CEQA Conclusion: Environmental Commitment 15 Localized Reduction of Predatory Fish is intended to reduce localized abundance of fish predators of salmonids in the Delta. Therefore there would be no impact on longfin smelt.

Impact AQUA-32: Effects of Nonphysical Fish Barriers on Longfin Smelt (Environmental Commitment 16)

Potential impacts on longfin smelt from the installation of an NPB at the divergence of Georgiana Slough from the Sacramento River are expected to be similar to those for delta smelt (see Impact AQUA-14), with even less potential for any effect because of even lower overlap of longfin smelt distribution with the proposed location of the NPB.

NEPA Effects: There would be no demonstrable effect of the NPB on longfin smelt because they are not likely to be in the area of the barrier and the potential for predation of longfin smelt around the barriers is low.

CEQA Conclusion: As discussed above, there would be no demonstrable effect of this conservation measure on longfin smelt. Consequently, the impact is less than significant and no mitigation would be required.

Winter-Run Chinook Salmon

Construction and Maintenance of Water Conveyance Facilities

The discussion of potential effects to delta smelt from construction and maintenance of the water conveyance facilities under Alternative 4A is also relevant to winter-run Chinook salmon because the same types of impact mechanisms would apply. However, adult and juvenile winter-run Chinook salmon would have somewhat greater potential to overlap construction and maintenance than delta smelt (Table 11-8).

Impact AQUA-37: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

The potential effects of construction of the water conveyance facilities on winter-run Chinook salmon would be the same as described for Alternative 4 (Impact AQUA-37). This section provides additional detail on underwater noise impacts which are also applicable to Impact AQUA-37 in Alternative 4.

Table 11-8 presents the life stages of the four runs of Chinook salmon and the months of their potential presence in the north, east, and south Delta during the proposed in-water construction period (June 1–October 31). Winter-run, spring-run, fall-run, and late fall–run Chinook salmon eggs and fry would not be exposed to underwater noise from pile driving activities because the proposed construction activities are located in areas that do not provide suitable habitat for these life stages or because these life stages would not be present during the proposed in-water construction period.

Under Alternative 4A, the potential for exposure of adult and juvenile winter-, spring-, and late fall-run Chinook salmon to pile driving noise is highest in the north Delta (Sacramento River in the vicinity of the three proposed intakes) which serves as the primary migration route utilized by adults to access upstream spawning areas, and the primary migration route for juveniles entering the Delta and estuary from upstream spawning and rearing areas. Restricting in-water pile driving to June 1 to October 31 avoids the peak migration periods of winter-, spring-, and late fall-run adults and juveniles. Some overlap with winter-run and spring-run adults may occur at the end of the migration season in June or July, and with late fall-run adults at the beginning of the migration season in October. Adult fall-run Chinook salmon, which migrate through the north, east, and south Delta on their way to upstream spawning areas in the Sacramento, San Joaquin, and east Delta tributaries, may be present in the vicinity of the intake structures and barge unloading facilities during in-water pile driving activities from August through October. Most juvenile Chinook salmon occur in the Delta from late fall through spring (November through May) although some fall- and spring-run smolts may encounter pile driving noise at the end of the outmigration season in June.

To minimize potential adverse effects when adult and juvenile salmon may be present, DWR proposes to use vibratory driving to the extent feasible to minimize both the area and duration of potentially harmful underwater noise levels associated with impact driving in open water. In addition, construction of the intake facilities would be spread out over a period of five years, limiting the number of sites and duration of pile driving encountered by adults and juveniles in any given year (Table 4.3.7-1 under Delta Smelt). Although pile driving activities could occur 42 to 55 days per season at each intake location, in-water pile driving will not be continuous and limited to daylight hours only, resulting in 12-16 hour periods each day for migrating fish to pass the construction sites undisturbed.

It is unlikely that pile driving sounds will cause injury or mortality of adult salmon based on the large size, mobility, and anticipated behavior during their migration through the affected areas. Adult Chinook salmon are large (typically 9–10 kilograms) and presumably much less vulnerable to pile driving noise than smaller fish targeted for protection by the SPL and SEL injury criteria (approximately 2 grams or smaller). In addition, migrating adult salmon are expected to readily avoid or swim away from areas of elevated noise. Similar pile driving operations indicate that single-strike peak SPLs and SELs exceeding the injury criteria would be limited to small areas immediately adjacent to source piles (<33–46 feet) and thus would affect only a small portion of the total channel width available for adults to pass (Table 4.3.7-1 under Delta Smelt). However, the potential for injury still exists because migrating adults would be faced with passing through larger channel reaches (spanning the entire channel width at most locations) subject to noise levels exceeding the cumulative thresholds for >2-gram fish (187 dB SEL). The potential for injury is considered low due to the large size of adults and rapid migration rates to upstream holding and spawning areas. While limited evidence suggests that pile driving operations may disrupt normal migratory behavior in salmonids (Feist et al. 1992), any delays in migration are expected to be minor because of the intermittent nature of pile driving and the daily cessation of pile driving at night.

Juvenile salmon are at higher risk of injury and mortality than adults because of their small size. However, the June 1 through October 31 pile driving period will avoid the primary juvenile outmigration period for all runs of Chinook salmon (November through May), and thus minimize the potential for adverse effects. Most juvenile Chinook salmon migrating through the Delta after June 1 or before October 31 are large, actively migrating smolts (> 2 grams) that are known to move rapidly through the Delta and estuary during their seaward migration (Williams 2006). These larger juveniles may be exposed to noise levels exceeding the injury thresholds for >2-gram fish (187 dB SEL) as they pass through the affected channel reaches. However, exposure is expected to be limited by their rapid migration rate and opportunities to pass the affected reaches at night after daily pile driving operations have ceased. In general, downstream movement of juvenile Chinook salmon occurs mainly at night or during the hours between dusk and dawn, limiting exposure of juveniles to pile driving noise to daylight hours; for example, Chapman et al. (2013) found that late fall-run Chinook salmon migrating through the Delta were ~70% nocturnal. For winter-run Chinook salmon, juveniles migrating in October may be smaller individuals < 60 mm, which would be more susceptible to pile-driving noise, but the proportion of all juveniles occurring in October is very small; the main migration into the Delta typically begins in November or December (del Rosario et al. 2013), outside the pile driving period. As discussed above, limited evidence suggests that pile driving noise may disrupt normal migratory behavior in salmonids. For juveniles, these behavioral effects may include responses that disrupt normal feeding, resting, and sheltering behavior, resulting in potential adverse effects on growth and survival (e.g., increased vulnerability to predation). Thus, pile driving activities could lead to indirect mortality if juveniles are exposed to a range of noise levels that could cause behavioral effects.

Based on the foregoing analysis, the potential exists for some injury and mortality of juvenile Chinook salmon from pile driving noise but only a small proportion of the population is at risk based on the low degree of overlap of pile driving activities with outmigration timing, and the relatively large size and mobility of juveniles that may encounter pile driving noise (migrating smolts). Implementation of Mitigation Measures AQUA-1a and AQUA-1b will further reduce this risk.

NEPA Effects: As concluded for Alternative 4, Impact AQUA-37, the effect would not be adverse for winter-run Chinook salmon. Implementation of the measures described in Appendix 3B, *Environmental Commitments*, such as *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan* would guide rapid and effective response in the case of inadvertent spills of hazardous materials. This species' natural tolerance to turbidity, would likely avoid the risk of any adverse turbidity effects resulting from project construction. Construction would not be expected to increase predation rates relative to baseline conditions. Construction will result in both temporary and permanent alteration of rearing and migratory habitats used by Chinook salmon. However, Alternative 4A includes Environmental Commitment 4 to restore tidal habitat and Environmental Commitment 6 to restore channel margin habitat. The direct effects of underwater construction noise on Chinook salmon that may be present could be adverse if Chinook salmon are exposed. However, implementation of Mitigation Measures AQUA-1a and AQUA-1b, combined with the in-water work window that would minimize exposure, would reduce the potential for effects from underwater noise and this effect would not be adverse.

CEQA Conclusion: As described in Alternative 4, Impact AQUA-37, the impact of the construction of water conveyance facilities on winter-run Chinook salmon would not be significant except for construction noise associated with pile driving. Construction of Alternative 4A involves several elements with the potential to affect winter-run Chinook salmon. However, these turbidity and hazardous material spill effects will be effectively avoided and/or minimized through implementation of environmental commitments (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment, and Countermeasure Plan; Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; *Fish Rescue and Salvage Plan*; and *Barge Operations Plan*). Implementation of Mitigation Measures AQUA-1a and AQUA-1b would reduce that noise impact to less than significant.

Mitigation Measure AQUA-1a: Minimize the Use of Impact Pile Driving to Address Effects of Pile Driving and Other Construction-Related Underwater Noise

Mitigation Measure AQUA-1b: Monitor Underwater Noise and if Necessary, Use an Attenuation Device to Reduce Effects of Pile Driving and Other Construction-Related Underwater Noise

Impact AQUA-38: Effects of Maintenance of Water Conveyance Facilities on Chinook Salmon (Winter-Run ESU)

NEPA Effects: Once constructed, Alternative 4A structures and facilities will require ongoing periodic maintenance that includes in-water work activities with the potential to affect Chinook salmon. These activities include periodic cleaning and replacement of screens, trash racks, and associated machinery and dredging to maintain intake capacity. These activities will produce disturbance and underwater noise, and may generate turbidity or other water quality effects. In general, the likelihood of adverse effects on Chinook salmon from maintenance activities would be avoided and minimized through the same methods and rationale described for Impact AQUA-1. The potential effects of water conveyance facilities maintenance under Alternative 4A would be similar to those described for Alternative 4, Impact AQUA-38. As concluded in Alternative 4, Impact AQUA-38, the impact would not be adverse for winter-run Chinook salmon.

CEQA Conclusion: Once constructed, Alternative 4A structures and facilities will require ongoing periodic maintenance that includes in-water work activities with the potential to affect delta smelt. These activities include periodic cleaning and replacement of screens, trash racks, and associated machinery and dredging to maintain intake capacity. These activities will produce disturbance and underwater noise, and may generate turbidity or other water quality effects. In general, the likelihood of adverse effects on delta smelt from maintenance activities would be avoided and minimized through the same methods and rationale described for Impact AQUA-1. As described in Alternative 4, Impact AQUA-38, the impact of the maintenance of water conveyance facilities on Chinook salmon would be less than significant and no mitigation is required.

