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Section C.5.4

Delta Habitat (Plan Area) Results

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C.5.4 Delta Habitat (Plan Area) Results

C.5.4.1 Yolo Bypass Floodplain Habitat (CM2 Yolo Bypass Fisheries Enhancement)

C.5.4.1.1 Sacramento Splittail Habitat Area

The most important spawning habitat for splittail occurs in the seasonally inundated floodplains of the Sutter and Yolo Bypasses of the Sacramento River. The analysis of floodplain habitat availability for splittail is directed primarily at the egg/embryo, larval, and juvenile stages because production of these life stages is especially important in determining year class abundance and because some information is available regarding their habitat requirements. As noted in the methods, only depth was considered in the habitat suitability indices because velocity was generally very low over the modeled area (lower velocities are generally suitable for splittail spawning) (Figure C.5.4-1).

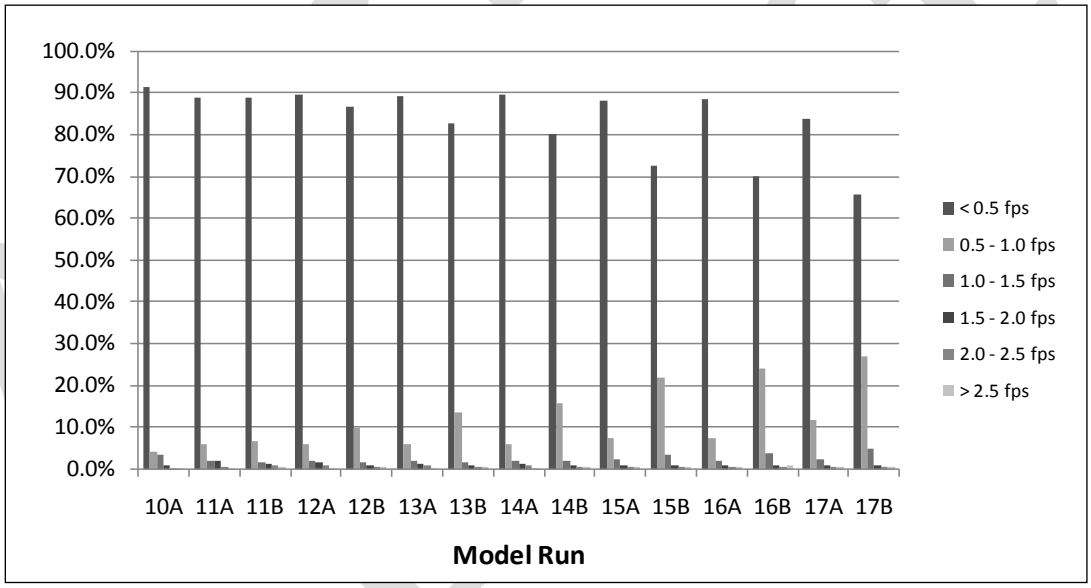

Figure C.5.4-1. Percentages of Total Surface Area with Six Flow Velocity Ranges in the Yolo Bypass from 15 2-D Modeling Runs

Results of the analyses show that the frequency and duration of inundation events are greater under the preliminary proposal (PP) than under either of the existing biological conditions (EBC1 and EBC2), especially for dry and critical year types (Figure C.5.4-2). Note that only the inundation events lasting more than 30 days are considered biologically beneficial to splittail. For wet year types in particular, the preliminary proposal results in a reduced frequency of shorter-duration events and an increased frequency of longer-duration events. This change is attributable to the influence of the Fremont Weir notch at lower flows.

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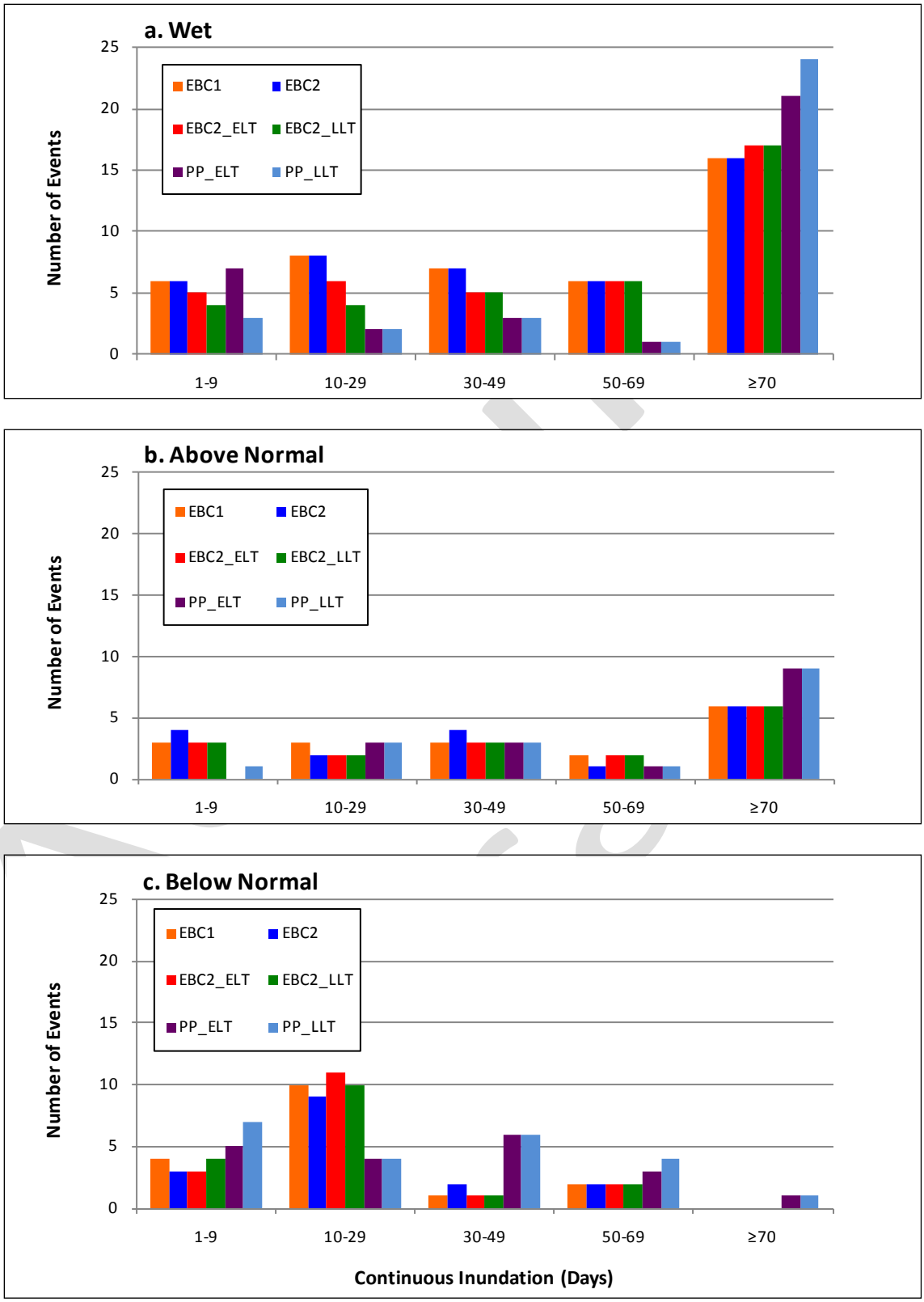

Figure C.5.4-2. Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs

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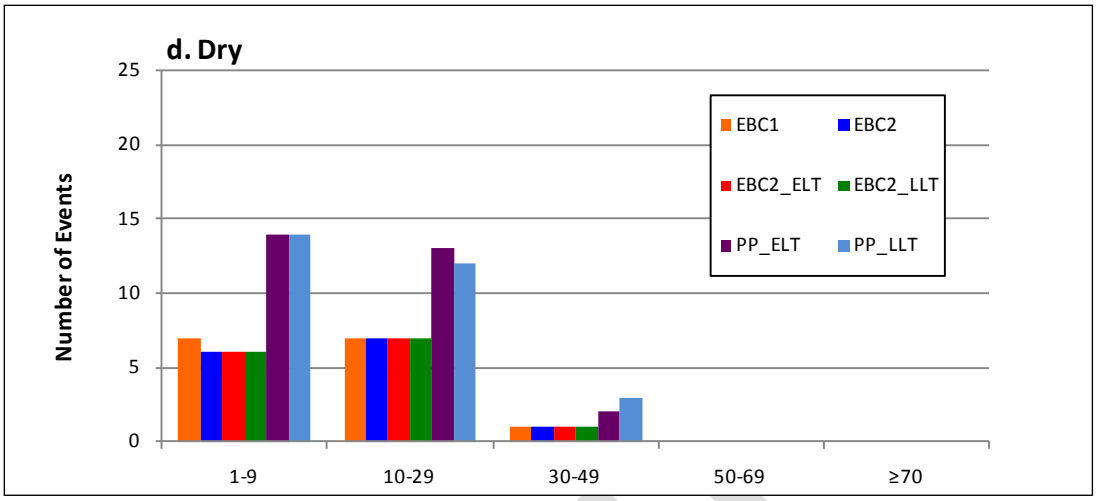

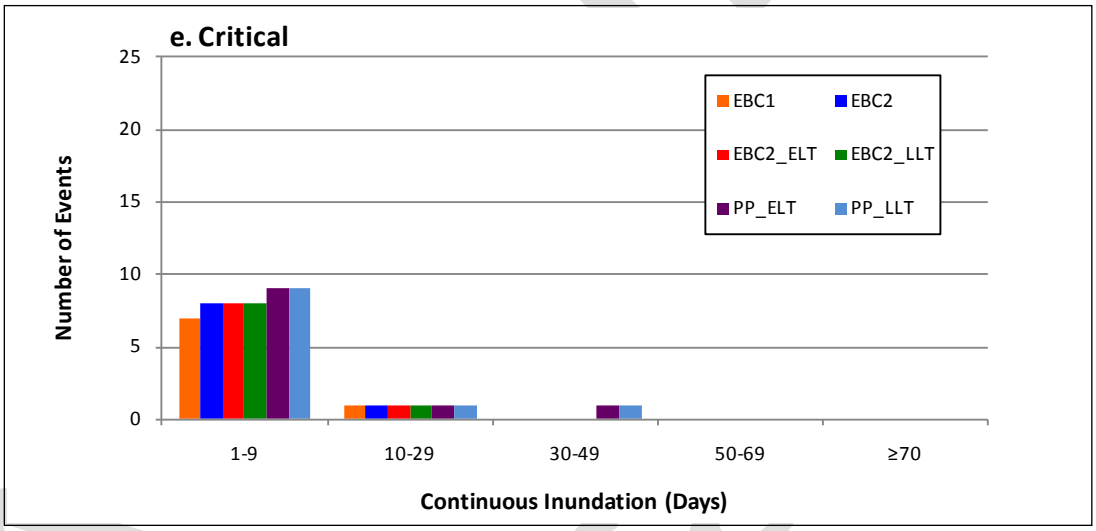

Figure C.5.4-3. Frequencies of Inundation Events (for 82-Year Simulations) of Different Durations on the Yolo Bypass under Different Scenarios and Water Year Types, February through June, from 15 2-D and Daily CALSIM II Modeling Runs (continued)

Results of the analyses also indicate that total surface areas of splittail habitat in the Yolo Bypass are substantially higher under the preliminary proposal than under EBC1 or EBC2 (Table C.5.4-1, Figure C.5.4-4).

Table C.5.4-1. Percent Increase in Splittail Weighted Habitat Area in Yolo Bypass from Existing Biological Conditions to Preliminary Proposal by Water Year Type from 15 2-D and Daily CALSIM II Modeling Runs

	PP_ELT			PP_LLT		
Water Year Type	**vs. EBC1**	**vs. EBC2**	**vs. EBC2_ELT**	**vs. EBC1**	**vs. EBC2**	**vs. EBC2_LLT**
Wet	71.6%	72.5%	62.0%	71.2%	72.1%	59.1%
Above Normal	65.0%	70.6%	65.7%	66.9%	72.5%	67.8%
Below Normal	269.2%	281.7%	281.4%	273.7%	286.3%	295.6%
Dry	NA[1]	NA	NA	NA	NA	NA
Critical	NA	NA	NA	NA	NA	NA

[1] NA: percent differences could not be computed for dry and critical year types because no splittail weighted habitat occurred in the bypass in those years for EBC scenarios.

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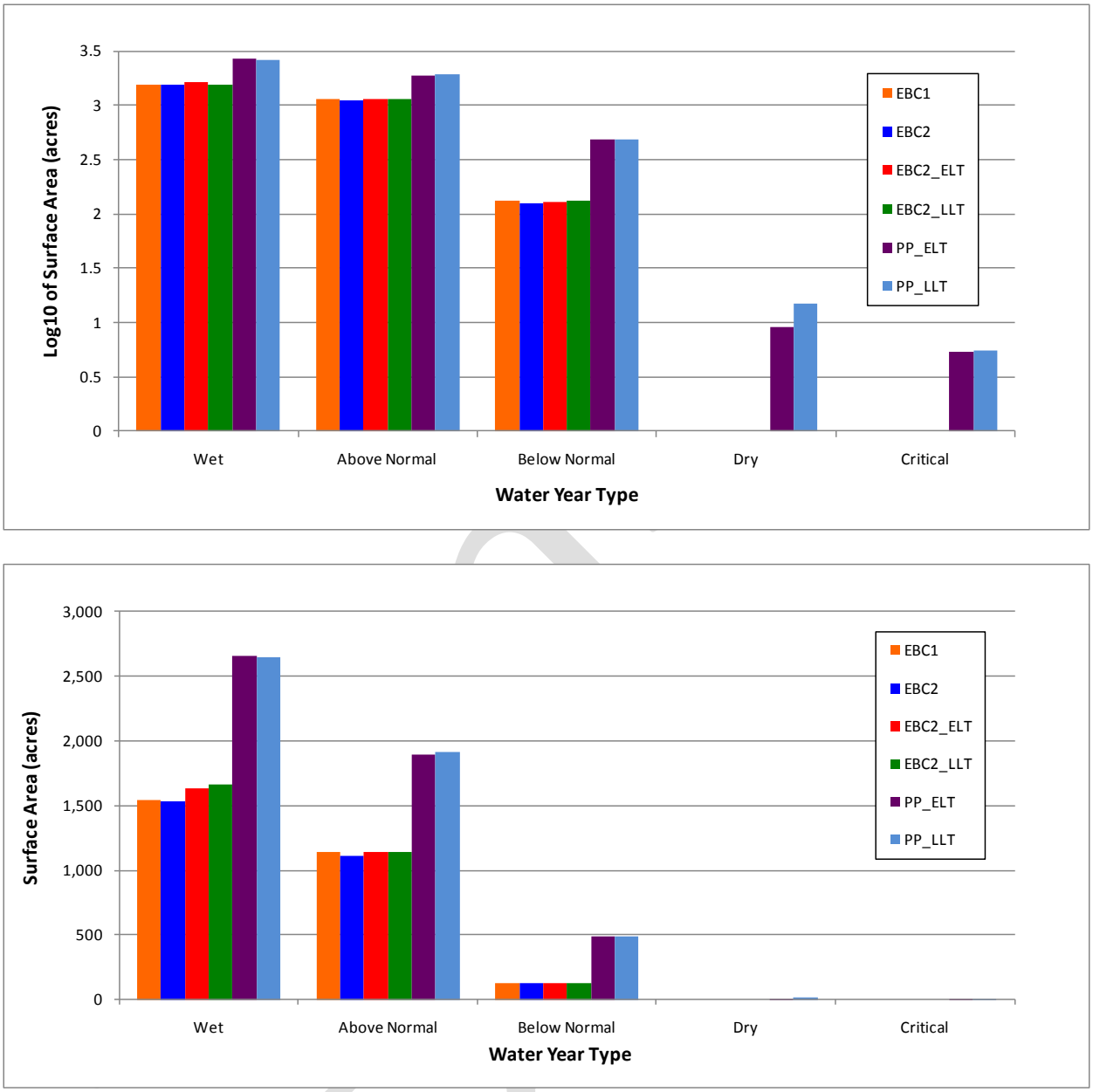

Figure C.5.4-4. Splittail Daily Average Weighted Habitat Area in Yolo Bypass for Each Modeling Scenario by Water Year Type, Shown on a Log (above) and Arithmetic (below) Scale

Figure C.5.4-5 compares the frequencies and cumulative frequencies, respectively, of daily average surface areas of habitat simulated under each model scenario. The figures show that, in comparison to the existing biological conditions, the preliminary proposal results in reductions in the frequency of days with no habitat area and an increase in the frequency of days with the largest total habitat areas. The reduced frequency of years with no habitat area reflects the influence of the Fremont Weir notch. Inundation events with the largest habitat areas result from flood flows, but the notch extends the duration of such events, resulting in higher average habitat areas for a year.

