAA for winter-run Chinook salmon.

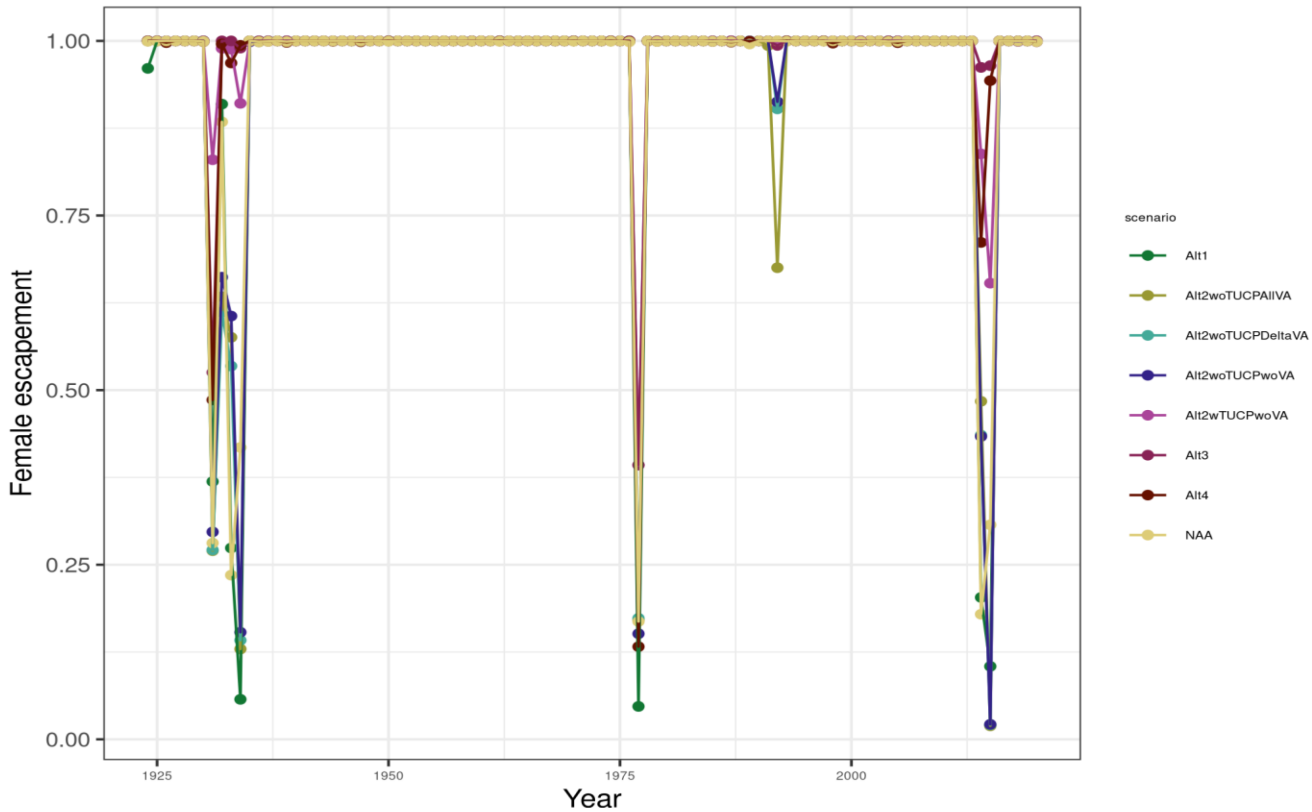


Figure F.5-15. Predicted mean annual winter-run Chinook female escapement.

Table F.5-13. Predicted mean annual winter-run Chinook female escapement. Difference from NAA shown in parenthesis.

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1924	Below Normal	3087	3087 (0.00%)	3087 (0.00%)	3087 (0.00%)	3087 (0.00%)	3087 (0.00%)	3087 (0.00%)	3087 (0.00%)
1925	Critical	6101	6086 (-0.24%)	6096 (-0.07%)	6112 (0.18%)	6098 (-0.04%)	6102 (0.03%)	6102 (0.01%)	6107 (0.10%)
1926	Dry	2218	2012 (-9.30%)	2263 (2.06%)	2332 (5.16%)	2250 (1.45%)	2263 (2.03%)	2289 (3.21%)	2257 (1.79%)
1927	Dry	4023	3228 (-19.75%)	4569 (13.55%)	4307 (7.05%)	4364 (8.46%)	4277 (6.30%)	4500 (11.84%)	4005 (-0.45%)
1928	Wet	2452	1924 (-21.53%)	2776 (13.22%)	2772 (13.02%)	2603 (6.14%)	2719 (10.89%)	2742 (11.80%)	2566 (4.64%)
1929	Above Normal	4257	3447 (-19.03%)	5239 (23.07%)	5197 (22.09%)	4937 (15.97%)	5219 (22.61%)	5228 (22.81%)	4800 (12.75%)
1930	Critical	2188	1665 (-23.92%)	2438 (11.44%)	2475 (13.14%)	2322 (6.10%)	2302 (5.22%)	2645 (20.87%)	2355 (7.61%)
1931	Dry	2414	1888 (-21.79%)	2743 (13.60%)	2818 (16.71%)	2630 (8.93%)	2739 (13.42%)	3044 (26.05%)	2572 (6.51%)
1932	Critical	1889	1418 (-24.96%)	2005 (6.15%)	2075 (9.84%)	1914 (1.29%)	1965 (4.00%)	2202 (16.55%)	1965 (3.99%)
1933	Critical	1177	934 (-20.65%)	1435 (21.94%)	1365 (16.04%)	1297 (10.21%)	1310 (11.32%)	1438 (22.18%)	1275 (8.36%)
1934	Critical	239	242 (1.29%)	1107 (363.20%)	231 (-3.36%)	189 (-20.91%)	188 (-21.18%)	551 (130.62%)	583 (144.05%)
1935	Critical	417	385 (-7.73%)	822 (96.92%)	311 (-25.60%)	264 (-36.68%)	267 (-36.04%)	852 (104.15%)	754 (80.67%)
1936	Below Normal	73	61 (-16.23%)	862 (1080.00%)	173 (137.26%)	141 (93.02%)	165 (125.61%)	709 (870.34%)	602 (724.22%)
1937	Below Normal	274	109 (-60.10%)	899 (228.15%)	144 (-47.25%)	134 (-50.94%)	141 (-48.60%)	1055 (285.17%)	991 (261.94%)
1938	Below Normal	977	834 (-14.63%)	1457 (49.19%)	993 (1.70%)	964 (-1.29%)	1005 (2.86%)	1416 (44.95%)	1219 (24.87%)
1939	Wet	971	822 (-15.30%)	1456 (49.97%)	959 (-1.19%)	948 (-2.28%)	896 (-7.73%)	1491 (53.61%)	1383 (42.52%)
1940	Dry	1766	1597 (-9.57%)	2231 (26.34%)	1818 (2.96%)	1707 (-3.32%)	1871 (5.97%)	2343 (32.69%)	2007 (13.64%)
1941	Above Normal	956	803 (-16.03%)	1198 (25.35%)	1000 (4.56%)	927 (-3.08%)	934 (-2.32%)	1166 (22.01%)	1078 (12.76%)
1942	Wet	2298	2049 (-10.83%)	2800 (21.83%)	2495 (8.54%)	2443 (6.28%)	2495 (8.57%)	2710 (17.92%)	2603 (13.27%)
1943	Wet	2527	2270 (-10.17%)	2903 (14.85%)	2580 (2.08%)	2500 (-1.07%)	2693 (6.56%)	2731 (8.08%)	2859 (13.11%)
1944	Wet	4050	3473 (-14.23%)	4770 (17.78%)	4292 (5.98%)	4269 (5.41%)	4331 (6.94%)	4485 (10.75%)	4573 (12.92%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1945	Dry	3784	3183 (-15.90%)	4182 (10.51%)	3802 (0.48%)	3594 (-5.03%)	3879 (2.50%)	3944 (4.21%)	4108 (8.56%)
1946	Dry	2756	2300 (-16.57%)	3336 (21.03%)	3042 (10.38%)	3015 (9.41%)	3025 (9.76%)	3013 (9.33%)	3154 (14.42%)
1947	Below Normal	2919	2567 (-12.04%)	3622 (24.12%)	3300 (13.08%)	3265 (11.86%)	3496 (19.78%)	3441 (17.91%)	3428 (17.47%)
1948	Dry	3255	2667 (-18.08%)	3696 (13.54%)	3353 (3.00%)	3314 (1.81%)	3329 (2.29%)	3664 (12.57%)	3562 (9.44%)
1949	Dry	1911	1619 (-15.32%)	2135 (11.69%)	1910 (-0.09%)	1966 (2.86%)	2049 (7.19%)	2264 (18.43%)	1997 (4.45%)
1950	Dry	1737	1509 (-13.12%)	2111 (21.52%)	1807 (3.99%)	1773 (2.07%)	1766 (1.64%)	2032 (16.95%)	1759 (1.23%)
1951	Dry	1386	1191 (-14.10%)	1538 (10.95%)	1364 (-1.58%)	1400 (1.03%)	1420 (2.42%)	1435 (3.54%)	1404 (1.32%)
1952	Above Normal	2059	1816 (-11.83%)	2413 (17.18%)	2182 (5.95%)	2012 (-2.28%)	2052 (-0.36%)	2227 (8.17%)	2064 (0.21%)
1953	Wet	2705	2429 (-10.19%)	2880 (6.47%)	2565 (-5.15%)	2661 (-1.60%)	2678 (-0.98%)	2912 (7.67%)	2674 (-1.12%)
1954	Above Normal	3754	3187 (-15.11%)	4114 (9.61%)	3856 (2.72%)	3680 (-1.96%)	3728 (-0.69%)	3919 (4.40%)	3843 (2.36%)
1955	Above Normal	3986	3513 (-11.88%)	4265 (6.98%)	4072 (2.14%)	3858 (-3.22%)	4009 (0.56%)	4338 (8.81%)	4169 (4.59%)
1956	Dry	3976	3694 (-7.08%)	4192 (5.42%)	4100 (3.11%)	3873 (-2.58%)	3999 (0.57%)	4590 (15.44%)	3943 (-0.83%)
1957	Wet	2981	2760 (-7.41%)	3033 (1.73%)	3011 (1.01%)	2834 (-4.93%)	3019 (1.26%)	3597 (20.65%)	3074 (3.11%)
1958	Below Normal	6524	5977 (-8.39%)	6930 (6.22%)	6941 (6.39%)	6372 (-2.33%)	6563 (0.59%)	7782 (19.28%)	6712 (2.89%)
1959	Wet	2717	2549 (-6.19%)	2903 (6.84%)	2933 (7.94%)	2806 (3.27%)	2825 (3.97%)	3546 (30.52%)	2844 (4.68%)
1960	Below Normal	7659	6763 (-11.70%)	8150 (6.42%)	8085 (5.57%)	7639 (-0.25%)	7370 (-3.77%)	8463 (10.51%)	7717 (0.76%)
1961	Dry	3369	2957 (-12.21%)	3462 (2.78%)	3750 (11.33%)	3410 (1.24%)	3468 (2.96%)	4334 (28.66%)	3368 (-0.03%)
1962	Dry	4561	3798 (-16.74%)	4914 (7.72%)	4923 (7.93%)	4447 (-2.51%)	4543 (-0.40%)	5247 (15.04%)	4428 (-2.93%)
1963	Dry	2935	2216 (-24.51%)	3079 (4.91%)	3194 (8.82%)	2997 (2.12%)	2984 (1.67%)	3520 (19.92%)	2755 (-6.15%)
1964	Wet	4058	3141 (-22.60%)	4332 (6.77%)	4331 (6.73%)	4140 (2.04%)	4072 (0.36%)	4583 (12.95%)	3797 (-6.43%)
1965	Dry	3199	2497 (-21.94%)	3315 (3.66%)	3512 (9.80%)	3322 (3.86%)	3235 (1.14%)	3780 (18.17%)	3024 (-5.45%)
1966	Wet	2830	2321 (-18.01%)	3001 (6.01%)	3004 (6.15%)	3040 (7.41%)	2865 (1.22%)	3653 (29.08%)	2807 (-0.82%)
1967	Below Normal	4596	3695 (-19.61%)	4891 (6.41%)	4846 (5.43%)	4901 (6.63%)	4775 (3.89%)	5515 (19.99%)	4522 (-1.62%)
1968	Wet	3237	2579 (-20.31%)	3445 (6.43%)	3344 (3.30%)	3462 (6.97%)	3295 (1.80%)	4156 (28.41%)	3193 (-1.34%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1969	Below Normal	5477	4193 (-23.45%)	5743 (4.86%)	5734 (4.69%)	5676 (3.64%)	5771 (5.37%)	6697 (22.29%)	5437 (-0.72%)
1970	Wet	4073	3166 (-22.27%)	4323 (6.14%)	4437 (8.94%)	4435 (8.89%)	4312 (5.86%)	5191 (27.44%)	4089 (0.38%)
1971	Wet	8676	6300 (-27.39%)	8557 (-1.37%)	9051 (4.32%)	8489 (-2.16%)	8802 (1.45%)	10117 (16.60%)	8234 (-5.10%)
1972	Wet	8111	6484 (-20.06%)	8523 (5.09%)	8691 (7.15%)	8270 (1.96%)	8475 (4.49%)	10429 (28.58%)	8028 (-1.01%)
1973	Below Normal	7801	5863 (-24.84%)	8058 (3.29%)	7982 (2.32%)	7658 (-1.83%)	7846 (0.58%)	10079 (29.19%)	7600 (-2.58%)
1974	Above Normal	4894	4108 (-16.06%)	5267 (7.64%)	5409 (10.53%)	5199 (6.24%)	5249 (7.26%)	7029 (43.64%)	5112 (4.45%)
1975	Wet	9116	7717 (-15.35%)	9720 (6.63%)	9559 (4.85%)	9301 (2.02%)	9856 (8.11%)	11302 (23.97%)	9430 (3.44%)
1976	Above Normal	7955	6621 (-16.76%)	8272 (4.00%)	8596 (8.06%)	8388 (5.45%)	8465 (6.42%)	10426 (31.06%)	8268 (3.94%)
1977	Critical	6581	5475 (-16.80%)	6495 (-1.30%)	6352 (-3.49%)	6464 (-1.78%)	6673 (1.39%)	7332 (11.41%)	6312 (-4.09%)
1978	Critical	3133	2689 (-14.17%)	3193 (1.92%)	3111 (-0.70%)	3018 (-3.67%)	3102 (-0.97%)	3709 (18.38%)	3329 (6.25%)
1979	Above Normal	2048	1830 (-10.66%)	2042 (-0.33%)	2133 (4.14%)	2056 (0.40%)	2055 (0.30%)	2810 (37.18%)	2047 (-0.06%)
1980	Dry	381	264 (-30.68%)	802 (110.52%)	340 (-10.80%)	367 (-3.69%)	353 (-7.29%)	1004 (163.59%)	307 (-19.50%)
1981	Above Normal	1828	1778 (-2.71%)	1953 (6.87%)	1866 (2.10%)	1989 (8.84%)	1873 (2.47%)	2517 (37.72%)	1797 (-1.67%)
1982	Dry	1473	1431 (-2.87%)	1969 (33.65%)	1610 (9.27%)	1651 (12.09%)	1498 (1.69%)	2167 (47.13%)	1562 (6.04%)
1983	Wet	1680	1538 (-8.47%)	1780 (5.94%)	1763 (4.97%)	1824 (8.57%)	1755 (4.49%)	2379 (41.62%)	1683 (0.21%)
1984	Wet	2845	2632 (-7.47%)	3375 (18.65%)	3026 (6.37%)	3068 (7.84%)	2896 (1.79%)	3722 (30.84%)	2906 (2.14%)
1985	Wet	3523	3391 (-3.74%)	3766 (6.88%)	3506 (-0.48%)	3598 (2.13%)	3640 (3.32%)	4723 (34.07%)	3325 (-5.62%)
1986	Below Normal	3531	3563 (0.91%)	3895 (10.32%)	3687 (4.43%)	3655 (3.52%)	3699 (4.75%)	4727 (33.88%)	3898 (10.40%)
1987	Wet	2380	2146 (-9.85%)	2557 (7.41%)	2399 (0.79%)	2337 (-1.80%)	2464 (3.50%)	3149 (32.29%)	2361 (-0.82%)
1988	Dry	4074	3359 (-17.53%)	4236 (3.99%)	4300 (5.57%)	3894 (-4.41%)	4231 (3.86%)	5116 (25.59%)	4330 (6.30%)
1989	Critical	1875	1549 (-17.35%)	2066 (10.21%)	2025 (8.00%)	1858 (-0.90%)	1943 (3.63%)	2271 (21.16%)	1819 (-2.99%)
1990	Dry	3071	2189 (-28.74%)	3048 (-0.77%)	3192 (3.92%)	2394 (-22.06%)	3036 (-1.14%)	3412 (11.10%)	3127 (1.80%)
1991	Critical	1202	1071 (-10.91%)	1291 (7.39%)	1357 (12.93%)	1167 (-2.94%)	1207 (0.38%)	1549 (28.85%)	1191 (-0.92%)
1992	Critical	1716	1280 (-25.38%)	1770 (3.17%)	1842 (7.32%)	1397 (-18.62%)	1710 (-0.36%)	1976 (15.16%)	1715 (-0.08%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1993	Critical	879	741 (-15.68%)	832 (-5.43%)	919 (4.46%)	770 (-12.40%)	945 (7.42%)	1068 (21.51%)	856 (-2.70%)
1994	Above Normal	1357	1055 (-22.25%)	1391 (2.52%)	1402 (3.34%)	1254 (-7.60%)	1169 (-13.82%)	1496 (10.27%)	1387 (2.23%)
1995	Critical	1509	1237 (-18.04%)	1531 (1.48%)	1196 (-20.70%)	1077 (-28.62%)	770 (-48.99%)	1545 (2.39%)	1550 (2.70%)
1996	Wet	1315	1109 (-15.63%)	1424 (8.32%)	1290 (-1.88%)	1211 (-7.86%)	1181 (-10.14%)	1426 (8.48%)	1272 (-3.26%)
1997	Wet	2772	2376 (-14.30%)	2872 (3.62%)	2595 (-6.40%)	2251 (-18.80%)	2032 (-26.70%)	3059 (10.34%)	2771 (-0.04%)
1998	Wet	2763	2289 (-17.15%)	2717 (-1.67%)	2585 (-6.46%)	2415 (-12.59%)	2333 (-15.57%)	2868 (3.80%)	2681 (-2.98%)
1999	Wet	5179	4631 (-10.59%)	5311 (2.54%)	4637 (-10.48%)	4314 (-16.71%)	3968 (-23.39%)	5643 (8.95%)	4935 (-4.73%)
2000	Wet	5048	4563 (-9.61%)	5245 (3.91%)	4950 (-1.94%)	4611 (-8.66%)	4390 (-13.04%)	5341 (5.80%)	5163 (2.29%)
2001	Above Normal	6269	5328 (-15.01%)	5950 (-5.08%)	5783 (-7.75%)	5430 (-13.38%)	4917 (-21.57%)	6575 (4.89%)	5919 (-5.58%)
2002	Dry	4991	4718 (-5.46%)	5277 (5.73%)	5247 (5.13%)	4954 (-0.73%)	4561 (-8.62%)	5683 (13.87%)	5189 (3.96%)
2003	Below Normal	3955	3326 (-15.90%)	3888 (-1.71%)	3941 (-0.35%)	3598 (-9.03%)	3397 (-14.10%)	4081 (3.18%)	3744 (-5.34%)
2004	Above Normal	4689	4718 (0.62%)	5035 (7.37%)	5047 (7.63%)	4722 (0.70%)	4555 (-2.85%)	5808 (23.87%)	4837 (3.16%)
2005	Above Normal	4737	4082 (-13.83%)	4720 (-0.34%)	4814 (1.63%)	4558 (-3.78%)	4464 (-5.76%)	5311 (12.13%)	4602 (-2.83%)
2006	Below Normal	5491	5464 (-0.50%)	5916 (7.74%)	5899 (7.43%)	5676 (3.36%)	5509 (0.32%)	6609 (20.35%)	5598 (1.94%)
2007	Wet	4647	4157 (-10.55%)	4720 (1.57%)	4686 (0.84%)	4697 (1.09%)	4438 (-4.49%)	5428 (16.81%)	4585 (-1.32%)
2008	Below Normal	7296	7010 (-3.92%)	7841 (7.47%)	7762 (6.39%)	7562 (3.64%)	7199 (-1.33%)	9193 (26.00%)	7597 (4.12%)
2009	Dry	3492	3149 (-9.85%)	3560 (1.93%)	3536 (1.24%)	3475 (-0.51%)	3344 (-4.25%)	4262 (22.03%)	3587 (2.69%)
2010	Dry	4752	4049 (-14.80%)	4816 (1.33%)	4862 (2.31%)	4641 (-2.34%)	4581 (-3.60%)	6256 (31.65%)	4821 (1.45%)

