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

Potential impacts associated with predation risk under Alternative 2 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 2 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 2 are expected to be similar to those described for Alternative 1.

This impact 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**.

8.3.3.3.2 Operations-Related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

Operations-related impacts associated with Alternative 2 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. Operations-related impacts under Alternative 2 are generally similar to operations-related impacts under Alternative 1.

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 changes in average monthly flows over the entire simulation period under Alternative 2 in the Sacramento River downstream of Fremont Weir would be similar to those described for Alternative 1. Therefore, migration and rearing conditions would be similar under Alternative 2 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 2 would result in the same or similar flows in the Sacramento River downstream of Fremont Weir relative to Existing Conditions; therefore, Alternative 2 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 changes in mean monthly water temperatures in the Sacramento River would be similar to those described for Alternative 1. 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 2 relative to Existing Conditions.

CEQA Conclusion

Alternative 2 would not result in substantial changes to water temperature suitability for fish species of focused evaluation relative to Existing Conditions; therefore, Alternative 2 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

Modeling results indicate that changes in mean monthly Delta hydrologic and water quality parameters under Alternative 2 would be similar to those described for Alternative 1. 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 2 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 2 would have a **less than significant impact** due to 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)

Changes in flow-dependent hydraulic habitat availability under Alternative 2 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

In the Yolo Bypass under Alternative 2, 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 2 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

Flows entering the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 2 are expected to be similar to those described for Alternative 1.

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 2 would have a **less than significant impact**.

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

Wetted extent in the Yolo and Sutter bypasses under Alternative 2 is expected to be similar to that described for Alternative 1. Therefore, an increase in wetted extent during the winter in the Yolo Bypass could increase food resources for fish species of focused evaluation in the Yolo Bypass and potentially the Delta. Minor reductions in wetted area in the Sutter Bypass could result in minor reductions in food resources 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 2 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

Flows entering the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 2 are expected to be similar to those described for Alternative 1.

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 2, adult salmon and sturgeon would be expected to successfully pass upstream through the transport channel and intake structure into the Sacramento River about 23 percent of the days from November through April over the water years 1997 through 2012 simulation period. The annual average date after which Alternative 2 would no longer meet the fish passage criteria is April 2.

CEQA Conclusion

Increased duration of potential adult fish passage opportunity from the Yolo Bypass into the Sacramento River under Alternative 2 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 2 would be expected to have a **beneficial impact** on changes in 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 2, such as the transport and intake channels, would be graded to provide suitable passage conditions for fish, assuming sufficient water is present. Although Alternative 1 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 2 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 as occurs under Existing Conditions.

CEQA Conclusion

The overall potential for adult fish stranding would be expected to be reduced under Alternative 2 relative to Existing Conditions. Juvenile stranding may potentially increase under Alternative 2, but design of the project facilities is expected to minimize any increases in juvenile stranding. Therefore, Alternative 2 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 2 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 2 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 2 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 2.

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 2 would be expected to have a **less than significant impact** on 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.

Modeling results indicate that changes in mean monthly flows spilling into the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 2 would be similar to those described for Alternative 1. However, entrainment estimates from the ELAM modeling are different for Alternative 2 relative to Alternative 1 and are presented for Alternative 2 below.

The ELAM modeling indicates that the entrainment-Sacramento River stage relationship under Alternative 2 exhibits a positive relationship as Sacramento River stage increases from 22.32 to 28.83 ft. Without the proposed Sacramento River channel and bank improvements, the percent of juveniles entrained peaks at 9.4 percent at the highest stage modeled (Smith et al. 2017; Appendix G1). However, based on the differences in maximum entrainment under ELAM model scenarios for Alternative 5 with the Sacramento River improvements (about 10 percent) and without the Sacramento River improvements (about 5.6 percent), entrainment of juveniles under Alternative 2 with the Sacramento River improvements is expected to increase the maximum rate of entrainment above 9.4 percent (representations of Alternative 5 were modeled with and without the Sacramento River improvements; Alternative 2 was only modeled without the improvements).

Because operations under Alternative 2 are expected to be very similar to operations under Alternative 1, simulated changes in indicators of the VSP parameters for fall-run, late fall-run, spring-run, and winter-run Chinook salmon would be similar to those described for Alternative 1. Although the SBM modeling was conducted using the proportion of flow approach to estimate juvenile entrainment into the Yolo Bypass, the ELAM modeling with and without Sacramento River improvements for a different alternative that would be at the same location (Alternative 5) suggests that the maximum entrainment rates for Alternative 2 with the Sacramento River improvements may be similar to Alternative 1. Therefore, the indicators of the VSP parameters under Alternative 2 are assumed to be similar to the results shown for Alternative 1.

CEQA Conclusion

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 2 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 2 relative to Existing Conditions.

Therefore, Alternative 2 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

Changes in simulated mean monthly storages in the SWP/CVP system under Alternative 2 relative to the bases of comparison would be similar to those described for Alternative 1. Therefore, simulated changes under Alternative 2 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 2 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, which could indirectly benefit fish resources (Yolo Habitat Conservancy 2017). Because Alternative 2 would include mitigation for physical habitat impacts, Alternative 2 would not conflict with HCPs or NCCPs, including the Yolo County HCP/NCCP (Yolo Habitat Conservancy 2017).

CEQA Conclusion

Alternative 2 is expected to have a **less than significant impact** on habitat conservation plans.

8.3.3.4 Alternative 3: West Side Gated Notch

Alternative 3, West Side Gated Notch, would provide a similar new gated notch through Fremont Weir as described for Alternative 1. The primary difference between Alternatives 1 and 3 is the location of the notch; Alternative 3 would site the notch on the western side of Fremont Weir. This gate would be a similar size but would have an invert elevation that is higher (16.1 feet) because the river is higher at this upstream location. Alternative 3 would allow up to 6,000 cfs through the gated notch to provide open channel flow for adult fish passage. See Section 2.6 for more details on the alternative features.

8.3.3.4.1 Construction-related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

The proposed construction schedule for Alternative 3 would be similar to the schedule described for Alternative 1. Construction- and maintenance-related activities evaluated for Alternative 3 are similar to those described for Alternative 1.

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 3 are expected to be similar to those described for Alternative 1. As an indicator of the extent of excavation that would occur under Alternative 3 in the Yolo Bypass, the estimated excess amount of spoils to be excavated during construction would be about 806,000 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 3 is 37,800 CY. This corresponds to an estimated total annual amount of sediment removal required of 334,350 CY under Alternative 2 relative to 296,550 CY under Existing Conditions. However, local depositional patterns will be dependent on the specific design of the downstream facilities. For example, although the total estimated increase in sediment deposition because of increased flows would be the same under Alternatives 1, 2, and 3, the additional lengths of channel connecting the intake facility to the Tule Pond under Alternatives 2 and 3 may result in the need for additional sediment removal under Alternatives 2 and 3 relative to Alternative 1.

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 3 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 3 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 32.5 acres (temporary impacts) and 80.9 acres (permanent impacts) of vegetated area would have the potential to be disturbed during Alternative 3 construction activities. Specifically, 8.8 acres (temporary impacts) and 20.1 acres (permanent impacts) would be riparian vegetation which would be a potential source of IWM inputs to the Sacramento River or Yolo Bypass (Table 8-13 and Figure 8-27).

Table 8-13. Vegetation Communities Potentially Affected under Alternative 3

Vegetation Community						
	Grassland	Freshwater Aquatic Vegetation	Freshwater Emergent Marsh	Marsh/Seep	Riparian Forest/Woodland	Total
Acres (Temporary)	19.6	1.0	2.2	0.9	8.8	32.5
Acres (Permanent)	42.8	4.0	10.0	4.0	20.1	80.9

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 3 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

Impacts associated with construction and maintenance 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 3 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 and stranded in the Yolo Bypass. Implementation of Mitigation Measure MM-FISH-3: Prepare a Fish Rescue and Salvage Plan would reduce this impact to **less than significant**.

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Figure 8-27a. Vegetation Communities Potentially Affected under Alternative 3

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Figure 8-27b. Vegetation Communities Potentially Affected under Alternative 3

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

Potential impacts associated with predation risk under Alternative 3 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 3 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 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 3 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**.

8.3.3.4.2 Operations-Related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

Operations-related impacts associated with Alternative 3 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. Operations-related impacts under Alternative 3 are generally similar to operations-related impacts under Alternative 1.

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

Changes in simulated average monthly flows over the entire simulation period under Alternative 3 in the Sacramento River downstream of Fremont Weir are expected to be similar to those described for Alternative 1. Therefore, migration and rearing conditions would be similar under Alternative 3 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 3 would result in the same or similar flows in the Sacramento River downstream of Fremont Weir relative to Existing Conditions; therefore, Alternative 3 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

Changes in simulated mean monthly water temperatures in the Sacramento River at Freeport under Alternative 3 are expected to be similar to those described for Alternative 1. 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 3 relative to Existing Conditions.

CEQA Conclusion

Alternative 3 would not result in substantial changes to water temperature suitability for fish species of focused evaluation relative to Existing Conditions; therefore, Alternative 3 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

Changes in simulated mean monthly Delta hydrologic and water quality parameters under Alternative 3 are expected to be similar to those described for Alternative 1. 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 3 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 3 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)

Changes in flow-dependent hydraulic habitat availability under Alternative 3 are expected to be similar to those described for Alternative 1.

CEQA Conclusion

In the Yolo Bypass under Alternative 3, 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 3 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

Flows entering the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 3 are expected to be similar to those described for Alternative 1.

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 3 would have a **less than significant impact**.

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

Wetted extent in the Yolo and Sutter bypasses under Alternative 3 is expected to be similar to that described for Alternative 1. Therefore, an increase in wetted extent during the winter in the Yolo Bypass could increase food resources for fish species of focused evaluation in the Yolo Bypass and potentially the Delta. Minor reductions in wetted area in the Sutter Bypass could result in minor reductions in food resources 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 3 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 under Alternative 3 would be similar to those described for Alternative 1.

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 3, adult salmon and sturgeon would be expected to successfully pass upstream through the transport channel and intake structure into the Sacramento River about 23 percent of the days from November through April over the water years 1997 through 2012 simulation period. The annual average date after which Alternative 3 would no longer meet the fish passage criteria is April 1.

CEQA Conclusion

Increased duration of potential adult fish passage opportunity from the Yolo Bypass into the Sacramento River under Alternative 3 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 3 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 3, such as the transport and intake channels, would be graded to provide suitable passage conditions for fish, assuming sufficient water is present. Although Alternative 3 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 3 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 3 relative to Existing Conditions. Juvenile stranding may potentially increase under Alternative 3, but design of the project facilities is expected to minimize any increases in juvenile stranding. Therefore, Alternative 3 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 3 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 3 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 3 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 3.

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 3 would be expected to have a **less than significant impact** on 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 was 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.

Changes in simulated mean monthly flows spilling into the Yolo Bypass from the Sacramento River at Fremont Weir under Alternative 3 are expected to be similar to those described for Alternative 1. However, juvenile entrainment estimates from the ELAM modeling differ under

Alternative 3 relative to Alternative 1. Therefore, the entrainment estimates from the ELAM modeling, as well as the entrainment estimates from the critical streakline analysis (which was not conducted for Alternative 1), are provided below for Alternative 3.

The ELAM modeling indicates that the entrainment-Sacramento River stage relationship under Alternative 3 exhibits a positive relationship as Sacramento River stage increases from 21.16 to 28.83 ft. The percent of juveniles entrained would peak at about 11 percent at the highest stage modeled (Smith et al. 2017; Appendix G1).

The critical streakline analysis for Alternative 3 (critical streakline scenario 1), which has the same maximum flow capacity as Alternative 1 but is located on the western edge of Fremont Weir, found that the percentage of the total annual abundance of juveniles entrained by run over the entire simulation period would be about 12 percent (confidence interval [CI] 6-21%) for fall-run Chinook salmon, five percent (CI 0-12%) for late fall-run Chinook salmon, nine percent (CI 2-17%) for winter-run Chinook salmon, and nine percent (CI 4-15%) for spring-run Chinook salmon. By contrast, the average annual percentages entrained by run using the proportion of flow approach would be about 15.4, 5.9, 11.3, and 10.3 percent (for all sizes), respectively, indicating that the critical streakline analysis-predicted average annual entrainment rates would be about three percent lower for fall-run, one percent lower for late fall-run, two percent lower for winter-run, and one percent lower for spring-run Chinook salmon for Alternative 3.

Because operations under Alternative 3 are expected to be similar to operations under Alternative 1, simulated changes in indicators of the VSP parameters for fall-run, late fall-run, spring-run, and winter-run Chinook salmon are expected to be similar to those described for Alternative 1. However, because 1) the SBM modeling was conducted using the proportion of flow approach to estimate juvenile entrainment into the Yolo Bypass, 2) the ELAM modeling indicates lower maximum entrainment rates for Alternative 3 relative to Alternative 1, and 3) the critical streakline analysis predicts lower total annual average entrainment rates by run than the proportion of flow approach, the indicators of the VSP parameters under Alternative 3 may be less beneficial than shown for Alternative 1.

CEQA Conclusion

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 3 and Existing Conditions, the abundance, productivity, diversity, and spatial structure indicators all exhibit marked improvement for fall-run, late fall-run, spring-run, and winter-run Chinook salmon under Alternative 3 relative to Existing Conditions.

Therefore, Alternative 3 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

Changes in simulated mean monthly storages in the SWP/CVP system under Alternative 3 relative to the basis of comparison would be similar to those described for Alternative 1. Therefore, simulated changes under Alternative 3 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 3 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, which could indirectly benefit fish resources (Yolo Habitat Conservancy 2017). Because Alternative 3 would include mitigation for physical habitat impacts, Alternative 3 would not conflict with HCPs or NCCPs, including the Yolo County HCP/NCCP (Yolo Habitat Conservancy 2017).

