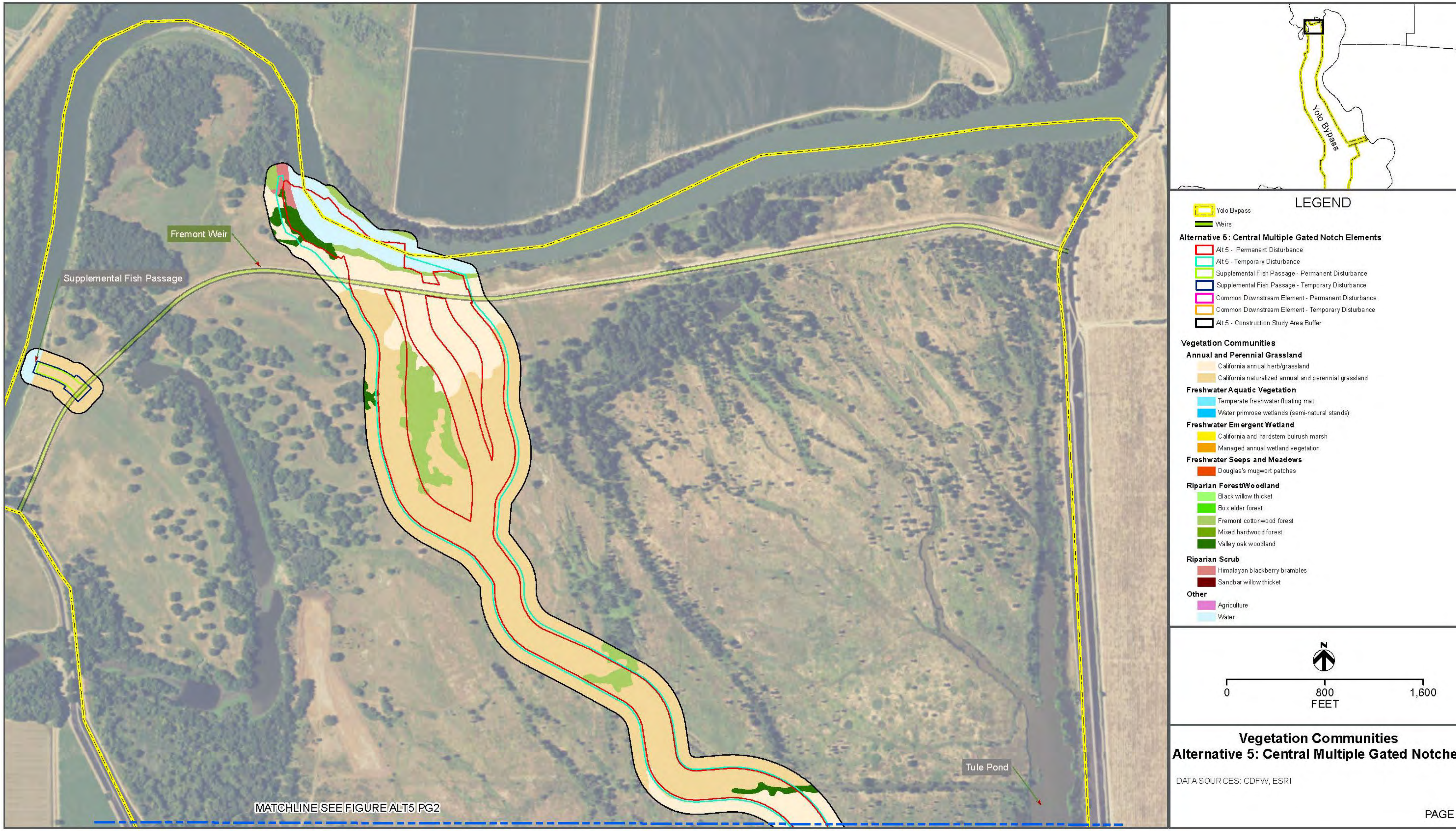

Figure 8-48a. Vegetation Communities Potentially Affected by Alternative 5

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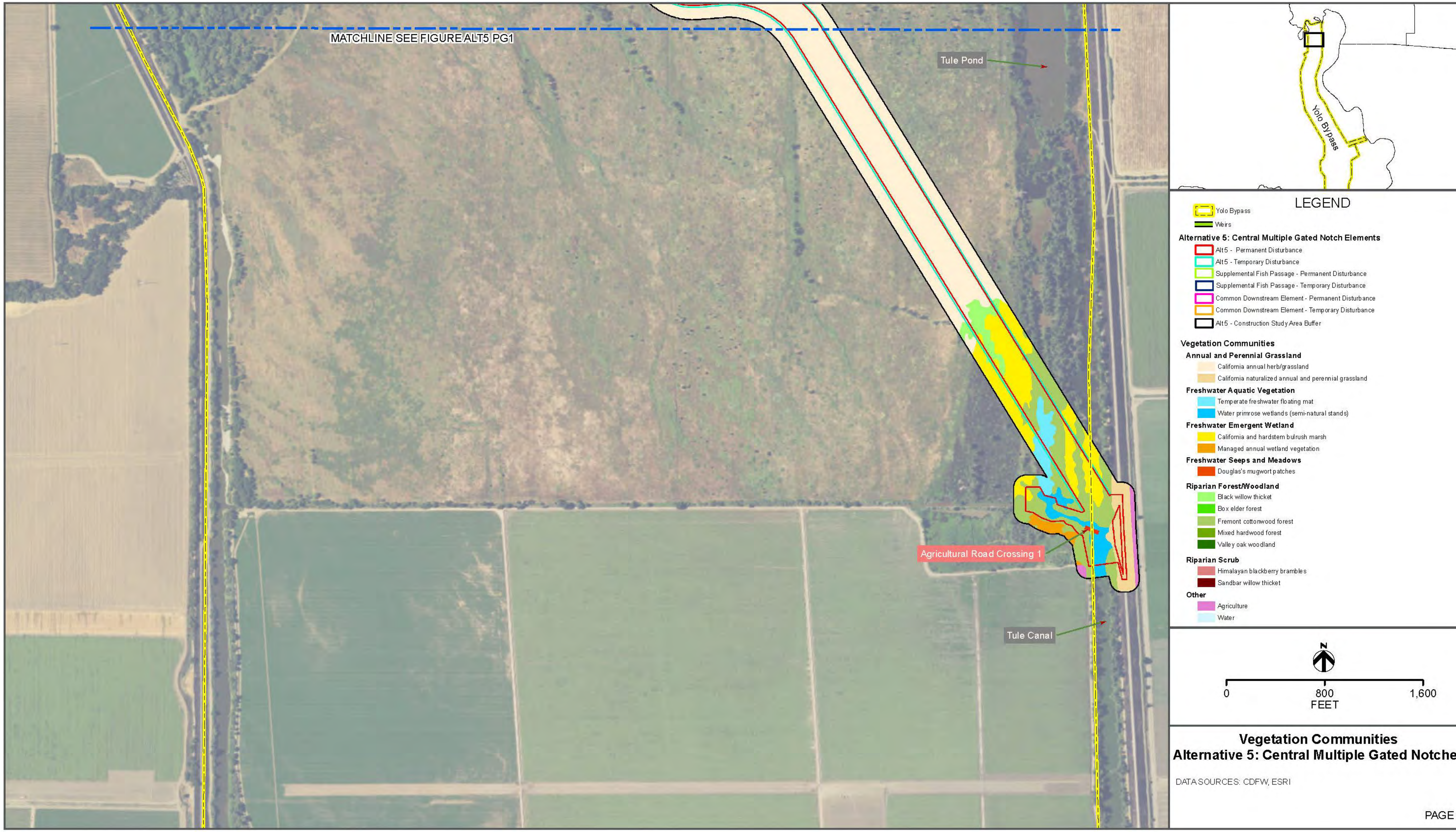

Figure 8-48b. Vegetation Communities Potentially Affected by Alternative 5

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CEQA Conclusion

Aquatic habitat modification adjacent to the Sacramento River and in the Yolo Bypass associated with construction activities would be **significant** because aquatic and riparian habitat would be permanently affected.

Implementation of Mitigation Measures MM-TERR-7 and MM-FISH-1 would reduce this impact to **less than significant**.

Impact FISH-4: Potential Disturbance to Fish Species or their Habitat due to Hydrostatic Pressure Waves, Noise, and Vibration

Potential impacts associated with hydrostatic pressure waves, noise, and vibration under Alternative 5 are expected to be similar to those described for Alternative 1. However, potential impacts due to noise associated with temporary cofferdam construction could occur from mid-May through mid-June due to the increased complexity of the intake facilities under Alternative 5.

CEQA Conclusion

Impacts associated with construction noise would be **less than significant** if a vibratory pile driver can be used for the entire construction of the cofferdam. However, impacts associated with noise would be **significant** if impact pile driving was conducted in the Sacramento River, resulting in direct potential impacts to fish species of focused evaluation.

Implementation of Mitigation Measure MM-FISH-2: Implement an Underwater Noise Reduction and Monitoring Plan would reduce this impact to **less than significant**.

Impact FISH-5: Potential Disturbance to Fish Species or their Habitat due to Stranding and Entrainment

Potential impacts associated with stranding and entrainment under Alternative 5 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Stranding and entrainment impacts would be **significant** because fish species of focused evaluation could be entrained in the temporary cofferdam.

Implementation of Mitigation Measure MM-FISH-3: Prepare a Fish Rescue and Salvage Plan would reduce this impact to **less than significant**.

Impact FISH-6: Potential Disturbance to Fish Species or their Habitat due to Predation Risk

Potential impacts associated with predation risk under Alternative 5 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Predation risk impacts would be **significant** because fish species of focused evaluation could be at increased risk of predation due to potential indirect effects of construction and maintenance activities.

Implementation of Mitigation Measures MM-WQ-2: Implement a Stormwater Pollution and Prevention Plan; MM-WQ-1: Prepare and Implement a Spill Prevention, Control, and Countermeasure Plan; MM-FISH-2: Implement an Underwater Noise Reduction and Monitoring Plan; and MM-FISH-3: Prepare a Fish Rescue and Salvage Plan would reduce this impact to less than significant.

Impact FISH-7: Potential Disturbance to Fish Species due to Changes in Fish Passage Conditions

Potential impacts associated with fish passage under Alternative 5 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Fish passage impacts would be **less than significant** because fish species of focused evaluation would either generally not be present near temporary fish passage blockages or would not be substantially affected by temporary blockages.

Impact FISH-8: Potential Disturbance to Fish Species or their Habitat due to Direct Harm

Potential impacts associated with direct physical injury and/or mortality under Alternative 5 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Direct harm impacts would be **significant** because fish species of focused evaluation could be directly harmed due to construction- and maintenance-related equipment, personnel, or debris.

Implementation of Mitigation Measure MM-FISH-4: Implement General Fish Protection Measures would reduce this impact to **less than significant**.

8.3.3.6.2 Operations-related Impacts

Operations-related impacts associated with Alternative 5 are evaluated in the Yolo Bypass, the Sacramento River at and downstream of the Fremont Weir, the Delta and downstream waterbodies, and the broader SWP/CVP system as appropriate.

Impact FISH-9: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Flows in the Sacramento River

Modeling results indicate that average monthly flows over the entire simulation period under Alternative 5 in the Sacramento River downstream of Fremont Weir would be the same or similar during most months and slightly (i.e., <5 percent) lower from November through March (see Appendix G6). During relatively low-flow conditions (i.e., lowest 40 percent of flows over the monthly exceedance distributions), no changes in flow of 10 percent or more would occur during any month of the year (see Appendix G6). Therefore, migration and rearing conditions would be similar under Alternative 5 relative to Existing Conditions in the lower Sacramento River for fish species of focused evaluation, including winter-run, spring-run, fall-run, and late fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, and Pacific lamprey. In addition, there would be minimal potential for reduced flows in the Sacramento River to result in increased exposure of fish species of focused evaluation to predators or to higher concentrations of water quality contaminants and minimal potential to exacerbate the channel homogenization in the lower Sacramento River.

CEQA Conclusion

Alternative 5 would result in the same or similar flows in the Sacramento River downstream of Fremont Weir relative to Existing Conditions; therefore, Alternative 5 would have a **less than significant impact** due to changes in flows in the Sacramento River.

Impact FISH-10: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Water Temperatures in the Sacramento River

Modeling results indicate that simulated mean monthly water temperatures in the Sacramento River at Freeport generally would not exceed species and life stage-specific water temperature index values more often under Alternative 5 relative to Existing Conditions (Appendix G7). Therefore, migration and rearing thermal conditions would not be substantially affected for fish species of focused evaluation expected to occur in the lower Sacramento River, including winter-run, spring-run, fall-run, and late fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, and Pacific lamprey under Alternative 5 relative to Existing Conditions.

CEQA Conclusion

Alternative 5 would not result in substantial changes to water temperature suitability for fish species of focused evaluation relative to Existing Conditions; therefore, Alternative 5 would have a **less than significant impact** due to changes in water temperatures in the Sacramento River.

Impact FISH-11: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Delta Hydrologic and Water Quality Conditions

Comparison of modeling results for mean monthly Delta hydrologic and water quality parameters with respect to species and life stage-specific time periods indicate that hydrologic and water quality metrics would not be altered under Alternative 5 relative to Existing Conditions (see Appendix G6). Therefore, habitat conditions in the Delta would be similar for all life stages evaluated. In addition, based on mean monthly Delta outflow, fisheries habitat conditions would be the same or similar in Suisun Bay.

CEQA Conclusion

Alternative 5 would result in the same or similar habitat conditions for fish species of focused evaluation in the Delta and in downstream areas relative to Existing Conditions; therefore, Alternative 5 would have a **less than significant impact** due to changes in Delta conditions.

Impact FISH-12: Impacts to Fisheries Habitat Conditions due to Changes in Flow-Dependent Habitat Availability in the Study Area (Yolo Bypass/Sutter Bypass)

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir would substantially increase more often from January through March. Therefore, inundation extent and/or duration of the Yolo Bypass would increase during these months, potentially providing for increased hydraulic habitat availability for fish species of focused evaluation, particularly juvenile salmonids and adult and juvenile Sacramento splittail.

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon pre-smolts in the Yolo Bypass under Alternative 5 would generally be substantially higher from December through March and similar for the remainder of the October through May evaluation period (Table 8-26). Simulated average monthly hydraulic habitat availability by water year type would be substantially higher under Alternative 5 relative to Existing Conditions during most water year types from December through February and during March of below normal, dry, and critical water year types.

Modeling results indicate that Chinook salmon pre-smolt hydraulic habitat availability would be higher under Alternative 5 relative to Existing Conditions over about 40 percent of the exceedance distribution (Figure 8-49). Over the exceedance distribution from November through March, daily hydraulic habitat availability would be substantially higher (i.e., higher by 10 percent or more) about 42 percent of the time and would never be lower by 10 percent or more under Alternative 5.

Table 8-26. Average Monthly Area of Pre-smolt Chinook Salmon Hydraulic Habitat in the Yolo Bypass under Alternative 5 from October through May based on TUFLOW Modeling

Alternative	Area (km^2) October	Area (km^2) November	Area (km^2) December	Area (km^2) January	Area (km^2) February	Area (km^2) March	Area (km^2) April	Area (km^2) May
Entire Simulation Period[1] (n=16)								
Alternative 5	19.8	21.6	38.1	54.9	56.0	52.8	37.4	27.5
Existing Conditions	19.8	21.2	31.1	47.6	43.7	46.9	36.9	27.2
Difference	0.0	0.4	7.0	7.3	12.3	5.9	0.5	0.3
Percent Difference[2]	0.0	1.9	22.5	15.3	28.1	12.6	1.4	1.1
Water Year Types[3]								
Wet (n=5)								
Alternative 5	19.8	22.3	52.1	55.9	68.3	72.6	58.8	32.0
Existing Conditions	19.8	21.1	37.7	48.5	56.9	68.7	58.3	31.8
Difference	0.0	1.2	14.4	7.4	11.4	3.9	0.5	0.2
Percent Difference[2]	0.0	5.7	38.2	15.3	20.0	5.7	0.9	0.6
Above Normal (n=3)								
Alternative 5	20.1	21.7	39.3	78.4	64.6	52.1	36.9	37.8
Existing Conditions	20.1	21.6	36.2	66.6	41.4	48.0	36.5	37.5
Difference	0.0	0.1	3.1	11.8	23.2	4.1	0.4	0.3
Percent Difference[2]	0.0	0.5	8.6	17.7	56.0	8.5	1.1	0.8
Below Normal (n=3)								
Alternative 5	19.7	21.2	29.4	53.7	51.9	44.6	27.0	21.3
Existing Conditions	19.7	21.2	25.1	45.4	41.8	40.0	26.6	21.0
Difference	0.0	0.0	4.3	8.3	10.1	4.6	0.4	0.3
Percent Difference[2]	0.0	0.0	17.1	18.3	24.2	11.5	1.5	1.4
Dry (n=4)								
Alternative 5	19.7	21.0	30.1	38.9	33.7	39.3	22.5	20.3
Existing Conditions	19.8	20.9	25.9	35.7	26.6	29.0	21.8	20.1
Difference	-0.1	0.1	4.2	3.2	7.1	10.3	0.7	0.2
Percent Difference[2]	-0.5	0.5	16.2	9.0	26.7	35.5	3.2	1.0
Critical (n=1)								
Alternative 5	19.6	20.7	21.8	46.7	70.3	33.6	22.7	20.6
Existing Conditions	19.7	20.7	21.4	39.9	57.7	27.6	22.2	20.5
Difference	-0.1	0.0	0.4	6.8	12.6	6.0	0.5	0.1
Percent Difference[2]	-0.5	0.0	1.9	17.0	21.8	21.7	2.3	0.5

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)
[2] Relative difference of the monthly average
[3] As defined by the Sacramento Valley Index (DWR 2017c)
Key: km^2 = square kilometer

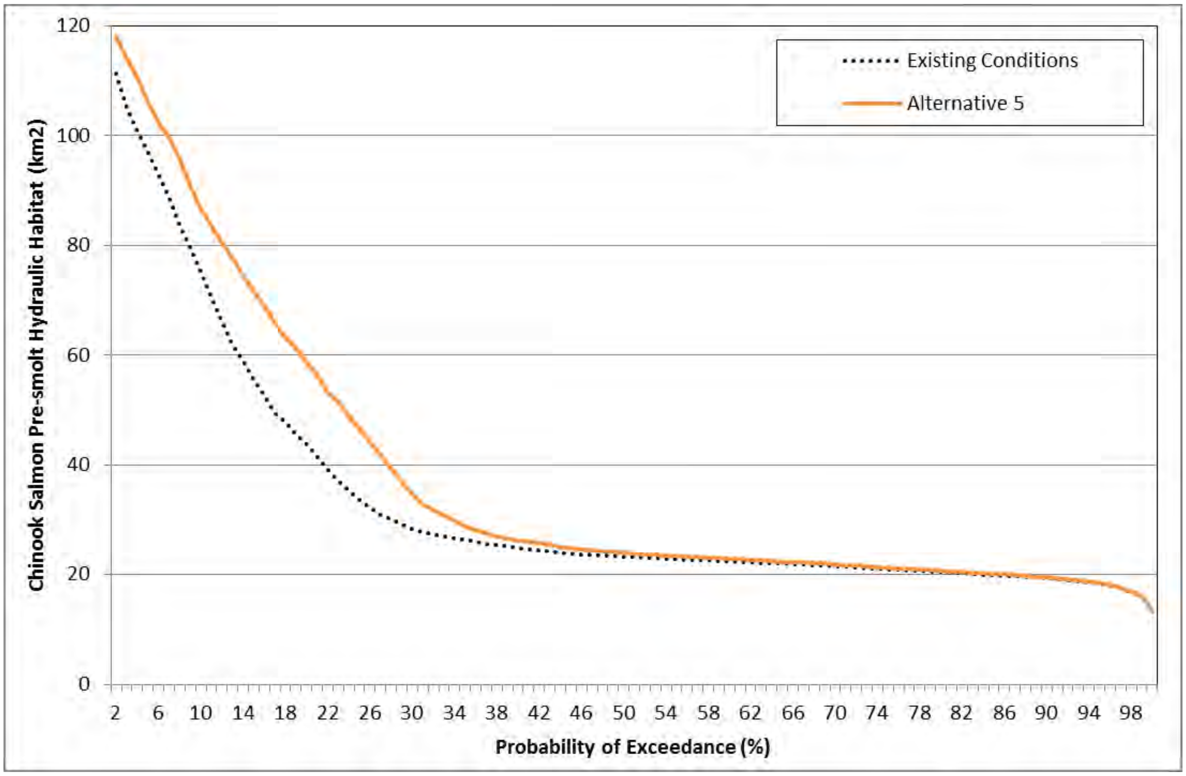

Figure 8-49. Simulated Chinook Salmon Pre-smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternative 5 and Existing Conditions from October through May based on TUFLOW Modeling

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon smolts in the Yolo Bypass under Alternative 5 relative to Existing Conditions would be substantially higher from December through February, somewhat higher (i.e., higher by less than 10 percent) in March, and similar for the remainder of the October through May evaluation period (Table 8-27). Simulated average monthly hydraulic habitat availability by water year type would be substantially higher during most water year types from December through February and during dry and critical water years in March.

Modeling results indicate that Chinook salmon smolt hydraulic habitat availability would be higher under Alternative 5 relative to Existing Conditions over about 40 percent of the exceedance distribution (Figure 8-50). Over the exceedance distribution from November through March, daily hydraulic habitat availability would be substantially higher (i.e., higher by 10 percent or more) about 36 percent of the time and would never be lower by 10 percent or more under Alternative 5.

Table 8-27. Average Monthly Area of Chinook Salmon Smolt Hydraulic Habitat in the Yolo Bypass under Alternative 5 from October through May based on TUFLOW Modeling

Alternative	Area (km^2) October	Area (km^2) November	Area (km^2) December	Area (km^2) January	Area (km^2) February	Area (km^2) March	Area (km^2) April	Area (km^2) May
Entire Simulation Period[1] (n=16)								
Alternative 5	31.5	32.4	51.7	78.7	83.0	82.2	59.3	43.2
Existing Conditions	31.6	32.0	44.2	70.0	69.7	76.0	58.8	43.1
Difference	-0.1	0.4	7.5	8.7	13.3	6.2	0.5	0.1
Percent Difference[2]	-0.3	1.3	17.0	12.4	19.1	8.2	0.9	0.2
Water Year Types[3]								
Wet (n=5)								
Alternative 5	31.3	33.3	70.4	98.5	113.0	123.6	100.3	50.8
Existing Conditions	31.4	32.1	55.4	90.2	100.6	119.0	99.6	50.7
Difference	-0.1	1.2	15.0	8.3	12.4	4.6	0.7	0.1
Percent Difference[2]	-0.3	3.7	27.1	9.2	12.3	3.9	0.7	0.2
Above Normal (n=3)								
Alternative 5	32.0	33.0	52.4	97.0	92.2	80.9	50.6	54.7
Existing Conditions	32.1	32.9	48.3	82.4	68.3	76.6	50.4	54.6
Difference	-0.1	0.1	4.1	14.6	23.9	4.3	0.2	0.1
Percent Difference[2]	-0.3	0.3	8.5	17.7	35.0	5.6	0.4	0.2
Below Normal (n=3)								
Alternative 5	31.6	31.8	40.7	68.3	73.3	67.6	41.0	35.1
Existing Conditions	31.7	31.8	36.2	57.8	62.3	62.6	40.6	34.9
Difference	-0.1	0.0	4.5	10.5	11.0	5.0	0.4	0.2
Percent Difference[2]	-0.3	0.0	12.4	18.2	17.7	8.0	1.0	0.6
Dry (n=4)								
Alternative 5	31.5	31.6	41.0	52.8	45.3	51.7	34.4	33.5
Existing Conditions	31.6	31.5	36.6	48.9	37.9	41.0	33.9	33.4
Difference	-0.1	0.1	4.4	3.9	7.4	10.7	0.5	0.1
Percent Difference[2]	-0.3	0.3	12.0	8.0	19.5	26.1	1.5	0.3
Critical (n=1)								
Alternative 5	30.9	31.2	31.4	59.5	85.2	45.2	34.8	34.0
Existing Conditions	31.0	31.2	30.9	52.1	70.2	39.2	34.4	33.9
Difference	-0.1	0.0	0.5	7.4	15.0	6.0	0.4	0.1
Percent Difference[2]	-0.3	0.0	1.6	14.2	21.4	15.3	1.2	0.3

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)
[2] Relative difference of the monthly average
[3] As defined by the Sacramento Valley Index (DWR 2017c)
Key: km^2 = square kilometer

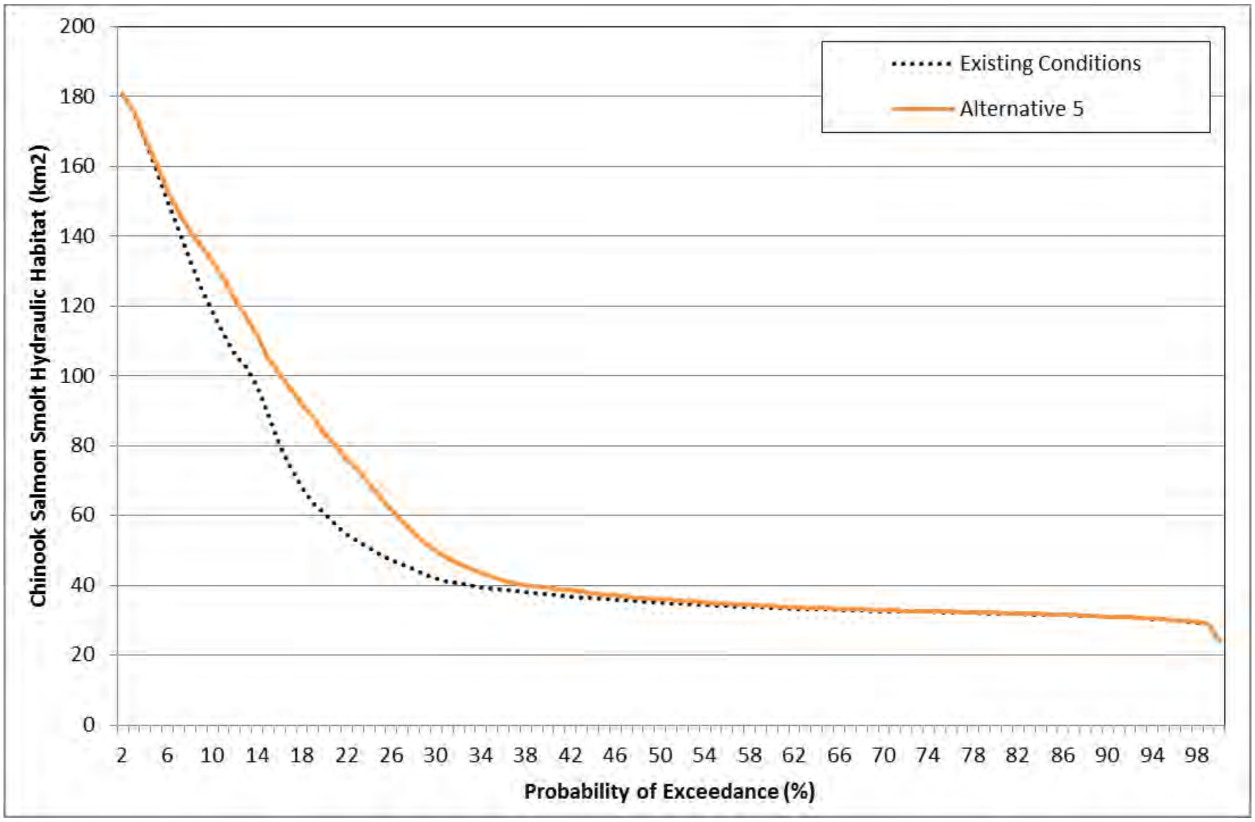

Figure 8-50. Simulated Chinook Salmon Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternative 5 and Existing Conditions from October through May based on TUFLOW Modeling

As previously discussed, changes in estimated hydraulic habitat availability for Chinook salmon pre-smolts is expected to be generally representative of potential changes in hydraulic habitat availability for juvenile Sacramento splittail, and changes in estimated hydraulic habitat availability for Chinook salmon smolts is generally expected to be representative of potential changes in hydraulic habitat availability for adult spawning Sacramento splittail and juvenile steelhead.

To provide a more comprehensive range of potential changes in hydraulic habitat availability for other fish species of focused evaluation, simulated wetted extent (area with a water depth greater than zero) was estimated for the Yolo Bypass under Alternative 5 relative to Existing Conditions. Modeling results indicate that average monthly wetted extent over the entire simulation period would be substantially higher from December and February, somewhat higher (i.e., higher by less than 10 percent) in January and March, and generally similar for the remainder of the October through May evaluation period under both scenarios (Table 8-28). Average monthly wetted area by water year type would be substantially higher during wet water years in December; during above normal, below normal, and critical water years in January; during all water year types except for wet water years in February; and during dry and critical water years in March.

Table 8-28. Average Monthly Wetted Area in the Yolo Bypass under Alternative 5 from October through May based on TUFLOW Modeling

Alternative	Wetted Area (km^2) October	Wetted Area (km^2) November	Wetted Area (km^2) December	Wetted Area (km^2) January	Wetted Area (km^2) February	Wetted Area (km^2) March	Wetted Area (km^2) April	Wetted Area (km^2) May
Entire Simulation Period[1] (n=16)								
Alternative 5	47.6	48.9	72.3	113.9	120.5	114.7	86.3	64.3
Existing Conditions	47.8	48.4	64.1	105.0	106.4	107.5	85.9	64.1
Difference	-0.2	0.5	8.2	8.9	14.1	7.2	0.4	0.2
Percent Difference[2]	-0.4	1.0	12.8	8.5	13.3	6.7	0.5	0.3
Water Year Types[3]								
Wet (n=5)								
Alternative 5	47.4	50.0	95.8	162.8	174.0	168.4	145.5	77.6
Existing Conditions	47.6	48.6	78.9	154.3	161.7	163.4	145.3	77.5
Difference	-0.2	1.4	16.9	8.5	12.3	5.0	0.2	0.1
Percent Difference[2]	-0.4	2.9	21.4	5.5	7.6	3.1	0.1	0.1
Above Normal (n=3)								
Alternative 5	48.3	50.1	72.1	121.6	126.1	116.9	72.7	77.1
Existing Conditions	48.5	49.9	68.3	108.0	100.1	111.7	72.5	77.0
Difference	-0.2	0.2	3.8	13.6	26.0	5.2	0.2	0.1
Percent Difference[2]	-0.4	0.4	5.6	12.6	26.0	4.7	0.3	0.1
Below Normal (n=3)								
Alternative 5	47.8	47.9	58.7	90.0	103.7	95.3	60.1	52.6
Existing Conditions	47.9	47.9	53.9	79.2	91.7	89.6	59.6	52.3
Difference	-0.1	0.0	4.8	10.8	12.0	5.7	0.5	0.3
Percent Difference[2]	-0.2	0.0	8.9	13.6	13.1	6.4	0.8	0.6
Dry (n=4)								
Alternative 5	47.6	47.8	59.7	72.5	64.8	72.7	50.9	50.2
Existing Conditions	47.8	47.6	54.5	68.3	56.0	60.3	50.3	49.9
Difference	-0.2	0.2	5.2	4.2	8.8	12.4	0.6	0.3
Percent Difference[2]	-0.4	0.4	9.5	6.1	15.7	20.6	1.2	0.6
Critical (n=1)								
Alternative 5	46.8	46.6	47.1	83.0	111.2	65.9	51.5	51.0
Existing Conditions	46.9	46.7	46.6	74.4	95.7	58.1	51.1	50.9
Difference	-0.1	-0.1	0.5	8.6	15.5	7.8	0.4	0.1
Percent Difference[2]	-0.2	-0.2	1.1	11.6	16.2	13.4	0.8	0.2

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)
[2] Relative difference of the monthly average
[3] As defined by the Sacramento Valley Index (DWR 2017c)
Key: km^2 = square kilometer

Modeling results indicate that wetted extent would be higher under Alternative 5 relative to Existing Conditions over about 30 percent of the middle to lower portion of the exceedance distribution (Figure 8-51). Over the exceedance distribution from November through March, daily wetted extent would be substantially higher (i.e., higher by 10 percent or more) about 34 percent of the time and would never be lower by 10 percent or more under Alternative 5.

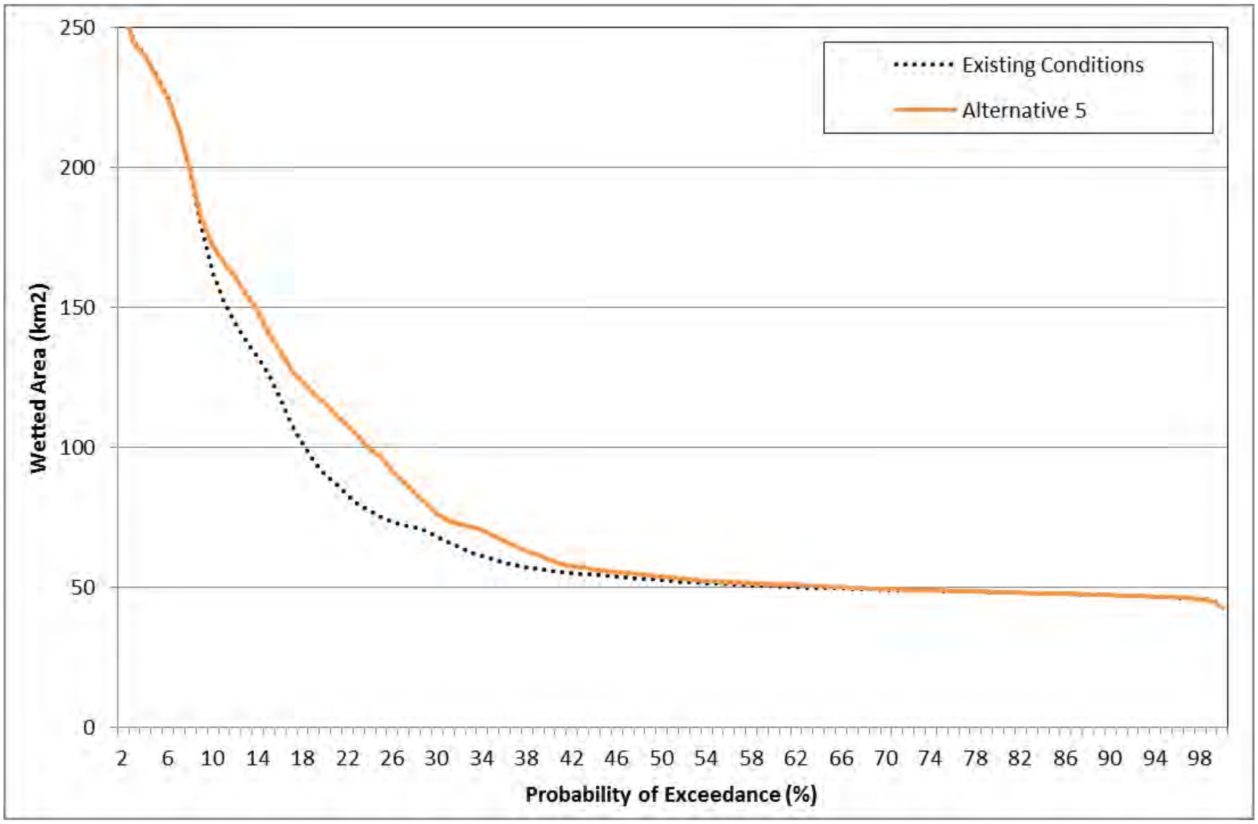

Figure 8-51. Simulated Wetted Area Probability of Exceedance Distributions under Alternative 5 and Existing Conditions from October through May based on TUFLOW Modeling

Average annual modeled wetted days in the Sutter Bypass would decrease under Alternative 5 relative to Existing Conditions by approximately one to seven days in the area of Sutter Bypass between the Sacramento River and Sacramento Slough and one to three days over most of the Sutter Bypass between Sacramento Slough and Nelson Slough.

CEQA Conclusion

In the Yolo Bypass under Alternative 5, increased hydraulic habitat availability for fish species of focused evaluation, particularly juvenile Chinook salmon and steelhead and adult and juvenile Sacramento splittail, is expected to result in more suitable conditions for these and other fish species of focused evaluation. Relatively minor reductions in the number of wetted days in the Sutter Bypass upstream of the Sacramento River at Fremont Weir are not expected to substantially affect rearing or migration of fish species of focused evaluation; therefore, Alternative 5 would be expected to have a **beneficial impact** on flow-dependent hydraulic habitat availability in the Yolo Bypass and a **less than significant impact** on flow-dependent hydraulic habitat availability in the Sutter Bypass.

Impact FISH-13: Impacts to Fisheries Habitat Conditions due to Changes in Water Quality in the Study Area

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 5 relative to Existing Conditions would substantially increase more often from January through March. Therefore, increased flows and the potential for increased wetting and drying of the Yolo Bypass could increase the amount of methylmercury and other contaminants in the Yolo Bypass and in fish prey. Increased concentrations of contaminants in the Yolo Bypass could potentially result in an increase in the exportation of contaminated water to the Delta. However, for juvenile Chinook salmon rearing in the Yolo Bypass, increased concentrations of accumulated methylmercury were reported to be insignificant in the tissues of the eventual adult-sized fish (Henery et al. 2010). Effects of increased methylmercury accumulation could be more substantial on resident fish species such as largemouth bass. Increased flows in the Yolo Bypass also could temporarily increase turbidity levels in the Yolo Bypass.

CEQA Conclusion

Based on higher mean monthly flows entering the Yolo Bypass, increased concentrations of methylmercury and other contaminants may occur in the Yolo Bypass and the Delta. However, the potential for increased concentrations of contaminants is not expected to substantially affect fish species of focused evaluation; therefore, Alternative 5 would have a **less than significant impact**.

Impact FISH-14: Impacts to Aquatic Primary and Secondary Production in the Study Area

Modeling results indicate that Alternative 5 would result in increased frequency and duration of inundation of the Yolo Bypass relative to Existing Conditions. An increase in frequency and duration of inundation of shallow-water habitat in the Yolo Bypass would be expected to increase primary production in the Yolo Bypass (Lehman et al. 2007). Increased primary and associated secondary production in the Yolo Bypass would likely increase food resources for fish species of focused evaluation in the Yolo Bypass. More productive water in the Yolo Bypass also could potentially be exported to the Delta downstream of the Yolo Bypass, which could increase food resources for fish in the Delta.

Modeled wetted area of the Yolo Bypass under Alternative 1 relative to Existing Conditions was used as an indicator of relative changes in inundation and associated primary and secondary production. As described above, increases in average monthly wetted area would occur under Alternative 5 relative to Existing Conditions, particularly from December through March, depending on water year type. Increased food resources in the Yolo Bypass during this period would be expected to improve growth and survival of some fish species of focused evaluation such as Chinook salmon and freshwater resident species. The potential for increased productivity downstream of the Yolo Bypass also could improve growth and survival of fish species of focused evaluation, particularly Delta resident species such as delta smelt.

Minor reductions in wetted area in the Sutter Bypass could reduce primary and secondary production in the Sutter Bypass. However, these reductions in wetted area would not be expected to substantially affect primary or secondary production in the Sutter Bypass or substantially affect fish species of focused evaluation in the Sutter Bypass.

CEQA Conclusion

Based on increased wetted extent in the Yolo Bypass during the winter, increased primary and secondary production in the Yolo Bypass (and potentially in localized areas of the Delta) could increase food resources for fish species of focused evaluation. In the Sutter Bypass, slight reductions in wetted area could reduce primary and secondary production, but these reductions are not expected to be sufficient to substantially affect food resources for fish species of focused evaluation. Therefore, Alternative 5 would result in a **beneficial impact** in the Yolo Bypass and a **less than significant impact** in the Sutter Bypass.

Impact FISH-15: Impacts to Fish Species of Focused Evaluation due to Changes in Adult Fish Passage Conditions through the Yolo Bypass

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir would substantially increase more often from January through March. Therefore, the duration of potential adult fish passage from the Yolo Bypass into the Sacramento River may potentially increase for late fall-run Chinook salmon, spring-run Chinook salmon, winter-run Chinook salmon, steelhead, green and white sturgeon, and Pacific and river lamprey, potentially providing for increased spawning success in the Sacramento River and its tributaries and reduced potential for mortality or migration delay in the Yolo Bypass. There is the potential that increased flows entering the Delta from the Yolo Bypass could attract more adult fish into the Yolo Bypass relative to the Sacramento River. However, adult fish passage would be provided at Fremont Weir more often relative to Existing Conditions.

Based on results of the YBPASS Tool, which applied fish passage criteria to modeled hydraulic conditions in the intake facility and transport channel under Alternative 5, adult salmon and sturgeon would be expected to successfully pass upstream through the transport channels and intake structures into the Sacramento River about 24 percent of the days from November through April over the water years 1997 through 2012 simulation period. The annual average date after which Alternative 5 would no longer meet the fish passage criteria is April 1.

Because Alternative 5 was designed to entrain more juvenile winter-run Chinook salmon at lower Sacramento River stages, Alternative 5 includes more complicated headworks with three separate notches at different elevations and multiple transport channels in the Yolo Bypass. Because different gates can be opened and closed based on changes in Sacramento River flows, there is the potential to cause delays in upstream migration of adults if gate operations are being modified as adults are attempting to move through the intake facilities.