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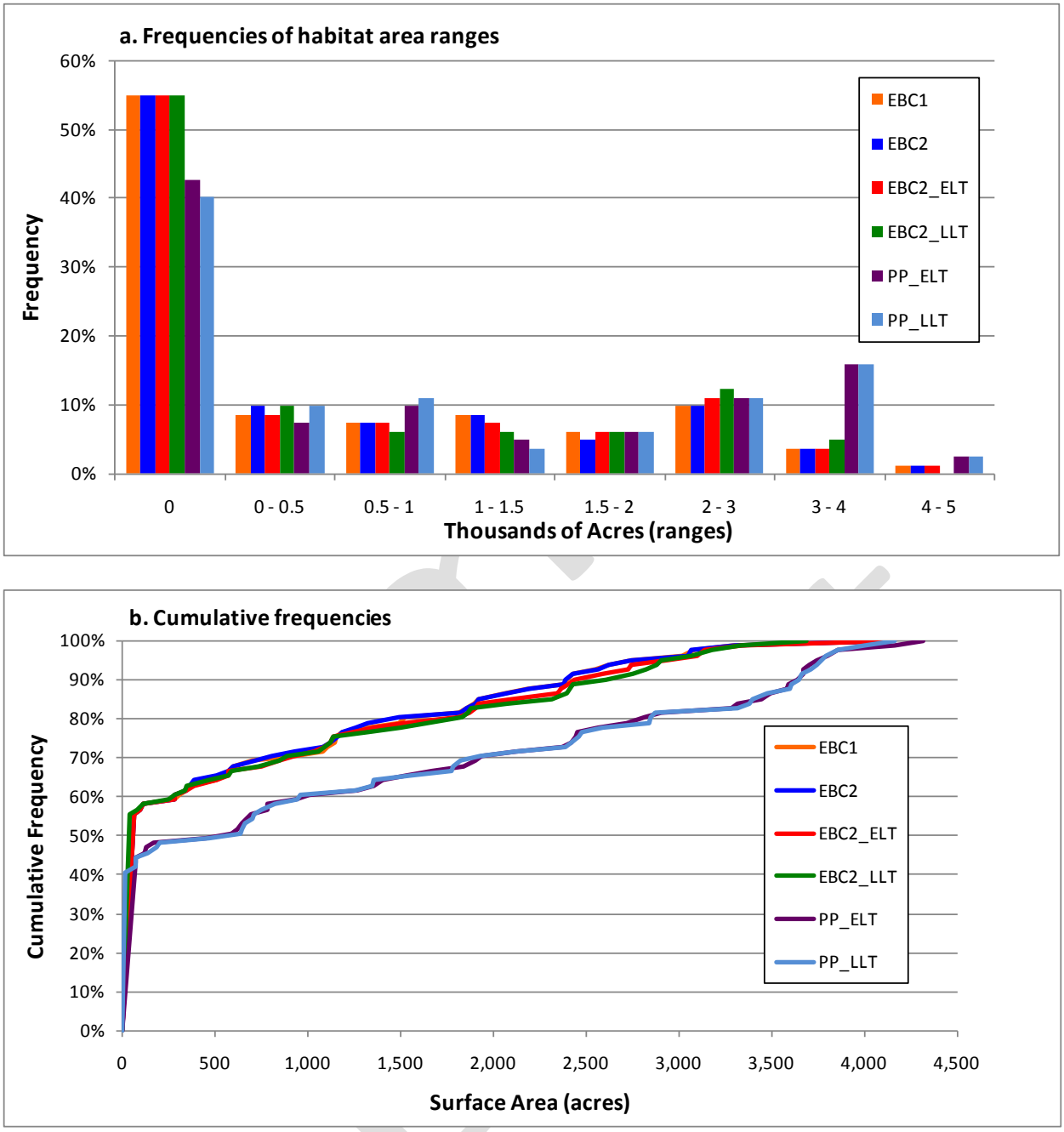

Figure C.5.4-5. Frequencies (a) and Cumulative Frequencies (b) of Splittail Daily Average Weighted Habitat Area in the Yolo Bypass, for Each Model Scenario

A potential adverse effect of CM2 that is not included in the modeling is reduced inundation of the Sutter Bypass as a result of increased flow diversion at the Fremont Weir. The Fremont Weir notch with gates opened would increase the amount Sacramento River flow diverted from the river into the bypass when the river's flow is greater than about 14,600 cfs (Munévar pers. comm.). As much as about 6,000 cfs more flow would be diverted from the river with the opened notch than without the notch, resulting in a 6,000 cfs decrease in Sacramento River flow at the weir. A decrease of 6,000 cfs in the river, according to rating curves developed for the river at the Fremont Weir, could result in as much as 3 feet of reduction in river stage (Munévar pers. comm.), although

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understanding of how notch flows would affect river stage is incomplete (Kirkland pers. comm.). In any case, a lower river stage at the Fremont Weir would be expected to result in a lower level of inundation in the lower Sutter Bypass. Because of the uncertainties regarding how drawdown of the river will propagate, the relationship between notch flow and the magnitude of lower Sutter Bypass inundation is poorly known. Despite this uncertainty, it is evident that CM2 has the potential to reduce some of the habitat benefits of Yolo Bypass inundation on splittail production due to effects on Sutter Bypass inundation. Splittail use the Sutter Bypass for spawning and rearing as they do the Yolo Bypass.

While the results presented here are preliminary, it appears unlikely that refinements in the analysis methods would affect the conclusion that the preliminary proposal CM2 would substantially increase available habitat for all the floodplain-dependent life stages of splittail on the Yolo Bypass. The results indicate that the increases, on a percentage basis, would be particularly large in drier year types, when, historically, availability of this habitat has been especially low.

C.5.4.1.2 Stranding (Steelhead, Chinook Salmon, Sacramento Splittail, White Sturgeon, and Green Sturgeon)

Due to a lack of quantitative tools and historical data to use in the analysis of preliminary proposal effects on stranding of migratory species, the following provides a narrative summary of potential effects. The Yolo Bypass is exceptionally well-drained because of grading for agriculture, which likely helps limit stranding mortality of covered species such as Sacramento splittail and juvenile Chinook salmon. Moreover, water stage decreases on the bypass are relatively gradual (Sommer et al. 2001). Stranding of Sacramento splittail in perennial ponds on the Yolo Bypass does not appear to be a problem under existing conditions (Feyrer et al. 2004). CM2 includes a number of actions designed, in part, to further reduce the risk of stranding. Such actions include grading; removal of existing berms, levees, and water control structures; construction of new berms or levees; and reworking of agricultural delivery channels and the Tule Canal/Toe Drain. These actions would allow water to inundate certain areas of the bypass to maximize biological benefits, while keeping water away from other areas to reduce stranding in isolated ponds. Actions under the preliminary proposal to increase the frequency of Yolo Bypass inundation would increase the frequency of potential stranding events. For splittail, an increase in inundation frequency would also increase the production of Sacramento splittail in the bypass. While total stranding losses may be greater under preliminary proposal conditions than under EBC1 or EBC2, the total number of splittail would be expected to be greater under the preliminary proposal.

In the Yolo Bypass, Sommer et al. (2005) found these potential losses are offset by the improvement in rearing conditions. Henning et al. (2006) also noted the potential for stranding risk as wetlands desiccate and oxygen concentrations decline, but the seasonal timing of use by juvenile salmonids may decrease these risks. Sommer et al. (2005) addressed the question of stranding and concluded the potential improvements in habitat capacity outweighed the potential stranding problems that may exist in some years.

Delta Regional Ecosystem Restoration Implementation Plan Evaluation of Stranding

The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) (2009) evaluation of Fremont Weir and Yolo Bypass Inundation (previously referred to as Water Operations Conservation Measure 2), Outcome N3 (Increased stranding of covered species) resulted in the

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following summary related to stranding of adults and juveniles of covered fish species (adapted from DRERIP [2009]; note that this summary also includes reference to passage issues, which were previously described in Section C.5.3).

Sacramento Splittail (Adult and Juvenile)

Connectivity problems can strand splittail (Opperman 2008: page 27, citing Sommer et al. 2005). The approach specified for this action includes grading, which may reduce this risk; however, the specifics are not known.

- Magnitude = 1: Densities of splittail are low in isolated ponds in the Yolo Bypass (California Department of Water Resources unpublished data; Feyrer et al. 2004).
- Certainty = 4: Sommer et al. (2005) showed that there is relatively little ponded area following floodplain inundation. Low level of ponding reduces stranding.

Green/White Sturgeon (Adult/Juvenile)

Current Fremont and Sacramento Weirs create stranding and passage problems for white sturgeon and green sturgeon (Sommer et al. 2005; Harrell and Sommer 2003). Observations indicate substantial legal/illegal harvest resulting from blocked passage.

- Magnitude = 1: Blocked passage will be minimal behind the modified weir as it will be designed to improve passage, and grading will limit stranding on the floodplain for adults.
- Certainty = 4: The assumption is that the problem of blocked passage will be resolved by the modifications to the weir.

Steelhead[1]

Adult passage of white sturgeon, green sturgeon, splittail, steelhead, and salmon is likely constrained in the Yolo Bypass (Harrell and Sommer 2003). Current Fremont and Sacramento Weirs create stranding problems for white sturgeon and green sturgeon (Sommer et al. 2005); hence, efforts to improve passage and redesign weirs will reduce stranding (Harrell and Sommer 2003).

- Magnitude = 1 (adults), 2 (juveniles): Blocked passage will be minimal behind the modified weir as it will be designed to improve passage, and grading will limit stranding on the floodplain for adults. Juveniles are more susceptible to stranding; thus, the effect is greater.
- Certainty = 4: Evidence is good that efficient drainage results in low stranding (Sommer et al. 2005); hence, additional grading should prevent stranding.

Chinook Salmon

Most juvenile Chinook salmon can exit the existing floodplain configuration (Sommer et al. 2005). Adult passage of salmon is likely constrained in the Yolo Bypass (Harrell and Sommer 2003). Current Fremont and Sacramento Weirs create stranding problems for salmonids (Sommer et al. 2005); hence, efforts to improve passage and redesign weirs will reduce stranding (Harrell and Sommer 2003). Assumption is that operable gates/ladders would be operable at all times to allow year-round passage.

[1] Although the majority of this text applies to sturgeon, it also is relevant to steelhead.

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- Magnitude = 1 (adults), 2 (juveniles): Stranding is minimal on the Yolo Bypass now. This proposal will further reduce stranding behind the weir because the new weir design will improve passage and the floodplain will be graded. There is some possibility of reduced passage if migrating salmon encounter the modified structure when it is closed or there is insufficient flow to allow passage.
- Certainty = 4: Evidence is good that efficient drainage results in low stranding (Sommer et al. 2005); hence, additional grading should prevent stranding.

C.5.4.1.3 Fall-Run Chinook Salmon Fry Yolo Bypass Growth Analysis

Yolo Bypass Fry Rearing Model Results

Percentage of Fish Entering Yolo Bypass

Figure C.5.4-6 summarizes the differences in annual percentages of fall-run Chinook salmon juveniles entering the Yolo Bypass among the modeled scenarios for the 82-year simulation period. These differences reflect the effect of the timing and magnitude of upstream flows on fry movements in the Sacramento River and differences in spill characteristics of the Fremont Weir under existing and proposed weir modifications. Under the PP scenarios and associated weir modifications, fall-run Chinook salmon juveniles entered the Yolo Bypass in 74 (90%) of the years compared to 45–47 (55–57%) of the years under the EBC scenarios. Annual percentages of fish entering the Yolo Bypass ranged from 0–5% in most of the critical and dry years to more than 30% in wet years. The median percentage of fish entering the Yolo Bypass over the 82-year simulation period was 6% under the PP scenarios and ≤1% under the EBC scenarios.

Figure C.5.4-7 through Figure C.5.4-11 summarize the results by water year type. In critical years, Fremont Weir spills occurred only under the PP scenarios, resulting in <1–5% of the fall-run juveniles entering the Yolo Bypass in 6 out of the 12 critical water years; the median percentages of fish entering the Yolo Bypass were 0% under all scenarios. In dry years, annual percentages of juveniles entering the Yolo Bypass ranged from 0 to 8% of the total numbers passing the Fremont Weir; spills occurred in most years under the PP scenarios but in only 4 of the 18 dry water years under the EBC scenarios. The median percentages of fish entering the Yolo Bypass were 3% under the PP scenarios and 0% under the EBC scenarios. Spills occurred in all below normal water years under the PP scenarios but in only 5–6 years out of 14 years under the EBC scenarios; the median percentage of fish entering the Yolo Bypass was 5% under the PP scenarios and 0% under the EBC scenarios. In above normal years (total = 12 years), the frequency and magnitude of spills increased substantially under all scenarios, resulting in median values of 10–11% of juveniles entering the Yolo Bypass under the PP scenarios and 4–6% of juveniles entering the Yolo Bypass under the EBC scenarios. The frequency and magnitude of spills increased further in wet years (total = 26 years), with median values of 20% of fry entering the Bypass under the PP scenarios and 15–17% entering under the EBC scenarios.