Operations of Water Conveyance Facilities

Impact AQUA-39: Effects of Water Operations on Entrainment of Chinook Salmon (Winter-Run ESU)

Water Exports from SWP/CVP South Delta Facilities

The proportion of juvenile winter-run Chinook salmon subject to entrainment is low under Existing Conditions and NAA_ELT (annual index of abundance average 1.4%) and Alternative 4A would further reduce entrainment of juvenile winter-run Chinook salmon at the south Delta facilities. For example, Scenario H3_ELT would reduce the proportion of juvenile winter-run Chinook entrained in the south Delta export facilities (average of 0.6%). As such, average entrainment under Scenario H3_ELT would be reduced by 54% (~3,800 fish[2]: Table 11-4A-10) across all water years compared

[2] As noted for longfin smelt, although the salvage-density method gives estimates of entrainment loss or salvage in numbers of fish and there are a number of factors included in the calculations such as multipliers applied for prescreen loss and normalization to population size, it is most appropriate to view the results comparatively, i.e., to compare relative differences between scenarios as opposed to examining the estimates of total number of fish lost

to NAA_ELT. Entrainment would be substantially reduced in wet and above normal water year types (65–72% less than NAA_ELT) and would be moderately reduced in below normal, dry, and critical water year types (14–44% less than NAA_ELT).

Scenario H4_ELT would be expected to have similar or slightly lower entrainment of winter-run Chinook salmon as Scenario H3_ELT because south Delta exports during the spring (March–May) under H4_ELT would be less compared to H3_ELT.

Table 11-4A-10. Juvenile Winter-Run Chinook Salmon Annual Entrainment Index at the SWP and CVP Salvage Facilities—Differences between Model Scenarios for Alternative 4A (Scenario H3_ELT)

	Absolute Difference (Percent Difference)	
Water Year	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-7,947 (-70%)	-8,670 (-72%)
Above Normal	-4,246 (-64%)	-4,396 (-65%)
Below Normal	-3,044 (-42%)	-3,230 (-44%)
Dry	-928 (-24%)	-793 (-22%)
Critical	-260 (-21%)	-170 (-14%)
All Years	-3,625 (-53%)	-3,773 (-54%)

Note:
Estimated annual number of fish lost, based on normalized data.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Water Exports from SWP/CVP North Delta Intake Facilities

As noted for Alternative 4, the effect of Alternative 4A on entrainment and impingement at the north Delta intakes would be the same as described for Alternative 1A (Impact AQUA-39), but the degree would be less because Alternative 4A would have fewer intakes. State-of-the-art[3] fish screens operated with an adaptive management plan would be expected to eliminate entrainment and impingement risk for juvenile winter-run Chinook salmon. Biologically-based triggers to minimize effects on salmonids and sturgeon during their migration past the intakes are being developed through the ESA consultation process.

Predation Associated with Entrainment

Entrainment-related predation loss of winter-run Chinook salmon at the south Delta facilities under this alternative would be no greater than loss under NAA_ELT and may be lower than loss under NAA_ELT due to a decrease in entrainment loss. Entrainment-related predation losses at the south

to entrainment or salvaged. In essence, the salvage-density method provides an entrainment index that reflects export pumping weighted by each covered species' seasonal pattern of abundance in the Plan Area, as reflected by historical salvage data. This same caveat applies to the other salmonids, the sturgeons, and the lampreys, which all use the salvage-density method.

[3] The fish screens would be state of the art by incorporating the best available technology and operating to fishery agency standards of protection for fishes. The features of the fish screens are described in more detail in Section 3.6.1.1 of Chapter 3, Description of Alternatives.

Delta under Scenario H4_ELT may be similar or slightly lower than under Scenario H3_ELT as spring outflow is increased and south Delta exports are decreased under Scenario H4_ELT.

Predation at the north Delta would be increased due to the installation of the proposed SWP/CVP North Delta intake facilities on the Sacramento River. Bioenergetics modeling with a median predator density predicts increased predation loss of about 4,200 juveniles, or 0.16% of the winter-run Chinook salmon juvenile index of abundance under Alternative 4A (Table 11-4A-11). Note that this estimate does not provide context to the level of predation in this reach that would occur without implementation of Alternative 4A. See additional discussion under Impact AQUA-42.

Table 11-4A-11. Winter-Run Chinook Salmon Predation Loss at the Proposed North Delta Diversion (NDD) Intakes (Three Intakes for Alternative 4A)

Striped Bass at NDD (Three Intakes)			Winter-Run Chinook Consumed	
Density Assumption	Bass per 1,000 Feet of Intake	Total Number of Bass	Number	Percentage of Annual Juvenile Production Entering the Delta[1]
Low	18	86	633	0.02%
Median	119	571	4,182	0.16%
High	219	1,051	7,696	0.30%

Note: Based on bioenergetics modeling of Chinook salmon consumption by striped bass (*BDCP Effects Analysis*, Appendix 5F Biological Stressors, hereby incorporated by reference).

[1] Estimated as 2.6 million juveniles. See Section 5.F.3.2.1 in *BDCP Effects Analysis*, Appendix 5F Biological Stressors, hereby incorporated by reference.

NEPA Effects: In conclusion, Alternative 4A would reduce overall entrainment and associated predation losses of juvenile winter-run Chinook salmon relative to NAA_ELT. This effect would not be adverse and would provide a benefit to the species because of the reductions in entrainment loss and mortality.

CEQA Conclusion: As described above, entrainment and associated predation losses of juvenile winter-run Chinook salmon at the south Delta facilities would decrease under Alternative 4A compared to Existing Conditions (Table 11-4A-10). Overall, impacts of water operations on entrainment of juvenile Chinook salmon (winter-run ESU) would be less than significant and may be beneficial. No mitigation would be required.

Impact AQUA-40: Effects of Water Operations on Spawning and Egg Incubation Habitat for Chinook Salmon (Winter-Run ESU)

In general, the effects of Alternative 4A on spawning and egg incubation habitat for winter-run Chinook salmon relative to the NAA are not adverse.

H3_ELT/ESO_ELT[4]

Flows in the Sacramento River between Keswick and upstream of Red Bluff Diversion Dam were examined during the May through September winter-run spawning and incubation period

[4] H3_ELT/ESO_ELT is the acronym used for Alternative 4A, Scenario H3 in the early long-term implementation period.

(Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can reduce the instream area available for spawning and egg incubation. Mean flows under H3_ELT at Keswick would generally be similar to flows under NAA_ELT, with flows under H3_ELT up to 12% higher than under NAA_ELT during May through July and up to 15% lower during August and September. Mean flows upstream of Red Bluff would generally be more similar between H3_ELT and NAA_ELT than those at Keswick. Based on these flow results, it is expected that H3_ELT would have little effect on flow-related winter-run Chinook salmon spawning and egg incubation habitat due to their low magnitude and frequency.

Shasta Reservoir storage volume at the end of May influences flow rates below the dam during the May through September winter-run spawning and egg incubation period. Mean Shasta May storage under H3_ELT would be similar (<5% difference) to storage under NAA_ELT for all water year types (Table 11-4A-12).

Table 11-4A-12. Difference and Percent Difference in Mean May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for Alternative 4A (Scenario H3_ELT)

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	-13 (-0.3%)	0 (0%)
Above Normal	-73 (-2%)	-46 (-1%)
Below Normal	-83 (-2%)	13 (0.3%)
Dry	-223 (-6%)	-19 (-1%)
Critical	-205 (-8%)	92 (4%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean water temperatures for each water year type in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be negligible differences (<5%) in mean water temperature between H3_ELT and NAA_ELT for all months and water year types throughout the period at both locations, except for August of critical years at Keswick, which would be 7% warmer under H3_ELT. If extreme drought conditions occur again in the future, DWR and Reclamation would work in close coordination with regulatory agencies to manage reservoir operations to avoid negative impacts to fish, as is currently being done.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4A-14. Differences between H3_ELT and baselines in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4A-15. There would be 4 (5%) more years with a "red" level of concern under H3_ELT. These differences would not be biologically meaningful to winter-run Chinook salmon spawners and eggs, as the 4 years constitute a small proportion of the 82 year period used for this analysis, as long as the years were not consecutive, which they were not in this case. If multiple years of drought occurs in the future, DWR and Reclamation would work in close coordination with regulatory agencies to manage reservoir operations to avoid negative impacts to fish, as is currently being done.

Table 11-4A-13. Maximum Water Temperature Thresholds for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Location	Period	Maximum Water Temperature (°F)	Purpose
Upper Sacramento River			
Bend Bridge	May–Sep	56	Winter- and spring-run spawning and egg incubation
		63	Green sturgeon spawning and egg incubation
Red Bluff	Oct–Apr	56	Spring-, fall-, and late fall–run spawning and egg incubation
Hamilton City	Mar–Jun	61 (optimal), 68 (lethal)	White sturgeon spawning and egg incubation
Feather River			
Robinson Riffle (RM 61.6)	Sep–Apr	56	Spring-run (Sep-Jan) and steelhead (Jan-Apr) spawning and incubation
	May–Aug	63	Spring-run and steelhead rearing
Gridley Bridge	Oct–Apr	56	Fall- and late fall–run spawning and steelhead rearing
	May–Sep	64	Green sturgeon spawning, incubation, and rearing
American River			
Watt Avenue Bridge	May–Oct	65	Juvenile steelhead rearing

Table 11-4A-14. Number of Days per Month Required to Trigger Each Level of Concern for Water Temperature Exceedances in the Sacramento River for Covered Salmonids and Sturgeon Provided by NMFS and Used in the BDCP Effects Analysis

Exceedance above Water Temperature Threshold (°F)	Level of Concern			
	None	Yellow	Orange	Red
1	0–9 days	10–14 days	15–19 days	≥20 days
2	0–4 days	5–9 days	10–14 days	≥15 days
3	0 days	1–4 days	5–9 days	≥10 days

Table 11-4A-15. Differences between H3_ELT and NAA_ELT in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Red	28 (55%)	4 (5%)
Orange	-14 (-82%)	-3 (-50%)
Yellow	-11 (-100%)	-1 (-100%)
None	-3 (-100%)	0 (NA)

Note: For definitions of levels of concern, see Table 11-4A-14.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

Total degree-days exceeding 56°F at Bend Bridge were summed for all years by month and water year type during May through September (Table 11-4A-16). The monthly total degree-days under H3_ELT would be up to 8% lower than under NAA_ELT during May and June, up to 9% higher during August and September, and similar for July. However, the CALSIM modeling used for this analysis assumed a change in release patterns between May and September compared to NAA_ELT that is driving this increase in temperatures later in the summer. In reality, Shasta reservoir would not be operated differently from NAA_ELT, using real time operations and adaptive management, and temperatures are expected to be similar to those under NAA_ELT.