CEQA Conclusion

Alternative 3 is expected to have a **less than significant impact** on habitat conservation plans.

8.3.3.5 Alternative 4: West Side Gated Notch – Managed Flow

Alternative 4, West Side Gated Notch – Managed Flow, would have a smaller amount of flow entering the Yolo Bypass through the gated notch in Fremont Weir than some other alternatives, but it would incorporate water control structures to maintain inundation for longer periods of time within the northern portion of the Yolo Bypass. Alternative 4 would include the same gated notch and associated facilities as described for Alternative 3; however, it would be operated to limit the maximum inflow to 3,000 cfs. See Section 2.7 for more details on the alternative features.

8.3.3.5.1 Construction- and Maintenance-related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

The proposed construction schedule for Alternative 4 would be similar to the schedule described for Alternative 1. Construction- and maintenance-related activities evaluated for Alternative 4 are similar to those described for Alternative 1: however, Alternative 4 includes additional major construction activities, including construction of the two water control facilities, modifications to berms, and sturgeon bypass channels.

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 4 are expected to be similar to those described for Alternative 1. However, due to additional construction activity on and adjacent to Tule Canal associated with the water control structures and bypass channels, there is additional potential for increased sedimentation and turbidity in the Tule Canal under Alternative 4 relative to Alternative 1. As an indicator of the extent of excavation that would occur under Alternative 4 in the Yolo Bypass, the estimated excess amount of spoils to be excavated during construction would be about 746,000 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 from implementation of Alternative 4 is 18,900 CY. This corresponds to an estimated total annual amount of sediment removal required of 315,450 CY under Alternative 4 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 4 are expected to be similar to those described for Alternative 1. However, due to additional construction activity on and adjacent to Tule Canal associated with the water control structures and bypass channels, there is additional potential for the accidental release of contaminants into Tule Canal under Alternative 4 relative to 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 types of impacts associated with aquatic habitat modification under Alternative 4 are expected to be similar to those described for Alternative 1; however, additional acreages would have the potential to be affected due to construction associated with additional facilities and berms under Alternative 4.

Preliminary estimates based on calculations in ArcGIS indicate that a total of 168.4 acres (temporary impacts) and 117.4 acres (permanent impacts) of vegetated area would have the potential to be disturbed during Alternative 4 construction activities. Specifically, 31.1 acres (temporary impacts) and 23.0 acres (permanent impacts) would be riparian vegetation, which would be a potential source of IWM inputs to the Sacramento River or Yolo Bypass (Table 8-14 and Figure 8-28).

Table 8-14. Vegetation Communities Potentially Affected by Alternative 4

Vegetation Community						
	Grassland	**Freshwater Aquatic Vegetation**	**Freshwater Emergent Marsh**	**Marsh/Seep**	**Riparian Forest/Woodland**	**Total**
Acres (Temporary)	102.7	2.7	27.0	4.9	31.1	168.4
Acres (Permanent)	66.1	4.1	20.2	4.0	23.0	117.4

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 8-28a. Vegetation Communities Potentially Affected under Alternative 4

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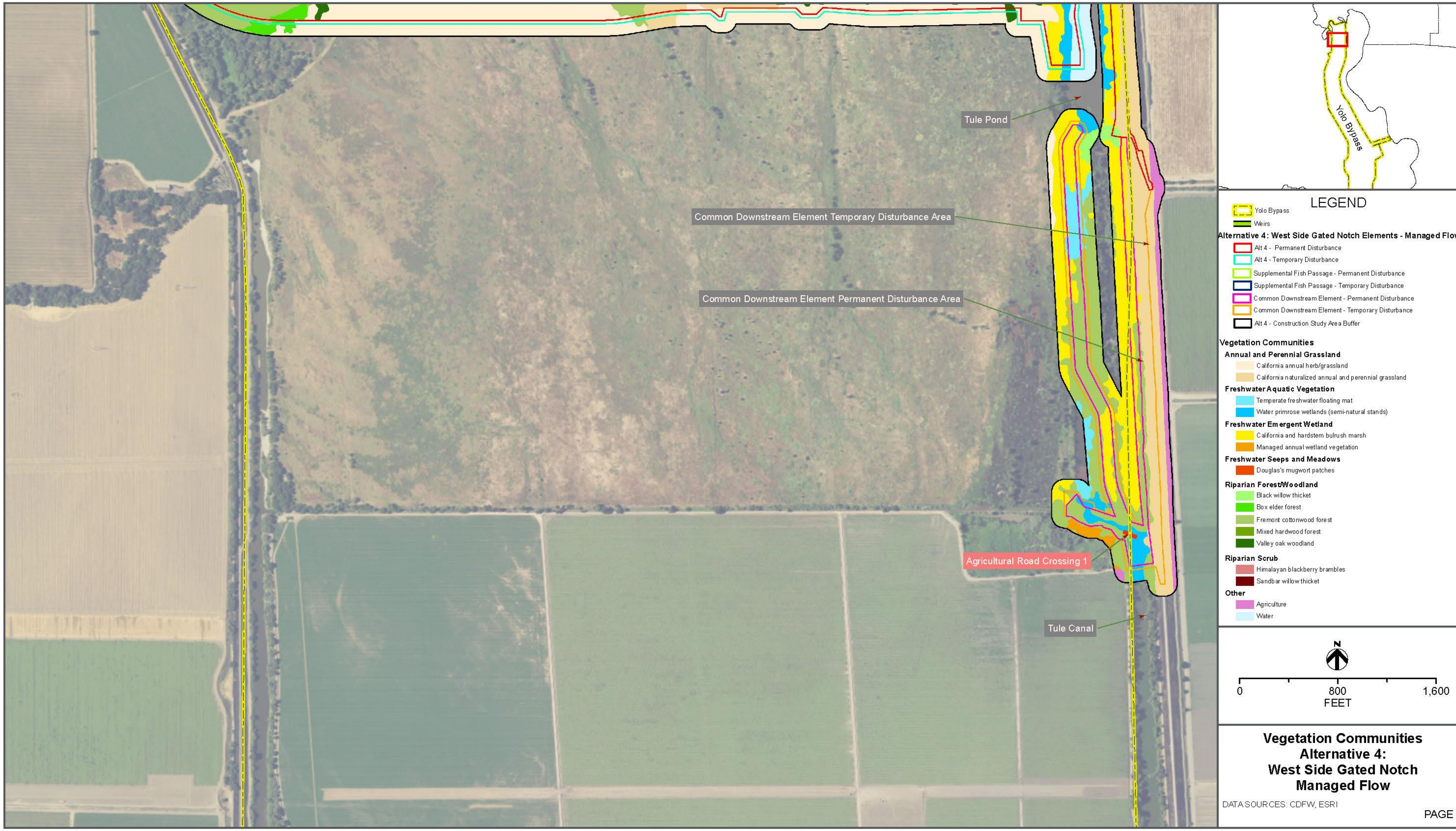

Figure 8-28b. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28c. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28d. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28e. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28f. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28g. Vegetation Communities Potentially Affected under Alternative 4

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Figure 8-28h. Vegetation Communities Potentially Affected under Alternative 4

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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 4 are expected to be similar to those described for Alternative 1. However, there is increased potential for pressure waves and underwater noise to occur under Alternative 4 in and adjacent to the Tule Canal associated with constructing temporary cofferdams and pile driving associated with the water control structures.

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 4 are expected to be similar to those described for Alternative 1. However, there would be additional potential for entrainment to fish species of focused evaluation associated with the dewatering of cofferdams for constructing the water control structures on the Tule Canal under Alternative 4.

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 4 are expected to be similar to those described for Alternative 1. However, there could be increased potential for predation risk associated with increased construction activity, including for constructing the water control structures and bypass channels on the Tule Canal.

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 4 are expected to be similar to those described for Alternative 1, but Alternative 4 has additional potential to impede fish passage associated with construction of the temporary cofferdams, water control structures, and bypass channels on the Tule Canal. However, migratory fish species of focused evaluation would not be migrating through Tule Canal during construction activities, and non-migratory species would have habitat available in the Tule Canal downstream of and away from construction activities.

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 4 are expected to be similar to those described for Alternative 1. However, additional construction activities on the Tule Canal under Alternative 4 could result in additional potential for direct harm to occur to fish species of focused evaluation in the Tule Canal.

This impact 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**.

8.3.3.5.2 Operations-related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

Operations-related impacts associated with Alternative 4 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 4 in the Sacramento River downstream of Fremont Weir would be the same or similar during most months and would be 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 cumulative monthly probability of 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 4 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 4 would result in the same or similar flows in the Sacramento River downstream of Fremont Weir relative to Existing Conditions; therefore, Alternative 4 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 mean monthly water temperatures in the Sacramento River at Freeport would not exceed species and life stage-specific water temperature index values more often under Alternative 4 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 4 relative to Existing Conditions.

CEQA Conclusion

Alternative 4 would not result in substantial changes to water temperature suitability for fish species of focused evaluation relative to Existing Conditions; therefore, Alternative 4 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 simulated 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 4 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 4 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 4 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.

Because Alternative 4 includes two potential variations in operation, allowing inundation flows through the notch through March 7 or March 15, hydraulic habitat availability was simulated for both options—Alternative 4a (March 15) and Alternative 4b (March 7).

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 substantially higher from December through March and similar for the remainder of the October through May evaluation period under Alternatives 4a and 4b (Tables 8-15 and 8-16). Simulated average monthly hydraulic habitat availability by water year type is substantially higher during most water year types from December through March under Alternatives 4a and 4b.

Modeling results indicate that Chinook salmon pre-smolt hydraulic habitat availability would be higher under Alternatives 4a and 4b relative to Existing Conditions over about 50 percent of the cumulative probability exceedance distribution (Figure 8-29). Alternative 4a would provide slightly more habitat over a relatively small portion of the exceedance distribution relative to Alternative 4b. Over the exceedance distribution from November through March, daily hydraulic habitat availability would be higher by 10 percent or more about 64 and 62 percent of the time under Alternative 4a and Alternative 4b, respectively, and would never be lower by 10 percent or more under Alternatives 4a or 4b.

Table 8-15. Average Monthly Area of Pre-smolt Chinook Salmon Hydraulic Habitat in the Yolo Bypass under Alternative 4a 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 4a	20.1	22.0	42.2	59.9	63.2	57.0	37.6	27.5
Existing Conditions	19.8	21.2	31.1	47.6	43.7	46.9	36.9	27.2
Difference	0.3	0.8	11.1	12.3	19.5	10.1	0.7	0.3
Percent Difference[2]	1.5	3.8	35.7	25.8	44.6	21.5	1.9	1.1
Water Year Types[3]								
Wet (n=5)								
Alternative 4a	20.1	23.3	58.8	60.2	70.9	74.2	59.0	32.0
Existing Conditions	19.8	21.1	37.7	48.5	56.9	68.7	58.3	31.8
Difference	0.3	2.2	21.1	11.7	14.0	5.5	0.7	0.2
Percent Difference[2]	1.5	10.4	56.0	24.1	24.6	8.0	1.2	0.6
Above Normal (n=3)								
Alternative 4a	20.3	21.7	43.0	80.9	68.9	56.8	37.2	38.1
Existing Conditions	20.1	21.6	36.2	66.6	41.4	48.0	36.5	37.5
Difference	0.2	0.1	6.8	14.3	27.5	8.8	0.7	0.6
Percent Difference[2]	1.0	0.5	18.8	21.5	66.4	18.3	1.9	1.6
Below Normal (n=3)								
Alternative 4a	20.0	21.4	30.8	55.8	60.1	48.9	27.1	21.2
Existing Conditions	19.7	21.2	25.1	45.4	41.8	40.0	26.6	21.0
Difference	0.3	0.2	5.7	10.4	18.3	8.9	0.5	0.2
Percent Difference[2]	1.5	0.9	22.7	22.9	43.8	22.3	1.9	1.0
Dry (n=4)								
Alternative 4a	20.0	21.4	34.1	47.8	48.0	45.5	22.7	20.3
Existing Conditions	19.8	20.9	25.9	35.7	26.6	29.0	21.8	20.1
Difference	0.2	0.5	8.2	12.1	21.4	16.5	0.9	0.2
Percent Difference[2]	1.0	2.4	31.7	33.9	80.5	56.9	4.1	1.0
Critical (n=1)								
Alternative 4a	19.9	21.0	22.9	55.5	77.5	41.8	23.4	20.5
Existing Conditions	19.7	20.7	21.4	39.9	57.7	27.6	22.2	20.5
Difference	0.2	0.3	1.5	15.6	19.8	14.2	1.2	0.0
Percent Difference[2]	1.0	1.4	7.0	39.1	34.3	51.4	5.4	0.0