CEQA Conclusion

Increased duration of potential adult fish passage opportunity from the Yolo Bypass into the Sacramento River under Alternative 5 is expected to result in improved upstream spawning success and less potential for mortality or migration delay for fish species of focused evaluation;

therefore, Alternative 5 would be expected to have a **beneficial impact** on adult fish passage conditions through the Yolo Bypass.

Impact FISH-16: Impacts to Fish Species due to Changes in Potential for Stranding and Entrainment

Project facilities constructed under Alternative 5, such as the transport and intake channels, would be graded to provide suitable passage conditions for fish, assuming sufficient water is present. Although Alternative 5 would allow for entrainment of juvenile fish at lower flows relative to Existing Conditions, the design of the transport channel to Tule Canal is expected to minimize the potential for stranding of juveniles. However, anthropogenic structures that interrupt natural drainage patterns, such as water control structures, create the greatest risk for stranding (Sommer et al. 2005). Therefore, there is some potential for increased juvenile stranding in the Yolo Bypass.

Because Alternative 5 would allow for adult migration into the Sacramento River during periods when adult migration is impeded or blocked at Fremont Weir under Existing Conditions, the potential for adult fish stranding in the Yolo Bypass would be expected to be reduced. However, because the Fremont Weir notch would be in the central region of the Fremont Weir and the supplemental fish passage facility would be located at the western region of the Fremont Weir, adults located near the eastern portion of Fremont Weir may still have the same likelihood of stranding that occurs under Existing Conditions.

CEQA Conclusion

The overall potential for adult fish stranding would be expected to be reduced under Alternative 5 relative to Existing Conditions. Juvenile stranding may potentially increase under Alternative 5, but design of the project facilities is expected to minimize any increases in juvenile stranding. Therefore, Alternative 5 would be expected to have a **less than significant impact** on stranding and entrainment.

Impact FISH-17: Impacts to Fish Species due to Changes in Potential for Predation

Construction of the intake facility, supplemental fish passage facility, and intake and transport channels lined with rock could increase the potential for predation of fish species of focused evaluation under Alternative 5 relative to Existing Conditions by providing habitat for predatory fish species in these areas. However, the facilities on the Sacramento River are not expected to substantially increase the potential area of refugia for species such as striped bass relative to Existing Conditions. Increased flow pulses into the Yolo Bypass associated with Alternative 5 during the winter months (primarily December through March) could reduce the potential for predation of fish species such as juvenile salmonids by non-native fish species. For example, Sommer et al. (2014) found that increased connectivity to the Yolo Bypass would provide an overall benefit to native fish species, particularly during the winter, because it is prior to the spawning periods of non-native fish species in the spring. Frantzich et al. (2013) found that native fish species were more widely distributed during wetter years, and low flows may provide more suitable conditions for the spawning and recruitment of non-native centrarchids. Opperman et al. (2017) argued that flooding the Yolo Bypass from January through April would benefit native fish species. In addition, given the perennial nature of the Tule Canal and its ability to support non-native fish species under Existing Conditions, it is not expected that the proposed facilities under Alternative 5 would increase predation of fish species of focused evaluation above baseline levels in the Yolo Bypass. In addition, results of the SBM (evaluated under *Impact FISH-18*) account for predation associated with the estimated migration path and migration duration for juvenile Chinook salmon in the Yolo Bypass associated with Alternative 5.

CEQA Conclusion

Overall potential for predation of fish species of focused evaluation is not expected to substantially differ relative to predation rates under Existing Conditions; therefore, Alternative 5 would be expected to have a **less than significant impact** due to changes in predation.

Impact FISH-18: Impacts to Chinook Salmon Species/Runs due to Changes in Viable Salmonid Population Parameters

As previously discussed, model output from the SBM is used to evaluate the VSP parameters (abundance, productivity, diversity, and spatial structure) for fall-run, late fall-run, spring-run, and winter-run Chinook salmon.

Abundance and Productivity

Modeling results indicate that annual average adult Chinook salmon returns under Alternative 5 relative to Existing Conditions would be generally similar or slightly higher (i.e., higher by about 5 percent or less) over the entire simulation period and during most water year types for fall-run Chinook salmon but would be substantially higher during critical water years. Annual average adult returns would be similar over the entire simulation period and by water year type for late fall-run and winter-run Chinook salmon and higher (by less than 10 percent) over the entire simulation period and during most water year types for spring-run Chinook salmon (Table 8-29). Similarly, the adult fall-run Chinook salmon returns probability of exceedance distribution for Alternative 5 is generally similar or slightly higher over the entire distribution relative to Existing Conditions (Figures 8-52 through 8-55).

Table 8-29. Average Annual Chinook Salmon Adult Returns under Alternative 5

Alternative	Entire Simulation Period[1]	Water Year Types[2] Wet	Water Year Types[2] Above Normal	Water Year Types[2] Below Normal	Water Year Types[2] Dry	Water Year Types[2] Critical
Fall-run Chinook Salmon						
Alternative 5	180,969	242,555	206,474	85,135	166,718	45,193
Existing Conditions	172,025	232,876	192,956	82,267	158,383	39,065
Difference	8,944	9,679	13,519	2,868	8,336	6,128
Percent Difference[3]	5	4	7	3	5	16
Late Fall-run Chinook Salmon						
Alternative 5	57,645	59,408	67,542	19,686	61,505	79,617
Existing Conditions	58,390	60,218	68,937	19,914	61,780	81,012
Difference	-746	-810	-1,395	-228	-275	-1,395
Percent Difference[3]	-1	-1	-2	-1	0	-2
Spring-run Chinook Salmon						
Alternative 5	6,300	9,425	6,012	2,295	5,088	4,399
Existing Conditions	5,960	8,803	5,821	2,174	4,884	4,031
Difference	340	622	191	121	204	368
Percent Difference[3]	6	7	3	6	4	9
Winter-run Chinook Salmon						
Alternative 5	5,629	5,709	5,570	5,357	6,317	3,197
Existing Conditions	5,518	5,504	5,558	5,334	6,197	3,118
Difference	111	205	13	24	119	79
Percent Difference[3]	2	4	0	0	2	3

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)
[2] As defined by the Sacramento Valley Index (DWR 2017c)
[3] Relative difference of the annual average

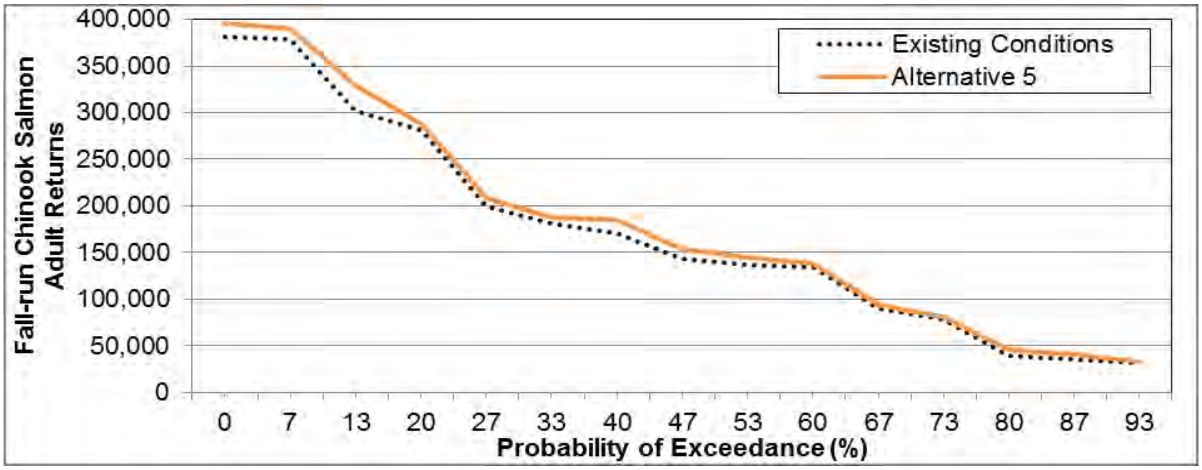

Figure 8-52. Simulated Adult Fall-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

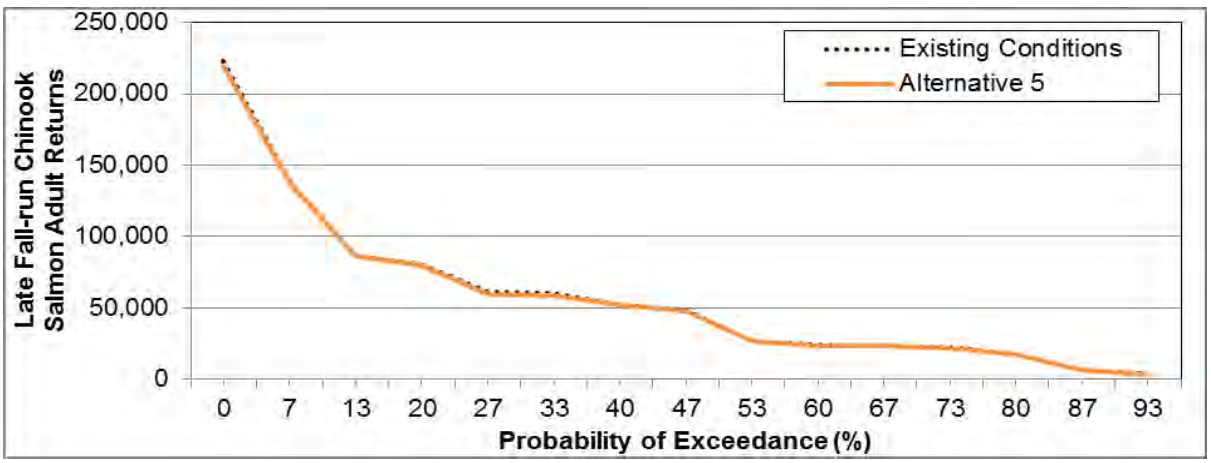

Figure 8-53. Simulated Adult Late Fall-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

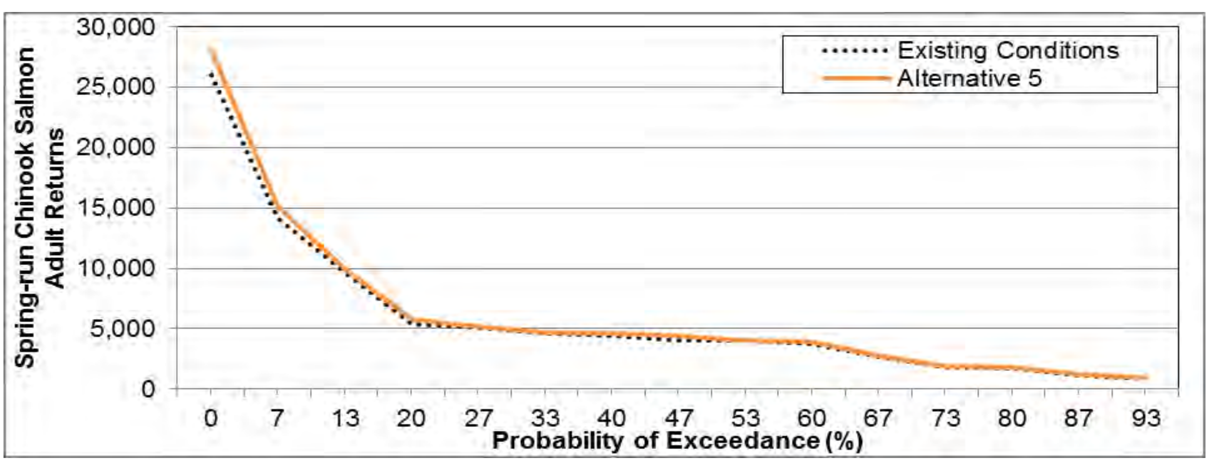

Figure 8-54. Simulated Adult Spring-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

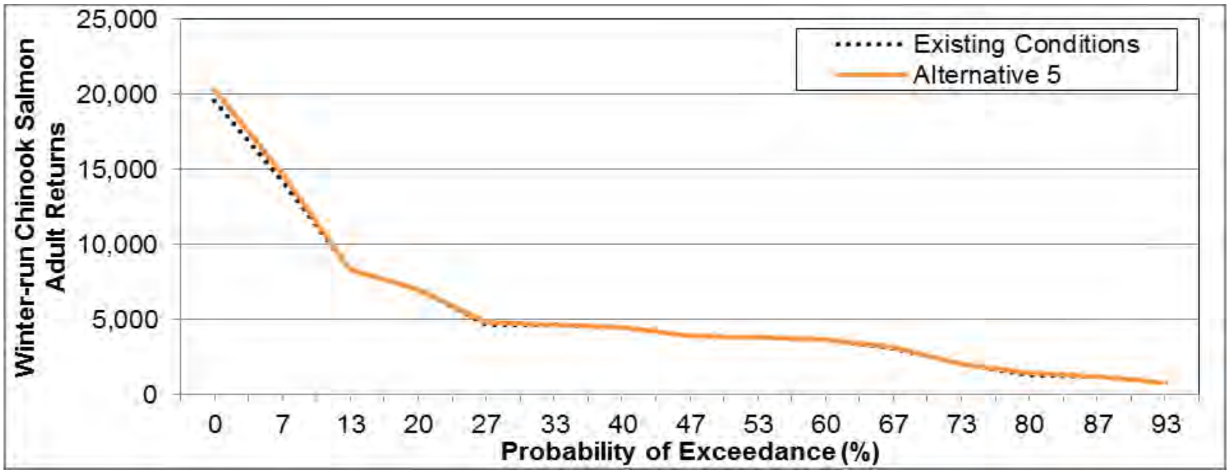

Figure 8-55. Simulated Adult Winter-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

Diversity

VARIATION IN JUVENILE CHINOOK SALMON SIZE

Modeling results indicate that annual average juvenile fall-run Chinook salmon coefficient of variation in size (FL) under Alternative 5 relative to Existing Conditions would be substantially higher over the entire simulation period and during most water year types for fall-run, spring-run, and winter-run Chinook salmon and would be similar over the entire simulation period and by water year type for late fall-run Chinook salmon (Table 8-30).

The juvenile fall-run Chinook salmon coefficient of variation in size probability of exceedance distribution for Alternative 5 would be substantially higher over most of the distribution for fall-run, spring-run, and winter-run Chinook salmon and would be similar over the entire distribution for late fall-run Chinook salmon (Figures 8-56 through 8-59).

Table 8-30. Average Annual Juvenile Chinook Salmon Coefficient of Variation in Size under Alternative 5

Alternative	Entire Simulation Period[1]	Water Year Types[2] Wet	Water Year Types[2] Above Normal	Water Year Types[2] Below Normal	Water Year Types[2] Dry	Water Year Types[2] Critical
Fall-run Chinook Salmon						
Alternative 5	0.42	0.46	0.41	0.39	0.40	0.38
Existing Conditions	0.35	0.44	0.32	0.35	0.31	0.13
Difference	0.07	0.02	0.09	0.04	0.09	0.25
Percent Difference[3]	20	4	27	10	29	193
Late Fall-run Chinook Salmon						
Alternative 5	0.33	0.41	0.48	0.50	0.11	0.07
Existing Conditions	0.33	0.41	0.48	0.50	0.11	0.07

Alternative	Entire Simulation Period[1]	Water Year Types[2] Wet	Water Year Types[2] Above Normal	Water Year Types[2] Below Normal	Water Year Types[2] Dry	Water Year Types[2] Critical
Difference	0.00	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	0	1	0	0	0	0
Spring-run Chinook Salmon						
Alternative 5	0.35	0.45	0.33	0.33	0.26	0.29
Existing Conditions	0.30	0.42	0.30	0.26	0.22	0.18
Difference	0.05	0.03	0.04	0.07	0.04	0.11
Percent Difference[3]	15	8	13	27	18	63
Winter-run Chinook Salmon						
Alternative 5	0.17	0.22	0.14	0.19	0.12	0.09
Existing Conditions	0.14	0.20	0.12	0.17	0.10	0.06
Difference	0.02	0.03	0.02	0.02	0.02	0.04
Percent Difference[3]	17	13	21	11	23	60

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)
[2] As defined by the Sacramento Valley Index (DWR 2017c)
[3] Relative difference of the annual average

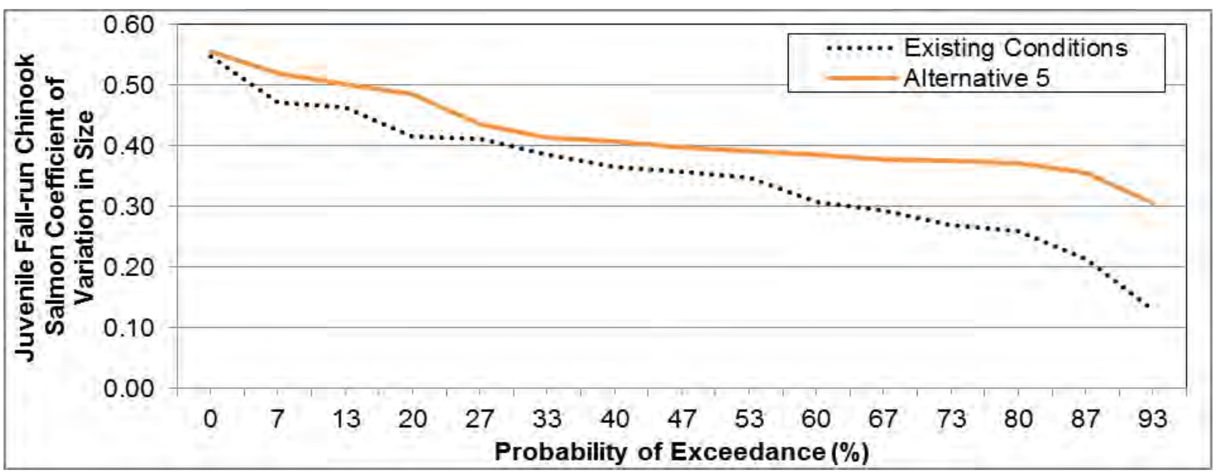

Figure 8-56. Simulated Juvenile Fall-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

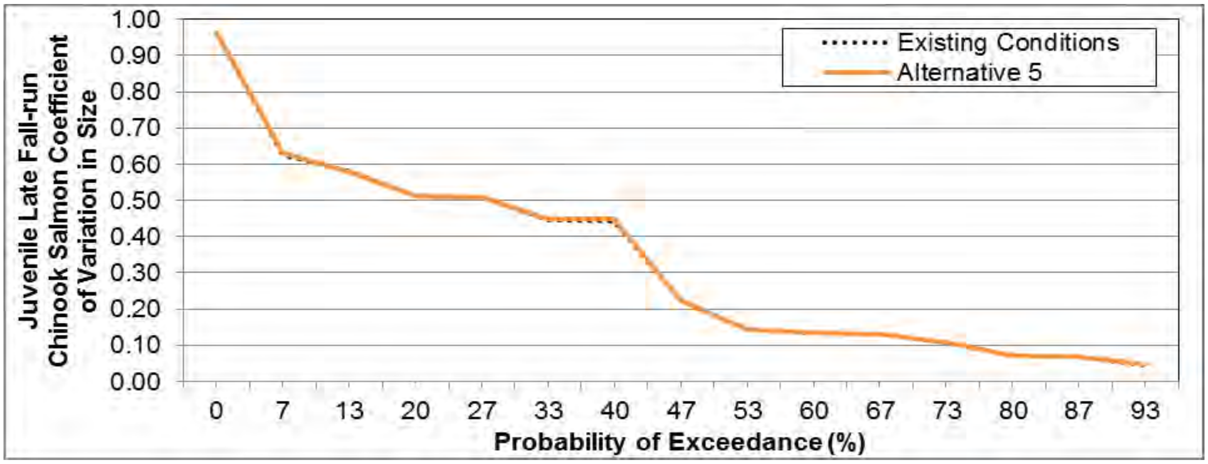

Figure 8-57. Simulated Juvenile Late Fall-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

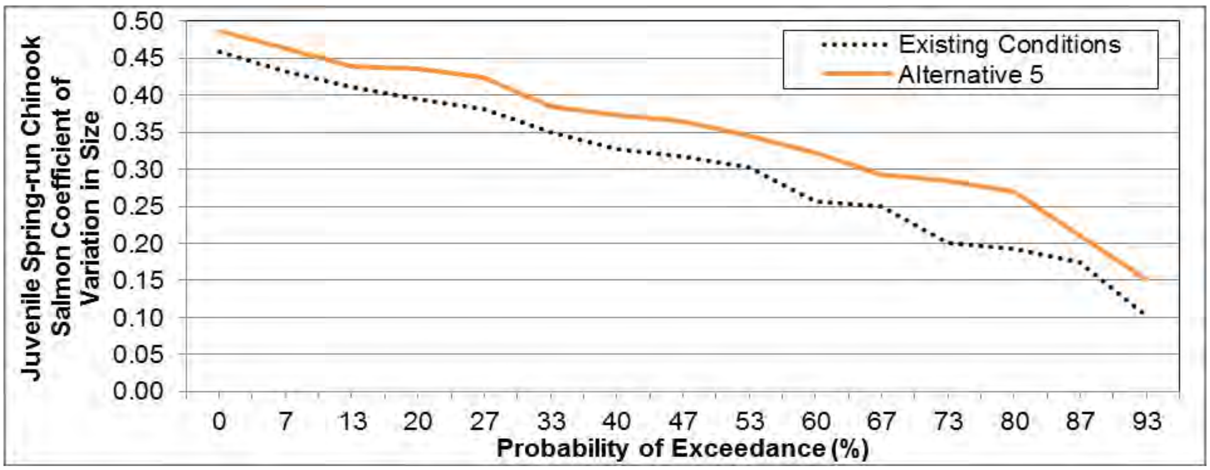

Figure 8-58. Simulated Juvenile Spring-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

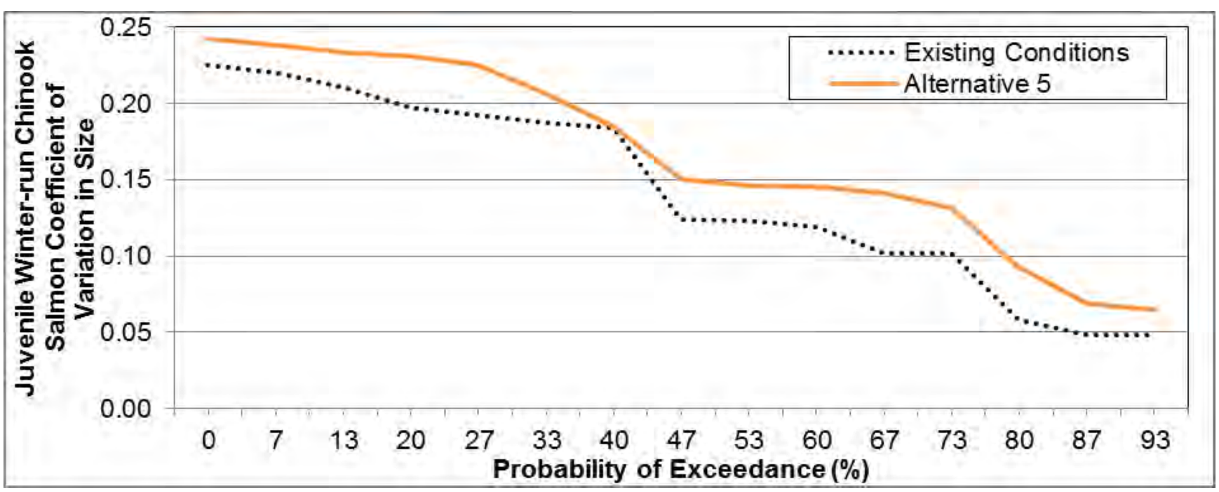

Figure 8-59. Simulated Juvenile Winter-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

VARIATION IN JUVENILE CHINOOK SALMON ESTUARY ENTRY TIMING

Modeling results indicate that annual average juvenile Chinook salmon coefficient of variation in estuary entry timing under Alternative 5 relative to Existing Conditions would be slightly higher over the entire simulation period; similar during wet and below normal water years; and higher or substantially higher during above normal, dry, and critical water years for fall-run Chinook salmon (Table 8-31). Annual average juvenile Chinook salmon coefficient of variation in estuary entry timing under Alternative 5 relative to Existing Conditions would be similar over the entire simulation period and during most water year types for late fall-run, spring-run, and winter-run Chinook salmon but would be substantially higher during critical water years for spring-run Chinook salmon.

The juvenile Chinook salmon coefficient of variation in estuary entry timing probability of exceedance distributions would be similar or higher over most of the distributions under Alternative 5 relative to Existing Conditions for fall-run, spring-run, and winter-run Chinook salmon and would be similar for late fall-run Chinook salmon (Figures 8-60 through 8-63).

Table 8-31. Average Annual Juvenile Chinook Salmon Coefficient of Variation in Estuary Entry Timing under Alternative 5

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 5	0.25	0.29	0.24	0.25	0.21	0.20
Existing Conditions	0.24	0.29	0.22	0.25	0.19	0.16
Difference	0.01	0.00	0.02	0.00	0.02	0.05
Percent Difference[3]	5	0	9	2	11	28
Late Fall-run Chinook Salmon						
Alternative 5	0.33	0.44	0.33	0.21	0.29	0.15
Existing Conditions	0.33	0.44	0.33	0.21	0.29	0.15
Difference	0.00	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	0	-1	-1	0	0	-1
Spring-run Chinook Salmon						
Alternative 5	0.30	0.39	0.28	0.28	0.24	0.21
Existing Conditions	0.29	0.38	0.28	0.26	0.23	0.18
Difference	0.01	0.01	0.01	0.02	0.01	0.03
Percent Difference[3]	3	1	2	6	3	14

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Winter-run Chinook Salmon						
Alternative 5	0.28	0.39	0.23	0.31	0.22	0.13
Existing Conditions	0.28	0.38	0.22	0.30	0.21	0.12
Difference	0.01	0.01	0.01	0.01	0.01	0.01
Percent Difference[3]	2	2	3	2	3	7

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

[3] Relative difference of the annual average

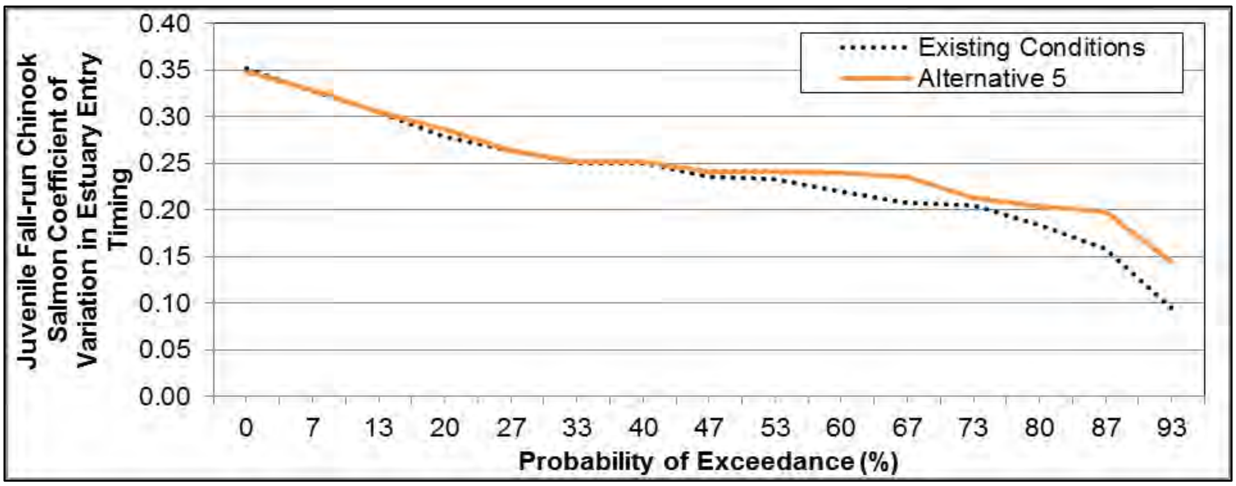

Figure 8-60. Simulated Juvenile Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under Alternative 5 and Existing Conditions

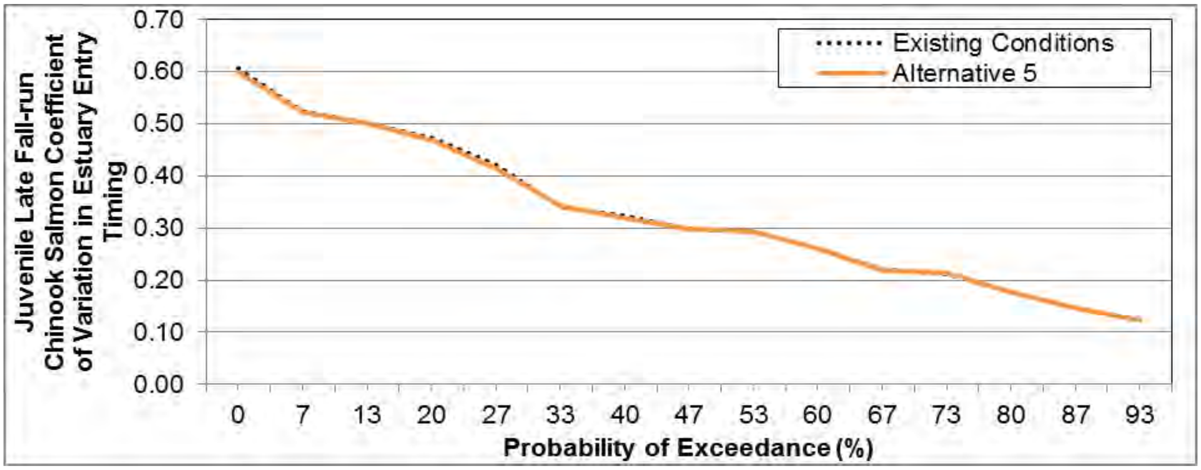

Figure 8-61. Simulated Juvenile Late Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 5

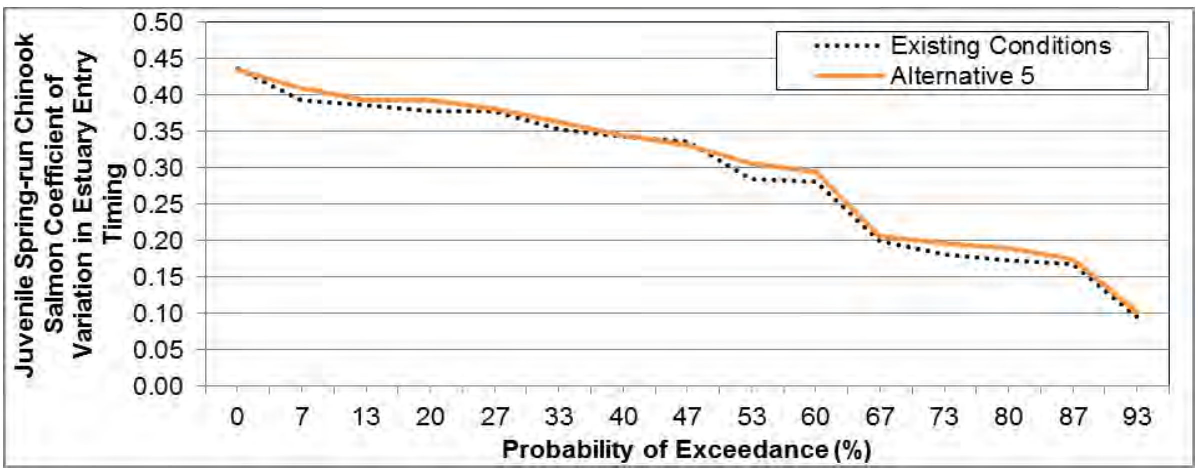

Figure 8-62. Simulated Juvenile Spring-Run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 5

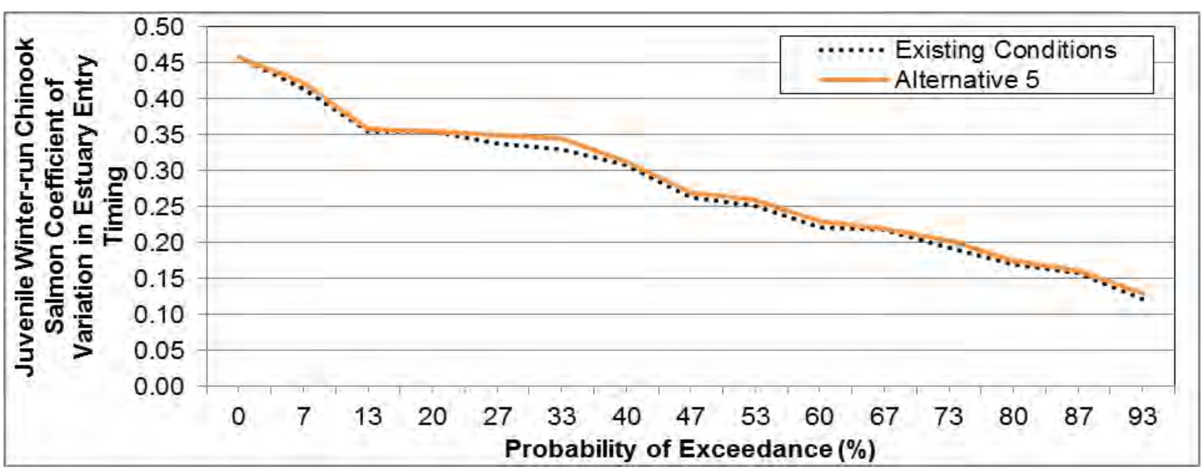

Figure 8-63. Simulated Juvenile Winter-run Chinook salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 5

Spatial Structure

ENTRAINMENT INTO THE YOLO BYPASS

Modeling results indicate that mean monthly flows spilling into the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 5 relative to Existing Conditions would be higher from November through March and would be similar over the remainder of the year under both scenarios (see Appendix G6). Mean monthly flows would be substantially higher (i.e., higher by 10 percent or more) during at least some water year types in November (wet water years), December (wet and above normal water years), January (above normal, below normal, and dry water years), February (above normal, below normal, dry, and critical water years), and March (below normal and dry water years). Over the entire simulation period, net increases in flows of 10 percent or more would occur with substantially higher frequency (i.e., 10 percent or more of the time) from December through March (see Appendix G6).

Based on increases in simulated monthly flows from December through March, it is expected that juvenile salmonids and potentially other fish species would be more likely to be entrained into the Yolo Bypass from December through March under Alternative 5 relative to Existing Conditions.

The estimated average annual percentages of juvenile fall-run, late fall-run, winter-run, and spring-run Chinook salmon (all sizes) entrained into the Yolo Bypass using the proportion of flow approach would be about 13.3, 5.4, 9.8, and 8.8 percent under Alternative 5, respectively (relative to about 7.1, 2.6, 3.9, and 3.1 percent, respectively, under Existing Conditions) (DWR 2017a; Appendix G3). For smaller juveniles (i.e., <80 mm), the percentages of fall-run, late fall-run, winter-run, and spring-run Chinook salmon entrained into the Yolo Bypass would be 13.8, 1.0, 6.2, and 9.4 percent, respectively (DWR 2017a; Appendix G3).

The ELAM modeling indicates that the entrainment-Sacramento River stage relationship under Alternative 5 exhibits a positive relationship as Sacramento River stage increases from 21.16 to 25.54 ft. Without the proposed Sacramento River channel and bank improvements, the percent of juveniles entrained under Alternative 5 would peak at about 5.6 percent at a stage of 25.54 ft and would decrease to about 2.6 percent at the highest stage modeled (28.83 ft) (Smith et al. 2017; Appendix G1). However, including the proposed modifications to the Sacramento River channel and bank to improve hydraulic entrainment conditions suggests that Alternative 5 could entrain up to about 10 percent of juveniles (see Smith et al. 2017).

JUVENILE REARING IN THE YOLO BYPASS FOR ONE OR MORE DAYS

Modeling results indicate that annual average numbers of juvenile fall-run Chinook salmon rearing for one or more days in the Yolo Bypass under Alternative 5 relative to Existing Conditions would be substantially higher over the entire simulation period and during all water year types for fall-run, late fall-run, spring-run, and winter-run Chinook salmon (Table 8-32).

The annual proportion of juvenile Chinook salmon rearing for one or more days in the Yolo Bypass exceedance distribution for Alternative 5 would be substantially higher over the entire distribution relative to Existing Conditions for fall-run, spring-run, and winter-run Chinook salmon and would be higher over most of the distribution for late fall-run Chinook salmon (Figures 8-64 through 8-67).

In addition, Alternative 5 would allow for juvenile rearing in the Yolo Bypass over about 20 percent of the distribution when no juvenile fall-run Chinook salmon would be rearing in the Yolo Bypass, over about 40 percent of the distribution when no juvenile late fall-run Chinook salmon would be rearing in the Yolo Bypass, and over about 30 percent of the distribution when no juvenile spring-run and winter-run Chinook salmon would be rearing in the Yolo Bypass under Existing Conditions.