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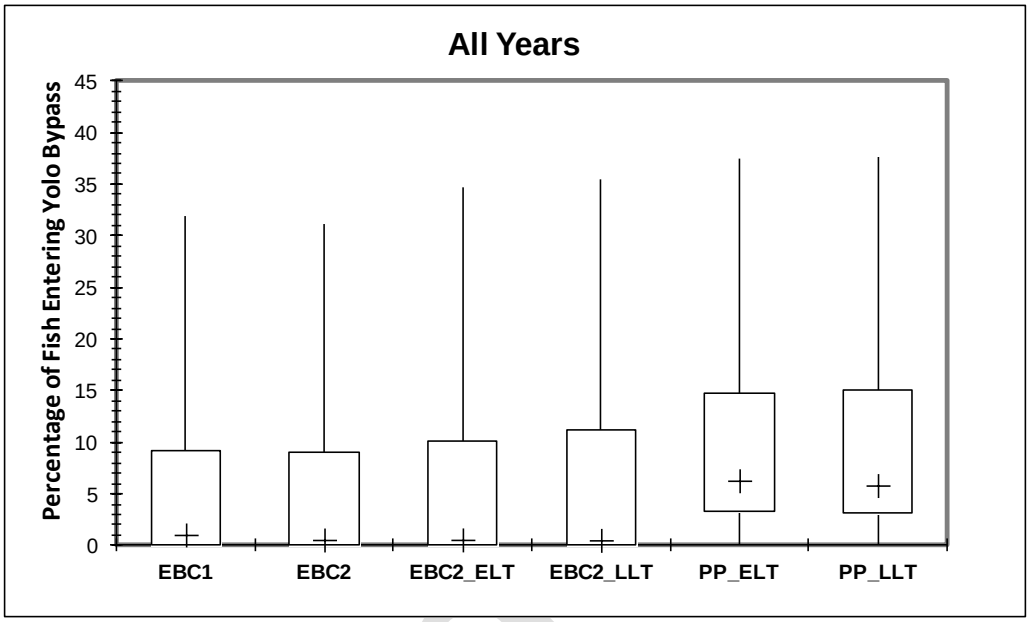
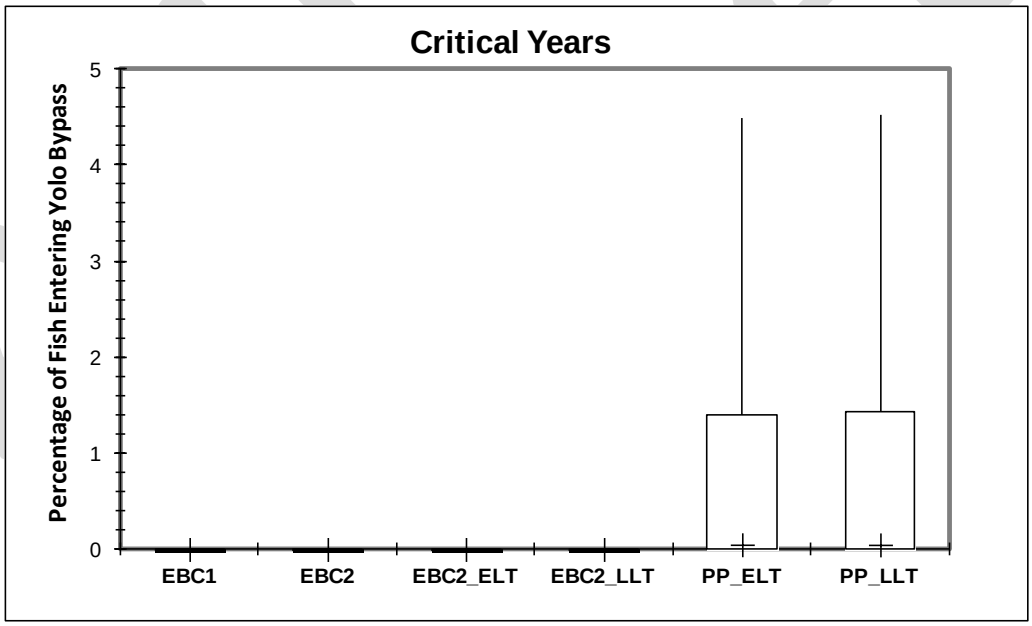


Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-6. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for All Modeled Years



Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-7. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for Critical Water Years

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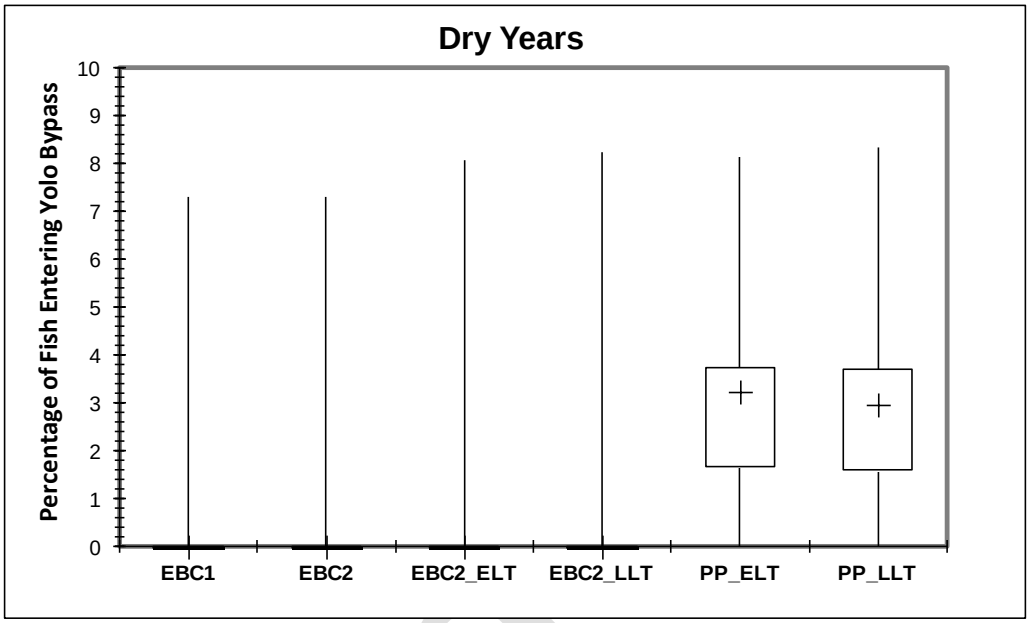
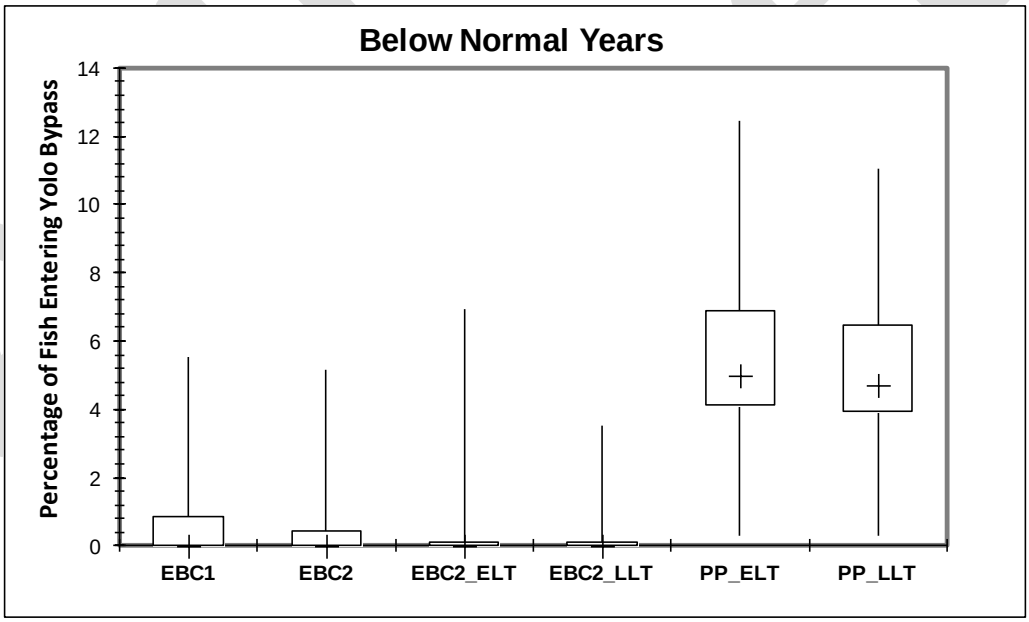


Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-8. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for Dry Water Years



Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-9. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for below Normal Water Years

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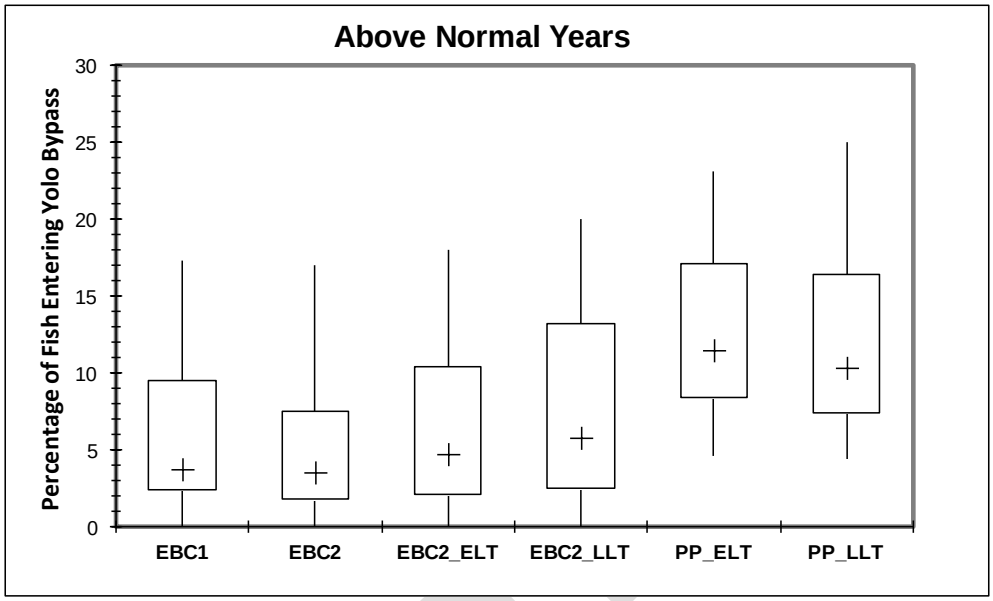
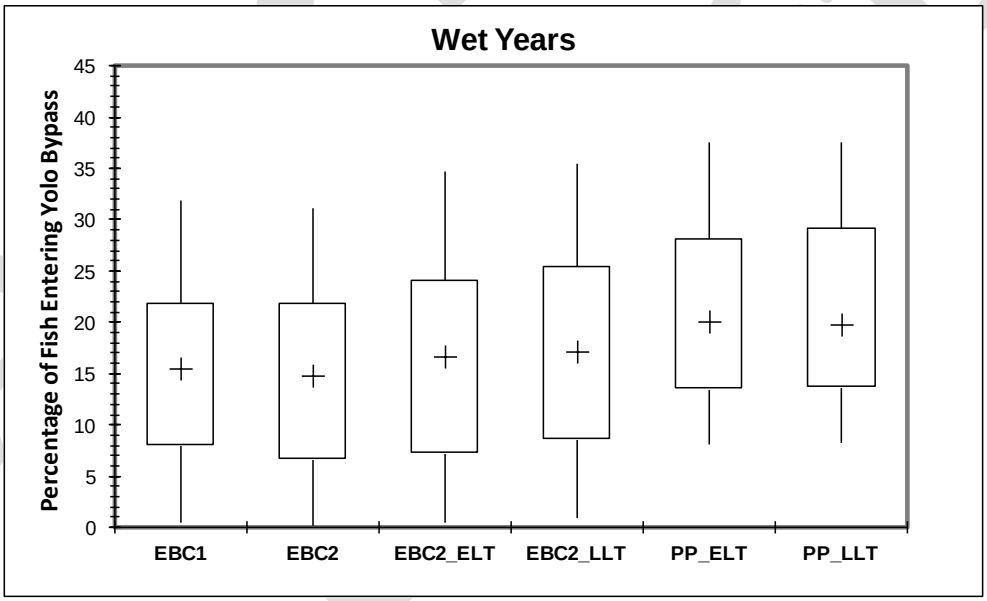


Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-10. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for above Normal Water Years



Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum annual percentages by modeled scenario.

Figure C.5.4-11. Percentage of Juvenile Fall-Run Chinook Salmon Entering Yolo Bypass Based on YBFR Model Results for Wet Water Years

Returns to Ocean Fishery

Figure C.5.4-12 and Figure C.5.4-13 summarize the differences in annual return indices of fall-run Chinook salmon to the ocean fishery among the modeled scenarios for the 82-year simulation period. These differences reflect the effect of upstream flows and Fremont Weir spills on the percentages of juveniles entering the Yolo Bypass, relative differences in growth and survival of

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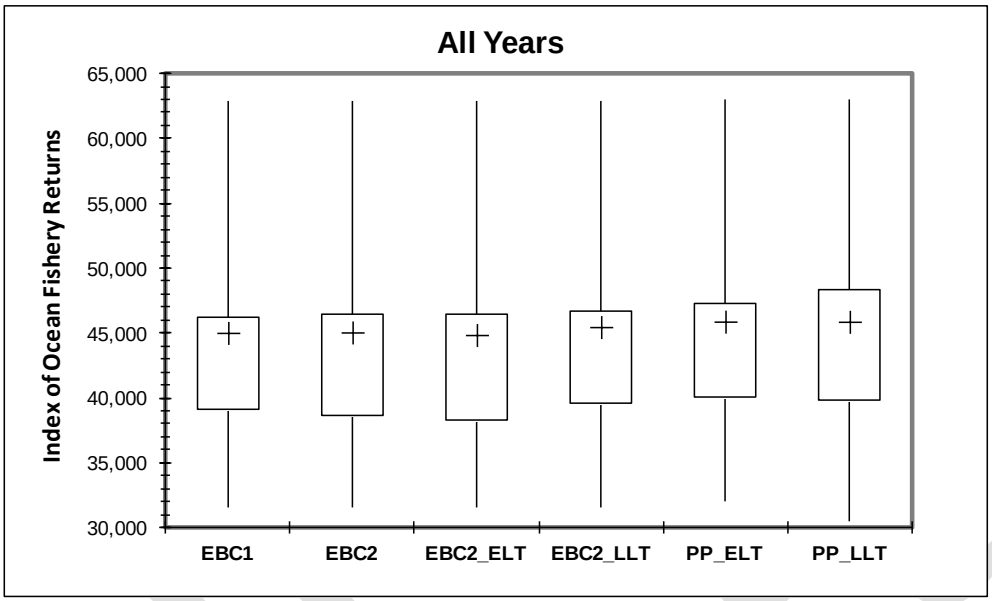
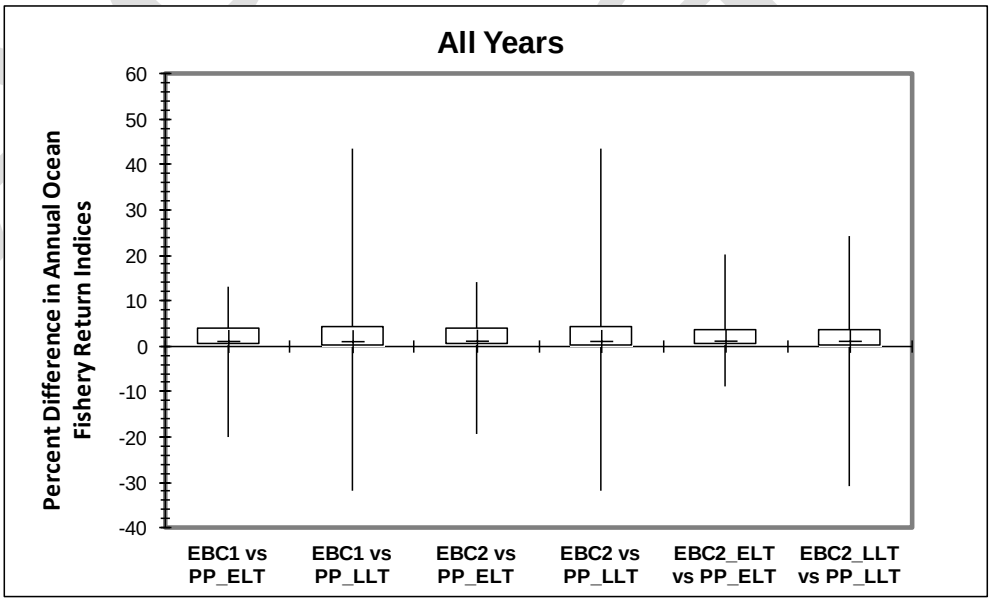
juveniles in the Yolo Bypass and Sacramento River, and the numbers and mean size of juveniles (smolts) entering the estuary. Over all years, annual fishery return indices were only slightly higher under the PP scenarios relative to the EBC scenarios; median annual returns under the PP scenarios were approximately 45,500 fish, which was 1.6% higher than median annual returns under the EBC scenarios (about 44,800 fish). These differences were similar across water year types.



Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum indices by modeled scenario.

Figure C.5.4-12. Fall-Run Chinook Salmon Ocean Fishery Return Indices Based on YBFR Model Results for All Modeled Years



Box and whisker plots show minimum, 25th, 50th (denoted by +), 75th, and maximum percent differences based on comparisons between PP and EBC scenarios. Positive differences indicate higher returns for PP scenarios.

