Appendix 9L

Junction Entrainment Analysis Documentation

This appendix provides information about the junction entrainment analysis methods and assumptions used for the Remanded Biological Opinions on the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) Environmental Impact Statement (EIS) analysis and pertinent results. This appendix is organized in two main sections:

- Section 9L.1: Methodology and Assumptions
  - The junction entrainment analysis uses the statistical relationship published in Cavallo et al. (2015) to predict the fish routing based on the proportion of flow moving through channel junctions in the Delta. This section briefly describes the approach and assumptions of the junction entrainment analysis.
- Section 9L.2: Results
  - This section presents the junction entrainment analysis results. Results are presented in a series of figures showing the probability of fish entrainment at various junctions in the Delta.

9L.1 Methodology and Assumptions

9L.1.1 Methodology

In this analysis, predicted entrainment into a distributary was based on 15-minute flow output from DSM2 over the 82-year simulation period following the statistical relationship reported in Cavallo et al. (2015). In that analysis, the proportion of acoustically tagged juvenile Chinook Salmon entrained in a distributary at seven junctions in the Delta was regressed against the proportion of flow into the distributary. The releases of tagged juvenile Chinook Salmon included fall- and late-fall-run fish.

The probability of fish entrainment was predicted at five Delta junctions: Georgiana Slough, Head of Old River, Turner Cut, Columbia Cut, and Middle River. Using the proportion of flow entering the distributary for every 15-minute observation in the 82-year simulation period, the mean daily proportion of flow into the distributary was calculated. The mean daily flow proportion was then used to calculate the predicted daily probability of fish entrainment.

9L.1.2 Scenario Assumptions

The junction entrainment analysis includes the following assumptions.

- The entrainment analysis is applicable to spring- and winter-run Chinook Salmon even though only fall- and late-fall-run Chinook Salmon were used to construct the statistical model.
- Hatchery fish used in the tagging studies behave similarly to natural-origin fish when migrating through channel junctions.
- The proportion of flow into a distributary could not exceed one.
- When flow was entering a junction from the distributary, the proportion of flow into the distributary was set to zero.

9L.2 Results

The following scenario comparisons are presented as box-whiskers plots[1] (Figures 9L.1 through 9L.30), comparing the probability of fish entrainment at various junctions:

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 3 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the No Action Alternative
- Alternative 5 compared to the Second Basis of Comparison

Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented separately. Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented separately.

The EIS impact analysis starts with use of the monthly CalSim II model to project CVP and SWP water deliveries. Because this regional model uses monthly time steps to simulate requirements that change weekly or change through observations, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing. Therefore, reductions of 5 percent or less in this comparative analysis are considered to be not substantially different, or "similar."

9L.3 Reference

Cavallo, B., P. Gaskill, J. Melgo, and S.C. Zeug. 2015. "Predicting juvenile Chinook Salmon routing in riverine and tidal channels of a freshwater estuary" 98:1571-1582.

[1] The box represents 25th and 75th percentiles, the line represents the median, and whiskers represent minimum and maximum (excluding the outliers). The outliers are defined as data points outside of 1.5 times the length of the box away from the box and are represented in points.

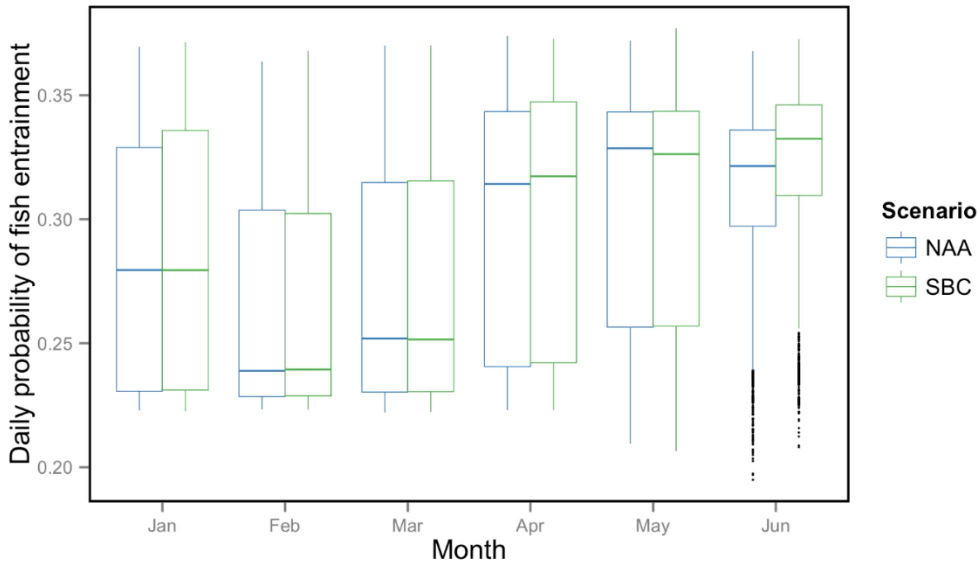


Figure 9L.1 Probability of Fish Entrainment into Georgiana Slough under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

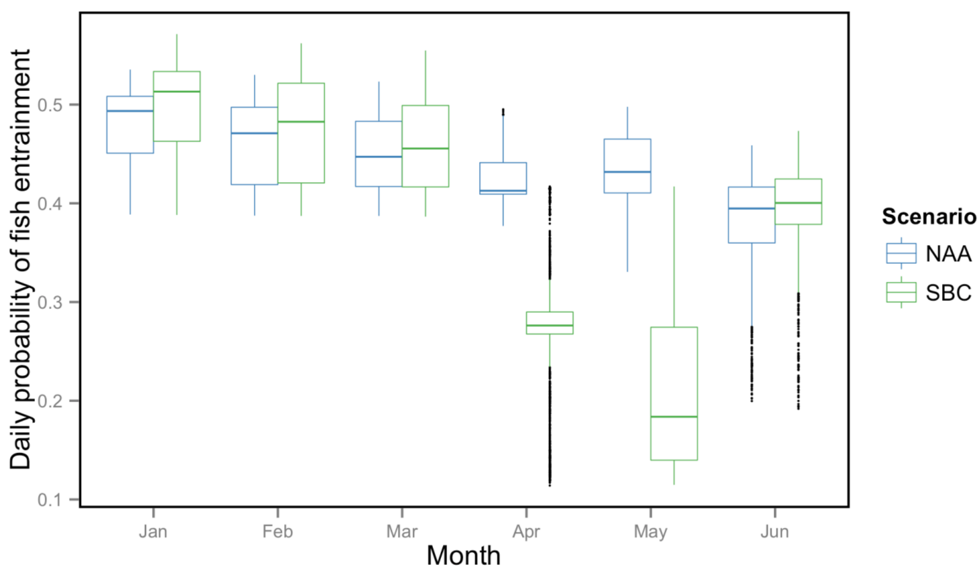


Figure 9L.2 Probability of Fish Entrainment into Head of Old River under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

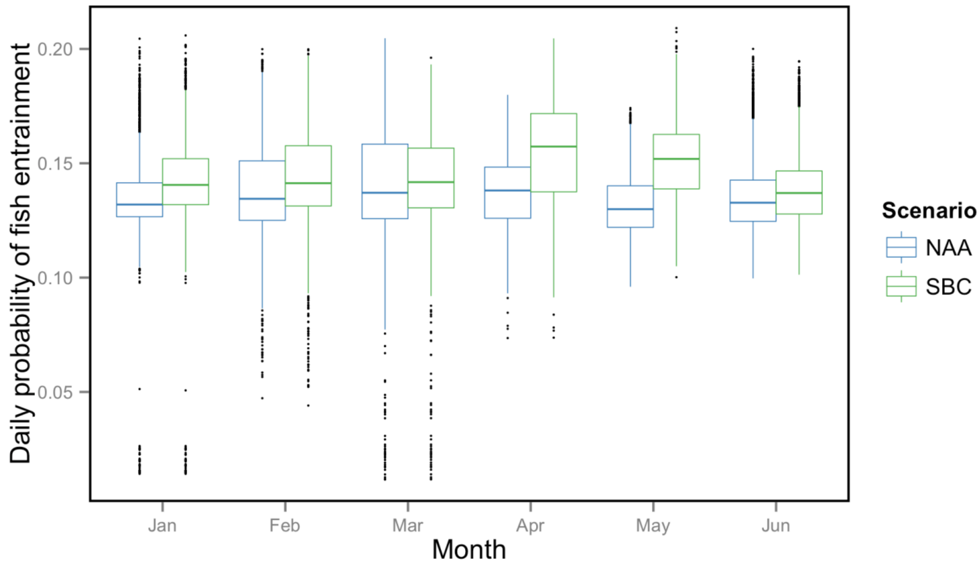


Figure 9L.3 Probability of Fish Entrainment into Turner Cut under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

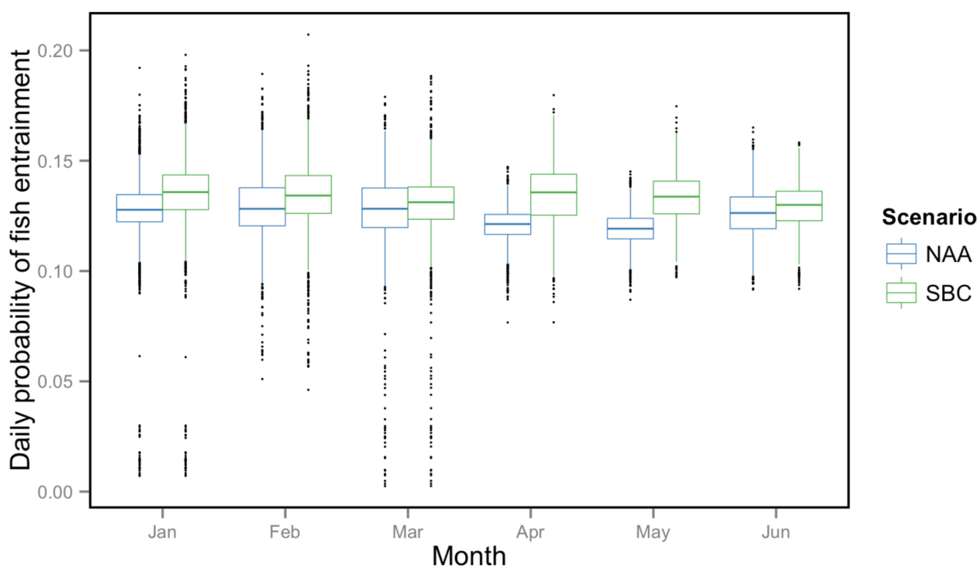


Figure 9L.4 Probability of Fish Entrainment into Columbia Cut under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

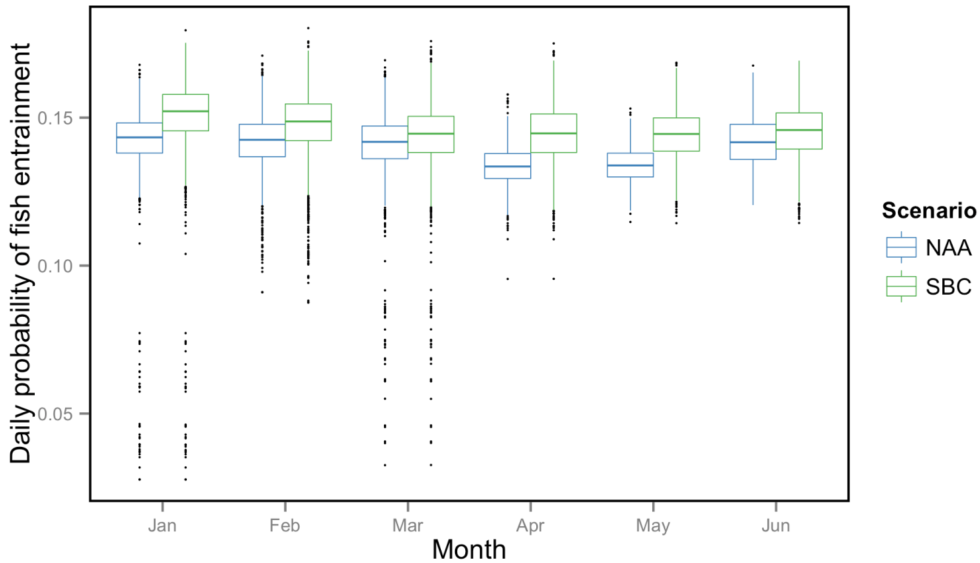


Figure 9L.5 Probability of Fish Entrainment into Middle River under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

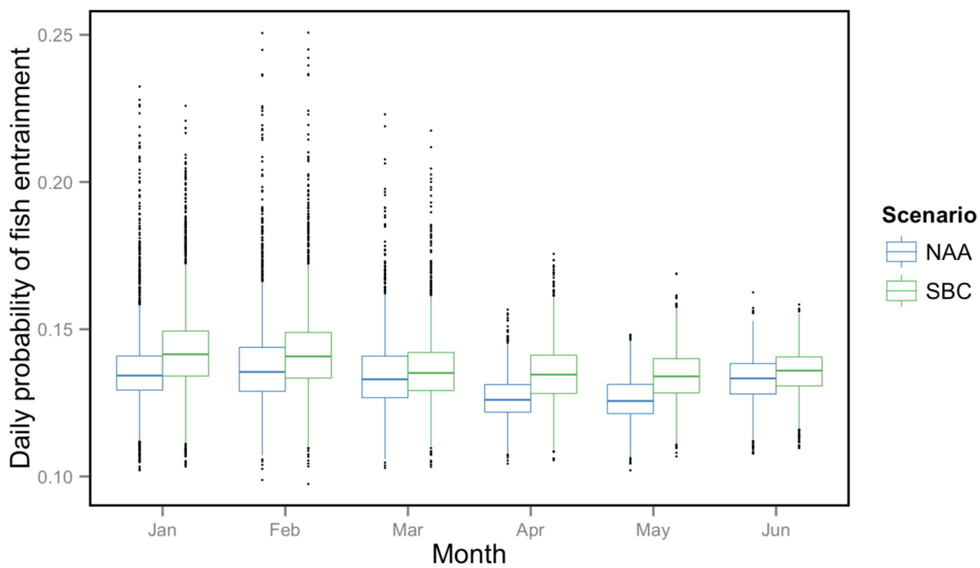


Figure 9L.6 Probability of Fish Entrainment into Old River under the No Action Alternative (NAA) compared to the Second Basis of Comparison (SBC)

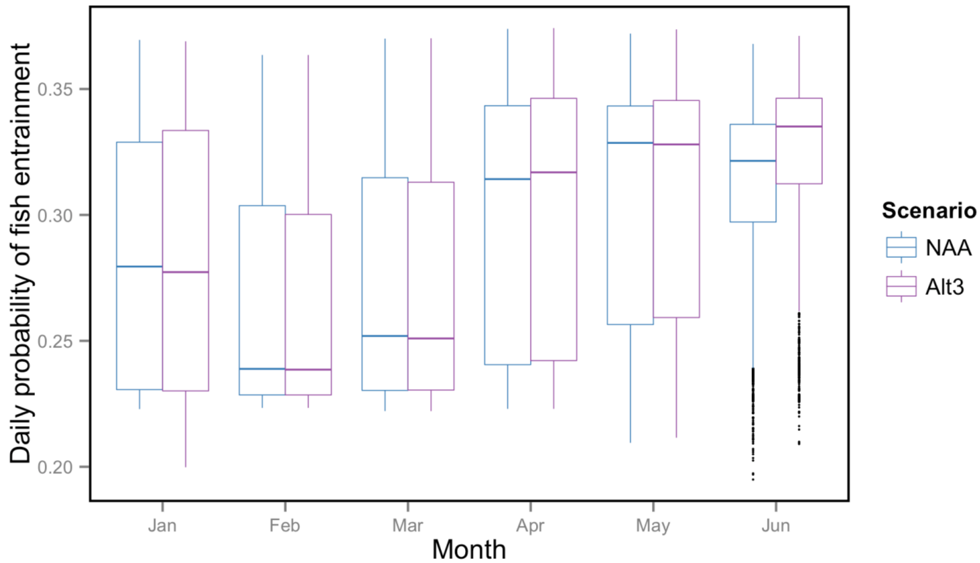


Figure 9L.7 Probability of Fish Entrainment into Georgiana Slough under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