Water Year	Water Year Type	NAA	Alt1	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2011	Below Normal	2328	2067 (-11.21%)	2601 (11.69%)	2501 (7.41%)	2535 (8.86%)	2492 (7.01%)	3205 (37.66%)	2537 (8.97%)
2012	Wet	3757	3275 (-12.83%)	3853 (2.56%)	3859 (2.71%)	3873 (3.09%)	3955 (5.29%)	5125 (36.43%)	3859 (2.73%)
2013	Below Normal	2723	2295 (-15.73%)	2761 (1.39%)	2646 (-2.84%)	2777 (2.00%)	2762 (1.42%)	3561 (30.78%)	2747 (0.90%)
2014	Dry	2075	1764 (-14.98%)	2245 (8.19%)	2196 (5.82%)	2182 (5.14%)	2281 (9.93%)	2678 (29.08%)	2208 (6.43%)
2015	Critical	2104	1700 (-19.20%)	2212 (5.15%)	2183 (3.74%)	2232 (6.07%)	2134 (1.39%)	2619 (24.48%)	2180 (3.61%)
2016	Critical	963	869 (-9.72%)	1196 (24.20%)	1079 (12.05%)	1060 (10.14%)	1135 (17.91%)	1508 (56.68%)	1111 (15.37%)
2017	Below Normal	50	75 (49.20%)	699 (1298.59%)	193 (285.67%)	202 (303.42%)	220 (339.34%)	1422 (2745.63%)	560 (1020.68%)
2018	Wet	241	176 (-26.87%)	665 (176.06%)	188 (-22.10%)	188 (-22.05%)	198 (-17.68%)	1538 (538.79%)	1004 (316.86%)
2019	Below Normal	1215	1215 (0.04%)	1830 (50.66%)	1359 (11.85%)	1356 (11.68%)	1429 (17.68%)	2931 (141.29%)	1685 (38.74%)
2020	Wet	766	749 (-2.15%)	969 (26.61%)	788 (2.99%)	775 (1.18%)	798 (4.19%)	1541 (101.26%)	1176 (53.61%)
2021	Dry	1723	1612 (-6.41%)	2168 (25.86%)	1759 (2.11%)	1787 (3.71%)	1831 (6.31%)	3406 (97.72%)	2139 (24.20%)

F.5.3.2 BA Results

EXP1 was not included in the predicted survival box plots under this model. Under the EXP1 scenario, flows are vastly reduced in the Sacramento River (roughly a third of the flow of other scenarios) and are expected to have higher temperatures (~15°F higher). Taken together, this results in zero survival in the model, and values that are undefined as a result of trying to divide by zero.

F.5.3.2.1 Egg survival

Predicted egg survival of winter-run Chinook salmon was the same for all water year types with the exception of Critical water years. The lowest mean predicted egg survival of winter-run Chinook salmon occurred under Alt2 Without TUCP Without VA of Critical water years (0.684) followed by Critical water years under Alt2 Without TUCP Delta VA (0.696) (Figure F.5-16 and Table F.5-14).

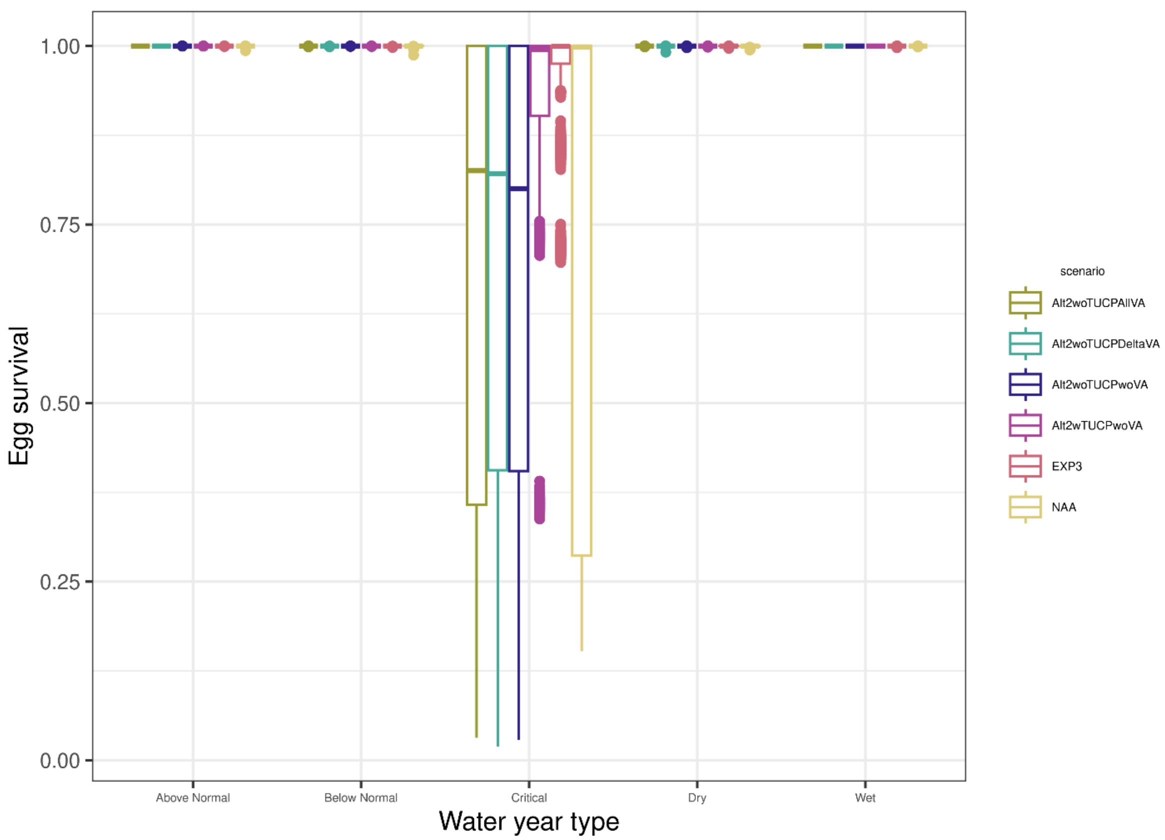


Figure F.5-16. Boxplots showing predicted winter-run Chinook egg survival by water year.