Figure C.5.4-13. Percent Differences in Fall-Run Chinook Salmon Ocean Fishery Return Indices Based on YBFR Model Results for All Modeled Years

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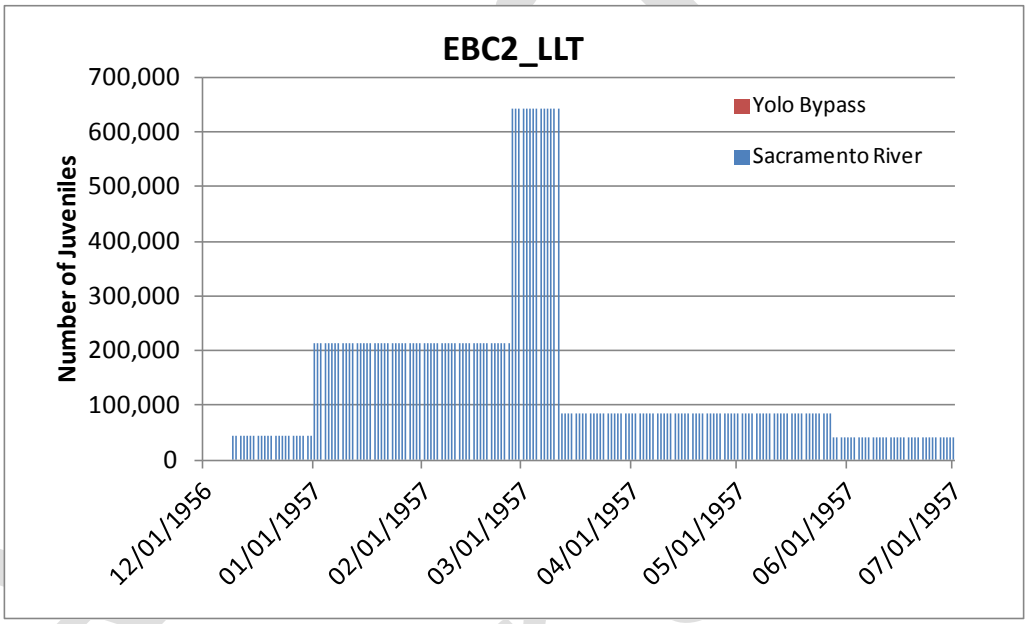
There were several years in which the PP_LLT scenarios resulted in substantially higher or lower returns than the EBC scenarios (Figure C.5.4-13). These differences appear to be related primarily to differences in upstream hydrology and reservoir operations and the frequency of flow events triggering peak fry movements in the Sacramento River. For example, in the 1957 year class, annual Chinook salmon returns to the ocean fishery associated with the PP_LLT were 31–32% lower than the annual returns under the EBC scenarios. An examination of the daily results revealed that higher Sacramento River flows under the PP_LLT resulted in two fry migration pulses versus only one pulse under the EBC scenarios. The resulting migration patterns and percentages of fish entering the Yolo Bypass under the EBC2_LLT and PP_LLT scenarios are shown in Figure C.5.4-14 and Figure C.5.4-15. The most important difference is the larger numbers of juveniles that emigrated as fry under the PP_LLT; approximately 90% of the juveniles emigrated as fry (before March 10) compared to approximately 70% under the EBC2_LLT.



No Fremont Weir spills occurred in 1957 under this scenario.

Figure C.5.4-14. Number of Fall-Run Chinook Salmon Juveniles Passing the Fremont Weir and Either Continuing Down the Sacramento River or Entering the Yolo Bypass Via the Fremont Weir Based on YBFR Model Results for the EBC2_LLT Scenario (Water Year 1957)

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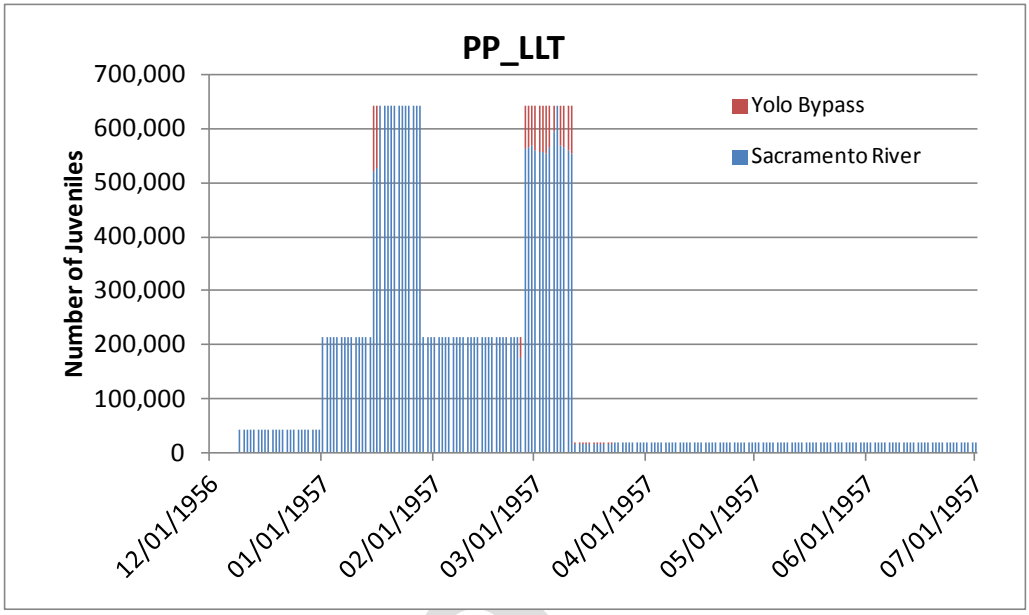

Figure C.5.4-15. Number of Fall-Run Chinook Salmon Juveniles Passing the Fremont Weir and Either Continuing Down the Sacramento River or Entering the Yolo Bypass Via the Fremont Weir Based on YBFR Model Results for the PP_LLT Scenario (Water Year 1957)

This example illustrates the tradeoffs incorporated into the model between the potential benefits associated with fry rearing on the Yolo Bypass floodplain and potential benefits associated with upstream rearing and emigration of juveniles later in the season in years with little or no floodplain availability. Under the PP_LLT scenario, only a small percentage of the fry that emigrated during the first migration pulse was able to enter the Yolo Bypass because spills over the Fremont Weir lasted only 2 days (Figure C.5.4-15). In addition, these fish experienced only minimal growth benefits because of the brief period of floodplain inundation (9 days including floodplain drainage). During the second migration pulse, a larger percentage of fish entered the Yolo Bypass and experienced up to 33 days of floodplain inundation (Figure C.5.4-15). Overall, however, the total numbers of fish that survived to the estuary were lower than those under the EBC2_LLT. Under the simulated flow and spill conditions in 1957, this can be explained by the larger percentage of fry that migrated to the lower Sacramento River, the lack of significant Fremont Weir spills and floodplain rearing opportunities during peak movements of fry, and the lower survival of fry compared to larger, later-migrating juveniles. Although no spills occurred during the fry emigration season under the EBC2_LLT, the total numbers of juveniles surviving to the estuary was bolstered by the relatively large contribution of larger juveniles that migrated to the lower Sacramento River later in the spring (after March 10) (Figure C.5.4-14).

These results for 1957 can be contrasted with those of 1998, a year in which annual Chinook salmon returns to the ocean fishery under the PP scenarios were 6–10% higher than under the EBC scenarios. In 1998, the Yolo Bypass was flooded nearly continuously between mid-January and early April. Figure C.5.4-16 and Figure C.5.4-17 show the migration patterns and proportions of fall-run Chinook salmon juveniles entering the Yolo Bypass based on application of YBFR model to simulated 1998 Sacramento River flows and Fremont Weir spills under the EBC2_LLT and PP_LLT scenarios. Because of similar flows under these two scenarios, the differences in ocean fishery returns are due largely to differences in the timing, duration, and magnitude of Fremont Weir spills. Under the PP_LLT, spills associated with floodplain inundation in the Yolo Bypass (≥3,000 cfs) occurred from

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January 1 through April 30 (120 days) and encompassed the entire fry migration period, including the fry migration pulse that occurred in mid-January (Figure C.5.4-17). Under the EBC2_LLT, spills associated with floodplain inundation did not occur until 5 days after the initiation of the fry pulse (Figure C.5.4-16). Overall, approximately 34% of the fall-run Chinook salmon juveniles passing the Fremont Weir entered the Yolo Bypass under the PP_LLT versus 26% under the EBC2_LLT.

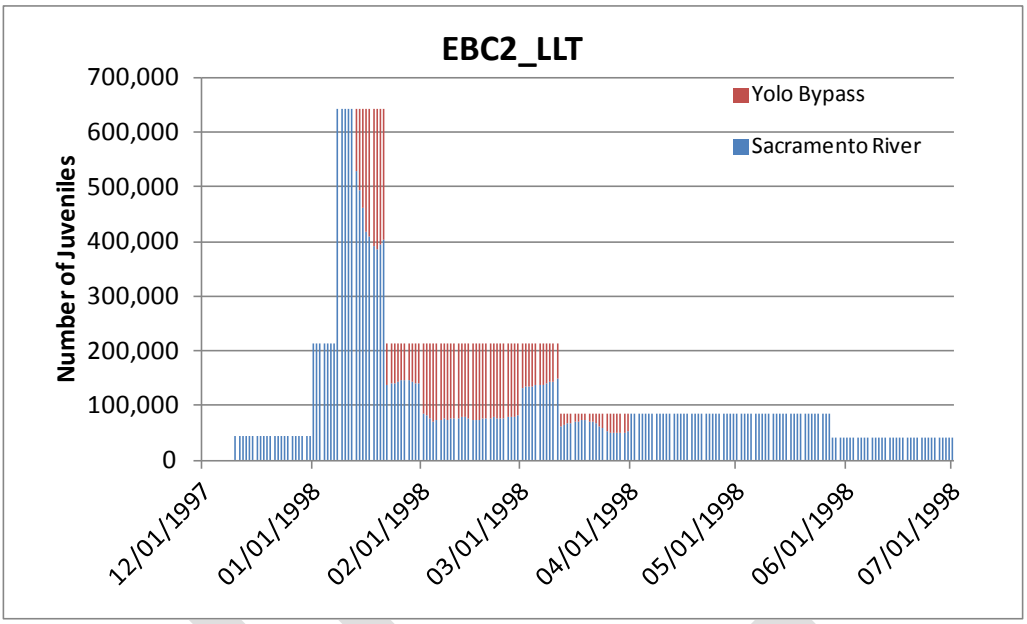

Figure C.5.4-16. Number of Fall-Run Chinook Salmon Juveniles Passing the Fremont Weir and Either Continuing Down the Sacramento River or Entering the Yolo Bypass Via the Fremont Weir Based on YBFR Model Results for the EBC2_LLT Scenario (Water Year 1998)

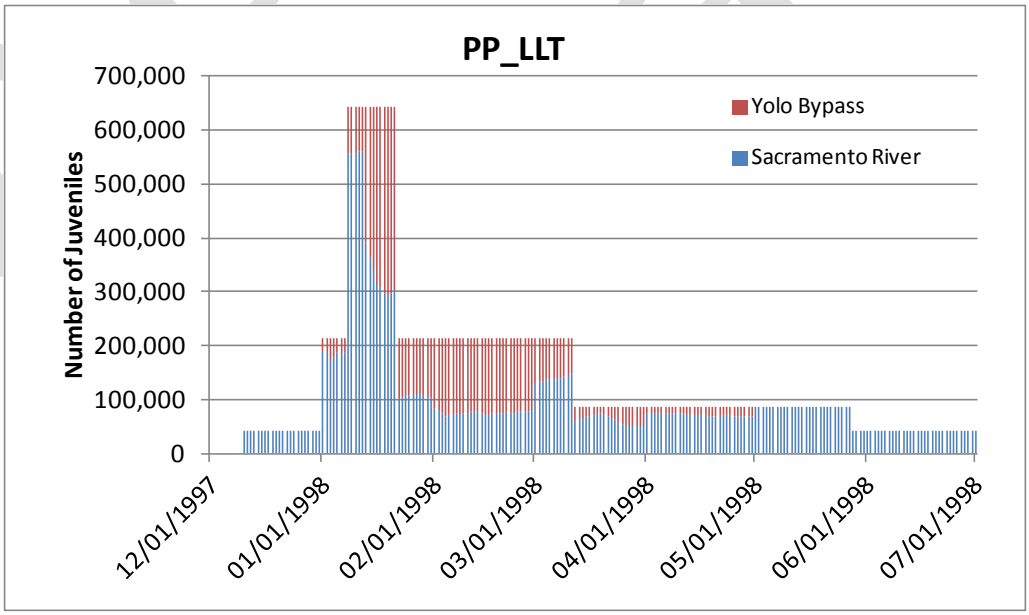

Figure C.5.4-17. Number of Fall-Run Chinook Salmon Juveniles Passing the Fremont Weir and Either Continuing Down the Sacramento River or Entering the Yolo Bypass Via the Fremont Weir Based on YBFR Model Results for the PP_LLT Scenario (Water Year 1998)

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Again, it should be noted that the results described above are based on simple rules designed to simulate the general patterns of abundance and fish movement in the Sacramento River above the Fremont Weir that may be revised following completion of an analysis of historic daily catch and flow data being conducted by the DFG.

C.5.4.2 Wetland Bench Inundation

The frequency of inundation of habitat benches along eight sites on the Sacramento River was explored under each model scenario to assess the effect of the preliminary proposal. Inundation was determined from DMS2 daily model output at the node nearest to each bench. The distribution of inundation frequency for each model scenario at each habitat bench and elevation is presented as the percent exceedance for all years (Figure C.5.4-18 through Figure C.5.4-25), and by month (Figure C.5.4-26 through Figure C.5.4-33) to capture seasonal dynamics of flows. Exceedance frequencies showed that inundation under the PP scenarios was generally equal or greater than EBC1 and EBC2 scenarios for both time periods (ELT and LLT). Especially at elevations of 0 feet and 2 feet, flow exceedances were highest for PP_LLT, but were generally among the lowest for PP_ELT. Variation in inundation frequency was high among sites. At higher elevations (4 feet and 6 feet), the highest inundation was generally under the EBC2 scenario. However, at higher elevations, the range of inundation exceedances was markedly reduced, suggesting little difference among model scenarios. It should be noted that these analyses are based on total inundation frequency (i.e., where the minimum stage of the river at the particular site exceeded the chosen elevation) and did not capture days during which a bench was partially inundated (i.e., where the maximum stage exceeded bench elevation). There is considerable variability in the inundation dynamics of habitat benches, and this variability is likely greater than the variance observed among scenarios, especially at higher elevations. The annual dynamics of inundation of habitat benches by month supported similar conclusions.