Table 8-32. Average Annual Number of Juvenile Fall-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days under Alternative 5

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 5	4,409,403	9,343,903	4,247,306	889,485	1,052,912	688,990
Existing Conditions	3,179,250	8,028,286	2,198,294	436,145	20,038	0
Difference	1,230,153	1,315,617	2,049,011	453,341	1,032,874	688,990
Percent Difference[3]	39	16	93	104	5,155	n/a
Late Fall-run Chinook Salmon						
Alternative 5	237,623	659,907	44,622	15,584	24,807	551
Existing Conditions	190,830	571,919	953	0	0	0
Difference	46,793	87,988	43,668	15,584	24,807	551
Percent Difference[3]	25	15	4,581	n/a	n/a	n/a
Spring-run Chinook Salmon						
Alternative 5	80,948	161,542	72,070	18,363	27,482	43,648
Existing Conditions	32,657	72,311	41,409	1,894	70	0
Difference	48,291	89,231	30,660	16,470	27,411	43,648
Percent Difference[3]	148	123	74	870	39,020	n/a
Winter-run Chinook Salmon						
Alternative 5	61,011	97,614	77,902	26,558	29,824	20,975
Existing Conditions	28,031	54,261	46,976	3,552	283	0
Difference	32,979	43,353	30,926	23,006	29,541	20,975
Percent Difference[3]	118	80	66	648	10,429	n/a

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

[3] Relative difference of the annual average

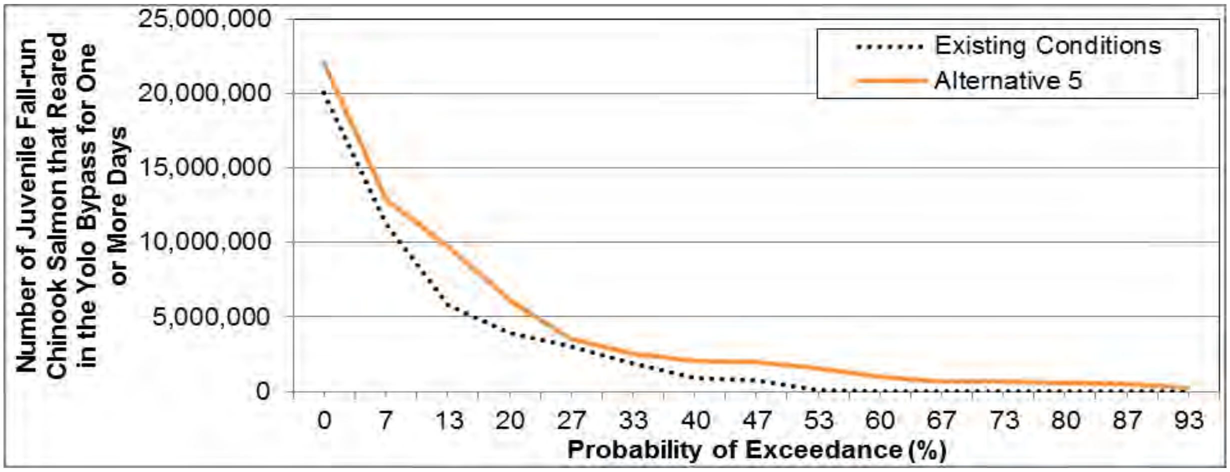

Figure 8-64. Simulated Number of Juvenile Fall-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 5

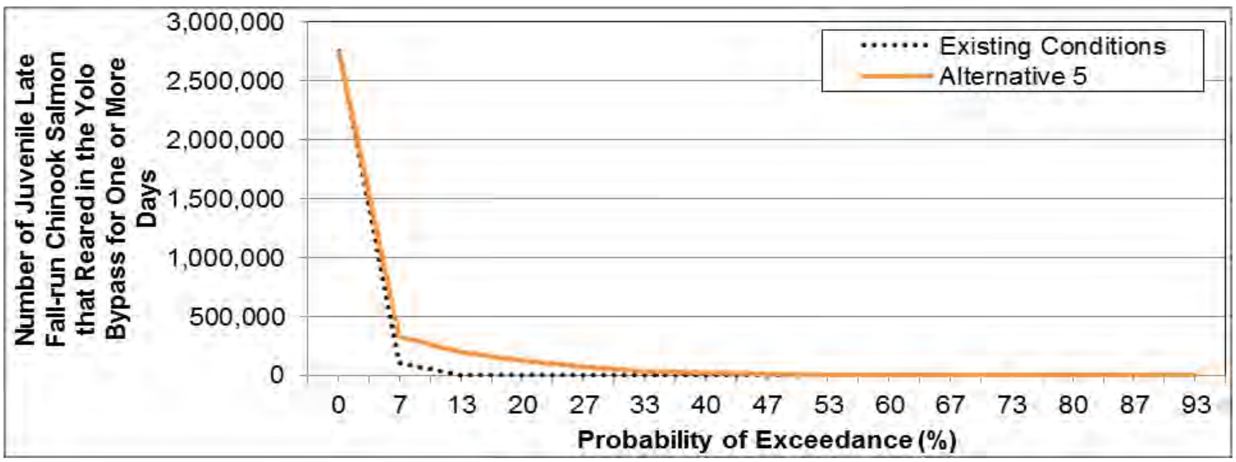

Figure 8-65. Simulated Number of Juvenile Late Fall-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 5

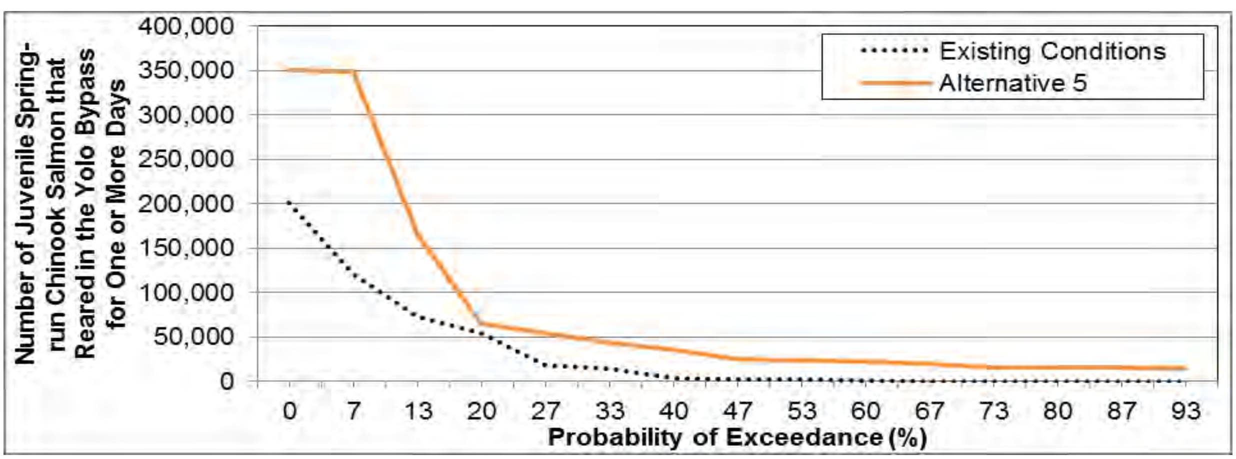

Figure 8-66. Simulated Number of Juvenile Spring-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 5

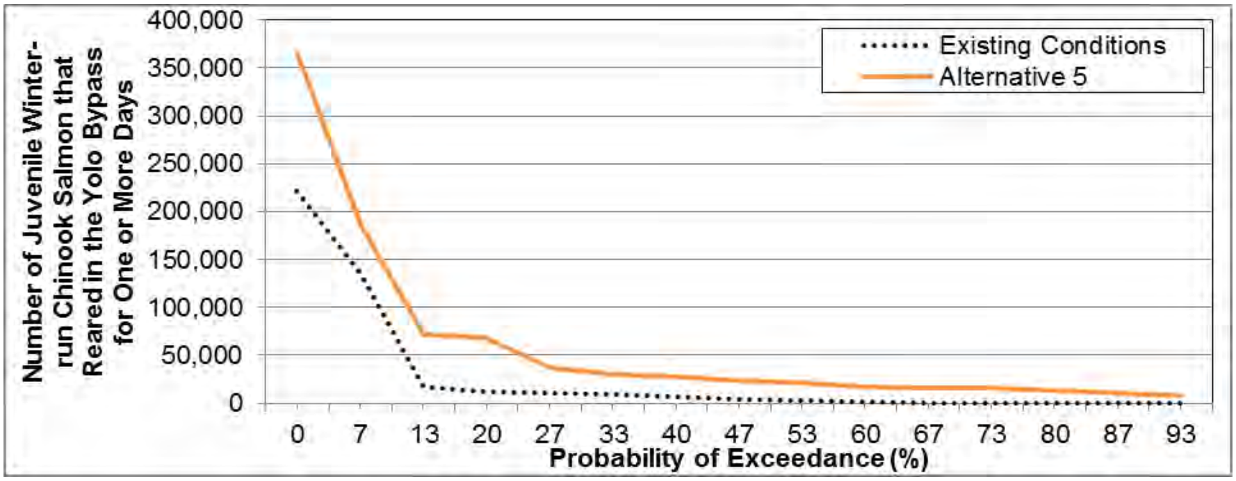

Figure 8-67. Simulated Number of Juvenile Winter-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 5

CEQA Conclusion

Simulated population metric indicators from the SBM were used to evaluate changes in the VSP parameters under Alternative 5 relative to Existing Conditions. Except for the abundance and productivity parameters for late fall-run and winter-run Chinook salmon and the diversity parameter for late fall-run Chinook salmon, which indicate generally similar conditions under Alternative 5 and Existing Conditions, the abundance, productivity, diversity, and spatial structure indicators all exhibit improvement for fall-run, late fall-run, spring-run, and winter-run Chinook salmon under Alternative 5 relative to Existing Conditions.

Therefore, Alternative 5 would be expected to have a **less than significant impact**.

Impact FISH-19: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Hydrologic Conditions in the SWP/CVP System

Changes in simulated mean monthly storages in the SWP/CVP system under Alternative *5* relative to the basis of comparison would be similar to those described for Alternative 1. Therefore, simulated changes under Alternative 5 relative to the No Action Alternative (and Existing Conditions) would not result in substantial adverse effects to fish species of focused evaluation and their habitats in the SWP/CVP system.

CEQA Conclusion

Due to similar modeled hydrology in the SWP/CVP system, Alternative 5 would be expected to have a **less than significant impact**.

Impact FISH-20: Conflict with Adopted Habitat Conservation Plan; Natural Community Conservation Plan; or Other Approved Local, Regional, or State Habitat Conservation Plan

Although the Yolo County HCP/NCCP does not directly address fish species, it does include goals and policies related to protecting and improving habitat conditions in the Yolo Bypass that could indirectly benefit fish resources (Yolo Habitat Conservancy 2017). Because Alternative 5 would include mitigation for physical habitat impacts, Alternative 5 would not conflict with HCPs or NCCPs, including the Yolo County HCP/NCCP (Yolo Habitat Conservancy 2017).

CEQA Conclusion

Alternative 5 is expected to have a **less than significant impact** relative to Existing Conditions.

Impact FISH-21: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Tule Canal Floodplain Improvements (Program Level)

As described in Section 2.8.1.7, Alternative 5 would include floodplain improvements along Tule Canal, just north of I-80. These improvements would not be constructed at the same time as the remaining facilities. They would not be necessary for the project-level components to function but would enhance the performance of the overall alternatives. They are included at a program level of detail to consider all the potential impacts and benefits of Alternative 5. Subsequent consideration of environmental impacts would be necessary before construction could begin.

The floodplain improvements would develop a series of secondary channels that connect to Tule Canal north of I-80 (see Figure 2-21 in Chapter 2, *Description of Alternatives*). These channels would increase inundation and available fish rearing habitat in the surrounding areas, which are currently managed as wetland habitat for waterfowl. The floodplain improvement channels would have a 30-foot bottom width with 3:1 side slopes (horizontal to vertical). An operable weir in the Tule Canal would help increase the water surface elevation upstream and move water into these channels. These improvements also include a bypass channel around the weir with a 10-foot bottom width and 3:1 side slopes (horizontal to vertical). The bypass channel would be about 2,100 feet long and convey up to 300 cfs. These channels would increase inundation in the surrounding areas, which are currently managed as wetland habitat for waterfowl.

Implementation of Tule Canal floodplain improvements would have the potential to adversely impact the same species and habitats identified above in impacts FISH-1 through FISH-8 (i.e., construction- and maintenance-related impacts) and FISH-12 through FISH-18 (i.e., operations-related impacts in the Yolo Bypass). When final plans and specifications of the improvements are determined, impacts will need to be quantified, and appropriate avoidance, minimization, and compensatory mitigation measures will be applied.

CEQA Conclusion

Construction-related impacts associated with the Tule Canal floodplain improvements would be **significant** because construction of the Tule Canal floodplain improvements could result in direct and indirect construction-related effects on species and associated suitable habitats. However, implementation of MM-WQ-1: Prepare and Implement a Spill Prevention, Control, and Countermeasure Plan, MM-WQ-2: Implement a Stormwater Pollution and Prevention Plan, MM-WQ-3: Develop Turbidity Monitoring Program, MM-TERR-7: Restoration of Temporarily Disturbed Giant Garter Snake Aquatic and Upland Habitat, MM-FISH-1: Restore Degraded Riparian and SRA Habitat, MM-FISH-2: Implement an Underwater Noise Reduction and Monitoring Plan, MM-FISH-3: Prepare a Fish Rescue and Salvage Plan, and MM-FISH-4: Implement General Fish Protection Measures would reduce construction-related impacts to **less than significant**.

Impacts from operations could cause adverse effects. The operable weir and bypass channels could result in passage delays for migratory fish species moving through the Tule Canal, which would be a **significant impact**. However, implementation of MM-FISH-5: Adult Fish Passage Monitoring and Adaptive Management would reduce this to a **less than significant impact**.

Additional operations-related impacts under the Tule Canal floodplain improvements relative to Existing Conditions include increased potential for stranding and predation of fish species of focused evaluation, which would be **significant and unavoidable impacts** No mitigation measures could be identified to reduce these impacts to less than significant. Increasing potential levels of standing and predation of fish species of focused evaluation, particularly juvenile Chinook salmon, would exacerbate existing stressors under Existing Conditions.

8.3.3.7 Alternative 6: West Side Large Gated Notch

Alternative 6, West Side Large Gated Notch, is a large notch in the western location that would allow flows up to 12,000 cfs. It was designed with the goal of entraining more fish, with the strategy of allowing more flow into the bypass when the Sacramento River is at lower elevations. See Section 2.9 for more details on the alternative features.

8.3.3.7.1 Construction- and Maintenance-related Impacts

Impact FISH-1: Potential Disturbance to Fish Species or their Habitat due to Erosion, Sedimentation, and Turbidity

Potential impacts associated with erosion, sedimentation, and turbidity under Alternative 6 are expected to be similar to those described for Alternative 1. However, substantially more excavation would occur in the Yolo Bypass under Alternative 6. As an indicator of the extent of excavation that would occur under Alternative 6 in the Yolo Bypass, the estimated excess amount of spoils to be excavated during construction would be about 1,711,000 CY. As an indicator of maintenance-related impacts, the estimated additional annual amount of sediment removal required in the area between Fremont Weir and Agricultural Road Crossing 1 because of increased flows into the Yolo Bypass under implementation of Alternative 6 is 75,600 CY. This corresponds to an estimated total annual amount of sediment removal required of 372,150 CY under Alternative 6 relative to 296,550 CY under Existing Conditions. However, local deposition patterns will be dependent on the specific design of downstream facilities.

CEQA Conclusion

Erosion, sedimentation, and turbidity impacts would be **significant** because construction and maintenance activities would result in temporary increases in sedimentation and turbidity in the Sacramento River and the Yolo Bypass and could temporarily adversely affect all fish species of focused evaluation.

Development and implementation of Mitigation Measure MM-WQ-2: Implement a Stormwater Pollution and Prevention Plan and Mitigation Measure MM-WQ-3: Develop Turbidity Monitoring Program would reduce this impact to **less than significant**.

Impact FISH-2: Potential Disturbance to Fish Species or their Habitat due to Hazardous Materials and Chemical Spills

Potential impacts associated with hazardous materials and chemical spills under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Hazardous materials and chemical spills impacts would be **significant** because construction and maintenance activities could potentially result in the release of contaminants to aquatic habitats in the Sacramento River and the Yolo Bypass and could adversely affect all fish species of focused evaluation.

Development and implementation of Mitigation Measure MM-WQ-1: Prepare and Implement a Spill Prevention, Control, and Countermeasure Plan would reduce this impact to **less than significant**.

Impact FISH-3: Potential Disturbance to Fish Species or their Habitat due to Aquatic Habitat Modification

Potential impacts associated with aquatic habitat modification under Alternative 6 are expected to be similar to those described for Alternative 1, except as described below.

Preliminary estimates based on calculations in ArcGIS indicate that a total of 32.3 acres (temporary impacts) and 107.2 acres (permanent impacts) of vegetated area would have the potential to be disturbed during Alternative 6 construction activities. Specifically, 8.1 acres (temporary impacts) and 26.8 acres (permanent impacts) would be riparian vegetation, which would be a potential source of IWM inputs to the Sacramento River or Yolo Bypass (Table 8-33 and Figure 8-68).

Table 8-33. Vegetation Communities Potentially Affected by Alternative 6

Vegetation Community	Grassland	Freshwater Aquatic Vegetation	Freshwater Emergent Marsh	Marsh/Seep	Riparian Forest/Woodland	Total
Acres (Temporary)	20.6	1.0	2.0	0.6	8.1	32.3
Acres (Permanent)	60.2	4.3	10.5	5.4	26.8	107.2

CEQA Conclusion

Aquatic habitat modification adjacent to the Sacramento River and in the Yolo Bypass associated with construction activities would be **significant** because aquatic and riparian habitat would be permanently affected.

Implementation of Mitigation Measures MM-TERR-7 and MM-FISH-1 would reduce this impact to **less than significant**.

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Figure 8-68a. Vegetation Communities Potentially Affected by Alternative 6

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Figure 8-68b. Vegetation Communities Potentially Affected by Alternative 6

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Impact FISH-4: Potential Disturbance to Fish Species or their Habitat due to Hydrostatic Pressure Waves, Noise, and Vibration

Potential impacts associated with hydrostatic pressure waves, noise, and vibration under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Impacts associated with construction noise would be **less than significant** if a vibratory pile driver can be used for the entire construction of the cofferdam. However, impacts associated with noise would be **significant** if impact pile driving was conducted in the Sacramento River, resulting in direct potential impacts to fish species of focused evaluation.

Implementation of Mitigation Measure MM-FISH-2: Implement an Underwater Noise Reduction and Monitoring Plan would reduce this impact to **less than significant**.

Impact FISH-5: Potential Disturbance to Fish Species or their Habitat due to Stranding and Entrainment

Potential impacts associated with stranding and entrainment under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Stranding and entrainment impacts would be **significant** because fish species of focused evaluation could be entrained in the temporary cofferdam.

Implementation of Mitigation Measure MM-FISH-3: Prepare a Fish Rescue and Salvage Plan would reduce this impact to **less than significant**.

Impact FISH-6: Potential Disturbance to Fish Species or their Habitat due to Predation Risk

Potential impacts associated with predation risk under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Predation risk impacts would be **significant** because fish species of focused evaluation could be at increased risk of predation due to potential indirect effects of construction and maintenance activities.

Implementation of Mitigation Measures MM-WQ-2: Implement a Stormwater Pollution and Prevention Plan; MM-WQ-1: Prepare and Implement a Spill Prevention, Control, and Countermeasure Plan; MM-FISH-2: Implement an Underwater Noise Reduction and Monitoring Plan; and MM-FISH-3: Prepare a Fish Rescue and Salvage Plan would reduce this impact to **less than significant**.

Impact FISH-7: Potential Disturbance to Fish Species or their Habitat due to Changes in Fish Passage Conditions

Potential impacts associated with fish passage under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Fish passage impacts would be **less than significant** because fish species of focused evaluation would either generally not be present near temporary fish passage blockages or would not be substantially affected by temporary blockages.

Impact FISH-8: Potential Disturbance to Fish Species or their Habitat due to Direct Harm

Potential impacts associated with direct physical injury and/or mortality under Alternative 6 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Direct harm impacts would be **significant** because fish species of focused evaluation could be directly harmed due to construction- and maintenance-related equipment, personnel, or debris.

Implementation of Mitigation Measure MM-FISH-4: Implement General Fish Protection Measures would reduce this impact to **less than significant**.

8.3.3.7.2 Operations-related Impacts

Operations-related impacts associated with Alternative 6 are evaluated in the Yolo Bypass, the Sacramento River at and downstream of the Fremont Weir, the Delta and downstream waterbodies, and the broader SWP/CVP system as appropriate.

Impact FISH-9: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Flows in the Sacramento River

Modeling results indicate that average monthly flows over the entire simulation period under Alternative 6 in the Sacramento River downstream of Fremont Weir would be the same or similar during most months but somewhat lower (i.e., two to six percent) from November through March. However, during relatively low-flow conditions (i.e., lowest 40 percent of flows over the monthly exceedance distributions), no changes in flow of 10 percent or more would occur during any month of the year. Therefore, migration and rearing conditions would be similar under Alternative 6 relative to Existing Conditions in the lower Sacramento River for fish species of focused evaluation, including winter-run, spring-run, fall-run, and late fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, and Pacific lamprey. In addition, there would be minimal potential for reduced flows in the Sacramento River to result in increased exposure of fish species of focused evaluation to predators or to higher concentrations of water quality contaminants and minimal potential to exacerbate the channel homogenization in the lower Sacramento River.

CEQA Conclusion

Alternative 6 would result in the same or similar flows during relatively low-flow conditions in the Sacramento River downstream of Fremont Weir relative to Existing Conditions; therefore, Alternative 6 would have a **less than significant impact** due to changes in flows in the Sacramento River.

Impact FISH-10: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Water Temperatures in the Sacramento River

Modeling results indicate that simulated mean monthly water temperatures in the Sacramento River at Freeport would generally not exceed species and life stage-specific water temperature index values more often under Alternative 6 relative to Existing Conditions (see Appendix G7). Therefore, migration and rearing thermal conditions would not be substantially affected for fish species of focused evaluation expected to occur in the lower Sacramento River, including winter-run, spring-run, fall-run, and late fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, and Pacific lamprey under Alternative 6 relative to Existing Conditions.

CEQA Conclusion

Alternative 6 would not result in substantial changes to water temperature suitability for fish species of focused evaluation relative to Existing Conditions; therefore, Alternative 6 would have a **less than significant impact** due to changes in water temperatures in the Sacramento River.

Impact FISH-11: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Delta Hydrologic and Water Quality Conditions

Evaluation of modeling results for mean monthly Delta hydrologic and water quality parameters with respect to species and life stage-specific time periods indicate that hydrologic and water quality metrics would not be altered under Alternative 6 relative to Existing Conditions. Therefore, habitat conditions in the Delta would be similar for all life stages evaluated. In addition, based on mean monthly Delta outflow, fisheries habitat conditions would be the same or similar in Suisun Bay.

CEQA Conclusion

Alternative 6 would result in the same or similar habitat conditions for fish species of focused evaluation in the Delta and in downstream areas relative to Existing Conditions; therefore, Alternative 6 would have a **less than significant impact** due to changes in Delta conditions.

Impact FISH-12: Impacts to Fisheries Habitat Conditions due to Changes in Flow-Dependent Habitat Availability in the Study Area (Yolo Bypass/Sutter Bypass)

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir would substantially increase more often from January through March. Therefore, inundation extent and/or duration of the Yolo Bypass would increase during these months, potentially providing for increased hydraulic habitat availability for fish species of focused evaluation, particularly juvenile salmonids and adult and juvenile Sacramento splittail.

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon pre-smolts in the Yolo Bypass under Alternative 6 would generally be substantially higher (i.e., higher by 10 percent or more) from December through March and similar for the remainder of the October through May evaluation period (Table 8-34). Simulated average monthly hydraulic habitat availability by water year type would generally be substantially higher during most water year types for December through March.

Modeling results indicate that Chinook salmon pre-smolt hydraulic habitat availability would be higher under Alternative 6 relative to Existing Conditions over about 40 percent of the exceedance distribution (Figure 8-69). Over the exceedance distribution from November through March, daily hydraulic habitat availability would be substantially higher (i.e., higher by 10 percent or more) about 50 percent of the time and would never be lower by 10 percent or more under Alternative 6.

Table 8-34. Average Monthly Area of Pre-smolt Chinook Salmon Hydraulic Habitat in the Yolo Bypass under Alternative 6 from October through May based on TUFLOW Modeling

Alternative	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Entire Simulation Period[1] (n=16)								
Alternative 6	20.0	21.9	42.3	58.2	61.9	55.7	37.3	27.1
Existing Conditions	19.8	21.2	31.1	47.6	43.7	46.9	36.9	27.2
Difference	0.2	0.7	11.2	10.6	18.2	8.8	0.4	-0.1
Percent Difference[2]	1.0	3.3	36.0	22.3	41.6	18.8	1.1	-0.4
Water Year Types[3]								
Wet (n=5)								
Alternative 6	20.1	23.1	61.8	61.4	72.9	74.1	58.5	31.7
Existing Conditions	19.8	21.1	37.7	48.5	56.9	68.7	58.3	31.8
Difference	0.3	2.0	24.1	12.9	16.0	5.4	0.2	-0.1
Percent Difference[2]	1.5	9.5	63.9	26.6	28.1	7.9	0.3	-0.3
Above Normal (n=3)								
Alternative 6	20.3	21.8	39.8	82.0	75.7	54.6	36.7	37.5
Existing Conditions	20.1	21.6	36.2	66.6	41.4	48.0	36.5	37.5
Difference	0.2	0.2	3.6	15.4	34.3	6.6	0.2	0.0
Percent Difference[2]	1.0	0.9	9.9	23.1	82.9	13.8	0.5	0.0
Below Normal (n=3)								
Alternative 6	19.9	21.4	31.9	55.6	56.4	46.6	27.0	21.1

Alternative	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Existing Conditions	19.7	21.2	25.1	45.4	41.8	40.0	26.6	21.0
Difference	0.2	0.2	6.8	10.2	14.6	6.6	0.4	0.1
Percent Difference[2]	1.0	0.9	27.1	22.5	34.9	16.5	1.5	0.5
Dry (n=4)								
Alternative 6	20.0	21.1	32.8	40.2	37.9	45.2	22.4	20.0
Existing Conditions	19.8	20.9	25.9	35.7	26.6	29.0	21.8	20.1
Difference	0.2	0.2	6.9	4.5	11.3	16.2	0.6	-0.1
Percent Difference[2]	1.0	1.0	26.6	12.6	42.5	55.9	2.8	-0.5
Critical (n=1)								
Alternative 6	19.8	20.9	21.8	51.5	77.2	37.0	22.5	20.3
Existing Conditions	19.7	20.7	21.4	39.9	57.7	27.6	22.2	20.5
Difference	0.1	0.2	0.4	11.6	19.5	9.4	0.3	-0.2
Percent Difference[2]	0.5	1.0	1.9	29.1	33.8	34.1	1.4	-1.0

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)

[2] Relative difference of the monthly average

[3] As defined by the Sacramento Valley Index (DWR 2017c)

Key: km^2 = square kilometer

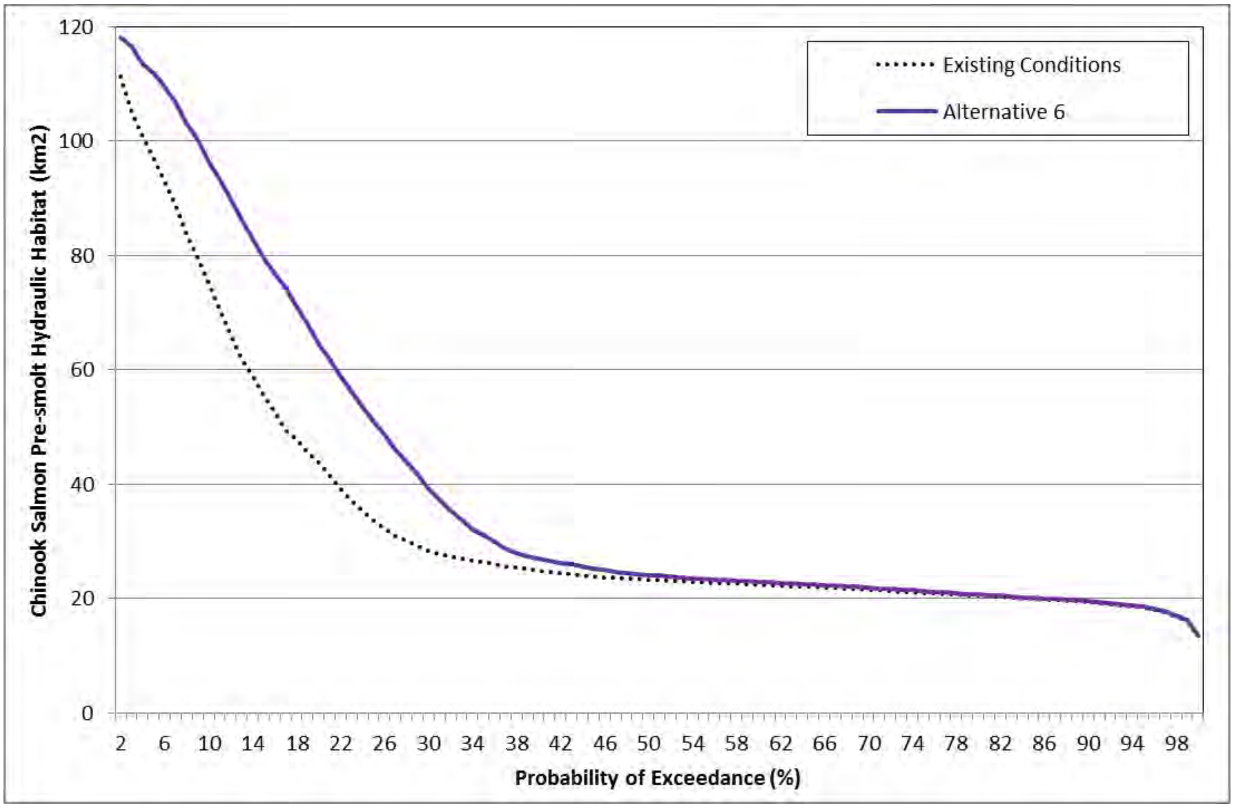


Figure 8-69. Simulated Chinook Salmon Pre-smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternative 6 and Existing Conditions from October through May based on TUFLOW Modeling

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon smolts in the Yolo Bypass under Alternative 6 relative to Existing Conditions would generally be substantially higher (i.e., higher by 10 percent or more) from December through March and would be similar for the remainder of the October through May evaluation period under both scenarios (Table 8-35). Simulated average monthly hydraulic habitat availability by water year type also would be substantially higher during most water year types from December through March.

Modeling results indicate that Chinook salmon smolt hydraulic habitat availability would be higher under Alternative 6 relative to Existing Conditions over about 40 percent of the exceedance distribution (Figure 8-70). Over the exceedance distribution from November through March, daily hydraulic habitat availability would be substantially higher (i.e., higher by 10 percent or more) about 44 percent of the time and would never be lower by 10 percent or more under Alternative 6.

Table 8-35. Average Monthly Area of Chinook Salmon Smolt Hydraulic Habitat in the Yolo Bypass under Alternative 6 from October through May based on TUFLOW Modeling

Alternative	Area (km^2) October	Area (km^2) November	Area (km^2) December	Area (km^2) January	Area (km^2) February	Area (km^2) March	Area (km^2) April	Area (km^2) May
Entire Simulation Period[1] (n=16)								
Alternative 6	31.7	32.7	57.9	85.7	90.6	86.3	59.1	42.9
Existing Conditions	31.6	32.0	44.2	70.0	69.7	76.0	58.8	43.1
Difference	0.1	0.7	13.7	15.7	20.9	10.3	0.3	-0.2
Percent Difference[2]	0.3	2.2	31.0	22.4	30.0	13.6	0.5	-0.5
Water Year Types[3]								
Wet (n=5)								
Alternative 6	31.5	34.1	85.1	107.1	120.8	126.8	99.9	50.4
Existing Conditions	31.4	32.1	55.4	90.2	100.6	119.0	99.6	50.7
Difference	0.1	2.0	29.7	16.9	20.2	7.8	0.3	-0.3
Percent Difference[2]	0.3	6.2	53.6	18.7	20.1	6.6	0.3	-0.6
Above Normal (n=3)								
Alternative 6	32.2	33.1	54.6	107.0	104.9	83.5	50.5	54.4
Existing Conditions	32.1	32.9	48.3	82.4	68.3	76.6	50.4	54.6
Difference	0.1	0.2	6.3	24.6	36.6	6.9	0.1	-0.2
Percent Difference[2]	0.3	0.6	13.0	29.9	53.6	9.0	0.2	-0.4
Below Normal (n=3)								
Alternative 6	31.9	32.0	43.6	75.4	79.2	71.1	41.0	34.8
Existing Conditions	31.7	31.8	36.2	57.8	62.3	62.6	40.6	34.9
Difference	0.2	0.2	7.4	17.6	16.9	8.5	0.4	-0.1
Percent Difference[2]	0.6	0.6	20.4	30.4	27.1	13.6	1.0	-0.3
Dry (n=4)								
Alternative 6	31.7	31.7	43.8	55.9	49.9	58.6	34.4	33.2
Existing Conditions	31.6	31.5	36.6	48.9	37.9	41.0	33.9	33.4
Difference	0.1	0.2	7.2	7.0	12.0	17.6	0.5	-0.2
Percent Difference[2]	0.3	0.6	19.7	14.3	31.7	42.9	1.5	-0.6
Critical (n=1)								
Alternative 6	31.1	31.4	31.5	65.1	94.3	48.7	34.5	33.7
Existing Conditions	31.0	31.2	30.9	52.1	70.2	39.2	34.4	33.9
Difference	0.1	0.2	0.6	13.0	24.1	9.5	0.1	-0.2
Percent Difference[2]	0.3	0.6	1.9	25.0	34.3	24.2	0.3	-0.6

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)
[2] Relative difference of the monthly average
[3] As defined by the Sacramento Valley Index (DWR 2017c)
Key: km^2 = square kilometer

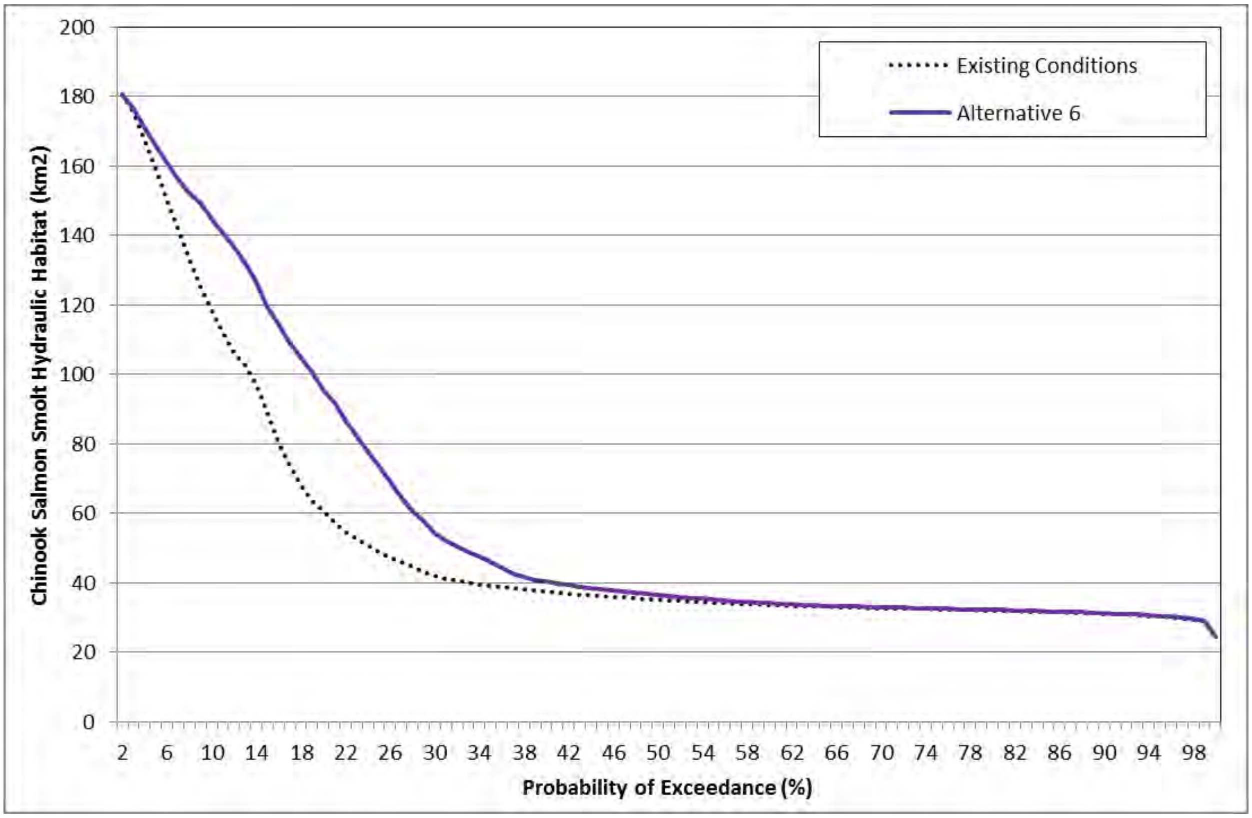


Figure 8-70. Simulated Chinook Salmon Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternative 6 and Existing Conditions from October through May based on TUFLOW Modeling

As previously discussed, changes in estimated hydraulic habitat availability for Chinook salmon pre-smolts is expected to be generally representative of potential changes in hydraulic habitat availability (based only on hydraulics) for juvenile Sacramento splittail, and changes in estimated hydraulic habitat availability for Chinook salmon smolts is generally expected to be representative of potential changes in habitat availability for adult spawning Sacramento splittail and juvenile steelhead.

To provide a more comprehensive range of potential changes in hydraulic habitat availability for other fish species of focused evaluation, simulated wetted extent (area with a water depth greater than 0.0 ft) was estimated for the Yolo Bypass under Alternative 6 relative to Existing Conditions. Modeling results indicate that average monthly wetted extent over the entire simulation period would be substantially higher from December through March (Table 8-36). Monthly average wetted extent by water year type would be substantially higher (i.e., higher by 10 percent or more) during most water year types for December through March.

Table 8-36. Average Monthly Wetted Area in the Yolo Bypass under Alternative 6 from October through May based on TUFLOW Modeling

Alternative	Wetted Area (km^2) October	Wetted Area (km^2) November	Wetted Area (km^2) December	Wetted Area (km^2) January	Wetted Area (km^2) February	Wetted Area (km^2) March	Wetted Area (km^2) April	Wetted Area (km^2) May
Entire Simulation Period[1] (n=16)								
Alternative 6	48.1	49.4	78.9	121.3	128.8	119.4	86.1	63.9
Existing Conditions	47.8	48.4	64.1	105.0	106.4	107.5	85.9	64.1
Difference	0.3	1.0	14.8	16.3	22.4	11.9	0.2	-0.2
Percent Difference[2]	0.6	2.1	23.1	15.5	21.1	11.1	0.2	-0.3
Water Year Types[3]								
Wet (n=5)								
Alternative 6	47.8	51.1	110.6	172.0	182.2	172.1	145.0	77.0
Existing Conditions	47.6	48.6	78.9	154.3	161.7	163.4	145.3	77.5
Difference	0.2	2.5	31.7	17.7	20.5	8.7	-0.3	-0.5
Percent Difference[2]	0.4	5.1	40.2	11.5	12.7	5.3	-0.2	-0.6
Above Normal (n=3)								
Alternative 6	48.7	50.2	74.3	131.4	139.2	120.2	72.4	76.7
Existing Conditions	48.5	49.9	68.3	108.0	100.1	111.7	72.5	77.0
Difference	0.2	0.3	6.0	23.4	39.1	8.5	-0.1	-0.3
Percent Difference[2]	0.4	0.6	8.8	21.7	39.1	7.6	-0.1	-0.4
Below Normal (n=3)								
Alternative 6	48.2	48.2	61.9	97.4	110.3	99.1	59.9	52.1
Existing Conditions	47.9	47.9	53.9	79.2	91.7	89.6	59.6	52.3
Difference	0.3	0.3	8.0	18.2	18.6	9.5	0.3	-0.2
Percent Difference[2]	0.6	0.6	14.8	23.0	20.3	10.6	0.5	-0.4
Dry (n=4)								
Alternative 6	48.0	48.1	63.1	76.1	70.1	80.6	50.9	49.8
Existing Conditions	47.8	47.6	54.5	68.3	56.0	60.3	50.3	49.9
Difference	0.2	0.5	8.6	7.8	14.1	20.3	0.6	-0.1
Percent Difference[2]	0.4	1.1	15.8	11.4	25.2	33.7	1.2	-0.2
Critical (n=1)								
Alternative 6	47.2	47.0	47.3	89.2	121.4	70.2	51.2	50.7
Existing Conditions	46.9	46.7	46.6	74.4	95.7	58.1	51.1	50.9
Difference	0.3	0.3	0.7	14.8	25.7	12.1	0.1	-0.2
Percent Difference[2]	0.6	0.6	1.5	19.9	26.9	20.8	0.2	-0.4

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)

[2] Relative difference of the monthly average

[3] As defined by the Sacramento Valley Index (DWR 2017c)

Key: km^2 = square kilometer

Modeling results indicate that wetted extent would be higher under Alternative 6 relative to Existing Conditions over about 40 percent of the middle to lower portion of the exceedance distribution (Figure 8-71). Over the exceedance distribution from November through March, daily wetted extent would be substantially higher (i.e., higher by 10 percent or more) about 41 percent of the time and would never be lower by 10 percent or more under Alternative 6.

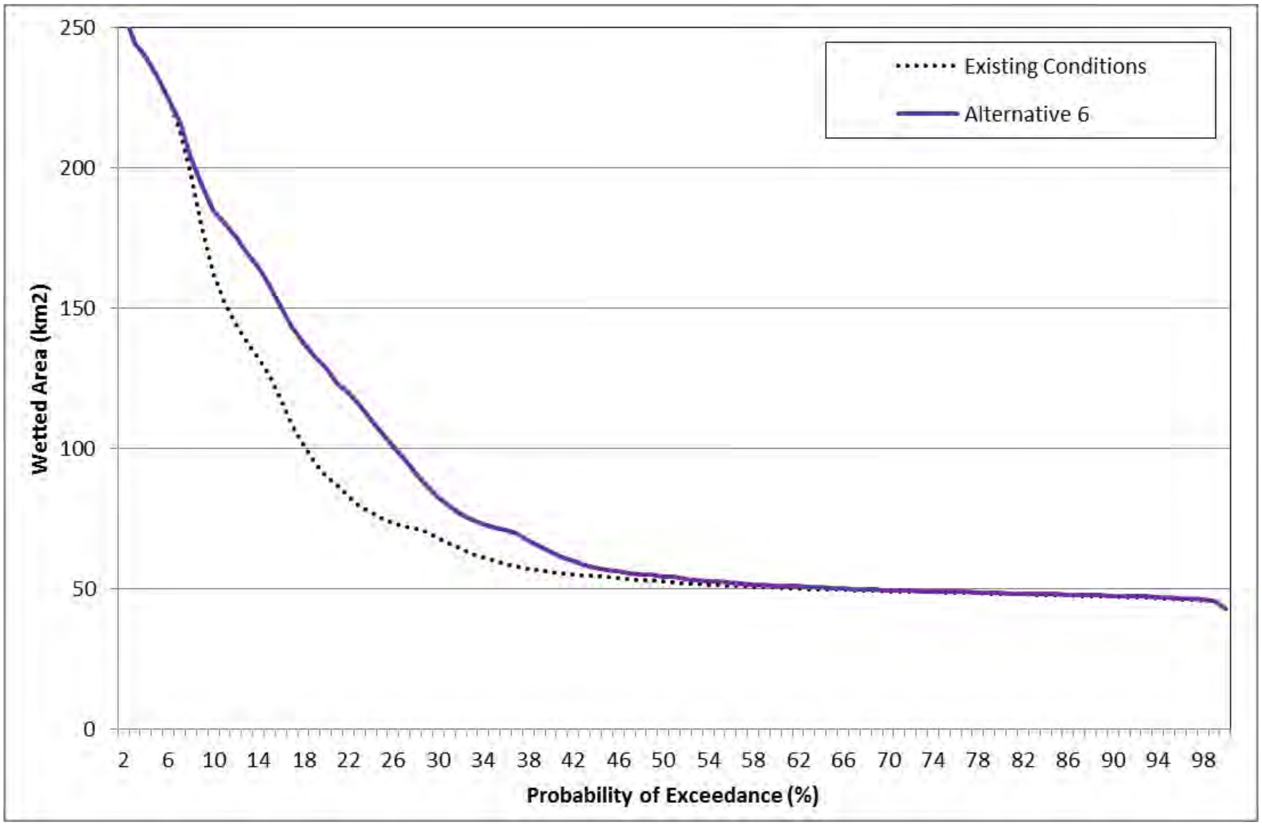


Figure 8-71. Simulated Wetted Area Probability of Exceedance Distributions under Alternative 6 and Existing Conditions from October through May based on TUFLOW Modeling

Average annual modeled wetted days in the Sutter Bypass would decrease under Alternative 6 relative to Existing Conditions by approximately three to seven days in most of the area of Sutter Bypass between the Sacramento River and Sacramento Slough and by approximately three to seven days over most of the Sutter Bypass between Sacramento Slough and Nelson Slough.