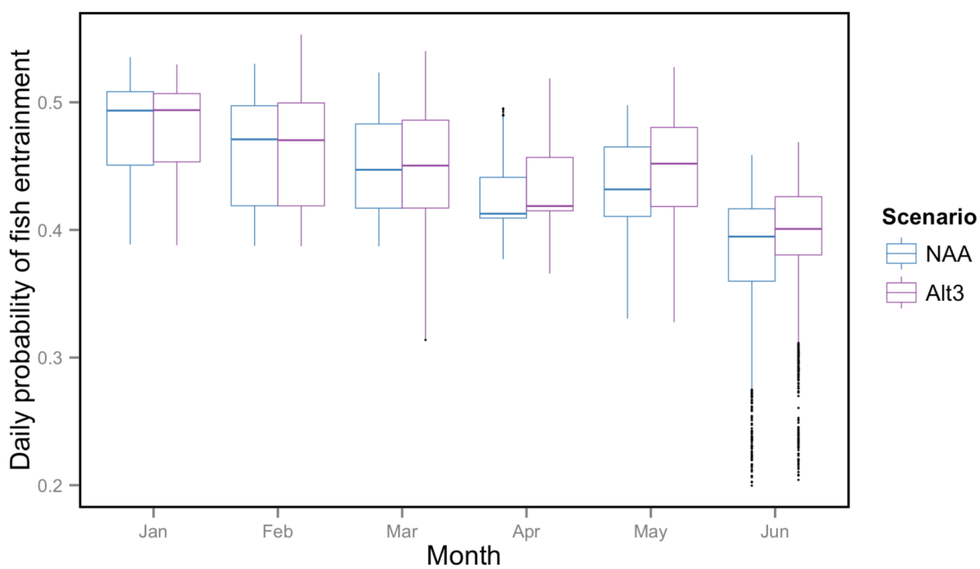


Figure 9L.8 Probability of Fish Entrainment into Head of Old River under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

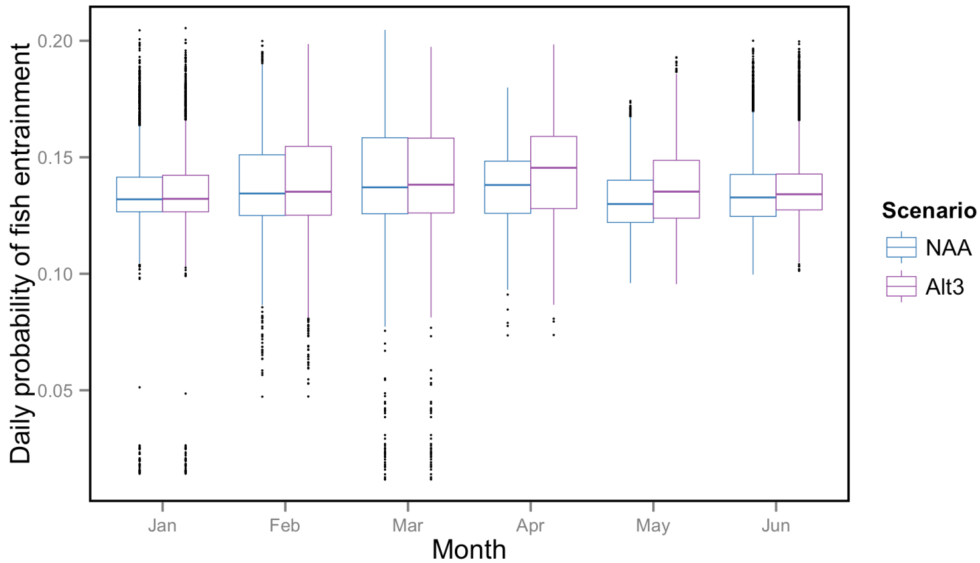


Figure 9L.9 Probability of Fish Entrainment into Turner Cut under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

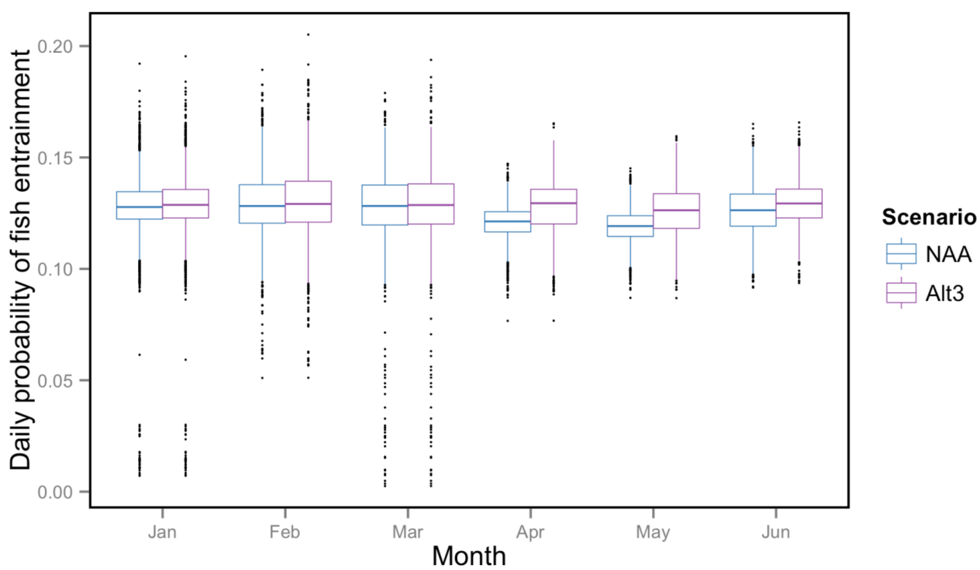


Figure 9L.10 Probability of Fish Entrainment into Columbia Cut under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

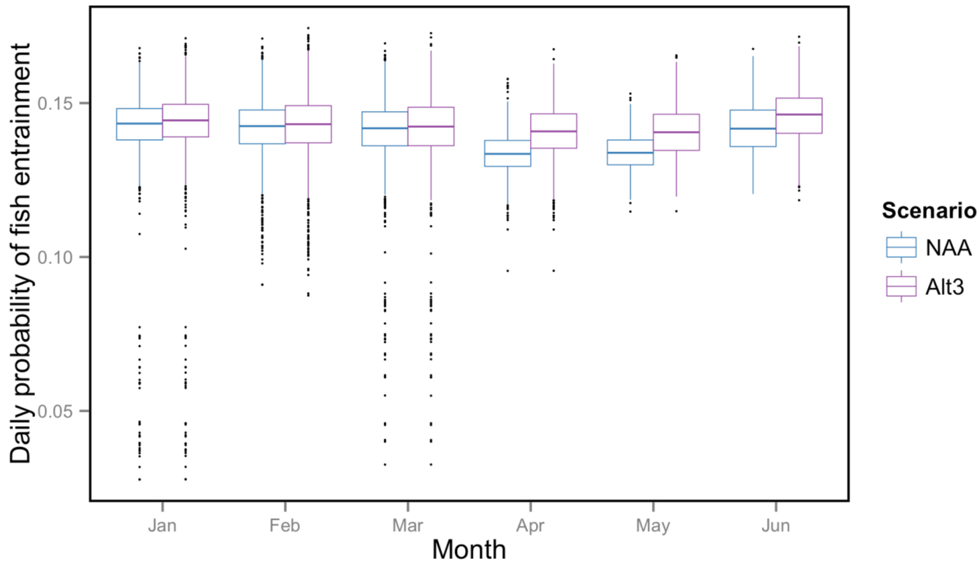


Figure 9L.11 Probability of Fish Entrainment into Middle River under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

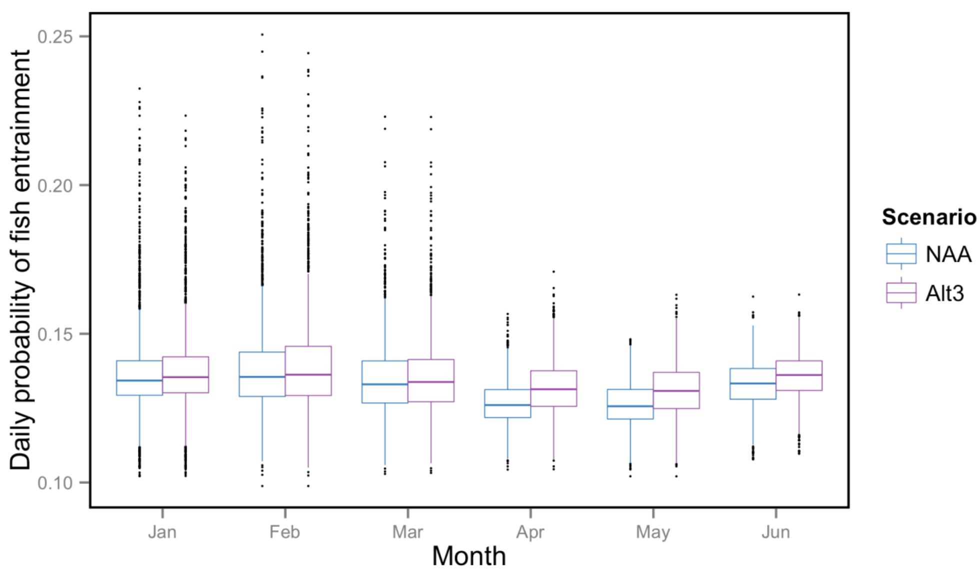


Figure 9L.12 Probability of Fish Entrainment into Old River under Alternative 3 (Alt 3) as compared to the No Action Alternative (NAA)

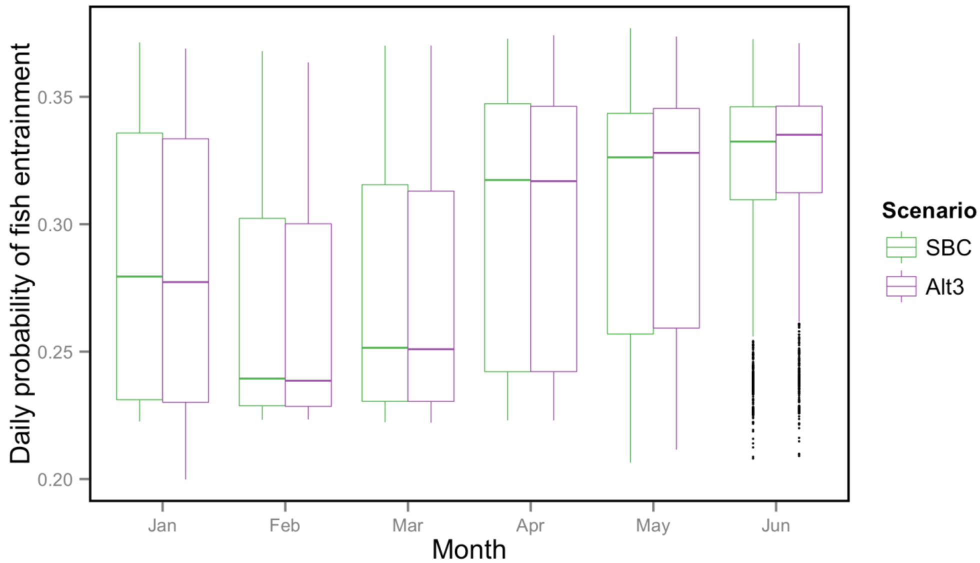


Figure 9L.13 Probability of Fish Entrainment into Georgiana Slough under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

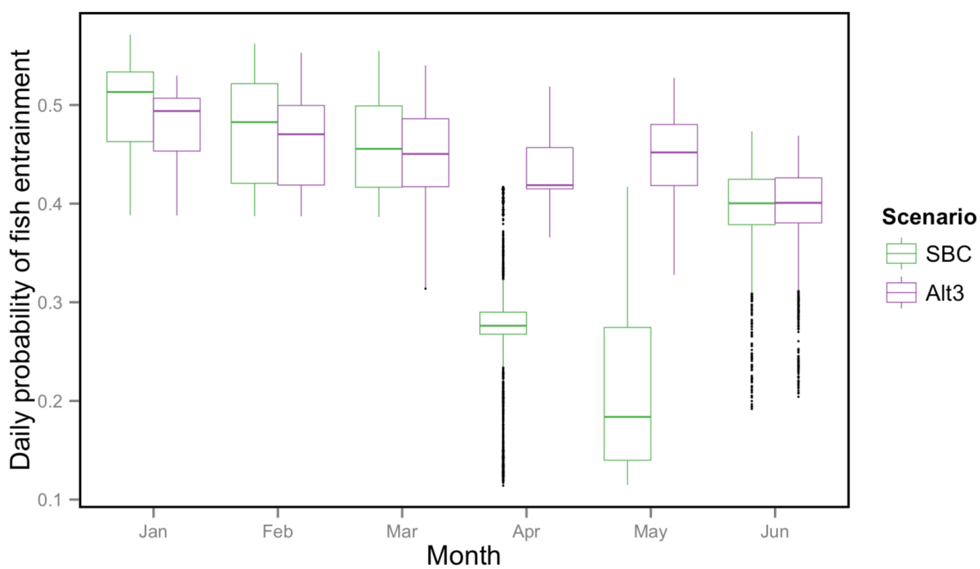


Figure 9L.14 Probability of Fish Entrainment into Head of Old River under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

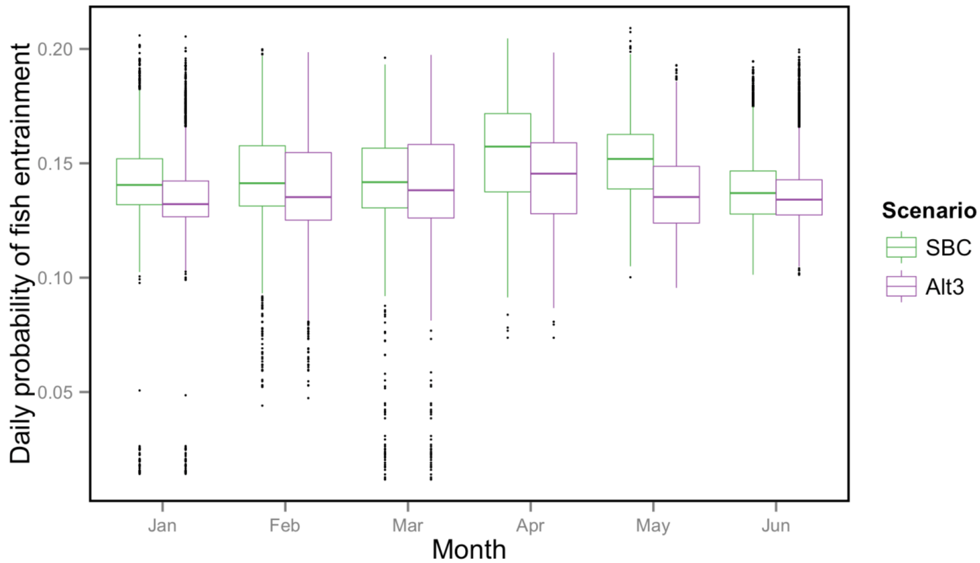


Figure 9L.15 Probability of Fish Entrainment into Turner Cut under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