Table F.5-14. Predicted mean of winter-run Chinook egg survival by water year type.

Water Year Type	EXP3	NAA	Alt2wTUCP woVA	Alt2woTUCP woVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA
Above Normal	1	1	1	1	1	1
Below Normal	1	1	1	1	1	1
Critical	0.965	0.698	0.918	0.684	0.696	0.697
Dry	1	1	1	1	1	1
Wet	1	1	1	1	1	1

The mean annual predicted egg survival of winter-run Chinook salmon was the same for all water year types with the exception of Critical water years. The mean annual predicted egg survival of winter-run Chinook salmon was lowest under Alt2 Without TUCP Delta VA in 2015 (0.026) followed by Alt2 Without TUCP Systemwide VA in 2015 (0.035). Across the entire time period mean annual predicted egg survival for winter-run Chinook salmon was 0.96 (Figure F.5-17 and Table F.5-15).

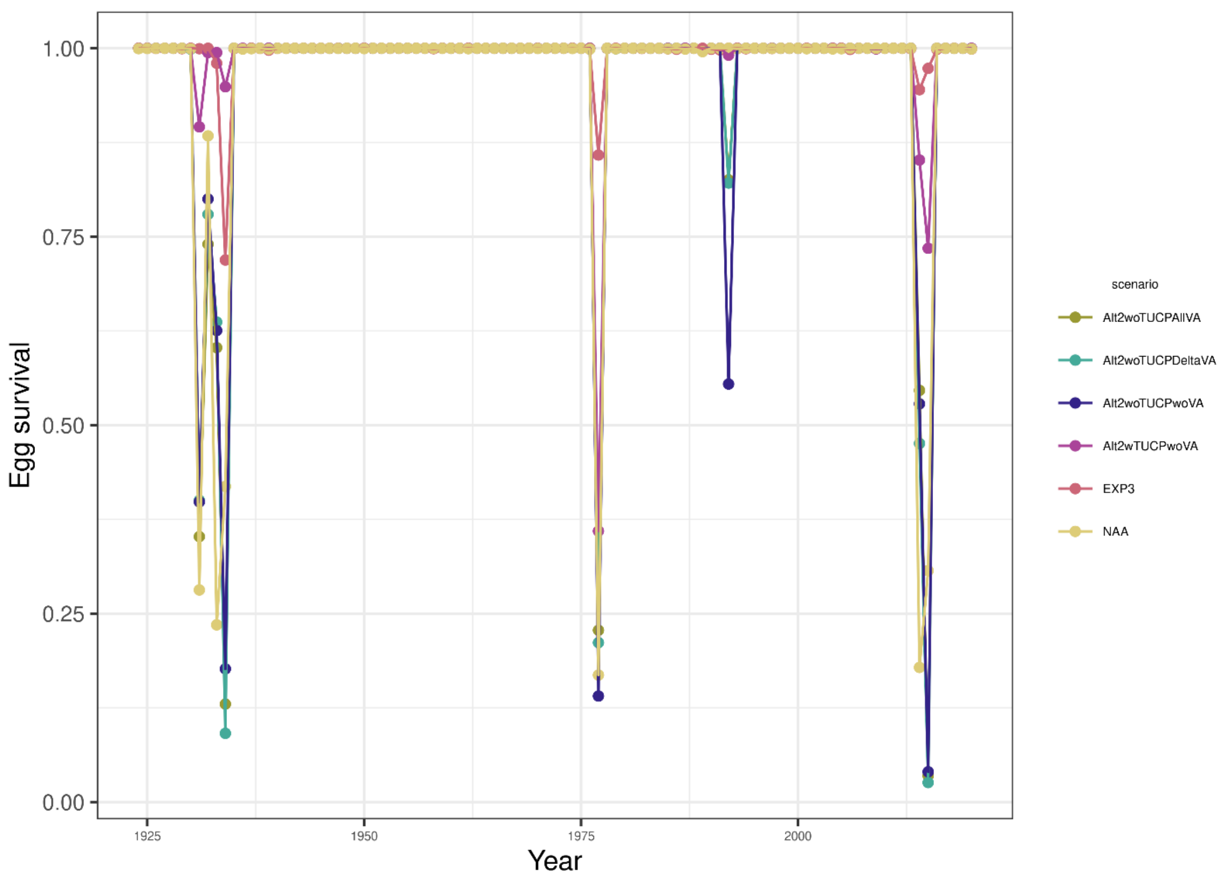


Figure F.5-17. Predicted mean annual winter-run Chinook egg survival.

Table F.5-15. Predicted mean annual winter-run Chinook egg survival.

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1923	Below Normal	0	1	1	1	1	1	1
1924	Critical	0	1	1	1	1	1	1
1925	Dry	0	1	1	1	1	1	1
1926	Dry	0	1	1	1	1	1	1
1927	Wet	0.008	1	1	1	1	1	1
1928	Above Normal	0	1	1	1	1	1	1
1929	Critical	0	0.999	1	1	1	1	1
1930	Dry	0	1	0.999	1	1	0.999	0.999
1931	Critical	0	0.999	0.281	0.895	0.399	0.4	0.353
1932	Critical	0	1	0.884	0.994	0.8	0.781	0.739
1933	Critical	0	0.98	0.235	0.994	0.625	0.638	0.603
1934	Critical	0	0.719	0.418	0.948	0.176	0.091	0.13
1935	Below Normal	0	1	1	1	1	1	1
1936	Below Normal	0	0.999	0.999	1	1	1	1
1937	Below Normal	0	1	0.999	1	1	1	1
1938	Wet	0.002	1	1	1	1	1	1
1939	Dry	0	0.998	0.999	1	1	1	1
1940	Above Normal	0.002	1	1	1	1	1	1
1941	Wet	0.001	1	1	1	1	1	1
1942	Wet	0.001	1	1	1	1	1	1
1943	Wet	0	1	1	1	1	1	1
1944	Dry	0	1	1	1	1	1	1
1945	Dry	0	1	1	1	1	1	1
1946	Below Normal	0	1	1	1	1	1	1
1947	Dry	0	1	1	1	1	1	1
1948	Dry	0	1	1	1	1	1	1
1949	Dry	0	1	1	1	1	1	1
1950	Dry	0	1	1	1	1	1	1
1951	Above Normal	0	1	1	1	1	1	1
1952	Wet	0.002	1	1	1	1	1	1
1953	Above Normal	0.003	1	1	1	1	1	1

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1954	Above Normal	0	1	1	1	1	1	1
1955	Dry	0	1	1	1	1	1	1
1956	Wet	0.004	1	1	1	1	1	1
1957	Below Normal	0	1	1	1	1	1	1
1958	Wet	0.001	0.999	1	1	1	1	1
1959	Below Normal	0	1	1	1	1	1	1
1960	Dry	0	1	1	1	1	1	1
1961	Dry	0	1	1	1	1	1	1
1962	Dry	0.005	1	0.999	1	1	1	1
1963	Wet	0.002	1	1	1	1	1	1
1964	Dry	0.001	1	1	1	1	1	1
1965	Wet	0.001	1	1	1	1	1	1
1966	Below Normal	0.001	1	1	1	1	1	1
1967	Wet	0	1	1	1	1	1	1
1968	Below Normal	0	1	1	1	1	1	1
1969	Wet	0.005	1	1	1	1	1	1
1970	Wet	0.076	1	1	1	1	1	1
1971	Wet	0.001	1	1	1	1	1	1
1972	Below Normal	0	1	1	1	1	1	1
1973	Above Normal	0	1	1	1	1	1	1
1974	Wet	0.012	1	1	1	1	1	1
1975	Above Normal	0	1	1	1	1	1	1
1976	Critical	0	1	0.999	1	1	1	1
1977	Critical	0	0.859	0.169	0.36	0.14	0.21	0.227
1978	Above Normal	0.005	1	1	1	1	1	1
1979	Dry	0	1	0.999	1	1	0.999	0.999
1980	Above Normal	0.003	1	1	1	1	1	1
1981	Dry	0	1	1	1	1	1	1
1982	Wet	0.001	1	1	1	1	1	1
1983	Wet	0.001	1	1	1	1	1	1
1984	Wet	0	1	1	1	1	1	1
1985	Below Normal	0	0.999	0.999	1	1	1	1
1986	Wet	0.02	0.999	1	1	1	1	1

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1987	Dry	0	0.999	0.999	1	1	1	1
1988	Critical	0	1	1	1	1	1	1
1989	Dry	0	1	0.996	0.999	0.999	1	1
1990	Critical	0	0.999	1	1	1	1	1
1991	Critical	0	0.998	1	1	1	1	1
1992	Critical	0	1	1	0.991	0.555	0.821	0.825
1993	Above Normal	0	1	0.999	1	1	1	1
1994	Critical	0	0.999	1	1	1	1	1
1995	Wet	0.004	1	1	1	1	1	1
1996	Wet	0.001	1	1	1	1	1	1
1997	Wet	0.015	1	1	1	1	1	1
1998	Wet	0.001	1	1	1	1	1	1
1999	Wet	0	1	1	1	1	1	1
2000	Above Normal	0.002	1	1	1	1	1	1
2001	Dry	0	1	0.999	1	1	1	1
2002	Below Normal	0	1	1	1	1	1	1
2003	Above Normal	0	1	1	1	1	1	1
2004	Above Normal	0.003	1	0.999	1	1	1	1
2005	Below Normal	0	1	0.999	1	1	1	1
2006	Wet	0	0.999	1	1	1	1	1
2007	Below Normal	0	1	1	1	1	1	1
2008	Dry	0	1	1	1	1	1	1
2009	Dry	0	1	1	0.999	0.999	1	1
2010	Below Normal	0	1	1	1	1	1	1
2011	Wet	0.001	1	1	1	1	1	1
2012	Below Normal	0	1	1	1	1	1	1
2013	Dry	0	1	1	1	1	1	1
2014	Critical	0	0.945	0.179	0.851	0.528	0.475	0.547
2015	Critical	0	0.972	0.307	0.735	0.04	0.026	0.035
2016	Below Normal	0.001	0.999	1	1	1	1	1
2017	Wet	0.01	1	1	1	1	1	1
2018	Below Normal	0	1	1	1	1	1	1
2019	Wet	0.001	1	1	1	1	1	1

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
2020	Dry	0	0.999	0.999	1	1	1	1

F.5.3.2.2 Fry survival

Highest mean predicted fry survival of winter-run Chinook salmon occurred under NAA of Wet water years (0.964), followed by Wet water years under Alt2 Without TUCP Without VA (0.963). The lowest mean predicted fry survival of winter-run Chinook salmon occurred under Alt2 Without TUCP Without VA of Critical water years (0.613) followed by Critical water years under Alt2 Without TUCP Delta VA (0.62) (Figure F.5-18 and Table F.5-16).

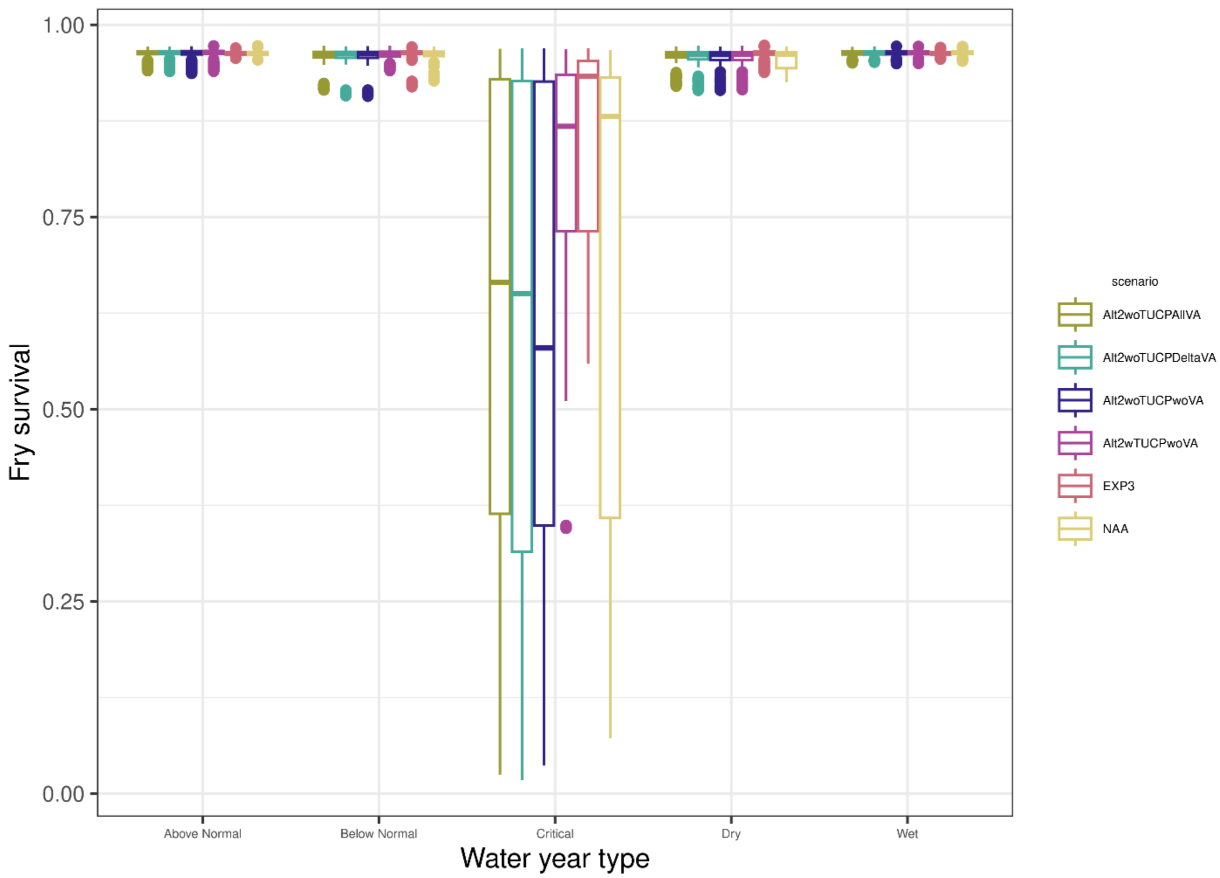


Figure F.5-18. Boxplots showing predicted winter-run Chinook fry survival by water year type.