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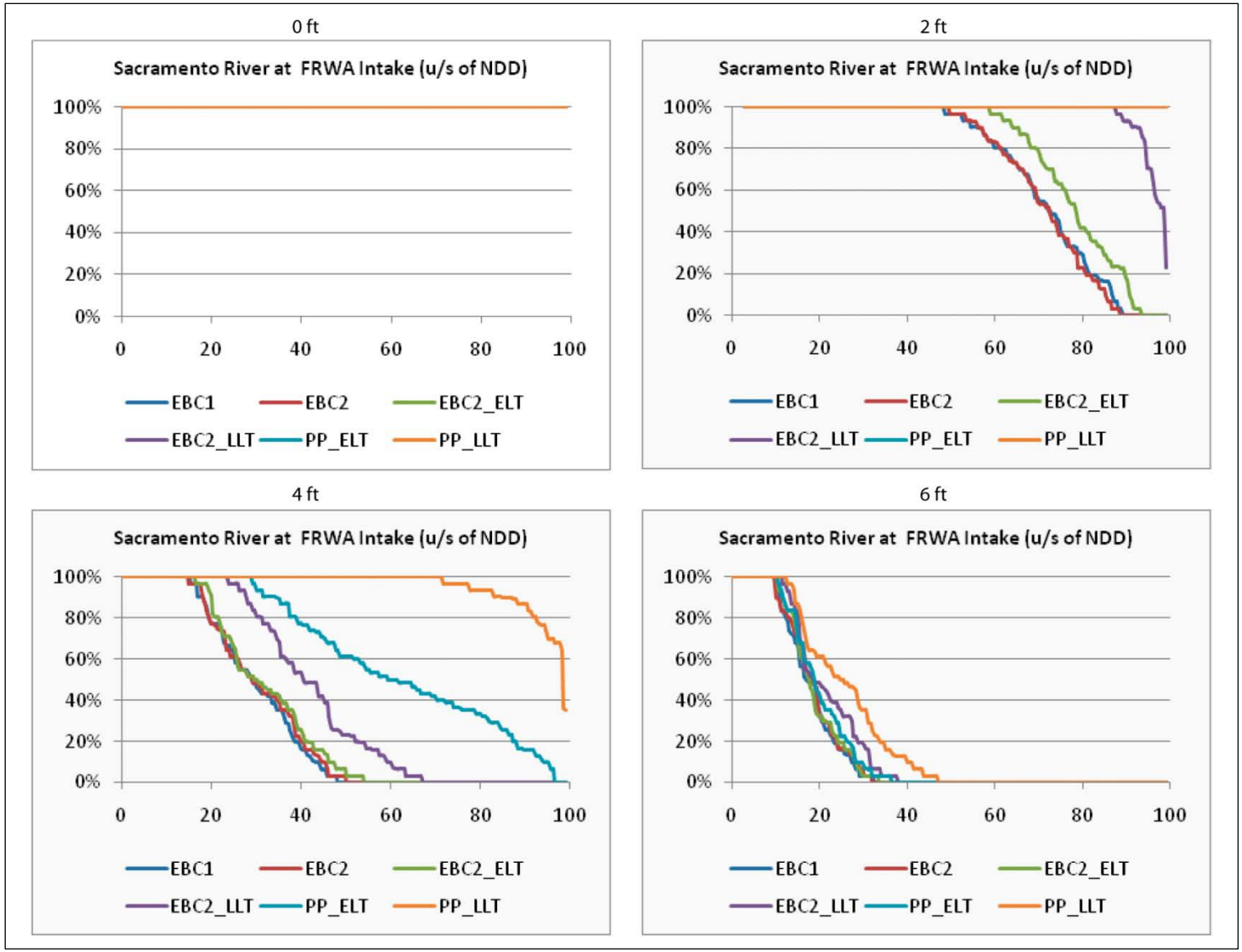

Figure C.5.4-18. Exceedance Plots for Inundation Frequency (Percent of Total Days) for Four Elevations, Sacramento River at FRWA Intake

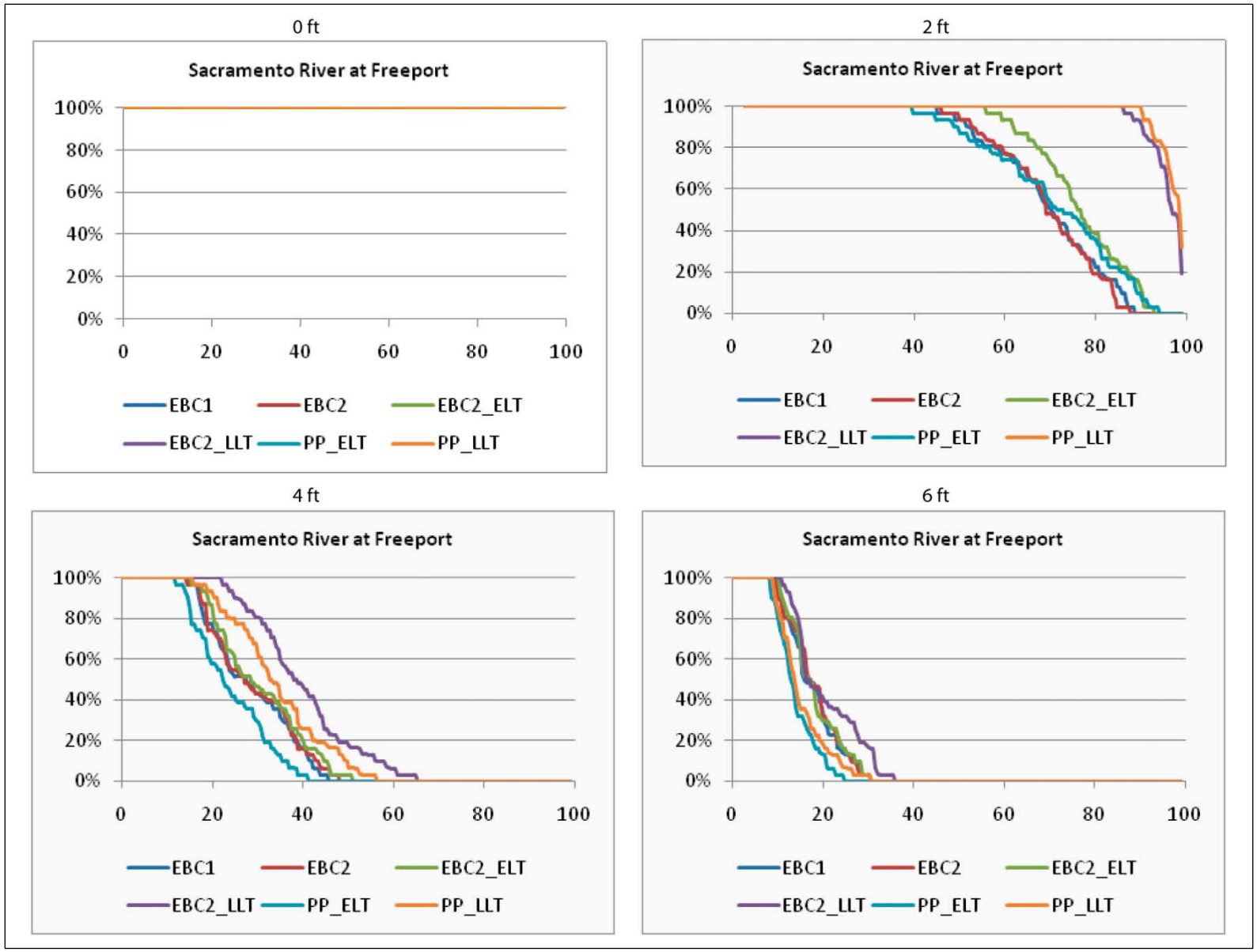

Figure C.5.4-19. Exceedance Plots for Inundation Frequency (Percent of Total Days) for Four Elevations, Sacramento River at Freeport

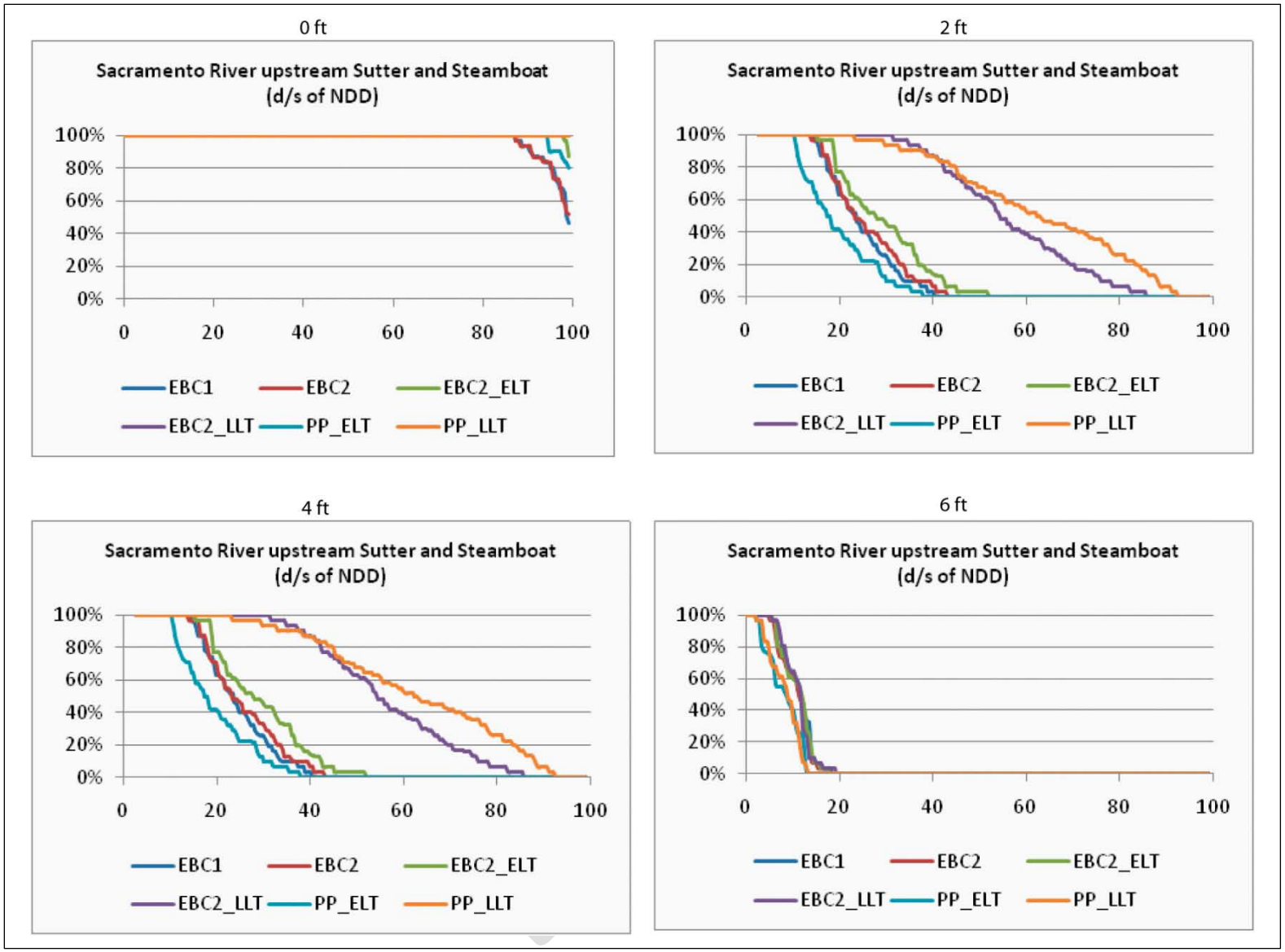

Figure C.5.4-20. Exceedance Plots for Inundation Frequency (Percent of Total Days) for Four Elevations, Sacramento River Upstream of Sutter and Steamboat Sloughs

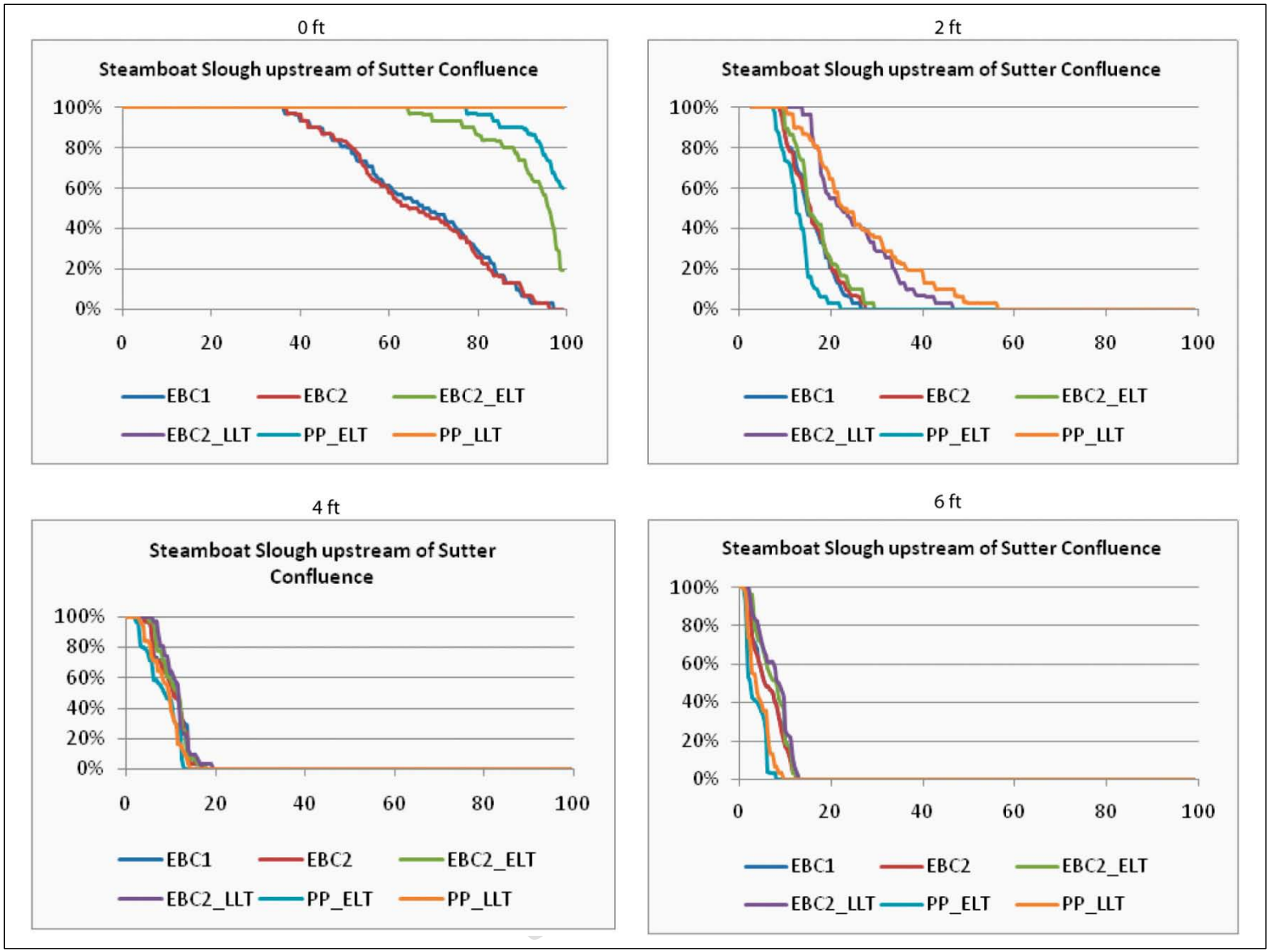

Figure C.5.4-21. .Exceedance Plots for Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Steamboat Slough Upstream of Sutter Slough Confluence