CEQA Conclusion

In the Yolo Bypass under Alternative 6, increased hydraulic habitat availability for fish species of focused evaluation, particularly juvenile Chinook salmon and steelhead and adult and juvenile Sacramento splittail, is expected to result in more suitable conditions for these and other fish species of focused evaluation. Relatively minor reductions in the number of wetted days in the Sutter Bypass upstream of the Sacramento River at Fremont Weir are not expected to substantially affect rearing or migration of fish species of focused evaluation; therefore, Alternative 6 would be expected to have a **beneficial impact** on flow-dependent hydraulic habitat availability in the Yolo Bypass and a **less than significant impact** on flow-dependent hydraulic habitat availability in the Sutter Bypass.

Impact FISH-13: Impacts to Fisheries Habitat Conditions due to Changes in Water Quality in the Study Area

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 6 relative to Existing Conditions would substantially increase more often from January through March. Therefore, increased flows and the potential for increased wetting and drying of the Yolo Bypass could increase the amount of methylmercury and other contaminants in the Yolo Bypass and in fish prey. Increased concentrations of contaminants in the Yolo Bypass could potentially result in an increase in the exportation of contaminated water to the Delta. However, for juvenile Chinook salmon rearing in the Yolo Bypass, increased concentrations of accumulated methylmercury were reported to be insignificant in the tissues of the eventual adult-sized fish (Henery et al. 2010). Effects of increased methylmercury accumulation could be more substantial on resident fish species such as largemouth bass. Increased flows in the Yolo Bypass also could temporarily increase turbidity levels in the Yolo Bypass.

CEQA Conclusion

Based on higher mean monthly flows entering the Yolo Bypass, increased concentrations of methylmercury and other contaminants may occur in the Yolo Bypass and the Delta. However, the potential for increased concentrations of contaminants is not expected to substantially affect fish species of focused evaluation; therefore, Alternative 6 would have a **less than significant impact**.

Impact FISH-14: Impacts to Aquatic Primary and Secondary Production in the Study Area

Modeling results indicate that Alternative 6 would result in increased frequency and duration of inundation of the Yolo Bypass relative to Existing Conditions. An increase in frequency and duration of inundation of shallow-water habitat in the Yolo Bypass would be expected to increase primary production in the Yolo Bypass (Lehman et al. 2007). Increased primary and associated secondary production in the Yolo Bypass would likely increase food resources for fish species of focused evaluation in the Yolo Bypass. More productive water in the Yolo Bypass also could potentially be exported to the Delta downstream of the Yolo Bypass, which could increase food resources for fish in the Delta.

Modeled wetted area of the Yolo Bypass under Alternative 6 relative to Existing Conditions was used as an indicator of relative changes in inundation and associated primary and secondary production. As described above, increases in average monthly wetted area would occur under Alternative 6 relative to Existing Conditions, particularly from December through March, depending on water year type. Increased food resources in the Yolo Bypass during this period would be expected to improve growth and survival of some fish species of focused evaluation, such as Chinook salmon and freshwater resident species. The potential for increased productivity downstream of the Yolo Bypass also could improve growth and survival of fish species of focused evaluation, particularly Delta resident species such as delta smelt.

Minor reductions in wetted area in the Sutter Bypass could reduce primary and secondary production in the Sutter Bypass. However, these reductions in wetted area are not expected to substantially affect primary or secondary production in the Sutter Bypass or fish species of focused evaluation in the Sutter Bypass.

CEQA Conclusion

Based on increased wetted extent in the Yolo Bypass during the winter, increased primary and secondary production in the Yolo Bypass (and potentially in localized areas of the Delta) could increase food resources for fish species of focused evaluation. In the Sutter Bypass, slight reductions in wetted area could reduce primary and secondary production, but these reductions are not expected to be sufficient to substantially affect food resources for fish species of focused evaluation. Therefore, Alternative 6 would result in a **beneficial impact** in the Yolo Bypass and a **less than significant impact** in the Sutter Bypass.

Impact FISH-15: Impacts to Fish Species of Focused Evaluation due to Changes in Adult Fish Passage Conditions through the Yolo Bypass

Modeling results indicate that flows entering the Yolo Bypass from the Sacramento River at Fremont Weir would substantially increase (i.e., increase by 10 percent or more) more often from January through March, which could indicate increased potential for passage between the Yolo Bypass and the Sacramento River for fish species of focused evaluation in the Yolo Bypass.

Based on results of the YBPASS Tool, which applied fish passage criteria to modeled hydraulic conditions in the intake facility and transport channel under Alternative 6, adult salmon and sturgeon would be expected to successfully pass upstream through the transport channels and intake structures into the Sacramento River for about 19 percent of the days from November through April over the water years 1997 through 2012 simulation period. The annual average date after which Alternative 6 would no longer meet the fish passage criteria is March 3.

Because Alternative 6 allows for up to 12,000 cfs to pass through the proposed notch, there could be substantially increased potential for adult salmon, sturgeon and other migratory fish species to be attracted into the Yolo Bypass during their upstream migration relative to Existing Conditions. However, hydraulic conditions may impede passage of adults by the time they reach the intake facility, which could result in additional adults becoming stranded in the Yolo Bypass below Fremont Weir relative to Existing Conditions. In addition, because Alternative 6 would no longer meet adult fish passage criteria after March 3, adult winter-run and spring-run Chinook salmon and green sturgeon that entered the Yolo Bypass after late February may be unable to reach their upstream spawning grounds.

CEQA Conclusion

Alternative 6 could potentially attract substantially more adult salmon and sturgeon into the Yolo Bypass, but because of the relatively high flow capacity of the proposed notch, hydraulic conditions may impede or prevent passage at the intake facility or in the transport channel and could strand more adult salmon and sturgeon in the Yolo Bypass relative to Existing Conditions. In addition, Alternative 6 would not provide improved adult fish passage conditions from the

Yolo Bypass into the Sacramento River after about early March and could result in more stranding of adult salmonids and sturgeon entering the Yolo Bypass in March. Therefore, Alternative 6 would be expected to have a **potentially significant and unavoidable impact** due to changes in adult fish passage conditions through the Yolo Bypass. No mitigation measures could be identified to reduce this potential impact to a less-than-significant level; a potential reduction in adult passage suitability would exacerbate an existing stressor to adult Chinook salmon and sturgeon.

Impact FISH-16: Impacts to Fish Species due to Changes in Potential for Stranding and Entrainment

Project facilities constructed under Alternative 6, such as the transport and intake channels, would be graded to provide suitable passage conditions for fish, assuming sufficient water is present. Although Alternative 6 would allow for entrainment of juvenile fish at lower flows relative to Existing Conditions, the design of the transport channel to Tule Canal is expected to minimize the potential for stranding of juveniles. However, anthropogenic structures that interrupt natural drainage patterns, such as water control structures, create the greatest risk for stranding (Sommer et al. 2005). Therefore, there is some potential for increased juvenile stranding in the Yolo Bypass.

Because Alternative 6 would allow for adult migration into the Sacramento River during periods when adult migration is impeded or blocked at Fremont Weir under Existing Conditions, the potential for adult fish stranding in the Yolo Bypass would be expected to be reduced.

CEQA Conclusion

The potential for adult fish stranding would be expected to be reduced under Alternative 6 relative to Existing Conditions. Juvenile stranding may potentially increase under Alternative 6, but design of the project facilities is expected to minimize any increases in juvenile stranding. Therefore, Alternative 6 would be expected to have a **less than significant impact** on stranding and entrainment.

Impact FISH-17: Impacts to Fish Species due to Changes in Potential for Predation

Construction of the intake facility, supplemental fish passage facility, and intake and transport channels lined with rock could increase the potential for predation of fish species of focused evaluation under Alternative 6 relative to Existing Conditions by providing habitat for predatory fish species in these areas. However, the facilities on the Sacramento River are not expected to substantially increase the potential area of refugia for species such as striped bass relative to Existing Conditions. In the Yolo Bypass, increased flow pulses into the Yolo Bypass associated with Alternative 6 during the winter months (primarily December through March) could reduce the potential for predation of fish species such as juvenile salmonids by non-native fish species. For example, Sommer et al. (2014) found that increased connectivity to the Yolo Bypass would provide an overall benefit to native fish species, particularly during the winter, because it is prior to the spawning periods of non-native fish species in the spring. Frantzich et al. (2013) found that native fish species were more widely distributed during wetter years, and low flows may provide more suitable conditions for the spawning and recruitment of non-native centrarchids. Opperman et al. (2017) argued that flooding the Yolo Bypass from January through April would benefit native fish species. In addition, given the perennial nature of the Tule Canal and its ability to support non-native fish species under Existing Conditions, it is not expected that the proposed facilities under Alternative 6 would increase predation of fish species of focused evaluation above baseline levels in the Yolo Bypass. In addition, results of the SBM (evaluated under *Impact FISH-18*) account for predation associated with the estimated migration path and migration duration for juvenile Chinook salmon in the Yolo Bypass associated with Alternative 6.

CEQA Conclusion

Overall potential for predation of fish species of focused evaluation is not expected to substantially differ relative to predation rates under Existing Conditions; therefore, Alternative 6 would be expected to have a **less than significant impact** due to changes in predation.

Impact FISH-18: Impacts to Chinook Salmon Species/Runs due to Changes in Viable Salmonid Population Parameters

As previously discussed, model output from the SBM is used to evaluate the VSP parameters (abundance, productivity, diversity, and spatial structure) for fall-run, late fall-run, spring-run, and winter-run Chinook salmon.

Abundance and Productivity

Modeling results indicate that annual average adult Chinook salmon returns under Alternative 6 relative to Existing Conditions would be higher or substantially higher over the entire simulation period and by water year type for fall-run and spring-run Chinook salmon and would be similar for late fall-run and winter-run Chinook salmon (Table 8-37). The adult Chinook salmon returns probability of exceedance distribution under Alternative 6 relative to Existing Conditions would be higher or substantially higher over the entire distribution for fall-run Chinook salmon, higher over most of the distribution for spring-run Chinook salmon, and similar for late fall-run and winter-run Chinook salmon (Figures 8-72 through 8-75).

Table 8-37. Average Annual Fall-run Chinook Salmon Adult Returns under Alternative 6

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 6	190,605	257,137	218,206	88,613	173,057	49,314
Existing Conditions	172,025	232,876	192,956	82,267	158,383	39,065
Difference	18,580	24,261	25,251	6,346	14,675	10,249
Percent Difference[3]	11	10	13	8	9	26
Late Fall-run Chinook Salmon						
Alternative 6	56,969	58,660	66,218	19,378	61,256	78,812
Existing Conditions	58,390	60,218	68,937	19,914	61,780	81,012

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Difference	-1,421	-1,558	-2,719	-536	-524	-2,200
Percent Difference[3]	-2	-3	-4	-3	-1	-3
Spring-run Chinook Salmon						
Alternative 6	6,690	10,230	6,184	2,507	5,244	4,658
Existing Conditions	5,960	8,803	5,821	2,174	4,884	4,031
Difference	730	1,427	363	334	360	627
Percent Difference[3]	12	16	6	15	7	16
Winter-run Chinook Salmon						
Alternative 6	5,746	5,947	5,582	5,363	6,433	3,253
Existing Conditions	5,518	5,504	5,558	5,334	6,197	3,118
Difference	228	443	24	29	236	135
Percent Difference[3]	4	8	0	1	4	4

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)
[2] As defined by the Sacramento Valley Index (DWR 2017c)
[3] Relative difference of the annual average

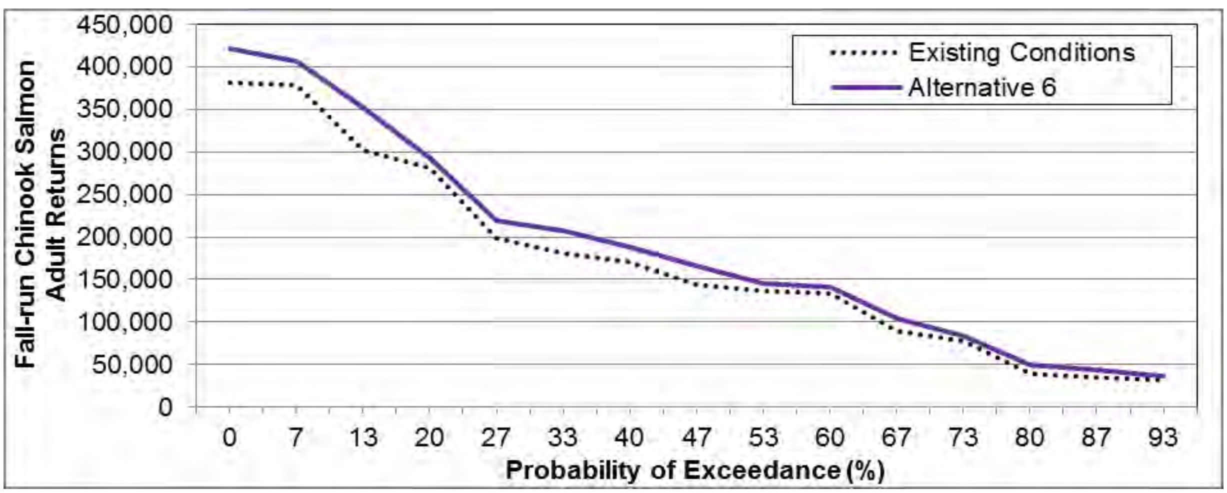


Figure 8-72. Simulated Adult Fall-run Chinook Salmon Returns Exceedance Distributions under Alternative 6 and Existing Conditions

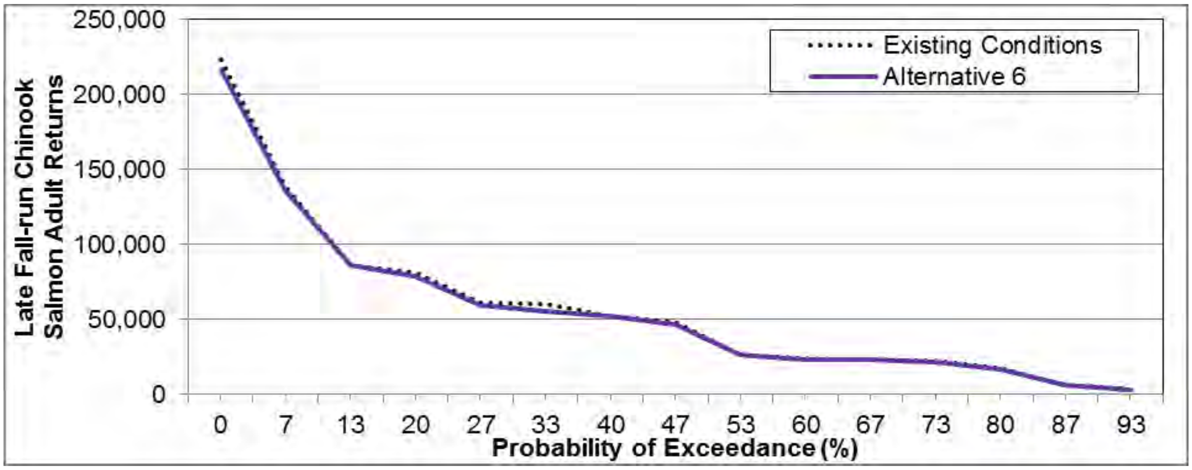


Figure 8-73. Simulated Adult Late Fall-run Chinook Salmon Returns Exceedance Distributions under Alternative 6 and Existing Conditions

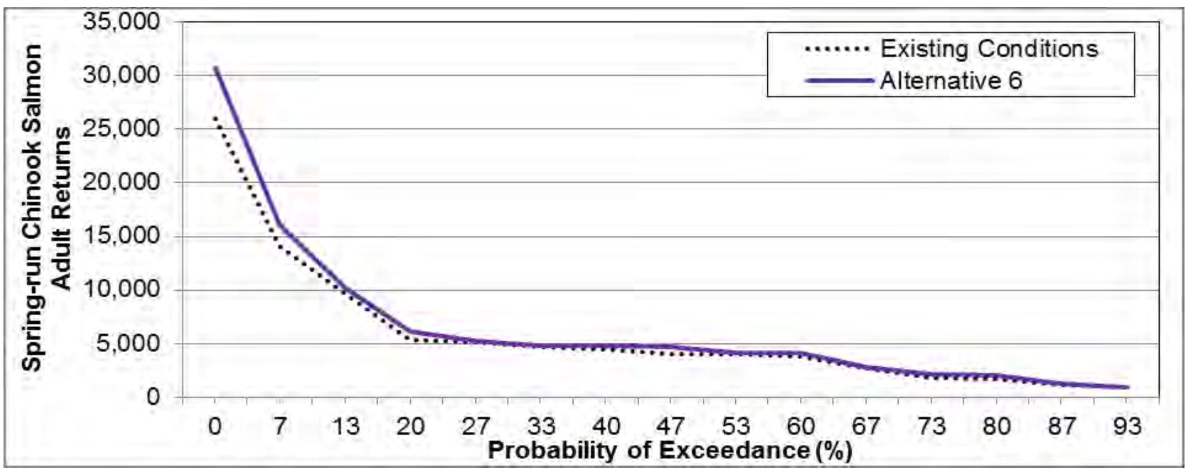


Figure 8-74. Simulated Adult Spring-run Chinook Salmon Returns Exceedance Distributions under Alternative 6 and Existing Conditions

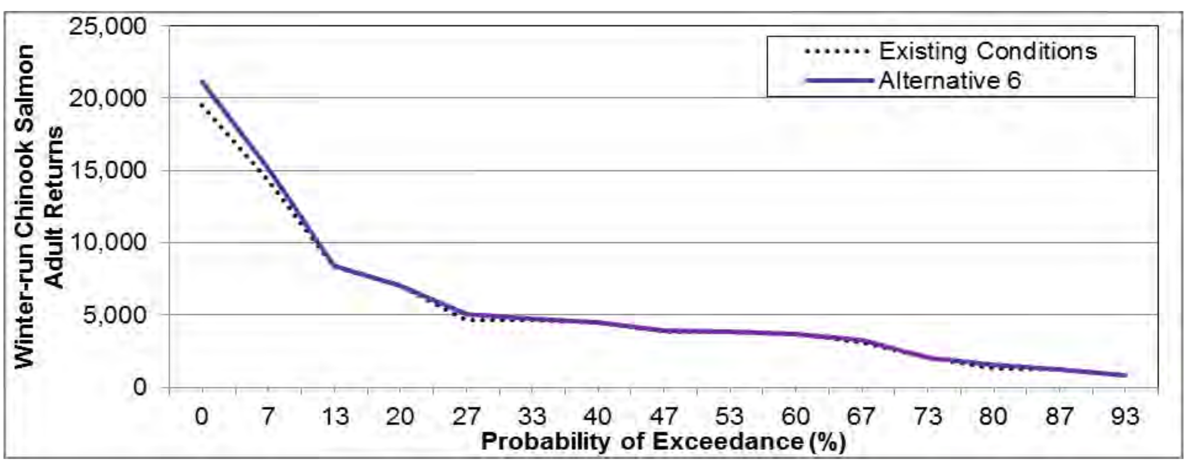


Figure 8-75. Simulated Adult Winter-run Chinook Salmon Returns Exceedance Distributions under Alternative 6 and Existing Conditions

Diversity

VARIATION IN JUVENILE CHINOOK SALMON SIZE

Modeling results indicate that annual average juvenile Chinook salmon coefficient of variation in size (FL) under Alternative 6 relative to Existing Conditions would be substantially higher over the entire simulation period and during most water year types for fall-run, spring-run, and winter-run Chinook salmon and would be similar for late fall-run Chinook salmon (Table 8-38). Similarly, the juvenile Chinook salmon coefficient of variation in size probability of exceedance distribution for Alternative 6 relative to Existing Conditions would be substantially higher over most of the distribution for fall-run, spring-run, and winter-run Chinook salmon and would be similar for late fall-run Chinook salmon (Figures 8-76 through 8-79).

Table 8-38. Average Annual Juvenile Chinook Salmon Coefficient of Variation in Size under Alternative 6

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 6	0.46	0.47	0.47	0.42	0.44	0.46
Existing Conditions	0.35	0.44	0.32	0.35	0.31	0.13
Difference	0.11	0.03	0.15	0.07	0.13	0.33
Percent Difference[3]	30	7	45	19	43	257
Late Fall-run Chinook Salmon						
Alternative 6	0.34	0.41	0.48	0.51	0.11	0.07
Existing Conditions	0.33	0.41	0.48	0.50	0.11	0.07
Difference	0.00	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	1	1	0	0	1	0
Spring-run Chinook Salmon						
Alternative 6	0.38	0.47	0.36	0.40	0.29	0.34
Existing Conditions	0.30	0.42	0.30	0.26	0.22	0.18
Difference	0.08	0.06	0.07	0.14	0.06	0.16
Percent Difference[3]	26	14	23	54	29	92
Winter-run Chinook Salmon						
Alternative 6	0.19	0.25	0.16	0.21	0.14	0.11
Existing Conditions	0.14	0.20	0.12	0.17	0.10	0.06
Difference	0.04	0.05	0.05	0.04	0.04	0.05
Percent Difference[3]	31	24	39	24	40	90

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

[3] Relative difference of the annual average

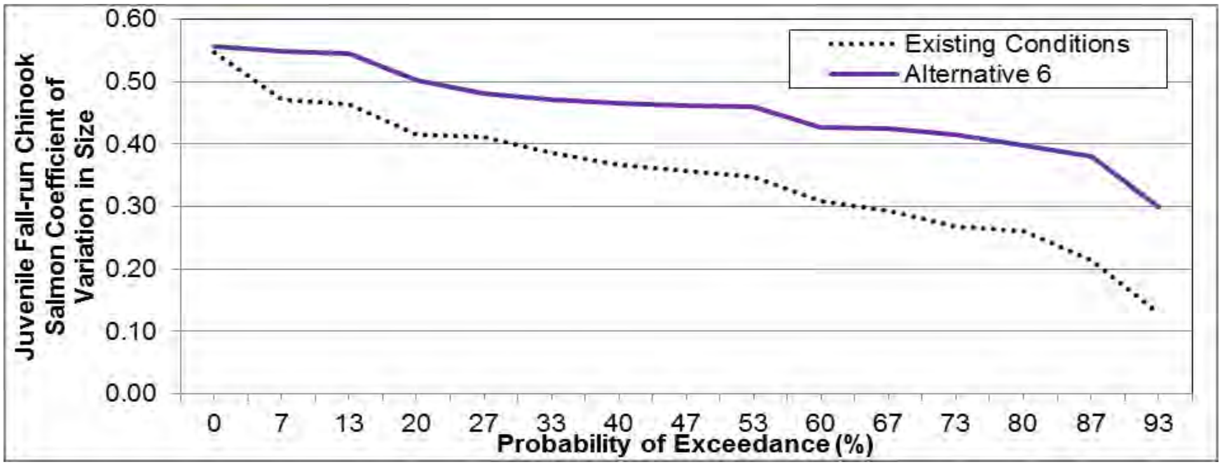


Figure 8-76. Simulated Juvenile Fall-run Chinook salmon Coefficient of Variation in Size Exceedance Distributions under Alternative 6 and Existing Conditions

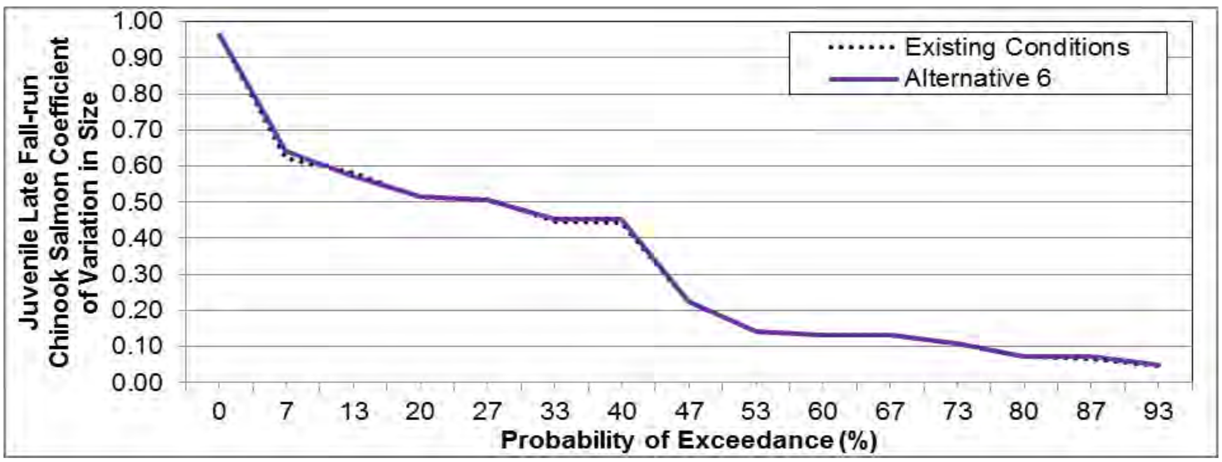


Figure 8-77. Simulated Juvenile Late Fall-run Chinook salmon Coefficient of Variation in Size Exceedance Distributions under Alternative 6 and Existing Conditions

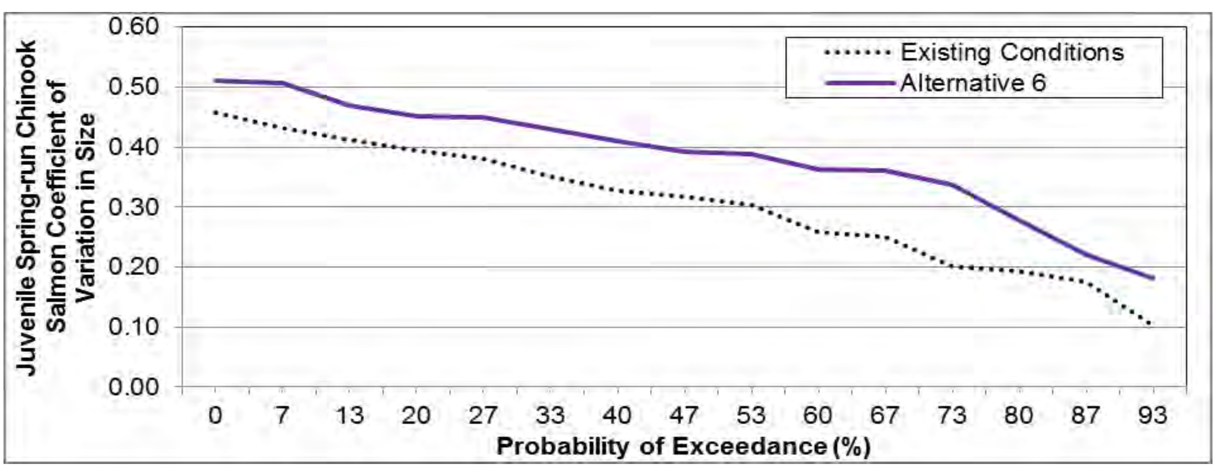


Figure 8-78. Simulated Juvenile Spring-run Chinook salmon Coefficient of Variation in Size Exceedance Distributions under Alternative 6 and Existing Conditions

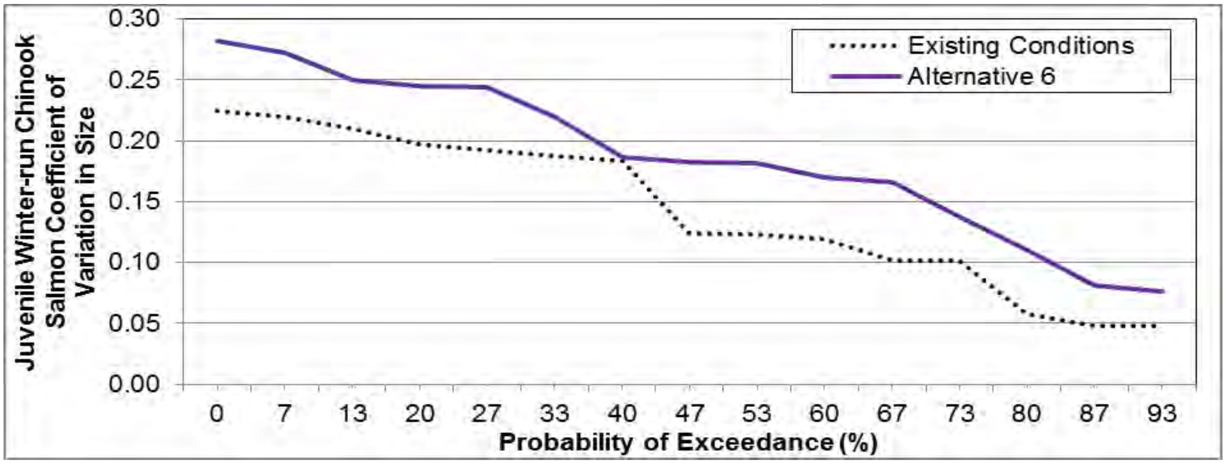


Figure 8-79. Simulated Juvenile Winter-run Chinook Salmon Coefficient of Variation in Size Exceedance Distributions under Alternative 6 and Existing Conditions

VARIATION IN JUVENILE CHINOOK SALMON ESTUARY ENTRY TIMING

Modeling results indicate that annual average juvenile Chinook salmon coefficient of variation in estuary entry timing under Alternative 6 relative to Existing Conditions would be slightly higher over the entire simulation period; similar during wet and below normal water years; and substantially higher during above normal, dry, and critical water years for fall-run Chinook salmon (Table 8-39). Annual average juvenile Chinook salmon coefficient of variation in estuary entry timing under Alternative 6 relative to Existing Conditions would be similar over the entire simulation period and during most water year types for late fall-run, spring-run, and winter-run Chinook salmon but would be substantially higher during below normal and critical water years for spring-run Chinook salmon and during critical water years for winter-run Chinook salmon.

The juvenile Chinook salmon coefficient of variation in estuary entry timing exceedance distributions would be higher or substantially higher over most of the distributions under Alternative 6 relative to Existing Conditions for fall-run, spring-run, and winter-run Chinook salmon and would be similar for late fall-run Chinook salmon (Figures 8-80 through 8-83).

Table 8-39. Average Annual Juvenile Chinook Salmon Coefficient of Variation in Estuary Entry Timing under Alternative 6

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 6	0.26	0.29	0.26	0.25	0.23	0.23
Existing Conditions	0.24	0.29	0.22	0.25	0.19	0.16
Difference	0.02	-0.01	0.04	0.00	0.03	0.07
Percent Difference[3]	8	-3	16	1	16	44

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Late Fall-run Chinook Salmon						
Alternative 6	0.33	0.44	0.32	0.21	0.29	0.15
Existing Conditions	0.33	0.44	0.33	0.21	0.29	0.15
Difference	0.00	-0.01	0.00	0.00	0.00	0.00
Percent Difference[3]	-1	-1	-1	0	0	-1
Spring-run Chinook Salmon						
Alternative 6	0.31	0.39	0.29	0.30	0.25	0.22
Existing Conditions	0.29	0.38	0.28	0.26	0.23	0.18
Difference	0.01	0.00	0.01	0.04	0.01	0.04
Percent Difference[3]	5	1	4	14	5	23
Winter-run Chinook Salmon						
Alternative 6	0.29	0.39	0.24	0.32	0.23	0.13
Existing Conditions	0.28	0.38	0.22	0.30	0.21	0.12
Difference	0.01	0.02	0.01	0.02	0.01	0.01
Percent Difference[3]	5	4	6	5	5	11

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

[3] Relative difference of the annual average

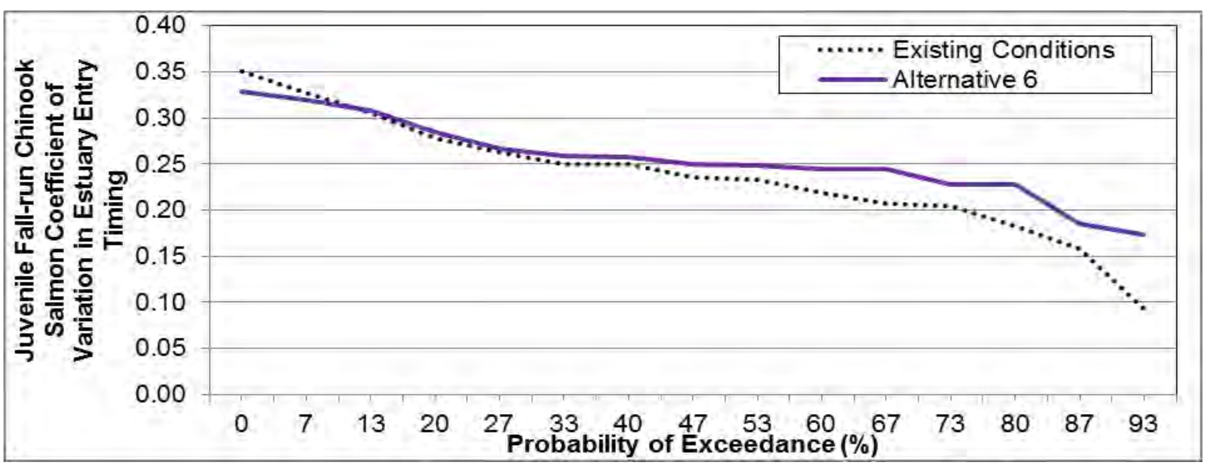


Figure 8-80. Simulated Juvenile Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 6

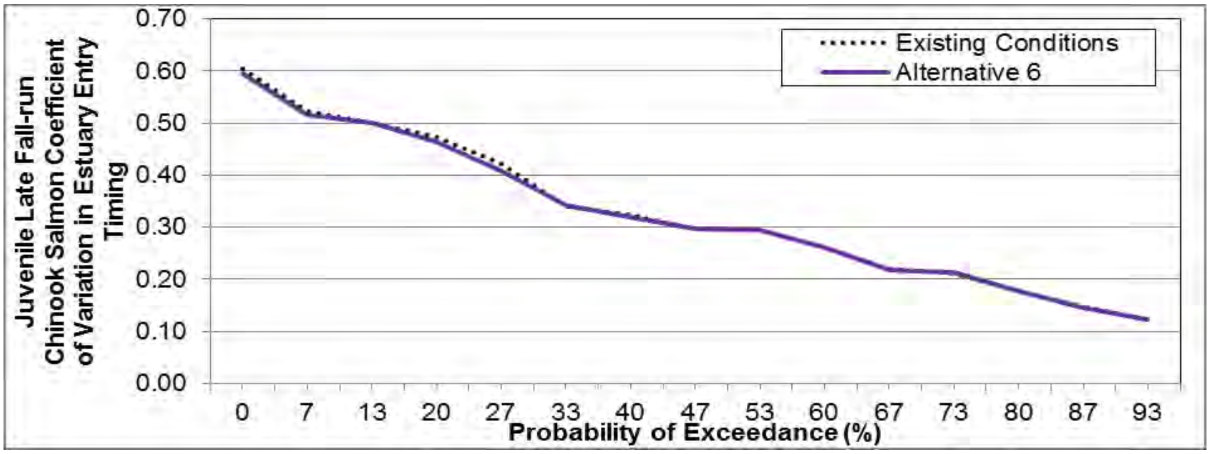


Figure 8-81. Simulated Juvenile Late Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 6

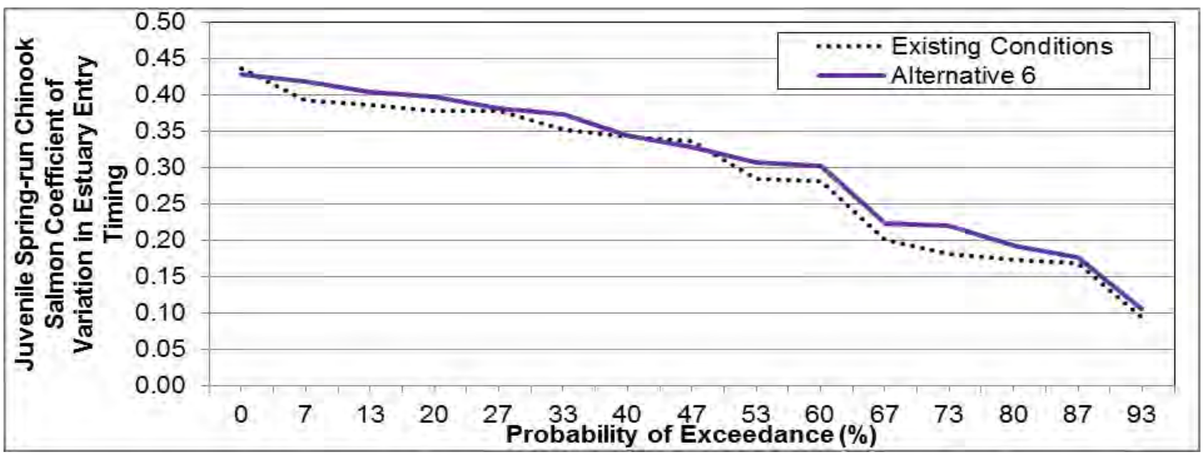


Figure 8-82. Simulated Juvenile Spring-Run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 6

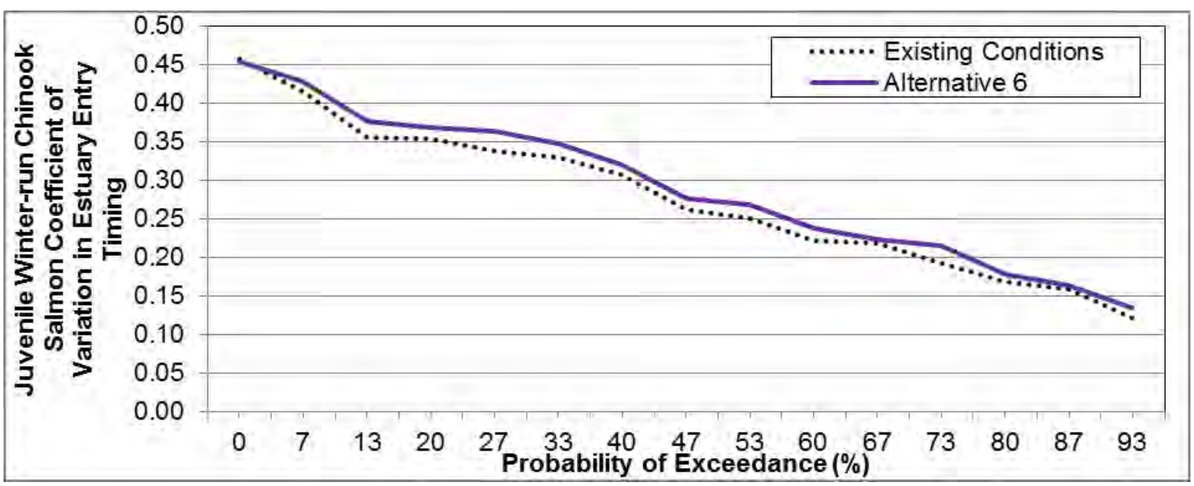


Figure 8-83. Simulated Juvenile Winter-run Chinook salmon Coefficient of Variation in Estuary Entry Timing Exceedance Distributions under Alternative 6

Spatial Structure

ENTRAINMENT INTO THE YOLO BYPASS

Modeling results indicate that mean monthly flows spilling into the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 6 relative to the Existing Condition would be substantially higher from November through March and similar over the remainder of the year under both scenarios (see Appendix G6). Mean monthly flows would be substantially higher (by 10 percent or more) during at least some water year types in November (wet water years), December (wet and above normal water years), January (wet, above normal, below normal, and dry water years), February (above normal, below normal, dry, and critical water years), and March (above normal, below normal, and dry water years). Over the entire simulation period, net increases in flows of 10 percent or more would occur with substantially higher frequency (10 percent or more often) from December through March (see Appendix G6).

Based on increases in simulated monthly flows from December through March, it is expected that juvenile salmonids and potentially other fish species would be more likely to be entrained into the Yolo Bypass from December through March under Alternative 6 relative to the Existing Conditions.

The estimated average annual percentages of juvenile fall-run, late fall-run, winter-run, and spring-run Chinook salmon (all sizes) entrained into the Yolo Bypass using the proportion of flow approach would be about 21.3, 8.5, 17.4, and 16.1 percent under Alternative 6, respectively (relative to about 7.1, 2.6, 3.9, and 3.1 percent, respectively, under Existing Conditions) (DWR 2017a; Appendix G3). For smaller juveniles (i.e., <80 mm), the percentages of fall-run, late fall-run, winter-run, and spring-run Chinook salmon entrained into the Yolo Bypass would be 20.0, 1.2, 12.0, and 16.1 percent, respectively (DWR 2017a; Appendix G3).

The ELAM modeling indicates that the entrainment-Sacramento River stage relationship under Alternative 6 exhibits a positive relationship over the range of modeled Sacramento River stages (20.23 to 28.83 ft). The percent of juveniles entrained would peak at about 37 percent at the highest stage modeled (28.83 ft) (Smith et al. 2017; Appendix G1).

The critical streakline analysis for Alternative 6 (critical streakline scenario 3) found that the percentage of the total annual abundance of juveniles entrained by run over the entire simulation period was about 28 percent (CI 12-43%) for fall-run Chinook salmon, 11 percent (CI 0-38%) for late fall-run Chinook salmon, 23 (CI 4-42%) percent for winter-run Chinook salmon, and about 22 percent (CI 6-42%) for spring-run Chinook salmon.

The entrainment modeling results indicate that the critical streakline analysis-predicted average annual entrainment rates would be about seven percent higher for fall-run, 2.5% higher for late fall-run, six percent higher for winter-rn, and six percent higher for spring-run Chinook salmon relative to proportion of flow approach estimates for Alternative 6. Because the SBM modeling was conducted using the proportion of flow approach to estimate juvenile entrainment into the Yolo Bypass, the indicators of the VSP parameters presented for Alternative 6 may be more beneficial than shown if the critical streakline entrainment estimates were applied.