Table 11-4A-16. Differences between H3_ELT and NAA_ELT in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
May	Wet	502 (133%)	3 (0.3%)
	Above Normal	130 (61%)	-105 (-23%)
	Below Normal	270 (123%)	-18 (-4%)
	Dry	186 (100%)	-99 (-21%)
	Critical	212 (96%)	-6 (-1%)
	All	1,300 (107%)	-225 (-8%)
June	Wet	336 (88%)	-29 (-4%)
	Above Normal	94 (64%)	-20 (-8%)
	Below Normal	121 (87%)	-19 (-7%)
	Dry	147 (78%)	-62 (-16%)
	Critical	185 (46%)	-59 (-9%)
	All	883 (70%)	-189 (-8%)
July	Wet	166 (32%)	-56 (-8%)
	Above Normal	105 (130%)	29 (18%)
	Below Normal	156 (106%)	-28 (-8%)
	Dry	340 (121%)	83 (15%)
	Critical	735 (89%)	-49 (-3%)
	All	1,502 (81%)	-21 (-1%)
August	Wet	952 (137%)	16 (1%)
	Above Normal	279 (68%)	-7 (-1%)
	Below Normal	465 (175%)	-27 (-4%)
	Dry	1,119 (167%)	311 (21%)
	Critical	1,209 (81%)	-67 (-2%)
	All	4,024 (114%)	226 (3%)
September	Wet	92 (12%)	83 (11%)
	Above Normal	146 (20%)	266 (45%)
	Below Normal	742 (99%)	289 (24%)
	Dry	1,368 (107%)	119 (5%)
	Critical	981 (47%)	-49 (-2%)
	All	3,329 (60%)	708 (9%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under H3_ELT would be lower or similar to mortality under NAA_ELT except in below normal water years (23% greater), although the absolute increase in mortality for this water year type would be less than 1% (Table 11-4A-17). Therefore, the increase in mortality from NAA_ELT to H3_ELT, although large on a relative scale, would be negligible at an absolute scale to the winter-run population. If multiple years of drought occurs in the future, DWR and Reclamation would work in close coordination with regulatory agencies to manage reservoir operations to avoid negative impacts to fish, as is currently being done.

Table 11-4A-17. Difference and Percent Difference in Percent Mortality of Winter-Run Chinook Salmon Eggs in the Sacramento River (Egg Mortality Model)

Water Year Type	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Wet	0.4 (100%)	0 (0%)
Above Normal	0.4 (80%)	0 (0%)
Below Normal	0.6 (60%)	0.3 (23%)
Dry	2 (107%)	0 (0%)
Critical	18 (68%)	-4 (-9%)
All	3 (72%)	-1 (-7%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

SacEFT predicts that there would be a 20% relative decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3_ELT compared to NAA_ELT (Table 11-4A-18). On an absolute scale, this reduction would be small (i.e., 9% lower). SacEFT predicts that the percentage of years with good (lower) redd scour risk would be similar to the percentage of years under NAA_ELT. SacEFT predicts that the percentage of years with good egg incubation conditions under H3_ELT would be 9% lower than under NAA_ELT. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under H3_ELT would be 7% lower than the percentage of years under NAA_ELT. These results indicate that Alternative 4A would cause a modest reduction in spawning WUA, egg incubation conditions, and red dewatering risk.

The biological significance of a 9% reduction in available suitable spawning habitat varies at the population level in response to a number of factors, including adult escapement. For those years when adult escapement is less than the carrying capacity of the spawning habitat, a reduction in area would have little or no population level effect. In years when escapement exceeds carrying capacity of the reduced habitat, competition among spawners for space (e.g., increased redd superimposition) would increase, resulting in reduced reproductive success. The reduction in the frequency of years in which spawning habitat availability is considered to be good by SacEFT could result in reduced reproductive success and abundance of winter-run Chinook salmon if the number of spawners is limited by spawning habitat quantity. However, it is unlikely that spawning habitat is limiting to winter-run Chinook salmon due to their small spawning adult population sizes in recent years relative to historical numbers.

Table 11-4A-**18. Difference and Percent Difference in Percentage of Years with "Good" Conditions** for Winter-Run Chinook Salmon Habitat Metrics in the Upper Sacramento River (from SacEFT)

Metric	EXISTING CONDITIONS vs. H3_ELT	NAA_ELT vs. H3_ELT
Spawning WUA	-21 (-36%)	-9 (-20%)
Redd Scour Risk	0 (0%)	0 (0%)
Egg Incubation	-9 (-9%)	-9 (-9%)
Redd Dewatering Risk	2 (8%)	-2 (-7%)
Juvenile Rearing WUA	-5 (-10%)	8 (22%)
Juvenile Stranding Risk	-8 (-40%)	-20 (-63%)

WUA = Weighted Usable Area.

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

H4_ELT/HOS_ELT

Flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4_ELT between May and September would generally be similar to flows under NAA_ELT (Appendix B, Section B.7). May storage in Shasta Reservoir under H4_ELT would be similar to storage under NAA_ELT, except in critical water years in which storage would be 11% greater under H4_ELT (Table 11-4A-19).

Table 11-4A-19. Difference and Percent Difference in May Water Storage Volume (thousand acre-feet) in Shasta Reservoir for H4_ELT Scenario

Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Wet	-10 (-0.2%)	2 (-0%)
Above Normal	-53 (-1.2%)	-26 (-0.6%)
Below Normal	-67 (-1.6%)	29 (0.7%)
Dry	-141 (-3.7%)	62 (1.7%)
Critical	-53 (-2.2%)	244 (11.4%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

Mean water temperatures for each water year type in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between H4_ELT and NAA_ELT in any month or water year type throughout the period at either location.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4A-14. Differences between H4_ELT and NAA_ELT in the levels of concern across all months and all 82 modeled years are presented in Table 11-4A-20. There would be little difference in the highest level of concern between H4_ELT and NAA_ELT. There would be 1 (17%) more year with an "orange" level of concern and 1 more year with a "yellow" level of concern under H4_ELT, which would not be biologically meaningful to winter-run Chinook salmon spawners and eggs.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4A-21). The monthly total degree-days under H4_ELT would be lower than under NAA_ELT for all 5 months, with up to 13% lower total degree-days (August). Total degree-days under H4_ELT would be most similar to that under NAA_ELT for the months of June and September.

Table 11-4A-20. Differences between H4_ELT and NAA_ELT in the Number of Years in Which Water Temperature Exceedances above 56°F Are within Each Level of Concern, Sacramento River at Bend Bridge, May through September

Level of Concern	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
Red	21 (41%)	-3 (-4%)
Orange	-10 (-59%)	1 (17%)
Yellow	-9 (-82%)	1 (100%)
None	-2 (-67%)	1 (NA)

Note: For definitions of levels of concern, see Table 11-4A-14.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
NA = could not be calculated because the denominator was 0.

Table 11-4A-21. Differences between H4_ELT and NAA_ELT in Total Degree-Days (°F-Days) by Month and Water Year Type for Water Temperature Exceedances above 56°F in the Sacramento River at Bend Bridge, May through September

Month	Water Year Type	EXISTING CONDITIONS vs. H4_ELT	NAA_ELT vs. H4_ELT
May	Wet	502 (133%)	3 (0%)
	Above Normal	149 (70%)	-86 (-19%)
	Below Normal	291 (133%)	3 (1%)
	Dry	244 (131%)	-41 (-9%)
	Critical	188 (85%)	-30 (-7%)
	All	1,374 (113%)	-151 (-6%)
June	Wet	362 (94%)	-3 (0%)
	Above Normal	150 (101%)	36 (14%)
	Below Normal	144 (104%)	4 (1%)
	Dry	202 (107%)	-7 (-2%)
	Critical	141 (35%)	-103 (-16%)
	All	999 (79%)	-73 (-3%)
July	Wet	175 (34%)	-47 (-6%)
	Above Normal	63 (78%)	-13 (-8%)
	Below Normal	158 (107%)	-26 (-8%)
	Dry	345 (122%)	88 (16%)
	Critical	569 (69.1%)	-215 (-13%)
	All	1,310 (71%)	-213 (-6%)
August	Wet	853 (122%)	-83 (-5%)
	Above Normal	199 (49%)	-87 (-13%)
	Below Normal	406 (153%)	-86 (-11%)
	Dry	673 (100%)	-135 (-9%)
	Critical	709 (48%)	-567 (-21%)
	All	2,840 (81%)	-958 (-13%)
September	Wet	47 (6%)	38 (5%)
	Above Normal	9 (1%)	129 (22%)
	Below Normal	737 (99%)	284 (24%)
	Dry	1,138 (89%)	-111 (-4%)
	Critical	514 (25%)	-516 (-17%)
	All	2,445 (44%)	-176 (-2%)

Note: Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).

NEPA Effects: Alternative 4A does not propose any changes in Shasta Reservoir operating criteria, and CALSIM results show that Reclamation could operate Shasta in such a manner that it does not affect upstream storage or flows substantially as compared to the NAA_ELT. However, the CALSIM modeling used for this analysis assumed a change in release patterns between May and September, compared to NAA. This resulted in the available analytical tools showing conflicting results regarding the temperature effects of relatively small changes in predicted summer and fall flows.

Several models (CALSIM, SRWQM, and Reclamation Egg Mortality Model) generally show no change in upstream conditions as a result of Alternative 4A. However, one model, SacEFT, shows adverse effects under some conditions, primarily in the later summer. After extensive investigation of these modeling results, they appear to be a function of high model sensitivity to relatively small changes in estimated upstream conditions combined with the assumed CALSIM release patterns, which may or may not accurately predict adverse effects. Temperature and end of September storage criteria from the NMFS (2009a) BiOp for Shasta reservoir are maintained, in order to minimize adverse effects to spawning and incubating salmonids including winter-run Chinook salmon. Review of modeling results by FWS and NMFS has confirmed that no additional upstream criteria are necessary to meet the NMFS BiOp criteria under Alternative 4A and, because operations of Alternative 4A will require continued compliance with the NMFS BiOp for Shasta operations, regardless of Delta operations, this effect would not be adverse.

CEQA Conclusion: Collectively, the results of the Impact AQUA-40 CEQA analysis show that the difference between the CEQA baseline and Alternative 4A could be significant because, when compared to the CEQA baseline, the alternative, including climate change, would substantially reduce the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to Existing Conditions. However, as further described below in the Summary of CEQA Conclusion, the comparison to the NAA_ELT is a better approach because it isolates the effects of the alternative from those of sea level rise, climate change, and future water demand. Based on this identification of the actual increment of change attributable to the alternative, Alternative 4A would not affect the quantity and quality of spawning and egg incubation habitat for winter-run Chinook salmon relative to the Existing Conditions.

H3_ELT/ESO_ELT

CALSIM flows in the Sacramento River between Keswick and Red Bluff Diversion Dam were examined during the May through September winter-run spawning and egg incubation period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows between Keswick and Red Bluff Diversion Dam under H3_ELT would be similar to or up to 15% lower than flows under Existing Conditions during May through August. Mean flows during September would be up to 24% lower (dry years) and 34% higher (above normal years) than flows under Existing Conditions.