[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

Table 8-16. Average Monthly Area of Pre-smolt Chinook Salmon Hydraulic Habitat in the Yolo Bypass under Alternative 4b 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 4b	20.0	22.0	42.1	59.9	63.2	53.3	37.4	27.4
Existing Conditions	19.8	21.2	31.1	47.6	43.7	46.9	36.9	27.2
Difference	0.2	0.8	11.0	12.3	19.5	6.4	0.5	0.2
Percent Difference[2]	1.0	3.8	35.4	25.8	44.6	13.6	1.4	0.7
Water Year Types[3]								
Wet (n=5)								
Alternative 4b	20.1	23.3	58.8	60.2	70.9	71.9	58.9	31.9
Existing Conditions	19.8	21.1	37.7	48.5	56.9	68.7	58.3	31.8
Difference	0.3	2.2	21.1	11.7	14.0	3.2	0.6	0.1
Percent Difference[2]	1.5	10.4	56.0	24.1	24.6	4.7	1.0	0.3
Above Normal (n=3)								
Alternative 4b	20.2	21.6	43.0	80.9	68.9	53.8	36.9	38.0
Existing Conditions	20.1	21.6	36.2	66.6	41.4	48.0	36.5	37.5
Difference	0.1	0.0	6.8	14.3	27.5	5.8	0.4	0.5
Percent Difference[2]	0.5	0.0	18.8	21.5	66.4	12.1	1.1	1.3
Below Normal (n=3)								
Alternative 4b	20.0	21.4	30.8	55.8	60.1	45.2	26.8	21.1
Existing Conditions	19.7	21.2	25.1	45.4	41.8	40.0	26.6	21.0
Difference	0.3	0.2	5.7	10.4	18.3	5.2	0.2	0.1
Percent Difference[2]	1.5	0.9	22.7	22.9	43.8	13.0	0.8	0.5
Dry (n=4)								
Alternative 4b	19.9	21.3	34.1	47.8	48.0	39.6	22.4	20.2
Existing Conditions	19.8	20.9	25.9	35.7	26.6	29.0	21.8	20.1
Difference	0.1	0.4	8.2	12.1	21.4	10.6	0.6	0.1
Percent Difference[2]	0.5	1.9	31.7	33.9	80.5	36.6	2.8	0.5
Critical (n=1)								
Alternative 4b	19.8	21.0	22.8	55.6	77.5	37.2	23.1	20.4
Existing Conditions	19.7	20.7	21.4	39.9	57.7	27.6	22.2	20.5
Difference	0.1	0.3	1.4	15.7	19.8	9.6	0.9	-0.1
Percent Difference[2]	0.5	1.4	6.5	39.3	34.3	34.8	4.1	-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

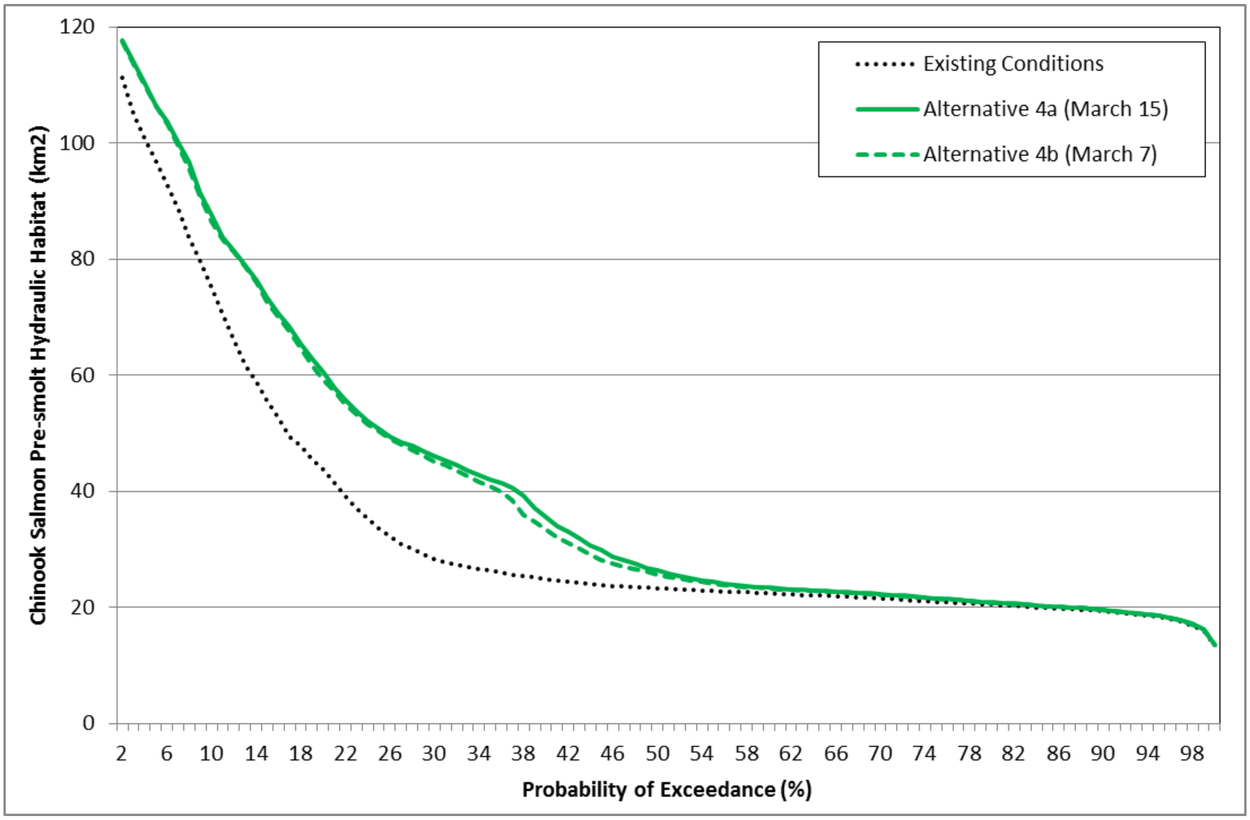

Figure 8-29. Simulated Chinook Salmon Pre-Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions from October through May based on TUFLOW Modeling

Modeling results indicate that average monthly hydraulic habitat availability over the entire simulation period for Chinook salmon smolts in the Yolo Bypass would be substantially higher (i.e., higher by 10 percent or more) from December through March, including during most water year types, and would be similar (i.e., change by less than 5 percent) for the remainder of the October through May evaluation period over the entire simulation period and during most water year types under Alternatives 4a and 4b relative to Existing Conditions (Tables 8-17 and 8-18).

Modeling results indicate that Chinook salmon smolt hydraulic habitat availability would be higher under Alternative 1 relative to Existing Conditions over about 60 percent of the cumulative probability exceedance distribution (Figure 8-30). Alternative 4a would provide slightly more habitat over a relatively small portion of the exceedance distribution relative to Alternative 4b. Over the exceedance distribution from November through March, daily hydraulic habitat availability would be higher by 10 percent or more about 58 and 56 percent of the time under Alternatives 4a and 4b, respectively, and would never be lower by 10 percent or more under either alternative.

Table 8-17. Average Monthly Area of Chinook Salmon Smolt Hydraulic Habitat in the Yolo Bypass under Alternative 4a 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 4a	31.8	32.9	56.4	84.6	91.2	87.2	59.6	43.2
Existing Conditions	31.6	32.0	44.2	70.0	69.7	76.0	58.8	43.1
Difference	0.2	0.9	12.2	14.6	21.5	11.2	0.8	0.1
Percent Difference[2]	0.6	2.8	27.6	20.9	30.8	14.7	1.4	0.2
Water Year Types[3]								
Wet (n=5)								
Alternative 4a	31.6	34.4	78.2	103.5	116.4	126.0	100.6	50.9
Existing Conditions	31.4	32.1	55.4	90.2	100.6	119.0	99.6	50.7
Difference	0.2	2.3	22.8	13.3	15.8	7.0	1.0	0.2
Percent Difference[2]	0.6	7.2	41.2	14.7	15.7	5.9	1.0	0.4
Above Normal (n=3)								
Alternative 4a	32.2	33.0	56.8	100.8	97.6	86.2	50.9	55.1
Existing Conditions	32.1	32.9	48.3	82.4	68.3	76.6	50.4	54.6
Difference	0.1	0.1	8.5	18.4	29.3	9.6	0.5	0.5
Percent Difference[2]	0.3	0.3	17.6	22.3	42.9	12.5	1.0	0.9
Below Normal (n=3)								
Alternative 4a	31.9	32.0	42.3	70.9	82.8	72.4	41.1	34.9
Existing Conditions	31.7	31.8	36.2	57.8	62.3	62.6	40.6	34.9
Difference	0.2	0.2	6.1	13.1	20.5	9.8	0.5	0.0
Percent Difference[2]	0.6	0.6	16.9	22.7	32.9	15.7	1.2	0.0
Dry (n=4)								
Alternative 4a	31.7	31.9	45.3	62.8	60.5	58.6	34.7	33.4
Existing Conditions	31.6	31.5	36.6	48.9	37.9	41.0	33.9	33.4
Difference	0.1	0.4	8.7	13.9	22.6	17.6	0.8	0.0
Percent Difference[2]	0.3	1.3	23.8	28.4	59.6	42.9	2.4	0.0
Critical (n=1)								
Alternative 4a	31.1	31.4	32.7	69.6	93.7	54.4	35.4	33.8
Existing Conditions	31.0	31.2	30.9	52.1	70.2	39.2	34.4	33.9
Difference	0.1	0.2	1.8	17.5	23.5	15.2	1.0	-0.1
Percent Difference[2]	0.3	0.6	5.8	33.6	33.5	38.8	2.9	-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

Table 8-18. Average Monthly Area of Chinook Salmon Smolt Hydraulic Habitat in the Yolo Bypass under Alternative 4b 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 4b	31.7	32.8	56.3	84.5	91.1	82.9	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	0.8	12.1	14.5	21.4	6.9	0.5	0.1
Percent Difference[2]	0.3	2.5	27.4	20.7	30.7	9.1	0.9	0.2
Water Year Types[3]								
Wet (n=5)								
Alternative 4b	31.5	34.3	78.1	103.4	116.3	123.1	100.5	50.8
Existing Conditions	31.4	32.1	55.4	90.2	100.6	119.0	99.6	50.7
Difference	0.1	2.2	22.7	13.2	15.7	4.1	0.9	0.1
Percent Difference[2]	0.3	6.9	41.0	14.6	15.6	3.4	0.9	0.2
Above Normal (n=3)								
Alternative 4b	32.1	32.9	56.7	100.7	97.5	83.0	50.6	55.0
Existing Conditions	32.1	32.9	48.3	82.4	68.3	76.6	50.4	54.6
Difference	0.0	0.0	8.4	18.3	29.2	6.4	0.2	0.4
Percent Difference[2]	0.0	0.0	17.4	22.2	42.8	8.4	0.4	0.7
Below Normal (n=3)								
Alternative 4b	31.9	32.0	42.2	70.9	82.7	68.2	40.8	34.9
Existing Conditions	31.7	31.8	36.2	57.8	62.3	62.6	40.6	34.9
Difference	0.2	0.2	6.0	13.1	20.4	5.6	0.2	0.0
Percent Difference[2]	0.6	0.6	16.6	22.7	32.7	8.9	0.5	0.0
Dry (n=4)								
Alternative 4b	31.7	31.9	45.2	62.6	60.3	52.2	34.3	33.3
Existing Conditions	31.6	31.5	36.6	48.9	37.9	41.0	33.9	33.4
Difference	0.1	0.4	8.6	13.7	22.4	11.2	0.4	-0.1
Percent Difference[2]	0.3	1.3	23.5	28.0	59.1	27.3	1.2	-0.3
Critical (n=1)								
Alternative 4b	31.1	31.4	32.6	69.5	93.6	49.3	35.1	33.8
Existing Conditions	31.0	31.2	30.9	52.1	70.2	39.2	34.4	33.9
Difference	0.1	0.2	1.7	17.4	23.4	10.1	0.7	-0.1
Percent Difference[2]	0.3	0.6	5.5	33.4	33.3	25.8	2.0	-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

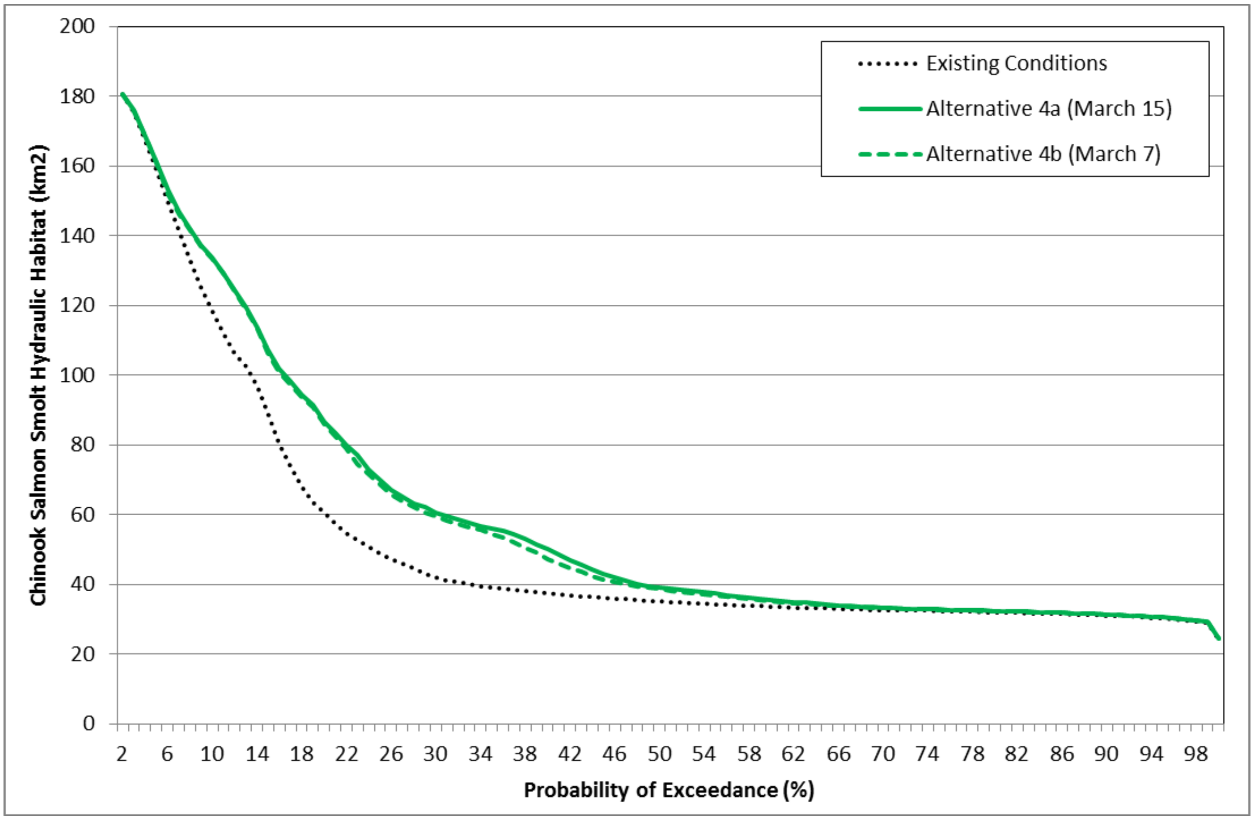

Figure 8-30. Simulated Chinook Salmon Smolt Hydraulic Habitat Availability Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions from October through May based on TUFLOW Modeling

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 0.0 feet) was estimated for the Yolo Bypass under Alternatives 4a and 4b relative to Existing Conditions. Modeling results indicate that average monthly wetted extent over the entire simulation period and by water year type would be higher or substantially higher from December through March, including during most water year types (Table 8-19). Similar but slightly lower increases in average monthly hydraulic habitat availability would be provided by Alternative 4b (Table 8-20).