Juvenile Rearing in the Yolo Bypass for One or More Days

Modeling results indicate that annual average numbers of juvenile Chinook salmon rearing for one or more days in the Yolo Bypass under Alternative 6 relative to Existing Conditions would be substantially higher over the entire simulation period and during all water year types for fall-run, late fall-run, spring-run, and winter-run Chinook salmon (Table 8-40). Similarly, the annual number of juvenile Chinook salmon rearing for one or more days in the Yolo Bypass probability of exceedance distribution for Alternative 6 would be substantially higher over the entire distribution for fall-run, spring-run, and winter-run Chinook salmon and would be substantially higher over nearly the entire distribution for late fall-run Chinook salmon (Figures 8-84 through 8-87). In addition, Alternative 6 would provide for juvenile rearing in the Yolo Bypass over about 20 percent of the distribution when no juvenile fall-run Chinook salmon would be rearing in the Yolo Bypass, over about 40 percent of the distribution when no juvenile late fall-run Chinook salmon would be rearing in the Yolo Bypass, and over about 30 percent of the distributions when no juvenile spring-run or winter-run Chinook salmon would be rearing in the Yolo Bypass under Existing Conditions.

Table 8-40. Average Annual Number of Juvenile Chinook Salmon that Reared in the Yolo Bypass for One or More Days under Alternative 6

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Fall-run Chinook Salmon						
Alternative 6	5,855,293	11,391,404	6,415,522	1,435,798	1,899,505	1,156,192
Existing Conditions	3,179,250	8,028,286	2,198,294	436,145	20,038	0
Difference	2,676,043	3,363,118	4,217,227	999,654	1,879,468	1,156,192
Percent Difference[3]	84	42	192	229	9,380	n/a
Late Fall-run Chinook Salmon						
Alternative 6	293,159	772,096	90,228	34,898	48,934	698
Existing Conditions	190,830	571,919	953	0	0	0
Difference	102,329	200,178	89,274	34,898	48,934	698
Percent Difference[3]	54	35	9,364	n/a	n/a	n/a
Spring-run Chinook Salmon						
Alternative 6	135,799	274,475	101,164	46,113	48,635	74,347
Existing Conditions	32,657	72,311	41,409	1,894	70	0
Difference	103,142	202,164	59,755	44,219	48,565	74,347
Percent Difference[3]	316	280	144	2,335	69,132	n/a
Winter-run Chinook Salmon						
Alternative 6	100,687	149,659	112,109	79,044	57,938	35,845
Existing Conditions	28,031	54,261	46,976	3,552	283	0
Difference	72,656	95,398	65,133	75,492	57,654	35,845
Percent Difference[3]	259	176	139	2,126	20,355	n/a

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

[3] Relative difference of the annual average

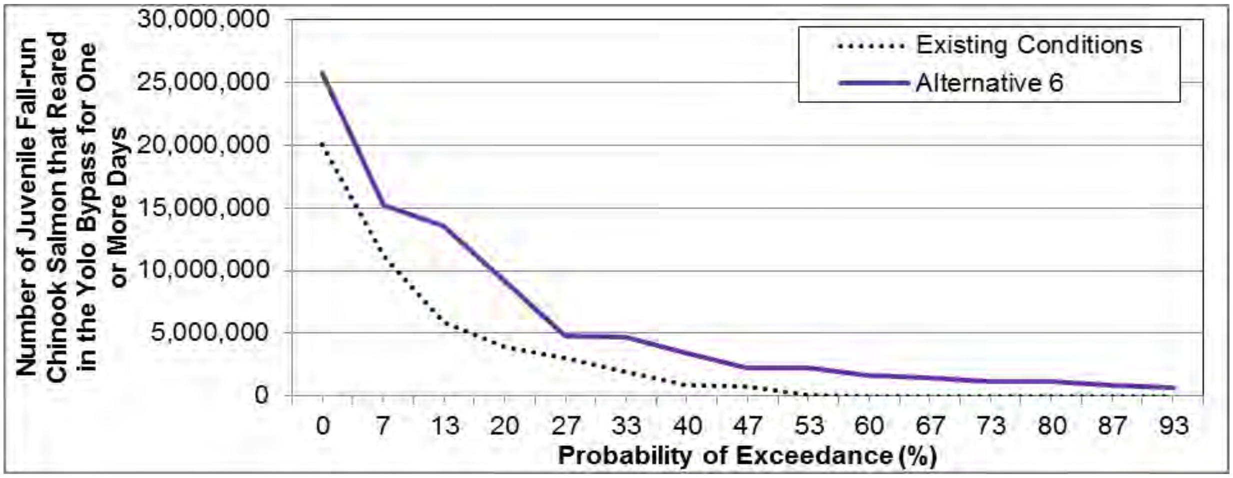


Figure 8-84. Simulated Number of Juvenile Fall-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 6

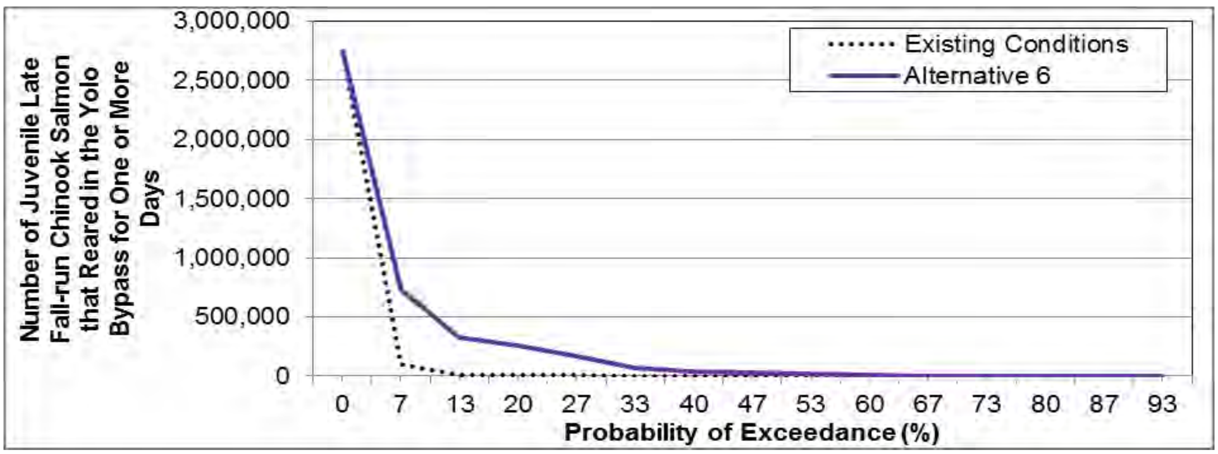


Figure 8-85. Simulated Number of Juvenile Late Fall-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 6

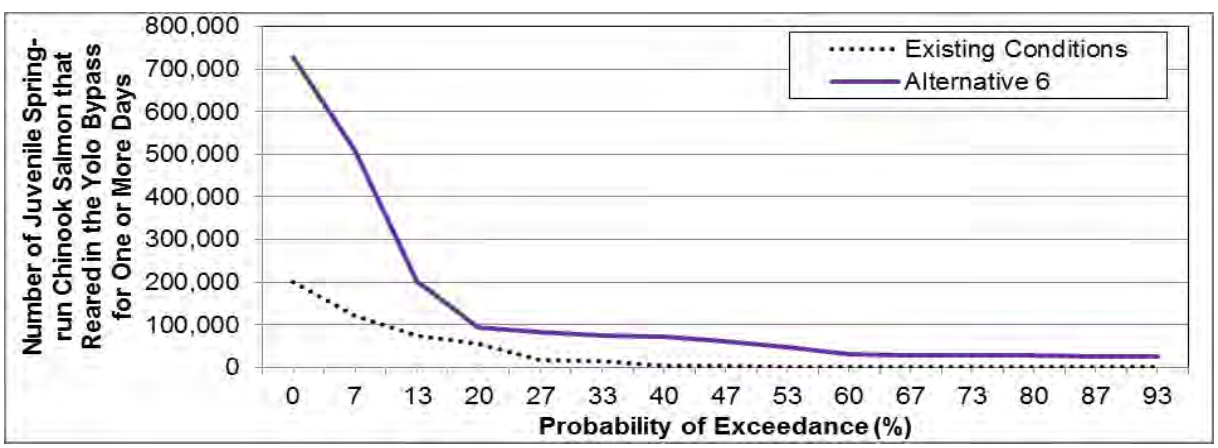


Figure 8-86. Simulated Number of Juvenile Spring-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 6

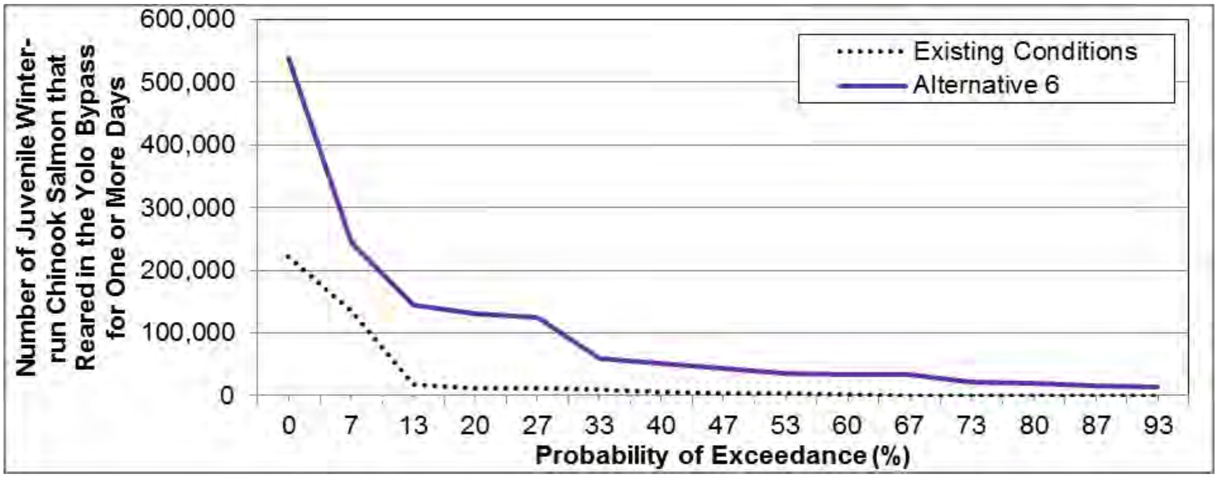


Figure 8-87. Simulated Number of Juvenile Winter-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Exceedance Distributions under Alternative 6

CEQA Conclusion

Simulated population metric indicators from the SBM were used to evaluate changes in the VSP parameters under Alternative 6 relative to Existing Conditions. Except for the abundance and productivity parameters for late fall-run and winter-run Chinook salmon and the diversity parameter for late fall-run Chinook salmon, which indicate generally similar conditions under Alternative 6 and Existing Conditions, the abundance, productivity, diversity, and spatial structure indicators all exhibit improvement for fall-run, late fall-run, spring-run, and winter-run Chinook salmon under Alternative 6 relative to Existing Conditions.

Therefore, Alternative 6 would be expected to have a **less than significant impact** on VSP parameters.

Impact FISH-19: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Hydrologic Conditions in the SWP/CVP System

Modeling results indicate that changes in simulated mean monthly storages in the SWP/CVP system under Alternative 6 relative to the basis of comparison would be similar to those described for Alternative 1. Therefore, simulated changes under Alternative 6 relative to the No Action Alternative (and Existing Conditions) would not result in substantial adverse effects to fish species of focused evaluation and their habitats in the SWP/CVP system.

CEQA Conclusion

Due to similar modeled hydrology in the SWP/CVP system, Alternative 6 would be expected to have a **less than significant impact** due to changes in hydrologic conditions in the SWP/CVP system.

Impact FISH-20: Conflict with Adopted Habitat Conservation Plan; Natural Community Conservation Plan; or Other Approved Local, Regional, or State Habitat Conservation Plan

Although the Yolo County HCP/NCCP does not directly address fish species, it does include goals and policies related to protecting and improving habitat conditions in the Yolo Bypass that could indirectly benefit fish resources (Yolo Habitat Conservancy 2017). Because Alternative 6 would include mitigation for physical habitat impacts, Alternative 6 would not conflict with HCPs or NCCPs, including the Yolo County HCP/NCCP (Yolo Habitat Conservancy 2017).

CEQA Conclusion

Alternative 6 is expected to have a **less than significant impact** on habitat conservation plans.

8.3.4 Summary of Impacts

Table 8-41 summarizes the identified impacts to aquatic resources and fisheries in the study area.

Table 8-41. Summary of Impacts and Mitigation Measures – Aquatic Resources and Fisheries

Impact	Alternative	Level of Significance before Mitigation	Mitigation Measures	Level of Significance after Mitigation
Impact FISH-1: Potential Disturbance to Fish Species or their Habitat due to Erosion, Sedimentation, and Turbidity	No Action	NI	—	NI
	All Action Alternatives	S	MM-WQ-2; MM-WQ-3	LTS
Impact FISH-2: Potential Disturbance to Fish Species or their Habitat due to Hazardous Materials and Chemical Spills	No Action	NI	—	NI
	All Action Alternatives	S	MM-WQ-1	LTS
Impact FISH-3: Potential Disturbance to Fish Species or their Habitat due to Aquatic Habitat Modification	No Action	NI	—	NI
	All Action Alternatives	S	MM-TERR-7; MM-FISH-1	LTS
Impact FISH-4: Potential Disturbance to Fish Species or their Habitat due to Hydrostatic Pressure Waves, Noise, and Vibration	No Action	NI	—	NI
	All Action Alternatives	S	MM-FISH-2	LTS
Impact FISH-5: Potential Disturbance to Fish Species or their Habitat due to Stranding and Entrainment	No Action	NI	—	NI
	All Action Alternatives	S	MM-FISH-3	LTS

Impact	Alternative	Level of Significance before Mitigation	Mitigation Measures	Level of Significance after Mitigation
Impact FISH-6: Potential Disturbance to Fish Species or their Habitat due to Predation Risk	No Action	NI	—	NI
	All Action Alternatives	S	MM-WQ-1; MM-WQ-2; MM-WQ-3; MM-FISH-2; MM-FISH-3	LTS
Impact FISH-7: Potential Disturbance to Fish Species due to Changes in Fish Passage Conditions	No Action	NI	—	NI
	All Action Alternatives	LTS	—	LTS
Impact FISH-8: Potential Disturbance to Fish Species or Their Habitat due to Direct Harm	No Action	NI	—	NI
	All Action Alternatives	S	MM-FISH-3; MM-FISH-4	LTS
Impact FISH-9: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Flows in the Sacramento River	No Action	S	—	SU
	All Action Alternatives	LTS	—	LTS
Impact FISH-10: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Water Temperatures in the Sacramento River	No Action	S	—	SU
	All Action Alternatives	LTS	—	LTS
Impact FISH-11: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Delta Hydrologic and Water Quality Conditions	No Action	S	—	SU
	All Action Alternatives	LTS	—	LTS
Impact FISH-12: Impacts to Fisheries Habitat Conditions due to Changes in Flow-dependent Habitat Availability in the Study Area (Yolo Bypass/Sutter Bypass)	No Action	B	—	B
	All Action Alternatives	B/LTS	—	B/LTS

Impact	Alternative	Level of Significance before Mitigation	Mitigation Measures	Level of Significance after Mitigation
Impact FISH-13: Impacts to Fisheries Habitat Conditions due to Changes in Water Quality in the Study Area	No Action	LTS	—	LTS
	All Action Alternatives	LTS	—	LTS
Impact FISH-14: Impacts to Aquatic Primary and Secondary Production in the Study Area	No Action	B	—	B
	All Action Alternatives	LTS	—	LTS
Impact FISH-15: Impacts to Fish Species of Focused Evaluation due to Changes in Adult Fish Passage Conditions through the Yolo Bypass	No Action	B	—	B
	1, 2, 3, 5	B	—	B
	4	S	MM-FISH-5	LTS
	6	S	—	SU
Impact FISH-16: Impacts to Fish Species due to Changes in Potential for Stranding and Entrainment	No Action	LTS	—	LTS
	1, 2, 3, 5, 6	LTS	—	LTS
	4	S	—	SU
Impact FISH-17: Impacts to Fish Species due to Changes in Potential for Predation	No Action	LTS	—	LTS
	1, 2, 3, 5, 6	LTS	—	LTS
	4	S	—	SU
Impact FISH-18: Impacts to Chinook Salmon Species/Runs due to Changes in Viable Salmonid Population Parameters	No Action	LTS	—	LTS
	All Action Alternatives	LTS	—	LTS
Impact FISH-19: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Changes in Hydrologic Conditions in the SWP/CVP System	No Action	S	—	SU
	All Action Alternatives	LTS	—	LTS

Impact	Alternative	Level of Significance before Mitigation	Mitigation Measures	Level of Significance after Mitigation
Impact FISH-20: Conflict with Adopted Habitat Conservation Plan; Natural Community Conservation Plan; or Other Approved Local, Regional, or State Habitat Conservation Plan	No Action	LTS	—	LTS
	All Action Alternatives	LTS	—	LTS
Impact FISH-21: Impacts to Fish Species of Focused Evaluation and Fisheries Habitat Conditions due to Tule Canal Floodplain Improvements (Program Level)	No Action	NI	—	NI
	1, 2, 3, 4, 5 (Project), 6	N/A	N/A	N/A
	5 (Program)	S	MM-WQ-1, 2, 3; MM-TERR-7; MM-FISH-1, 2, 3, 4, 5	SU

Key: B = beneficial; LTS = less than significant; NI = no impact; N/A= not applicable; S = significant; SU = significant and unavoidable

8.4 Cumulative Impacts Analysis

This section describes the cumulative impacts analysis for fisheries and aquatic resources. Section 3.3, *Cumulative Impacts*, presents an overview of the cumulative impacts analysis, including the methodology and the projects, plans, and programs considered in the cumulative impacts analysis.

8.4.1 Methodology

This evaluation of cumulative impacts considers the effects of the Project and how they might combine with the effects of other past, present, and future projects or actions to create significant impacts on specific resources. The area of analysis for these cumulative impacts includes both the Yolo Bypass area and the larger Sacramento River system. The timeframe for this cumulative impacts analysis includes the past, present, and probable future projects producing related or cumulative impacts that have been identified in the area of analysis. Several related and reasonably foreseeable projects and actions could result in impacts to fisheries and aquatic resources in the Project area, such as the following:

- American River Common Features General Reevaluation Report
- Bay-Delta Water Quality Control Plan Update
- Central Valley Flood Management Planning Program
- The Folsom Dam Water Control Manual Update
- The Liberty Island Conservation Bank

- California Water Fix
- Environmental Permitting for Operation and Maintenance, Oroville Facilities Federal Energy Regulatory Commission Relicensing and License Implementation
- EchoWater Project
- Delta Plan
- Delta Wetlands Project
- Lower Cache Creek Flood Risk Management Feasibility Study and the Woodland Flood Risk Reduction Project
- Lower Elkhorn Basin Levee Setback Project
- Lower Putah Creek 2 North American Wetlands Conservation Act Project
- Lower Yolo Restoration Project
- North Bay Aqueduct Alternative Intake Project
- North Delta Fish Conservation Bank
- North Delta Flood Control and Ecosystem Restoration Project
- Sacramento River Bank Protection Project
- Sacramento River General Reevaluation Report
- Sacramento-San Joaquin Delta Estuary Total Maximum Daily Load for Methylmercury
- Shasta Lake Water Resources Investigation
- Sites Reservoir Project
- Upstream Sacramento River Fisheries Projects
- The Yolo HCP/NCCP and Yolo Local Conservation Plan
- EcoRestore projects, including Agricultural Road Crossing 4 Fish Passage Improvement Project, Cache Slough Area Restoration – Prospect Island, Fremont Weir Adult Fish Passage Modification Project, Knights Landing Outfall Gate Project, Lisbon Weir Modification Project, Lower Putah Creek Realignment Project, Prospect Island Tidal Habitat Restoration Project, Tule Red Tidal Marsh Restoration Project, and Wallace Weir Fish Rescue Facility Project

8.4.2 Cumulative Impacts

All potential impacts associated with construction- and maintenance-related activities and operations-related activities would be less than significant after mitigation or beneficial to fish species of focused evaluation and their habitats under Alternatives 1, 2, and 3. Therefore, **Alternatives 1, 2, and 3 would not result in cumulatively considerable impacts** to fish and aquatic resources. **Alternatives 4, 5, and 6 could result in cumulatively considerable impacts** to fish and aquatic resources due to potentially significant impacts associated with stranding and predation under Alternatives 4 and 5 and from potentially significant impacts associated with adult fish passage under Alternative 6. Increasing levels of juvenile Chinook salmon stranding and predation above existing levels could reduce survival of juvenile Chinook salmon rearing in the Yolo Bypass under Alternatives 4 and 5. Decreasing the suitability of adult fish passage conditions through the Yolo Bypass for green and white sturgeon, Chinook salmon, and steelhead under Alternative 6 could increase mortality of adults and reduce spawning success.

8.5 Alternatives Comparison

This section conducts a relative assessment of the expected performance of each of the alternatives with respect to the project objectives and the potential for significant impacts relative to Existing Conditions.

As previously described in Chapter 1, specific biological objectives of the Project pertain to improving habitat and passage conditions for winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon, as summarized below.

- Increase the availability of floodplain fisheries rearing habitat for juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.
  - Improve access onto seasonal floodplain fisheries rearing habitat through volitional entry
  - Increase acreage of seasonal floodplain fisheries rearing habitat
  - Reduce stranding and presence of migration barriers
  - Increase aquatic primary and secondary biotic production to provide food through an ecosystem approach
- Reduce migratory delays and loss of fish at Fremont Weir and other structures in the Yolo Bypass.
  - Improve connectivity within the Yolo Bypass for passage of salmonids and green sturgeon
  - Improve connectivity between the Sacramento River and Yolo Bypass to provide safe and timely passage for:
    - Adult Sacramento River winter-run Chinook salmon between mid-November and May when elevations in the Sacramento River are amenable to fish passage
    - Adult Central Valley spring-run Chinook salmon between January and May when elevations in the Sacramento River are amenable to fish passage
    - Adult California Central Valley steelhead in the event their presence overlaps with the defined seasonal window for other target species when elevations in the Sacramento River are amenable to fish passage
    - Adult Southern DPS green sturgeon between February and May when elevations in the Sacramento River are amenable to fish passage

Although not specifically identified as project objectives, additional pertinent objectives evaluated include the following.

- Improve phenotypic diversity of juvenile winter-run and spring-run Chinook salmon
- Increase abundances of returning adult winter-run and spring-run Chinook salmon

The following sections describe the estimated relative extent to which each alternative promotes the project objectives relative to Existing Conditions.

8.5.1 Improve Access to Seasonal Habitat Through Volitional Entry

The improvement in access of juvenile Chinook salmon to seasonal habitat in the Yolo Bypass through volitional entry was evaluated based on multiple methods that were applied by the Lead Agencies. Methodologies included the proportion of flow approach (DWR 2017a; Appendix G3), ELAM modeling (Smith et al. 2017), and a critical streakline analysis (Blake et al. 2017; Appendix G2).

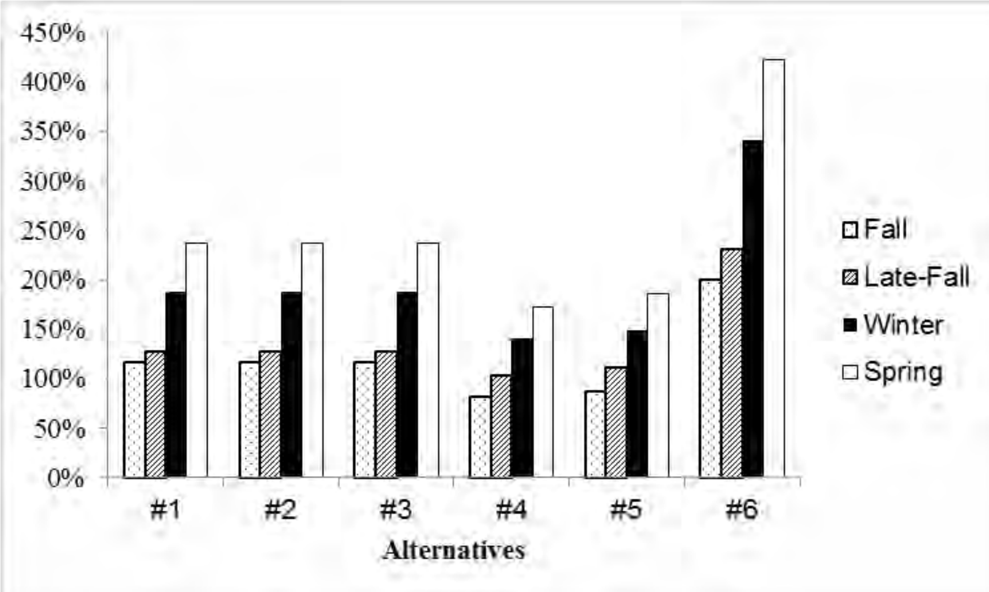
8.5.1.1 Proportion of Flow Approach

Average annual entrainment estimates indicate that Alternative 6 would entrain the largest percentage of juvenile Chinook salmon (all size classes) for all runs and a substantially larger percentage of juvenile fall-run, winter-run, and spring-run Chinook salmon than the other alternatives (Table 8-42). Alternatives 1 through 3 would entrain the second-largest percentage of juvenile Chinook salmon for each run. Average entrainment of each run would be similar under Alternatives 4 and 5 but slightly higher under Alternative 5. The average annual increase in estimated entrainment of each Chinook salmon run for each alternative relative to Existing Conditions is shown in Figure 8-88.

Table 8-42. Average Annual Percentages of Juvenile Chinook Salmon Runs (All Sizes) Entrained onto the Yolo Bypass under the Alternatives and Existing Conditions (Proportion of Flow)

Run	Existing Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Fall	7.11%	15.40%	15.40%	15.40%	12.97%	13.27%	21.33%
Late Fall	2.57%	5.86%	5.86%	5.86%	5.23%	5.44%	8.53%
Winter	3.94%	11.33%	11.33%	11.33%	9.49%	9.78%	17.37%
Spring	3.07%	10.33%	10.33%	10.33%	8.35%	8.80%	16.06%

Source: DWR 2017a; Appendix G3

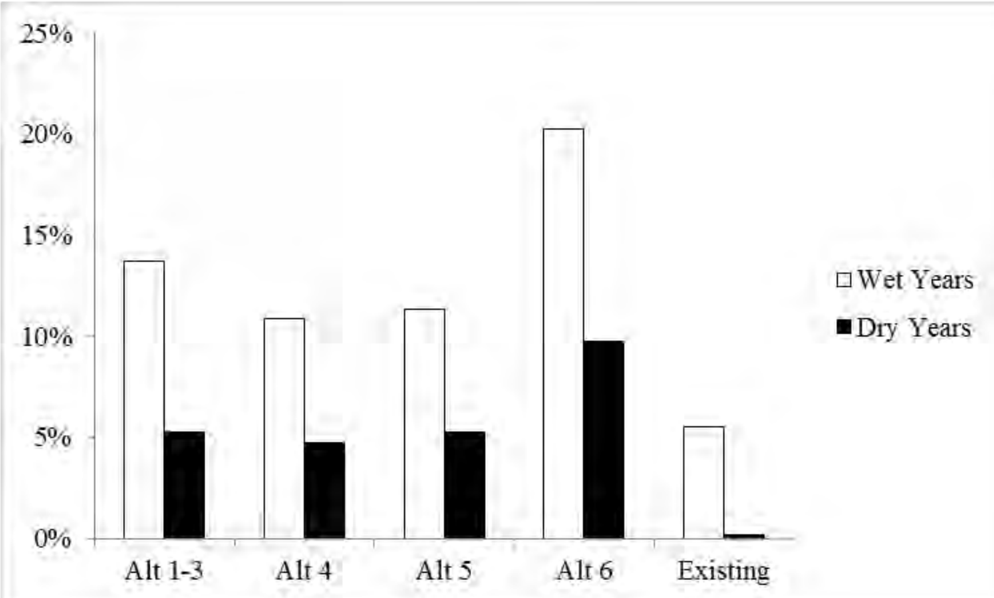


Source: DWR 2017a; Appendix G3

Figure 8-88. Average Annual Increase in the Percentage of the Total Population of Juvenile Chinook salmon (All Sizes) Entrained onto the Yolo Bypass relative to Existing Conditions by Run (Proportion of Flow)

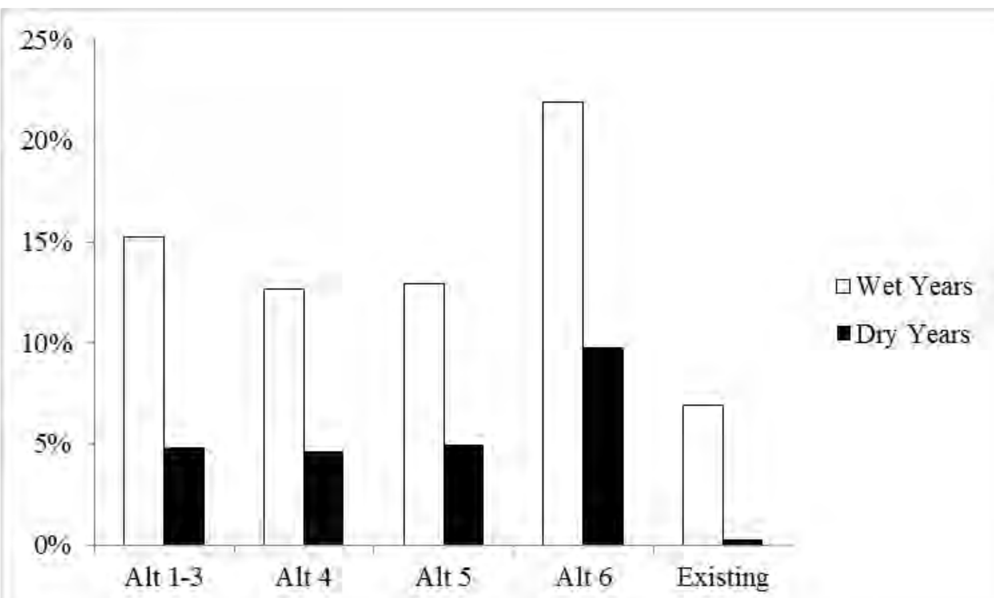
Average annual estimated entrainment of spring-run and winter-run Chinook salmon during wet (i.e., wet and above normal) water years and dry (i.e., dry and critical) water years among alternatives exhibits similar relative patterns as described for the average entrainment estimates over the entire simulation period (Figures 8-89 and 8-90) (DWR 2017a; Appendix G3). During wet and above normal water years, entrainment of spring-run and winter-run Chinook salmon would be highest under Alternative 6, second-highest under Alternatives 1 through 3, and lowest under Alternatives 4 and 5. However, during dry and critical water years, although entrainment would be highest under Alternative 6, entrainment would be generally similar under Alternatives 1 through 5. All alternatives would be particularly effective at increasing entrainment during dry and critical water years relative to Existing Conditions. During dry and critical years, naturally occurring spills over Fremont Weir would be rare and often short in duration, providing minimal opportunity for juveniles to access the Yolo Bypass (DWR 2017a; Appendix G3).

Based on the temporal distribution of juvenile spring-run Chinook salmon emigrating through the Sacramento River, juvenile spring-run Chinook salmon could still be emigrating downstream into the Yolo Bypass after the end of the alternative's operational period in mid-March (DWR 2017a; Appendix G3). Because all alternatives except for Alternative 6 include the potential for extended but limited operation of the gates (up to 1,000 cfs) into late March or early April as conditions allow, juvenile spring-run Chinook salmon may have an opportunity to enter the Yolo Bypass after mid-March under all alternatives except Alternative 6 (DWR 2017a; Appendix G3).



Source: DWR 2017a; Appendix G3

Figure 8-89. Mean Annual Entrainment of Juvenile Spring-run Chinook Salmon (All Sizes) onto the Yolo Bypass under the Alternatives and Existing Conditions (Proportion of Flow)



Source: DWR 2017a; Appendix G3

Figure 8-90. Mean Annual Entrainment of Juvenile Winter-run Chinook salmon (All Sizes) onto the Yolo Bypass under the Alternatives and Existing Conditions (Proportion of Flow)

Because it is assumed that entraining smaller juvenile Chinook salmon into the Yolo Bypass would be more beneficial due to the higher likelihood of smaller juveniles taking advantage of improved rearing habitat in the Yolo Bypass, DWR (2017a) also estimated the average annual percentages of each run entrained into the Yolo Bypass for juveniles less than 80 mm FL (Table 8-43).

Table 8-43. Average Annual Percentages of Juvenile Chinook Salmon (<80 mm FL) Runs Entrained onto the Yolo Bypass under the Alternatives and Existing Conditions (Proportion of Flow)

Run	Existing Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4a	Alternative 4b	Alternative 5	Alternative 6
Fall	9.2%	15.3%	15.3%	15.3%	13.6%	12.9%	13.8%	20.0%
Late Fall	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.2%
Winter	1.2%	7.1%	7.1%	7.1%	5.9%	5.9%	6.2%	12.0%
Spring	3.6%	10.6%	10.6%	10.6%	8.9%	8.7%	9.4%	16.1%

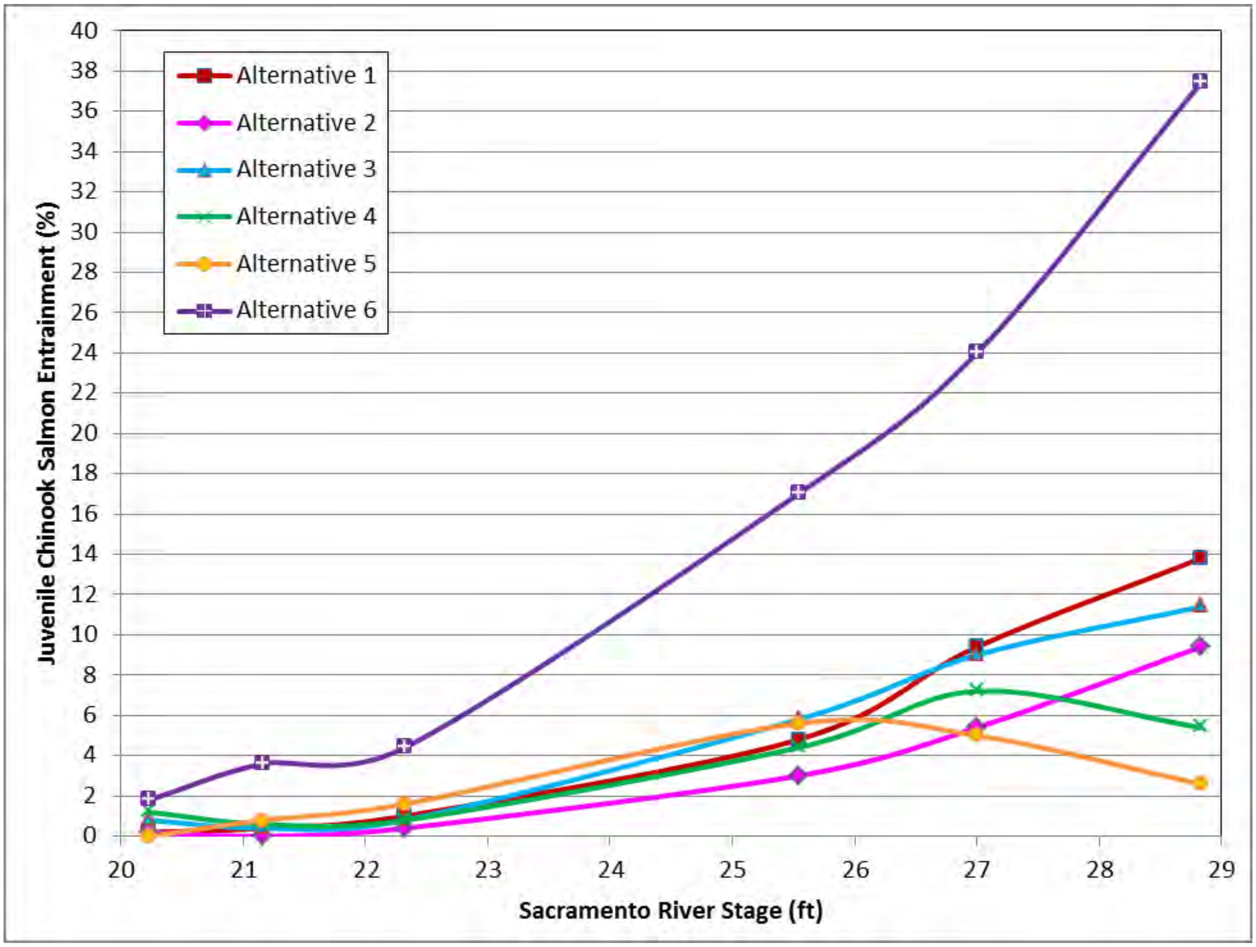
Source: DWR 2017a; Appendix G3

Relative to simulated entrainment of all sizes of juveniles, the proportion of flow entrainment approach indicates that for smaller juveniles (<80 mm), similar percentages of fall-run and spring-run Chinook salmon would be entrained under all alternatives, and fewer late fall-run and winter-run Chinook salmon would be entrained under all alternatives.

8.5.1.2 ELAM

The ELAM modeling also was used by the Lead Agencies to estimate relative entrainment rates of juvenile salmonids into the Yolo Bypass for each Alternative (see Appendix 1 of Smith et al. 2017). ELAM modeled relationships between the percentage of juvenile Chinook salmon entrained into the Yolo Bypass and Sacramento River stage at Fremont Weir are shown for all alternatives in Figure 8-91. However, the entrainment-discharge relationships shown for Alternatives 2 and 5 do not account for the proposed Sacramento River channel and bank improvements. With the improvements, entrainment under Alternative 5 would be expected to peak at approximately 10 percent (instead of six percent), and entrainment under Alternative 2 would be expected to peak at a rate higher than 10 percent.

The ELAM modeling indicates that larger notch flows generally entrain greater numbers of juveniles but not in proportion to the flow volume through the notch. Alternative 6 exhibits the strongest positive relationship between Sacramento River stage and entrainment rate across the entire range of modeled stages and would entrain more juveniles than the other alternatives. Alternative 1 would have the second-highest maximum entrainment rate (about 14 percent), followed by Alternatives 2 (greater than 10 percent), 3 (about 11 percent), and 5 (about 10 percent). Alternative 4 would have a relatively low maximum entrainment rate relative to other alternatives of about seven percent and would have a lower entrainment rate at the highest stage modeled (28.83 feet).



Reproduced from: Smith et al. 2017

Figure 8-91. Juvenile Entrainment-Sacramento River Stage Relationships for each Alternative (ELAM)

Overall, Alternative 6 would allow for the greatest entrainment rates with the greatest certainty based on the consistently positive entrainment-discharge relationship. Alternatives 1, 2, and 3 would provide the next-highest maximum entrainment rates, followed by Alternative 5. Alternative 4 would exhibit the lowest maximum entrainment rates.

8.5.1.3 Critical Streakline Analysis

The critical streakline analysis was conducted for Alternatives 3, 4, 5, and 6. However, although Alternative 5 would be located near the central portion of Fremont Weir, Alternative 5 was modeled at the western edge of Fremont Weir. Therefore, critical streakline entrainment estimates for Alternative 5 are not used for comparing entrainment rates among alternatives.

The critical streakline analysis estimated the average percentage of the total annual abundances of Chinook salmon juveniles by run entrained over the entire simulation period (Appendix G2, Table 8-44). Ninety percent confidence intervals are shown in parenthesis.

Table 8-44. Estimated Total Entrainment of each Chinook Salmon Run over the Entire Simulation Period (Critical Streakline)

Alternative	Estimated Total Entrainment (%)	Estimated Total Entrainment (%)	Estimated Total Entrainment (%)	Estimated Total Entrainment (%)
	Fall-run	Late Fall-run	Winter-run	Spring-run
3	12 (6-21)	5 (-12)	9 (2-17)	9 (4-15)
4	9 (2-21)	4 (0-11)	7 (2-15)	7 (4-14)
6	28 (12-43)	11 (0-38)	23 (4-42)	22 (6-42)

Reproduced from: Blake et al. 2017; Appendix G2

Consistent with the proportion of flow approach and the ELAM modeling, Alternative 6 was estimated to provide the greatest rates of entrainment for all runs due to the higher flow capacity of the notch. Alternative 3 would provide the second-highest rates of entrainment, followed by Alternatives 4 and 5, which would provide similar rates of entrainment for most runs, including winter-run and spring-run Chinook salmon.

8.5.1.4 Entrainment Summary

Entrainment results for each of the three methods by run and alternative are provided in Table 8-45. Alternative 6 would consistently entrain the highest percentages of each run, followed by Alternative 1, followed by Alternatives 2 and 3, then by Alternatives 4 and 5.

It should be noted that a modified version of Alternative 4 was modeled using the critical streakline analysis, assuming a lower rating curve to entrain water at a lower Sacramento River stage. This modified alternative scenario resulted in substantially higher entrainment estimates (14, 9, 16, and 13 percent for fall-run, late fall-run, winter-run, and spring-run, respectively) than shown for Alternative 4.

Because the proportion of flow entrainment estimates were assumed in the SBM modeling, application of the critical streakline or ELAM entrainment estimates could result in reduced numbers of juveniles entrained into the Yolo Bypass and therefore could result in different benefits to juvenile and adult metrics than shown in this assessment for most alternatives.