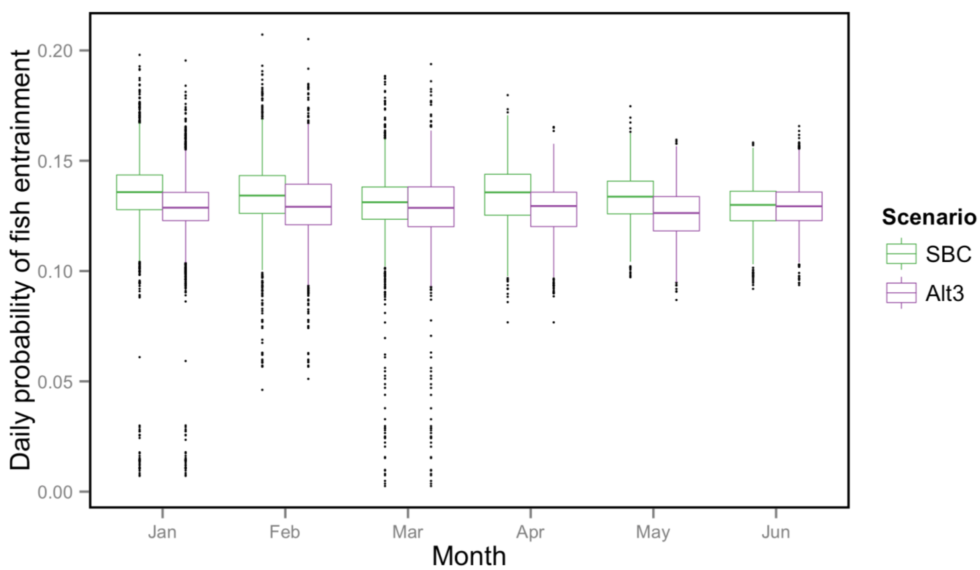


Figure 9L.16 Probability of Fish Entrainment into Columbia Cut under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

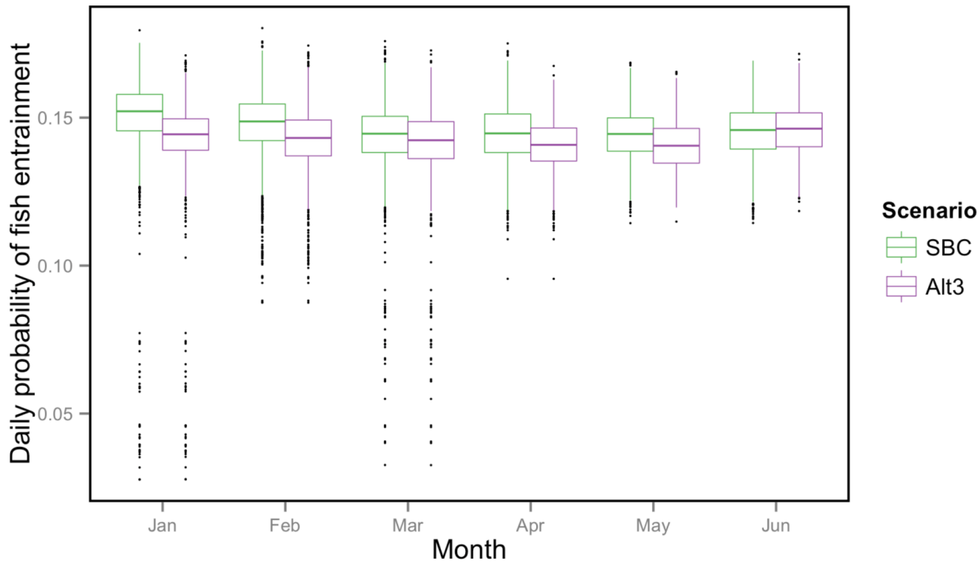


Figure 9L.17 Probability of Fish Entrainment into Middle River under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

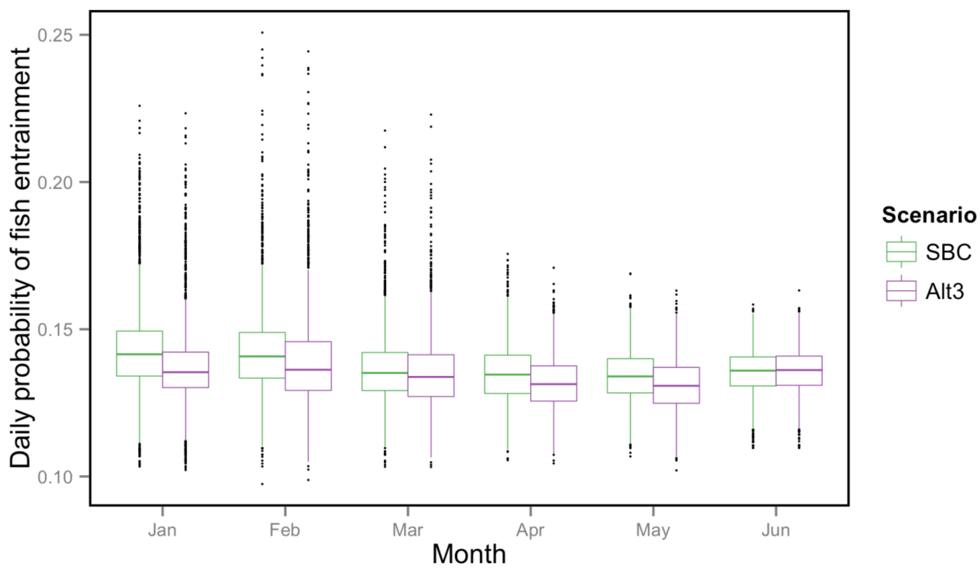


Figure 9L.18 Probability of Fish Entrainment into Old River under Alternative 3 (Alt 3) as compared to the Second Basis of Comparison (SBC)

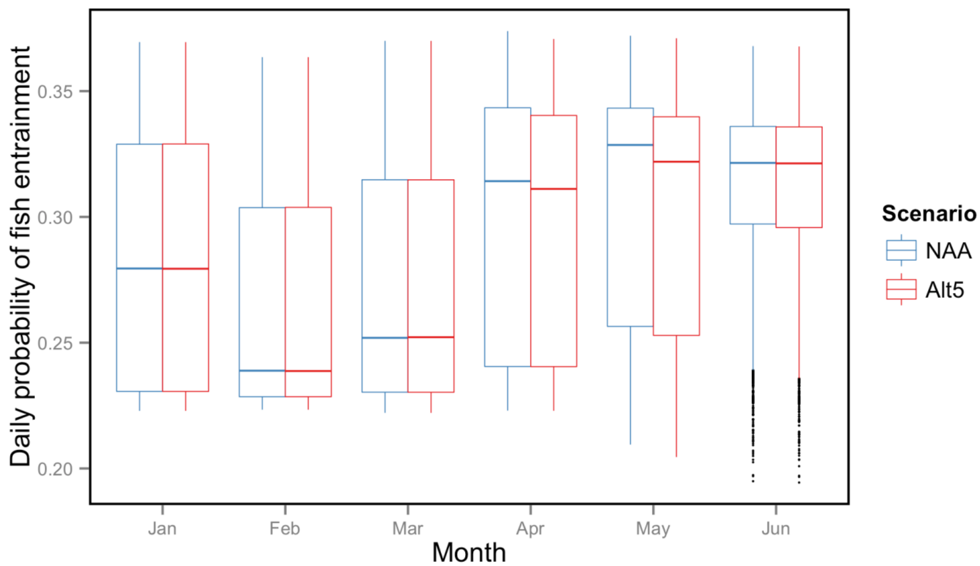


Figure 9L.19 Probability of Fish Entrainment into Georgiana Slough under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

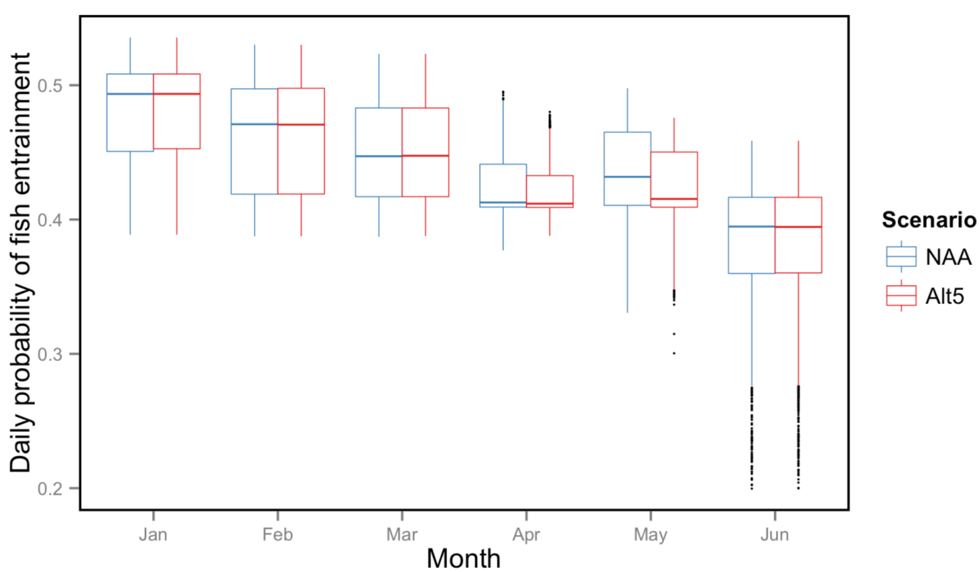


Figure 9L.20 Probability of Fish Entrainment into Head of Old River under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

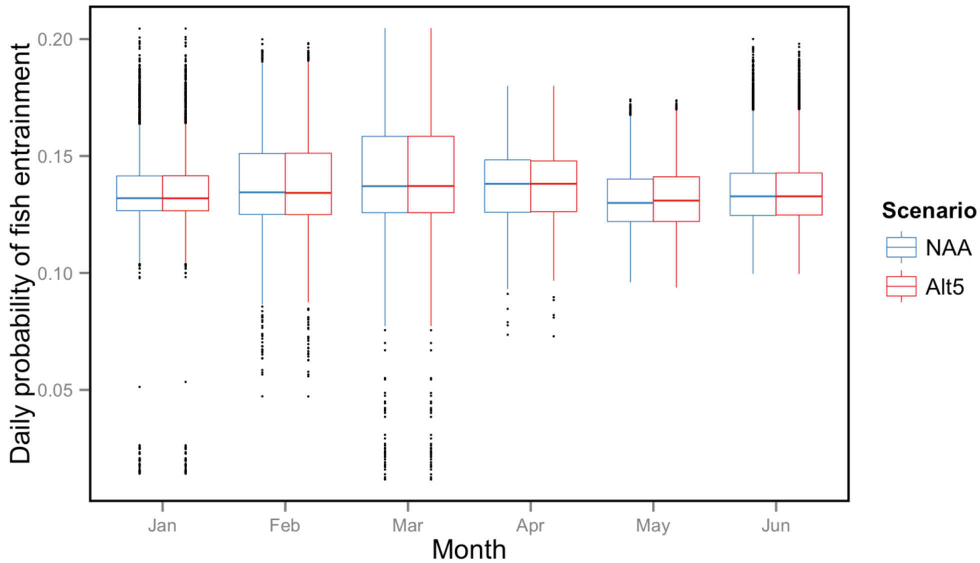


Figure 9L.21 Probability of Fish Entrainment into Turner Cut under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

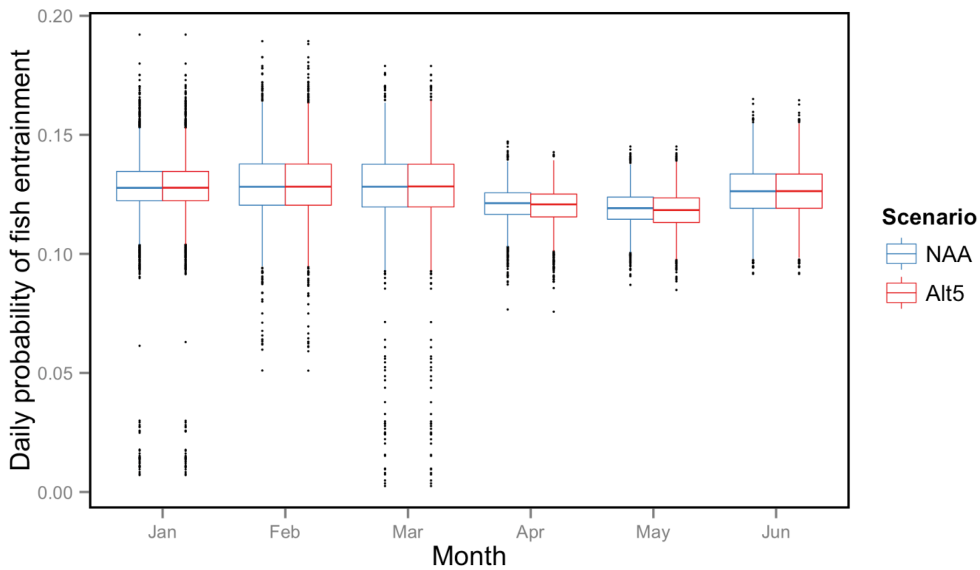


Figure 9L.22 Probability of Fish Entrainment into Columbia Cut under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

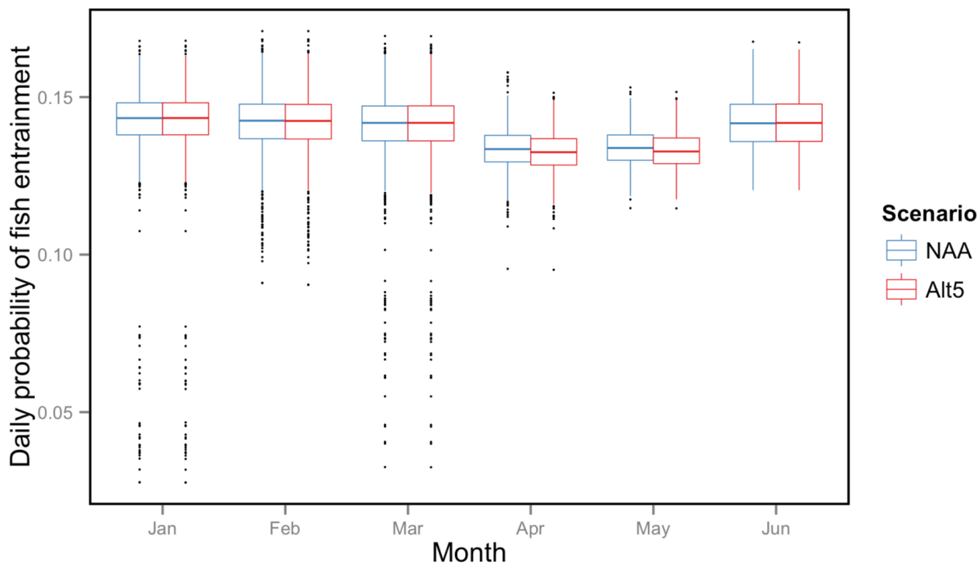


Figure 9L.23 Probability of Fish Entrainment into Middle River under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