Table 8-19. Average Monthly Wetted Area in the Yolo Bypass under Alternative 4a 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 4a	48.0	49.5	77.1	120.1	129.1	120.1	86.5	64.1
Existing Conditions	47.8	48.4	64.1	105.0	106.4	107.5	85.9	64.1
Difference	0.2	1.1	13.0	15.1	22.7	12.6	0.6	0.0
Percent Difference[2]	0.4	2.3	20.3	14.4	21.3	11.7	0.7	0.0
Water Year Types[3]								
Wet (n=5)								
Alternative 4a	47.8	51.2	103.4	168.1	177.9	170.8	145.8	77.2
Existing Conditions	47.6	48.6	78.9	154.3	161.7	163.4	145.3	77.5
Difference	0.2	2.6	24.5	13.8	16.2	7.4	0.5	-0.3
Percent Difference[2]	0.4	5.3	31.1	8.9	10.0	4.5	0.3	-0.4
Above Normal (n=3)								
Alternative 4a	48.6	50.1	76.5	125.5	131.0	122.6	72.6	77.3
Existing Conditions	48.5	49.9	68.3	108.0	100.1	111.7	72.5	77.0
Difference	0.1	0.2	8.2	17.5	30.9	10.9	0.1	0.3
Percent Difference[2]	0.2	0.4	12.0	16.2	30.9	9.8	0.1	0.4
Below Normal (n=3)								
Alternative 4a	48.2	48.3	60.3	92.3	113.4	100.7	59.9	52.2
Existing Conditions	47.9	47.9	53.9	79.2	91.7	89.6	59.6	52.3
Difference	0.3	0.4	6.4	13.1	21.7	11.1	0.3	-0.1
Percent Difference[2]	0.6	0.8	11.9	16.5	23.7	12.4	0.5	-0.2
Dry (n=4)								
Alternative 4a	47.9	48.3	64.2	83.8	81.0	80.5	51.2	50.0
Existing Conditions	47.8	47.6	54.5	68.3	56.0	60.3	50.3	49.9
Difference	0.1	0.7	9.7	15.5	25.0	20.2	0.9	0.1
Percent Difference[2]	0.2	1.5	17.8	22.7	44.6	33.5	1.8	0.2
Critical (n=1)								
Alternative 4a	47.2	47.0	48.9	92.9	119.7	76.3	52.1	51.0
Existing Conditions	46.9	46.7	46.6	74.4	95.7	58.1	51.1	50.9
Difference	0.3	0.3	2.3	18.5	24.0	18.2	1.0	0.1
Percent Difference[2]	0.6	0.6	4.9	24.9	25.1	31.3	2.0	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

Table 8-20. Average Monthly Wetted Area in the Yolo Bypass under Alternative 4b 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)								
Alternative 4b	48.0	49.4	76.9	120.0	128.9	115.5	86.2	64.0
Existing Conditions	47.8	48.4	64.1	105.0	106.4	107.5	85.9	64.1
Difference	0.2	1.0	12.8	15.0	22.5	8.0	0.3	-0.1
Percent Difference[2]	0.4	2.1	20.0	14.3	21.1	7.4	0.3	-0.2
Water Year Types[3]								
Wet (n=5)								
Alternative 4b	47.7	51.1	103.3	168.0	177.8	167.7	145.6	77.1
Existing Conditions	47.6	48.6	78.9	154.3	161.7	163.4	145.3	77.5
Difference	0.1	2.5	24.4	13.7	16.1	4.3	0.3	-0.4
Percent Difference[2]	0.2	5.1	30.9	8.9	10.0	2.6	0.2	-0.5
Above Normal (n=3)								
Alternative 4b	48.6	50.0	76.3	125.3	130.8	119.1	72.3	77.2
Existing Conditions	48.5	49.9	68.3	108.0	100.1	111.7	72.5	77.0
Difference	0.1	0.1	8.0	17.3	30.7	7.4	-0.2	0.2
Percent Difference[2]	0.2	0.2	11.7	16.0	30.7	6.6	-0.3	0.3
Below Normal (n=3)								
Alternative 4b	48.1	48.2	60.3	92.1	113.2	96.0	59.6	52.1
Existing Conditions	47.9	47.9	53.9	79.2	91.7	89.6	59.6	52.3
Difference	0.2	0.3	6.4	12.9	21.5	6.4	0.0	-0.2
Percent Difference[2]	0.4	0.6	11.9	16.3	23.4	7.1	0.0	-0.4
Dry (n=4)								
Alternative 4b	47.9	48.3	64.1	83.6	80.8	73.2	50.7	49.9
Existing Conditions	47.8	47.6	54.5	68.3	56.0	60.3	50.3	49.9
Difference	0.1	0.7	9.6	15.3	24.8	12.9	0.4	0.0
Percent Difference[2]	0.2	1.5	17.6	22.4	44.3	21.4	0.8	0.0
Critical (n=1)								
Alternative 4b	47.2	47.0	48.8	92.7	119.5	70.7	51.8	50.9
Existing Conditions	46.9	46.7	46.6	74.4	95.7	58.1	51.1	50.9
Difference	0.3	0.3	2.2	18.3	23.8	12.6	0.7	0.0
Percent Difference[2]	0.6	0.6	4.7	24.6	24.9	21.7	1.4	0.0

[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

Modeling results indicate that wetted extent would be higher under Alternatives 4a and 4b relative to Existing Conditions over about 50 percent of the probability of exceedance distribution (Figure 8-31). Over the exceedance distribution from November through March, daily wetted extent would be substantially higher (i.e., higher by 10 percent or more) about 55 and 52 percent of the time under Alternatives 4a and 4b, respectively, and would never be lower by 10 percent or more under either alternative.

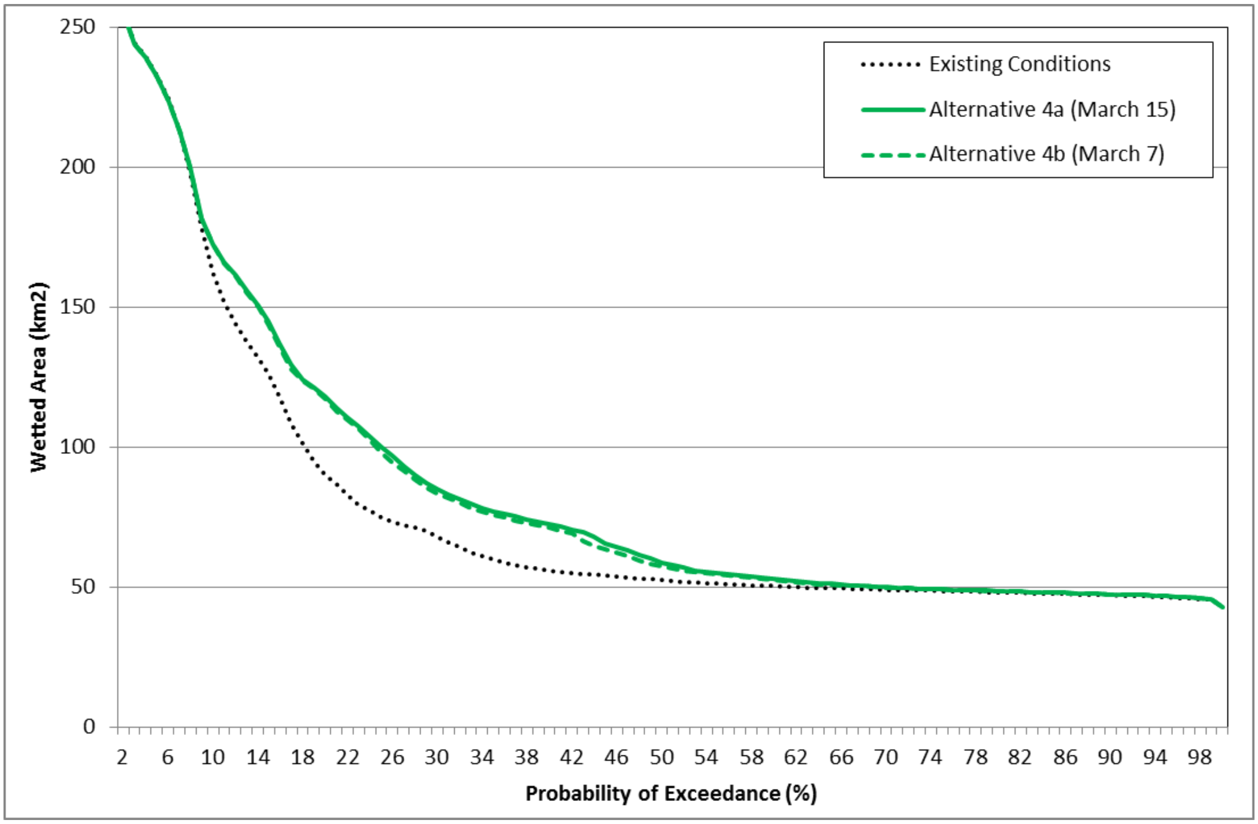

Figure 8-31. Simulated Wetted Area Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions from October through May based on TUFLOW Modeling

Average annual modeled wetted days in the Sutter Bypass would decrease under Alternative 4 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 4, 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 4 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 4 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 4 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 4 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 4 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 4 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 4 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 4, adult salmon and sturgeon would be expected to successfully pass upstream through the transport channel and intake structure into the Sacramento River about 18 percent of the days from November through April over the water years 1997 through 2012 simulation period. The bypass channels would be designed and operated to meet the fish passage criteria (when the water control structures are in the closed position) during the same period. The annual average date after which Alternative 4 would no longer meet the fish passage criteria would be March 31.

In general, installation of the water control structures and bypass channels create additional potential for delay of adult migratory fishes traveling upstream in the Tule Canal toward Fremont Weir. When the water control structures are in the closed position, adults may have difficulty finding the bypass channels, depending on the flow and hydraulic conditions immediately downstream of the water control structures and at the point of entrance to the bypass channels. The presence of the water control structures also allows the potential for a structural failure and uncontrolled release of sediment and water downstream (Flosi et al. 2010).

The use of a fishway (e.g., bypass channel) around a fish passage barrier is the least favorable option for providing fish passage at a facility (Flosi et al. 2010). Fish passage solutions with diverse hydraulic conditions and passage corridors, such as stream simulation, roughened channels and boulder weirs, are preferred over formal fishways because they provide passage for a broader range of species, often over a broader range of flows (Flosi et al. 2010). A primary key to successful fish passage with a fishway is attracting fish into the fishway, which can also be the greatest challenge in the design of a bypass fishway.

Successful passage at fishways requires that fish can locate and enter the fishway entrance and are able to successfully pass upstream of the fishway. Bunt et al. (2012) compiled and summarized fish passage studies that contained data on fish attraction and passage efficiency following a documented methodology that included tracking fish as they approached and attempted to pass upstream through fishways under natural (i.e., field) conditions. Attraction efficiency was defined as the proportion of tagged fish that were subsequently located within less than approximately three m (~10 ft) from the fishway entrance (Bunt et al. 1999 as cited in Bunt et al. 2012) or close enough to the entrance for fish to detect attraction flow from the fishway (Aarestrup et al., 2003 as cited in Bunt et al. 2012). The available data were generally not sufficient for assessing rates at which fish physically entered the fishways or potential delay (Bunt et al. 2012). Passage efficiency through the fishway was calculated by dividing the number of fish of a species that exited the fishway by the number of fish that were detected at the fishway entrance (Bunt et al., 1999; Aarestrup et al., 2003, both as cited in Bunt et al. 2012). Total passage efficiency was calculated based on the product of the attraction efficiency and passage efficiency.

Bunt et al. (2012) found that the attraction efficiency for "nature-like" fishways was less favorable than for other fishway types (i.e., pool-and-weir, vertical-slot, and Denil), averaging 56 percent among 21 studies (representing clupeids, centrarchids, percids, catastomids, cyprinids, salmonids, lotids, and esocids). Passage efficiency averaged 76 percent for the same studies. Total efficiency, accounting for both attraction and passage efficiency, was 43 percent, indicating that less than half of the individual fish studied could locate and successfully pass through the fishway.

Nature-like fishways appear to provide better passage conditions for species with reduced swimming performance than other fishway types, potentially due to the typical low slope of nature-like fishways (Bunt et al. 2012). However, attraction flows were often too low at nature-like fishways to attract fish to the entrance; therefore, additional study on the design of nature-like fishways is needed before they can be readily prescribed (Bunt et al. 2012). Overall, based on review of attraction and passage efficiency at all fishway types, Bunt et al. (2012, p.464) reported that "the vast majority of fishway structures do not effectively mitigate the effects of barriers that block access to areas upstream."