Because the critical streakline entrainment analysis estimated a comparable annual entrainment metric for each run as the proportion of flow approach, relative differences in the SBM metrics were estimated based on using the critical streakline entrainment estimates relative to the proportion of flow entrainment estimates (for Alternatives 3, 4, and 6). For Alternatives 3 and 4, reduced critical streakline entrainment estimates relative to the proportion of flow estimates indicate that fewer juveniles would be entrained into the Yolo Bypass; therefore, benefits shown for the SBM juvenile and adult metrics would be reduced with the critical streakline entrainment rates. However, for Alternative 6, application of the proportion of flow entrainment estimates underestimate the number of juveniles entrained into the Yolo Bypass relative to the critical streakline analysis; therefore, the SBM output may underestimate the benefits of Alternative 6 with respect to the juvenile and adult metrics relative to the other alternatives.

Table 8-45. Summary of Entrainment Estimates by Alternative and Chinook Salmon Run (All Sizes)

Method	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Fall-run Chinook Salmon						
Proportion of Flow[1]	15.4%	15.4%	15.4%	13.0%	13.3%	21.3%
ELAM[2]	14%	>10%	11%	7%	10%	37%
Critical Streakline[3]	n/a	n/a	12%	9%	n/a	28%
Late Fall-run Chinook Salmon						
Proportion of Flow	5.9%	5.9%	5.9%	5.2%	5.4%	8.5%
ELAM	14%	>10%	11%	7%	10%	37%
Critical Streakline	n/a	n/a	5%	4%	n/a	11%
Winter-run Chinook Salmon						
Proportion of Flow	11.3%	11.3%	11.3%	9.5%	9.8%	17.4%
ELAM	14%	>10%	11%	7%	10%	37%
Critical Streakline	n/a	n/a	9%	7%	n/a	23%
Spring-run Chinook Salmon						
Proportion of Flow	10.3%	10.3%	10.3%	8.4%	8.8%	16.1%
ELAM	14%	>10%	11%	7%	10%	37%
Critical Streakline	n/a	n/a	9%	7%	n/a	22%

[1] Estimated total entrainment percentage of each run over the simulation period

[2] Maximum entrainment rate on the entrainment-Sacramento River stage relationship (not run-specific)

[3] Estimated average annual percentages of each run entrained over the simulation period

8.5.2 Increase Access to and Acreage of Seasonal Floodplain Fisheries Rearing Habitat

Changes in access to and use of seasonal floodplain habitat in the Yolo Bypass were evaluated for each alternative based on the potential for juvenile entrainment into the Yolo Bypass (discussed above) and modeled abundance of juveniles rearing on the Yolo Bypass for one or more days. Because not all juveniles entrained into the Yolo Bypass would necessarily spend time rearing in the Yolo Bypass, the simulated number of juveniles rearing in the Yolo Bypass would differ from the number of juveniles entrained into the Yolo Bypass. Changes in acreage of floodplain habitat were evaluated for each alternative based on the modeled changes in area of habitat in the Yolo Bypass based on hydraulic habitat suitability criteria applied for Chinook salmon pre-smolts and smolts. Because the proportion of flow approach was used to estimate juvenile entrainment into the Yolo Bypass for the SBM, the following model results shown for Alternative 1 also apply to Alternatives 2 and 3.

8.5.2.1 Rearing in the Yolo Bypass

8.5.2.1.1 Spring-run Chinook Salmon

Modeling results indicate that annual average abundance of juvenile spring-run Chinook salmon rearing for one or more days in the Yolo Bypass would be highest under Alternative 6 and second-highest under Alternatives 1 through 3 (Table 8-46). Annual average abundance of juveniles rearing for one or more days in the Yolo Bypass under Alternatives 4a, 4b, and 5 would be similar over the entire simulation period and by water year type and generally lower than under Alternatives 6 and 1 through 3. The largest differences (increases) in numbers of juveniles rearing under Alternatives 1 through 3 relative to Alternatives 4a, 4b, and 5 would occur during wet, above normal, and below normal water years, with less differences during dry and critical water years.

Table 8-46. Average Annual Abundance of Juvenile Spring-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days under each Alternative and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	32,657	72,311	41,409	1,894	70	0
Alternatives 1-3	93,719	193,287	78,417	24,560	28,243	42,004
Alternative 4a	75,020	149,586	70,133	16,564	23,793	38,668
Alternative 4b	74,738	149,487	70,172	16,343	22,943	38,668
Alternative 5	80,948	161,542	72,070	18,363	27,482	43,648
Alternative 6	135,799	274,475	101,164	46,113	48,635	74,347

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)
[2] As defined by the Sacramento Valley Index (DWR 2017c)

Similar to the results described for the annual average number of juvenile spring-run Chinook salmon rearing for one or more days in the Yolo Bypass, the probability of exceedance distributions shows similar differences among alternatives (Figure 8-92[10]). The number of juvenile spring-run Chinook salmon rearing in the Yolo Bypass for one or more days would be highest under Alternative 6 over the entire distribution, followed by Alternatives 1 through 3, which would result in similar or higher numbers of juveniles rearing in the Yolo Bypass over the distribution relative to Alternatives 4a, 4b, and 5. The numbers of juveniles rearing in the Yolo Bypass for one or more days would be generally similar over most of the distribution under Alternatives 4a, 4b, and 5 but higher over portions of the distribution under Alternative 5.

All alternatives would provide for substantially higher numbers of juvenile spring-run Chinook salmon rearing in the Yolo Bypass for one or more days over the entire distribution relative to Existing Conditions. All alternatives would provide for some spring-run Chinook salmon juvenile rearing in the Yolo Bypass over about 30 percent of the distribution when very few or no juveniles would be rearing in the Yolo Bypass under Existing Conditions.

[10] Inset figure is displaying the same data with a truncated y-axis to allow for better visual observation of the differences among the alternatives and Existing Conditions

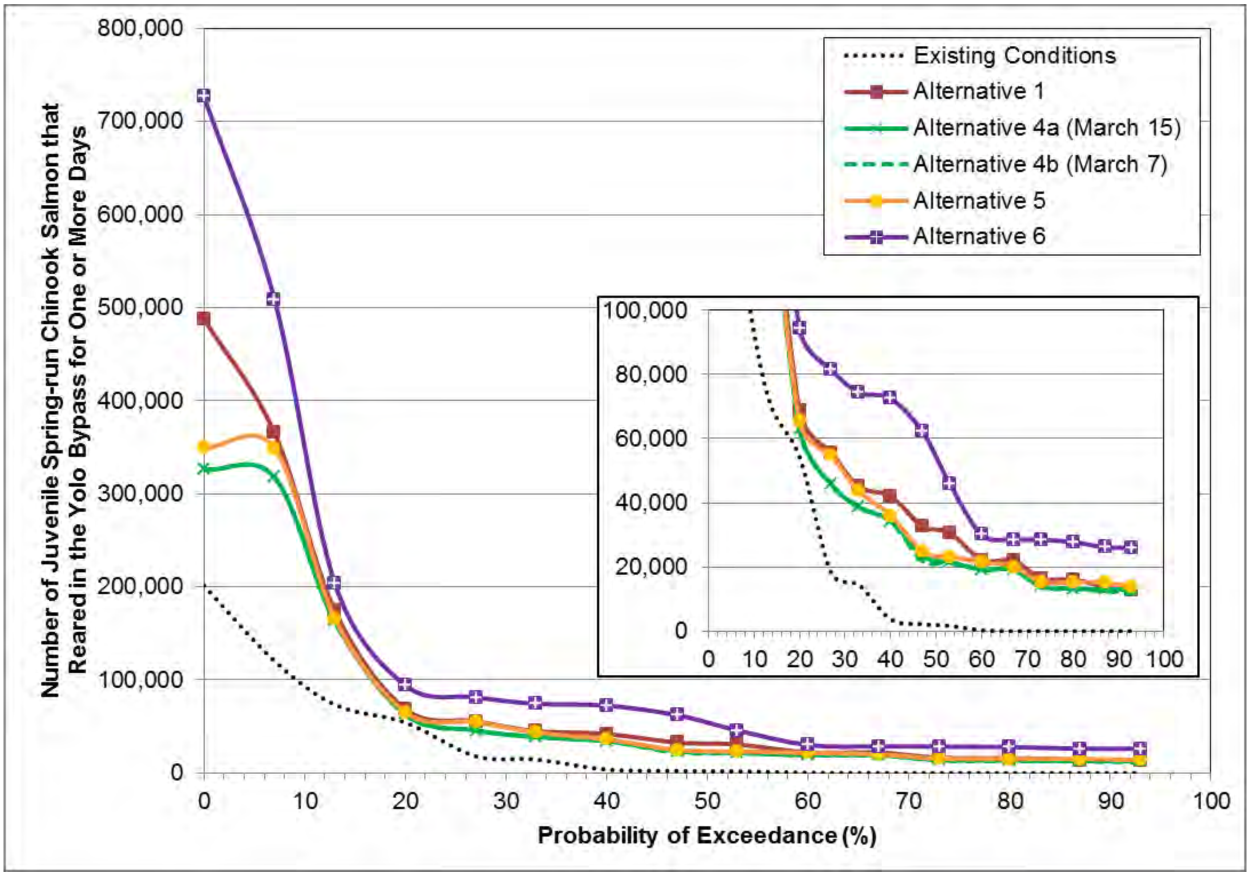


Figure 8-92. Simulated Number of Juvenile Spring-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Probability of Exceedance Distributions under each Alternative and Existing Conditions

8.5.2.1.2 Winter-run Chinook Salmon

Modeling results indicate that annual average abundance of juvenile winter-run Chinook salmon rearing for one or more days in the Yolo Bypass would be highest under Alternative 6 and second-highest under Alternatives 1 through 3 over the entire simulation period and during most water year types (Table 8-47). Simulated annual average abundance of juveniles rearing for one or more days in the Yolo Bypass would be slightly higher under Alternative 5 relative to Alternatives 4a and 4b over the entire simulation period and by water year type. During dry and critical water years, Alternative 5 would result in slightly higher numbers of juveniles rearing in the Yolo Bypass relative to Alternatives 1 through 3.

Table 8-47. Average Annual Number of Juvenile Winter-run Chinook Salmon that Reared in the Yolo Bypass for One or More Days under each Alternative and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	28,031	54,261	46,976	3,552	283	0
Alternatives 1-3	66,153	104,777	85,621	38,842	28,468	19,998
Alternative 4a	57,512	93,169	76,158	22,429	26,186	18,765
Alternative 4b	57,287	93,072	76,121	22,322	25,544	18,765
Alternative 5	61,011	97,614	77,902	26,558	29,824	20,975
Alternative 6	100,687	149,659	112,109	79,044	57,938	35,845

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

Similar to the results described for the annual average abundance of juvenile winter-run Chinook salmon rearing for one or more days in the Yolo Bypass, the probability of exceedance distributions shows similar differences among alternatives (Figure 8-93). The number of juvenile winter-run Chinook salmon rearing in the Yolo Bypass would be highest under Alternative 6 over the entire distribution, followed by Alternatives 1 through 3, then Alternative 5, and followed by Alternatives 4a and 4b.

All alternatives would provide for substantially higher numbers of juvenile winter-run Chinook salmon rearing on the Yolo Bypass over the entire distribution relative to Existing Conditions. All alternatives would provide for some winter-run Chinook salmon juvenile rearing on the Yolo Bypass over about 30 percent of the distribution when very few or no juveniles would be rearing in the Yolo Bypass under Existing Conditions.

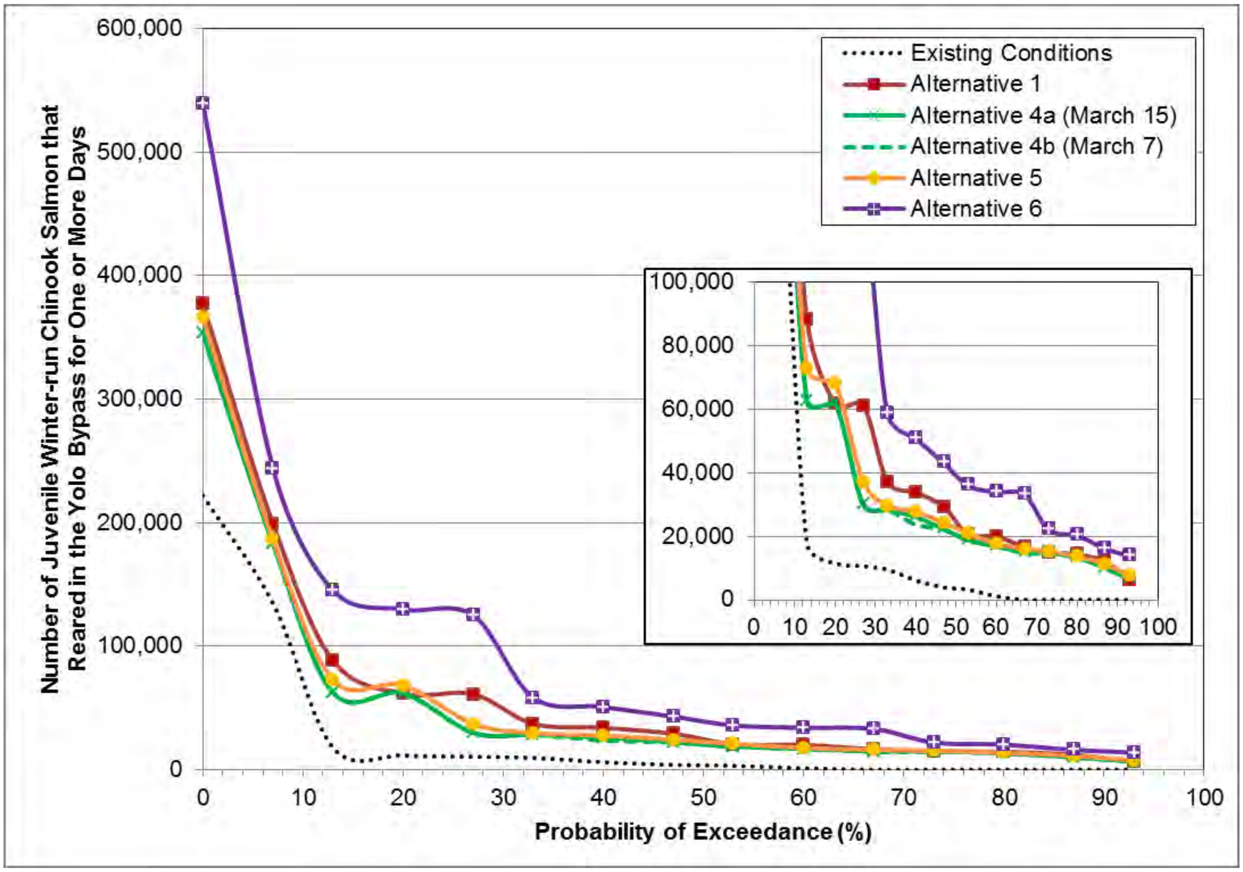


Figure 8-93. Simulated Number of Juvenile Winter-Run Chinook Salmon that Reared in the Yolo Bypass for One or More Days Probability of Exceedance Distributions under each Alternative and Existing Conditions

8.5.2.2 Flow-Dependent Habitat Availability

8.5.2.2.1 Chinook Salmon Pre-Smolt Habitat

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon pre-smolts in the Yolo Bypass would be generally similar under all alternatives and Existing Conditions in October, November, April, and May and higher under all alternatives from December through March relative to Existing Conditions (Table 8-48). Average monthly pre-smolt hydraulic habitat availability would be generally higher from December through March under Alternatives 4a, 4b, and 6 than the other alternatives over the entire simulation period and during most water year types.

Table 8-48. Average Monthly Area of Pre-smolt Chinook Salmon Hydraulic Habitat in the Yolo Bypass from October through May based on TUFLOW Modeling (Water Year 1997 to 2012)

Alternative	Area (km^2) October	Area (km^2) November	Area (km^2) December	Area (km^2) January	Area (km^2) February	Area (km^2) March	Area (km^2) April	Area (km^2) May
Entire Simulation Period[1] (n=16)								
Existing Conditions	20	21	31	48	44	47	37	27
Alternative 1	20	22	39	56	56	52	37	27
Alternative 4a	20	22	42	60	63	57	38	28
Alternative 4b	20	22	42	60	63	53	37	27
Alternative 5	20	22	38	55	56	53	37	28
Alternative 6	20	22	42	58	62	56	37	27
Water Year Types[2]								
Wet (n=5)								
Existing Conditions	20	21	38	49	57	69	58	32
Alternative 1	20	22	56	59	70	72	58	32
Alternative 4a	20	23	59	60	71	74	59	32
Alternative 4b	20	23	59	60	71	72	59	32
Alternative 5	20	22	52	56	68	73	59	32
Alternative 6	20	23	62	61	73	74	59	32
Above Normal (n=3)								
Existing Conditions	20	22	36	67	41	48	37	38
Alternative 1	20	22	39	79	65	51	36	37
Alternative 4a	20	22	43	81	69	57	37	38
Alternative 4b	20	22	43	81	69	54	37	38
Alternative 5	20	22	39	78	65	52	37	38
Alternative 6	20	22	40	82	76	55	37	38
Below Normal (n=3)								
Existing Conditions	20	21	25	45	42	40	27	21
Alternative 1	20	21	29	54	51	44	27	21
Alternative 4a	20	21	31	56	60	49	27	21
Alternative 4b	20	21	31	56	60	45	27	21
Alternative 5	20	21	29	54	52	45	27	21
Alternative 6	20	21	32	56	56	47	27	21
Dry (n=4)								
Existing Conditions	20	21	26	36	27	29	22	20
Alternative 1	20	21	29	38	33	40	22	20

Alternative	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Alternative 4a	20	21	34	48	48	46	23	20
Alternative 4b	20	21	34	48	48	40	22	20
Alternative 5	20	21	30	39	34	39	23	20
Alternative 6	20	21	33	40	38	45	22	20
Critical (n=1)								
Existing Conditions	20	21	21	40	58	28	22	21
Alternative 1	20	21	22	46	70	33	22	20
Alternative 4a	20	21	23	56	78	42	23	21
Alternative 4b	20	21	23	56	78	37	23	20
Alternative 5	20	21	22	47	70	34	23	21
Alternative 6	20	21	22	52	77	37	23	20

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

Key: km^2 = square kilometer

Chinook salmon pre-smolt hydraulic habitat availability would be similar over the exceedance distributions for all alternatives and Existing Conditions over the highest ~40 percent of the distribution (when habitat availability is lowest) (Figure 8-94). Alternatives 4a and 4b would provide substantially more hydraulic habitat than the other alternatives over the middle ~25 percent of the distributions. Over the lowest ~25 percent of the distributions (when habitat availability is highest), Alternative 6 would provide slightly more pre-smolt hydraulic habitat relative to the other alternatives, whereas Alternatives 1 through 5 would provide similar amounts of hydraulic habitat. All alternatives would provide substantially more pre-smolt hydraulic habitat relative to Existing Conditions over about 30 to 50 percent of the distributions.

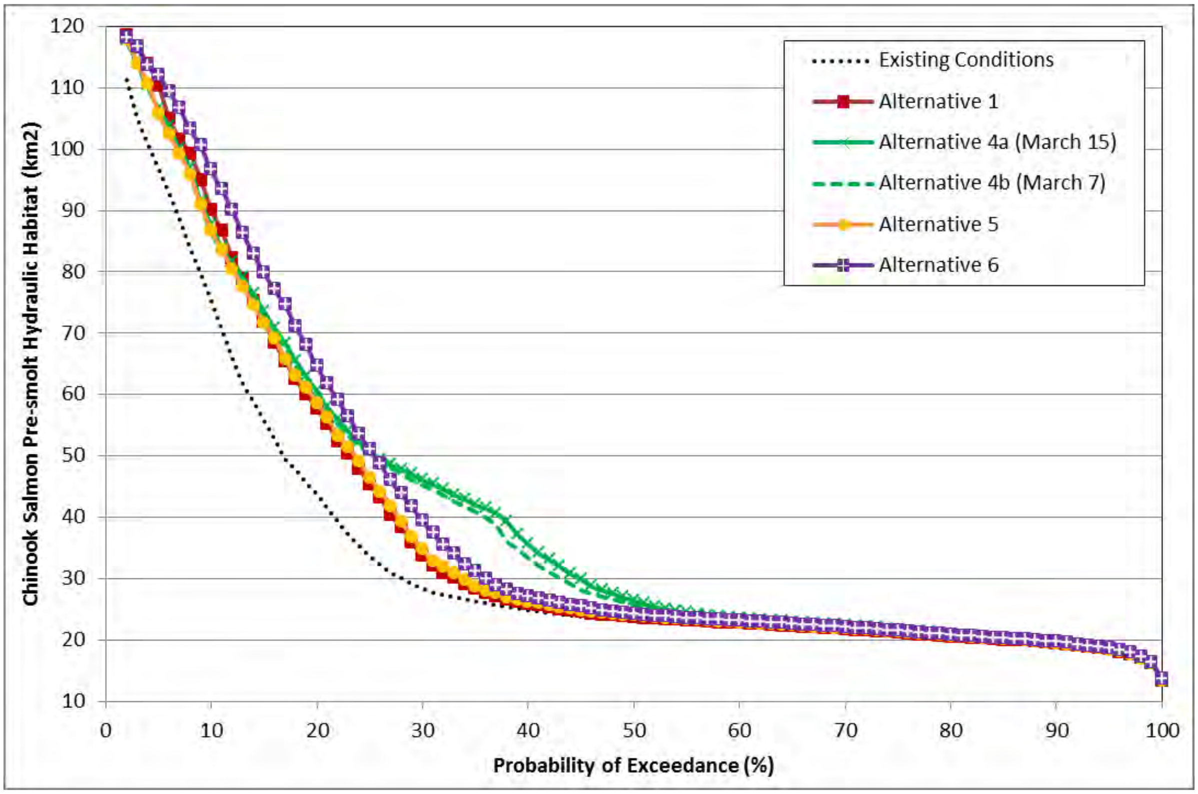


Figure 8-94. Simulated Chinook Salmon Pre-Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under All Alternatives and Existing Conditions from October through May based on TUFLOW Modeling (Water Years 1997 through 2012)

8.5.2.2.2 Chinook Salmon Smolt Habitat

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon smolts in the Yolo Bypass would be generally similar under all alternatives and Existing Conditions in October, November, April, and May and higher under all alternatives from December through March relative to Existing Conditions (Table 8-49). Average monthly smolt hydraulic habitat availability would be generally higher under Alternatives 4a, 4b, and 6 relative to the other alternatives over the entire simulation period and by water year type.

Table 8-49. Average Monthly Area of Chinook Salmon Smolt Hydraulic Habitat in the Yolo Bypass from October through May based on TUFLOW Modeling (Water Years 1997 through 2012)

Alternative	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Entire Simulation Period[1] (n=16)								
Existing Conditions	32	32	44	70	70	76	59	43
Alternative 1	32	32	53	81	83	82	59	43
Alternative 4a	32	33	56	85	91	87	60	43
Alternative 4b	32	33	56	85	91	83	59	43
Alternative 5	32	32	52	79	83	82	59	43
Alternative 6	32	33	58	86	91	86	59	43
Water Year Types[2]								
Wet (n=5)								
Existing Conditions	31	32	55	90	101	119	100	51
Alternative 1	32	33	75	102	115	124	100	50
Alternative 4a	32	34	78	104	116	126	101	51
Alternative 4b	32	34	78	103	116	123	101	51
Alternative 5	31	33	70	99	113	124	100	51
Alternative 6	32	34	85	107	121	127	100	50
Above Normal (n=3)								
Existing Conditions	32	33	48	82	68	77	50	55
Alternative 1	32	33	53	100	93	80	50	54
Alternative 4a	32	33	57	101	98	86	51	55
Alternative 4b	32	33	57	101	98	83	51	55
Alternative 5	32	33	52	97	92	81	51	55
Alternative 6	32	33	55	107	105	84	51	54
Below Normal (n=3)								
Existing Conditions	32	32	36	58	62	63	41	35
Alternative 1	32	32	40	70	72	67	41	35
Alternative 4a	32	32	42	71	83	72	41	35
Alternative 4b	32	32	42	71	83	68	41	35
Alternative 5	32	32	41	68	73	68	41	35
Alternative 6	32	32	44	75	79	71	41	35
Dry (n=4)								
Existing Conditions	32	32	37	49	38	41	34	33
Alternative 1	32	32	40	53	45	52	34	33
Alternative 4a	32	32	45	63	61	59	35	33

Alternative	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Alternative 4b	32	32	45	63	60	52	34	33
Alternative 5	32	32	41	53	45	52	34	34
Alternative 6	32	32	44	56	50	59	34	33
Critical (n=1)								
Existing Conditions	31	31	31	52	70	39	34	34
Alternative 1	31	31	31	59	85	44	34	34
Alternative 4a	31	31	33	70	94	54	35	34
Alternative 4b	31	31	33	70	94	49	35	34
Alternative 5	31	31	31	60	85	45	35	34
Alternative 6	31	31	32	65	94	49	35	34

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

Key: km^2 = square kilometer

Chinook salmon smolt hydraulic habitat availability would be similar over the cumulative probability of exceedance distributions for all alternatives and Existing Conditions over the highest ~40 percent of the distribution (when habitat availability is lowest) (Figure 8-95). Alternatives 4a and 4b would provide more hydraulic habitat than the other alternatives over the middle ~25 percent of the distributions. Over the lowest ~25 percent of the distributions (when habitat availability is highest), Alternative 6 would provide slightly more smolt hydraulic habitat relative to the other alternatives, whereas Alternatives 1 through 5 would provide similar amounts of hydraulic habitat. All alternatives would provide substantially more smolt hydraulic habitat relative to Existing Conditions over about 30 to 50 percent of the distributions.

As previously discussed, changes in estimated hydraulic habitat availability for Chinook salmon smolts is expected to be generally representative of potential changes in hydraulic habitat availability for juvenile steelhead.

Overall, there would not be substantial differences in average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon pre-smolts and smolts among the alternatives. However, Alternatives 4 and 6 would provide more hydraulic habitat than the other alternatives during some months and water years. Because Alternative 6 would provide more hydraulic habitat than the other alternatives when hydraulic habitat availability is relatively high (i.e., >70 km^2) and Alternative 4 would provide more hydraulic habitat when hydraulic habitat availability is relatively low (i.e., about 40-60 km^2), Alternative 4 may be the best-performing alternative in providing increased amounts of suitable hydraulic floodplain habitat, followed by Alternative 6. Alternatives 1 through 3 and 5 would provide less but similar amounts of hydraulic habitat. However, the programmatic floodplain improvements associated with Alternative 5 may provide increased hydraulic habitat for a longer duration in the area upstream of the proposed water control structure relative to Alternatives 1 through 3.

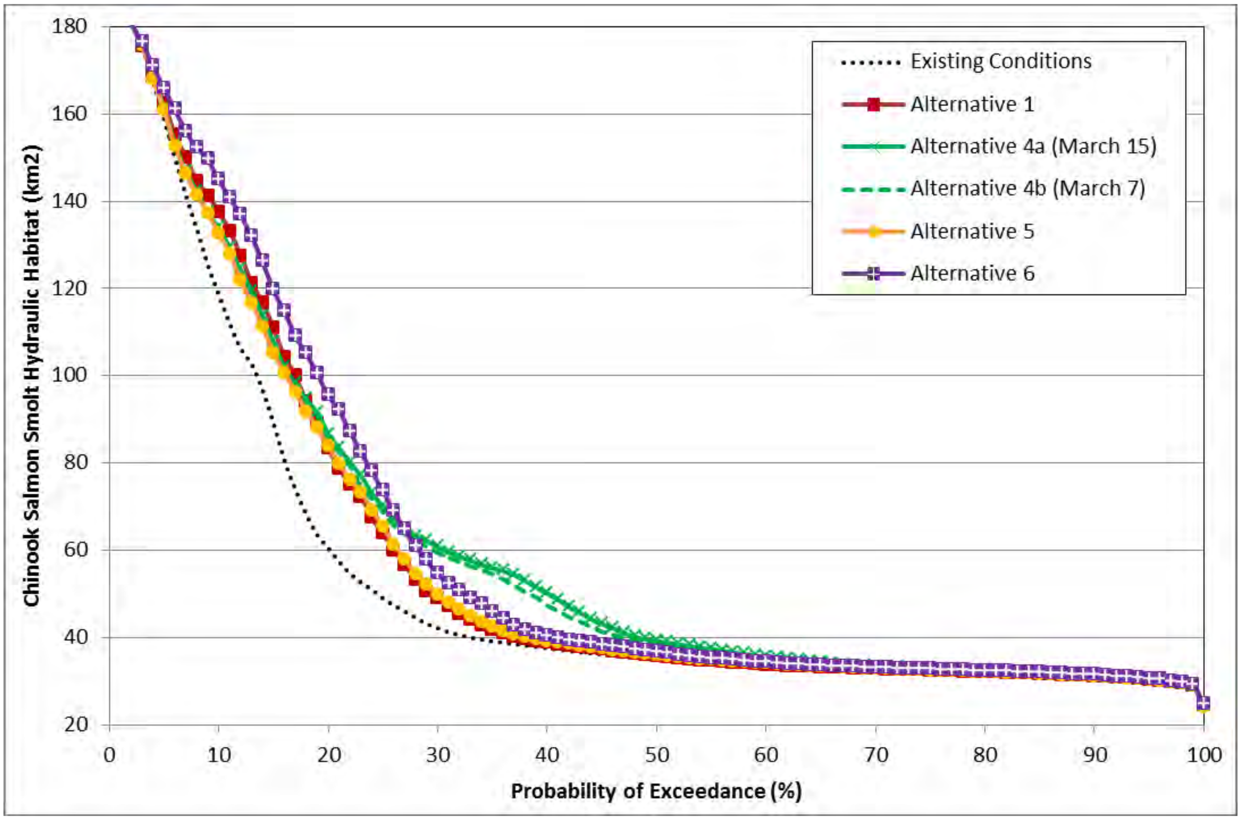


Figure 8-95. Simulated Chinook Salmon Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 1997to 2012)

Although not quantitatively evaluated, it should be noted that retaining water on the floodplain under Alternative 4 (and the programmatic improvements under Alternative 5) would have higher potential for creating less suitable water temperature, dissolved oxygen, and piscivorous predation conditions for juvenile Chinook salmon relative to the other alternatives.

8.5.3 Reduce Stranding and Presence of Migration Barriers

All Project alternatives include construction of at least one transport channel in the Yolo Bypass to allow migration of juvenile and adult fishes between one or more intake facilities and the Tule Pond. Therefore, during conditions when water is not overtopping the Fremont Weir and sufficient water is flowing through the intake facilities and transport channel, all Project alternatives would reduce the potential for temporary or permanent juvenile and adult stranding in the upper region of Yolo Bypass relative to Existing Conditions. In addition, all Project alternatives include the remediation of Agricultural Road Crossing 1 on the Tule Canal to provide for more suitable passage conditions through Tule Canal more frequently relative to Existing Conditions.

Variables that differ among alternatives that could potentially influence stranding include the size of the transport channels, the complexity of the intake facilities, the location of the intake facilities and supplemental passage facilities, and additional alternative-specific features such as the water control structures and bypass channels under Alternative 4 and under the programmatic elements of Alternative 5.

For alternatives with a wider transport channel or with multiple transport channels, there is the potential that under relatively low-flow conditions, there could be increased potential for stranding relative to alternatives with one transport channel that is relatively smaller. Therefore, based on the size and complexity of the transport channel(s), there may be relatively less potential for fish stranding in the transport channels under Alternatives 1 through 4 relative to Alternatives 5 and 6 (Table 8-50). Alternative 5 includes multiple transport channels of varying widths that are greater than the transport channel widths under Alternatives 1 through 4, which may result in less consistent flows through each of the transport channels. In addition, because Alternative 5 has substantially more gates being operated at the intake facility than the other alternatives, there could be additional potential for more variable flows through one or more of the transport channels, resulting in a higher potential for fish stranding relative to the other alternatives. Alternative 6 has a relatively wider transport channel than all other alternatives, resulting in a greater potential for fish stranding during low-flow conditions in the transport channel.

The locations of the intake facilities and supplemental passage facilities for Alternatives 2 and 5 may allow for increased potential for adult fish stranding relative to the other alternatives near Fremont Weir. The intake facility would be in the central portion of the weir, and the supplemental passage facility would be located at the western portion of the weir, which could result in continued stranding of adult fish near the eastern portion of Fremont Weir as flows recede.

In addition to differences in the potential for fish stranding in the transport channels, Alternative 4 includes two water control structures on the Tule Canal and two bypass channels going around the water control structures. The operation of the water control structures and bypass channels allow for additional potential for fish stranding in the Tule Canal or in the bypass channels under variable or low-flow conditions. The programmatic component of Alternative 5 also includes a water control structure on the Tule Canal and a bypass channel, increasing the potential for fish stranding under variable or low-flow conditions.

Overall, it is expected that Alternatives 1 and 3 would provide the least potential for stranding and fish passage impediments, followed by Alternatives 2 and 6, then by Alternatives 4 and 5. Adult fish passage through the Yolo Bypass into the Sacramento River is addressed in Section 8.5.6.

Table 8-50. Dimensions of the Notches and Transport Channels under each Alternative

	Alternative	Maximum Design Discharge (cfs)	Gated Notch	Description	Transport Channel Description	Transport Channel Description	Transport Channel Description
			Dimensions	Invert elevations	Bottom width (ft)	Bench bottom width (ft)	Side slope
1.	Eastern Alignment	6,000	Gate 1: 18 x 34 ft; Gates 2 & 3: 14 x 27 ft	Gate 1: 14-ft; Gates 2 & 3: 18-ft	30	30	3:1
2.	Central Alignment	6,000	Gate 1: 17 x 40 ft; Gates 2 & 3: 13 x 27 ft	Gate 1: 14.8-ft; Gates 2 & 3: 18.8-ft	50	30	3:1
3.	Western Alignment	6,000	Gate 1: 16 x 40 ft; Gates 2 & 3: 12 x 27 ft	Gate 1: 16.1-ft; Gates 2 & 3: 20.1-ft	60	30	3:1
4.	Western Alignment	3,000	Gate 1: 16 x 40 ft; Gates 2 & 3: 12 x 27 ft	Gate 1: 16.1-ft; Gates 2 & 3: 20.1-ft	60	30	3:1
5.	Central Alignment	3,400	27 Gates; Intakes A, B & C: 10 ft x 10 ft; Intake D: 10 ft x 7 ft	Intake A: 14-ft; Intake B: 17-ft; Intake C: 20-ft; Intake D: 23-ft	Intakes A & B: 80; Intake C: 130; Intake D: 142	N/A	3:1
6.	Western Alignment	12,000	Gates 1-5: 14 x 40 ft	16.1-ft Invert	200	N/A	3:1

Source: DWR 2017b; Appendix G5

Key: cfs= cubic feet per second; ft= feet

8.5.4 Increase Aquatic Primary and Secondary Biotic Production to Provide Food Through an Ecosystem Approach

All Project alternatives would result in increased frequency and duration of inundation of the Yolo Bypass relative to Existing Conditions. An increase in frequency and duration of inundation of shallow-water habitat in the Yolo Bypass would be expected to increase primary production in the Yolo Bypass (Lehman et al. 2007). Therefore, all Project alternatives would be expected to increase primary and potentially secondary production in the Yolo Bypass relative to Existing Conditions.

Modeled wetted extent of the Yolo Bypass (i.e., area with a water depth greater than zero ft) under the alternatives was used as an indicator of relative changes in inundation and associated primary and secondary production. Average monthly wetted area over the entire simulation period would be similar among all alternatives in October, November, April, and May (Table 8-51). From December through March, Alternatives 4a, 4b, and 6 would provide slightly more average monthly wetted area than Alternatives 1 through 3 and 5 over the entire simulation period. Similar trends in wetted area among the alternatives would occur during wetter water years. During dry and critical water years, Alternatives 4a and 4b would provide more wetted area than all other alternatives during most months between December and March.

Table 8-51. Average Monthly Wetted Area in the Yolo Bypass from October through May based on TUFLOW Modeling

Alternative	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Entire Simulation Period[1] (n=16)								
Existing Conditions	48	48	64	105	106	108	86	64
Alternatives 1-3	48	49	73	116	121	115	86	64
Alternative 4a	48	50	77	120	129	120	87	64
Alternative 4b	48	49	77	120	129	116	86	64
Alternative 5	48	49	72	114	121	115	86	64
Alternative 6	48	49	79	121	129	119	86	64
Water Year Types[2]								
Wet (n=5)								
Existing Conditions	48	49	79	154	162	163	145	78
Alternatives 1-3	48	50	100	167	177	169	145	77
Alternative 4a	48	51	103	168	178	171	146	77
Alternative 4b	48	51	103	168	178	168	146	77
Alternative 5	47	50	96	163	174	168	146	78
Alternative 6	48	51	111	172	182	172	145	77
Above Normal (n=3)								
Existing Conditions	49	50	68	108	100	112	73	77
Alternatives 1-3	49	50	72	124	127	116	72	77
Alternative 4a	49	50	77	126	131	123	73	77
Alternative 4b	49	50	76	125	131	119	72	77
Alternative 5	48	50	72	122	126	117	73	77
Alternative 6	49	50	74	131	139	120	72	77
Below Normal (n=3)								
Existing Conditions	48	48	54	79	92	90	60	52
Alternatives 1-3	48	48	58	91	103	95	60	52
Alternative 4a	48	48	60	92	113	101	60	52
Alternative 4b	48	48	60	92	113	96	60	52
Alternative 5	48	48	59	90	104	95	60	53
Alternative 6	48	48	62	97	110	99	60	52
Dry (n=4)								
Existing Conditions	48	48	55	68	56	60	50	50
Alternatives 1-3	48	48	59	72	64	73	51	50

Alternative	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)	Wetted Area (km^2)
	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**
Alternative 4a	48	48	64	84	81	81	51	50
Alternative 4b	48	48	64	84	81	73	51	50
Alternative 5	48	48	60	73	65	73	51	50
Alternative 6	48	48	63	76	70	81	51	50
Critical (n=1)								
Existing Conditions	47	47	47	74	96	58	51	51
Alternatives 1-3	47	47	47	82	111	65	51	51
Alternative 4a	47	47	49	93	120	76	52	51
Alternative 4b	47	47	49	93	120	71	52	51
Alternative 5	47	47	47	83	111	66	52	51
Alternative 6	47	47	47	89	121	70	51	51

[1] Based on modeled average daily values over a 16-year simulation period (water years 1997 through 2012)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

Key: km^2 = square kilometer

Wetted area would be similar over the cumulative probability of exceedance distributions for all alternatives and Existing Conditions over the highest ~60 percent of the distributions (when wetted area is lowest) (Figure 8-96). Wetted area would be highest under Alternatives 4a and 4b over about the middle ~25 percent of the distributions. Over the lowest ~30 percent of the distributions (when wetted area is highest), Alternative 6 would provide slightly more wetted area than the other alternatives. Alternatives 1 through 3 and 5 would provide similar amounts of wetted area over most of the distributions but would provide more wetted area than Existing Conditions.

Overall, there would not be substantial differences in average monthly wetted area over the entire simulation period in the Yolo Bypass among the alternatives. However, Alternatives 4 and 6 would provide more wetted area than the other alternatives during some months and water years. Because Alternative 6 would provide more wetted area than the other alternatives when wetted area is relatively high and Alternative 4 would provide more wetted area when wetted area is relatively lower, Alternative 4 may be the best-performing alternative in providing increased amounts of wetted area, followed by Alternative 6.

Although the probability of exceedance distributions facilitates the assessment of general changes in simulated wetted area among the alternatives, assessing the wetted area daily time series may better inform potential differences in promoting primary and secondary production in the Yolo Bypass among the alternatives. In contrast to exceedance distributions, daily time series allow for a visual assessment of the duration of a given wetted area during a particular year. As previously described in the Environmental Setting section, promoting primary (and secondary) production in the Yolo Bypass requires that areas be inundated for sufficient duration and reduced residence time of water moving through the Yolo Bypass has reduced primary and secondary productivity under Existing Conditions. Therefore, increased duration of a given wetted area may increase primary and secondary production in the Yolo Bypass.