Table F.5-16. Predicted mean winter-run Chinook fry survival by water year type.

Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
Above Normal	NaN	0.963	0.963	0.962	0.962	0.962	0.962
Below Normal	NaN	0.961	0.959	0.961	0.959	0.959	0.959
Critical	NaN	0.861	0.652	0.804	0.613	0.62	0.622
Dry	NaN	0.962	0.955	0.957	0.957	0.957	0.959
Wet	NaN	0.963	0.964	0.963	0.963	0.963	0.963

NaN = Not a number

Mean annual predicted fry survival of winter-run Chinook salmon was highest under Alt2 Without TUCP Systemwide VA in 1969 (0.968), followed by Alt2 With TUCP Without VA in 1969 (0.967). The mean annual predicted fry survival of winter-run Chinook salmon was lowest under Alt2 Without TUCP Delta VA in 2016 (0.018) followed by Alt2 Without TUCP Systemwide VA in 2016 (0.025). Across the entire time period mean annual predicted fry survival for winter-run Chinook salmon was 0.915 (Figure F.5-19 and Table F.5-17).

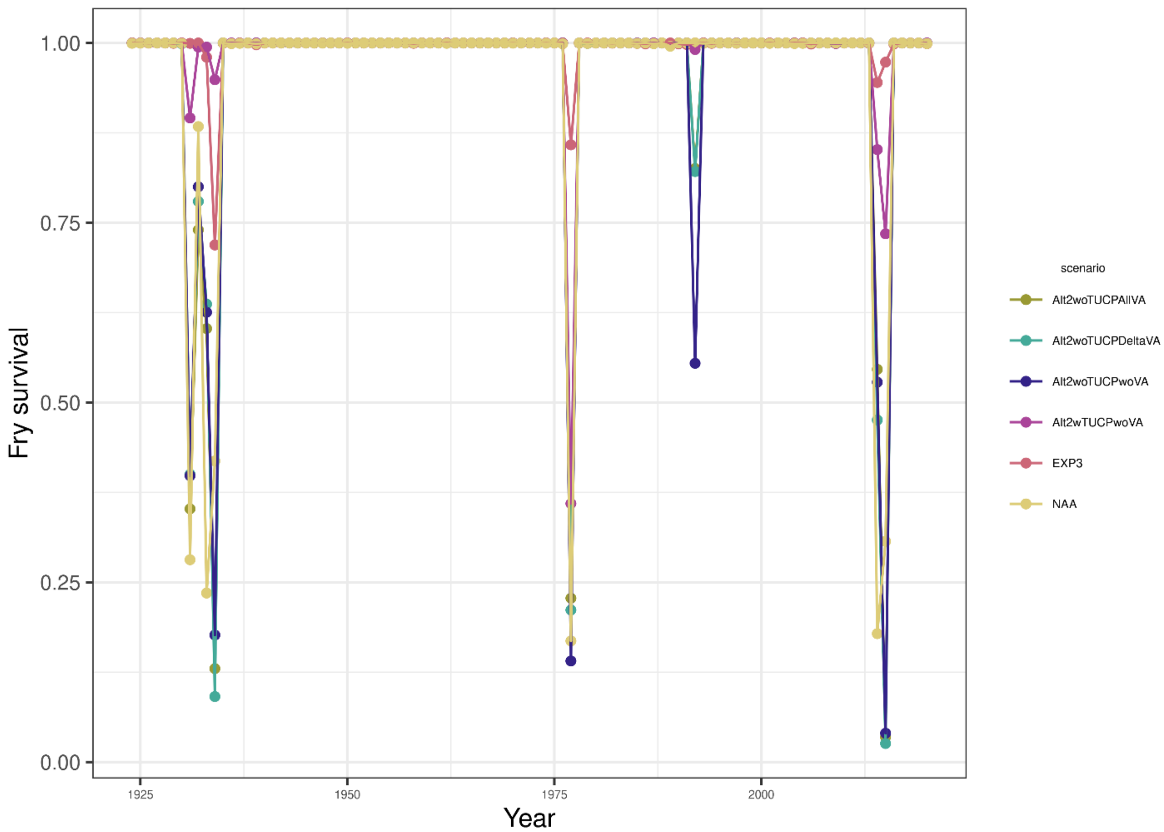


Figure F.5-19. Predicted mean annual winter-run Chinook fry survival.

Table F.5-17. Predicted mean annual winter-run Chinook fry survival.

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1924	Below Normal	0.01	0.964	0.962	0.96	0.96	0.96	0.961
1925	Critical	NaN	0.938	0.897	0.942	0.922	0.922	0.932
1926	Dry	NaN	0.962	0.955	0.961	0.962	0.96	0.959
1927	Dry	NaN	0.957	0.936	0.942	0.943	0.95	0.958
1928	Wet	NaN	0.963	0.964	0.966	0.967	0.967	0.966
1929	Above Normal	NaN	0.963	0.961	0.944	0.941	0.944	0.945
1930	Critical	NaN	0.952	0.937	0.947	0.937	0.938	0.941
1931	Dry	NaN	0.963	0.961	0.963	0.958	0.958	0.96
1932	Critical	NaN	0.862	0.384	0.731	0.402	0.4	0.363
1933	Critical	NaN	0.926	0.614	0.861	0.58	0.578	0.542
1934	Critical	NaN	0.786	0.358	0.868	0.544	0.541	0.527

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1935	Critical	NaN	0.562	0.43	0.77	0.166	0.062	0.09
1936	Below Normal	NaN	0.923	0.934	0.946	0.911	0.912	0.919
1937	Below Normal	NaN	0.961	0.957	0.966	0.964	0.964	0.964
1938	Below Normal	NaN	0.966	0.961	0.962	0.963	0.963	0.962
1939	Wet	NaN	0.963	0.964	0.965	0.965	0.966	0.966
1940	Dry	NaN	0.943	0.942	0.929	0.929	0.929	0.933
1941	Above Normal	0.027	0.964	0.959	0.948	0.95	0.948	0.949
1942	Wet	NaN	0.963	0.964	0.966	0.965	0.965	0.965
1943	Wet	0.033	0.961	0.962	0.962	0.962	0.962	0.962
1944	Wet	NaN	0.962	0.965	0.964	0.964	0.962	0.962
1945	Dry	NaN	0.967	0.929	0.953	0.953	0.951	0.955
1946	Dry	NaN	0.965	0.964	0.964	0.964	0.965	0.965
1947	Below Normal	NaN	0.965	0.964	0.964	0.964	0.964	0.963
1948	Dry	NaN	0.964	0.964	0.964	0.964	0.961	0.964
1949	Dry	NaN	0.952	0.967	0.964	0.964	0.964	0.964
1950	Dry	NaN	0.962	0.962	0.962	0.962	0.961	0.962
1951	Dry	NaN	0.964	0.964	0.965	0.965	0.965	0.965
1952	Above Normal	NaN	0.965	0.963	0.964	0.964	0.964	0.964
1953	Wet	0.019	0.963	0.964	0.964	0.964	0.964	0.964
1954	Above Normal	0.03	0.962	0.964	0.964	0.964	0.964	0.964
1955	Above Normal	NaN	0.962	0.966	0.967	0.967	0.967	0.967
1956	Dry	NaN	0.963	0.961	0.966	0.966	0.966	0.966
1957	Wet	0.056	0.963	0.964	0.964	0.964	0.964	0.964
1958	Below Normal	NaN	0.963	0.963	0.964	0.964	0.965	0.964
1959	Wet	0.013	0.962	0.966	0.963	0.963	0.963	0.963
1960	Below Normal	NaN	0.964	0.964	0.963	0.963	0.964	0.963
1961	Dry	NaN	0.964	0.964	0.967	0.967	0.967	0.967
1962	Dry	NaN	0.965	0.963	0.964	0.964	0.964	0.964
1963	Dry	0.045	0.963	0.963	0.963	0.964	0.964	0.964
1964	Wet	0.079	0.963	0.964	0.966	0.966	0.966	0.965
1965	Dry	NaN	0.964	0.966	0.967	0.966	0.966	0.966
1966	Wet	0.055	0.963	0.965	0.965	0.966	0.966	0.966
1967	Below Normal	0.018	0.963	0.965	0.964	0.964	0.965	0.965

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1968	Wet	NaN	0.964	0.964	0.964	0.964	0.964	0.964
1969	Below Normal	NaN	0.963	0.967	0.967	0.967	0.967	0.968
1970	Wet	NaN	0.962	0.965	0.965	0.965	0.965	0.965
1971	Wet	NaN	0.964	0.965	0.965	0.965	0.965	0.965
1972	Wet	0.015	0.963	0.964	0.964	0.964	0.964	0.964
1973	Below Normal	NaN	0.964	0.964	0.966	0.965	0.965	0.965
1974	Above Normal	NaN	0.965	0.964	0.964	0.965	0.965	0.965
1975	Wet	0.077	0.962	0.962	0.965	0.965	0.964	0.965
1976	Above Normal	NaN	0.962	0.961	0.964	0.965	0.964	0.964
1977	Critical	NaN	0.951	0.962	0.964	0.964	0.964	0.965
1978	Critical	NaN	0.73	0.265	0.347	0.16	0.206	0.224
1979	Above Normal	0.05	0.962	0.96	0.962	0.961	0.962	0.962
1980	Dry	NaN	0.963	0.942	0.961	0.962	0.964	0.962
1981	Above Normal	NaN	0.962	0.961	0.964	0.964	0.964	0.964
1982	Dry	NaN	0.964	0.962	0.953	0.953	0.953	0.957
1983	Wet	NaN	0.964	0.962	0.963	0.962	0.962	0.962
1984	Wet	NaN	0.964	0.963	0.958	0.958	0.959	0.958
1985	Wet	0.021	0.964	0.965	0.965	0.965	0.965	0.965
1986	Below Normal	NaN	0.964	0.966	0.963	0.963	0.963	0.963
1987	Wet	0.107	0.963	0.961	0.961	0.961	0.961	0.961
1988	Dry	NaN	0.967	0.965	0.963	0.963	0.963	0.964
1989	Critical	NaN	0.956	0.932	0.92	0.915	0.925	0.914
1990	Dry	NaN	0.963	0.961	0.965	0.962	0.964	0.964
1991	Critical	NaN	0.952	0.93	0.936	0.927	0.928	0.927
1992	Critical	NaN	0.958	0.881	0.907	0.886	0.918	0.918
1993	Critical	NaN	0.933	0.911	0.836	0.477	0.65	0.665
1994	Above Normal	NaN	0.961	0.962	0.964	0.963	0.964	0.964
1995	Critical	NaN	0.965	0.953	0.925	0.934	0.929	0.93
1996	Wet	0.065	0.963	0.964	0.965	0.965	0.964	0.964
1997	Wet	NaN	0.964	0.965	0.955	0.955	0.956	0.955
1998	Wet	0.174	0.965	0.964	0.965	0.965	0.965	0.965
1999	Wet	0.002	0.963	0.965	0.958	0.957	0.959	0.956
2000	Wet	NaN	0.962	0.961	0.961	0.961	0.962	0.961

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
2001	Above Normal	NaN	0.962	0.964	0.966	0.966	0.966	0.966
2002	Dry	NaN	0.967	0.964	0.956	0.956	0.957	0.958
2003	Below Normal	NaN	0.964	0.963	0.965	0.965	0.965	0.965
2004	Above Normal	NaN	0.962	0.964	0.966	0.966	0.966	0.966
2005	Above Normal	NaN	0.964	0.967	0.966	0.966	0.966	0.966
2006	Below Normal	NaN	0.965	0.967	0.956	0.956	0.956	0.957
2007	Wet	NaN	0.961	0.963	0.966	0.965	0.965	0.965
2008	Below Normal	NaN	0.963	0.964	0.961	0.962	0.962	0.961
2009	Dry	NaN	0.963	0.937	0.957	0.957	0.957	0.961
2010	Dry	NaN	0.963	0.93	0.946	0.946	0.955	0.96
2011	Below Normal	NaN	0.964	0.961	0.965	0.965	0.964	0.965
2012	Wet	NaN	0.962	0.965	0.966	0.966	0.967	0.966
2013	Below Normal	NaN	0.965	0.961	0.954	0.954	0.954	0.955
2014	Dry	NaN	0.966	0.944	0.919	0.919	0.918	0.924
2015	Critical	NaN	0.713	0.072	0.594	0.348	0.314	0.372
2016	Critical	NaN	0.731	0.245	0.513	0.037	0.018	0.025
2017	Below Normal	NaN	0.964	0.931	0.96	0.955	0.956	0.955
2018	Wet	0.008	0.961	0.957	0.963	0.962	0.96	0.96
2019	Below Normal	NaN	0.96	0.951	0.952	0.952	0.952	0.953
2020	Wet	NaN	0.96	0.965	0.955	0.96	0.96	0.96
2021	Dry	NaN	0.958	0.956	0.955	0.955	0.955	0.956

NaN = Not a number

F.5.3.2.3 Through-river survival

Highest mean predicted river-migration survival of winter-run Chinook salmon occurred nder Alt2 Without TUCP Systemwide VA of Wet water years (0.294), followed by Wet water years under Alt2 With TUCP Without VA (0.294). The lowest mean predicted river-migration survival of winter-run Chinook salmon occurred under NAA of Critical water years (0.247) followed by Critical water years under Alt2 Without TUCP Systemwide VA (0.247) (Figure F.5-20 and Table F.5-18).