Shasta Reservoir mean storage volume at the end of May under H3_ELT would be similar to storage under Existing Conditions in wet, above normal, and below normal water years and 6% and 8% lower than storage under Existing Conditions in dry and critical water years, respectively (Table 11-4A-12). This indicates that there would be a small effect of H3_ELT on flows during the spawning and egg incubation period in drier water years.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between H3_ELT and Existing Conditions during May and June. Mean water temperature at Keswick would be up to 14% higher under H3_ELT in July through September. Higher temperatures are persistent throughout the two months of August and September at Keswick, which would cause a negative effect on winter-run Chinook salmons spawning and egg incubation. Mean temperature at Bend Bridge would be 5% higher under H3_ELT than under Existing Conditions in August of critical year types. There would be no other differences (<5%) at Bend Bridge.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4A-14. The number of years classified as "red" would increase by 55% (28 years) under H3_ELT relative to Existing Conditions (Table 11-4A-15). This would cause a negative effect to winter-run Chinook salmon spawning and egg incubation.

Total degree-days exceeding 56°F at Bend Bridge were summed for all years by month and water year type during May through September (Table 11-4A-16). The monthly total degree-days would be 60% to 107% higher under H3_ELT than under Existing Conditions depending on month. This would cause a negative effect to winter-run Chinook salmons spawning and egg incubation.

The Reclamation egg mortality model predicts that winter-run Chinook salmon egg mortality in the Sacramento River under H3_ELT would be 60% to 107% greater (relative scale) than mortality under Existing Conditions depending on water year type (Table 11-4A-17). However, the increase would be more than 5% of the winter-run population on an absolute scale, and therefore be biologically meaningful, only in critical years (18% higher). Overall, these results indicate that H3_ELT, in combination with climate change effects, would cause increased winter-run Chinook salmon mortality in the Sacramento River in critical years.

SacEFT predicts that there would be a 36% relative decrease in the percentage of years with good spawning availability, measured as weighted usable area, under H3_ELT compared to Existing Conditions (Table 11-4A-18) as a result of the combined effects of climate change and Alternative 4A. SacEFT predicts that the percentage of years with good (lower) redd scour risk under H3_ELT and climate change would be similar to the percentage of years under Existing Conditions. SacEFT predicts that the percentage of years with good egg incubation conditions under H3_ELT and climate change would be 9% lower than under Existing Conditions. SacEFT predicts that the percentage of years with good (lower) redd dewatering risk under H3_ELT and climate change would be 8% greater than the percentage of years under Existing Conditions. These results indicate that Alternative 4A, in combination with climate change effects, which are the primary driver for these changes, would cause large reductions in spawning WUA. However, due to the highly suppressed population size of winter-run Chinook salmon relative to historical population sizes, it is unlikely that spawning habitat is currently limiting.

H4_ELT/HOS_ELT

Mean flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4_ELT between May and August would generally be similar to or up to 14% lower than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Mean flows during September would be up to 20% lower (dry years) and 53% higher (above normal years) than flows under Existing Conditions. Mean May storage in Shasta Reservoir under H4_ELT would be similar to storage under Existing Conditions in all water year types (Table 11-4A-19). Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the May through September winter-run spawning period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperatures between H3_ELT and Existing Conditions at either location.

The number of days when temperatures exceeded the analysis criterion (i.e., 56°F identified in Table 11-4A-13) by >0.5°F to >5°F in 0.5°F increments was determined for each month (May through September) and year of the 82-year modeling period. The combination of number of days and degrees above the 56°F threshold were further assigned a "level of concern", as defined in Table 11-4A-14. Differences between baselines and H4_ELT in the highest level of concern across all months and all 82 modeled years are presented in Table 11-4A-20. There would be a 41% increase in the number of years with a red level of concern under H4_ELT relative to Existing Conditions.

Total degree-days exceeding 56°F at Bend Bridge were summed by month and water year type during May through September (Table 11-4A-21). The monthly total degree-days under H4_ELT would range from 44% to 113% higher than under Existing Conditions depending on month.

Summary of CEQA Conclusion

Under Alternative 4A, egg mortality (according to the Reclamation egg mortality model) in drier water years, during which winter-run Chinook salmon would already be stressed due to reduced flows and increased temperatures, would be up to 18% greater (absolute difference) than egg mortality under the CEQA baseline. The extent of spawning habitat and egg incubation conditions according to the SacEFT model are predicted to be 21% and 9% lower, respectively, on an absolute scale. Years with water temperatures at the red level of concern and exceedances above NMFS temperature thresholds would be substantially greater under Alternative 4A relative to the CEQA baseline. Therefore, these modeling results indicate that the difference between Existing Conditions and Alternative 4A could be significant because the alternative could substantially reduce suitable spawning habitat and substantially reduce the number of winter-run as a result of egg mortality, although, due to the highly suppressed population size of winter-run Chinook salmon relative to historical population sizes, it is unlikely that spawning habitat is currently limiting.

As discussed in Section 11.3.3, because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA_ELT) models anticipated future conditions that would occur at 2025 (ELT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change, and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. The comparison to the NAA_ELT is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA_ELT and informed by the NEPA analysis above, flows, reservoir storage, and water temperatures in the Sacramento River would generally be similar between NAA_ELT and Alternative 4A. SacEFT predicts that the extent of spawning habitat and egg incubation conditions in the Sacramento River would result in adverse effects under some conditions. These modeling results represent the increment of change attributable to the alternative, demonstrating the general similarities in flows, reservoir storage, and water temperature under Alternative 4A and the NAA_ELT, and addressing the limitations of the CEQA baseline (Existing Conditions). Therefore, this impact is found to be less than significant and no mitigation is required.

Impact AQUA-41: Effects of Water Operations on Rearing Habitat for Chinook Salmon (Winter-Run ESU)

In general, Alternative 4A would not adversely affect rearing habitat for fry and juvenile winter-run Chinook salmon relative to the NAA_ELT.

H3_ELT/ESO_ELT

Sacramento River flows between Keswick and upstream of Red Bluff Diversion Dam were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Mean flows under H3_ELT during August through October and December would generally be similar to flows under NAA_ELT, with minor exceptions. Flows during November under H3_ELT would be up to 23% lower than flows under NAA_ELT. The biological implications of this reduction during November is analyzed below in the SALMOD and SacEFT analyses, which analyze the effects of flow changes on weighted usable rearing area for winter-run Chinook salmon in the Sacramento River.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be negligible differences (<5%) in mean water temperature between H3_ELT and NAA_ELT in any month or water year type throughout the period at either location, except a 7% increase for August of critical years.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3_ELT would be 22% greater on a relative scale (8% on an absolute scale) than the percentage of years under NAA_ELT (Table 11-4A-18). However, the percentage of years with good (low) juvenile stranding risk under H3_ELT is predicted to be 63% lower on a relative scale (20% on an absolute scale) than under NAA_ELT. These results indicate that while the quantity of juvenile rearing habitat in the Sacramento River would slightly increase under H3_ELT, its quality, with respect to stranding risk, would be reduced. However, although there would be an improvement in rearing weighted usable area, it would not likely result in a benefit to the population due to the highly suppressed population sizes in recent years.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under H3_ELT would be 7% lower than under NAA_ELT. These results are inconsistent with SacEFT results, which indicate that juvenile stranding risk would increase under H3_ELT (Table 11-4A-18).

Both SacEFT and SALMOD are considered to be reliable models for winter-run Chinook salmon in the Sacramento River. SALMOD has been used for decades for assessing changes in flows associated with SWP and CVP and SacEFT has been peer-reviewed. Therefore, results of both models were used to draw conclusions about winter-run Chinook salmon rearing conditions. Although SALMOD does not parse out stranding effects specifically, the model incorporates effects to all early life stages, including eggs, fry, and juveniles. Therefore, although SacEFT predicts that juvenile stranding risk may increase under H3_ELT, when combined with all early life stage effects in SALMOD, the effects of H3_ELT would be marginally beneficial to winter-run Chinook salmon survival. Further, these results indicate that the November flow reductions in the Sacramento River identified above would not have a biological effect on winter-run Chinook salmon rearing.

H4_ELT/HOS_ELT

Mean flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4_ELT during August through October and December would be similar to flows under NAA_ELT, with minor exceptions, but flows in November would be lower for all water year types (11% to 20% lower) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Flow reductions in this reach of the Sacramento River under H4_ELT during November are very similar to those under H3_ELT. As described above, under H3_ELT, further biological modeling indicated that these November flow reductions would not cause a biologically meaningful effect on winter-run Chinook salmon. Although no further biological modeling was conducted for H4_ELT, it can be concluded, based on the similar nature of these results, that these reductions under H4_ELT would also not cause a biologically meaningful effect on winter-run Chinook salmon rearing.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run juvenile rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between H4_ELT and NAA_ELT in any month or water year type throughout the period at either location.

NEPA Effects: Collectively, these modeling results indicate that the effect of Alternative 4A is not adverse because it does not have the potential to substantially reduce the amount of suitable habitat or substantially interfere with winter-run Chinook salmon rearing. Differences in flows and temperatures are generally small and inconsistent among months and water year types. SALMOD and SacEFT predicted contradicting results regarding habitat-related mortality. SacEFT found that juvenile stranding risk is expected to increase. However, SALMOD results include the effects to all early life stages combined and, therefore, are more representative of the overall effects to winter-run Chinook salmon in the upper Sacramento River. The SALMOD model found that Alternative 4A would provide a minor beneficial effect (7% reduction in habitat-related mortality) to early life stages of winter-run Chinook salmon. Flow and temperature results are predominantly similar between H3 and H4.

CEQA Conclusion: In general, Alternative 4A would not reduce the quantity and quality of fry and juvenile rearing habitat for winter-run Chinook salmon relative to Existing Conditions.

H3_ELT/ESO_ELT

Sacramento River flows between Keswick and Red Bluff Diversion Dam were examined for the juvenile winter-run Chinook salmon rearing period (August through December) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). Lower flows can lead to reduced extent and quality of fry and juvenile rearing habitat. Mean flows under H3_ELT during August and October through December would generally be similar to or up to 20% lower than flows under Existing Conditions. Flows under H3_ELT during September would be up to 24% lower (dry years) and 34% higher (above normal years) than flows under Existing Conditions.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean water temperature at Keswick would be higher (by up to 14%, but generally less than 8%) under H3_ELT than under Existing Conditions in August through October, depending on month and water year type. There would be an increase of 6% in mean water temperature at Bend Bridge for August of critical years, but no other differences in water temperature at this location, and no differences (<5%) between Existing Conditions and H3_ELT in mean water temperature during November and December for any of the water year type at either location.