Although the studies reviewed did not include sturgeon species, Chinook salmon, or steelhead in nature-like fishways, the data summarized by Bunt et al. (2012) suggests that the bypass channels under Alternative 4 may only attract and pass approximately 50 percent or less of adults migrating up the Tule Canal when the water control structures are in the closed position. Because there are two bypass channels, the cumulative total passage efficiency may be closer to 25 percent or less. Further, an attraction flow of 300 cfs exiting the fishways may be insufficient to attract adult fish, particularly if flows are relatively high in Knights Landing Ridge Cut. If more adults migrate to Wallace Weir due to higher attraction flows at Knights Landing Ridge Cut, they would have to be salvaged and transported to the Sacramento River, which could reduce spawning success and increase the potential for mortality.

The bypass channels would increase the potential for delays to reaching upstream spawning grounds and may increase energy expenditure of adults, which could also negatively affect spawning success. Impeded migration of large fish such as green or white sturgeon also would increase their susceptibility to being stranded or poached.

When the water control structures are lowered (i.e., moved to the open position), there is the potential for a pulse of water to travel downstream to the Delta and attract adults to migrate upstream through the Yolo Bypass when upstream passage may not be available through the transport channels and/or Fremont Weir facilities to the Sacramento River.

CEQA Conclusion

Although increased duration of potential adult fish passage opportunity from the Yolo Bypass below Fremont Weir into the Sacramento River would be expected to improve under Alternative 4 associated with the Fremont Weir facilities, the placement of the water control structures and bypass channels would result in the potential for additional migration delay or an impediment to migration relative to Existing Conditions for fish species of focused evaluation, particularly adult white and green sturgeon. Therefore, Alternative 4 would be expected to have a potentially **significant impact** on adult fish passage conditions through the Yolo Bypass.

Mitigation Measure MM-FISH-5: Adult fish passage monitoring and adaptive management

To mitigate for the potential delay or blockage of adult fish passage in the Tule Canal associated with the proposed water control structures and bypass channels, hydraulic and fish passage monitoring would be conducted downstream of the water control structures and in the bypass channels. Monitoring activities would include telemetry of tagged adult white sturgeon (as a surrogate for green sturgeon) approaching and passing through the bypass channels and measurement of depths and velocities downstream of and within the bypass channels. Monitoring would be conducted for a specified number of years per the MMRP to ensure that the water control structures and fish passage facilities are operating and functioning to provide suitable fish passage conditions. Performance objectives would include providing suitable passage conditions for adult salmon and sturgeon 100 percent of the time that passage is expected to be provided under Existing Conditions and providing successful passage to all tagged adult sturgeon attempting to migrate upstream, as described below.

The percentage of successfully tagged sturgeon will be quantified for the first three years of operation. If less than 100 percent of tagged sturgeon successfully pass through the bypass channels during the first three-year period of operation, operations-related and structural modifications of the facility will be considered and evaluated for an additional three years. If less than 100 percent of tagged sturgeon successfully pass through the modified bypass channel, the Tule Canal water control structures operation will be restricted to an open position during the sturgeon migration period (after February 15) for an additional three-year period. During these initial nine years, the percentage of successfully tagged fish will be quantified. If the percentage of successful pass attempts by tagged sturgeon is greater with the water control structures remaining open, they will be left open when sturgeon are anticipated to be present, beginning February 15 of each year. If sturgeon passage does not increase during this period, structural changes to the water control structures and bypass channels may be scoped and evaluated through an independent NEPA and CEQA process, which is not part of the Project alternative.

As part of this measure, attraction flows in the bypass channels would be monitored in comparison to flows at Knights Landing Ridge Cut to assess whether the attraction flows in the bypass channels were sufficient to attract adult fish species of focused evaluation such as green sturgeon, white sturgeon, Chinook salmon, and steelhead.

In consultation with CDFW, NMFS and USFWS, tagging and monitoring of additional fish species, such as Chinook salmon, steelhead, Sacramento splittail, and Pacific lamprey, would occur to assesses attraction and passage efficiency at the bypass channels.

Implementation of Mitigation Measure MM-FISH-5: Adult Fish Passage Monitoring and Adaptive Management would reduce this impact to **less than significant**.

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

Project facilities constructed under Alternative 4, such as the transport, intake and bypass channels, would be graded to provide suitable passage conditions for fish, assuming sufficient water is present. Although Alternative 4 would allow for entrainment of juvenile fish at lower flows relative to Existing Conditions, the design of the transport channel to the Tule Canal is expected to minimize the potential for stranding of juveniles. However, anthropogenic structures that interrupt natural drainage patterns, such as berms and 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 associated with the operation of the Fremont Weir facilities and transport channels. In addition, because water control structures promote juvenile Chinook salmon stranding due to the occurrence of unusual hydraulic conditions, the presence of the two Tule Canal water control structures, berms, and bypass channels under Alternative 4 could further increase the potential for juvenile fish stranding. In addition, Fremont Weir overtopping events could potentially result in water surface elevations in the Yolo Bypass exceeding the proposed west bypass channel levees, which could increase potential for stranding in the areas between the embankment and the bypass channel as flows recede.

Because Alternative 4 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 could be reduced. However, potential migratory delay or impedance downstream of or within the bypass channels may increase the susceptibility of some fish species, such as sturgeon, to being stranded.

CEQA Conclusion

The potential for adult fish stranding may decrease in the northern region of the Yolo Bypass below Fremont Weir but may increase in the Tule Canal, under Alternative 4 relative to Existing Conditions. The potential for juvenile fish stranding may increase due to the presence of substantially different hydraulic conditions associated with the water control structures and berms under Alternative 4, which could result in a **significant and unavoidable impact** on stranding and entrainment. No known actions could be identified to reduce this impact to a less-than-significant level; the creation of unusual hydraulic conditions would not be avoided with the presence of the water control structures, berms, and bypass channels.

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 4 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 4 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, 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 4.

However, the proposed water control structures and bypass channels under Alternative 4 may provide increased refuge for predatory fish species such as striped bass relative to Existing Conditions. 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, which act as blockages in the Tule Canal when the gates are closed, may result in increased predation of juvenile salmonids by piscivorous fish under Alternative 4 relative to Existing Conditions. The water control structures and bypass channels also may provide improved opportunity for marine mammals and river otters to prey on juvenile salmonids. The potential for poaching of adult fish near the water control structures and within the bypass channels also could increase under Alternative 4 relative to Existing Conditions due to the potential migratory delay or impedance caused by the water control structures and bypass channels.

CEQA Conclusion

The potential for predation of fish species of focused evaluation, such as juvenile salmonids, may increase relative to predation rates under Existing Conditions; therefore, Alternative 4 would be expected to have a **significant and unavoidable impact** on predation. No known actions could be identified to reduce this impact to a less-than-significant level; the presence of the water control structures and bypass channels could increase predation rates of juvenile salmonids, which is a stressor to juvenile salmonids under Existing Conditions.

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 Alternatives 4a and 4b relative to Existing Conditions would be higher over the entire simulation period and by water year type for fall-run and spring-run Chinook salmon but are substantially higher during critical water years for fall-run Chinook salmon (Table 8-21). Simulated annual average adult Chinook salmon returns under Alternatives 4a and 4b relative to Existing Conditions would be similar over the entire simulation period and during all water year types for late fall-run and winter-run Chinook salmon.

The adult Chinook salmon returns probability of exceedance distributions for Alternatives 4a and 4b relative to Existing Conditions generally would be slightly higher over the entire distributions for fall-run Chinook salmon and would be similar for late fall-run, spring-run, and winter-run Chinook salmon (Figures 8-32 through 8-35).

Table 8-21. Average Annual Chinook Salmon Adult Returns under Alternatives 4a and 4b

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 4a	179,959	240,972	205,724	84,770	165,766	44,744
Existing Conditions	172,025	232,876	192,956	82,267	158,383	39,065
Difference	7,934	8,097	12,768	2,503	7,383	5,679
Percent Difference[3]	5	3	7	3	5	15
Alternative 4b	179,721	240,349	205,634	84,785	165,712	44,744
Existing Conditions	172,025	232,876	192,956	82,267	158,383	39,065
Difference	7,696	7,474	12,678	2,518	7,330	5,679
Percent Difference[3]	4	3	7	3	5	15
Late Fall-run Chinook Salmon						
Alternative 4a	57,744	59,571	67,635	19,706	61,541	79,821
Existing Conditions	58,390	60,218	68,937	19,914	61,780	81,012
Difference	-647	-647	-1,302	-208	-239	-1,191
Percent Difference[3]	-1	-1	-2	-1	0	-1
Alternative 4b	57,744	59,571	67,635	19,706	61,541	79,821
Existing Conditions	58,390	60,218	68,937	19,914	61,780	81,012
Difference	-647	-647	-1,302	-208	-239	-1,191
Percent Difference[3]	-1	-1	-2	-1	0	-1

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
Spring-run Chinook Salmon						
Alternative 4a	6,259	9,343	6,002	2,281	5,062	4,357
Existing Conditions	5,960	8,803	5,821	2,174	4,884	4,031
Difference	299	540	181	108	177	326
Percent Difference[3]	5	6	3	5	4	8
Alternative 4b	6,257	9,342	6,000	2,280	5,056	4,357
Existing Conditions	5,960	8,803	5,821	2,174	4,884	4,031
Difference	297	539	179	107	172	326
Percent Difference[3]	5	6	3	5	4	8
Winter-run Chinook Salmon						
Alternative 4a	5,617	5,690	5,571	5,353	6,301	3,188
Existing Conditions	5,518	5,504	5,558	5,334	6,197	3,118
Difference	99	186	13	19	104	70
Percent Difference[3]	2	3	0	0	2	2
Alternative 4b	5,617	5,690	5,571	5,354	6,300	3,188
Existing Conditions	5,518	5,504	5,558	5,334	6,197	3,118
Difference	99	186	13	20	102	70
Percent Difference[3]	2	3	0	0	2	2

[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

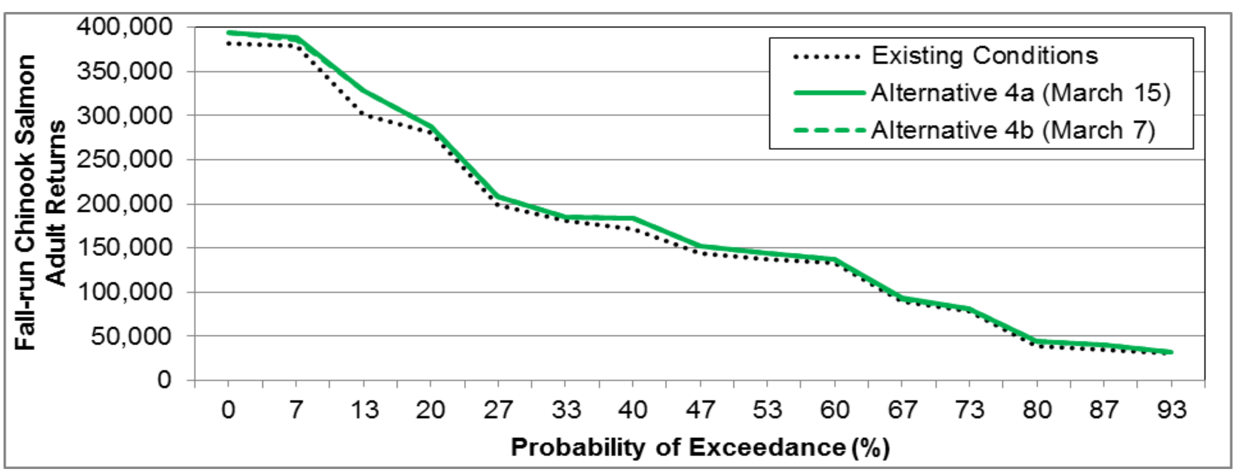

Figure 8-32. Simulated Adult Fall-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions

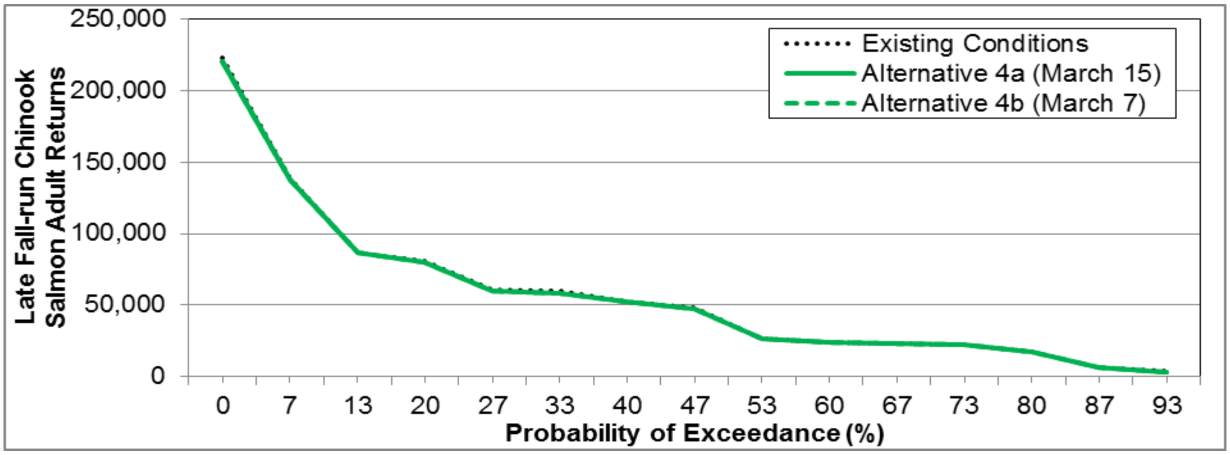

Figure 8-33. Simulated Adult Late Fall-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions