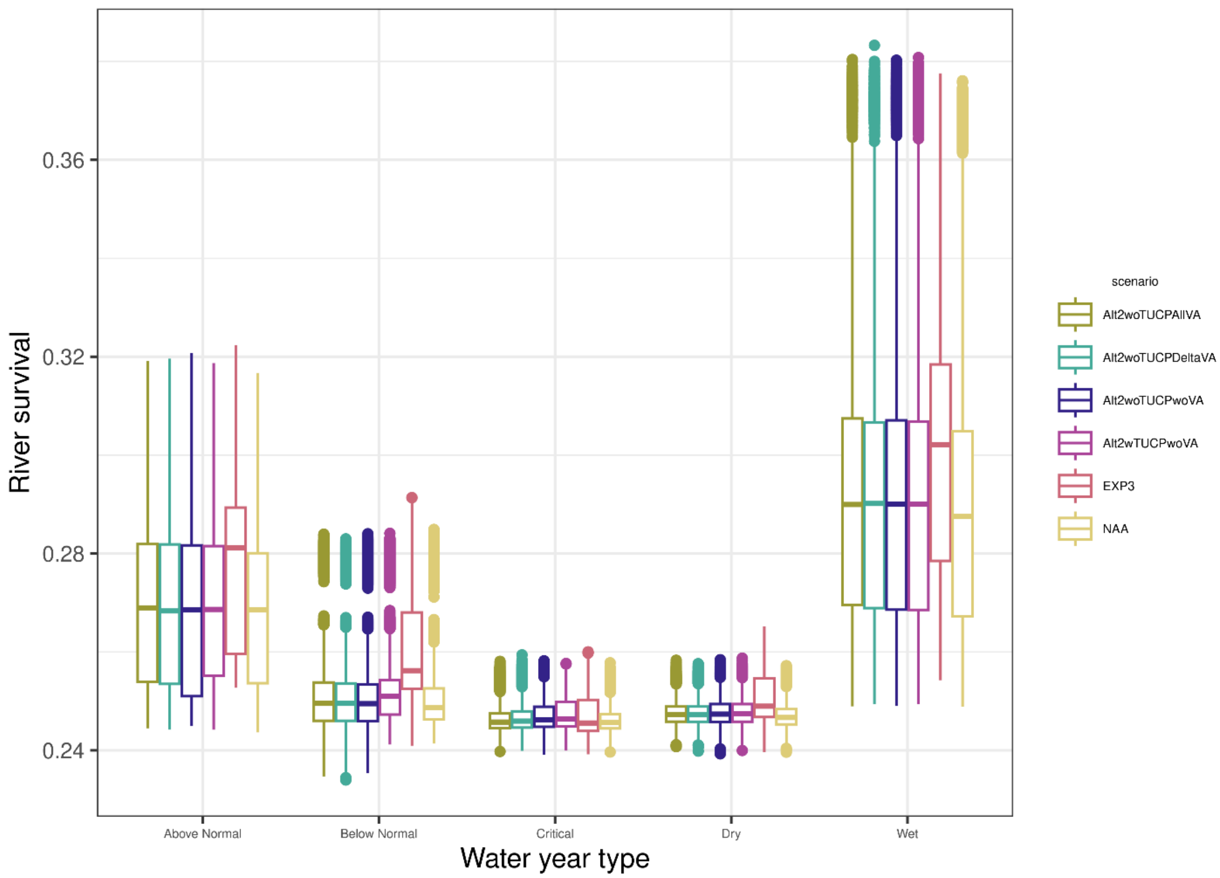


Figure F.5-20. Boxplots showing predicted winter-run Chinook through-river-migration survival by water year type.

Table F.5-18. Predicted mean winter-run Chinook through-river-migration survival by water year type.

Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
Above Normal	NaN	0.28	0.27	0.27	0.269	0.269	0.27
Below Normal	NaN	0.26	0.25	0.254	0.253	0.253	0.253
Critical	NaN	0.25	0.25	0.247	0.247	0.247	0.247
Dry	NaN	0.25	0.25	0.248	0.248	0.248	0.248
Wet	NaN	0.3	0.29	0.294	0.294	0.294	0.294

NaN = Not a number

Mean annual predicted river-migration survival of winter-run Chinook salmon was highest under Alt2 With TUCP Without VA in 1970 (0.372), followed by Alt2 Without TUCP Delta VA in 1970 (0.372). The mean annual predicted river-migration survival of winter-run Chinook salmon was lowest under Alt2 Without TUCP Delta VA in 2016 (0.242) followed by Alt2 Without TUCP Systemwide VA in 2016 (0.242). Across the entire time period mean annual predicted river-migration survival for winter-run Chinook salmon was 0.264 (Figure F.5-21 and Table F.5-19).

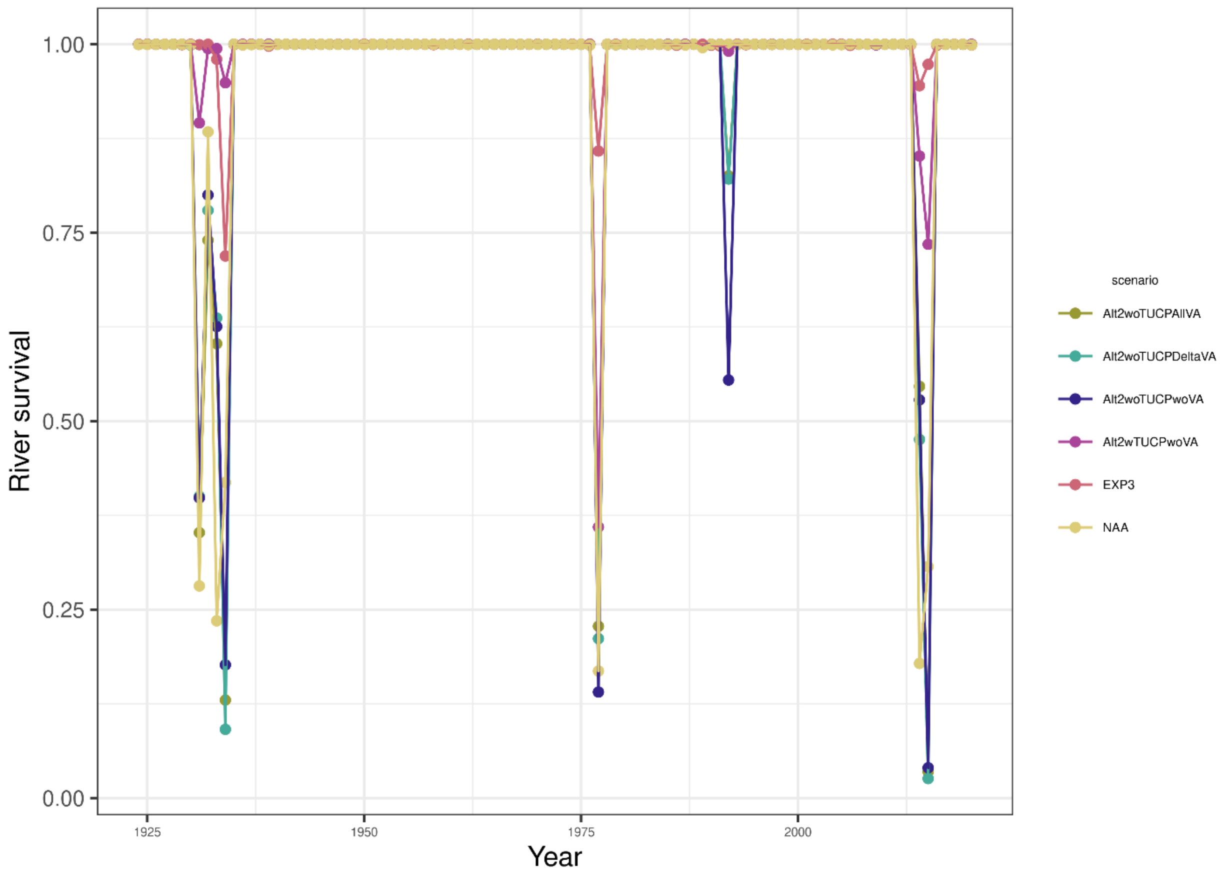


Figure F.5-21. Predicted mean annual winter-run Chinook through-river migration survival.

Table F.5-19. Predicted mean annual winter-run Chinook through-river migration survival.

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1924	Critical	0.243	0.244	0.244	0.245	0.245	0.245	0.245
1925	Dry	NaN	0.248	0.246	0.248	0.247	0.247	0.247
1926	Dry	NaN	0.248	0.246	0.247	0.247	0.247	0.247

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1927	Wet	NaN	0.274	0.258	0.268	0.268	0.269	0.27
1928	Above Normal	NaN	0.257	0.249	0.25	0.25	0.249	0.249
1929	Critical	NaN	0.245	0.245	0.245	0.245	0.245	0.245
1930	Dry	NaN	0.248	0.247	0.247	0.247	0.247	0.248
1931	Critical	NaN	0.245	0.246	0.246	0.246	0.246	0.246
1932	Critical	NaN	0.25	0.251	0.251	0.251	0.251	0.251
1933	Critical	NaN	0.245	0.245	0.245	0.244	0.244	0.244
1934	Critical	NaN	0.247	0.245	0.247	0.246	0.246	0.246
1935	Below Normal	NaN	0.25	0.246	0.253	0.245	0.245	0.245
1936	Below Normal	NaN	0.253	0.25	0.252	0.251	0.251	0.251
1937	Below Normal	NaN	0.245	0.245	0.245	0.245	0.245	0.245
1938	Wet	NaN	0.285	0.278	0.281	0.281	0.281	0.281
1939	Dry	NaN	0.25	0.247	0.247	0.247	0.247	0.247
1940	Above Normal	NaN	0.259	0.257	0.257	0.257	0.257	0.258
1941	Wet	0.244	0.317	0.303	0.306	0.306	0.305	0.305
1942	Wet	NaN	0.306	0.297	0.298	0.298	0.298	0.298
1943	Wet	0.246	0.286	0.279	0.28	0.279	0.279	0.279
1944	Dry	NaN	0.247	0.245	0.245	0.245	0.245	0.245
1945	Dry	NaN	0.25	0.246	0.247	0.247	0.247	0.247
1946	Below Normal	NaN	0.288	0.281	0.28	0.28	0.28	0.28
1947	Dry	NaN	0.245	0.244	0.244	0.244	0.244	0.245
1948	Dry	NaN	0.249	0.246	0.25	0.25	0.246	0.246
1949	Dry	NaN	0.25	0.245	0.245	0.245	0.245	0.245
1950	Dry	NaN	0.246	0.246	0.246	0.246	0.247	0.246
1951	Above Normal	NaN	0.287	0.28	0.28	0.28	0.28	0.28
1952	Wet	NaN	0.298	0.287	0.289	0.289	0.289	0.289
1953	Above Normal	0.243	0.318	0.312	0.315	0.314	0.314	0.313
1954	Above Normal	0.251	0.282	0.27	0.27	0.269	0.269	0.27
1955	Dry	NaN	0.258	0.249	0.249	0.249	0.249	0.249
1956	Wet	NaN	0.35	0.344	0.346	0.346	0.346	0.347
1957	Below Normal	0.247	0.251	0.246	0.245	0.245	0.245	0.245
1958	Wet	NaN	0.3	0.288	0.29	0.29	0.29	0.29
1959	Below Normal	0.246	0.268	0.258	0.259	0.259	0.258	0.258
1960	Dry	NaN	0.247	0.246	0.246	0.246	0.247	0.247