SacEFT predicts that the percentage of years with good juvenile rearing habitat availability, measured as weighted usable area, under H3_ELT, combined with climate change, would be 10% lower on a relative scale (5% on an absolute scale) than under Existing Conditions (Table 11-4A-18). The percentage of years with good (low) juvenile stranding risk under H3_ELT is predicted to be 40% lower on a relative scale (8% on an absolute scale) than the percentage under Existing Conditions. These results indicate that the quantity and quality, with respect to stranding risk, of juvenile rearing habitat in the Sacramento River would be marginally lower under H3_ELT relative to Existing Conditions.

SALMOD predicts that winter-run smolt equivalent habitat-related mortality under H3_ELT would be 28% lower than under Existing Conditions. These results are somewhat inconsistent with SacEFT results, which indicate that the number of years with good juvenile rearing WUA and with good (low) stranding risk would both marginally increase under H3_ELT (Table 11-4A-18). Both SacEFT and SALMOD are considered to be reliable models for winter-run Chinook salmon in the Sacramento River. SALMOD has been used for decades for assessing changes in flows associated with SWP and CVP. Therefore, results of both models were used to draw conclusions about winter-run Chinook salmon rearing conditions. The SALMOD model incorporates effects to all early life stages, including eggs, fry, and juveniles. Therefore, although SacEFT predicts that juvenile stranding risk may increase under H3_ELT, when combined with all early life stage effects in SALMOD, the effects of H3_ELT would be marginally beneficial to winter-run Chinook salmon.

H4_ELT/HOS_ELT

Mean flows in the Sacramento River between Keswick and Red Bluff Diversion Dam under H4_ELT in August and October through December would generally be similar to or up to 19% lower than flows under Existing Conditions. Flows under H4_ELT during September would be up to 53% higher (above normal years) and up to 20% lower (dry years) than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the August through December winter-run rearing period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*) There would be no differences (<5%) in mean monthly water temperature between H4_ELT and Existing Conditions in any month or water year type throughout the period at either location.

Summary of CEQA Conclusion

These modeling results indicate that the impact would be less than significant because it does not have the potential to substantially reduce the amount of suitable habitat and substantially interfere with the movement of fish, and no mitigation is necessary. Flows under Alternative 4A would be highly variable relative to Existing Conditions and there would be small increases under the alternative in water temperatures during some of the period of presence. SALMOD and SacEFT predicted contradicting results regarding habitat-related mortality, although because SALMOD incorporates more of the life cycle of winter-run Chinook salmon, its results are more representative of overall effects to winter-run Chinook salmon in the upper Sacramento River. Overall, the impact would be less than significant and no mitigation is required. Flow and temperature results are predominantly similar between H3 and H4.

Impact AQUA-42: Effects of Water Operations on Migration Conditions for Chinook Salmon (Winter-Run ESU)

In general, the effects of Alternative 4A on winter-run Chinook salmon migration conditions relative to the NAA are not adverse because the primary impact mechanism is the change in flow past the proposed NDD, and as described in Chapter 3, the operations of the NDD would take into account triggers developed by DFW and NMFS that would allow for adjustments in NDD operations to minimize and avoid effects on Chinook salmon and steelhead.

Upstream of the Delta

H3_ELT/ESO_ELT

Flows in the Sacramento River upstream of Red Bluff were examined for the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). A substantial reduction in flow may reduce the ability of juvenile winter-run to migrate effectively through the Sacramento River due to a reduction in olfactory cues, although there is little empirical evidence supporting this. Mean flows under H3_ELT would be up to 18% lower than under NAA_ELT during November and generally similar to NAA_ELT during the rest of the juvenile winter-run Chinook salmon migration period (July through October), with minor exceptions.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean water temperature would be 7% higher under H3_ELT than under NAA_ELT for August of critical years. There would be no other differences (<5%) in mean monthly water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period at either location.

Flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) under H3_ELT would generally be similar to those under NAA_ELT.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA_ELT and H3_ELT in any month or water year type throughout the period at either location, except a 7% increase in water temperature under H3_ELT at Bend Bridge for August of critical years.

H4_ELT/HOS_ELT

Flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H4_ELT would generally be similar to flows under NAA_ELT, except in November, in which flows would be lower for all water year types (up to 15% lower for below normal years) (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). These flow reductions would not be of sufficient frequency or magnitude to cause biologically meaningful effects on migrating juveniles.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean monthly water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period at either location.

Mean flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) under H4_ELT would generally be similar to flows under NAA_ELT (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between NAA_ELT and H4_ELT in any month or water year type throughout the period at either location.

Through-Delta

H3_ELT/ESO_ELT

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids (primarily for those remaining in the Sacramento River as opposed to entering the Yolo Bypass at Fremont Weir) and would be affected by the north Delta diversions, as discussed above for winter-run Chinook (Impact AQUA-42 for Alternative 1A). Average monthly Sacramento River flows below the NDD under H3_ELT for juvenile winter-run migrants (November through May) would be reduced 4% to 30% compared to NAA_ELT, depending on water year type (Appendix B, *Supplemental Modeling for Alternative 4A,* Section B.7), assuming that NDD operations are based solely on operations described in Table 3-16 in Chapter 3 of Appendix A of this RDEIR/SDEIS. Note that the modeling of NAA_ELT does not account for any flow entering the Yolo Bypass because of Fremont Weir modifications that would occur separately from Alternative 4A (but which are included in the modeling of H3_ELT and H4_ELT; see also Section 4.1.2.2 of Section 4); this would slightly decrease the amount of water in the Sacramento River under NAA_ELT, so the above comparison of H3_ELT vs. NAA_ELT is conservative. As noted for Alternative 4 and described in more detail for Alternative 1A, *CM1 Water Facilities and Operation* includes bypass flow criteria that will be managed in real time, based on triggers developed by DFW and NMFS, to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids. Additional detail is provided in Chapter 3, Section 3.6.4.2.

Potential predation effects at the north Delta intakes for juvenile salmonids remaining in the Sacramento River (as opposed to entering the Yolo Bypass) could occur if predatory fish aggregated along the screens as has been observed at other long screens in the Central Valley (Vogel 2008). Baseline levels of predation are uncertain, however. Analysis by a bioenergetics model (Appendix 5.F, *Biological Stressors on Covered Fish,* Section 5.F.3.2.1) suggests that considerably less than 0.3% of winter-run juveniles could be preyed upon (Table 11-4A-11). Using another scenario of predation that assumes a 5% loss per intake (based on GCID losses, Vogel 2008) would yield a cumulative loss of about 12% of the annual production that reaches the north Delta. The three intake structures and associated permanent bankline modifications would result in a permanent loss of up to 13.7 acres aquatic habitat and the permanent modification of 2.6 miles of shoreline along the migration route. There are appreciable uncertainties in the analysis of predation loss, including unknown baseline levels of predation[5], uncertainty in the bioenergetics model parameters, and the comparability of the GCID intakes for estimating loss rates. As discussed for Alternative 1A, the GCID screen and the proposed north Delta diversion intake screens are substantially different. The GCID is located along a relatively narrow oxbow channel (about 10 to 50 meters wide) while the north Delta intakes would be located on the much wider channel of the mainstem lower Sacramento River (about 150 to 180 meters wide). In addition, the fish tested at GCID were relatively small (average length generally less than 70 mm; Vogel 2008) in comparison to the size of winter-run Chinook salmon that would generally occur near the north Delta intakes (average length generally greater than 70 mm; del Rosario et al. 2013), which could have resulted in different susceptibility to predation. For the purposes of the analysis of Alternative 4A, it is assumed that all juvenile salmon migrating down the mainstem Sacramento River would come in close proximity to the intakes, although there is high uncertainty with this assumption. However, the estimates of predation loss at GCID are for a single large diversion intake, while Alternative 4A would have three north Delta intakes. Thus, while factors unique to the GCID screen may increase predation loss estimates relative to the north Delta, the cumulative amount of intake structure proposed under the Plan would be much larger than the GCID screen, increasing exposure of juvenile salmon to screen-related impacts. Overall, a fixed 5% loss per intake represents a conservative upper bound on predation loss.

Through-Delta survival by juvenile winter-run Chinook salmon, as estimated by the Delta Passage Model under Scenario H3_ELT, averaged 32.8% across all years, 25.5% in drier years, and 45.0% in wetter years (for further details, refer to *BDCP Appendix 5.C, Section 5C.5.3.1.3.1 herby incorporated by reference*). Average juvenile through-Delta survival under H3_ELT was similar or slightly lower than NAA_ELT (1.6% less, a 4.7% relative decrease), based on operations assuming no adjustments made in real-time in response to actual presence of fish (Table 11-4A-23). However, as noted previously in the introduction to the impact assessment for Alternative 4A and above, the modeling of NAA_ELT does not account for actions that would be pursued as part of other projects and programs, notably Yolo Bypass improvements and tidal habitat restoration under the NMFS and USFWS BiOps. To provide perspective on the potential for such changes to influence the results of the DPM, a modification to the NAA_ELT results (termed NAA_ELT (mod.) in Table 11-4A-23) was created by post-processing the outputs of the NAA_ELT scenario. The post-processing consisted of substituting year-specific Yolo Bypass entry percentages and Yolo Bypass survival from the H3_ELT scenario into the results from the NAA_ELT scenario; this was done to represent the Fremont Weir

[5] Data from the GCID study by Vogel (2008) for releases made in 2007—this being the only year of the study in which flow-control blocks at the weir at the downstream end of the fish screen were removed, to reduce predatory fish concentration—indicate that the proportion of tagged juvenile Chinook salmon released at the upstream end of the fish screen that were recaptured at a downstream location was similar or slightly greater than for fish released at the downstream end of the fish screen, when standardized for the distance that these fish had to travel to the release point. These data suggest that survival along the screen was at least similar to survival in the portion of the channel without the screen (i.e., screen survival was similar to baseline survival, if the latter is assumed to be represented by the channel downstream of the screen). However, test fish were released at the downstream end of the screen (below the flow-control weir) prior to the fish that were at the upstream end of the fish screen, which could have confounded comparisons of relative survival between these groups if predatory fishes became partly satiated prior to the arrival of the fish released at the upstream end of the screen (thus making their survival relatively higher).

modifications that would occur under NAA_ELT through a separate Yolo Bypass improvements program that is assumed to occur irrespective of Alternative 4A. These results illustrated that there would be a slightly larger incremental difference in survival under H3_ELT when considering incorporating Yolo Bypass improvements as part of NAA_ELT: across all years, the mean through-Delta survival under H3_ELT was 1.6% less (a 4.7% relative decrease) than NAA_ELT compared to 2.0% less (a 5.8% relative decrease) compared to NAA_ELT (mod.). The overall difference was driven mostly by the relatively larger difference in drier years, for which the mean through-Delta survival under H3_ELT was 1.7% less (a 6.3% relative decrease) than NAA_ELT, compared to 2.5% less (an 8.9% relative decrease) than NAA_ELT (mod.). The post-processing of the NAA_ELT outputs to give the NAA_ELT (mod.) results does not account for the resulting slightly lower flow in the Sacramento River (which would slightly reduce through-Delta survival outputs from the DPM because of the flow-survival relationships included in the model) because of increased flow entering the Yolo Bypass. The post-processing of the NAA_ELT outputs to give the NAA_ELT (mod.) results also does not account for changes in hydraulics at important channel divergences, particularly between the Sacramento River and Georgiana Slough, that would occur with the 8,000 acres of tidal habitat restoration under the NAA_ELT; as illustrated in the Draft BDCP (See *BDCP Appendix 5.C, Sections 5C.4.3.2.6 and 5C.5.3.8 incorporated by reference*), habitat restoration in the north Delta and the resulting dampening of tidal influence in the Sacramento River would tend to result in less fish entering the low-survival interior Delta, slightly increasing survival. It is assumed in this analysis that these opposing factors balance each other out, so that for the purposes of this analysis, the difference between H4_ELT and NAA_ELT (mod.) provides a reasonable indication of the difference in through-Delta survival between NAA_ELT and Alternative 4A (Scenario H4_ELT, in this case).