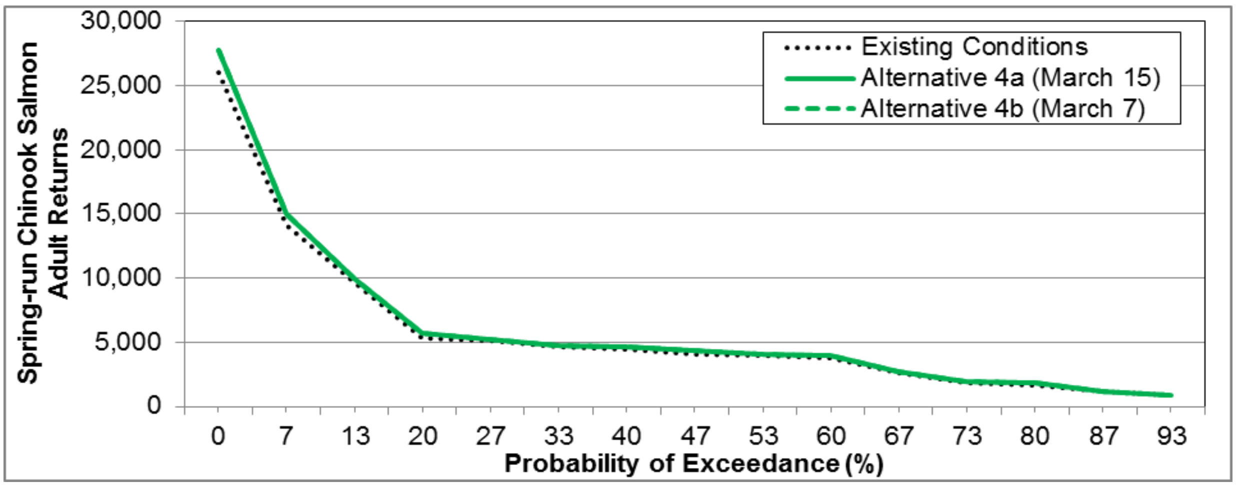

Figure 8-34. Simulated Adult Spring-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions

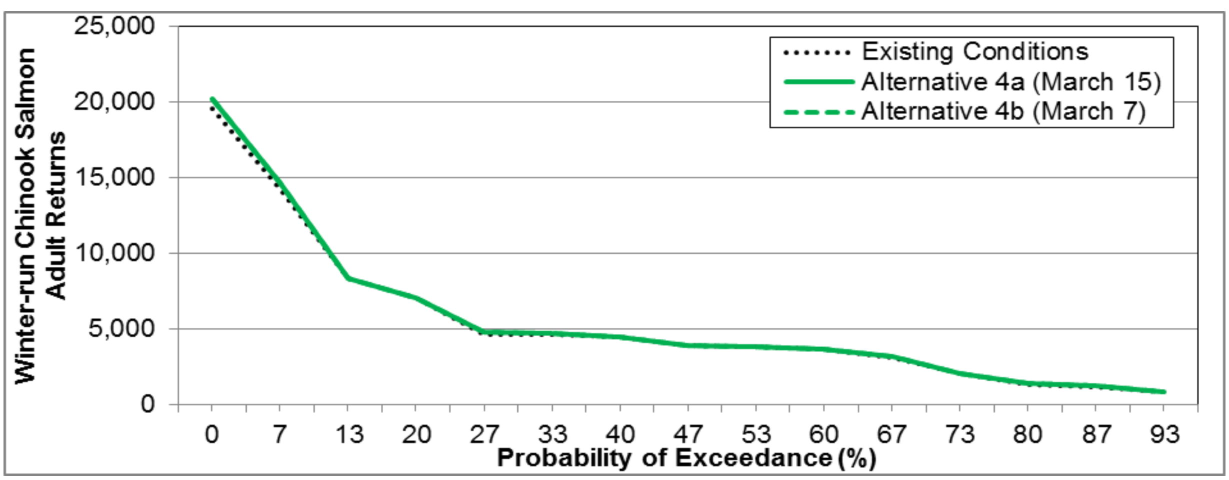

Figure 8-35. Simulated Adult Winter-run Chinook Salmon Returns Probability of Exceedance Distributions under Alternatives 4a and 4b and Existing Conditions

Diversity

VARIATION IN JUVENILE CHINOOK SALMON SIZE

Modeling results indicate that annual average juvenile Chinook salmon coefficient of variation in size (FL) under Alternatives 4a and 4b 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 8-22).

Similarly, the juvenile Chinook salmon coefficient of variation in size probability of exceedance distributions for Alternatives 4a and 4b relative to Existing Conditions would be higher over most or all of the entire distributions for fall-run, spring-run, and winter-run Chinook salmon and would be similar for late fall-run Chinook salmon (Figures 8-36 through 8-39).

Table 8-22. Average Annual Juvenile Coefficient of Variation in Size under Alternatives 4a and 4b

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 4a	0.41	0.46	0.40	0.39	0.39	0.37
Existing Conditions	0.35	0.44	0.32	0.35	0.31	0.13
Difference	0.06	0.02	0.08	0.03	0.08	0.24
Percent Difference[3]	18	4	25	9	27	184
Alternative 4b	0.41	0.46	0.40	0.38	0.39	0.37
Existing Condition	0.35	0.44	0.32	0.35	0.31	0.13
Difference	0.06	0.02	0.08	0.03	0.08	0.24
Percent Difference[3]	18	4	25	9	27	184
Late Fall-run Chinook Salmon						
Alternative 4a	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
Difference	0.00	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	0	0	0	0	0	0
Alternative 4b	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
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 4a	0.34	0.44	0.33	0.32	0.26	0.28
Existing Conditions	0.30	0.42	0.30	0.26	0.22	0.18
Difference	0.04	0.03	0.04	0.06	0.04	0.10

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
Percent Difference[3]	14	7	12	25	16	58
Alternative 4b	0.34	0.44	0.33	0.32	0.26	0.28
Existing Conditions	0.30	0.42	0.30	0.26	0.22	0.18
Difference	0.04	0.03	0.04	0.06	0.04	0.10
Percent Difference[3]	14	7	12	25	16	58
Winter-run Chinook Salmon						
Alternative 4a	0.16	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	0.02	0.02	0.02	0.02	0.03
Percent Difference[3]	15	11	20	10	21	55
Alternative 4b	0.16	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	0.02	0.02	0.02	0.02	0.03
Percent Difference[3]	15	11	20	10	20	55

[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

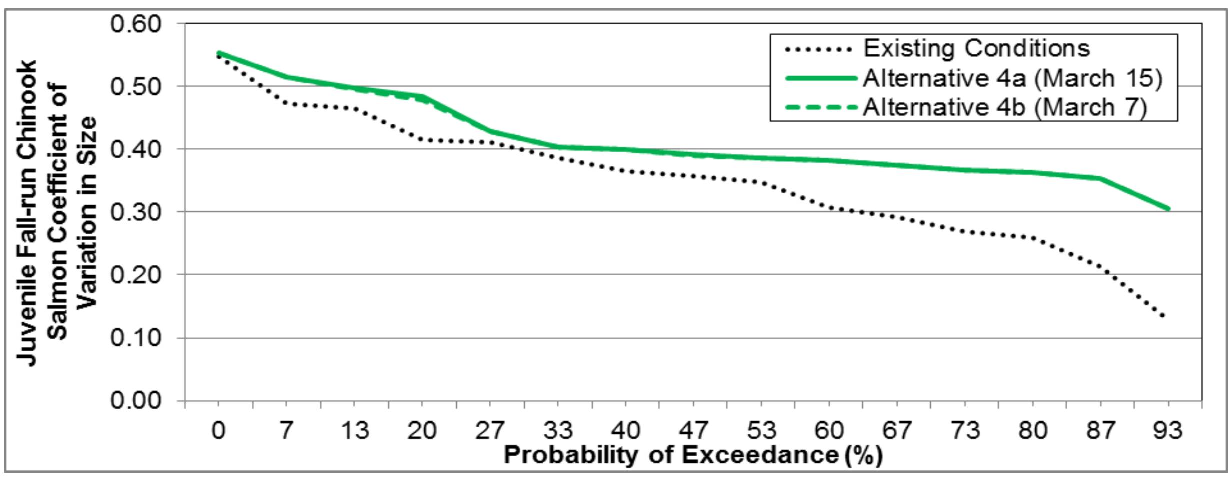

Figure 8-36. Simulated Juvenile Fall-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 4 and Existing Conditions

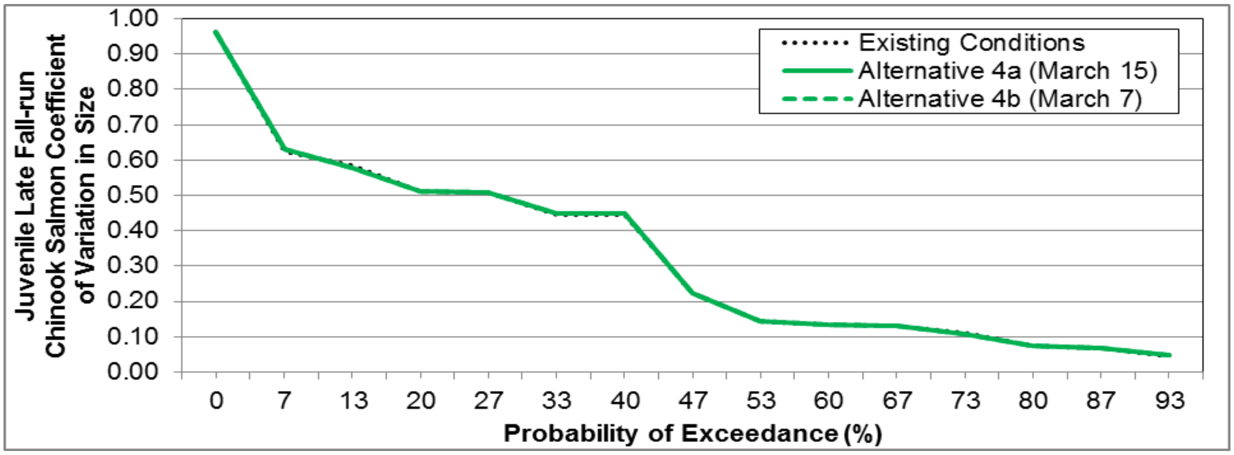

Figure 8-37. Simulated Juvenile Late Fall-run Chinook Salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 4 and Existing Conditions

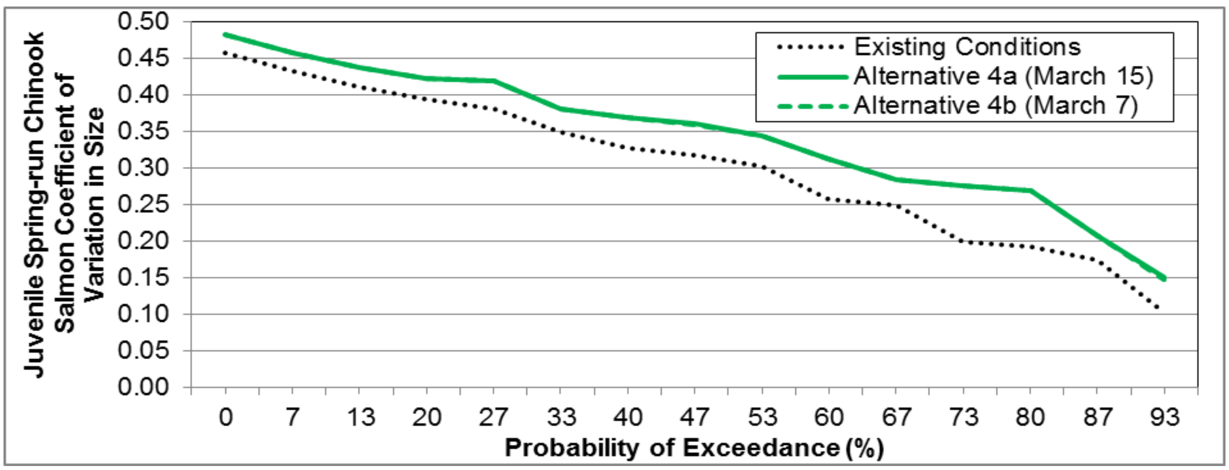

Figure 8-38. Simulated Juvenile Spring-run Chinook salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 4 and Existing Conditions

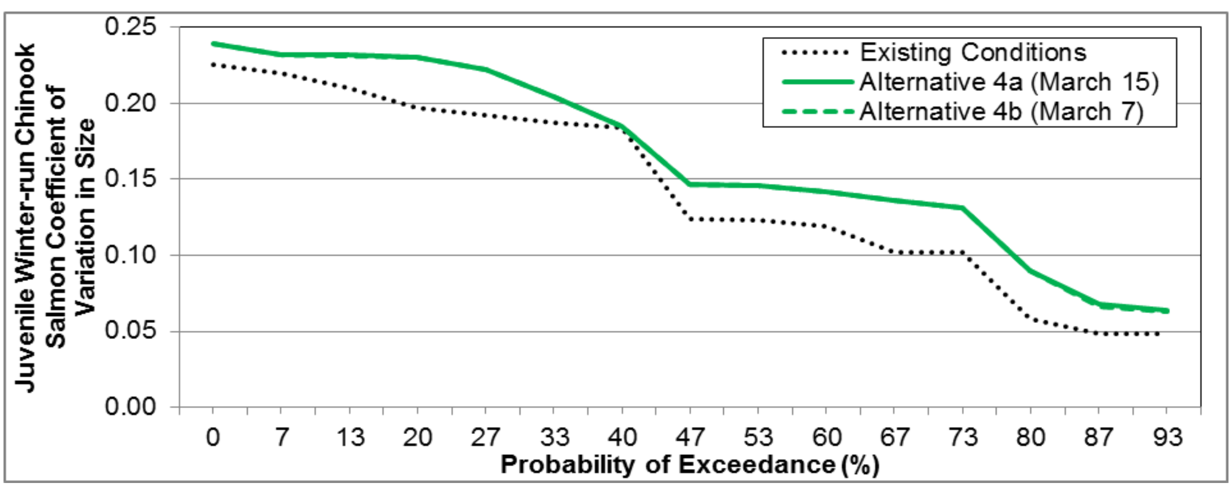

Figure 8-39. Simulated Juvenile Winter-run Chinook Salmon Coefficient of Variation in Size Probability of Exceedance Distributions under Alternative 4 and Existing Conditions

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 4 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 8-23). Annual average juvenile Chinook salmon coefficient of variation in estuary entry timing under Alternative 4 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 4 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 8-40 through 8-43).