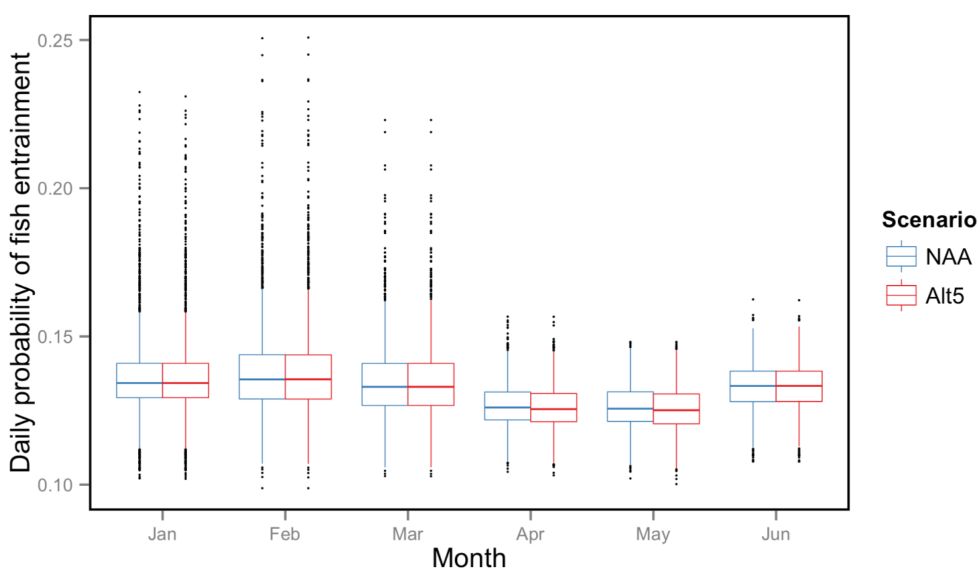


Figure 9L.24 Probability of Fish Entrainment into Old River under Alternative 5 (Alt 5) as compared to the No Action Alternative (NAA)

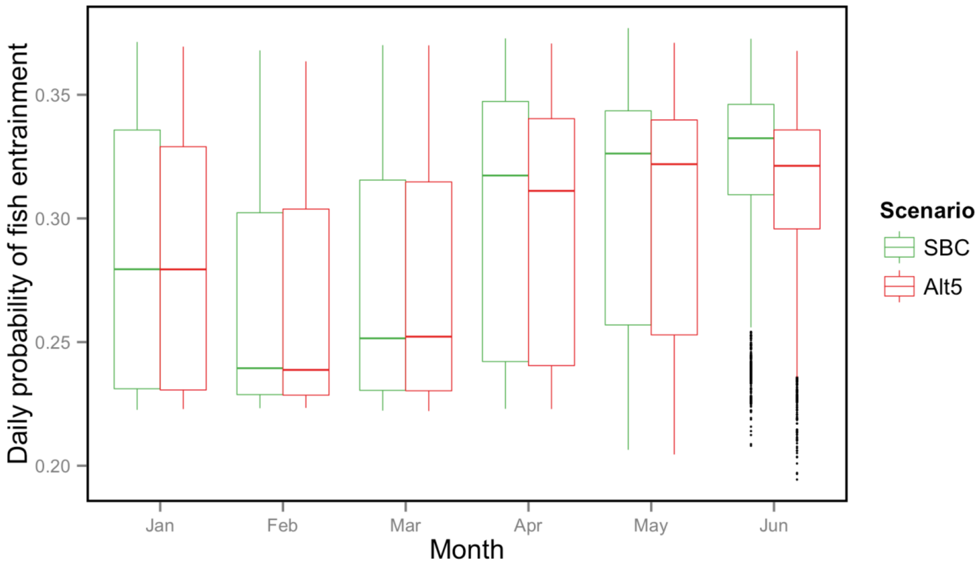


Figure 9L.25 Probability of Fish Entrainment into Georgiana Slough under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

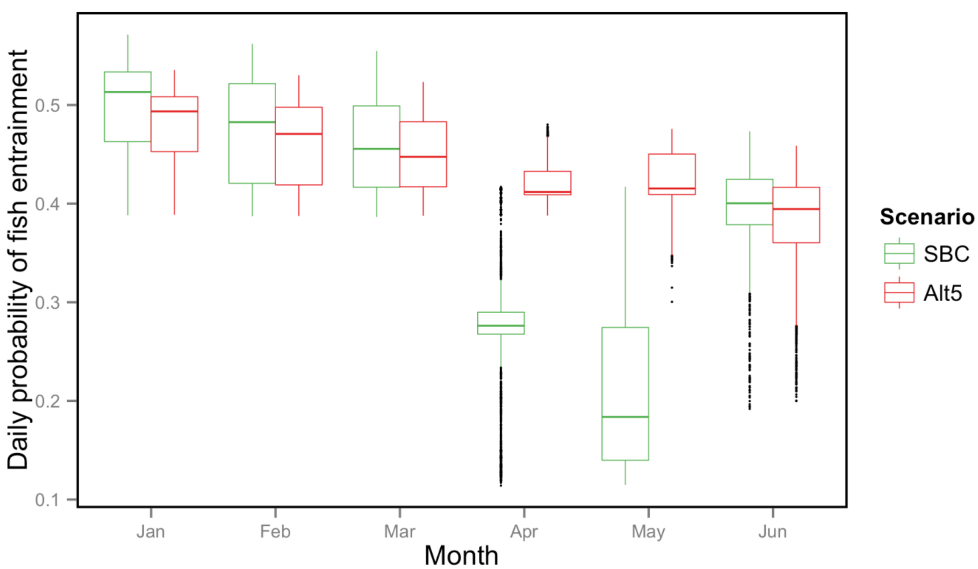


Figure 9L.26 Probability of Fish Entrainment into Head of Old River under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

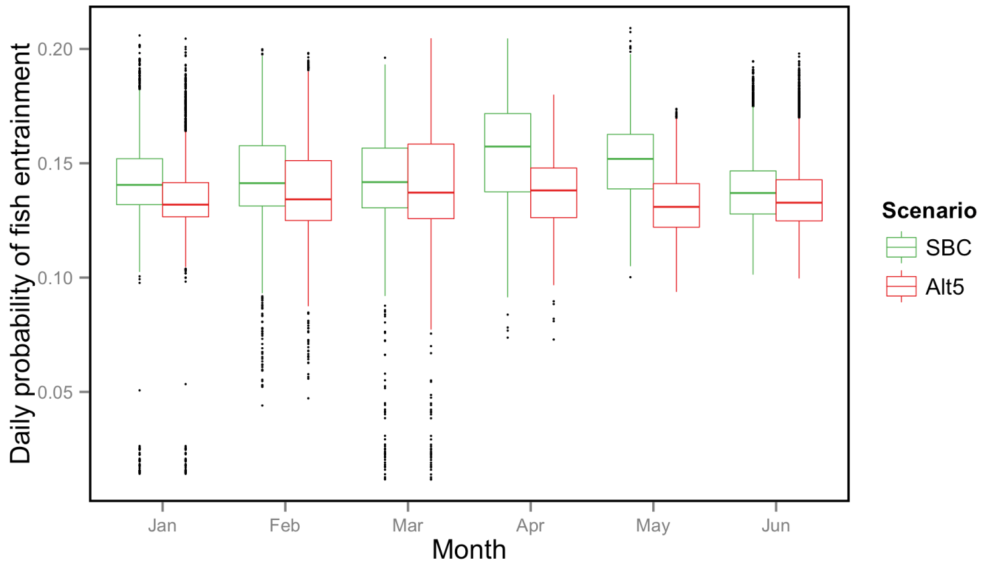


Figure 9L.27 Probability of Fish Entrainment into Turner Cut under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

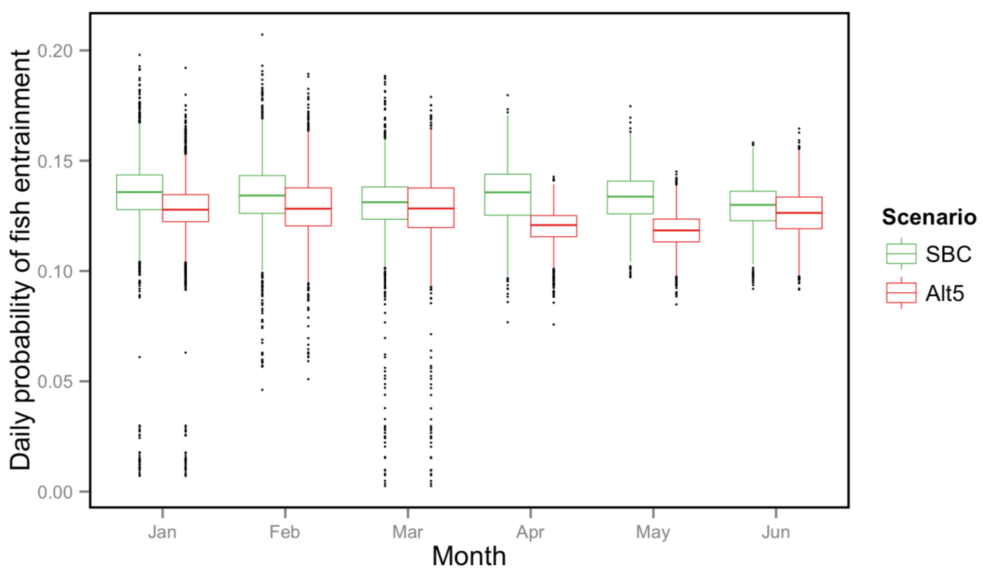


Figure 9L.28 Probability of Fish Entrainment into Columbia Cut under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

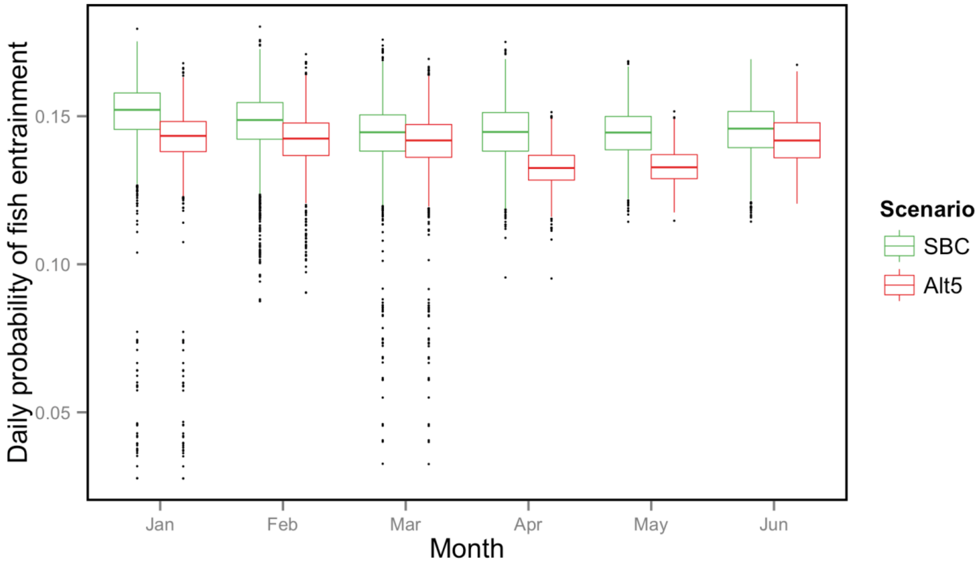


Figure 9L.29 Probability of Fish Entrainment into Middle River under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

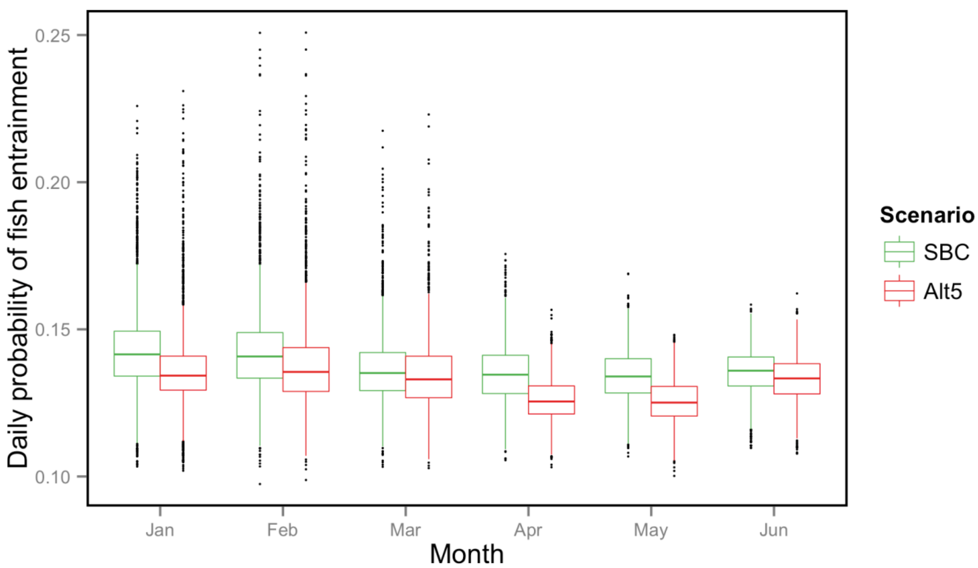


Figure 9L.30 Probability of Fish Entrainment into Old River under Alternative 5 (Alt 5) as compared to the Second Basis of Comparison (SBC)

This page left blank intentionally.

Appendix 9M

Salmonid Salvage Analysis Documentation

This appendix provides information about the methods and assumptions used for the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) Environmental Impact Statement (EIS) analysis using the Salmonid Salvage analysis. This appendix is organized in two main sections as follows:

- Section 9M.1: Salmonid Salvage Analysis Methodology and Assumptions
  - The Salmonid Salvage analysis uses the statistical relationship published in Zeug and Cavallo (2014) to estimate the proportion of Chinook Salmon juveniles predicted to be salvaged each month from January through June. This section briefly describes the approach and assumptions of the Salmonid Salvage analysis.
- Section 9M.2: Salmonid Salvage Analysis Results
  - This section presents the results of the Salmonid Salvage analysis. Results are presented in a series of figures showing the proportion of Chinook Salmon salvaged in each month.

9M.1 Salmonid Salvage Analysis Methodology and Assumptions

9M.1.1 Salmonid Salvage Analysis Methodology

Predicted monthly salvage from January through June for each scenario was estimated using statistical relationships reported in Zeug and Cavallo (2014). In that analysis, salvage at the CVP and SWP was modeled as a function of physical, biological, and hydrologic variables. The data set used for the Sacramento River was comprised of over 700 releases between 1993 and 2007, which was made up of approximately 30 million individual Chinook Salmon. Three of the four Chinook Salmon races were represented (winter, fall, and late-fall runs) in the model. The salvage of San Joaquin River origin Chinook Salmon was also modeled. However, the range of data used to construct the San Joaquin River statistical model was significantly narrower than the range of flows and exports represented in the scenarios examined in this report. Thus, only the Sacramento River model was used to predict salvage of Sacramento River-origin Chinook Salmon races.

The statistical model presented in Zeug and Cavallo (2014) included several predictors that were not well supported by the data (not found to be significant in their analysis) or were not relevant for the prediction function used in this analysis. For example, a variable of “ocean recoveries” was used by Zeug and

Cavallo (2014) to quantify the effect of salvage on future recoveries in the ocean. This variable was not relevant to the evaluation goals of the scenarios proposed herein. Thus, the statistical model was refitted using only significant and relevant predictor variables that included exports, river inflow, and fish size.

The resulting predictions of salvage probability were performed using average flow and export values in January, February, March, April, May, and June for each scenario. These flow and export values were model outputs from DSM2 and CalSim II hydrologic models. Fish size was fixed at 80 millimeter. The statistical model constructed by Zeug and Cavallo (2014) produced an estimated count of fish salvage with an offset variable that equals the number of fish in each release. To obtain a probability, the estimated count was divided by an offset variable. The probability of salvage was calculated for each week and then averaged for each month. The probability of salvage calculated by the model is independent of the number of fish available for salvage. Thus, a high probability of salvage may not be important if few fish are migrating through the delta at that time.