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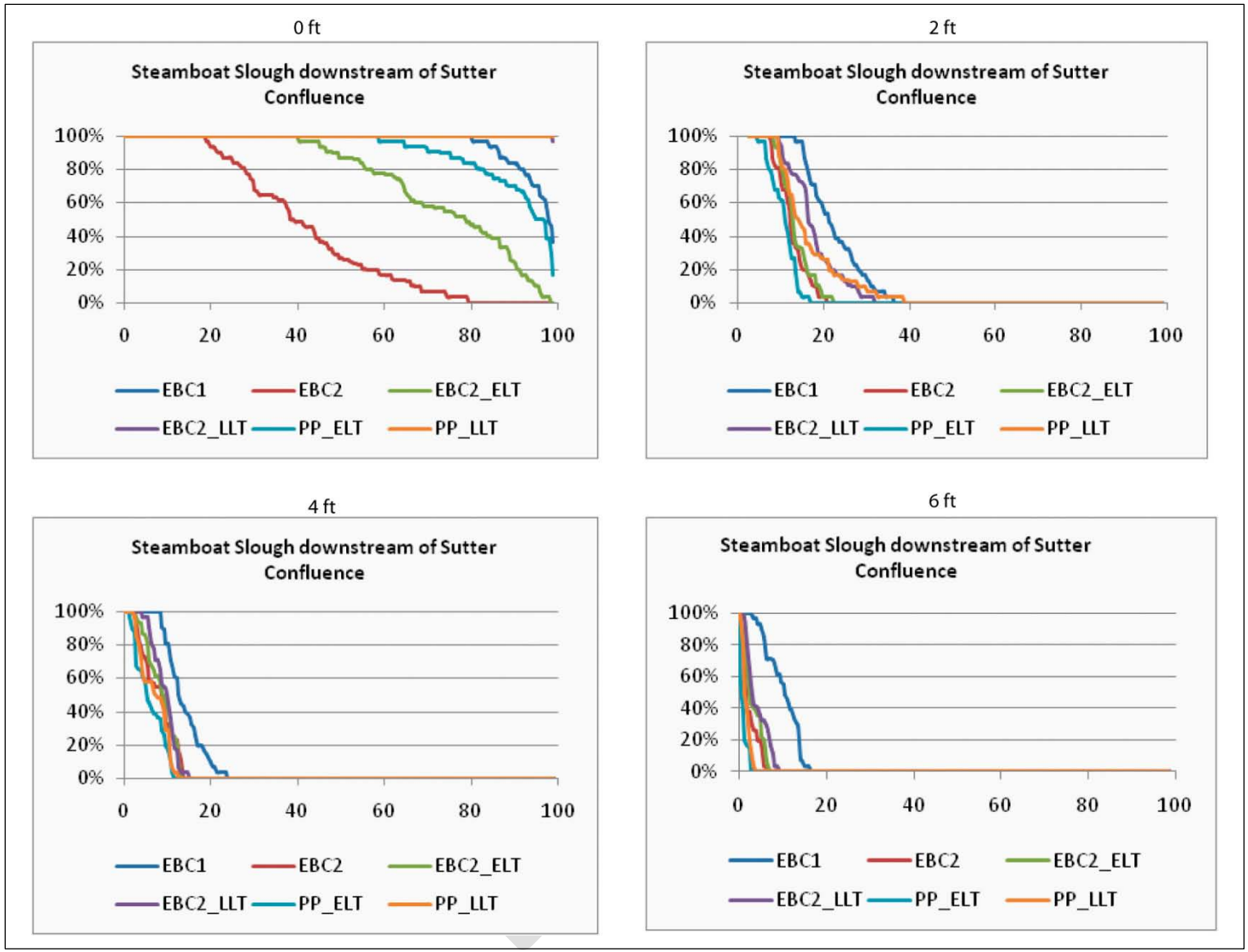

Figure C.5.4-22. Exceedance Plots for Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Steamboat Slough Downstream of Sutter Slough Confluence

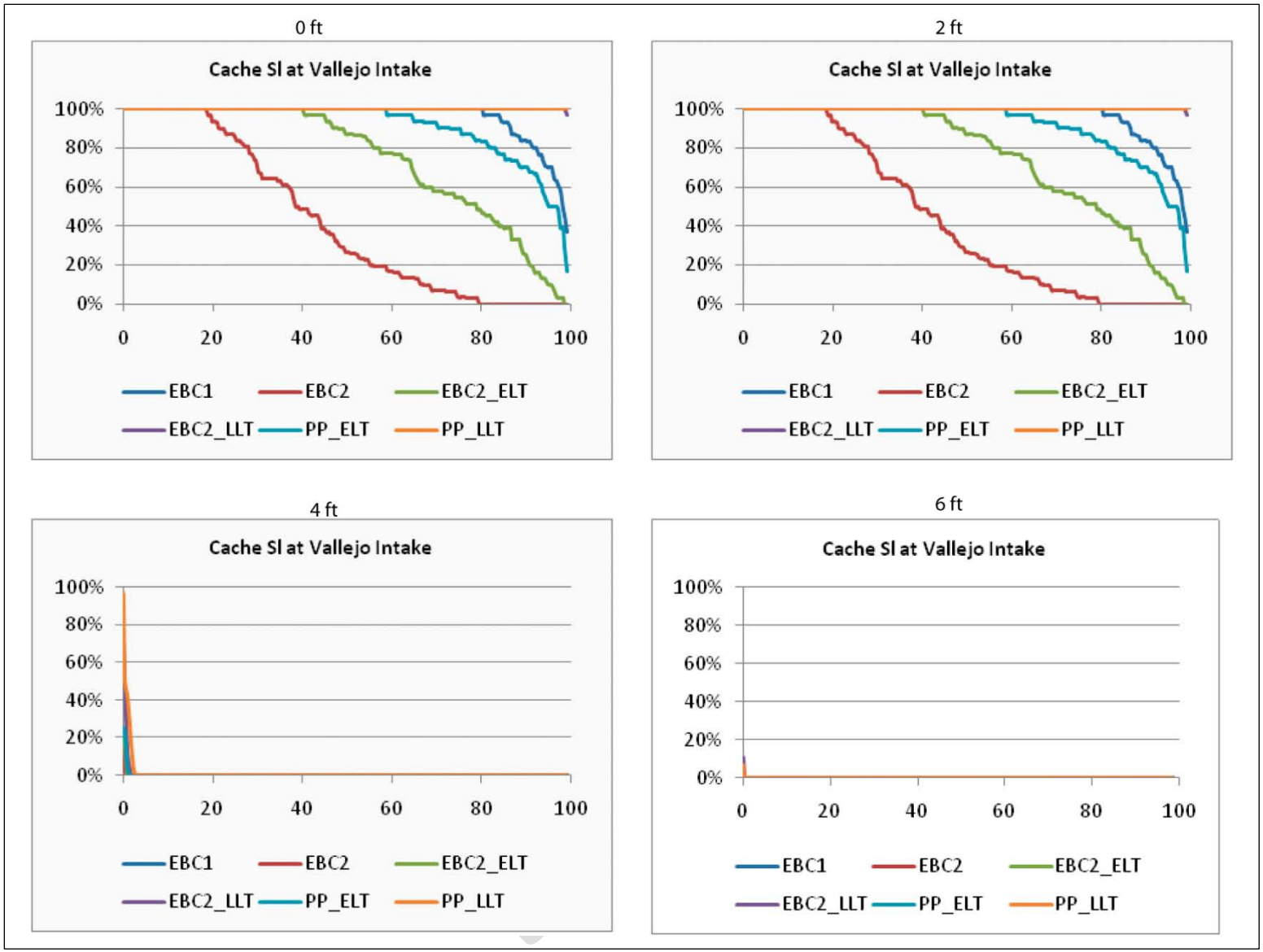

Figure C.5.4-23. Exceedance Plots for Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Cache Slough at Vallejo Intake

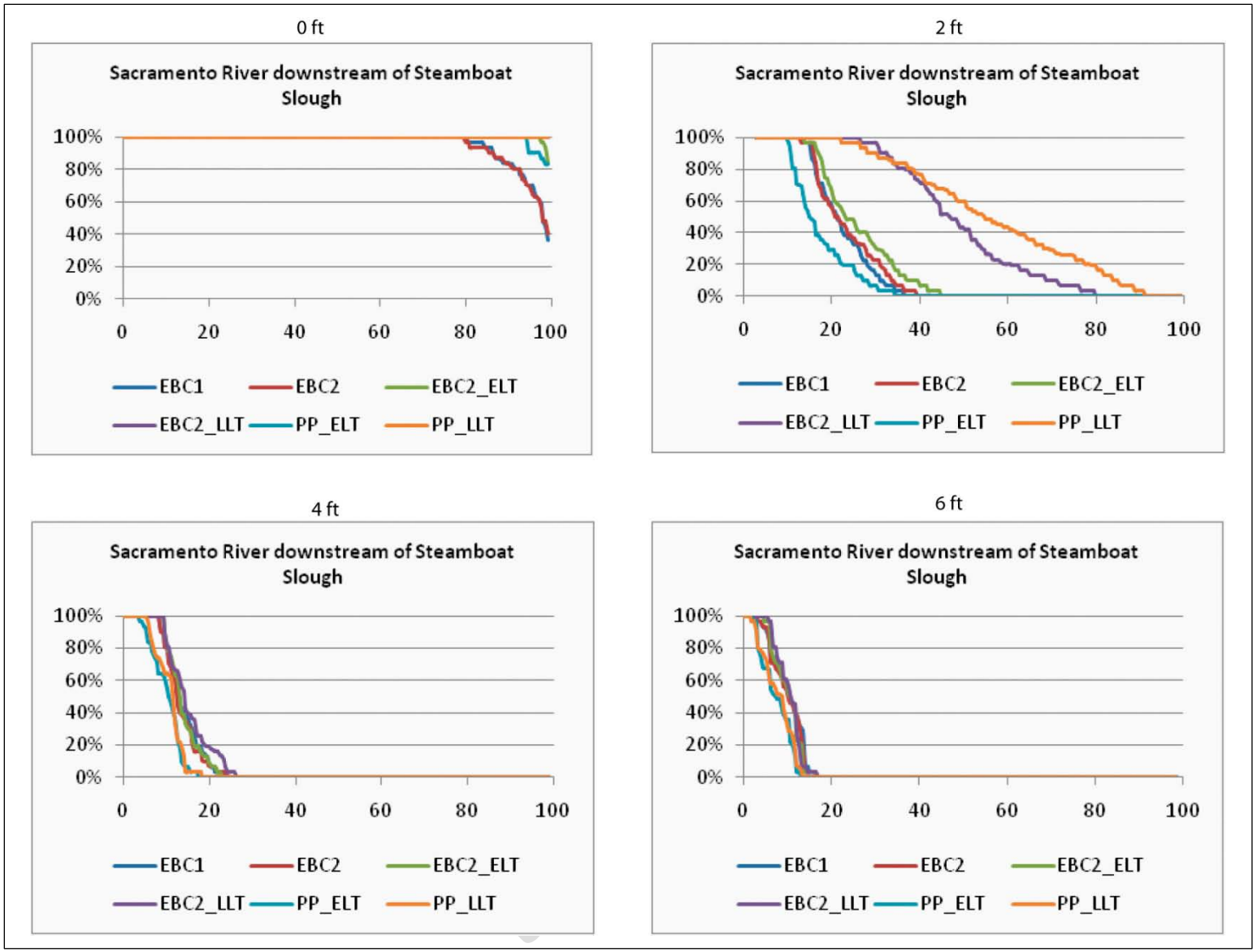

Figure C.5.4-24. Exceedance Plots for Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River Downstream of Steamboat Slough

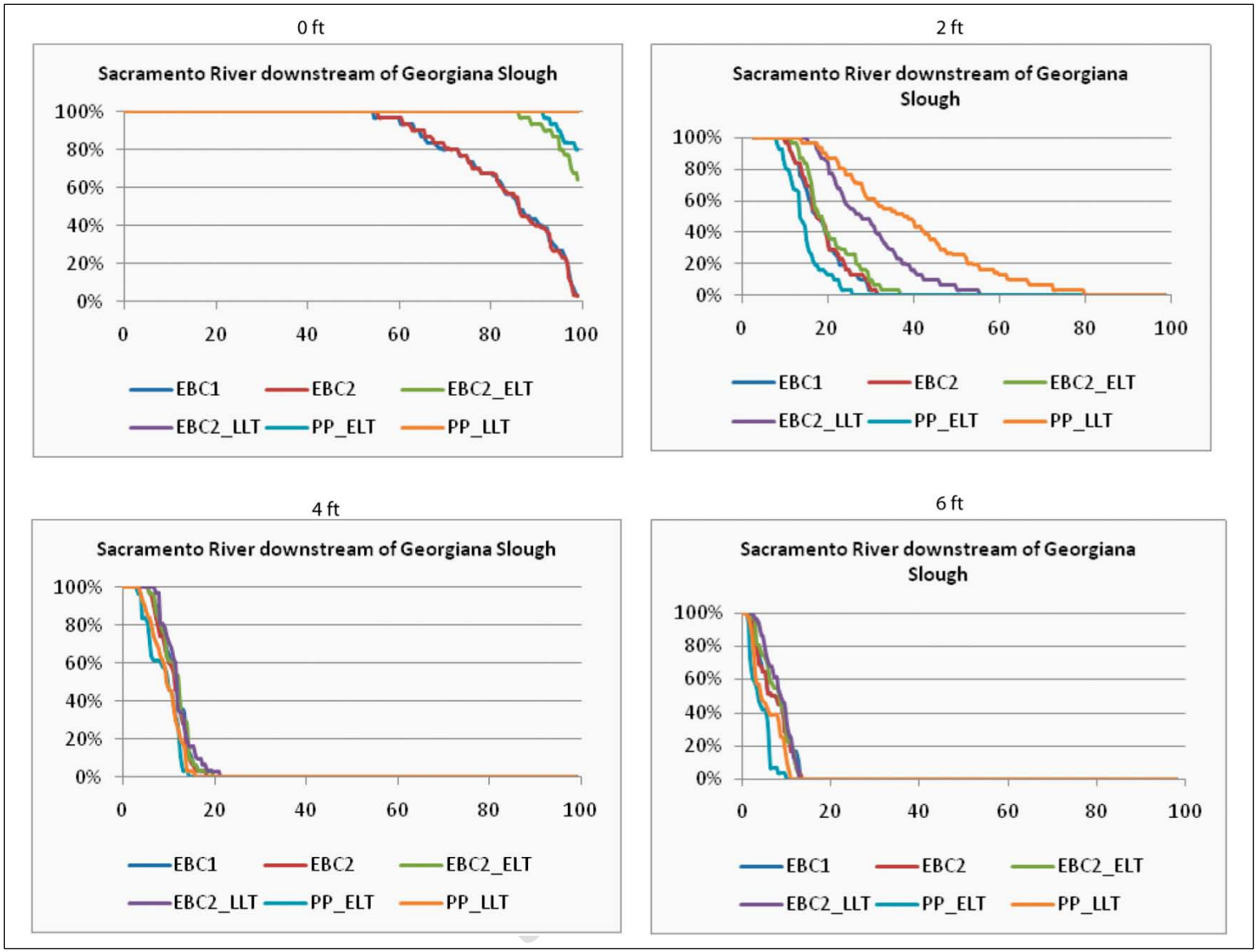

Figure C.5.4-25. Exceedance Plots for Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River Downstream of Georgiana Slough

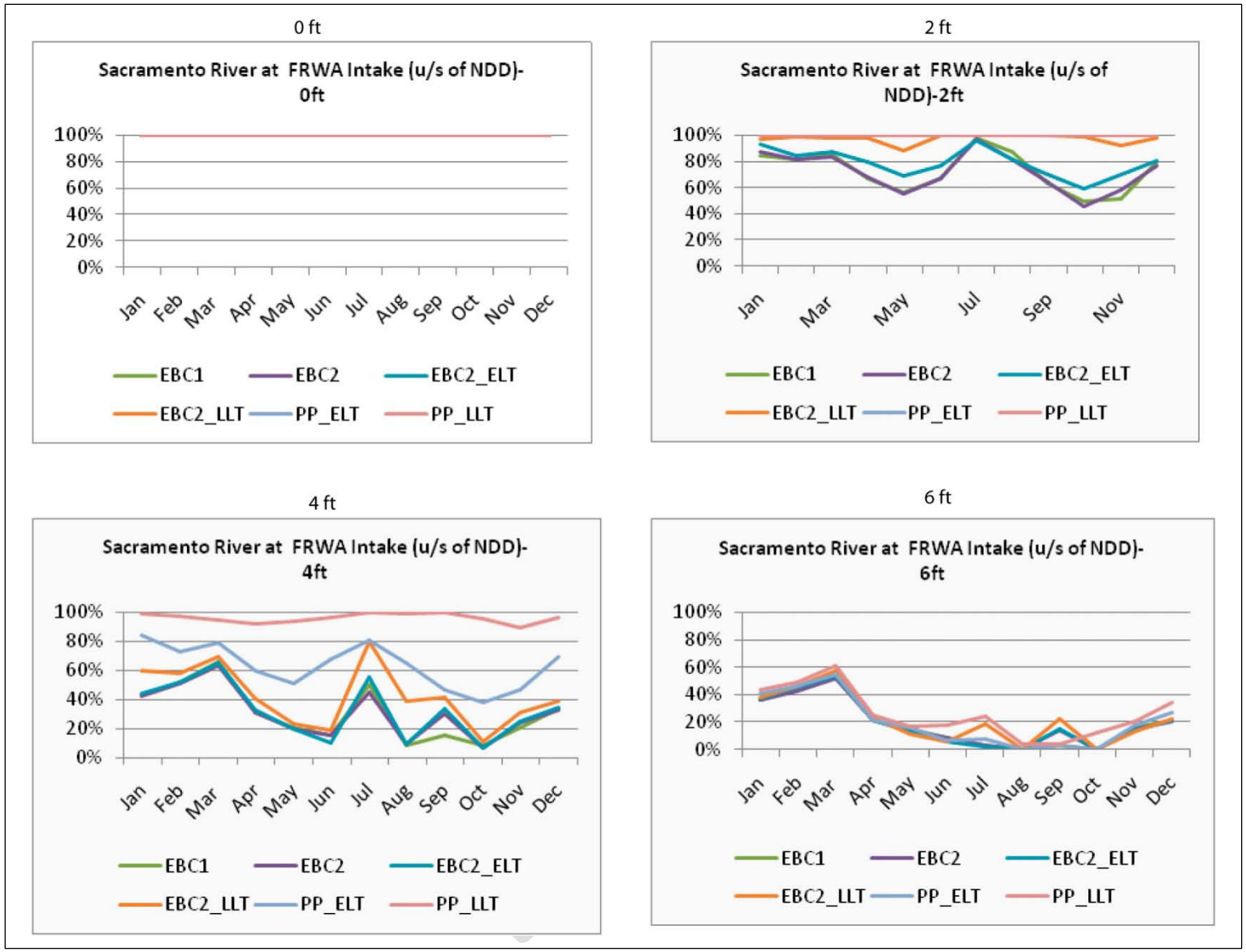

Figure C.5.4-26. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River at FRWA Intake