Table 8-23. Average Annual Juvenile Chinook Salmon Coefficient of Variation in Estuary Entry Timing under Alternative 4

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 4a	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	0.04
Percent Difference[3]	5	0	8	1	10	27
Alternative 4b	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	0.04
Percent Difference[3]	5	0	8	1	10	27
Late Fall-run Chinook Salmon						
Alternative 4a	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	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	0	-1	-1	0	0	-1
Alternative 4b	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	0.00	0.00	0.00	0.00	0.00
Percent Difference[3]	0	-1	-1	0	0	-1

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
Spring-run Chinook Salmon						
Alternative 4a	0.30	0.39	0.28	0.27	0.24	0.21
Existing Conditions	0.29	0.38	0.28	0.26	0.23	0.18
Difference	0.01	0.00	0.01	0.01	0.01	0.02
Percent Difference[3]	3	1	2	6	3	13
Alternative 4b	0.30	0.39	0.28	0.27	0.24	0.21
Existing Conditions	0.29	0.38	0.28	0.26	0.23	0.18
Difference	0.01	0.00	0.01	0.01	0.01	0.02
Percent Difference[3]	2	1	2	5	2	13
Winter-run Chinook Salmon						
Alternative 4a	0.28	0.38	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	0.00	0.01
Percent Difference[3]	2	1	3	2	2	6
Alternative 4b	0.28	0.38	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	0.00	0.01
Percent Difference[3]	2	1	3	2	2	6

[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

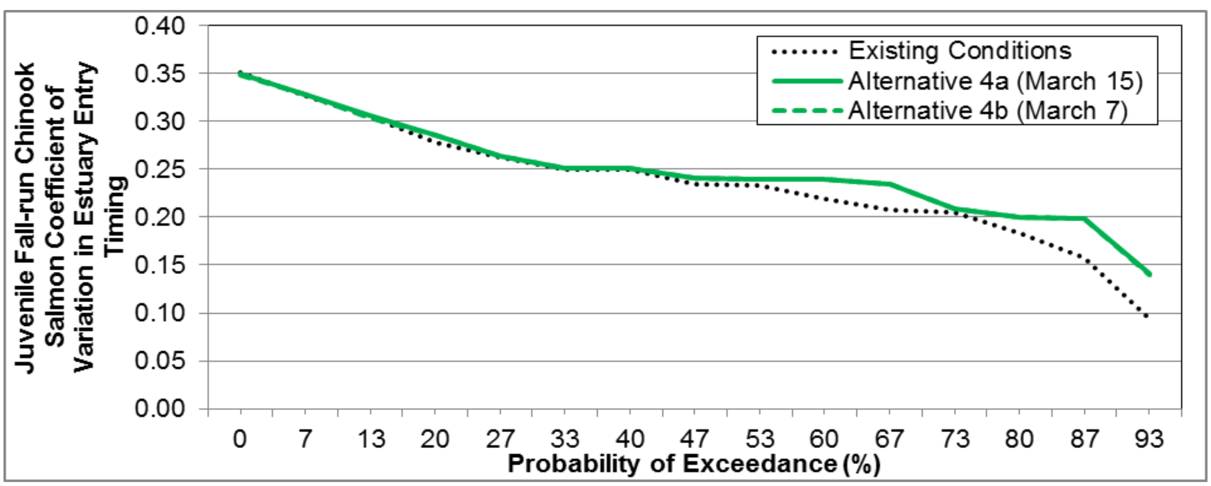

Figure 8-40. Simulated Juvenile Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under Alternative 4

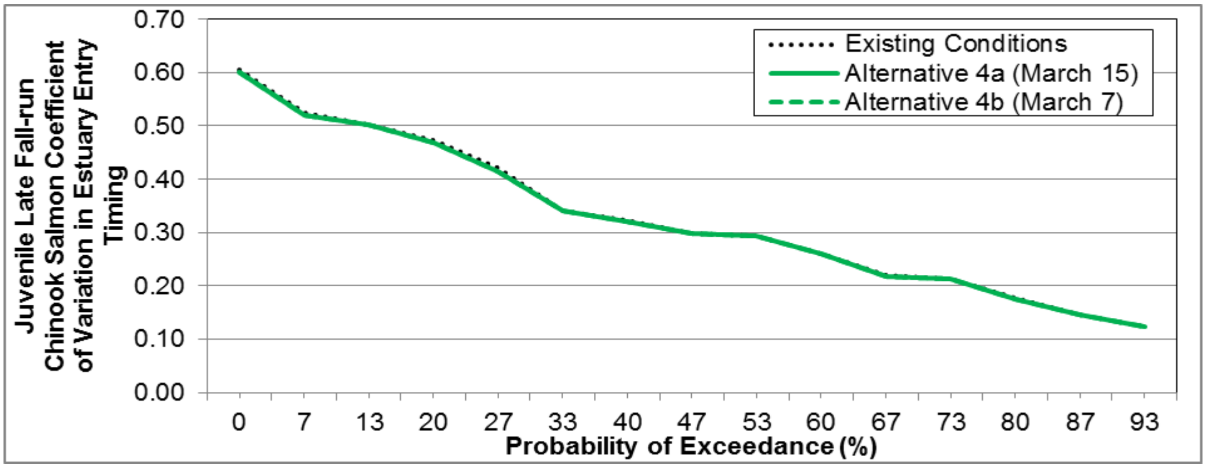

Figure 8-41. Simulated Juvenile Late Fall-run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under Alternative 4

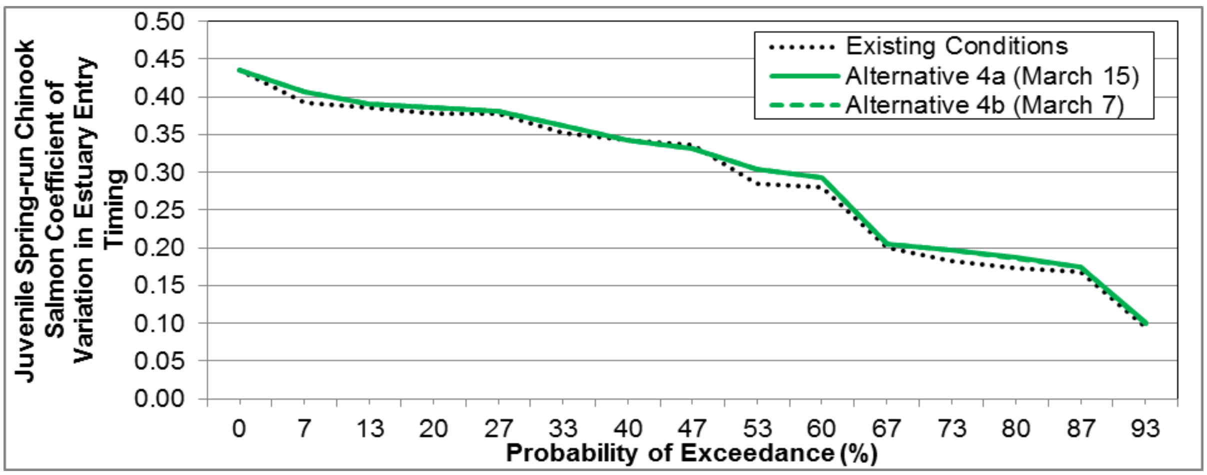

Figure 8-42. Simulated Juvenile Spring-Run Chinook Salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under Alternative 4

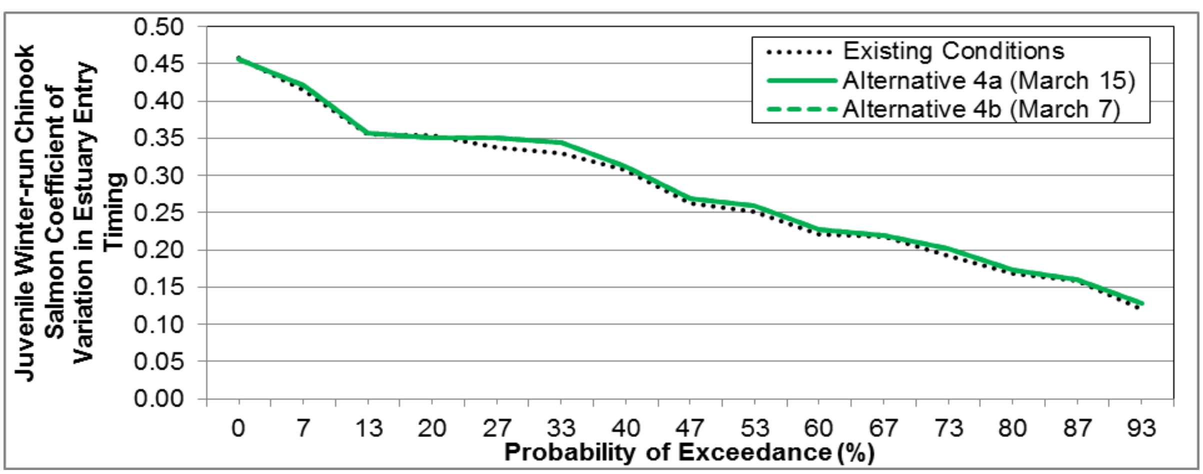

Figure 8-43. Simulated Juvenile Winter-run Chinook salmon Coefficient of Variation in Estuary Entry Timing Probability of Exceedance Distributions under Alternative 4

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 4 relative to Existing Conditions would be higher from November through March and would be similar over the remainder of the year (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 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 4 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 13, 5.2, 9.5, and 8.4 percent under Alternative 4, 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 13.6, 1.1, 5.9, and 8.9 percent, respectively (DWR 2017a; Appendix G3).

The ELAM modeling indicates that the entrainment-Sacramento River stage relationship under Alternative 4 exhibits a positive relationship as Sacramento River stage increases from 22.32 to 27 ft. The percent of juveniles entrained peaks at about seven percent at a stage of 27 ft and decreases to about five percent at the highest stage modeled (28.83 ft) (Smith et al. 2017; Appendix G1).

The critical streakline analysis for Alternative 4 (critical streakline scenario 2) found that the percentage of the total annual abundance of juveniles entrained by run over the entire simulation period would be about nine percent for fall-run Chinook salmon, four percent for late fall-run Chinook salmon, seven percent for winter-run Chinook salmon, and seven percent for spring-run Chinook salmon.

The entrainment modeling results indicate that the critical streakline analysis-predicted average annual entrainment rates would be about four percent lower for fall-run, one percent lower for late fall-run, 2.5 percent lower for winter-run, and one percent lower for spring-run Chinook salmon relative to the proportion of flow approach estimates (for all sizes of juveniles) for Alternative 4. 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 4 may be less 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 Alternatives 4a and 4b relative to Existing Conditions would be substantially higher over the entire simulation period and during all water year types for fall-run, spring-run, and winter-run Chinook salmon and substantially higher over the entire simulation period and during all water year types except for critical water years for late fall-run Chinook salmon (Table 8-24).

The annual number of juvenile Chinook salmon rearing for one or more days in the Yolo Bypass probability of exceedance distributions for Alternatives 4a and 4b relative to Existing Conditions would be higher over the entire distributions for fall-run Chinook salmon, higher over most of the distributions for late fall-run Chinook salmon, and substantially higher over the entire distributions for spring-run and winter-run Chinook salmon (Figures 8-44 through 8-47). In addition, Alternatives 4a and 4b would provide for rearing on the Yolo Bypass over about 20 percent of the distributions when no juvenile fall-run Chinook salmon would be rearing in the Yolo Bypass and over about 30 percent of the distributions when no juvenile late fall-run, spring-run, and winter-run Chinook salmon rearing would occur in the Yolo Bypass under Existing Conditions.