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1961	Dry	NaN	0.257	0.25	0.251	0.251	0.25	0.25
1962	Dry	NaN	0.258	0.251	0.252	0.252	0.252	0.252
1963	Wet	0.256	0.261	0.253	0.253	0.253	0.253	0.253
1964	Dry	0.253	0.259	0.248	0.248	0.248	0.248	0.248
1965	Wet	NaN	0.308	0.307	0.307	0.307	0.307	0.309
1966	Below Normal	0.25	0.272	0.264	0.264	0.264	0.264	0.264
1967	Wet	0.247	0.277	0.268	0.269	0.269	0.269	0.269
1968	Below Normal	NaN	0.257	0.251	0.252	0.252	0.252	0.252
1969	Wet	NaN	0.326	0.314	0.317	0.317	0.317	0.318
1970	Wet	NaN	0.369	0.368	0.372	0.372	0.372	0.372
1971	Wet	NaN	0.296	0.284	0.285	0.285	0.284	0.285
1972	Below Normal	0.246	0.256	0.246	0.247	0.246	0.247	0.246
1973	Above Normal	NaN	0.29	0.283	0.284	0.284	0.284	0.284
1974	Wet	NaN	0.353	0.344	0.344	0.345	0.345	0.345
1975	Above Normal	0.247	0.259	0.248	0.249	0.249	0.249	0.249
1976	Critical	NaN	0.255	0.246	0.246	0.246	0.246	0.246
1977	Critical	NaN	0.244	0.245	0.251	0.248	0.246	0.246
1978	Above Normal	NaN	0.268	0.248	0.249	0.25	0.25	0.25
1979	Dry	0.243	0.248	0.246	0.246	0.246	0.246	0.246
1980	Above Normal	NaN	0.292	0.279	0.286	0.287	0.286	0.286
1981	Dry	NaN	0.249	0.247	0.248	0.248	0.248	0.248
1982	Wet	NaN	0.304	0.289	0.289	0.289	0.29	0.29
1983	Wet	NaN	0.311	0.298	0.3	0.3	0.299	0.299
1984	Wet	NaN	0.3	0.285	0.284	0.284	0.284	0.284
1985	Below Normal	0.247	0.259	0.248	0.248	0.248	0.248	0.248
1986	Wet	NaN	0.264	0.26	0.261	0.261	0.261	0.263
1987	Dry	0.244	0.245	0.247	0.251	0.251	0.25	0.25
1988	Critical	NaN	0.257	0.254	0.254	0.254	0.254	0.254
1989	Dry	NaN	0.246	0.246	0.246	0.246	0.246	0.246
1990	Critical	NaN	0.245	0.245	0.245	0.245	0.246	0.246
1991	Critical	NaN	0.243	0.246	0.25	0.244	0.244	0.244
1992	Critical	NaN	0.244	0.244	0.244	0.249	0.244	0.244
1993	Above Normal	NaN	0.258	0.254	0.256	0.25	0.254	0.255
1994	Critical	NaN	0.252	0.245	0.246	0.245	0.246	0.245

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1995	Wet	NaN	0.319	0.3	0.302	0.306	0.305	0.306
1996	Wet	0.244	0.275	0.265	0.266	0.266	0.266	0.266
1997	Wet	NaN	0.345	0.327	0.328	0.327	0.328	0.328
1998	Wet	0.256	0.319	0.301	0.302	0.302	0.302	0.302
1999	Wet	0.253	0.28	0.266	0.267	0.268	0.267	0.268
2000	Above Normal	NaN	0.274	0.259	0.261	0.261	0.261	0.261
2001	Dry	NaN	0.253	0.247	0.247	0.247	0.247	0.247
2002	Below Normal	NaN	0.281	0.275	0.276	0.276	0.277	0.278
2003	Above Normal	NaN	0.29	0.281	0.281	0.281	0.281	0.281
2004	Above Normal	NaN	0.282	0.269	0.269	0.269	0.269	0.269
2005	Below Normal	NaN	0.256	0.251	0.251	0.251	0.251	0.251
2006	Wet	NaN	0.316	0.309	0.309	0.309	0.309	0.309
2007	Below Normal	NaN	0.256	0.249	0.25	0.25	0.25	0.25
2008	Dry	NaN	0.249	0.25	0.25	0.25	0.249	0.249
2009	Dry	NaN	0.244	0.244	0.245	0.245	0.245	0.245
2010	Below Normal	NaN	0.269	0.249	0.251	0.251	0.252	0.252
2011	Wet	NaN	0.267	0.26	0.259	0.259	0.259	0.259
2012	Below Normal	NaN	0.251	0.246	0.246	0.246	0.246	0.246
2013	Dry	NaN	0.261	0.254	0.254	0.254	0.254	0.254
2014	Critical	NaN	0.244	0.247	0.247	0.247	0.248	0.247
2015	Critical	NaN	0.251	0.253	0.251	0.254	0.255	0.254
2016	Below Normal	NaN	0.255	0.247	0.252	0.242	0.242	0.242
2017	Wet	NaN	0.319	0.281	0.299	0.293	0.293	0.293
2018	Below Normal	0.25	0.254	0.246	0.247	0.247	0.247	0.247
2019	Wet	NaN	0.258	0.253	0.253	0.253	0.253	0.253
2020	Dry	NaN	0.257	0.248	0.248	0.248	0.248	0.248
2021	Critical	NaN	0.244	0.245	0.245	0.245	0.245	0.245

NaN = Not a number

F.5.3.2.4 Through-Delta survival

Highest mean predicted through-Delta survival of winter-run Chinook salmon occurred under Alt2 With TUCP Without VA of Wet water years (0.358), followed by Wet water years under Alt2 Without TUCP Without VA (0.358). The lowest mean predicted through-Delta survival of winter-run Chinook salmon occurred under Alt2 Without TUCP Systemwide VA of Critical water years (0.168) followed by Critical water years under Alt2 Without TUCP Delta VA (0.169) (Figure F.5-22 and Table F.5-20).

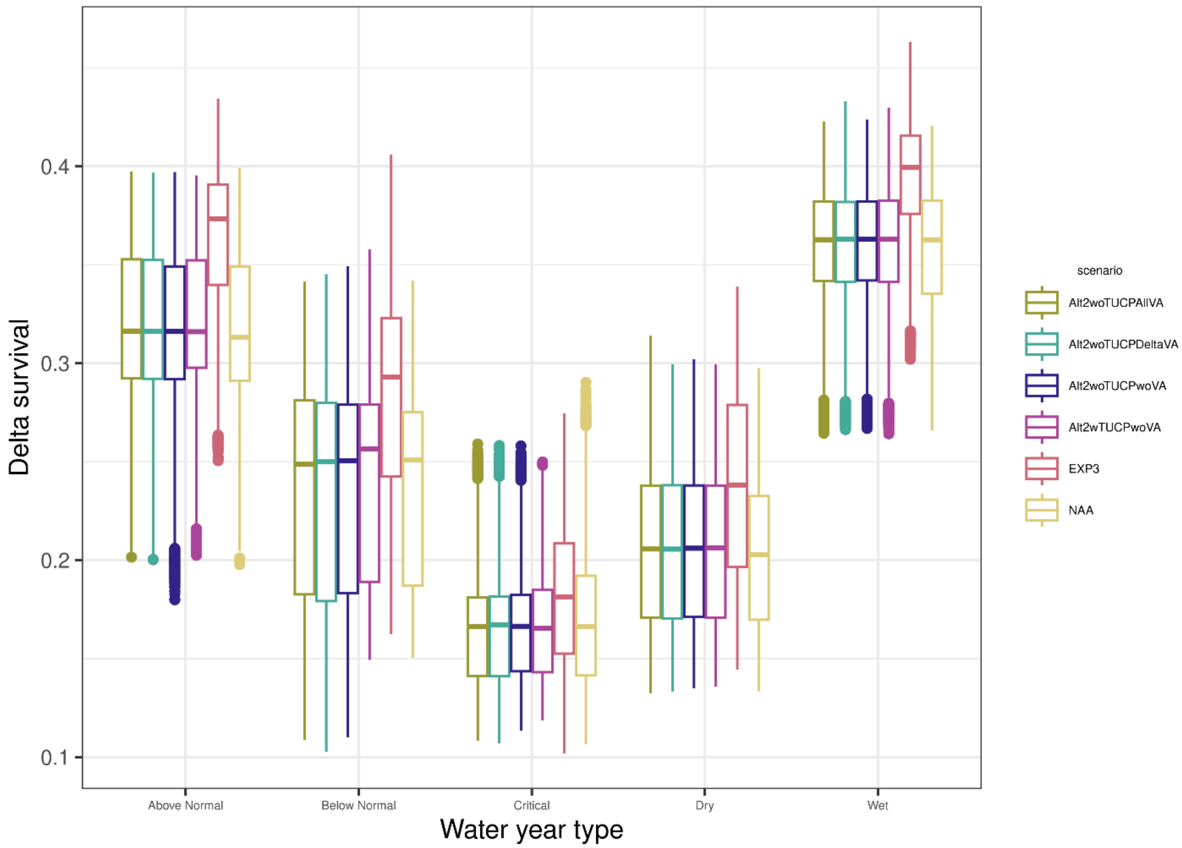


Figure F.5-22. Boxplots showing predicted winter-run Chinook through-Delta survival by water year type.

Table F.5-20. Predicted mean winter-run Chinook through-Delta by water year type.

Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
Above Normal	NaN	0.36	0.31	0.319	0.311	0.315	0.317
Below Normal	NaN	0.28	0.24	0.242	0.233	0.23	0.232
Critical	NaN	0.18	0.17	0.17	0.169	0.169	0.168
Dry	NaN	0.24	0.2	0.209	0.209	0.209	0.209
Wet	NaN	0.39	0.36	0.358	0.358	0.357	0.358

NaN = Not a number

Mean annual predicted through-Delta survival of winter-run Chinook salmon was highest under Alt2 With TUCP Without VA in 2017 (0.408), followed by Alt2 Without TUCP Without VA in 2017 (0.405). The mean annual predicted through-Delta survival of winter-run Chinook salmon was lowest under NAA in 1977 (0.117) followed by Alt2 Without TUCP Systemwide VA in 1977 (0.119). Across the entire time period mean annual predicted through-Delta survival for winter-run Chinook salmon was 0.263 (Figure F.5-23 and Table F.5-21).

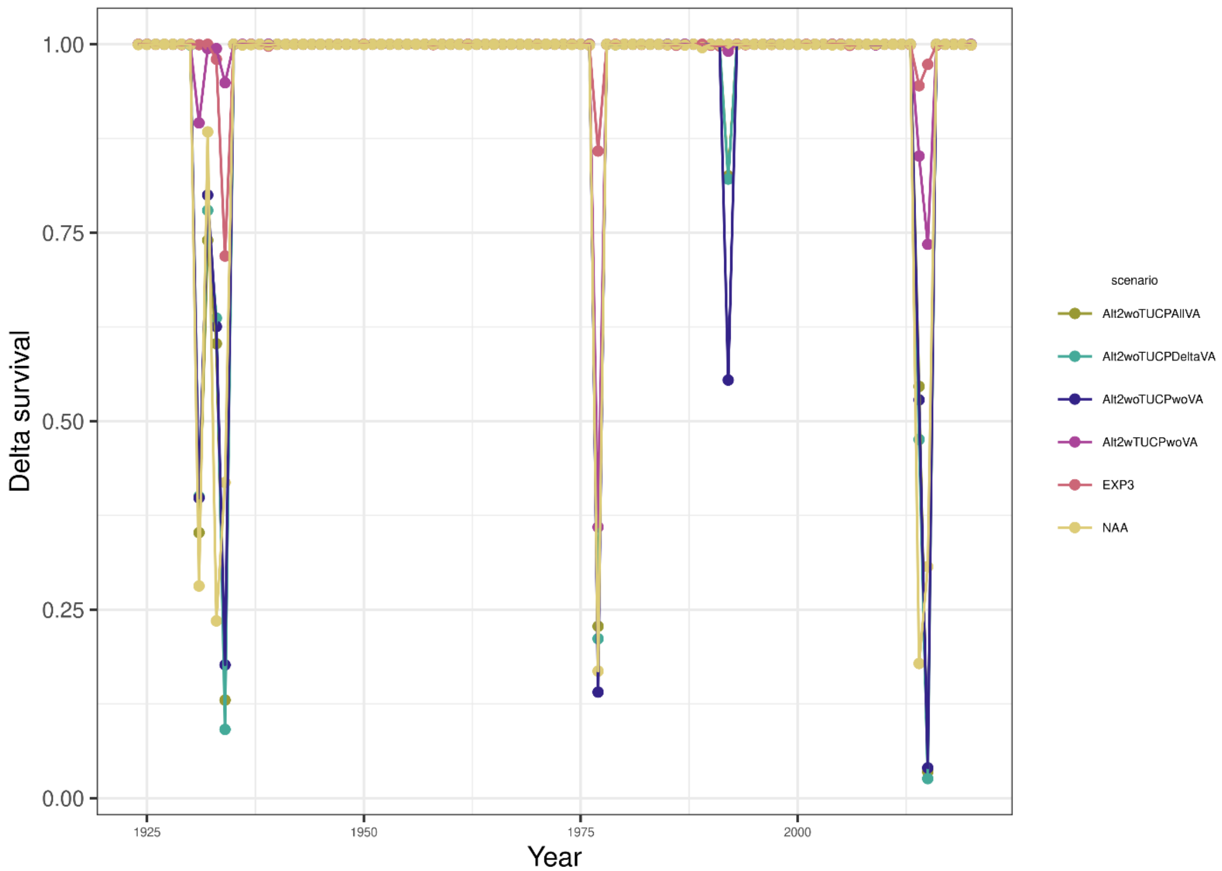


Figure F.5-23. Predicted mean annual winter-run Chinook through-Delta survival.