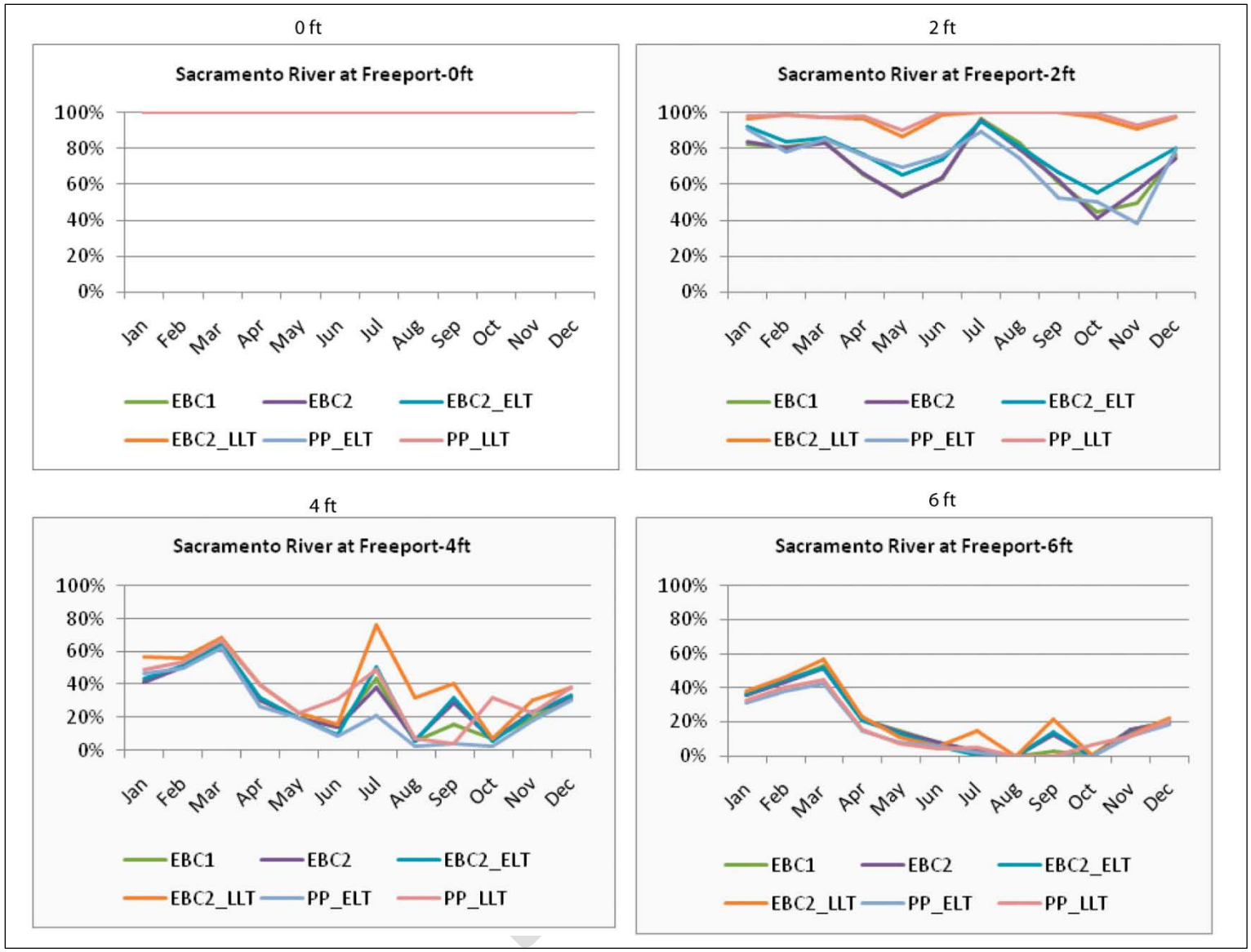

Figure C.5.4-27. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River at Freeport

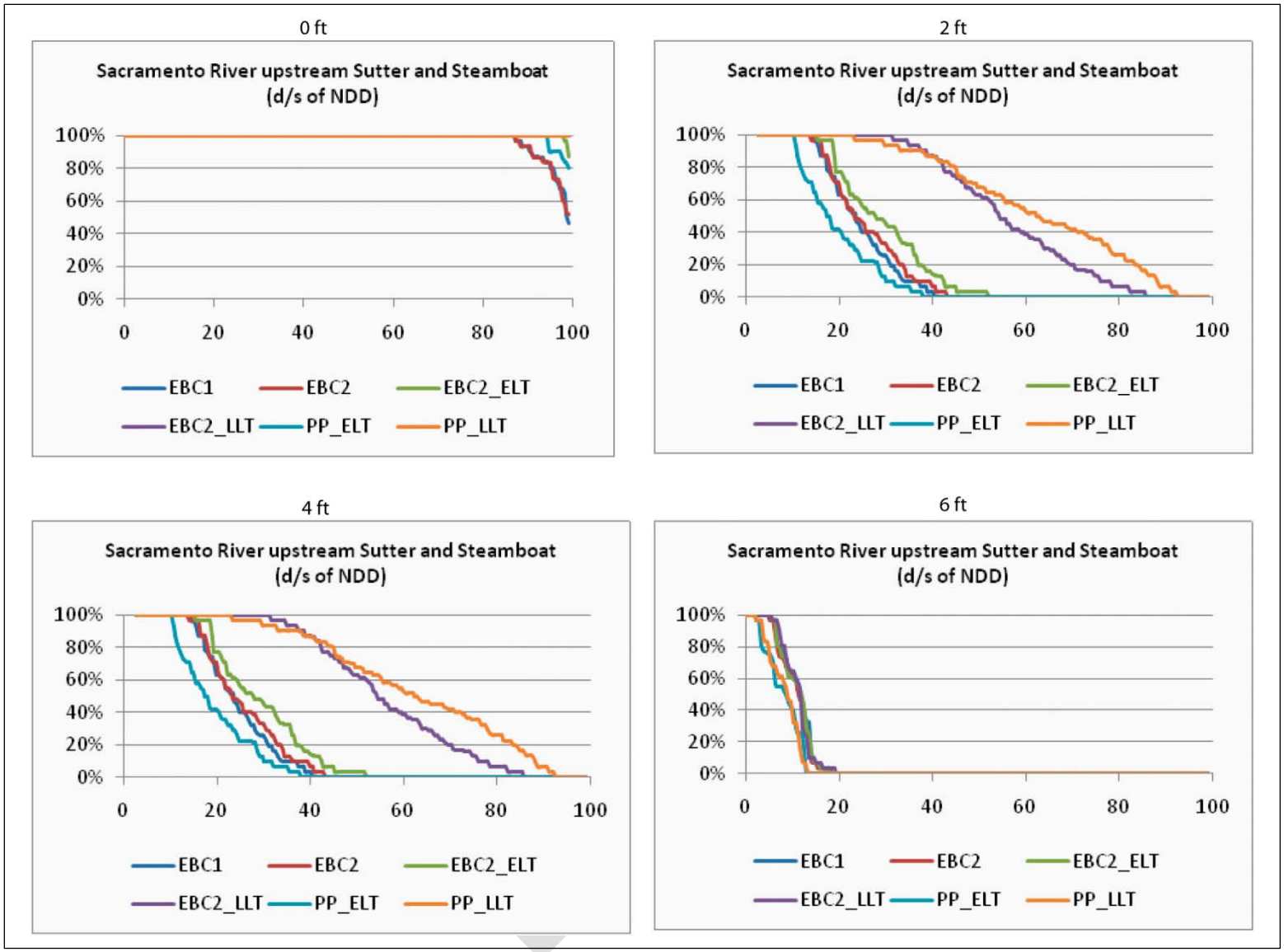

Figure C.5.4-28. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River Upstream of Sutter and Steamboat Sloughs

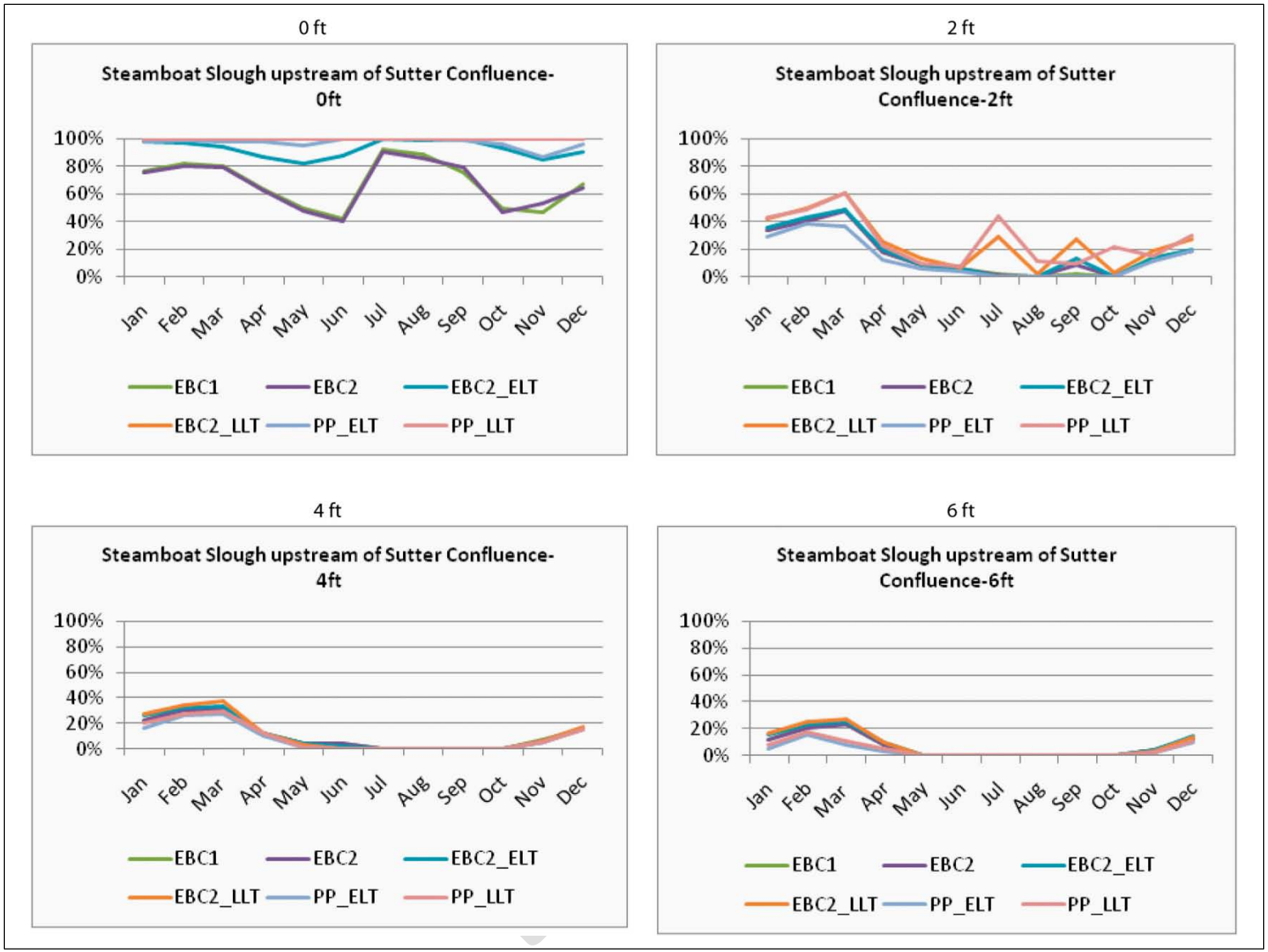

Figure C.5.4-29. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Steamboat Slough Upstream of Sutter Slough Confluence

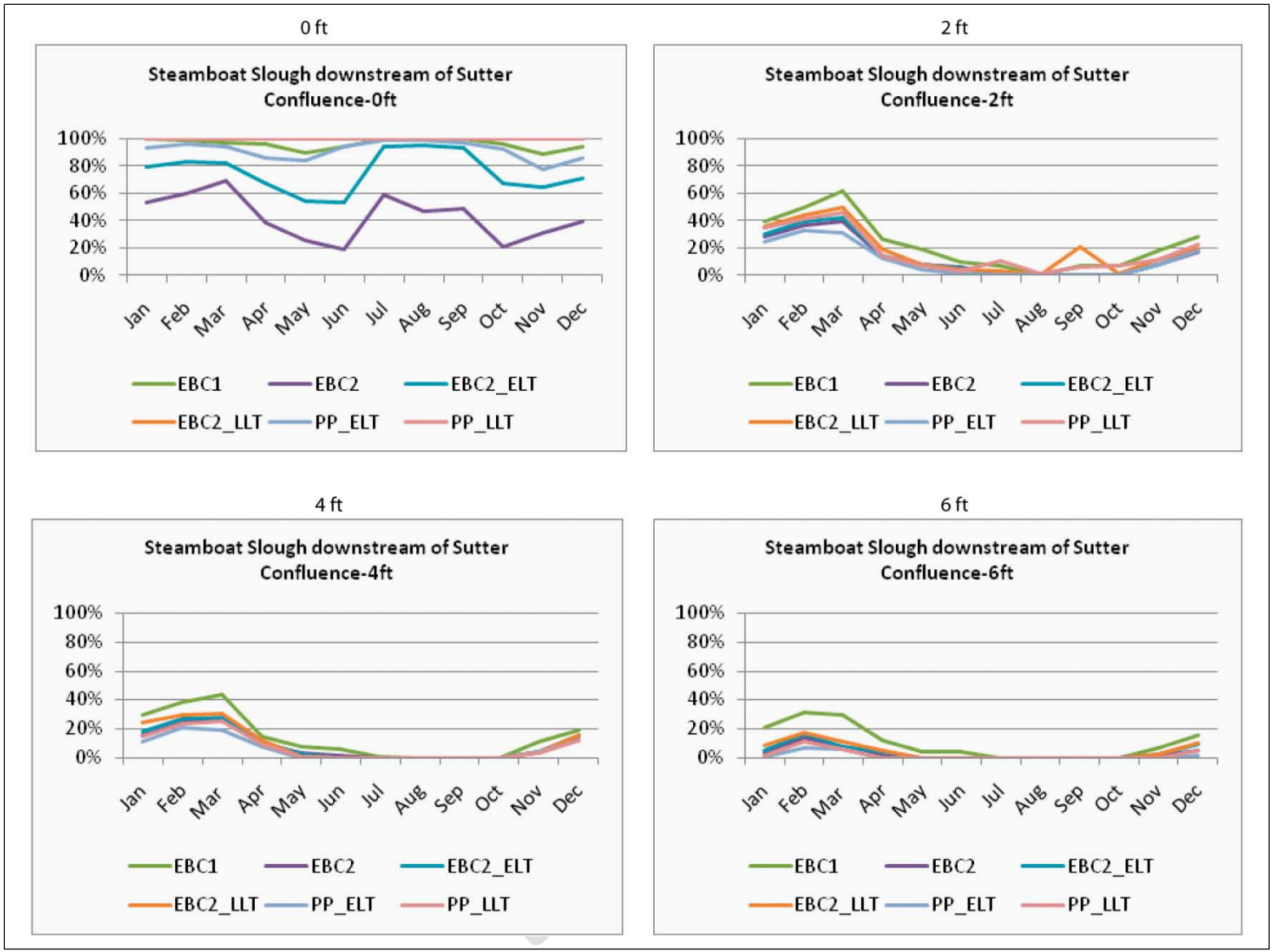

Figure C.5.4-30. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Steamboat Slough Downstream of Sutter Slough Confluence