Table 8-24. Average Annual Number of Juvenile Chinook Salmon that Reared in the Yolo Bypass for One or More Days

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 4a	4,265,025	9,137,640	4,094,586	834,982	923,737	638,512
Existing Conditions	3,179,250	8,028,286	2,198,294	436,145	20,038	0
Difference	1,085,775	1,109,354	1,896,292	398,838	903,700	638,512
Percent Difference[3]	34	14	86	91	4,510	n/a
Alternative 4b	4,231,370	9,044,105	4,096,970	831,294	914,504	638,512
Existing Conditions	3,179,250	8,028,286	2,198,294	436,145	20,038	0
Difference	1,052,120	1,015,819	1,898,676	395,150	894,466	638,512
Percent Difference[3]	33	13	86	91	4,464	n/a
Late Fall-run Chinook Salmon						
Alternative 4a	235,343	654,318	44,290	14,894	23,973	0
Existing Conditions	190,830	571,919	953	0	0	0
Difference	44,512	82,399	43,336	14,894	23,973	0
Percent Difference[3]	23	14	4,546	n/a	n/a	n/a
Alternative 4b	235,348	654,334	44,291	14,894	23,973	0
Existing Conditions	190,830	571,919	953	0	0	0
Difference	44,518	82,416	43,337	14,894	23,973	0
Percent Difference[3]	23	14	4,546	n/a	n/a	n/a

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
Spring-run Chinook Salmon						
Alternative 4a	75,020	149,586	70,133	16,564	23,793	38,668
Existing Conditions	32,657	72,311	41,409	1,894	70	0
Difference	42,363	77,275	28,724	14,671	23,723	38,668
Percent Difference[3]	130	107	69	775	33,769	n/a
Alternative 4b	74,738	149,487	70,172	16,343	22,943	38,668
Existing Conditions	32,657	72,311	41,409	1,894	70	0
Difference	42,082	77,176	28,763	14,450	22,873	38,668
Percent Difference[3]	129	107	69	763	32,559	n/a
Winter-run Chinook Salmon						
Alternative 4a	57,512	93,169	76,158	22,429	26,186	18,765
Existing Conditions	28,031	54,261	46,976	3,552	283	0
Difference	29,481	38,908	29,182	18,877	25,903	18,765
Percent Difference[3]	105	72	62	532	9,145	n/a
Alternative 4b	57,287	93,072	76,121	22,322	25,544	18,765
Existing Conditions	28,031	54,261	46,976	3,552	283	0
Difference	29,256	38,811	29,145	18,770	25,261	18,765
Percent Difference[3]	104	72	62	529	8,918	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

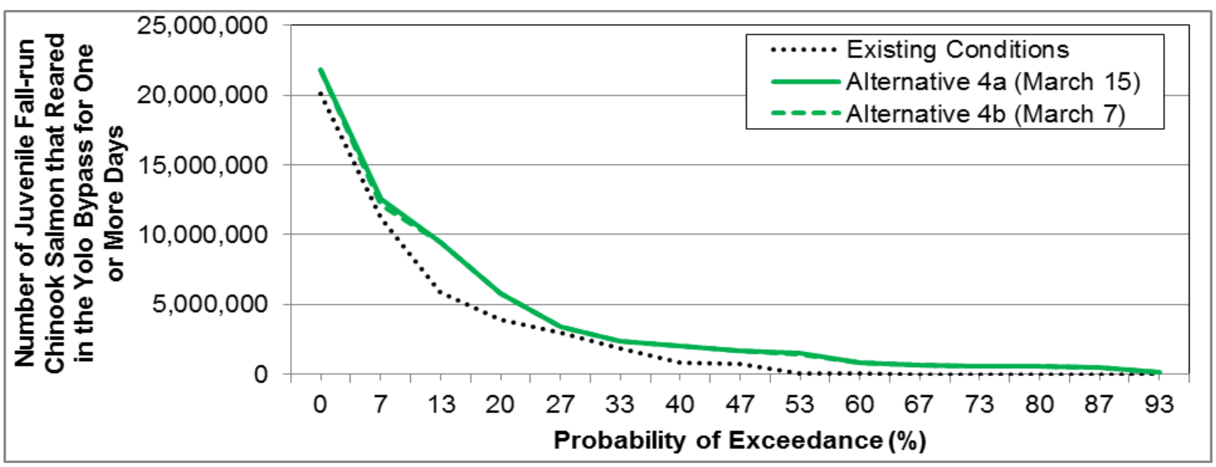

Figure 8-44. Simulated Number of Juvenile Fall-run Chinook Salmon Rearing for One or More Days in the Yolo Bypass Exceedance Distributions under Alternative 4

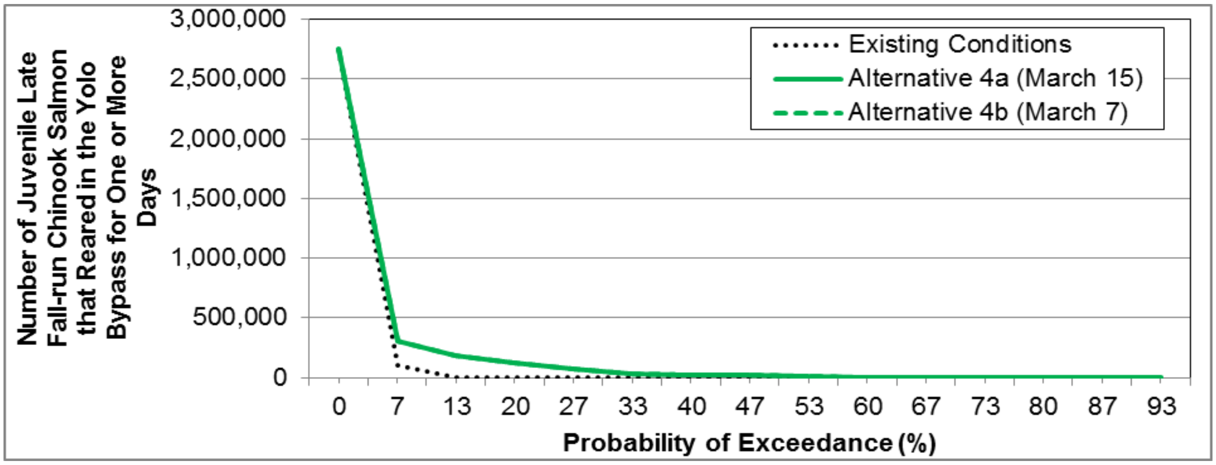

Figure 8-45. Simulated Number of Juvenile Late Fall-run Chinook Salmon Rearing for One or More Days in the Yolo Bypass Exceedance Distributions under Alternative 4

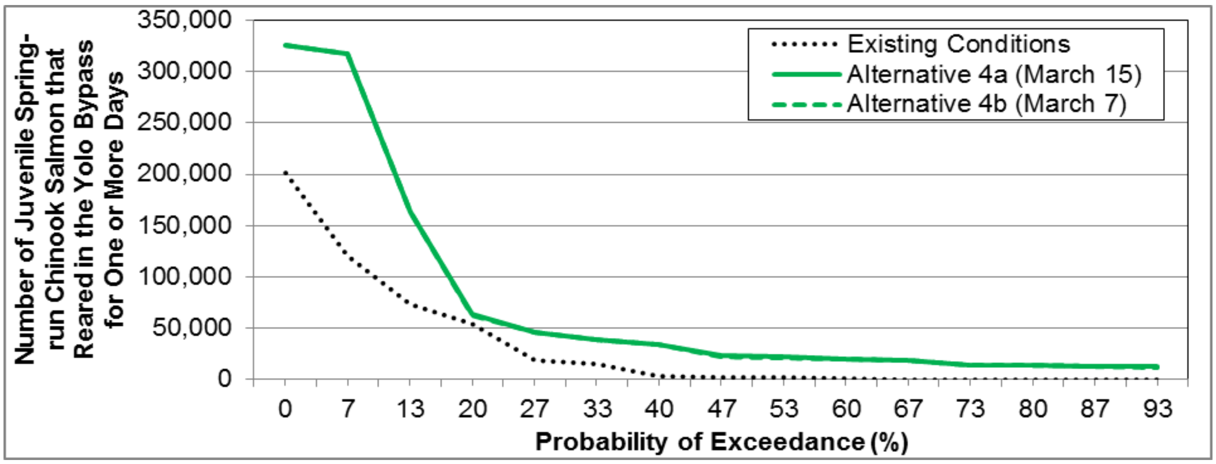

Figure 8-46. Simulated Number of Juvenile Spring-run Chinook Salmon Rearing for one or more days in the Yolo Bypass Exceedance Distributions under Alternative 4

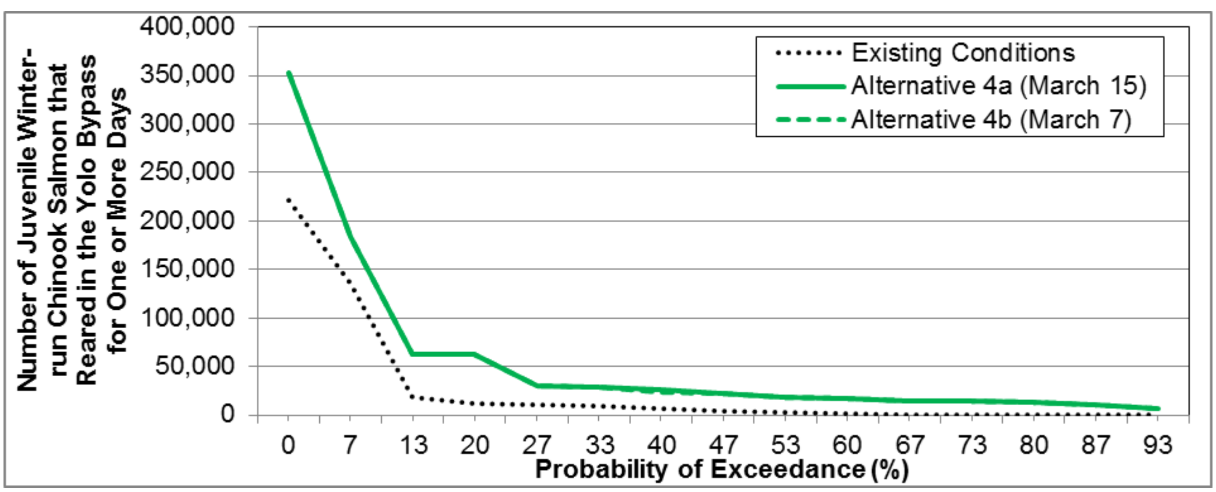

Figure 8-47. Simulated Number of Juvenile Winter-run Chinook Salmon Rearing for One or More Days in the Yolo Bypass Exceedance Distributions under Alternative 4

CEQA Conclusion

Simulated population metric indicators from the SBM were used to evaluate changes in the VSP parameters under Alternatives 4a and 4b 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 4 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 Alternatives 4a and 4b relative to Existing Conditions.

Therefore, Alternative 4 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

Changes in simulated mean monthly storages in the SWP/CVP system under Alternative 4 relative to the basis of comparison would be similar to those described for Alternative 1. Therefore, simulated changes under Alternative 4 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 4 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, which could indirectly benefit fish resources (Yolo Habitat Conservancy 2017). Because Alternative 4 would include mitigation for physical habitat impacts, Alternative 4 would not conflict with HCPs or NCCPs, including the Yolo County HCP/NCCP (Yolo Habitat Conservancy 2017).

CEQA Conclusion

Alternative 4 is expected to have a **less than significant impact** on habitat conservation plans.

8.3.3.6 Alternative 5: Central Multiple Gated Notches

Alternative 5, Central Multiple Gated Notches, would improve the capture of fish through using multiple gates and intake channels so that the deeper gate could allow more flow to enter the bypass when the river is at lower elevations. Flows would move to other gates when the river is higher to control inflows. Alternative 5 incorporates multiple gated notches in the central location on the existing Fremont Weir that would convey combined flows of up to 3,400 cfs. In addition, because hydraulic conditions upstream of the proposed Fremont Weir notch are not favorable to entraining juvenile Chinook salmon, Alternative 5 includes Sacramento River channel and bank improvements. These improvements include removing pilings in the Sacramento River and re-grading the Sacramento River channel and right bank. These improvements also are expected to fill in a scour hole near the pilings. See Section 2.8 for more details on the alternative features.

8.3.3.6.1 Construction- and Maintenance-related Impacts – Evaluation of Substantial Adverse Effects on Fish Species of Focused Evaluation and their Habitat and Movement

By contrast to the other alternatives, construction of Alternative 5 would likely begin in late 2020 or early 2021 and continue for two seasons. Construction in the first year is estimated to last 28 weeks and would be conducted during the non-flood season of April 15 through November 1. Construction efforts would continue for 13 weeks during the following year after April 15. Construction- and maintenance-related activities evaluated for Alternative 5 are similar to those described for Alternative 2. As described for Alternative 2, Alternative 5 also includes in-river activities just upstream of the proposed Fremont Weir notch. Activities include removing instream piles and re-grading the Sacramento River channel and right bank. In addition, future maintenance may be necessary to maintain the re-graded conditions in the Sacramento River channel and along the right bank to maintain hydraulic conditions that promote entrainment of juvenile Chinook salmon into the Fremont Weir notch.

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 5 are expected to be similar to those described for Alternative 1. However, substantially more excavation would occur in the Yolo Bypass under Alternative 5. As an indicator of the extent of excavation that would occur under Alternative 5 in the Yolo Bypass, the estimated excess amount of spoils to be excavated during construction would be about 4,615,000 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 5 is 18,900 CY. This corresponds to an estimated total annual amount of sediment removal required of 315,450 CY under Alternative 5 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 5 are expected to be similar to those described for Alternative 1. However, there likely would be increased potential for hazardous spills due to the extended construction period and additional excavation and construction activities relative to 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 5 are expected to be similar to those described for Alternative 1; however, more acreage of habitat would be affected under Alternative 5 due to more extensive grading and construction of multiple channels between the intake facilities and Tule Pond. In addition, under Alternative 5 only the upper portion of the outlet channels would be lined with rock revetment to promote the formation of meandering channels.

Preliminary estimates based on calculations in ArcGIS indicate that a total of 25.6 acres (temporary impacts) and 85.7 acres (permanent impacts) of vegetated area would have the potential to be disturbed during Alternative 5 construction activities. Specifically, 7.1 acres (temporary impacts) and 11.5 acres (permanent impacts) would be riparian, which would be a potential source of IWM inputs to the Sacramento River or Yolo Bypass (Table 8-25 and Figure 8-48). Table 8-25 does not include acreages for the Tule Canal floodplain improvements as these are being addressed only at a programmatic level in this EIS/EIR.

Table 8-25. Vegetation Communities Potentially Affected by Alternative 5

Vegetation Community					
	Grassland	**Freshwater Aquatic Vegetation**	**Freshwater Emergent Marsh**	**Riparian Forest/Woodland**	**Total**
Acres (Temporary)	17.9	0.1	0.5	7.1	25.6
Acres (Permanent)	66.7	2.6	4.9	11.5	85.7

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