Table 11-4A-23. Through-Delta Survival (%) of Emigrating Juvenile Winter-Run Chinook Salmon under Alternative 4A (Scenarios H3_ELT and H4_ELT)

	Average Percentage Survival					Difference in Percentage Survival (Relative Difference)					
	SCENARIO					EXISTING CONDITIONS vs. Alt 4A Scenario		NAA_ELT vs. Alt 4A Scenario			
Water Year Type	EXISTING CONDITIONS	NAA_ ELT	NAA_ ELT (mod.)	H3_ ELT	H4_ ELT	H3_ELT	H4_ELT	H3_ELT	H4_ELT	H3_ELT (vs. NAA_ELT mod.)	H4_ELT (vs. NAA_ELT mod.)
Wetter Years	46.3	46.3	46.3	45.0	46.0	-1.3 (-2.8%)	-0.4 (-0.8%)	-1.2 (-2.7%)	-0.3 (-0.7%)	-1.2 (-2.7%)	-0.4 (-0.9%)
Drier Years	28.0	27.3	28.0	25.5	25.6	-2.4 (-8.7%)	-2.4 (-8.6%)	-1.7 (-6.3%)	-1.7 (-6.2%)	-2.5 (-8.9%)	-2.5 (-8.9%)
All Years	34.9	34.4	34.9	32.8	33.2	-2.1 (-6.0%)	-1.7 (-4.9%)	-1.6 (-4.7%)	-1.2 (-3.5%)	-2.0 (-5.8%)	-1.7 (-4.9%)

Note: Average Delta Passage Model results for survival to Chipps Island.
Negative numbers indicate lower values under Alternative 4A (i.e., the calculations are based on Alternative 4A minus the baseline).
Wetter = Wet and Above Normal Water Years (6 years).
Drier = Below Normal, Dry and Critical Water Years (10 years).
H3_ELT = ESO_ELT operations, H4_ELT = High Outflow.
NAA_ELT (mod.) = NAA_ELT with Yolo Bypass entry % and Yolo Bypass survival of H3_ELT

Adults

As noted for Alternative 4, adult salmonids migrating through the delta use flow and olfactory cues for navigation to their natal streams (Marston et al. 2012), as discussed for winter-run Chinook under Impact AQUA-42 for Alternative 1A. Attraction flows and olfactory cues in the west Delta would be altered because of shifts in exports from the south Delta to the north Delta. Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced, with concomitant proportional increases in San Joaquin River flow, with differences between water-year types because of differences in the relative proportion of water being exported from the north Delta and south Delta facilities (Appendix B, *Supplemental Modeling for Alternative* 4A, Section B.7).

As described for Alternative 4, these changes may slightly decrease the Sacramento River olfactory cues used by migrating adults, although the changes are within the dilution factor and the behavioral response is uncertain. Fingerprint analyses determined that attraction flow, as estimated by the percentage of Sacramento River water at Collinsville, declined from NAA_ELT to Scenario H3_ELT operations by up to 6% during the peak migration period for winter-run adults (December through February) and by 10–12% in March–April (Table 11-4A-24). As noted for Alternative 4, the Sacramento River would still represent a substantial proportion of Delta outflows. Under Scenario H4_ELT, the difference would be less due to increased spring outflows in March, April, and May. Overall, the reductions in olfactory cues resulting from all scenarios would be less than the magnitude of change in dilution (20% or more) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Table 11-4A-24. Percentage (%) of Water at Collinsville that Originated in the Sacramento River during the Adult Winter-Run Chinook Salmon Migration Period for Alternative 4A (Scenario H3_ELT)

Month	EXISTING CONDITIONS	NAA_ELT	H3_ELT	EXISTING CONDITIONS vs. H3_ELT	NAA vs. H3_ELT
December	67	67	65	-1	-1
January	76	75	73	-2	-2
February	75	74	69	-6	-4
March	78	77	69	-9	-8
April	77	76	67	-10	-9
May	69	67	61	-8	-7
June	64	61	57	-7	-5
July	64	65	58	-6	-6
	Shading indicates 10% or greater absolute difference.				

H4_ELT/HOS_ELT

Juveniles

Plan Area flows have considerable importance for downstream migrating juvenile salmonids and would be affected by the north Delta diversions, as discussed for winter-run Chinook above (Impact AQUA-42 for Alternative 1A). Under H4_ELT, average Sacramento River flows below the NDD during the juvenile winter-run migration period (November–May) would range from being reduced by 32% to being increased by 15%, depending on water year type, compared to NAA_ELT (Appendix B, *Supplemental Modeling for Alternative 4A,* Section B.7). As described for the analysis of H3_ELT, the water conveyance facilities include bypass flow criteria that will be managed in real time to minimize adverse effects of diversions at the north Delta intakes on downstream-migrating salmonids, including the use of biological and hydrological triggers developed by NMFS and DFW to adjust NDD operations to protect migrating salmonids. Note also that, as described in the DPM analysis of H3_ELT above, CALSIM modeling of NAA_ELT does not include the slightly reduced Sacramento River flow that would occur because of Yolo Bypass improvements (more flow entering the Bypass through a modified Fremont Weir).

Through-Delta survival of juvenile winter-run Chinook salmon estimated by DPM under Scenario H4_ELT averaged 33.2% across all years, 25.6% in drier years, and 46.0% in wetter years (Table 11-4A-23; for further details, refer to *BDCP Appendix 5.C, Section 5C.5.3.1.3.1 incorporated by reference*). Average through-Delta juvenile survival under Scenario H4_ELT was generally similar to (in wetter years) or slightly lower than (in drier years) NAA_ELT based on operations assuming no adjustments made in real-time in response to actual presence of fish (Table 11-4A-23). However, as noted for the discussion of the H3_ELT scenario above, the DPM modeling results do not account for the inclusion of Yolo Bypass improvements in NAA_ELT. As done for the H3_ELT scenarios analysis, by assuming the same Yolo Bypass survival and entry as H3_ELT for NAA_ELT (mod.), there were slightly greater differences between H4_ELT and NAA_ELT (mod.) than between H4_ELT and NAA_ELT (Table 11-4A-23).

Overall, the relatively small difference in through-Delta survival between H3_ELT and H4_ELT is explained by the relatively low overlap of the winter-run Delta entry distribution with the spring period that has differing outflows for H3_ELT and H4_ELT. In addition, the DPM has less representation of intermediate-outflow years where the differences among the Alternative 4A operations (i.e., H3_ELT vs. H4_ELT) are more pronounced than wetter or drier years.

Adults

Results for H4_ELT regarding attraction flows and olfactory cues are presented as part of the corresponding discussion under H3_ELT (above).

NEPA Effects: Modeling analyses indicate that upstream migratory conditions would generally not change under Alternative 4A. Within the Delta, adult attraction flows under Alternative 4A would not be substantially different from those under NAA_ELT and the identified differences are not expected to result in behavioral changes in upstream migration.

Near-field effects of Alternative 4A on winter-run Chinook salmon related to impingement and predation associated with three new intake structures could result in negative effects on juvenile migrating winter-run Chinook salmon, although there is high uncertainty regarding the overall effects. It is expected that the level of near-field impacts would be directly correlated to the number of new intake structures in the river and thus, as described for Alternative 4, the level of impacts associated with 3 new intakes would be considerably lower than those expected from having 5 new intakes in the river (as examined for Alternative 1A, for example). Estimates within the effects analysis range from very low levels of effects (<1% mortality) to more significant effects (~ 12% mortality above current baseline levels). As noted for Alternative 4, Environmental Commitment 15 would be implemented with the intent of providing localized and temporary reductions in predation pressure at the NDD. Additionally, as described in the adaptive management and monitoring program in Section 4.1, several pre-construction studies to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Similarly, Alternative 4A also includes investigations to better understand factors affecting juvenile through-Delta migration (as described in the adaptive management and monitoring program in Section 4.1) and includes biologically-based triggers to inform real-time operations of the NDD, intended to provide adequate migration conditions for winter-run Chinook. However, at this time, due to the absence of comparable facilities anywhere in the lower Sacramento River/Delta, the degree of mortality expected from near-field effects at the NDD remains highly uncertain.

As noted for Alternative 4, two recent studies (Newman 2003 and Perry 2010) indicate that far-field effects associated with the new intakes could cause a reduction in smolt survival in the Sacramento River downstream of the NDD intakes due to reduced flows in this area. The analyses of other elements of Alternative 4A related to reduced interior Delta entry (Environmental Commitment 16) and reduced south Delta entrainment suggest that these could offset the far-field effects of reduced flow (see, for example, Table 5.C.5.3-36 in the *BDCP Effects Analysis Appendix 5.C hereby incorporated by reference*). The overall magnitude of each of these factors and how they might interact and/or offset each other in affecting salmonid survival through the plan area is uncertain, and will be investigated as part of the adaptive management and monitoring program described in Section 4.1.