9M.1.2 Salmonid Salvage Analysis Scenario Assumptions

The Salmonid Salvage analysis includes the following assumptions:

- The salvage model is applicable to spring-run Chinook Salmon, although only winter, fall, and late fall run Chinook Salmon were used to construct the statistical model.
- Exclusion of non-significant or irrelevant variables has little or no effect on predicted salvage.
- Hatchery fish used in the coded wire tag experiments are salvaged at a similar rate as natural-origin fish.

9M.2 Salmonid Salvage Analysis Results

The following scenario comparisons are presented as box-whiskers plots[1] (Figures 9M.1 through 9M.5), comparing the predicted proportion of Chinook Salmon salvaged in each month over the 82-year CalSim II simulation period:

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 3 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the No Action Alternative
- Alternative 5 compared to the Second Basis of Comparison

Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented separately. Model

[1] The box represents 25th and 75th percentiles, the line represents the median, and whiskers represent minimum and maximum (excluding the outliers). The outliers are defined as data points outside of 1.5 times the length of the box away from the box and are represented in points.

results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented separately.

The EIS impact analysis starts with use of the monthly CalSim II model to project CVP and SWP water deliveries. Because this regional model uses monthly time steps to simulate requirements that change weekly or change through observations, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing. Therefore, reductions of 5 percent or less in this comparative analysis are considered to be not substantially different, or "similar."

9M.3 Reference

Zeug SZ, Cavallo BJ. 2014. "Controls on the Entrainment of Juvenile Chinook Salmon (Oncorhynchus tshawytscha) into Large Water Diversions and Estimates of Population-level Loss." *PLoS ONE* 9(7): e101479. Doi:10.1371/journal.pone.0101479

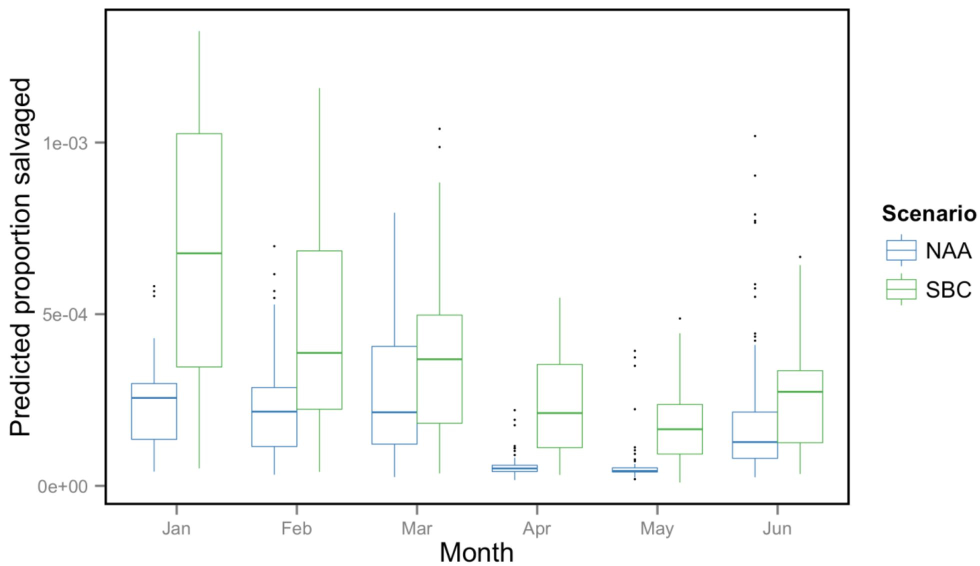


Figure 9M.1 Proportion of Chinook Salmon Salvaged in Each Month under the No Action Alternative (NAA) Compared to the Second Basis of Comparison (SBC)

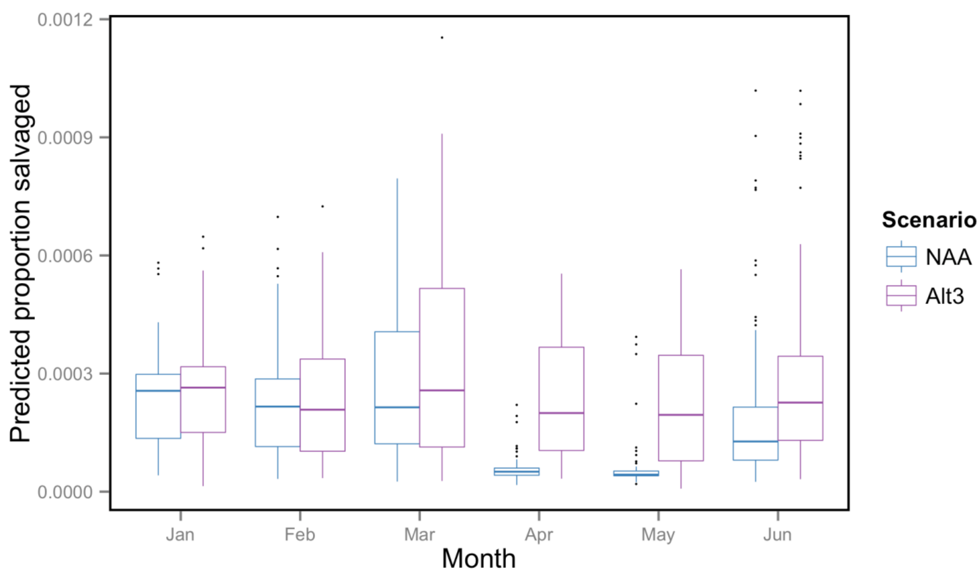


Figure 9M.2 Proportion of Chinook Salmon Salvaged in Each Month under Alternative 3 (Alt 3) Compared to the No Action Alternative (NAA)

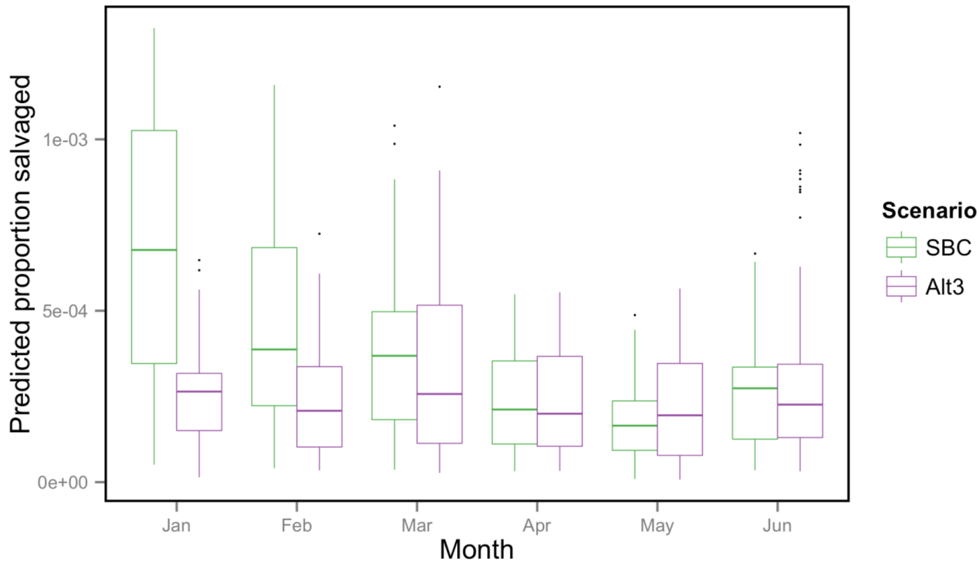


Figure 9M.3 Proportion of Chinook Salmon Salvaged in Each Month under Alternative 3 (Alt 3) as Compared to the Second Basis of Comparison (SBC)

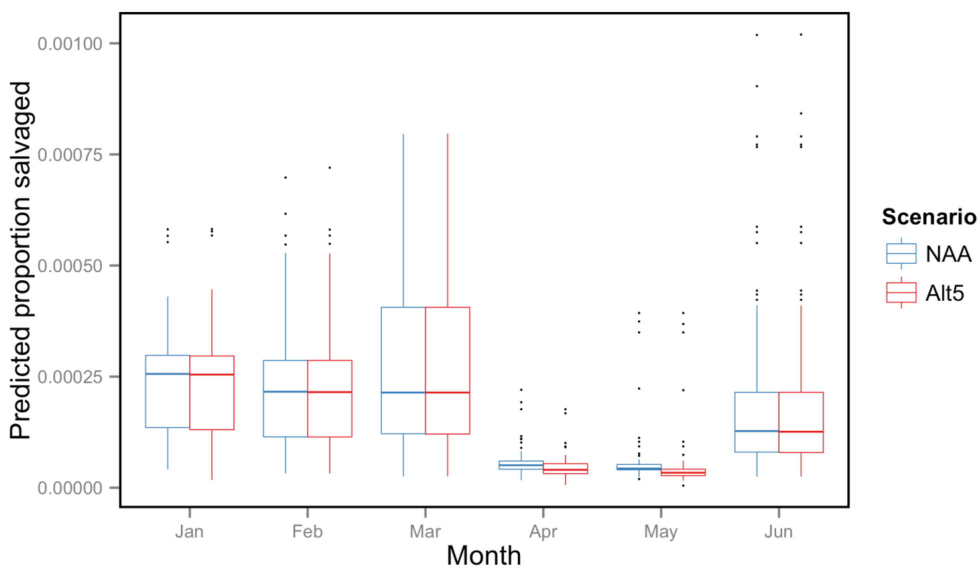


Figure 9M.4 Proportion of Chinook Salmon Salvaged in Each Month under Alternative 5 (Alt 5) as Compared to the No Action Alternative (NAA)

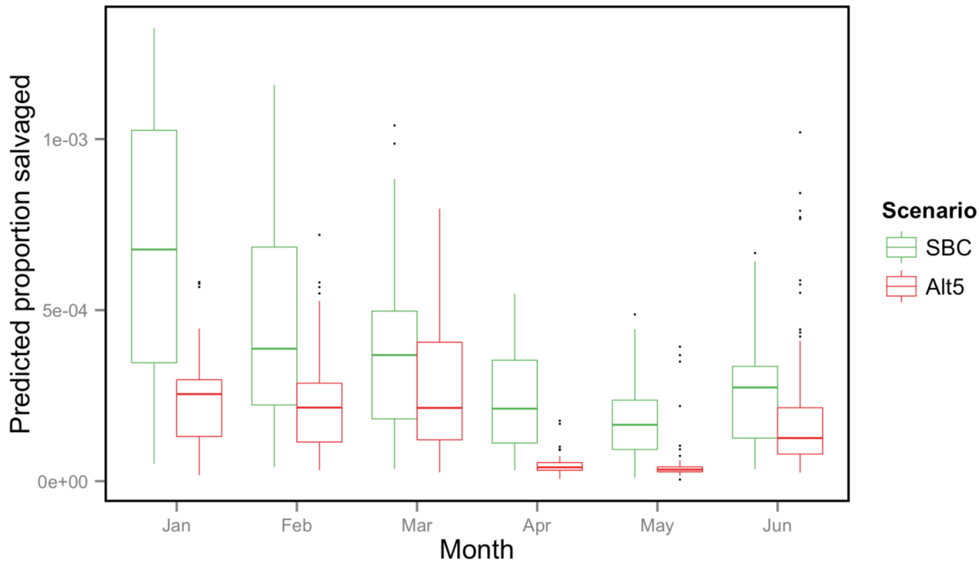


Figure 9M.5 Proportion of Chinook Salmon Salvaged in Each Month under Alternative 5 (Alt 5) as Compared to the Second Basis of Comparison (SBC)

Appendix 9N

Temperature Threshold Analysis

9N.1 Temperature Threshold Methodology and Assumptions

Monthly temperature data described in Appendix 6B were used to calculate the percentage of time (over the period 81-year simulation record) monthly temperature thresholds for different fish species and life stages were exceeded on the Trinity River, Clear Creek, Sacramento River, Feather River, American River, and Stanislaus River.

9N.2 Temperature Threshold Results

Table 9N.B.1 shows the percentage of years, over the 81-year simulation period, each of the different temperature thresholds was exceeded for the No Action Alternative, Second Basis of Comparison (Alternative 1), Alternative 3, and Alternative 5 as well as differences between the alternatives and the bases of comparison. Columns A through H describe the specific temperature threshold by species, life stage, river, reach, water year type, month, the actual temperature objective, and the reference where the target came from. Columns I through R show the threshold exceedances for each alternative and alternative comparison.

9N.3 References

DWR et al. (California Department of Water Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and National Marine Fisheries Service). 2013. *Environmental Impact Report/ Environmental Impact Statement for the Bay Delta Conservation Plan. Draft*. December.

National Marine Fisheries Service 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. June.

USFWS (U.S. Fish and Wildlife Service). 1999. *Trinity River Flow Evaluation. Final Report.* June.

This page left blank intentionally.