Table F.5-21. Predicted mean annual winter-run Chinook through-Delta survival.

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1924	Critical	0.12	0.18	0.17	0.167	0.168	0.168	0.168
1925	Dry	NaN	0.27	0.24	0.254	0.255	0.255	0.255
1926	Dry	NaN	0.3	0.25	0.261	0.261	0.261	0.26
1927	Wet	NaN	0.39	0.33	0.355	0.356	0.354	0.353
1928	Above Normal	NaN	0.27	0.22	0.219	0.22	0.219	0.219

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1929	Critical	NaN	0.18	0.17	0.172	0.173	0.172	0.172
1930	Dry	NaN	0.28	0.23	0.23	0.231	0.231	0.23
1931	Critical	NaN	0.16	0.14	0.142	0.144	0.144	0.144
1932	Critical	NaN	0.25	0.23	0.233	0.235	0.236	0.235
1933	Critical	NaN	0.19	0.16	0.158	0.159	0.159	0.158
1934	Critical	NaN	0.21	0.19	0.188	0.182	0.18	0.179
1935	Below Normal	NaN	0.28	0.25	0.242	0.218	0.177	0.202
1936	Below Normal	NaN	0.39	0.32	0.336	0.33	0.327	0.327
1937	Below Normal	NaN	0.29	0.25	0.255	0.253	0.251	0.251
1938	Wet	NaN	0.38	0.34	0.349	0.349	0.349	0.35
1939	Dry	NaN	0.16	0.15	0.146	0.147	0.146	0.146
1940	Above Normal	NaN	0.37	0.33	0.327	0.327	0.328	0.329
1941	Wet	0.24	0.42	0.38	0.385	0.385	0.385	0.385
1942	Wet	NaN	0.41	0.38	0.38	0.38	0.38	0.379
1943	Wet	0.21	0.39	0.35	0.347	0.346	0.347	0.347
1944	Dry	NaN	0.24	0.2	0.208	0.208	0.207	0.207
1945	Dry	NaN	0.3	0.23	0.255	0.256	0.258	0.256
1946	Below Normal	NaN	0.32	0.29	0.287	0.287	0.288	0.288
1947	Dry	NaN	0.19	0.17	0.17	0.17	0.17	0.17
1948	Dry	NaN	0.18	0.16	0.165	0.165	0.153	0.16
1949	Dry	NaN	0.18	0.16	0.166	0.165	0.166	0.165
1950	Dry	NaN	0.32	0.28	0.283	0.283	0.283	0.283
1951	Above Normal	NaN	0.4	0.36	0.363	0.363	0.363	0.364
1952	Wet	NaN	0.41	0.39	0.385	0.386	0.386	0.386
1953	Above Normal	0.21	0.34	0.31	0.308	0.308	0.309	0.308
1954	Above Normal	0.16	0.36	0.3	0.302	0.301	0.301	0.304
1955	Dry	NaN	0.21	0.17	0.168	0.168	0.168	0.168
1956	Wet	NaN	0.42	0.39	0.385	0.387	0.385	0.385
1957	Below Normal	0.13	0.25	0.18	0.183	0.183	0.183	0.182
1958	Wet	NaN	0.41	0.36	0.365	0.365	0.366	0.366
1959	Below Normal	0.14	0.34	0.29	0.289	0.289	0.288	0.289
1960	Dry	NaN	0.27	0.22	0.226	0.227	0.228	0.229
1961	Dry	NaN	0.25	0.23	0.226	0.226	0.227	0.223

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1962	Dry	NaN	0.31	0.27	0.274	0.274	0.273	0.276
1963	Wet	0.2	0.33	0.3	0.299	0.299	0.297	0.299
1964	Dry	0.28	0.23	0.19	0.185	0.185	0.185	0.184
1965	Wet	NaN	0.37	0.34	0.34	0.339	0.338	0.339
1966	Below Normal	0.24	0.3	0.26	0.256	0.256	0.257	0.257
1967	Wet	0.25	0.39	0.35	0.348	0.348	0.347	0.349
1968	Below Normal	NaN	0.34	0.29	0.295	0.295	0.294	0.296
1969	Wet	NaN	0.42	0.39	0.385	0.385	0.385	0.385
1970	Wet	NaN	0.42	0.38	0.383	0.382	0.382	0.382
1971	Wet	0.4	0.33	0.3	0.298	0.298	0.298	0.299
1972	Below Normal	0.17	0.24	0.19	0.19	0.19	0.19	0.19
1973	Above Normal	NaN	0.41	0.38	0.378	0.379	0.379	0.378
1974	Wet	NaN	0.4	0.37	0.363	0.364	0.364	0.364
1975	Above Normal	0.17	0.31	0.27	0.275	0.274	0.273	0.274
1976	Critical	NaN	0.15	0.14	0.133	0.133	0.134	0.134
1977	Critical	NaN	0.11	0.12	0.132	0.123	0.119	0.119
1978	Above Normal	NaN	0.38	0.25	0.3	0.205	0.252	0.261
1979	Dry	0.13	0.3	0.24	0.242	0.242	0.242	0.242
1980	Above Normal	NaN	0.41	0.37	0.372	0.374	0.373	0.375
1981	Dry	NaN	0.25	0.2	0.204	0.203	0.204	0.203
1982	Wet	NaN	0.41	0.37	0.373	0.372	0.373	0.372
1983	Wet	NaN	0.43	0.4	0.404	0.403	0.404	0.404
1984	Wet	NaN	0.35	0.32	0.315	0.315	0.315	0.315
1985	Below Normal	0.32	0.2	0.17	0.165	0.164	0.165	0.165
1986	Wet	NaN	0.37	0.33	0.337	0.337	0.336	0.339
1987	Dry	0.13	0.19	0.18	0.189	0.189	0.189	0.189
1988	Critical	NaN	0.21	0.23	0.232	0.232	0.231	0.232
1989	Dry	NaN	0.16	0.15	0.155	0.155	0.157	0.154
1990	Critical	NaN	0.18	0.17	0.168	0.167	0.168	0.168
1991	Critical	NaN	0.15	0.14	0.149	0.149	0.131	0.132
1992	Critical	NaN	0.24	0.2	0.211	0.212	0.214	0.212
1993	Above Normal	NaN	0.39	0.34	0.347	0.34	0.347	0.348
1994	Critical	NaN	0.22	0.18	0.182	0.182	0.182	0.182

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1995	Wet	NaN	0.4	0.37	0.376	0.376	0.375	0.376
1996	Wet	0.29	0.4	0.35	0.352	0.352	0.352	0.352
1997	Wet	NaN	0.41	0.38	0.373	0.373	0.373	0.373
1998	Wet	0.23	0.43	0.4	0.4	0.399	0.4	0.4
1999	Wet	0.24	0.38	0.35	0.349	0.349	0.35	0.35
2000	Above Normal	NaN	0.38	0.31	0.314	0.315	0.315	0.315
2001	Dry	NaN	0.23	0.2	0.199	0.199	0.199	0.2
2002	Below Normal	NaN	0.3	0.27	0.274	0.274	0.275	0.275
2003	Above Normal	NaN	0.33	0.3	0.297	0.296	0.297	0.297
2004	Above Normal	NaN	0.38	0.34	0.343	0.344	0.343	0.344
2005	Below Normal	NaN	0.31	0.26	0.259	0.259	0.26	0.259
2006	Wet	NaN	0.4	0.37	0.368	0.368	0.368	0.368
2007	Below Normal	NaN	0.25	0.2	0.199	0.199	0.2	0.199
2008	Dry	NaN	0.26	0.23	0.23	0.23	0.23	0.23
2009	Dry	NaN	0.23	0.17	0.192	0.192	0.192	0.192
2010	Below Normal	NaN	0.33	0.25	0.274	0.274	0.275	0.28
2011	Wet	NaN	0.32	0.28	0.28	0.28	0.279	0.28
2012	Below Normal	NaN	0.18	0.16	0.161	0.161	0.161	0.161
2013	Dry	NaN	0.22	0.23	0.227	0.227	0.228	0.227
2014	Critical	NaN	0.16	0.14	0.145	0.145	0.146	0.144
2015	Critical	NaN	0.19	0.26	0.167	0.172	0.176	0.17
2016	Below Normal	NaN	0.28	0.24	0.265	0.142	0.135	0.146
2017	Wet	NaN	0.44	0.4	0.408	0.405	0.405	0.404
2018	Below Normal	0.18	0.22	0.18	0.183	0.181	0.181	0.181
2019	Wet	NaN	0.37	0.32	0.315	0.314	0.313	0.312
2020	Dry	NaN	0.2	0.17	0.164	0.164	0.163	0.164
2021	Critical	NaN	0.15	0.14	0.133	0.133	0.138	0.14

NaN = Not a number

F.5.3.2.5 Female escapement

Highest mean predicted female escapement survival of winter-run Chinook salmon occurred under Alt2 With TUCP Without VA of Below Normal water years (4,096), followed by Above Normal water years under Alt2 With TUCP Without VA (3,969). The lowest mean predicted female escapement survival of winter-run Chinook salmon occurred under NAA of Critical water years (2,132) followed by Critical water years under Alt2 Without TUCP Without VA (2,136) (Figure F.5-24 and Table F.5-22).

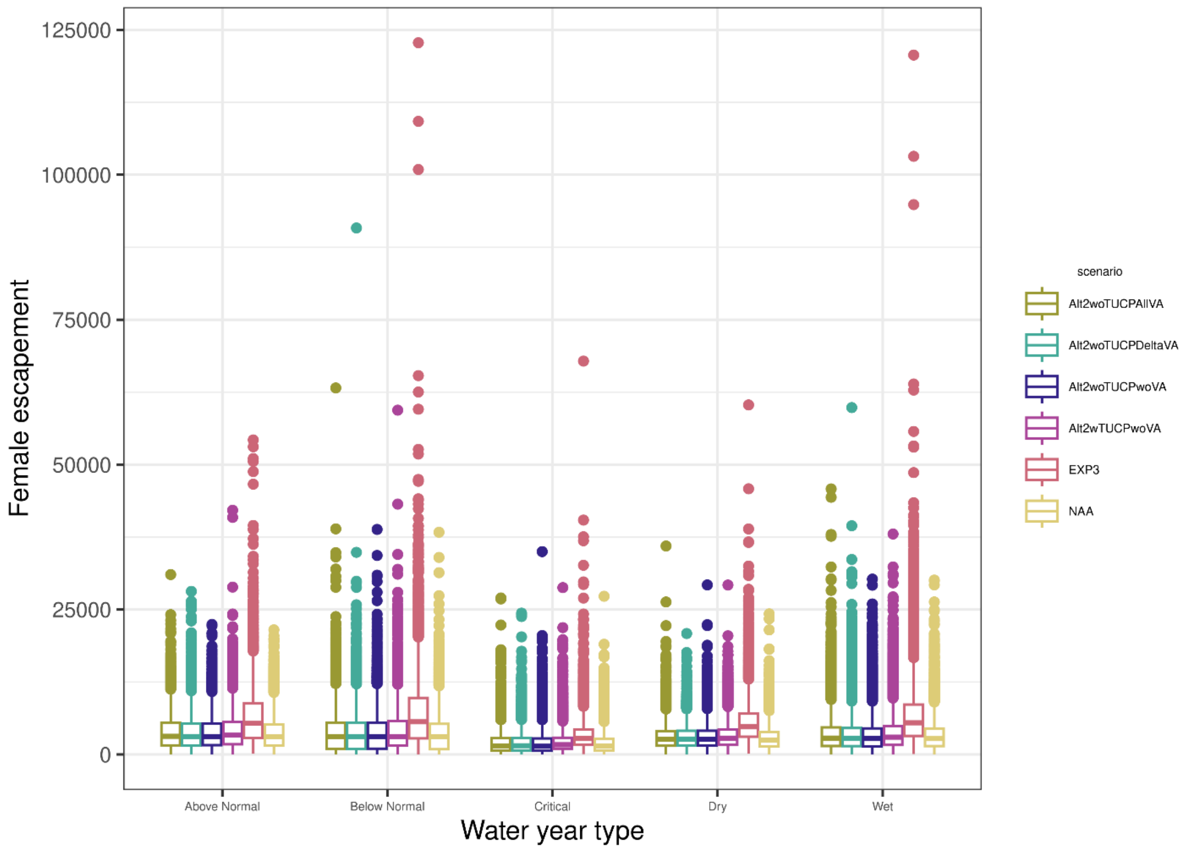


Figure F.5-24. Boxplots showing predicted winter-run Chinook female escapement by water year type.

Table F.5-22. Predicted mean winter-run Chinook female escapement by water year type.

Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
Above Normal	0	6241	3753	3969	3807	3755	3809
Below Normal	173	6832	3665	4096	3821	3672	3776
Critical	391	3445	2132	2329	2136	2136	2169
Dry	2	5448	2888	3177	3031	2953	2980
Wet	0	6518	3490	3732	3510	3466	3469

Mean annual predicted female escapement survival of winter-run Chinook salmon was highest under Alt2 Without TUCP Without VA in 1975 (9,651), followed by Alt2 With TUCP Without

VA in 1975 (9,474). The mean annual predicted female escapement survival of winter-run Chinook salmon was lowest under NAA in 2017 (50) followed by NAA in 1936 (73). Across the entire time period mean annual predicted female escapement survival for winter-run Chinook salmon was 3,285 (Figure F.5-25 and Table F.5-23).