As described for Alternative 4, the DPM is a flow-based model incorporating flow-survival and junction routing relationships with flow modeling of water operations to estimate relative differences between scenarios in smolt migration survival throughout the entire Delta. The DPM predicted that smolt migration survival under Alternative 4A would be similar or slightly lower than survival estimated for NAA_ELT, based on operations assuming no adjustments made in real-time in response to actual presence of fish. Although refinements to the DPM are likely to occur based on new data available from future studies and the current analysis has some uncertainty, the DPM analysis of Alternative 4A on juvenile winter-run Chinook salmon migration suggests a potential adverse effect of small magnitude. Note that the DPM focuses on smolt-sized individuals (70 mm or more) and is not based on survival data for fry-sized individuals, which also may be migrating and could be affected by Alternative 4A operations. There are no fry through-Delta survival data to inform the effects to these individuals in relation to operations and it is uncertain whether the relative difference between scenarios estimated from the DPM for smolt-sized fish would be representative of relative differences for fry. The potential adverse effect to all sizes of juvenile winter-run Chinook salmon would be minimized through the bypass flow criteria and real-time operations outlined above, as well as inclusion within Alternative 4A of specific important environmental commitments. These include *Environmental Commitment 6 Channel Margin Enhancement* to offset loss of channel margin habitat to the NDD footprint and far-field (water level) effects, *Environmental Commitment 15 Localized Reduction of Predatory Fishes* to limit predation potential at the NDD and *Environmental Commitment 16 Nonphysical Fish Barriers* to reduce entry of winter-run Chinook salmon juveniles into the low-survival interior Delta.

CEQA Conclusion: In general, Alternative 4A would not reduce migration conditions for winter-run Chinook salmon relative to Existing Conditions.

Upstream of the Delta

H3_ELT /ESO_ELT

Flows in the Sacramento River upstream of Red Bluff were examined during the July through November juvenile emigration period (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*). A reduction in flow may reduce the ability of juvenile winter-run to migrate effectively through the Sacramento River. Mean flows for juvenile migrants under H3_ELT, combined with climate change, would be similar to or up to 16% lower than flows under Existing Conditions during July, August, October, and November, and would be up to 22% lower (dry years) and 32% higher (above normal years) during September.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean water temperature at Keswick would be higher (by up to 14%, but generally less than 8%) under H3_ELT than under Existing Conditions in July through October, depending on month and water year type. There would be an increase of 6% in mean water temperature at Bend Bridge for August of critical years, but no other differences in water temperature at this location, and no differences (<5%) between Existing Conditions and H3_ELT in mean water temperature during November for any of the water year type at either location.

Flows in the Sacramento H3_ELT River upstream of Red Bluff were examined during the adult winter-run Chinook salmon upstream migration period (December through August). Flows under H3_ELT would generally be similar to flows under Existing Conditions throughout the adult migration period, except during August, in which flows would be up to 13% lower (critical years) under H3_ELT. These flow reductions would not be frequent or large enough to cause a biologically meaningful effect on adult migrants.

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). Mean water temperature at Keswick would be higher (by up to 14%, but generally less than 8%) under H3_ELT than under Existing Conditions in July and August, depending on month and water year type. There would be an increase of 6% in mean water temperature at Bend Bridge for August of critical years, but no other differences in water temperature at this location, and no differences (<5%) between Existing Conditions and H3_ELT in mean water temperature during December through June for any of the water year type at either location. These small increases are not expected to cause a biologically meaningful effect to adult migrants, which are less sensitive to temperatures than eggs and fry.

H4_ELT/HOS_ELT

Mean flows in the Sacramento River upstream of Red Bluff during the July through November juvenile emigration period under H4_ELT would generally be similar to or greater than flows under Existing Conditions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*) except during September (up to 18% lower for dry years and 49% higher for above normal years).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the July through November winter-run juvenile emigration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*). There would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT for all months, water year types, and locations.

Mean flows in the Sacramento River upstream of Red Bluff during the adult winter-run Chinook salmon upstream migration period (December through August) under H4_ELT would generally be similar to flows under Existing Conditions, with minor exceptions (Appendix 11C, *CALSIM II Model Results utilized in the Fish Analysis*).

Mean water temperatures in the Sacramento River at Keswick and Bend Bridge were examined during the December through August winter-run upstream migration period (Appendix 11D, *Sacramento River Water Quality Model and Reclamation Temperature Model Results utilized in the Fish Analysis*).There would be no differences (<5%) in mean water temperature between Existing Conditions and H4_ELT for all months, water year types, and locations.

Through-Delta

Juveniles

During the juvenile winter-run Chinook salmon emigration period (November through May), mean monthly flows in the Sacramento River below the NDD under H3_ELT averaged across years would be lower (13% to 23% lower monthly mean) compared to Existing Conditions. As described above in the discussion of NEPA Effects, potential predation losses at the three north Delta intakes would range from considerably less than 1% (bioenergetics modeling; Table 11-4A-11) to about 12% (conservative upper bound based on 5% loss per intake) of the annual production that reaches the north Delta. In addition, the three intake structures would permanently displace approximately 13.7 acres of in-water habitat.

Through-Delta survival by juvenile winter-run Chinook salmon, as estimated by the Delta Passage Model under Scenario H3_ELT, would be slightly lower than Existing Conditions for H3_ELT (2.1% less, a 6% relative decrease), with the greatest reduction in drier years (2.4% lower, a 8.7% relative decrease) (Table 11-4A-23), although this estimate does not account for the adjustments that can be made during real-time operations to further protect migrating fish as necessary.

Under Scenario H4_ELT, average survival was 1.7% less (a 4.9% relative decrease) than Existing Conditions, with a 2.4% reduction under H4_ELT in drier years (an 8.6% relative decrease).

Adults

Flows in the Sacramento River downstream of the north Delta intake diversions would be reduced, slightly reducing the olfactory cues for migrating adult salmon. Under Scenario H3_ELT, the proportion of Sacramento River water was reduced no more than 8% during peak migration (December through February) and reduced by 12–13% in March-May compared to Existing Conditions (Table 11-4A-24). As described in the NEPA Effects, the reductions in percentage are small in comparison with the magnitude of change in dilution (20% or more) reported to cause a significant change in migration by Fretwell (1989) and, therefore, are not expected to affect adult Chinook salmon migration. The Sacramento River would still represent a substantial proportion of Delta outflows. However, uncertainty remains with regard to adult salmon behavioral response to anticipated changes in lower Sacramento River flow percentages. This topic is discussed further in Impact AQUA-42 for Alternative 1A.

Summary of CEQA Conclusion

Contrary to the NEPA conclusion set forth above, these modeling results indicate that the difference between Existing Conditions and Alternative 4A could be significant because the alternative could substantially reduce juvenile migration conditions for winter-run Chinook salmon upstream of the Delta. Under Alternative 4A, there would be reductions in flow and increased temperatures in the

Sacramento River that could lead to biologically meaningful reductions in juvenile migration conditions, thereby reducing survival relative to Existing Conditions. Reduced migration conditions would delay or eliminate successful migration necessary to complete the winter-run Chinook salmon life cycle. Winter-run Chinook salmon juvenile survival through the Delta for Alternative 4A would be similar or slightly lower than for Existing Conditions. However, as described in the adaptive management and monitoring program in Section 4.1, several pre-construction studies to better understand how to minimize losses associated with the three new intake structures will be implemented as part of the final NDD screen design effort. Similarly, Alternative 4A also includes investigations to better understand factors affecting juvenile through-Delta migration (as described in the adaptive management and monitoring program in Section 4.1) and includes biologically-based triggers to implement real time operations. As noted in the NEPA Effects discussion, due to the inclusion of bypass flow criteria, real-time operational adjustments, *Environmental Commitment 6 Channel Margin Enhancement*, *Environmental Commitment 15 Localized Reduction of Predatory Fishes*, and *Environmental Commitment 16 Nonphysical Barriers*, the impacts would be minimized in the Delta.

This interpretation of the biological modeling is likely attributable to different modeling assumptions for four factors: sea level rise, climate change, future water demands, and implementation of the alternative. As discussed in Section 11.3.3, because of differences between the CEQA and NEPA baselines, it is sometimes possible for CEQA and NEPA significance conclusions to vary between one another under the same impact discussion. The baseline for the CEQA analysis is Existing Conditions at the time the NOP was prepared. Both the action alternative and the NEPA baseline (NAA) models anticipated future conditions that would occur at 2025 (ELT implementation period), including the projected effects of climate change (precipitation patterns), sea level rise and future water demands, as well as implementation of required actions under the 2008 USFWS BiOp and the 2009 NMFS BiOp. Because the action alternative modeling does not partition the effects of implementation of the alternative from the effects of sea level rise, climate change, and future water demands, the comparison to Existing Conditions may not offer a clear understanding of the impact of the alternative on the environment. This suggests that the comparison in results between the alternative and NAA, is a better approach because it isolates the effect of the alternative from those of sea level rise, climate change, and future water demands.

When compared to NAA and informed by the NEPA analysis above, there would be negligible effects on mean monthly flow and water temperatures for the juvenile and adult migration periods. Therefore, it is concluded that this impact is less than significant and no mitigation is required.

Environmental Commitments 4, 6, 7, and 10

As described for delta smelt and longfin smelt, Alternative 4A includes a greatly reduced extent of restoration measures relative to Alternative 4 and Alternative 1A, upon which the discussion of impacts for Alternative 4 is based. *Environmental Commitment 4 Tidal Natural Communities Restoration* is reduced from 65,000 acres to 59 acres, so that any impacts would be extremely small; *Environmental Commitment 6 Channel Margin Enhancement* is reduced from 20 miles to 4.6 miles and *Environmental Commitment 7 Riparian Natural Community Restoration* is reduced from 5,000 acres to 205 acres. The mechanisms of impacts of habitat restoration on winter-run Chinook salmon are anticipated to be similar under Alternative 4A to those described in detail for Alternative 1A, although the magnitude would be considerably reduced in proportion to the difference in restoration area. The effects of restoration measures described for delta smelt under Alternative 1A

(Impacts AQUA-43 through AQUA-45) appropriately disclose the nature of the anticipated effects of habitat restoration Environmental Commitments in Alternative 4A on Chinook salmon.

The following impacts are those presented under Alternative 4 and Alternative 1A that are anticipated to be similar in nature for Alternative 4A, but would occur to a lesser extent because of the reduced extent of the restoration measures as Environmental Commitments under Alternative 4A.

Impact AQUA-43: Effects of Construction of Restoration Measures on Chinook Salmon (Winter-Run ESU)

The effects of construction of restoration measures on winter-run Chinook salmon under Alternative 4A are similar in nature to those discussed in more detail under Alternative 1A: temporary increases in turbidity; increased exposure to mercury and methylmercury; accidental spills; disturbance of contaminated sediments; in-water work activities; and predation. In-water and shoreline restoration construction activities may result in short-term effects on winter-run Chinook salmon through direct disturbance, short-term water quality impacts, and increased exposure to contaminants associated with the incidental disturbance of contaminated sediments. Overall and as noted for Alternative 1A, the effect of restoration construction activities on the bioavailability of contaminants is expected to be minimal, as they would likely be localized, sporadic, and of low magnitude. Implementation of the environmental commitments described in Appendix 3B, *Environmental Commitments*, would minimize or eliminate effects on winter-run Chinook salmon. The relevant environmental commitments are: *Environmental Training; Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; Hazardous Materials Management Plan; Spill Prevention, Containment, and Countermeasure Plan; and Disposal of Spoils, Reusable Tunnel Material, and Dredged Material.* Pertinent details of these plans are provided under Impact AQUA-1 for delta smelt under Alternative 1A. Given the greatly reduced extent of restoration under Alternative 4A relative to Alternative 1A, the effects of construction of restoration measures on winter-run Chinook salmon would be expected to be less than for Alternative 1A.