Table 9N.B.1. Temperature Threshold Exceedances

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Spring-Run Chinook	Holding	Trinity	Lewiston to Douglas City Bridge	All	July	60	USFWS 1999	1%	1%	0%	1%	0%	-1%	0%	0%	-1%	0%
Spring-Run Chinook	Holding	Trinity	Lewiston to Douglas City Bridge	All	August	60	USFWS 1999	2%	2%	2%	0%	0%	0%	-2%	0%	0%	-2%
Spring-Run Chinook	Spawning	Trinity	Lewiston to Douglas City Bridge	All	September	56	USFWS 1999	9%	11%	9%	7%	2%	1%	-1%	-2%	-1%	-4%
Chinook	Spawning	Trinity	Lewiston to NF confluence	All	October	56	USFWS 1999	8%	6%	6%	7%	-1%	-2%	0%	1%	-1%	1%
Coho	Spawning	Trinity	Lewiston to NF confluence	All	October	56	USFWS 1999	8%	6%	6%	7%	-1%	-2%	0%	1%	-1%	1%
Steelhead	Spawning	Trinity	Lewiston to NF confluence	All	October	56	USFWS 1999	8%	6%	6%	7%	-1%	-2%	0%	1%	-1%	1%
Chinook	Spawning	Trinity	Lewiston to NF confluence	All	November	56	USFWS 1999	2%	2%	0%	2%	0%	-2%	0%	0%	-2%	0%
Coho	Spawning	Trinity	Lewiston to NF confluence	All	November	56	USFWS 1999	2%	2%	0%	2%	0%	-2%	0%	0%	-2%	0%
Steelhead	Spawning	Trinity	Lewiston to NF confluence	All	November	56	USFWS 1999	2%	2%	0%	2%	0%	-2%	0%	0%	-2%	0%
Chinook	Spawning	Trinity	Lewiston to NF confluence	All	December	56	USFWS 1999	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Coho	Spawning	Trinity	Lewiston to NF confluence	All	December	56	USFWS 1999	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Spawning	Trinity	Lewiston to NF confluence	All	December	56	USFWS 1999	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Clear Creek	Igo	All	June	60	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Clear Creek	Igo	All	July	60	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Clear Creek	Igo	All	August	60	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Spring-Run Chinook	Rearing	Clear Creek	Igo	All	September	56	BDCP 2013	15%	13%	12%	14%	-3%	-4%	-2%	3%	-1%	1%
Spring-Run Chinook	Rearing	Clear Creek	Igo	All	October	56	BDCP 2013	12%	10%	11%	12%	-2%	-2%	0%	2%	1%	2%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	April	56	NMFS NMFS BiOp 2009 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	May	56	NMFS BiOp 2009	3%	4%	4%	3%	1%	1%	0%	-1%	0%	-1%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	June	56	NMFS BiOp 2009	6%	4%	4%	7%	-2%	-2%	1%	2%	0%	3%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	July	56	NMFS BiOp 2009	14%	11%	11%	13%	-3%	-3%	-1%	3%	0%	2%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	August	56	NMFS BiOp 2009	32%	28%	28%	31%	-3%	-4%	0%	3%	0%	3%
Winter-Run Chinook	Egg incubation	Sacramento	Balls Ferry	All	September	56	NMFS BiOp 2009	42%	52%	49%	41%	10%	6%	-1%	-10%	-4%	-11%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	April	56	NMFS BiOp 2009	4%	4%	4%	4%	-1%	-1%	0%	1%	0%	1%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	May	56	NMFS BiOp 2009	44%	42%	44%	47%	-2%	0%	3%	2%	2%	5%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	June	56	NMFS BiOp 2009	52%	44%	44%	54%	-8%	-8%	1%	8%	0%	10%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	July	56	NMFS BiOp 2009	55%	59%	58%	54%	4%	3%	-1%	-4%	-1%	-5%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	August	56	NMFS BiOp 2009	89%	85%	89%	90%	-4%	0%	1%	4%	4%	5%
Winter-Run Chinook	Egg incubation	Sacramento	Bend Bridge	All	September	56	NMFS BiOp 2009	62%	90%	87%	60%	29%	26%	-1%	-29%	-3%	-30%
Green Sturgeon	Egg incubation	Sacramento	Bend Bridge	All	May	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Egg incubation	Sacramento	Bend Bridge	All	June	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Green Sturgeon	Egg incubation	Sacramento	Bend Bridge	All	July	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Egg incubation	Sacramento	Bend Bridge	All	August	63	BDCP 2013	7%	6%	6%	7%	-1%	-1%	0%	1%	0%	1%
Green Sturgeon	Egg incubation	Sacramento	Bend Bridge	All	September	63	BDCP 2013	12%	10%	9%	12%	-3%	-3%	-1%	3%	-1%	2%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	October	56	BDCP 2013	82%	79%	78%	80%	-4%	-4%	-2%	4%	0%	2%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	November	56	BDCP 2013	8%	7%	8%	7%	-1%	0%	-2%	1%	1%	-1%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	December	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	March	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	April	56	BDCP 2013	15%	13%	14%	14%	-2%	-1%	-1%	2%	1%	1%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	October	56	BDCP 2013	82%	79%	78%	80%	-4%	-4%	-2%	4%	0%	2%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	November	56	BDCP 2013	8%	7%	8%	7%	-1%	0%	-2%	1%	1%	-1%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	December	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	March	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Fall-Run Chinook	Egg incubation	Sacramento	Red Bluff	All	April	56	BDCP 2013	15%	13%	14%	14%	-2%	-1%	-1%	2%	1%	1%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	October	56	BDCP 2013	82%	79%	78%	80%	-4%	-4%	-2%	4%	0%	2%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	November	56	BDCP 2013	8%	7%	8%	7%	-1%	0%	-2%	1%	1%	-1%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	December	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	March	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Spawning	Sacramento	Red Bluff	All	April	56	BDCP 2013	15%	13%	14%	14%	-2%	-1%	-1%	2%	1%	1%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	October	56	BDCP 2013	82%	79%	78%	80%	-4%	-4%	-2%	4%	0%	2%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	November	56	BDCP 2013	8%	7%	8%	7%	-1%	0%	-2%	1%	1%	-1%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	December	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	March	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall-Run Chinook	Spawning	Sacramento	Red Bluff	All	April	56	BDCP 2013	15%	13%	14%	14%	-2%	-1%	-1%	2%	1%	1%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	March	61	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
White Sturgeon	Spawning	Sacramento	Hamilton City	All	April	61	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	May	61	BDCP 2013	55%	49%	49%	56%	-6%	-6%	1%	6%	0%	7%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	June	61	BDCP 2013	86%	74%	74%	87%	-13%	-13%	1%	13%	0%	13%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	March	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	April	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	May	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Spawning	Sacramento	Hamilton City	All	June	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	March	61	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	April	61	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	May	61	BDCP 2013	55%	49%	49%	56%	-6%	-6%	1%	6%	0%	7%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	June	61	BDCP 2013	86%	74%	74%	87%	-13%	-13%	1%	13%	0%	13%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	March	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	April	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	May	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
White Sturgeon	Egg incubation	Sacramento	Hamilton City	All	June	68	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	September	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	October	56	BDCP 2013	98%	97%	97%	97%	-1%	-1%	-1%	1%	-1%	0%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	November	56	BDCP 2013	27%	26%	26%	28%	-1%	-1%	1%	1%	-1%	2%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	March	56	BDCP 2013	18%	20%	19%	19%	2%	1%	1%	-2%	-1%	-1%
Spring-Run Chinook	Egg incubation	Feather	Robinson Riffle	All	April	56	BDCP 2013	75%	75%	75%	75%	0%	0%	0%	0%	0%	0%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	September	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	October	56	BDCP 2013	98%	97%	97%	97%	-1%	-1%	-1%	1%	-1%	0%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	November	56	BDCP 2013	27%	26%	26%	28%	-1%	-1%	1%	1%	-1%	2%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	March	56	BDCP 2013	18%	20%	19%	19%	2%	1%	1%	-2%	-1%	-1%
Steelhead	Egg incubation	Feather	Robinson Riffle	All	April	56	BDCP 2013	75%	75%	75%	75%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	September	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	October	56	BDCP 2013	98%	97%	97%	97%	-1%	-1%	-1%	1%	-1%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	November	56	BDCP 2013	27%	26%	26%	28%	-1%	-1%	1%	1%	-1%	2%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	March	56	BDCP 2013	18%	20%	19%	19%	2%	1%	1%	-2%	-1%	-1%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	April	56	BDCP 2013	75%	75%	75%	75%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	September	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	October	56	BDCP 2013	98%	97%	97%	97%	-1%	-1%	-1%	1%	-1%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	November	56	BDCP 2013	27%	26%	26%	28%	-1%	-1%	1%	1%	-1%	2%
Steelhead	Rearing	Feather	Robinson Riffle	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Steelhead	Rearing	Feather	Robinson Riffle	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	February	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	March	56	BDCP 2013	18%	20%	19%	19%	2%	1%	1%	-2%	-1%	-1%
Steelhead	Rearing	Feather	Robinson Riffle	All	April	56	BDCP 2013	75%	75%	75%	75%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	May	63	BDCP 2013	60%	51%	55%	57%	-9%	-5%	-2%	9%	4%	6%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	June	63	BDCP 2013	97%	97%	97%	97%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	July	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Spring-Run Chinook	Rearing	Feather	Robinson Riffle	All	August	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	May	63	BDCP 2013	60%	51%	55%	57%	-9%	-5%	-2%	9%	4%	6%
Steelhead	Rearing	Feather	Robinson Riffle	All	June	63	BDCP 2013	97%	97%	97%	97%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	July	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Robinson Riffle	All	August	63	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	October	56	BDCP 2013	98%	98%	98%	98%	-1%	-1%	0%	1%	0%	0%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	November	56	BDCP 2013	26%	24%	23%	26%	-1%	-3%	0%	1%	-1%	1%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	February	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	March	56	BDCP 2013	29%	28%	26%	29%	-2%	-4%	0%	2%	-2%	2%
Fall Chinook	Spawning	Feather	Gridley Bridge	All	April	56	BDCP 2013	85%	85%	85%	85%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Gridley Bridge	All	October	56	BDCP 2013	98%	98%	98%	98%	-1%	-1%	0%	1%	0%	0%
Steelhead	Rearing	Feather	Gridley Bridge	All	November	56	BDCP 2013	26%	24%	23%	26%	-1%	-3%	0%	1%	-1%	1%
Steelhead	Rearing	Feather	Gridley Bridge	All	December	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Steelhead	Rearing	Feather	Gridley Bridge	All	January	56	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Rearing	Feather	Gridley Bridge	All	February	56	BDCP 2013	1%	0%	0%	1%	-1%	-1%	0%	1%	0%	1%
Steelhead	Rearing	Feather	Gridley Bridge	All	March	56	BDCP 2013	29%	28%	26%	29%	-2%	-4%	0%	2%	-2%	2%
Steelhead	Rearing	Feather	Gridley Bridge	All	April	56	BDCP 2013	85%	85%	85%	85%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Spawning	Feather	Gridley Bridge	All	May	64	BDCP 2013	65%	56%	57%	64%	-9%	-7%	-1%	9%	1%	7%
Green Sturgeon	Spawning	Feather	Gridley Bridge	All	June	64	BDCP 2013	97%	97%	97%	97%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Spawning	Feather	Gridley Bridge	All	July	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Spawning	Feather	Gridley Bridge	All	August	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Spawning	Feather	Gridley Bridge	All	September	64	BDCP 2013	48%	83%	81%	49%	35%	33%	2%	-35%	-2%	-33%
Green Sturgeon	Egg incubation	Feather	Gridley Bridge	All	May	64	BDCP 2013	65%	56%	57%	64%	-9%	-7%	-1%	9%	1%	7%
Green Sturgeon	Egg incubation	Feather	Gridley Bridge	All	June	64	BDCP 2013	97%	97%	97%	97%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Egg incubation	Feather	Gridley Bridge	All	July	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Egg incubation	Feather	Gridley Bridge	All	August	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Egg incubation	Feather	Gridley Bridge	All	September	64	BDCP 2013	48%	83%	81%	49%	35%	33%	2%	-35%	-2%	-33%
Green Sturgeon	Rearing	Feather	Gridley Bridge	All	May	64	BDCP 2013	65%	56%	57%	64%	-9%	-7%	-1%	9%	1%	7%
Green Sturgeon	Rearing	Feather	Gridley Bridge	All	June	64	BDCP 2013	97%	97%	97%	97%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Green Sturgeon	Rearing	Feather	Gridley Bridge	All	July	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Rearing	Feather	Gridley Bridge	All	August	64	BDCP 2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Green Sturgeon	Rearing	Feather	Gridley Bridge	All	September	64	BDCP 2013	48%	83%	81%	49%	35%	33%	2%	-35%	-2%	-33%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	May	65	BDCP 2013	31%	31%	33%	32%	0%	2%	0%	0%	2%	0%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	June	65	BDCP 2013	56%	57%	55%	56%	1%	0%	0%	-1%	-1%	-1%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	July	65	BDCP 2013	99%	99%	99%	99%	0%	0%	0%	0%	0%	0%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	August	65	BDCP 2013	93%	93%	93%	94%	-1%	0%	0%	1%	1%	1%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	September	65	BDCP 2013	89%	96%	96%	90%	7%	7%	1%	-7%	0%	-6%
Juvenile steelhead	Rearing	American	Watt Ave Bridge	All	October	65	BDCP 2013	28%	28%	30%	28%	0%	2%	0%	0%	3%	0%
Steelhead	Adult Migration	Stanislaus	Orange Blossom Bridge	All	October	56	NMFS BiOp 2009	57%	85%	87%	58%	28%	31%	2%	-28%	2%	-27%
Steelhead	Adult Migration	Stanislaus	Orange Blossom Bridge	All	November	56	NMFS BiOp 2009	33%	28%	24%	36%	-5%	-9%	3%	5%	-4%	8%
Steelhead	Adult Migration	Stanislaus	Orange Blossom Bridge	All	December	56	NMFS BiOp 2009	0%	0%	0%	3%	0%	0%	3%	0%	0%	3%
Steelhead	Smoltification	Stanislaus	Knights Ferry (*Used Below Goodwin Dam)	All	January	52	NMFS BiOp 2009	0%	2%	2%	2%	2%	2%	2%	-2%	0%	0%
Steelhead	Smoltification	Stanislaus	Knights Ferry (*Used Below Goodwin Dam)	All	February	52	NMFS BiOp 2009	0%	2%	2%	0%	2%	2%	0%	-2%	0%	-2%
Steelhead	Smoltification	Stanislaus	Knights Ferry (*Used Below Goodwin Dam)	All	March	52	NMFS BiOp 2009	8%	9%	12%	8%	1%	4%	0%	-1%	3%	-1%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Steelhead	Smoltification	Stanislaus	Knights Ferry (*Used Below Goodwin Dam)	All	April	52	NMFS BiOp 2009	33%	31%	30%	37%	-2%	-2%	5%	2%	-1%	6%
Steelhead	Smoltification	Stanislaus	Knights Ferry (*Used Below Goodwin Dam)	All	May	52	NMFS BiOp 2009	63%	66%	63%	68%	3%	0%	5%	-3%	-3%	2%
Steelhead	Smoltification	Stanislaus	Orange Blossom Bridge	All	January	57	NMFS BiOp 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Smoltification	Stanislaus	Orange Blossom Bridge	All	February	57	NMFS BiOp 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Smoltification	Stanislaus	Orange Blossom Bridge	All	March	57	NMFS BiOp 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Smoltification	Stanislaus	Orange Blossom Bridge	All	April	57	NMFS BiOp 2009	2%	8%	3%	0%	6%	1%	-2%	-6%	-4%	-8%
Steelhead	Smoltification	Stanislaus	Orange Blossom Bridge	All	May	57	NMFS BiOp 2009	18%	10%	17%	8%	-8%	-1%	-11%	8%	7%	-3%
Steelhead	Spawning	Stanislaus	Orange Blossom Bridge	All	January	55	NMFS BiOp 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Steelhead	Spawning	Stanislaus	Orange Blossom Bridge	All	February	55	NMFS BiOp 2009	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%
Steelhead	Spawning	Stanislaus	Orange Blossom Bridge	All	March	55	NMFS BiOp 2009	21%	16%	25%	21%	-5%	3%	-1%	5%	8%	4%
Steelhead	Spawning	Stanislaus	Orange Blossom Bridge	All	April	55	NMFS BiOp 2009	16%	34%	17%	7%	17%	1%	-9%	-17%	-16%	-26%
Steelhead	Spawning	Stanislaus	Orange Blossom Bridge	All	May	55	NMFS BiOp 2009	49%	43%	53%	40%	-5%	4%	-8%	5%	10%	-3%
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	June	65	NMFS BiOp 2009	6%	2%	4%	6%	-3%	-1%	0%	3%	2%	3%
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	July	65	NMFS BiOp 2009	16%	16%	19%	21%	-1%	3%	5%	1%	4%	6%

[1]See section 9N.C for the full reference

Species	Lifestage	River	Reach	Water Year Type	Month	Temperature Objective (Degree F)	Temperature Objective Reference[1]	No Action Alternative	Second Basis of Comparison (Alternative 1)	Alternative 3	Alternative 5	Alternative 1 minus No Action Alternative	Alternative 3 minus No Action Alternative	Alternative 5 minus No Action Alternative	No Action Alternative minus Second Basis of Comparison	Alternative 3 minus Second Basis of Comparison	Alternative 5 minus Second Basis of Comparison
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	August	65	NMFS BiOp 2009	15%	13%	9%	21%	-2%	-6%	6%	2%	-4%	8%
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	September	65	NMFS BiOp 2009	11%	10%	7%	18%	0%	-4%	8%	0%	-3%	8%
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	October	65	NMFS BiOp 2009	7%	8%	4%	11%	1%	-3%	4%	-1%	-4%	3%
Steelhead	Rearing	Stanislaus	Orange Blossom Bridge	All	November	65	NMFS BiOp 2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[1]See section 9N.C for the full reference

Appendix 9O

Trap and Haul Program Background Information

Poor survival of juvenile salmonids in the Sacramento-San Joaquin Delta has been hypothesized as a major contributor to declines in the number of returning adults and may be a significant impediment to the recovery of threatened or endangered populations (NOAA 2009). Alternative 3 and Alternative 4 contain a trap and haul program for juvenile salmonids entering the Delta from the San Joaquin River, similar to the program in place on the Columbia River in Oregon. This appendix provides background information that was used in the qualitative analysis of the potential effects of a trap and haul program that would be implemented under Alternatives 3 and 4.