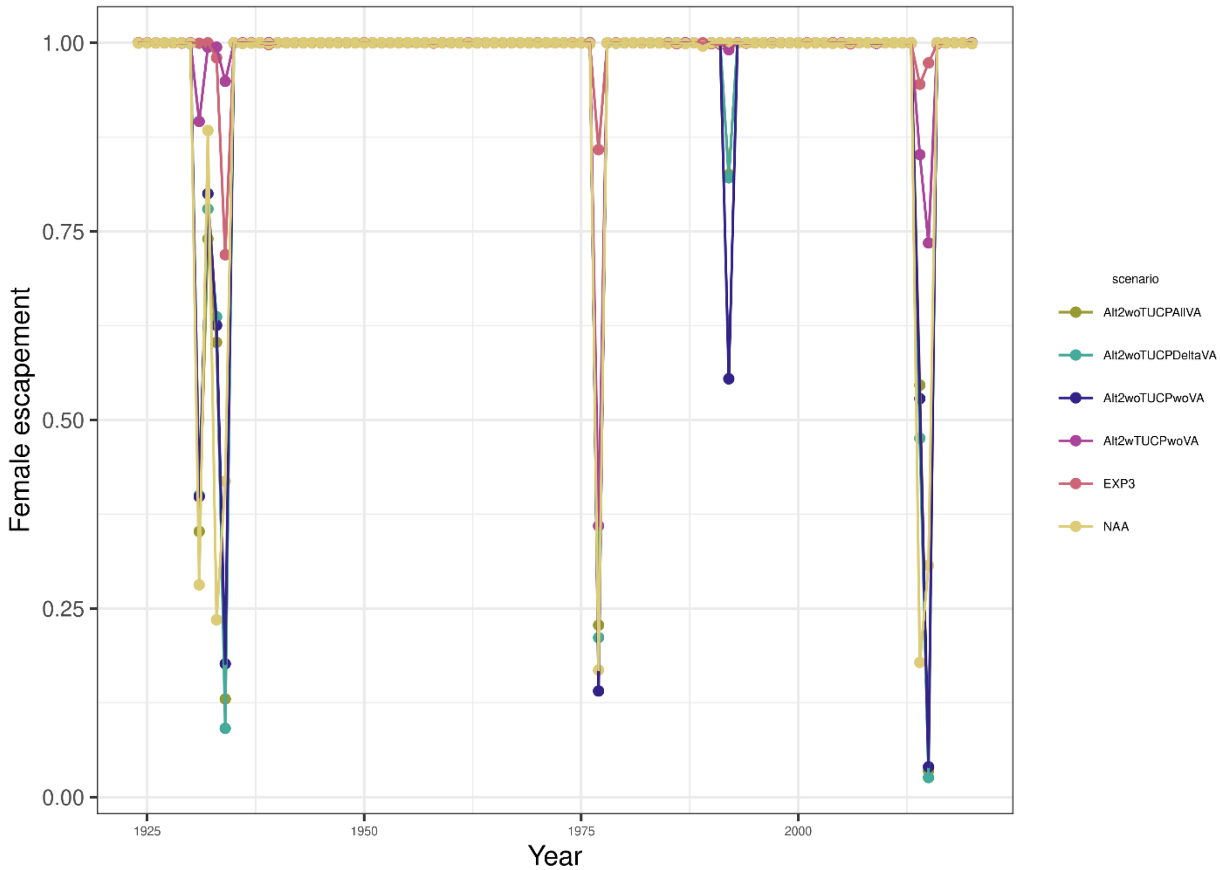


Figure F.5-25. Predicted mean annual winter-run Chinook female escapement.

Table F.5-23. Predicted mean annual winter-run Chinook female escapement.

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1924	Below Normal	3087	3087	3087	3087	3087	3087	3087
1925	Critical	5866	6122	6101	6093	6101	6092	6100
1926	Dry	53	2467	2218	2229	2276	2213	2279
1927	Dry	0	4836	4023	4509	4437	4400	4488
1928	Wet	0	3288	2452	2757	2678	2607	2727
1929	Above Normal	0	6380	4257	5297	5250	4984	5464

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1930	Critical	0	3389	2188	2383	2358	2255	2417
1931	Dry	0	3597	2414	2766	2781	2721	2810
1932	Critical	0	3280	1889	1971	2017	1965	2030
1933	Critical	0	2140	1177	1402	1341	1353	1366
1934	Critical	0	2562	239	1228	354	338	293
1935	Critical	0	1503	417	900	424	400	381
1936	Below Normal	0	1436	73	922	198	213	181
1937	Below Normal	0	996	274	1003	158	131	138
1938	Below Normal	0	2206	977	1621	1033	965	979
1939	Wet	0	1797	971	1487	980	940	883
1940	Dry	0	3523	1766	2576	1947	1845	1829
1941	Above Normal	0	1650	956	1253	998	929	941
1942	Wet	0	4680	2298	3133	2583	2407	2439
1943	Wet	0	4136	2527	3007	2693	2727	2534
1944	Wet	0	7391	4050	5034	4400	4288	4306
1945	Dry	0	6112	3784	4016	3966	3874	3648
1946	Dry	0	5234	2756	3379	3036	2933	2955
1947	Below Normal	0	5907	2919	3586	3396	3444	3240
1948	Dry	0	5907	3255	3817	3376	3334	3350
1949	Dry	0	3520	1911	2155	2127	2081	2038
1950	Dry	0	3197	1737	2134	1886	1739	1852
1951	Dry	0	2437	1386	1507	1509	1381	1420
1952	Above Normal	0	3727	2059	2313	2206	2022	2129
1953	Wet	0	4608	2705	2858	2916	2671	2892
1954	Above Normal	0	6526	3754	3992	4011	3702	3790
1955	Above Normal	0	7106	3986	4055	4199	4041	4166
1956	Dry	0	7540	3976	4186	4226	4016	4004
1957	Wet	0	5668	2981	3032	3165	3012	3000
1958	Below Normal	0	11851	6524	6943	7008	6535	6812
1959	Wet	0	5858	2717	2948	3002	2856	2850
1960	Below Normal	0	13187	7659	8101	8222	7295	7746
1961	Dry	0	7164	3369	3463	3617	3405	3500
1962	Dry	0	7868	4561	4803	4957	4634	4615

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1963	Dry	0	5697	2935	3078	3156	2948	2913
1964	Wet	0	7124	4058	4251	4470	4120	3896
1965	Dry	0	6156	3199	3319	3517	3083	3178
1966	Wet	0	5623	2830	3030	3129	2873	2769
1967	Below Normal	0	8507	4596	4813	4989	4490	4677
1968	Wet	0	6483	3237	3493	3512	3280	3295
1969	Below Normal	0	10007	5477	5940	5870	5293	5584
1970	Wet	0	8185	4073	4297	4407	4218	4156
1971	Wet	0	15007	8676	8835	8836	8539	8582
1972	Wet	3	14206	8111	8353	8486	7926	8183
1973	Below Normal	26	11991	7801	8031	7912	7587	7650
1974	Above Normal	0	8330	4894	4973	5221	5017	4985
1975	Wet	0	13746	9116	9474	9651	9278	9472
1976	Above Normal	0	13008	7955	8122	8311	8365	8158
1977	Critical	0	9713	6581	6495	6524	6375	6470
1978	Critical	0	4559	3133	3223	3128	3048	3146
1979	Above Normal	0	2977	2048	2350	2171	2083	2005
1980	Dry	0	4099	381	690	325	385	388
1981	Above Normal	0	3708	1828	2074	1901	1921	1756
1982	Dry	0	6310	1473	1839	1559	1599	1574
1983	Wet	0	4195	1680	1836	1739	1735	1646
1984	Wet	0	9749	2845	3284	2915	3012	2980
1985	Wet	0	8132	3523	3800	3435	3493	3593
1986	Below Normal	0	10406	3531	4013	3601	3721	3696
1987	Wet	0	5659	2380	2472	2342	2398	2452
1988	Dry	0	9568	4074	4430	4020	4315	4203
1989	Critical	0	3842	1875	2064	1944	1952	2015
1990	Dry	0	5137	3071	3256	3082	3142	3092
1991	Critical	0	2275	1202	1370	1274	1273	1300
1992	Critical	0	2618	1716	1841	1722	1768	1714
1993	Critical	0	1380	879	1011	931	853	841
1994	Above Normal	0	2307	1357	1497	1287	1419	1315
1995	Critical	0	2305	1509	1510	573	980	1006

Water Year	Water Year Type	EXP1	EXP3	NAA	Alt2 wTUCP woVA	Alt2 woTUCP woVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1996	Wet	0	2337	1315	1324	1150	1246	1230
1997	Wet	0	4354	2772	2658	1835	2248	2249
1998	Wet	0	4406	2763	2519	2219	2486	2371
1999	Wet	0	7951	5179	4889	3745	4428	4214
2000	Wet	1	8501	5048	4890	4330	4659	4577
2001	Above Normal	0	9464	6269	6017	4830	5428	5416
2002	Dry	0	9003	4991	5001	4676	4774	4981
2003	Below Normal	0	6214	3955	3817	3324	3586	3664
2004	Above Normal	0	8359	4689	4816	4702	4565	4862
2005	Above Normal	0	7599	4737	4839	4408	4342	4532
2006	Below Normal	0	9176	5491	5761	5453	5439	5725
2007	Wet	0	7871	4647	4696	4600	4429	4599
2008	Below Normal	0	11984	7296	7819	7434	7280	7472
2009	Dry	0	6249	3492	3552	3367	3280	3474
2010	Dry	0	6752	4752	4935	4812	4714	4678
2011	Below Normal	0	4967	2328	2657	2635	2583	2650
2012	Wet	0	7233	3757	4231	4106	4237	4177
2013	Below Normal	0	5645	2723	2840	2768	2820	2809
2014	Dry	0	3948	2075	2321	2253	2323	2245
2015	Critical	0	3875	2104	2238	2272	2283	2307
2016	Critical	0	2112	963	1202	1072	1111	1142
2017	Below Normal	0	1752	50	760	267	235	300
2018	Wet	0	2036	241	825	200	194	218
2019	Below Normal	0	3669	1215	2011	1429	1395	1553
2020	Wet	0	2311	766	1090	763	747	832
2021	Dry	0	4436	1723	2286	1827	1739	1993

F.5.4 References

Bartholow, J. M., and J. Heasley. 2006. *Evaluation of Shasta Dam Scenarios Using a Salmon Population Model.* Administrative Report. August. Fort Collins, CO. Prepared for U.S. Geological Survey, Reston, VA.

Beacham, T. D., and C. B. Murray. 1989. Variation in Developmental Biology of Sockeye Salmon (*Oncorhynchus nerka*) and Chinook Salmon (*Oncorhynchus tshawytscha*) in British Columbia. *Canadian Journal of Zoology* 67:2081–2089.

Grover, A., A. Low, P. Ward, J. Smith, M. Mohr, D. Viele, and C. Tracy. 2004. *Recommendations for Developing Fishery Management Plan Conservation Objectives for Sacramento River Spring Chinook.* Sacramento, CA. Available: http://www.pcouncil.org/bb/2004/0304/exc7.pdf. Accessed: November 16, 2011.

Jennings, E.D. and Hendrix, A.N., 2020. Spawn timing of winter-run chinook salmon in the upper Sacramento River. San Francisco Estuary and Watershed Science, 18(2).

Murray, C. B., and J. D. McPhail. 1988. Effect of Incubation Temperature on the Development of Five Species of Pacific Salmon (*Oncorhynchus*) Embryos and Alevins. *Canadian Journal of Zoology* 66(1):266–273.

Poytress, W. R., and F. D. Carillo. 2010. *Brood-Year 2007 Winter Chinook Juvenile Production Indices with Comparisons to Juvenile Production Estimates Derived from Adult Escapement.* Final Annual Report 2007. Grant Number P0685507. May. Red Bluff, CA. Prepared for California Department of Fish and Game, Sacramento, CA, and California Bay Delta Authority, Sacramento, CA. Prepared by U.S. Fish and Wildlife Service, Red Bluff, CA.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. *Fisheries Research Board of Canada, Bulletin* 191:265–296.

Snider, B., B. Reavis, and S. Hill. 2001. *Upper Sacramento River Winter-Run Chinook Salmon Escapement Survey, May-August 2000.* Stream Evaluation Program Technical Report No. 01-1. April. Sacramento, CA. Prepared by California Department of Fish and Game, Habitat Conservation Division, Sacramento, CA.

U.S. Fish and Wildlife Service. 1999. *Effects of Temperature on Early-Life Survival of Sacramento River Fall-Run and Winter-Run Chinook Salmon.* Final Report. Shepherdstown, WV.

Wells, B. K., C. B. Grimes, and J. B. Waldvogel. 2007. Quantifying the Effects of Wind, Upwelling, Curl, Sea Surface Temperature and Sea Level Height on Growth and Maturation of a California Chinook Salmon (*Oncorhynchus tshawytscha*). *Fisheries Oceanography* 16:363–382.

Zeug, S., P. Bergman, B. Cavallo, and K. Jones. 2012. *Application of a Life Cycle Simulation Model to Evaluate Impacts of Water Management and Conservation Actions on an Endangered Population of Chinook Salmon.* Environmental Modeling and Assessment. DOI 10.1007/s10666-012-9306-6.

F.5.4.1 Personal Communications

Niemela, Kevin pers. comm.