NEPA Effects: The effects of short-term construction activities would not be adverse to winter-run Chinook salmon due the environmental commitments described above as well as the limited extent of restoration that would occur.

CEQA Conclusion: As discussed for Alternative 1A, habitat restoration activities could result in short-term effects on winter-run Chinook salmon but would be localized, sporadic, and of low magnitude; such effects would be avoided by limiting the frequency, duration, and spatial extent of in-water work and with implementation of environmental commitments (see Appendix 3B, *Environmental Commitments*). The potential impact of habitat restoration activities is considered less than significant because it would not substantially reduce winter-run Chinook salmon habitat, restrict its range, or interfere with its movement. No additional mitigation would be required.

Impact AQUA-44: Effects of Contaminants Associated with Restoration Measures on Chinook Salmon (Winter-Run ESU)

Alternative 4A habitat restoration actions could result in the disturbance or mobilization of upland and aquatic contaminants that could affect winter-run Chinook salmon (e.g., by causing bioaccumulation). A detailed analysis of the potential effects based on the larger extent of tidal habitat restoration proposed under Alternative 4 can be found in the *BDCP Effects Analysis – Appendix 5D*, *Contaminants (hereby incorporated by reference)*. Potential impacts on winter-run

Chinook salmon from effects of methylmercury, selenium, copper, ammonia, and pesticides associated with habitat restoration activities would be similar to those discussed for delta smelt (see Impact AQUA-8). The Yolo Bypass, a notable rearing area for juvenile Chinook salmon, is an area expected to be among the highest for potential methylmercury production and would be inundated more under improvements that would be implemented as part of the NAA_ELT (see discussion in section 4.2.7 of Section 4) and that would also exist under Alternative 4A. While juvenile Chinook salmon show high spatial variability in the bioaccumulation of methylmercury (Henery et al. 2010), it has not been demonstrated that these accumulations impair small fishes. Future exposure levels in restored habitats that are similar to current levels may not affect the species' viability, though they may be of concern for passing mercury up the food web to birds and humans. As described in *BDCP Effects Analysis – Appendix D*, *Contaminants, Section 5D.4.1 Mercury (hereby incorporated by reference)*, the amounts of methylmercury mobilized and resultant effects on covered fish species are not currently quantifiable.

Within the relatively small extent of habitat restored under *Environmental Commitment 4 Tidal Natural Communities Restoration*, it is anticipated that any potential effects of methylmercury on winter-run Chinook salmon will be addressed through implementation of Environmental Commitment 12. Environmental Commitment 12 is intended to minimize methylmercury exposure associated with restoration measures for juvenile Chinook salmon. Additional analysis and tools may be developed to further reduce methylmercury exposure as the habitat restoration actions are refined and analyzed in site-specific documents. The site-specific analysis is the appropriate place to assess the potential for risk of methylmercury exposure for Chinook salmon once site-specific sampling and other information can be developed.

NEPA Effects: The effect contaminants related to restoration is not adverse to winter-run Chinook salmon with respect to selenium, copper, ammonia, pesticides, and methylmercury (with implementation of Environmental Commitment 12).

CEQA Conclusion: Alternative 4A restoration actions are likely to result in slightly increased production, mobilization, and bioavailability of methylmercury. However, implementation of *Environmental Commitment 12 Methylmercury Management* would help to minimize the increased mobilization of methylmercury from restoration areas. Therefore, the impact of contaminants is considered less than significant because it would not substantially affect winter-run Chinook salmon either directly or through habitat modifications. Consequently, no mitigation would be required.

Impact AQUA-45: Effects of Restored Habitat Conditions on Chinook Salmon (Winter-Run ESU)

Restored habitat under *Environmental Commitment 4 Tidal Natural Communities Restoration* and *Environmental Commitment 6 Channel Margin Enhancement* is intended to offset habitat loss/modification caused by construction and operation of the water facilities proposed under Alternative 4A.

NEPA Effects: The effects of restored habitat conditions on winter-run Chinook salmon would not be adverse because restoration is intended to provide habitat benefits to Chinook salmon.

CEQA Conclusion: As described above, habitat restoration would be undertaken to offset loss/modification of habitat from water facility construction and operation. The effects of restored habitat conditions on winter-run Chinook salmon would be less than significant. Consequently, no mitigation would be required.

Environmental Commitments 12, 15, and 16

As noted for delta smelt and longfin smelt, Alternative 4A includes three other Environmental Commitments environmental commitments, which are reduced in their extent relative to the Conservation Measures included in other alternatives in the Draft EIR/EIS (e.g., Alternative 1A and Alternative 4). While the extent of these commitments is reduced compared to these alternatives, the nature of the mechanisms remains the same.

Impact AQUA-46: Effects of Methylmercury Management on Chinook Salmon (Winter-Run ESU) (Environmental Commitment 12)

As noted under Impact AQUA-10 for delta smelt under Alternative 4A, Environmental Commitment 12 will attempt to minimize conditions that promote production of methylmercury in restored areas and its subsequent introduction to the foodweb, and to covered species such as winter-run Chinook salmon. As described for Alternative 1A, Environmental Commitment 12 describes pre-design characterization, design elements, and best management practices to attempt to minimize methylation of mercury, and requires monitoring and reporting of observed methylmercury levels.

NEPA Effects: The effects of methylmercury management on winter-run Chinook salmon would not be adverse because it is expected to reduce overall methylmercury levels resulting from habitat restoration.

CEQA Conclusion: Effects of *Environmental Commitment 12 Methylmercury Management* within the areas restored under Alternative 4A are expected to reduce overall methylmercury levels resulting from habitat restoration. Because it is designed to improve water quality and habitat conditions, impacts would be less than significant. Consequently, no mitigation is required.

Impact AQUA-49: Effects of Localized Reduction of Predatory Fish on Chinook Salmon (Winter-Run ESU) (Environmental Commitment 15)

Environmental Commitment 15 Localized Reduction of Predatory Fish would involve efforts to reduce predation by predatory fish at the proposed north Delta intakes and at the south Delta export facilities, including Clifton Court Forebay.

NEPA Effects: To the extent that localized predator control efforts of *Environmental Commitment 15 Localized Reduction of Predatory Fish* reduce the local abundance of fish predators at the north Delta diversions and near the south Delta export facilities (e.g., in Clifton Court Forebay), it is possible, but not assured, that there would be some reduction in losses to predation of juvenile winter-run Chinook salmon (predation of adults is not a concern). This is of relevance given the potential effects on winter-run Chinook salmon juveniles because of operations of the NDD (see Impact AQUA-42). Environmental Commitment 15 would not have an adverse effect on Chinook salmon and could potentially benefit the species. Due to the uncertainty in the effectiveness of Environmental Commitment 15, however, it is concluded that there would be no demonstrable effect of this commitment on Chinook salmon.

CEQA Conclusion: Environmental Commitment 15 would not have a significant impact on Chinook salmon and could potentially benefit the species. Due to the uncertainties associated with this Environmental Commitment, however, it is concluded that there would be no demonstrable effect on winter-run Chinook salmon. Consequently, no mitigation would be required.

Impact AQUA-50: Effects of Nonphysical Fish Barriers on Chinook Salmon (Winter-Run ESU) (Environmental Commitment 16)

Under Alternative 4A, an NPB at the divergence of Georgiana Slough from the Sacramento River would be intended to guide juvenile salmonid fish such as winter-run Chinook salmon away from Georgiana Slough and the interior Delta, wherein survival is relatively low compared to the Sacramento River (Perry et al. 2010). Exploration with the DPM of the potential effects of an NPB at this location suggests that with effectiveness similar to that observed during a pilot study in 2011 (Perry et al. 2012), through-Delta survival of winter-run Chinook salmon juveniles would not differ greatly between Alternative 4A and Existing Conditions or NAA_ELT (see Table 5.C.5.3-36 in the *BDCP Effects Analysis Appendix 5.C hereby incorporated by reference*). As discussed for Alternative 1A, the physical structure of an NPB may provide habitat for piscivorous fish in the area and increase localized predation risk, but the NPB is intended to improve migratory conditions for juvenile Sacramento River salmon, limiting their overall susceptibility to predation in the Delta.

NEPA Effects: The effects of NPBs would not be adverse because it would improve migration conditions for Chinook salmon.

CEQA Conclusion: As discussed above, the NPB at the divergence of Georgiana Slough from the Sacramento River has the potential to reduce the proportion of winter-run Chinook salmon entering the low-survival interior Delta. The impacts of *Environmental Commitment 16 Nonphysical Fish Barriers* are expected to be less than significant. Consequently, no mitigation would be required.

Spring-Run Chinook Salmon

Construction and Maintenance of Water Conveyance Facilities

The discussion of potential effects to delta smelt from construction and maintenance of the water conveyance facilities under Alternative 4A is also relevant to spring-run Chinook salmon. Adult and juvenile spring-run Chinook salmon would have the potential to overlap construction and maintenance to a minor degree (Table 11-8).

Impact AQUA-55: Effects of Construction of Water Conveyance Facilities on Chinook Salmon (Spring-Run ESU)

The potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be the same as described for Alternative 4 (Impact AQUA-55). The potential effects of underwater noise as a result of construction of the water conveyance facilities on spring-run Chinook salmon would be the same as described above for winter-run Chinook (Impact AQUA-37), which provides additional detail on underwater noise impacts which are also applicable to Impact AQUA-55 in Alternative 4.

NEPA Effects: Potential effects of construction of the water conveyance facilities on spring-run Chinook salmon would be similar to those discussed for winter-run Chinook salmon (see Impact AQUA-37 for winter run Chinook salmon). Construction of Alternative 4A involves several elements with the potential to cause adverse effects on spring-run Chinook salmon. However, these turbidity and hazardous material spill effects will be effectively avoided and/or minimized through implementation of environmental commitments (see Impact AQUA-1 and Appendix 3B, *Environmental Commitments*: *Environmental Training*; *Stormwater Pollution Prevention Plan*; *Erosion and Sediment Control Plan*; *Hazardous Materials Management Plan*; *Spill Prevention, Containment,*