9O.1 Survival of Transported Versus In-river Releases

To assess the potential benefits and risks of a transportation program for salmonids in the San Joaquin River, Cramer Fish Sciences conducted an analysis of coded-wire-tag (CWT) recovery rates for Chinook salmon reared at the Feather River Hatchery and the Mokelumne River Hatchery. In certain years, fish from both hatcheries were released in-river and trucked to San Pablo Bay allowing them to bypass the Delta. Fish from these releases were implanted with CWTs at the hatchery and their adipose fin was clipped which allowed them to be identified when recaptured. Tagged fish were recovered 2 to 4 years later in the commercial and recreational ocean fishery as well as on the spawning grounds and at the hatchery of origin. The ratio of tags recovered from transported (T) releases to tags recovered from in-river (I) releases in each year was estimated to produce a metric used evaluate the transportation program. This value (T/I) is referred to as the T/I ratio. When the value of T/I is > 1 the transportation program has a net positive effect. Although fish from the Feather and Mokelumne Rivers generally do not migrate through the same route as San Joaquin River-origin fish, we assume that their response to transport is representative of Central Valley stocks.

Paired transported and in-river releases of Mokelumne River-origin Chinook occurred in 1979, 1982 and 1994-1997 whereas paired releases of Feather River Hatchery Chinook occurred from 2002-2008. In-river releases of Mokelumne-origin fish occurred at the hatchery and at Woodbridge Dam. Paired bay releases occurred at several locations in Carquinez Strait and Eastern San Pablo Bay. In-river releases of Feather River-origin fish occurred at three different locations and paired bay releases occurred in Carquinez Strait and San Pablo Bay. Transportation of Feather River-origin salmonids bypassed a maximum of ≈ 230 km of the migration route and transport of Mokelumne River-origin fish bypassed a maximum of ≈ 170 km of the migration route. Exact estimates are unknown because multiple migration routes are available to salmonids in the Delta.

Several sources of uncertainty could influence the estimate of T/I, including variation in the release site among and within years, differences in release group size, and error in the recovery process. To account for this uncertainty, a Monte Carlo resampling strategy was employed. Release and recovery data was used to inform a binomial probability distribution for each in-river and transported release and one hundred resamples were performed. For each of the 100 resamples, the recovery rate for in-river and transported releases were averaged by river and year. The minimum 25th percentile, 50th percentile, 75th percentile, maximum and mean value of T/I was then calculated for each river in each year.

The distribution of T/I ratio for Feather River-origin Chinook salmon indicated that CWT recoveries of transported fish was almost always greater than in-river releases suggesting a consistent net benefit of transportation (Table 9O.1). Mean values of the T/I ratio ranged from 1.067 to 54.567 over the 7 year period and the only value below 1.0 was the minimum estimated value for 2002 (0.996). A plot of the mean recovery rate for transported and in-river releases with the T/I values suggest that the high value in 2004 was driven by extremely low recoveries of in-river releases (Figure 9O.1).

Table 9O.1 Distribution of the Ratio of CWT Recoveries for Transported and In-river Releases (T/I) of Feather River-origin Chinook Salmon

	2002	2003	2004	2005	2006	2007	2008
Mean	1.067	2.811	54.567	2.084	1.276	2.117	1.491
Minimum	0.996	2.709	39.492	1.930	1.102	1.884	1.339
25th	1.031	2.788	50.374	2.054	1.208	2.047	1.465
Median	1.064	2.808	54.016	2.086	1.272	2.101	1.489
75th	1.096	2.839	58.105	2.121	1.332	2.178	1.514
Maximum	1.210	2.905	70.976	2.221	1.495	2.399	1.597

Note:
Values greater than 1.0 indicate a net benefit of transportation.

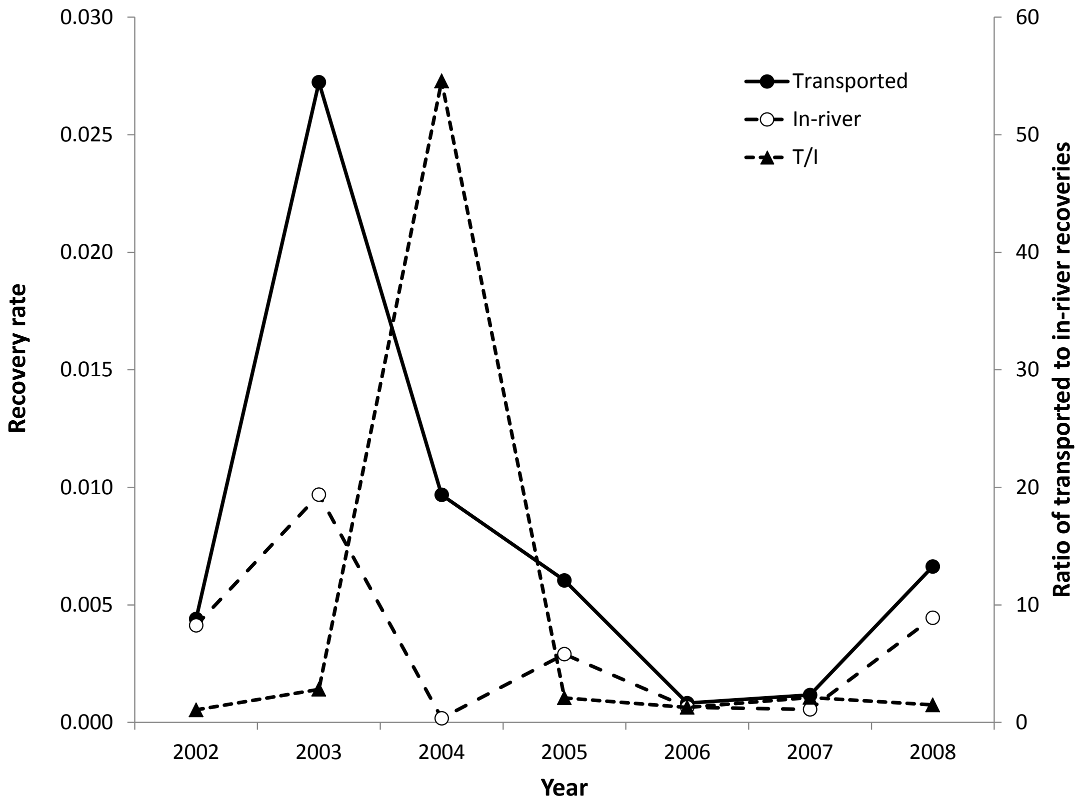


Figure 9O.1 Mean Recovery Rate of CWT Chinook Salmon Released in the Feather River and Transported to San Pablo Bay

Note: The ratio of transported to in-river recoveries (T/I) is plotted on the secondary y-axis.

Releases of Mokelume River-origin Chinook salmon followed a similar pattern to releases of Feather River-origin fish. Mean values of the T/I ratio were all above one and three years had mean values above 10.0 (Table 9O.2). A greater number of T/I values were less than 1.0 for Mokelumne releases; however all values less than one were minimum or 25th percentile values (Table 9O.2). The highest value of the T/I ratio for Mokelumne River-origin fish was greatest in the year when in river recovery rates were very low (Figure 9O.2).

Table 9O.2 Distribution of the Ratio of CWT Recoveries for Transported and In-river Releases (T/I) of Mokelumne River-origin Chinook Salmon

	1979	1982	1994	1995	1996	1997
Mean	1.78	1.23	10.88	138.18	1.01	17.07
Minimum	1.41	0.93	9.46	48.23	0.81	12.89
25th	1.68	1.15	10.30	83.93	0.95	15.69
Median	1.77	1.22	10.88	107.08	1.00	17.05
75th	1.87	1.29	11.23	173.92	1.05	18.20
Maximum	2.07	1.72	13.11	525.44	1.19	24.22

Note:
Values greater than 1.0 indicate a net benefit of transportation.

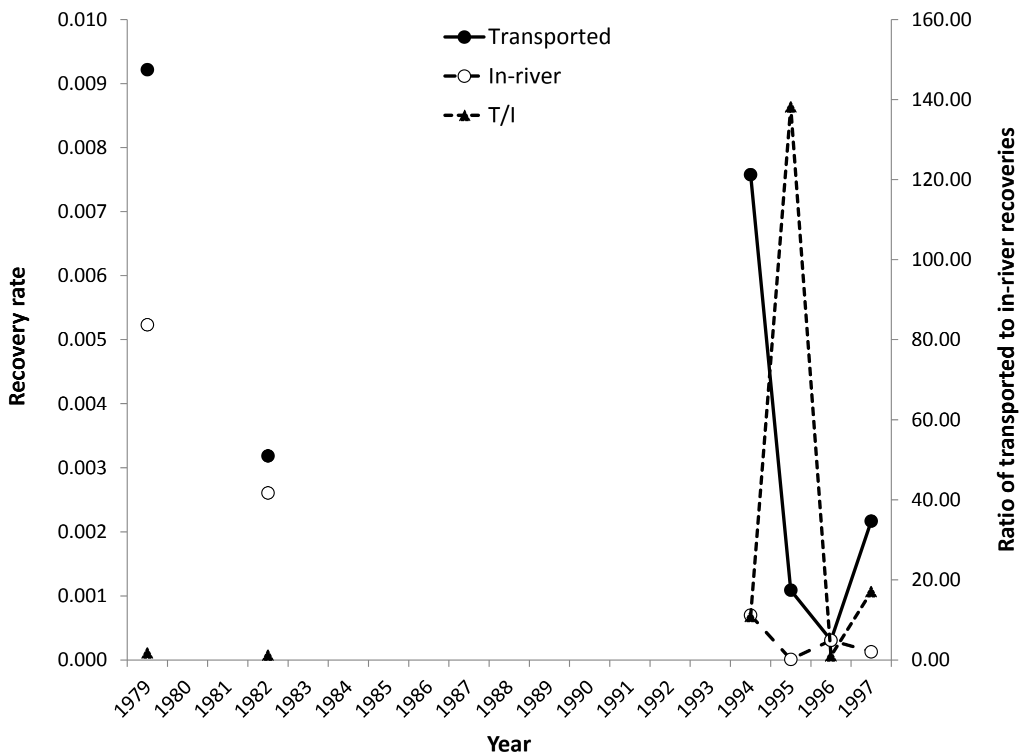


Figure 9O.2 Mean Recovery Rate of CWT Chinook Salmon Released in the Mokelumne River and Transported to San Pablo Bay

Note: The ratio of transported to in-river recoveries (T/I) is plotted on the secondary y-axis.

9O.2 Straying Rates of Transported Versus In-river Releases

One of the potential risks associated with a transportation program is an increase in the staying rates of transported fish. To estimate the straying rates of transported and in-river releases of fish from the Feather River and Mokelumne River hatcheries, CWT recoveries from spawning ground surveys and hatchery returns were used. The stray rate for each release was calculated as:

$$s = r_o/R_f$$

Where S is the estimate of straying rate, r_0 is the number of out-of-basin recoveries and R_f is the total number of freshwater recoveries.

Stray rates of transported fish was always greater than in-river releases for Feather River-origin fish (Figure 9O.3). However, from 2006-2008, stray rates increased for both transported and in-river releases. A similar pattern was observed for Mokelumne River-origin fish (Figure 9O.4). However, freshwater recoveries of Mokelumne River fish were low in all the years when paired releases of transported and in-river occurred. In 1982, there were no freshwater recoveries for either release group and until 1997, there were never more than 5 CWT recoveries of Mokelumne River-origin for any release group.

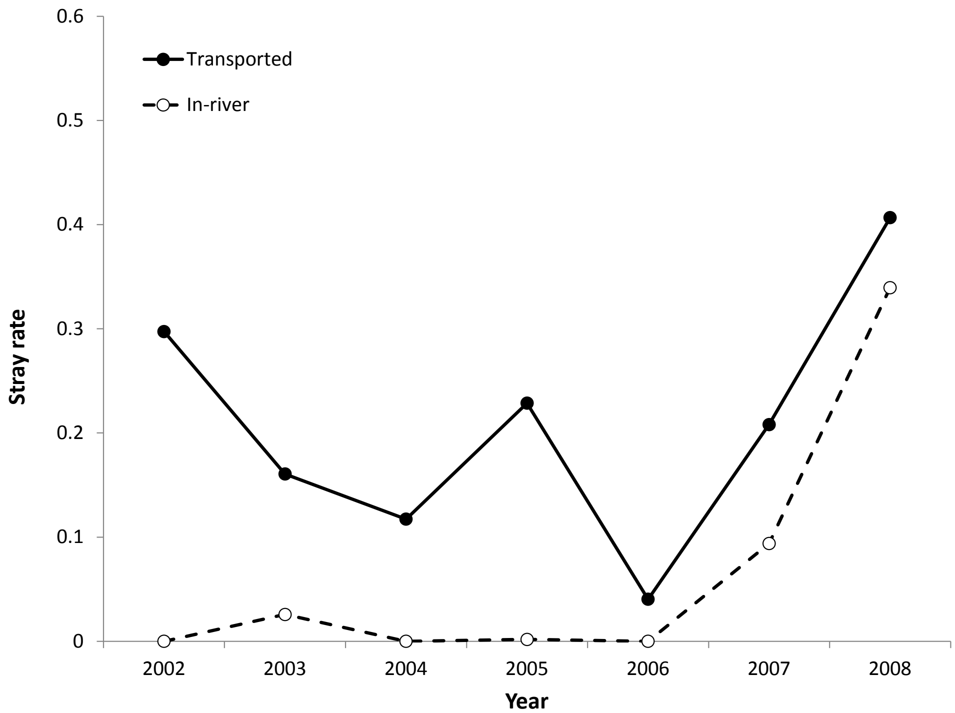


Figure 9O.3 Stray Rate of In-river and Transported Releases of Feather River-origin Chinook Salmon between 2002 and 2008

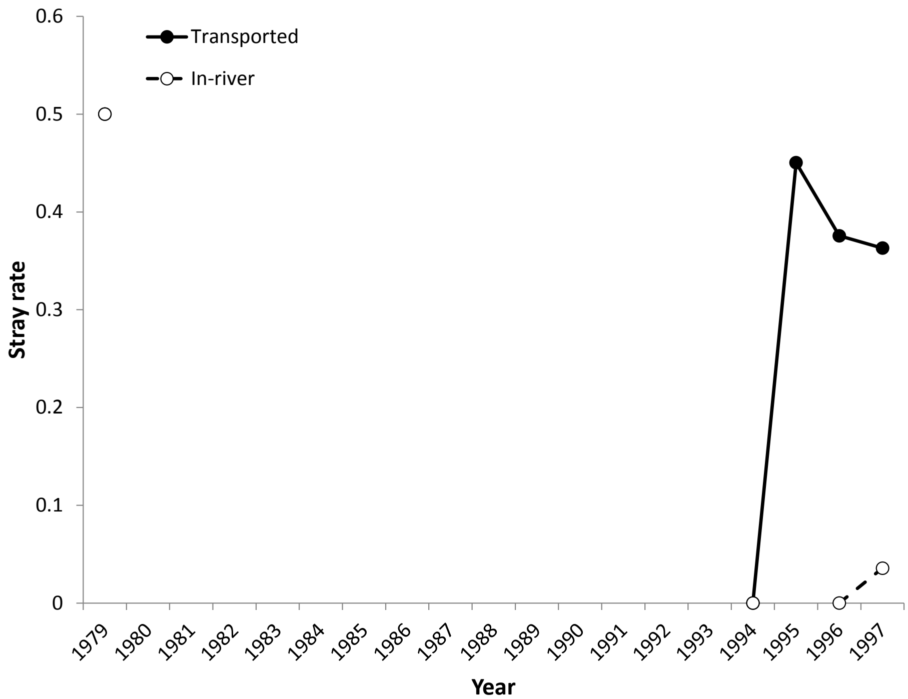


Figure 9O.4 Stray Rate of In-river and Transported Releases of Mokelumne River-origin Chinook Salmon in 1979, 1982, and 1994-1997

9O.3 References

Budy, P., G.P. Thiede, N. Bouwes, C.E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management, 22(1), 35-51.