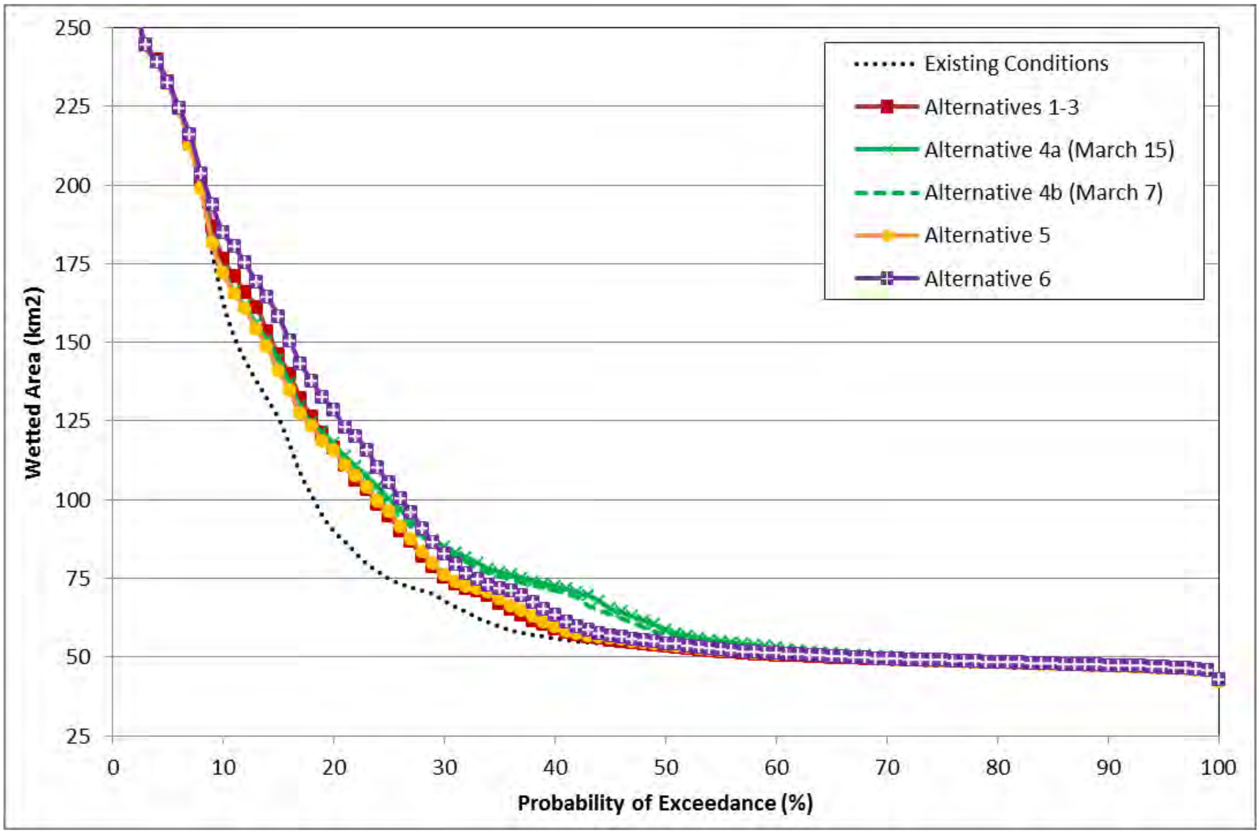
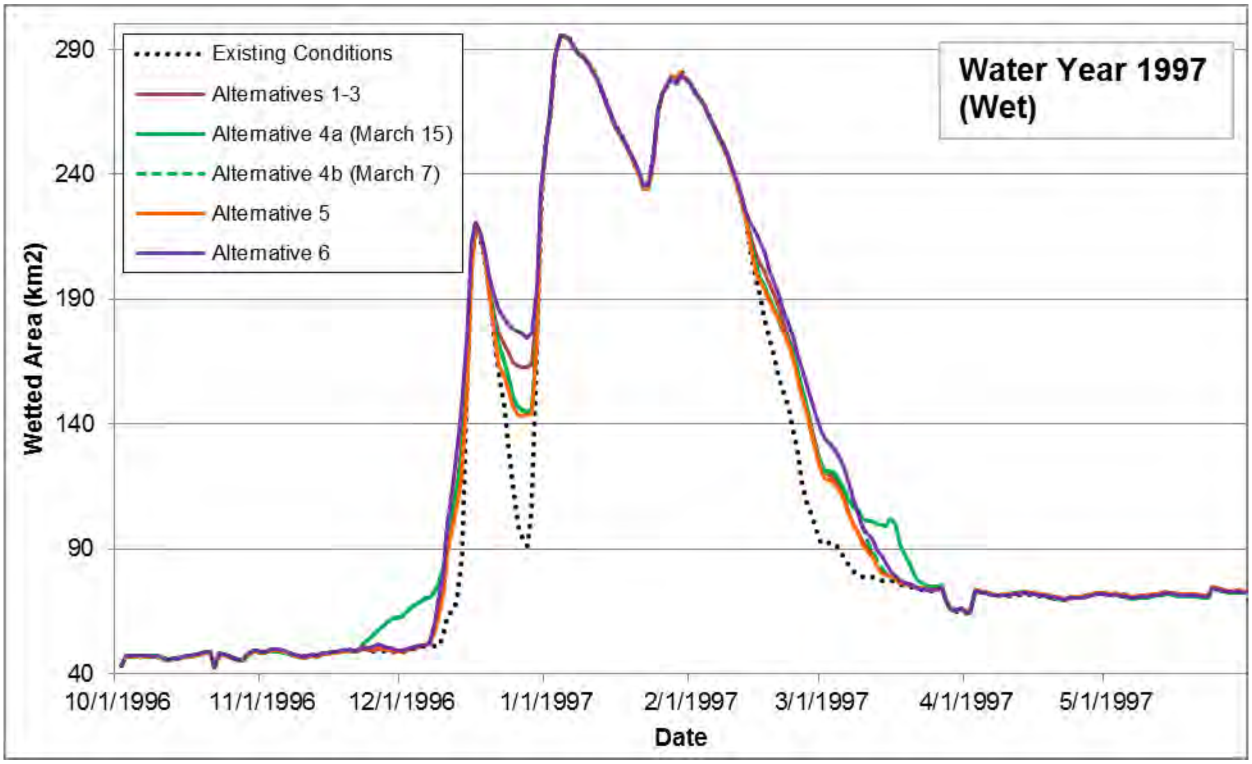


Figure 8-96. Simulated Wetted Area Probability of Exceedance Distributions from October through May under All Alternatives and Existing Conditions based on 16 years of TUFLOW Modeling (Water Years 1997 through 2012).

As shown in Figures 8-97 through 8-104, regardless of water year type, all alternatives would provide more wetted area relative to Existing Conditions for approximately one to three months during most years. When wetted area is relatively higher under all alternatives (e.g., during peaks in the wetted area time series), Alternative 6 typically would provide the most wetted area. This phenomenon is not associated with particular water year types and is most observable during water years 1999, 2000, 2001, 2003, 2004, 2008, 2009, 2010, and 2011. When wetted area is relatively lower under all alternatives, Alternative 4 typically would provide more wetted area most often, particularly in the early portion of the wet season (i.e., water years 1997, 2000, 2006, 2008, and 2009), during late portions of the wet season (i.e., water years 1997, 2002, 2003, 2005, 2007, 2008, and 2012), and during troughs in the wetted area time series, which are most easily observed during water years 1998, 2001, 2005, 2007, 2008, 2011, and 2012.

Although Alternative 6 would provide more wetted area when there is more wetted area available, Alternative 4 would extend the ascending and descending limbs of the wetted area time series, increasing the duration of increases in wetted area. More area wetted for a longer duration under Alternative 4 could result in increased primary and secondary production in the Yolo Bypass relative to the other alternatives.



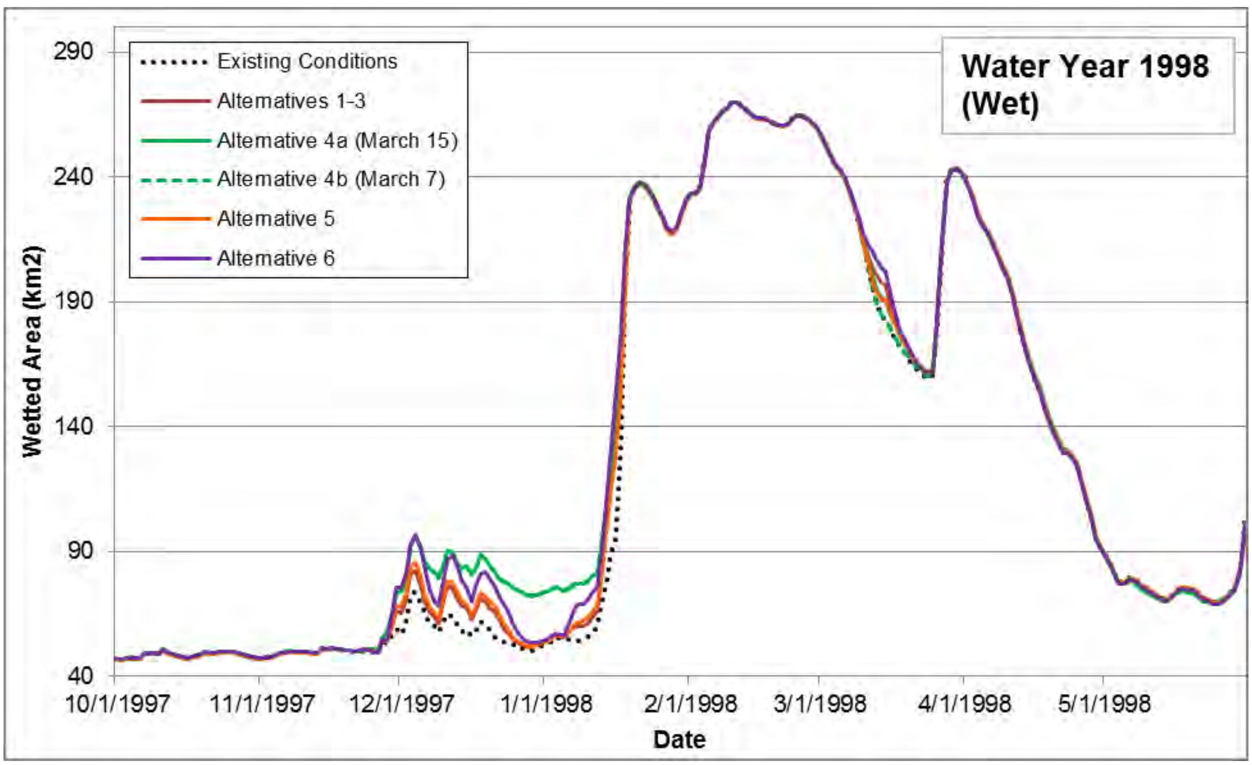


Figure 8-97. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 1997 and 1998).

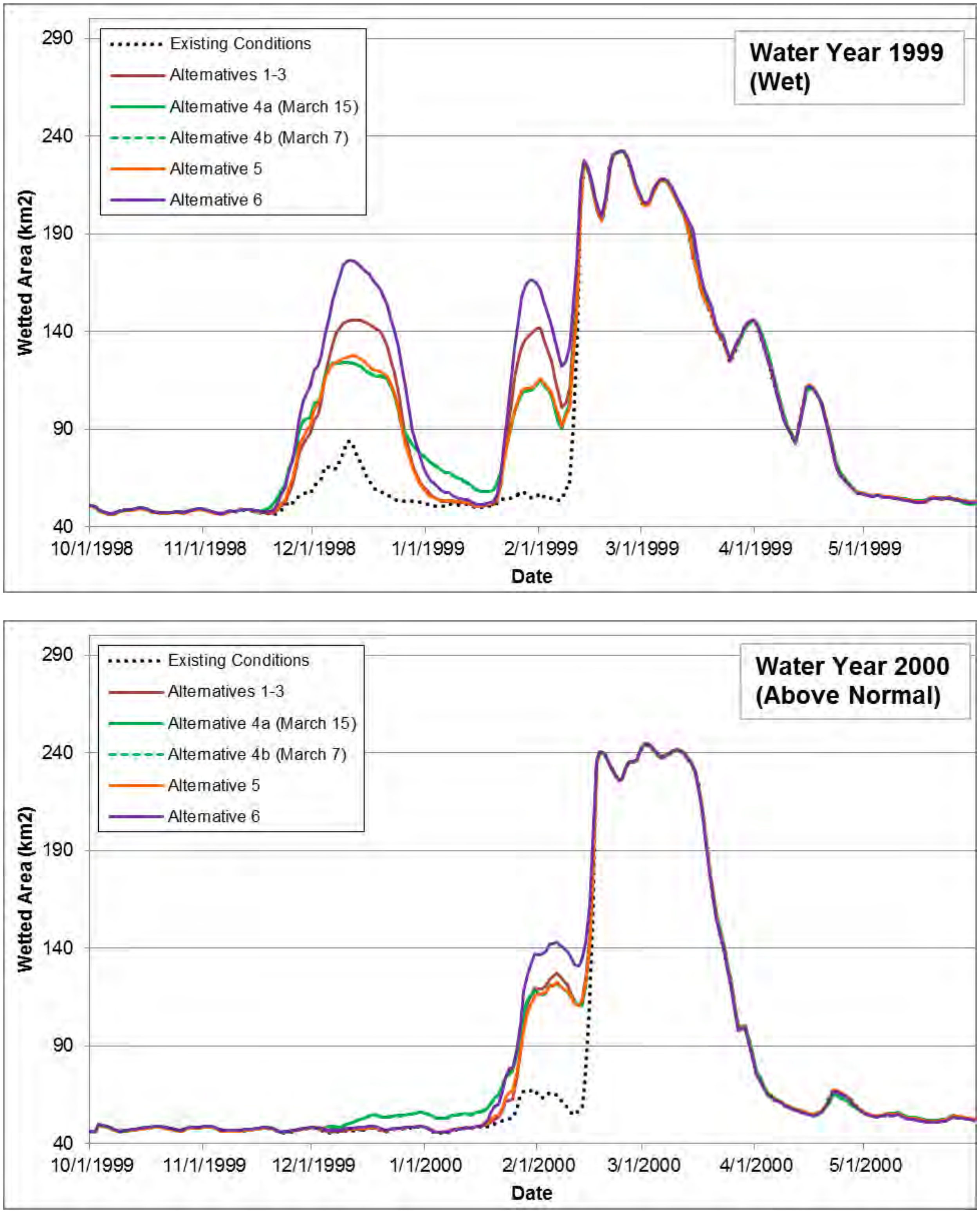


Figure 8-98. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 1999 and 2000).

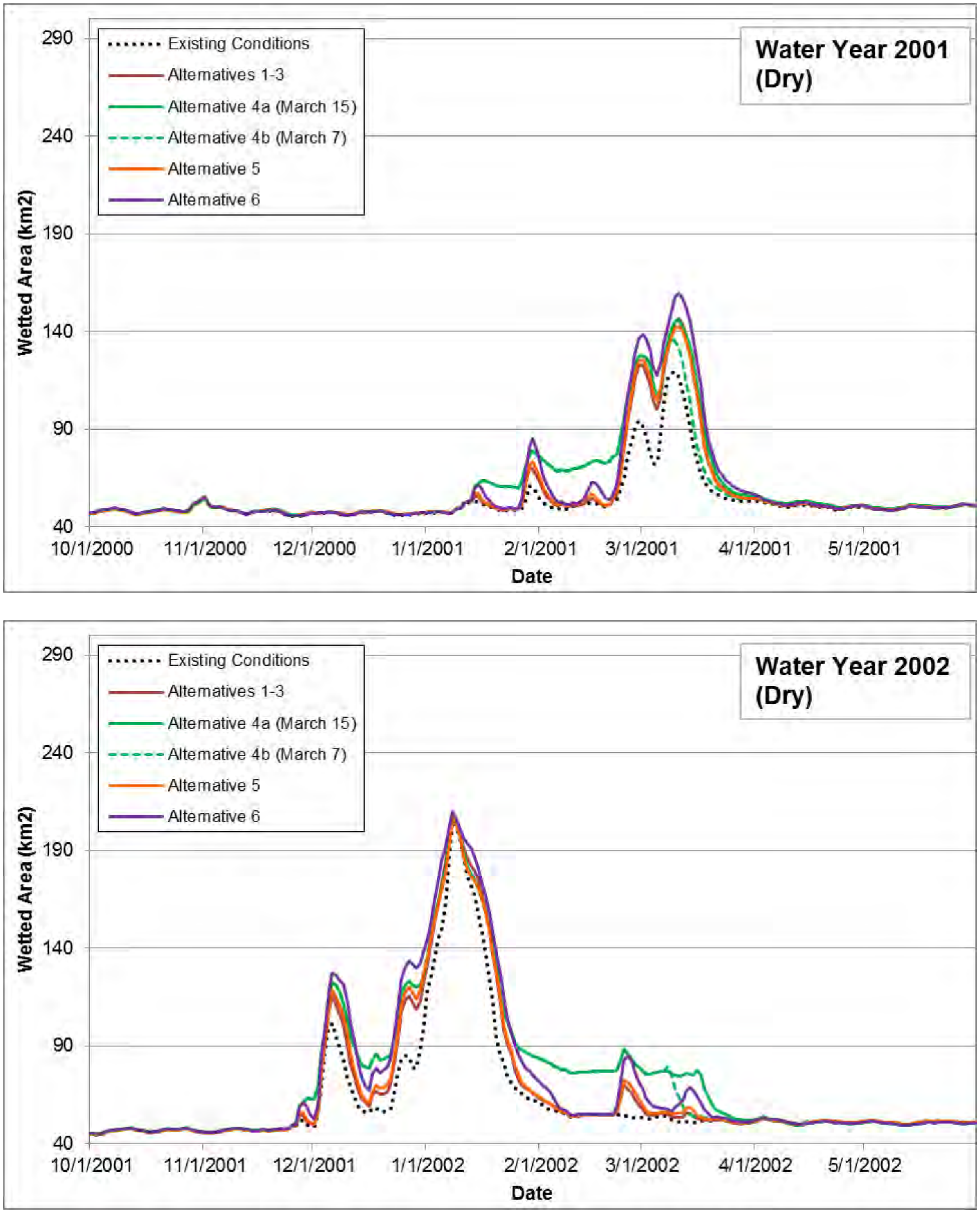
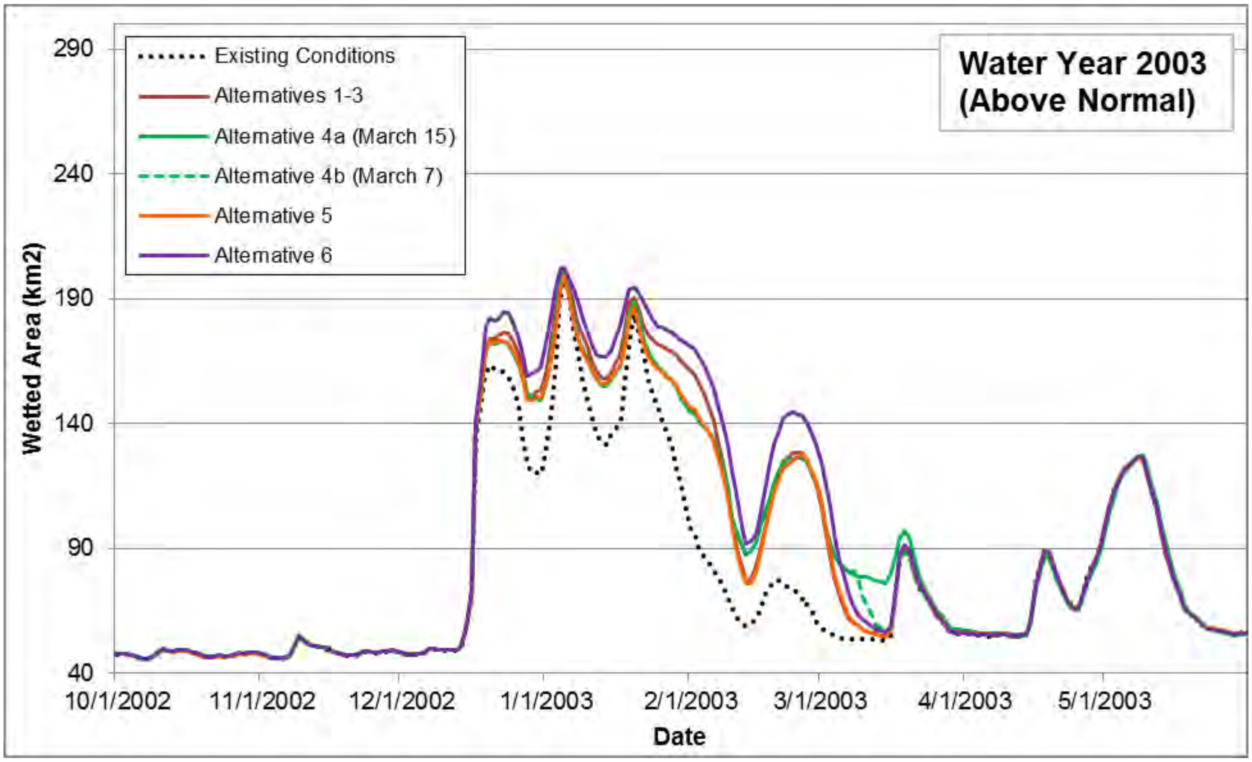


Figure 8-99. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2001 and 2002).



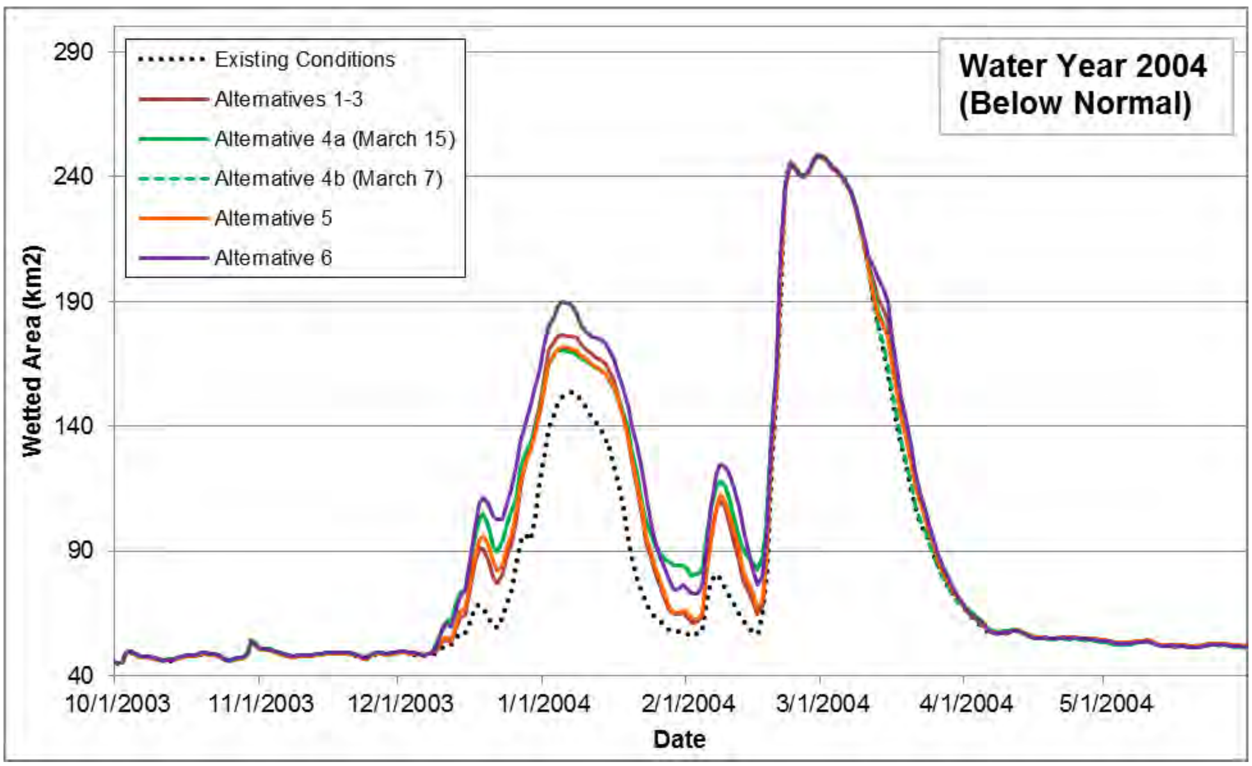
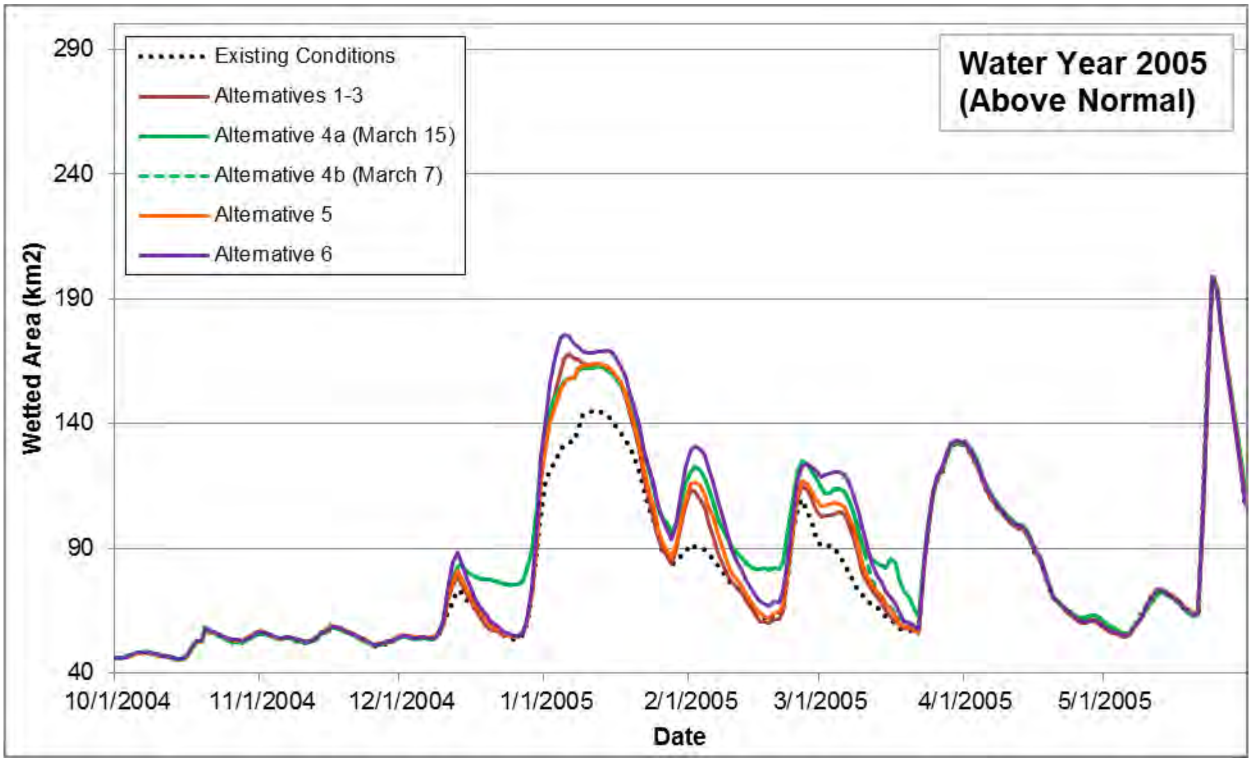


Figure 8-100. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2003 and 2004).



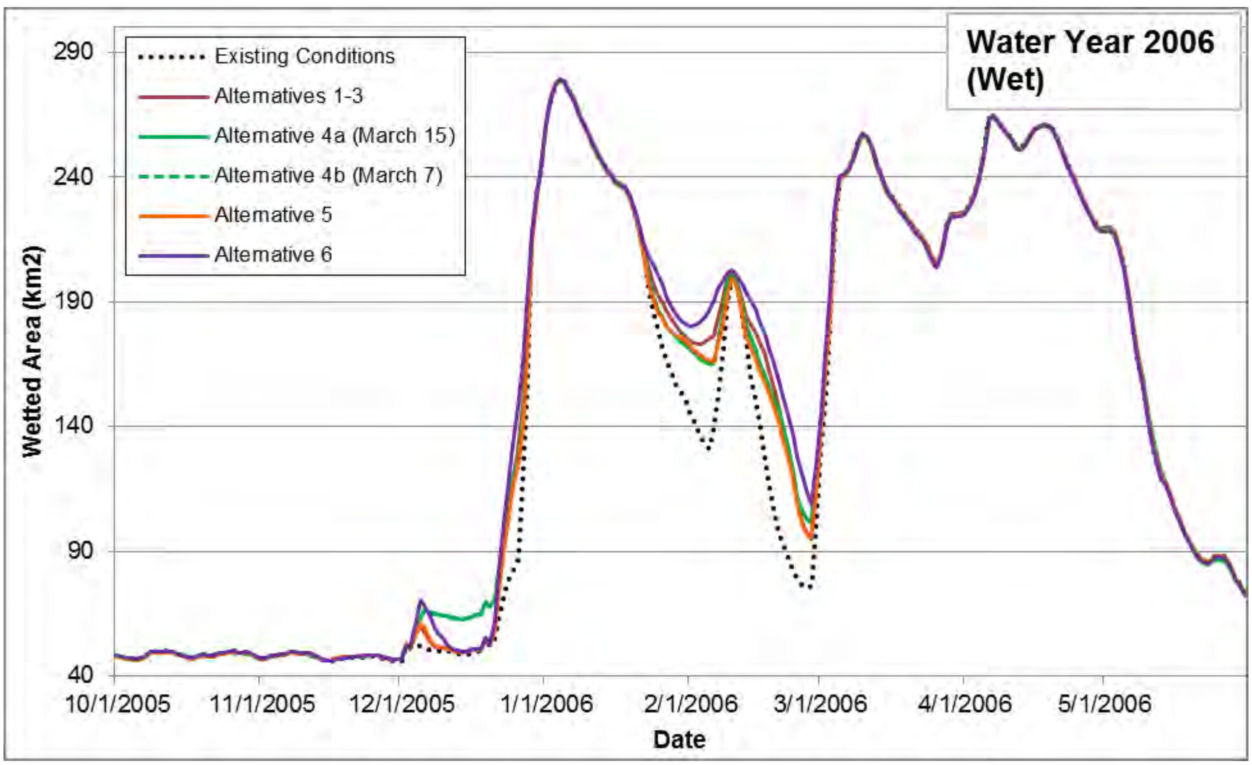


Figure 8-101. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2005 and 2006).

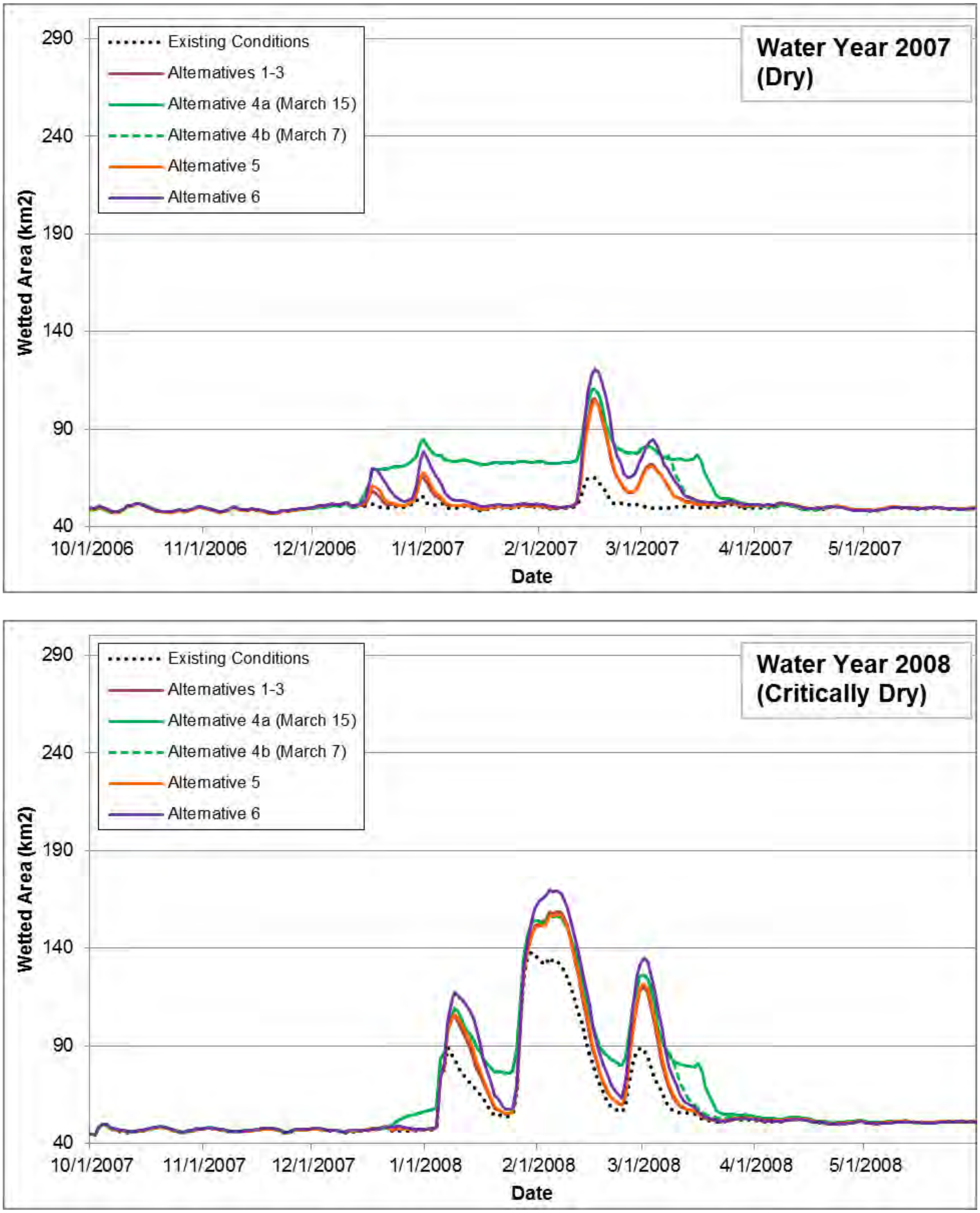
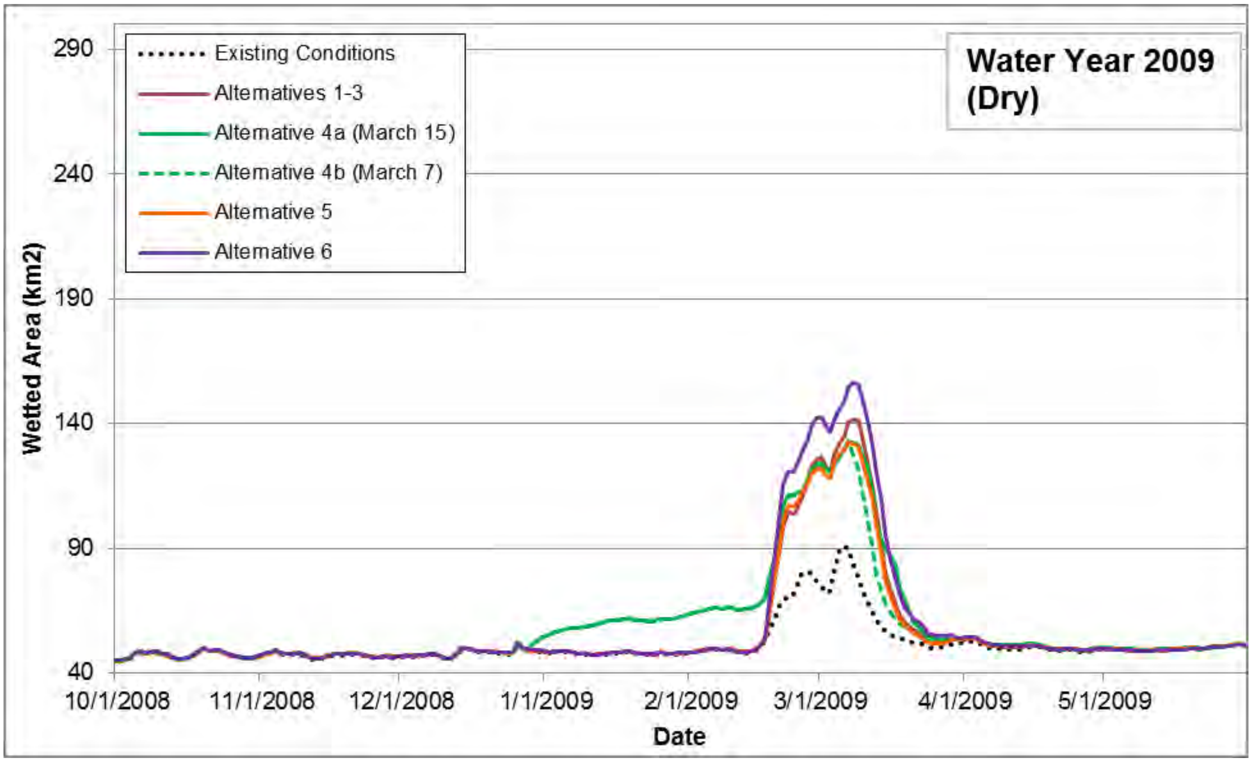


Figure 8-102. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2007 and 2008).



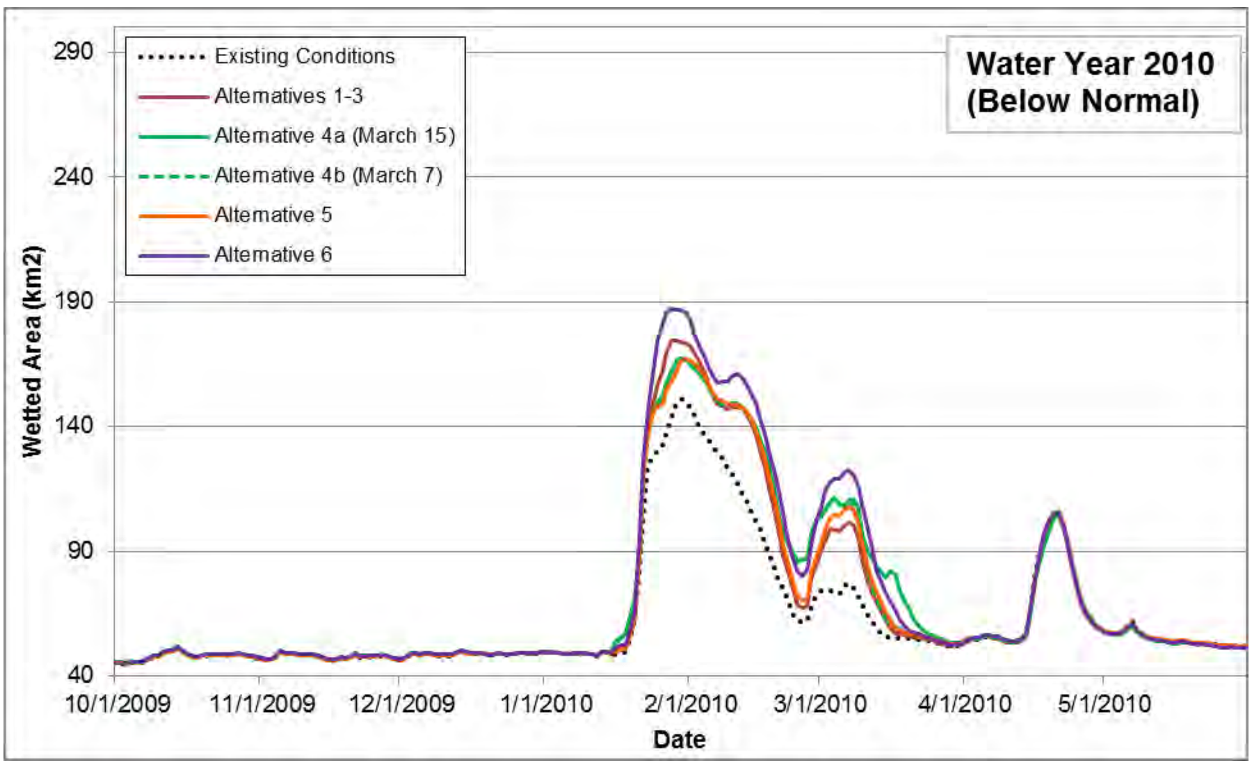


Figure 8-103. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2009 and 2010).

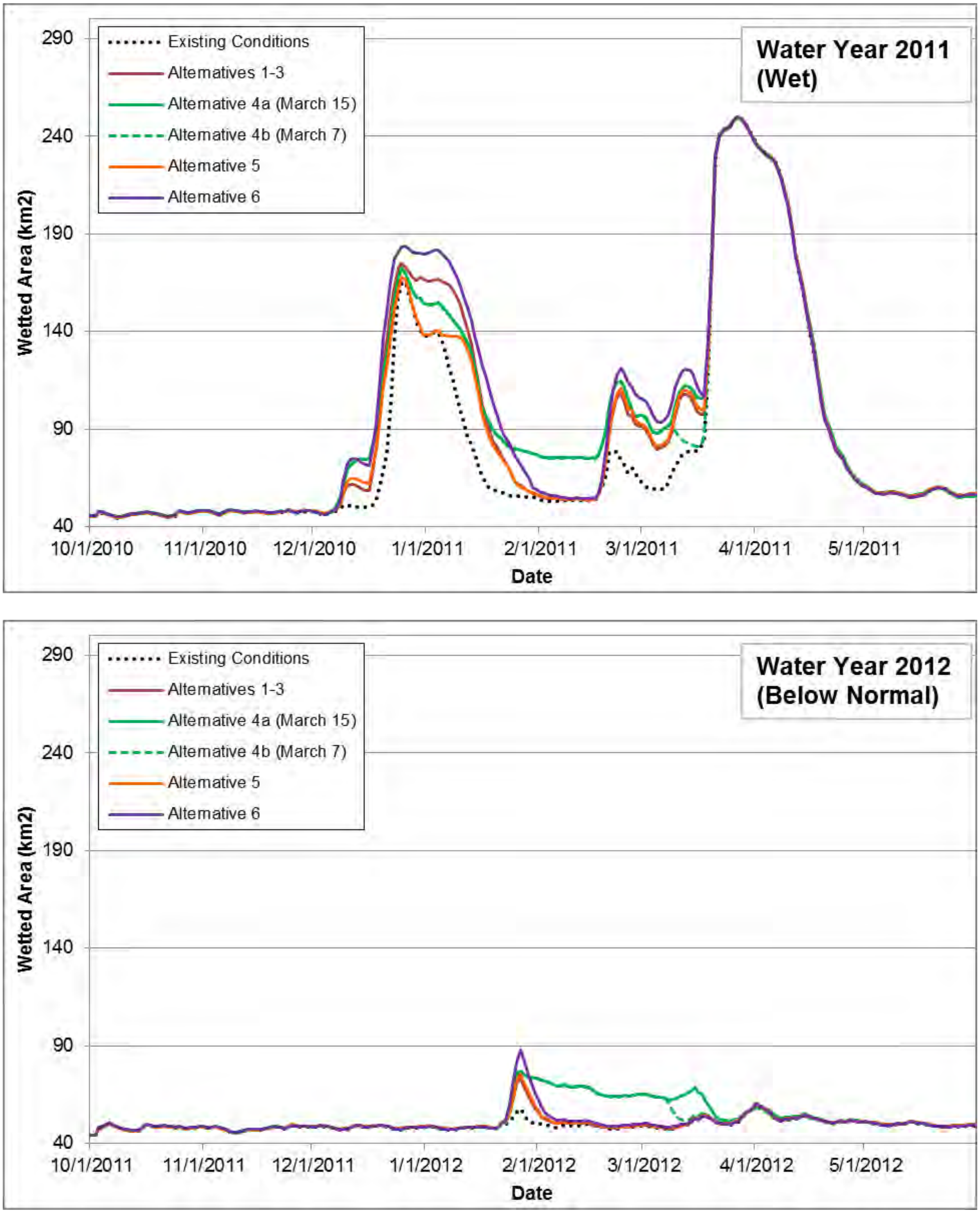


Figure 8-104. Simulated Wetted Area Time Series from October through May under All Alternatives and Existing Conditions based on TUFLOW Modeling (Water Years 2011 and 2012).