Congleton, J. L., W.J. LaVoie, C.B. Schreck, and L.E. Davis. (2000). Stress indices in migrating juvenile Chinook salmon and steelhead of wild and hatchery origin before and after barge transportation. Transactions of the American Fisheries Society, 129(4), 946-961.

Appendix 9P

Sturgeon Analysis Documentation

This appendix provides information about the methods and assumptions used for the Coordinated Long Term Operation of the CVP and SWP EIS (LTO EIS) Environmental Consequences analysis of effects on Green Sturgeon and White Sturgeon. It is organized in two main sections that are briefly described below:

- Section 9P.1: Sturgeon Analysis Methodology and Assumptions
  - The LTO EIS Sturgeon Analysis uses estimated Delta outflow as a metric for evaluating the potential for effects on sturgeon. This section briefly describes the overall analytical approach and assumptions of the Sturgeon Analysis.
- Section 9P.2: Sturgeon Analysis Results
  - This section presents the results of the Sturgeon Analysis in terms of the median values for mean (March-July) Delta outflow and the likelihood of mean (March-July) Delta outflow exceeding 50,000 cubic-feet-per-second during this time period.

9P.1 Sturgeon Analysis Methodology and Assumptions

9P.1.1 Sturgeon Analysis Methodology

Estimated Delta outflow from the CalSim II model was used to analyze the potential effects on sturgeon. The evaluation method used to assess the influence of Delta outflow on sturgeon was developed using the hypothesized relationship between Delta outflow and the age-0 Year Class Index (YCI) from the Bay Study in the presentation by Gingras et al. (2014) at the annual IEP Workshop. In that presentation, the relationship between the age-0 YCI and mean Delta outflow was examined for a variety of time periods with a strong relationship shown for the period when white sturgeon are spawning and when young white sturgeon are migrating downstream (March-July). Their analysis using a generalized linear model indicated that there is threshold at about 50,000 cfs, such that year classes are generally strong when flows are above the threshold (Gingras et al. 2014).

For this analysis, the mean Delta outflow during the March to July period for each year was calculated from the CalSim II output and used as an indicator of potential year class strength. This same values were used as an indicator of the likelihood of producing a strong year class of sturgeon by examining the number of years (over the 82-year CalSim II simulation) that mean (March-July) Delta outflow would exceed a threshold of 50,000 cfs.

The hypothesized relationships between White Sturgeon and Delta outflow was used as a surrogate for Green Sturgeon. It is recognized that while White Sturgeon have unique biology and ecology compared to Green Sturgeon, the mechanisms underlying this relationship for White Sturgeon are assumed to be similar to those for Green Sturgeon. The analysis presented in this appendix does not include other mechanisms such as temperature and habitat that may influence Green Sturgeon differently than White Sturgeon. The impact analysis in Chapter 9 takes into account both temperature and Delta outflow analysis results.

9P.1.2 Sturgeon Analysis Scenario Assumptions

This section describes the assumptions for the Sturgeon analysis for the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

The following CalSim II model simulations were performed as the basis of evaluating the impacts of the other alternatives:

- No Action Alternative
- Second Basis of Comparison
- Alternative 1 – for simulation purposes, considered the same as Second Basis of Comparison
- Alternative 2 – for simulation purposes, considered the same as No Action Alternative
- Alternative 3
- Alternative 4 – for simulation purposes, considered the same as Second Basis of Comparison.
- Alternative 5

Assumptions for each of these alternatives were developed with the surface water modeling tools and are described in Appendix 5A Section B.

9P.2 Sturgeon Analysis Results

Results are provided for each of the following runs separately:

- No Action Alternative
- Second Basis of Comparison
- Alternative 3
- Alternative 5

Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented separately. Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented separately.

The following results are presented in this section:

- Figure 9.P.2.1. Box-Whisker plots of mean (March-July) Delta outflow showing the mean, median, inter-quartile range, and range of values for each alternative.
- Figure 9.P.2.2. Flow exceedance graph of mean (March-July) Delta outflow over the 82-year simulation period.
- Table 9.P.2.1. Table of percent difference between the alternatives for median, long-term average, and average by water year type over the 82-year simulation period.

The impact analysis starts with use of the CalSim II model based on a monthly time step to project CVP and SWP water deliveries. Because this regional model uses monthly time steps to simulate requirements that change weekly or change through observations, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing. Therefore, reductions of 5 percent or less in this comparative analysis are considered to be not substantially different, or "similar."

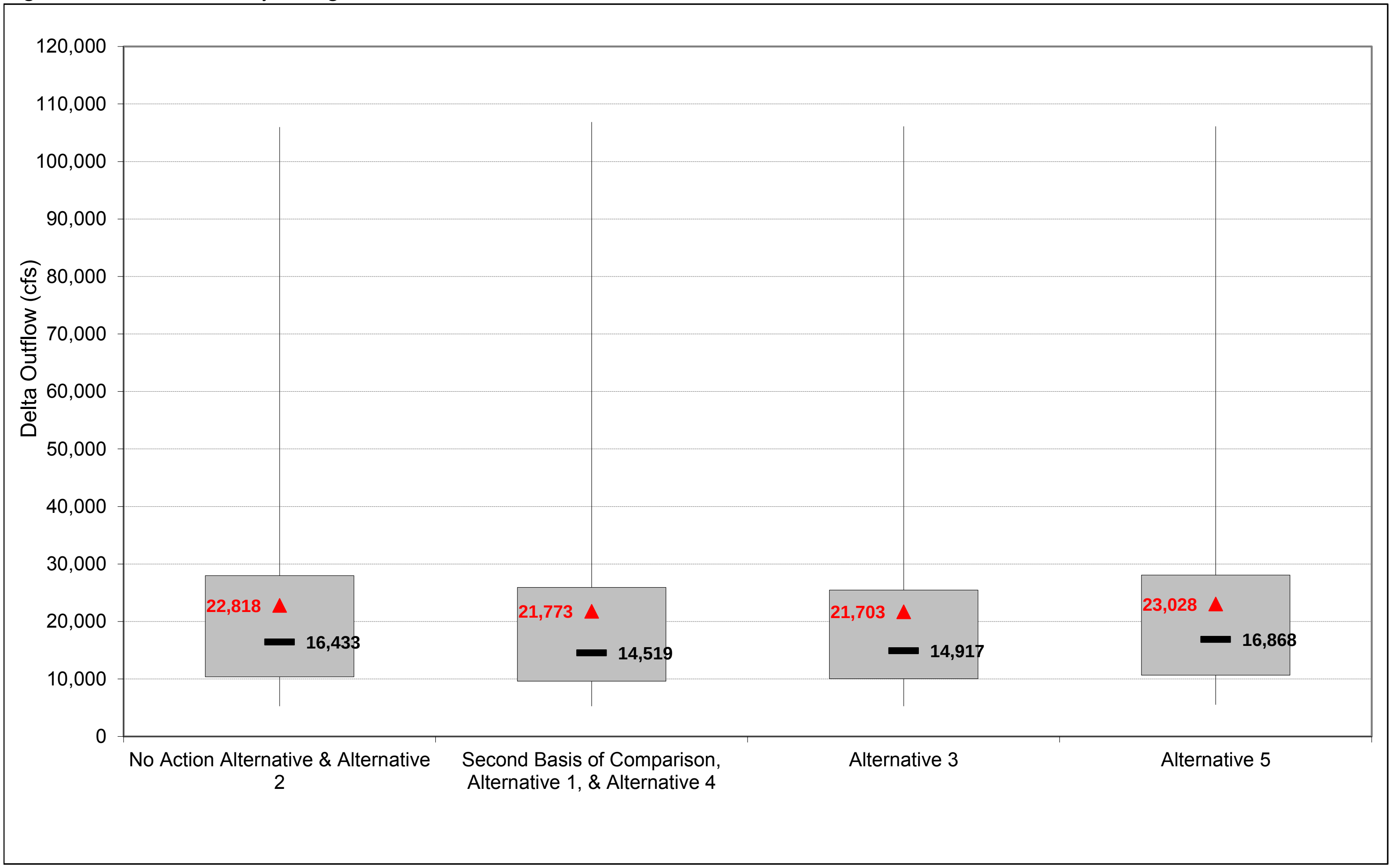
A summary and analysis of these results for purposes of the LTO EIS Environmental Consequences is provided in Chapter 9.

9P.3 References

Gingras, M., J. DuBois, and M. Fish. 2014. *Impact of Water Operations and Overfishing on White Sturgeon*. Presentation at the IEP Annual Workshop, Folsom, CA. 27 February 2014.

This page left blank intentionally.

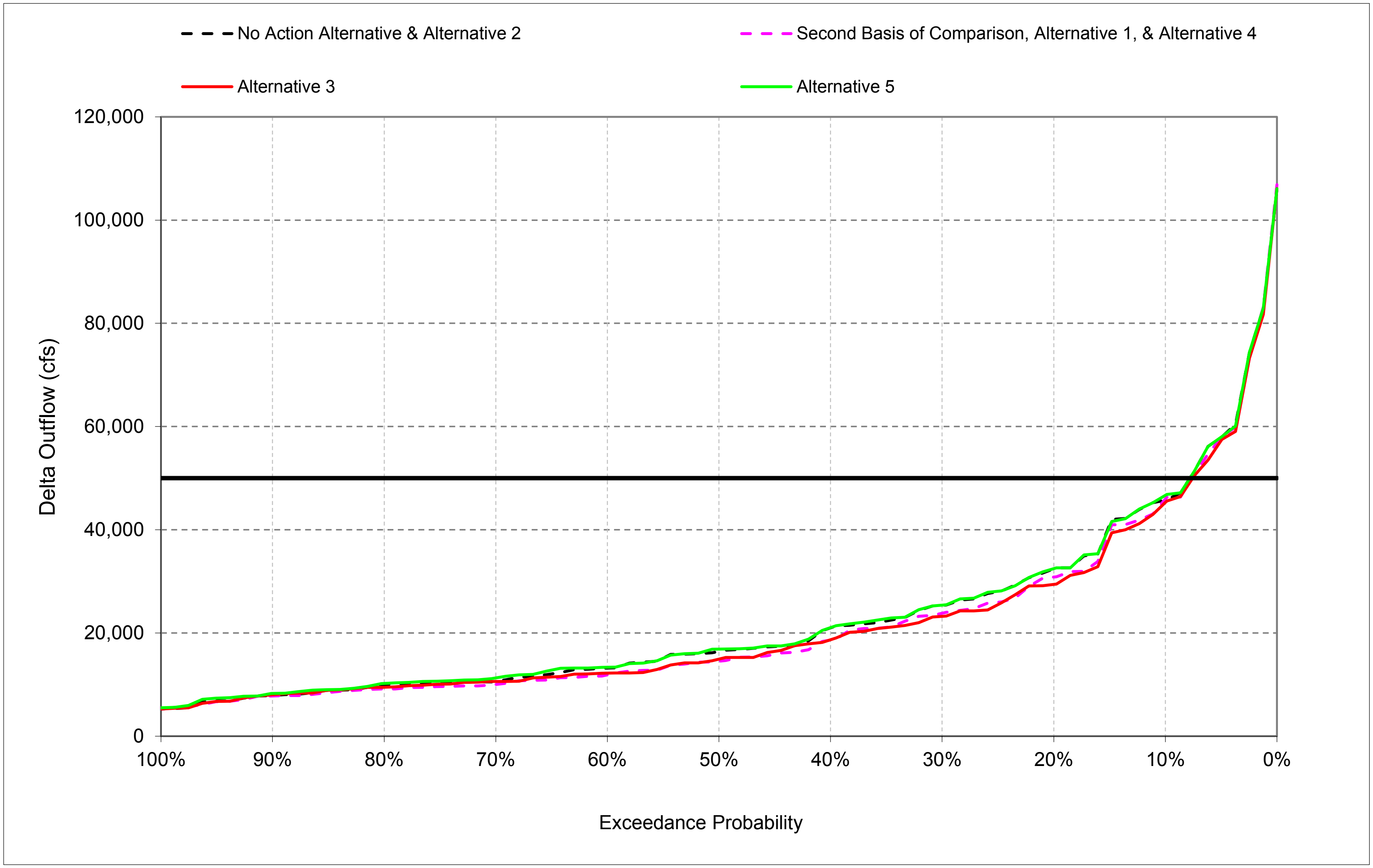
Figure 9.P.2.1. March to July Average Delta Outflow



(Box=25th to 75th percentile range, whiskers=min and max, dash=median, triangle=mean)

Notes: 1) All alternatives are simulated with projected hydrology and sea level at Year 2030 conditions. 2) Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented. Qualitative differences, if applicable, are discussed in the text. 3) Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented. Qualitative differences, if applicable, are discussed in the text.

Figure 9.P.2.2. March to July Average Delta Outflow



Notes: 1) Exceedance probability is defined as the probability a given value will be exceeded in any one year. 2) All alternatives are simulated with projected hydrology and sea level at Year 2030 conditions. 3) Model results for Alternatives 1, 4, and Second Basis of Comparison are the same, therefore Alternatives 1 and 4 results are not presented. Qualitative differences, if applicable, are discussed in the text. 4) Model results for Alternative 2 and No Action Alternative are the same, therefore Alternative 2 results are not presented. Qualitative differences, if applicable, are discussed in the text.

Table 9.P.2.1. March to July Average Delta Outflow

	Delta Outflow	Difference from No Action Alternative	Difference from Second Basis of Comparison	% Difference from No Action Alternative	% Difference from Second Basis of Comparison
	cfs	cfs	cfs	Percentage	Percentage
No Action Alternative					
Median	16,433	---	1,914	---	13%
Long-term Average	22,818	---	1,045	---	5%
Wet	40,999	---	1,238	---	3%
Above Normal	24,745	---	1,364	---	6%
Below Normal	12,755	---	961	---	8%
Dry	12,584	---	1,011	---	9%
Critical	7,620	---	418	---	6%
Second Basis of Comparison					
Median	14,519	-1,914	---	-12%	---
Long-term Average	21,773	-1,045	---	-5%	---
Wet	39,761	-1,238	---	-3%	---
Above Normal	23,382	-1,364	---	-6%	---
Below Normal	11,794	-961	---	-8%	---
Dry	11,573	-1,011	---	-8%	---
Critical	7,202	-418	---	-5%	---
Alternative 3					
Median	14,917	-1,516	398	-9%	3%
Long-term Average	21,703	-1,115	-70	-5%	0%
Wet	39,126	-1,873	-635	-5%	-2%
Above Normal	23,150	-1,595	-231	-6%	-1%
Below Normal	11,975	-780	182	-6%	2%
Dry	11,997	-586	425	-5%	4%
Critical	7,475	-144	274	-2%	4%
Alternative 5					
Median	16,868	435	2,350	3%	16%
Long-term Average	23,028	210	1,255	1%	6%
Wet	41,065	66	1,304	0%	3%
Above Normal	24,826	81	1,445	0%	6%
Below Normal	12,977	221	1,183	2%	10%
Dry	12,962	379	1,389	3%	12%
Critical	7,989	370	788	5%	11%

Notes: All results are based on the 82-year simulation period. The water year types are defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999); projected to Year 2030.

This page left blank intentionally.