Increasing a given amount of wetted area for a longer duration prior to a flow pulse could increase the exportation of phytoplankton and zooplankton into the Delta downstream of the Yolo Bypass under all alternatives relative to Existing Conditions. Examination of the wetted area time series suggests that, relative to the other alternatives, Alternative 4 has the best potential to export more productive water to the Delta during most years, particularly during water years 1998, 2000, 2001, 2005, 2007, 2008, 2009, and 2011. Alternative 6 also has the potential to export more productive water to the Delta relative to the other alternatives, including during water years 1997, 1999, 2000, 2008, and 2011. Although no modeling is available, the programmatic floodplain improvements associated with Alternative 5 would likely result in increased productivity in the area upstream of the water control structure relative to other alternatives.

8.5.5 Improve Connectivity within the Yolo Bypass for Passage of Salmonids and Green Sturgeon

As described above, connectivity would be improved within the Yolo Bypass for the passage of juvenile and adult salmonids and green sturgeon due to the remediation of Agricultural Road Crossing 1 under all alternatives. In addition, construction and maintenance of the transport channels under all alternatives would provide more suitable connectivity for fish passage between Fremont Weir and Tule Pond when the Yolo Bypass is not inundated. However, as previously described (see Impact FISH-15 for Alternatives 5 and 6), due to the multiple transport channels under Alternative 5 and the relatively wider transport channel under Alternative 6, Alternatives 5 and 6 may potentially provide less optimal fish passage conditions within the Yolo Bypass under low-flow conditions relative to Alternatives 1 through 4. In addition, as previously described (see Impact FSH-15 for Alternative 4), the water control structures and bypass channels on Tule Canal under Alternative 4 may act as impediments to fish passage, particularly for adult green sturgeon, under low-flow conditions. Therefore, Alternatives 1 through 3 may provide for improved connectivity within the Yolo Bypass for fish passage with the greatest certainty. Alternative 6 may be the next most suitable alternative for improving connectivity in the Yolo Bypass, followed by Alternatives 4 and 5.

8.5.6 Improve Connectivity Between the Sacramento River and Yolo Bypass to Provide Safe and Timely Adult Fish Passage

This objective is to improve adult fish passage conditions between the Sacramento River and the Yolo Bypass when Sacramento River elevations are amenable to fish passage for winter-run Chinook salmon (between mid-November and May), spring-run Chinook salmon (between January and May), steelhead (when presence overlaps with windows for other species), and green sturgeon (between February and May)

The YBPASS Tool applied fish passage criteria to modeled hydraulic conditions in the intake facilities and transport channels under all alternatives to evaluate the daily frequency with which water depth and velocity were suitable for passage of adult salmonids and sturgeon over the water years 1997 through 2012 period (DWR 2017b; Appendix G5). Results of the YBPASS Tool indicate that adult salmon and sturgeon would be able to successfully pass upstream through the transport channel and intake structure into the Sacramento River from November through April, with the highest daily frequency under Alternative 5 (24 percent of the time), followed by Alternatives 1 through 3 (23 percent of the time), then Alternative 6 (19 percent of the time) and Alternative 4 (18 percent of the time) (Table 8-52) (DWR 2017b; Appendix G5). However, the standard deviation of the average passage window (22 percent of season) was three percent across all six alternatives, making it difficult to distinguish differences among alternatives. The annual average date after which each alternative would no longer meet the fish passage criteria would be similar for Alternatives 1 through 5 (end of March or beginning of April) but would occur about one month sooner under Alternative 6 (beginning of March). Adult fish passage under Alternative 6 would be temporally constrained because of a lack of operation after March 15 due to depth and velocity barriers that would occur at a lower notch discharge (DWR 2017b; Appendix G5).

Table 8-52. YPBASS Tool Summary Results for Water Years 1997 through 2012 Assessing Adult Fish Passage from November through April for all Alternatives at the Fremont Weir

Alternative		Average number of days depth barrier exists	Average number of days velocity barrier exists	Average number of days alternative meets criteria	Average percent of season alternative meets criteria	Average last date alternative meets criteria
1.	Eastern Alignment	107 ± 41	32 ± 31	42 ± 15	23%	2-April
2.	Central Alignment	108 ± 41	31 ± 30	42 ± 15	23%	2-April
3.	Western Alignment	109 ± 41	30 ± 29	42 ± 17	23%	1-April
4.	Western Alignment	109 ± 41	39 ± 32	33 ± 12	18%	31-March
5.	Central Alignment	106 ± 41	32 ± 31	43 ± 16	24%	1-April
6.	Western Alignment	111 ± 41	36 ± 34	34 ± 14	19%	3-March

Source: DWR 2017b; Appendix G5

It should be noted that the YBPASS Tool results do not account for other components of the alternatives such as the water control structures and bypass channels in the Tule Canal associated with Alternative 4. Although these structures would be designed to provide for fish passage and would be adaptively managed, they create additional uncertainty in providing suitable fish passage conditions in the Yolo Bypass and would require monitoring and potential future actions under the adaptive management program to provide suitable fish passage conditions.

In addition, the YBPASS Tool does not consider fish behavior nor the operational reliability of the structure (DWR 2017b; Appendix G5). Based on YBPASS Tool results, Alternatives 1 through 3 and 5 would all perform similarly. However, the YBPASS Tool does not account for the complexity of design for each alternative that could influence fish behavior and thus fish passage efficiency. For instance, Alternatives 1 through 3 have three gates and one transport channel, whereas Alternative 5 has 27 gates and four transport channels. Because of this complexity, Alternative 5 has a greater possibility to confuse migratory fish due to the additional gates and channels. The YBPASS Tool does not evaluate the possibility of gate closure and rerouting of fish nor the increase in potential stranding with the addition of multiple channels. In addition to fish behavior, the operational reliability of the structure could also impact adult fish passage efficiency. For example, the gates could malfunction or the transport channel could get clogged up with debris, which would reduce fish passage efficiency (DWR 2017b; Appendix G5).

The YBPASS Tool also does not address the potential for increased attraction of adult salmonids and sturgeon into the Yolo Bypass. Because Alternative 6 would allow for substantially higher flows to enter the Yolo Bypass when Fremont Weir is not overtopping relative to the other alternatives and would provide for adult fish passage at the proposed facilities with lower frequency relative to Alternatives 1 through 3 and 5, Alternative 6 may result in increased numbers of adult fish entering the Yolo Bypass that cannot enter the Sacramento River relative to the other alternatives.

Based on the relative results of the YBPASS Tool and hydraulic modeling, as well as considerations described above related to the complexity of the intake facilities and transport channels and other alternative-specific effects, Alternatives 1 through 3 may provide the most suitable adult fish passage conditions between the Yolo Bypass and the Sacramento River with the greatest certainty. Alternative 6 would be expected to provide the least suitable adult fish passage conditions between the Yolo Bypass and the Sacramento River due to the increased potential for attraction of adults along with the relatively low frequency of fish passage provided. Further, Alternative 6 may be particularly less suitable for adult green sturgeon passage due to the lack of gate operations after the beginning of March.

8.5.7 Improve Phenotypic Diversity of Juvenile Winter-run and Spring-run Chinook Salmon

As previously described, the SBM simulated juvenile Chinook salmon variation in lengths at the time of emigration to the estuary (at Chipps Island in the Delta) as well as variation in time of estuary entry. Therefore, the coefficient of variation in size (length) and the coefficient of variation in estuary entry timing were used as indicators of phenotypic diversity in juvenile spring-run and winter-run Chinook salmon.

8.5.7.1 Spring-run Chinook Salmon

8.5.7.1.1 Variation in Juvenile Spring-run Chinook Salmon Size

Modeling results indicate that annual average juvenile spring-run Chinook salmon coefficient of variation in size (FL) would be higher under all alternatives relative to Existing Conditions over the entire simulation period and by water year type (Table 8-53). Average coefficient of variation in size would be highest under Alternative 6, followed by Alternatives 1 through 3, then Alternative 5 and Alternative 4. However, differences among the alternatives are generally insubstantial.

Table 8-53. Average Annual Juvenile Spring-run Chinook Salmon Coefficient of Variation in Size under all Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	0.30	0.42	0.30	0.26	0.22	0.18
Alternatives 1-3	0.36	0.45	0.34	0.35	0.27	0.28
Alternative 4a	0.34	0.44	0.33	0.32	0.26	0.28
Alternative 4b	0.34	0.44	0.33	0.32	0.26	0.28
Alternative 5	0.35	0.45	0.33	0.33	0.26	0.29
Alternative 6	0.38	0.47	0.36	0.40	0.29	0.34

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)
[2] As defined by the Sacramento Valley Index (DWR 2017c)

The juvenile spring-run Chinook salmon coefficient of variation in size probability of exceedance distributions indicates that all alternatives would result in increased size variability relative to Existing Conditions, particularly when the coefficient of variation is relatively low (Figure 8-105). Alternative 6 would provide higher coefficients of variation over the entire distribution relative to the other alternatives. Alternatives 1 through 3 would provide higher coefficients of variation over small portions of the distribution relative to Alternatives 4 and 5.

8.5.7.1.2 Variation in Juvenile Spring-run Chinook Salmon Estuary Entry Timing

Modeling results indicate that annual average juvenile spring-run Chinook salmon coefficient of variation in estuary entry timing would be similar or higher under all alternatives relative to Existing Conditions over the entire simulation period and by water year type (Table 8-54). Average coefficient of variation in estuary entry timing would be highest under Alternative 6, followed by Alternatives 1 through 5. However, differences among the alternatives are generally insubstantial.

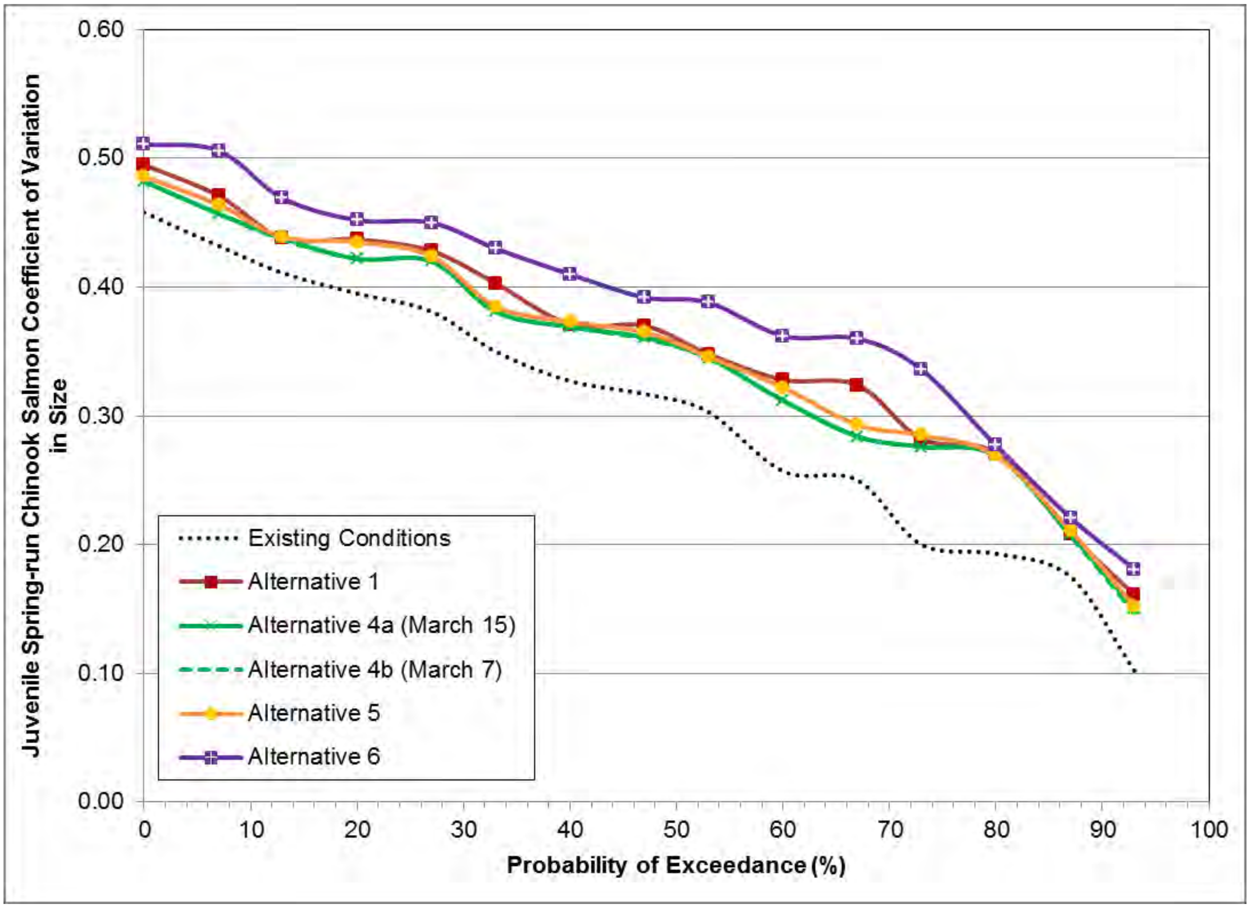


Figure 8-105. Simulated Juvenile Spring-Run Chinook Salmon Coefficient of Variation in Size Probability of Exceedance Distributions under All Alternatives and Existing Conditions

Table 8-54. Average Annual Juvenile Spring-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing under all Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	0.29	0.38	0.28	0.26	0.23	0.18
Alternative 1	0.30	0.39	0.28	0.28	0.24	0.21
Alternative 4a	0.30	0.39	0.28	0.27	0.24	0.21
Alternative 4b	0.30	0.39	0.28	0.27	0.24	0.21
Alternative 5	0.30	0.39	0.28	0.28	0.24	0.21
Alternative 6	0.31	0.39	0.29	0.30	0.25	0.22

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

The juvenile spring-run Chinook salmon coefficient of variation in estuary entry timing probability of exceedance distributions indicates that all alternatives would result in similar or increased estuary entry timing variability relative to Existing Conditions (Figure 8-106). Alternative 6 would provide higher coefficients of variation over about half of the distribution relative to the other alternatives.

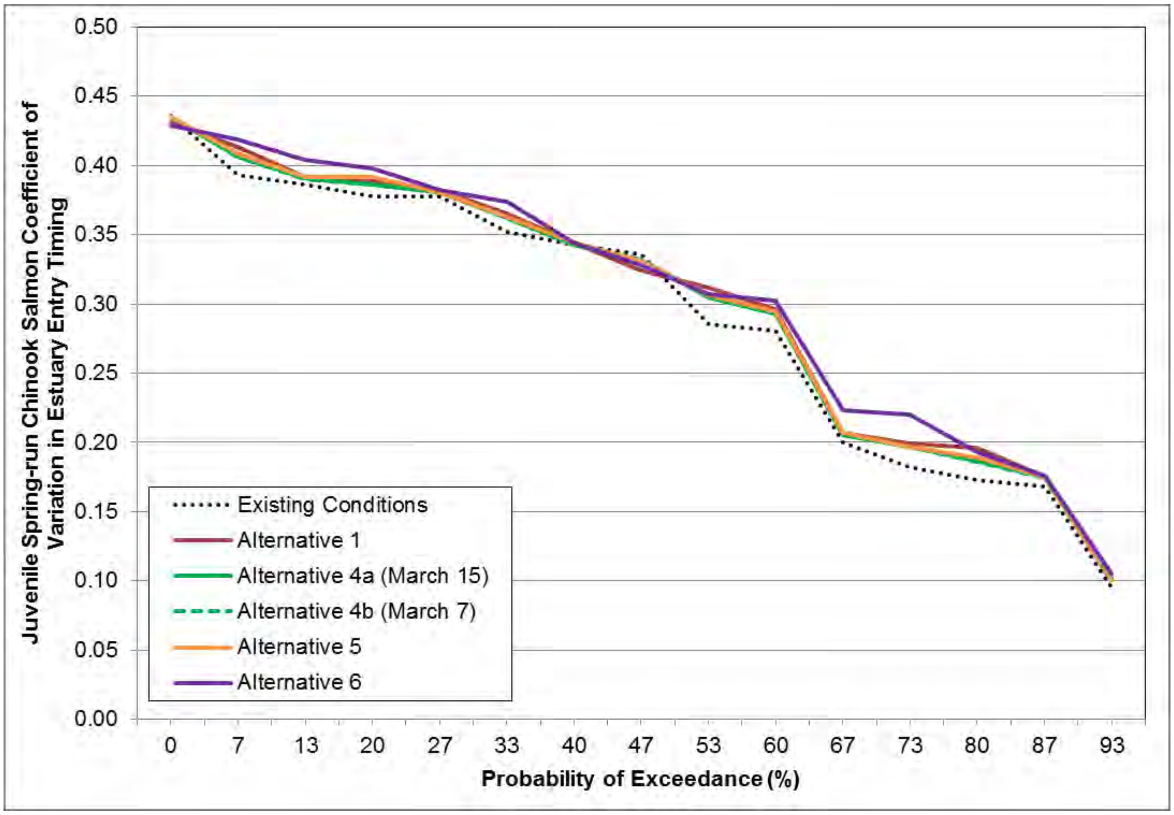


Figure 8-106. Simulated Juvenile Spring-Run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under All Alternatives and Existing Conditions

8.5.7.2 Winter-run Chinook Salmon

8.5.7.2.1 Variation in Juvenile Winter-run Chinook Salmon Size

Modeling results indicate that annual average juvenile winter-run Chinook salmon coefficient of variation in size would be higher under all alternatives relative to Existing Conditions over the entire simulation period and by water year type (Table 8-55). Among the alternatives, average annual variation in size would be slightly higher over the entire simulation period and by water year type under Alternative 6 relative to Alternatives 1 through 5 and similar among Alternatives 1 through 5.

Table 8-55. Average Annual Juvenile Winter-run Chinook Salmon Coefficient of Variation in Size under All Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	0.14	0.20	0.12	0.17	0.10	0.06
Alternatives 1-3	0.17	0.23	0.15	0.19	0.12	0.09
Alternative 4a	0.16	0.22	0.14	0.19	0.12	0.09
Alternative 4b	0.16	0.22	0.14	0.19	0.12	0.09
Alternative 5	0.17	0.22	0.14	0.19	0.12	0.09
Alternative 6	0.19	0.25	0.16	0.21	0.14	0.11

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

The juvenile winter-run Chinook salmon coefficient of variation in size probability of exceedance distributions indicates that all alternatives would result in increased size variability relative to Existing Conditions (Figure 8-107). Among the alternatives, Alternative 6 would provide higher coefficients of variation over most of the distribution relative to Alternatives 1 through 5, and Alternatives 1 through 3 would provide slightly more variation than Alternatives 4 and 5 over portions of the distribution. Overall, variation in size of juvenile winter-run Chinook salmon would be greater under Alternative 6 and not substantially different among Alternatives 1 through 5.

8.5.7.2.2 Variation in Juvenile Winter-run Chinook Salmon Estuary Entry Timing

Modeling results indicate that annual average juvenile winter-run Chinook salmon coefficient of variation in estuary entry timing would be similar or slightly higher under all alternatives relative to Existing Conditions over the entire simulation period and by water year type (Table 8-56). Average coefficient of variation in estuary entry timing would be highest under Alternative 6, followed by Alternatives 1 through 5. However, differences among the alternatives are generally insubstantial.

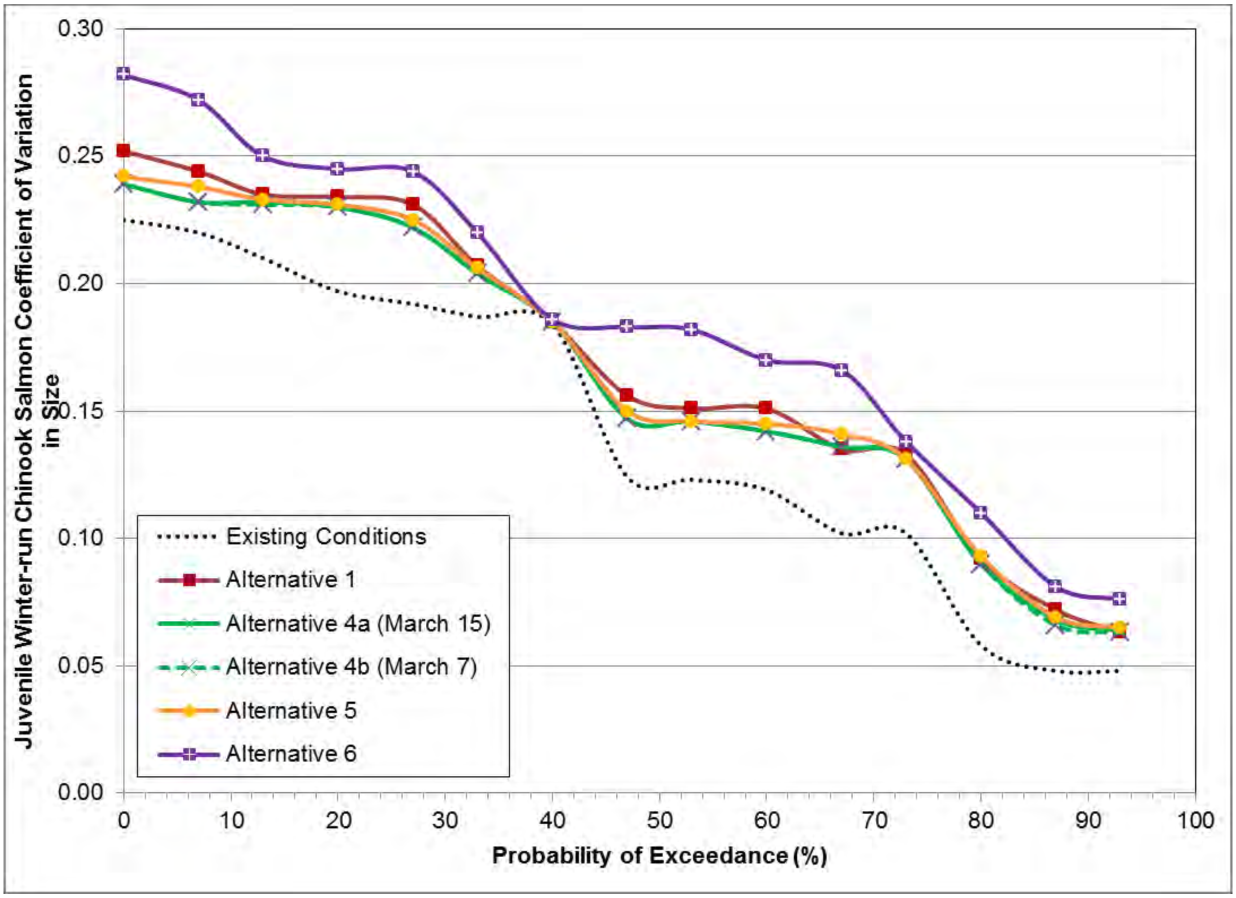


Figure 8-107. Simulated Juvenile Winter-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under All Alternatives and Existing Conditions

Table 8-56. Average Annual Juvenile Winter-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing under all Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	0.28	0.38	0.22	0.30	0.21	0.12
Alternative 1	0.28	0.39	0.23	0.31	0.22	0.13
Alternative 4a	0.28	0.38	0.23	0.31	0.22	0.13
Alternative 4b	0.28	0.38	0.23	0.31	0.22	0.13
Alternative 5	0.28	0.39	0.23	0.31	0.22	0.13
Alternative 6	0.29	0.39	0.24	0.32	0.23	0.13

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

The juvenile winter-run Chinook salmon coefficient of variation in estuary entry timing probability of exceedance distributions indicates that all alternatives would result in similar or increased estuary entry timing variability relative to Existing Conditions (Figure 8-108). Alternative 6 would provide higher coefficients of variation over most of the distribution relative to the other alternatives.

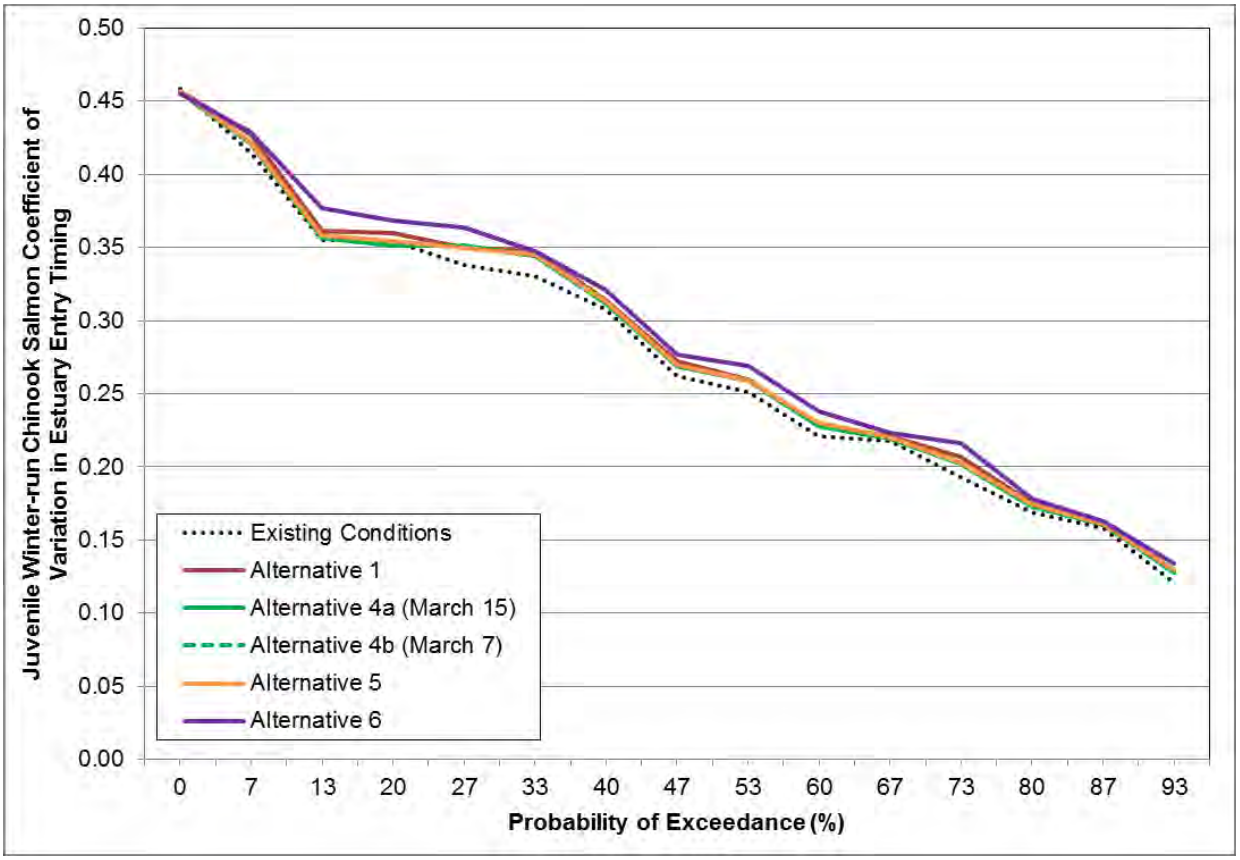


Figure 8-108. Simulated Juvenile Winter-Run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under All Alternatives and Existing Conditions

8.5.8 Increase Abundances of Returning Adult Winter-run and Spring-run Chinook Salmon

As previously described, the SBM simulated adult Chinook salmon returns under each alternative and Existing Conditions. Relative differences in simulated adult returns for spring-run and winter-run Chinook salmon were used as indicators of the impact of the alternatives on relative abundance of Sacramento River spring-run and winter-run Chinook salmon.

8.5.8.1 Spring-Run Chinook Salmon

Modeling results indicate that annual average adult spring-run Chinook salmon returns would be higher under all alternatives relative to Existing Conditions over the entire simulation period and during all water year types (Table 8-57). Average annual adult returns would be slightly higher under Alternative 6 relative to Alternatives 1 through 5.

Table 8-57. Average Annual Spring-run Chinook Salmon Adult Returns under All Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	5,960	8,803	5,821	2,174	4,884	4,031
Alternatives 1-3	6,391	9,652	6,049	2,345	5,094	4,385
Alternative 4a	6,259	9,343	6,002	2,281	5,062	4,357
Alternative 4b	6,257	9,342	6,000	2,280	5,056	4,357
Alternative 5	6,300	9,425	6,012	2,295	5,088	4,399
Alternative 6	6,690	10,230	6,184	2,507	5,244	4,658

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

The adult spring-run Chinook salmon returns probability of exceedance distributions indicate that there would not be substantial differences among the alternatives although Alternative 6 would result in slightly higher adult returns over most of the distribution relative to Alternatives 1 through 5 (Figure 8-109).

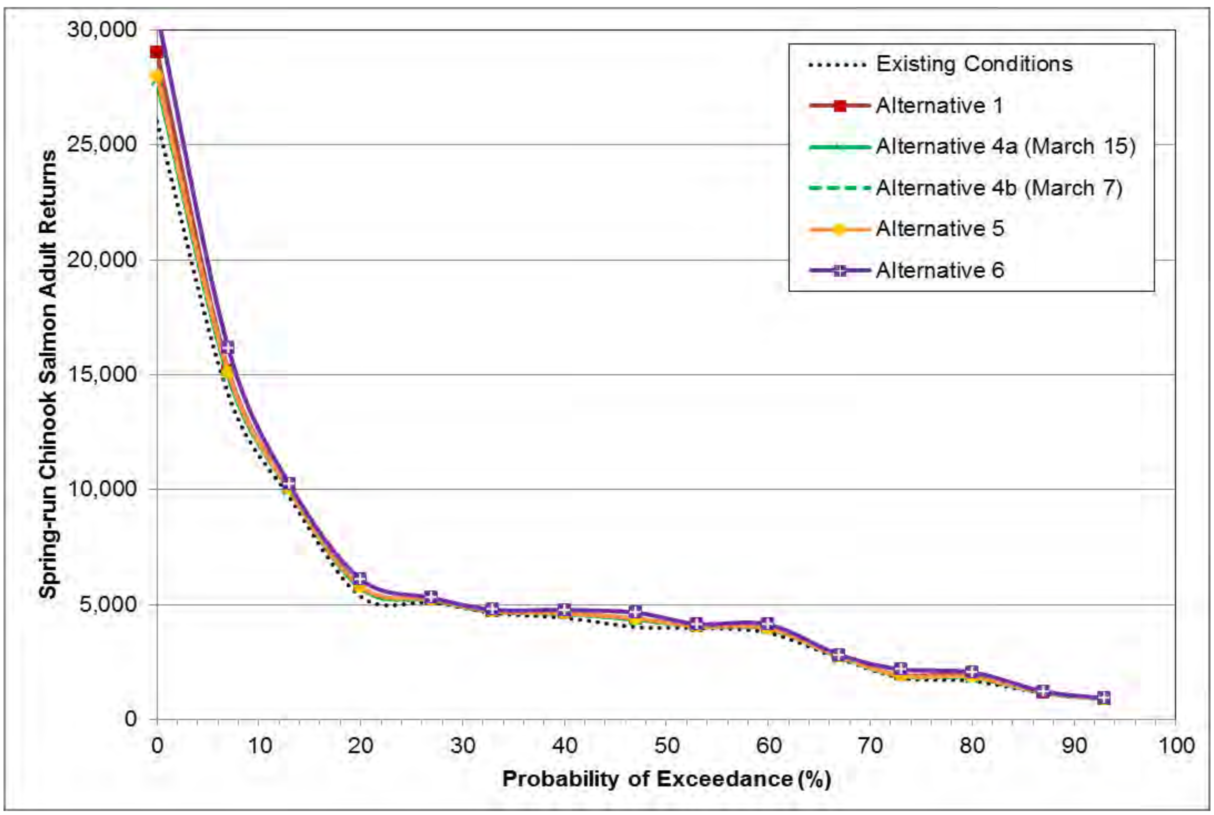


Figure 8-109. Simulated Adult Spring-run Chinook Salmon Returns Probability of Exceedance Distributions under All Alternatives and Existing Conditions

8.5.8.2 Winter-Run Chinook Salmon

Modeling results indicate that annual average adult winter-run Chinook salmon returns would be slightly higher under all alternatives relative to Existing Conditions over the entire simulation period and during all water year types (Table 8-58). Although there would be no substantial differences among the alternatives, Alternative 6 would result in slightly higher average annual adult returns over the entire simulation and by water year type.

Table 8-58. Average Annual Winter-run Chinook Salmon Adult Returns under All Alternatives and Existing Conditions

Alternative	Entire Simulation Period[1]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]	Water Year Types[2]
		Wet	Above Normal	Below Normal	Dry	Critical
Existing Conditions	5,518	5,504	5,558	5,334	6,197	3,118
Alternatives 1-3	5,630	5,732	5,574	5,344	6,297	3,192
Alternative 4a	5,617	5,690	5,571	5,353	6,301	3,188
Alternative 4b	5,617	5,690	5,571	5,354	6,300	3,188
Alternative 5	5,629	5,709	5,570	5,357	6,317	3,197
Alternative 6	5,746	5,947	5,582	5,363	6,433	3,253

[1] Based on modeled annual values over a 15-year simulation period (water years 1997 through 2011)

[2] As defined by the Sacramento Valley Index (DWR 2017c)

The adult winter-run Chinook salmon returns probability of exceedance distributions indicates that all alternatives would provide similar or slightly higher adult returns relative to Existing Conditions (Figure 8-110). All alternatives would provide similar numbers of adult winter-run Chinook salmon returns over most of the distributions; however, Alternative 6 would result in slightly higher adult returns over portions of the distributions relative to the other alternatives.

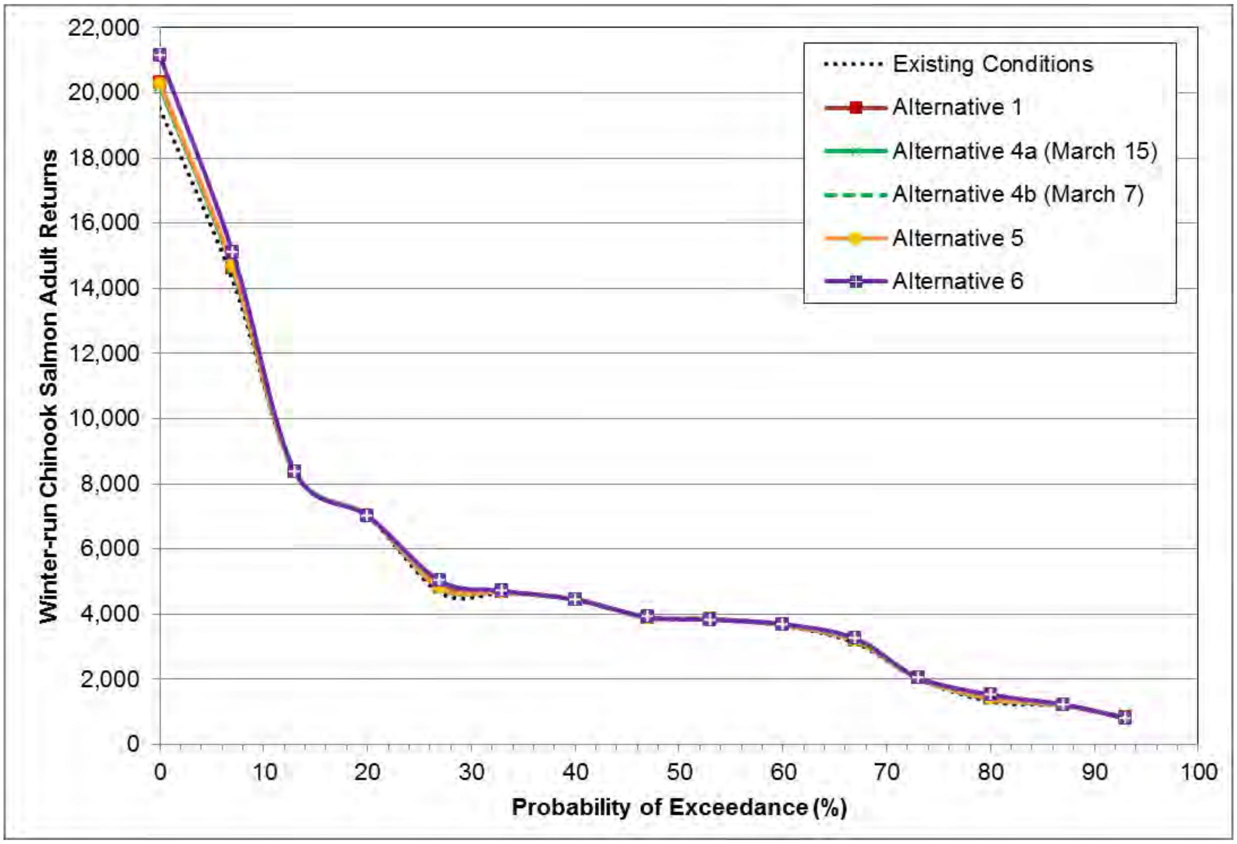


Figure 8-110. Simulated Adult Winter-run Chinook Salmon Returns Probability of Exceedance Distributions under All Alternatives and Existing Conditions

8.5.9 Additional Considerations

In addition to the assessment of the relative performance of each alternative with respect to the objectives described above, additional pertinent considerations not previously addressed in this section include the relative potential for predation not accounted for in the existing fisheries modeling and the potential for future adaptive management and flexibility in operating the Project.

8.5.9.1 Predation

The primary difference in the potential for changes in predation in the Yolo Bypass among the alternatives is expected to be associated with the construction of the water control structures under Alternative 4 and the programmatic Tule Canal floodplain improvements associated with Alternative 5. Because predatory fishes, such as striped bass, black bass, white catfish, channel catfish, and Sacramento pikeminnow, are observed in the perennial Tule Canal, the water control structures may provide suitable locations for predatory fish to inhabit and facilitate their predation on downstream migrating juvenile salmonids. Based on a review of predation studies and related literature in the Delta region, Grossman et al. (2013) found that most of the predation hot spots, where substantial predation of juvenile salmonids may consistently occur, were located near artificial structures such as bridges, radial gates, and physical obstructions in the channel. Therefore, the presence of the water control structures may result in increased predation of juvenile salmonids (and other native fish species of focused evaluation) under Alternative 4 and the Tule Canal Floodplain Improvements associated with Alternative 5 relative to the other alternatives.

8.5.9.2 Adaptive Management Potential

It is expected that the FETT will learn new information over time regarding juvenile entrainment, floodplain habitat conditions, and species responses associated with operations of the proposed Fremont Weir facilities. Therefore, alternatives with greater long-term flexibility would better allow for refining (adaptively managing) operations for the purposes of meeting the project objectives and avoiding or minimizing significant impacts. Given the uncertainties associated with estimating entrainment of size-specific juvenile Chinook salmon into the Yolo Bypass, multiple gates at the intake facilities under Alternative 5 would potentially allow for optimizing levels of juvenile Chinook salmon entrainment into the Yolo Bypass under various hydraulic conditions. Therefore, Alternative 5 would have better potential for future adaptive management to meet project objectives relative to the other alternatives.

Components of Alternative 4 also may facilitate the adaptive management of operations to better meet some of the project objectives. Operations of the water control structures could potentially be managed and refined over time to increase inundation duration during appropriate times to increase the suitability of habitat conditions for juvenile salmonids and juvenile and adult Sacramento splittail while increasing primary and secondary productivity in the Yolo Bypass and potentially exporting more productive water to localized areas in the Delta. For example, Henning et al. (2007) found that seasonally flooded freshwater wetlands with water control structures on a floodplain provided juvenile coho salmon more time for rearing relative to unmodified wetlands. Although relatively more intensive studies and monitoring may be required, components of Alternative 4 could provide additional opportunity for future adaptive management relative to the other alternatives.

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