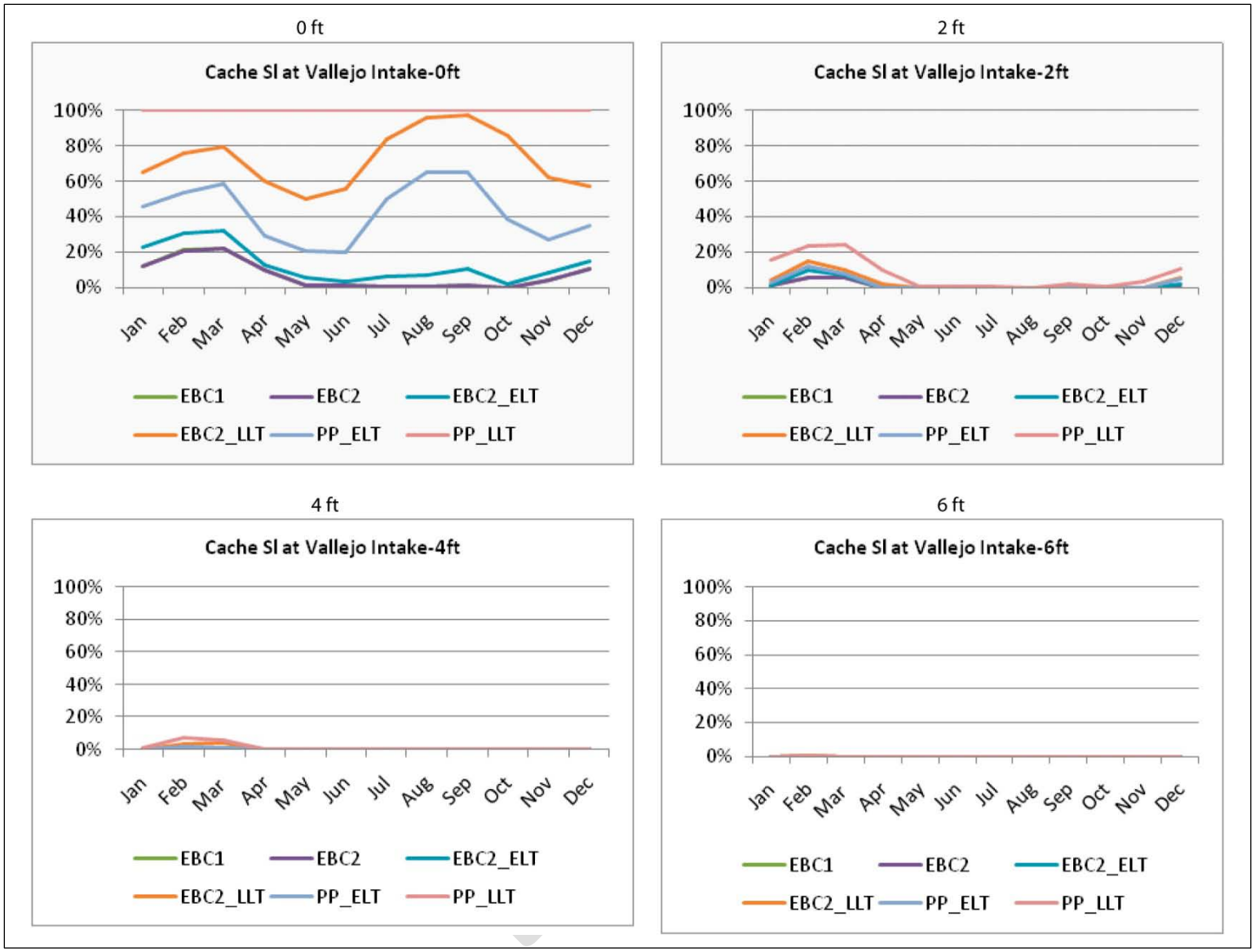

Figure C.5.4-31. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Cache Slough at Vallejo Intake

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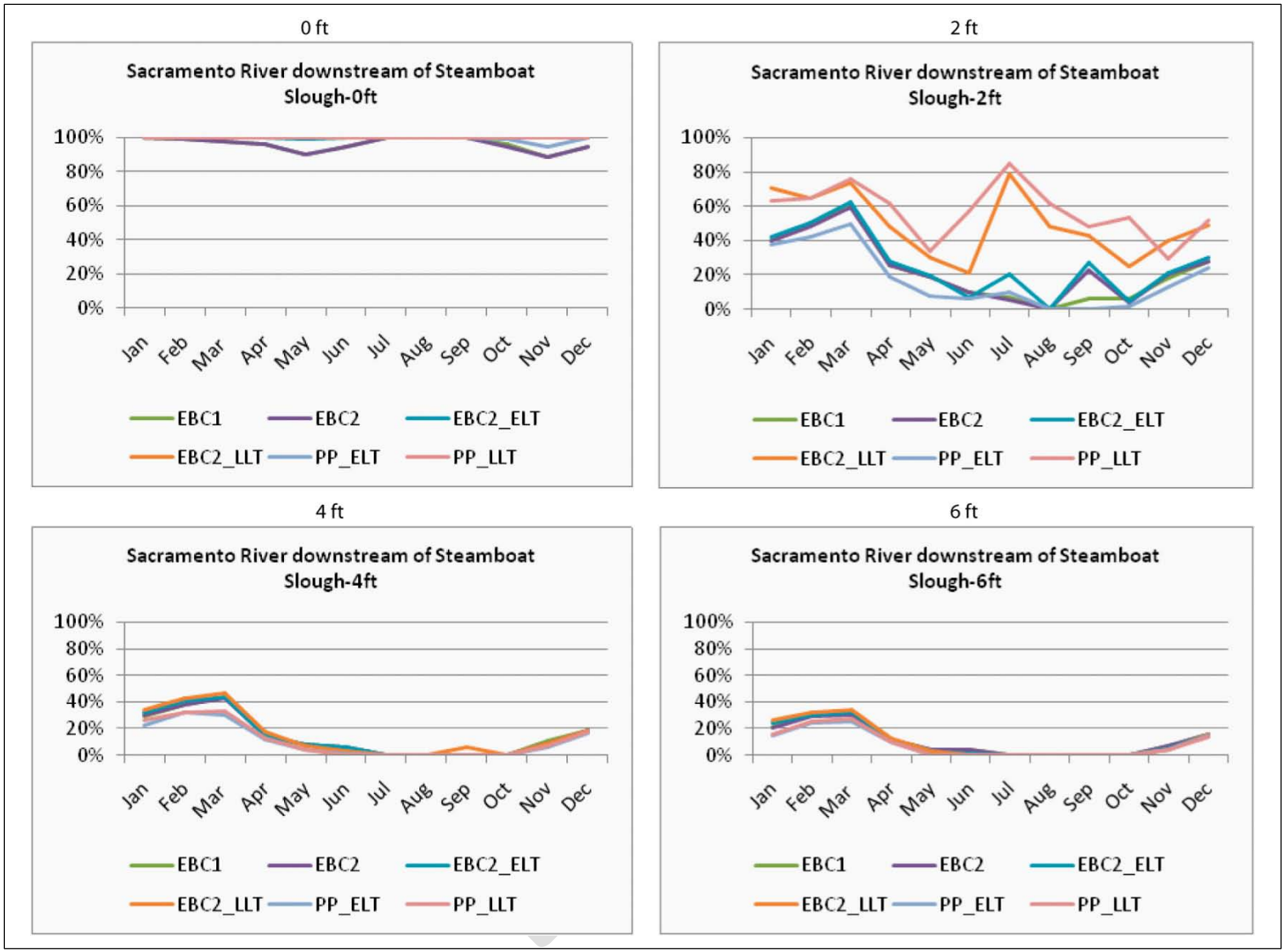

Figure C.5.4-32. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River Downstream of Steamboat Slough

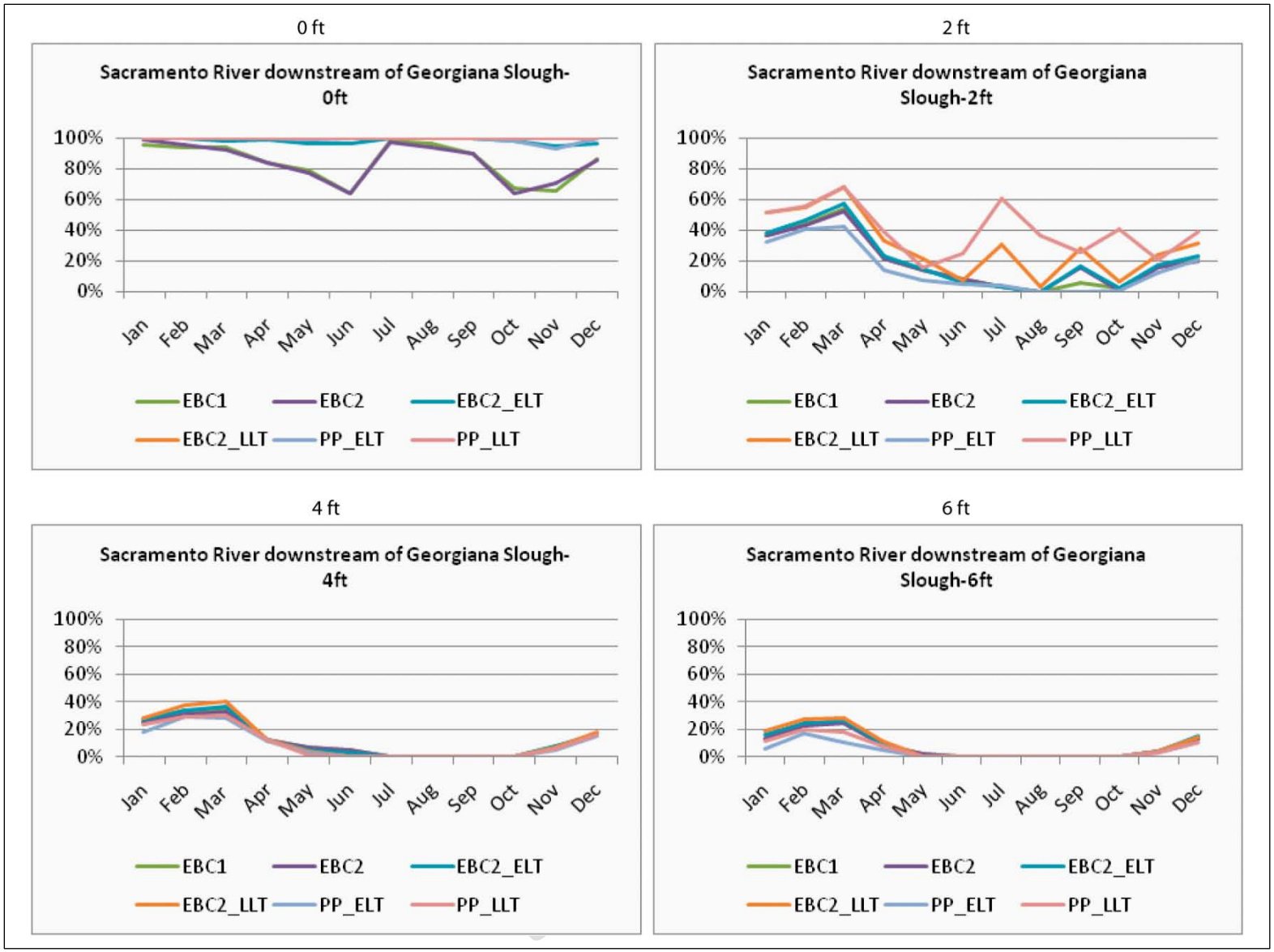

Figure C.5.4-33. Average Monthly Inundation Frequency (Percent of Total Days) of Hypothetical Habitat Benches at Four Elevations, Sacramento River Downstream of Georgiana Slough

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C.5.4.3 Water Temperature

C.5.4.3.1 Steelhead—Juvenile

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in juvenile rearing temperatures for steelhead in the Cache Slough subregion (Table C.5.4-2). The average number of optimal days was 193–194 days under EBC1 and EBC2 and 182–185 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 127 under EBC1 and EBC2, 143–145 under PP_ELT and EBC2_ELT, and 161–162 under PP_LLT and EBC2_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in juvenile rearing temperatures for steelhead in the East Delta subregion (Table C.5.4-3) differed little when accounting for climate change. The average number of optimal days was 190–191 days under EBC1 and EBC2 and 186–187 days under EBC2_ELT, EBC2_LLT, and 184–185 under PP_LLT, and PP_ELT, respectively. The average number of supraoptimal days was 136 for EBC1 and EBC2, 149 days under EBC2_ELT and PP_ELT, and 165–166 under EBC2_LLT and PP_LLT. There was one lethal day for EBC2_ELT in 1988, but the average number of lethal days was zero.

EBC scenarios and PP scenarios in juvenile rearing temperatures for steelhead in the North Delta subregion (Table C.5.4-4) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 173 for EBC1 and EBC2, and between 169 and 184 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 133 days under EBC1 and EBC2, and ranged from 143 to 157 days under EBC2_ELT and EBC2_LLT, and from 143 to 158 under PP_ELT and PP_LLT. A total of 17 days with lethal temperatures occurred during the modeling period and on average, lethal water temperatures were reached on one day under the EBC2_LLT scenario.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in juvenile rearing temperatures for steelhead in the San Joaquin portion of the South Delta subregion (Table C.5.4-5). Optimal water temperatures occurred on 191–192 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 186 to 192. Supraoptimal temperatures were reached on average for 137 and 136 days under EBC1 and EBC2, respectively. Under all other scenarios, this number ranged from 150 to 156 days. There were no lethal temperature days under any scenario.

Water temperatures in the South Delta for rearing steelhead juveniles were generally similar among the different scenarios (considering climate change) (Table C.5.4-6). Suboptimal temperatures occurred on 36–37 days under EBC1 and EBC2, and on 15–27 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Under EBC1 and EBC2, optimal water temperatures occurred on 195 days per year, on average. Optimal temperature conditions occurred on 186–188 days per year under EBC2_ELT, EBC2_LLT, PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 134 days under EBC1 and EBC2, and on 153–163 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

In the Suisun Bay subregion, juvenile rearing temperatures for steelhead were similar among scenarios (Table C.5.4-7) after accounting for changing climate. Optimal water temperatures were reached on average on 188 days under EBC1 and 179–181 days for all other scenarios. EBC1 and EBC2 averaged 135 and 134 days of supraoptimal days, respectively, while the number of days for

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EBC_ELT, EBC1_LLT, PP_ELT and PP_LLT varied from 147–158 days. There were no lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for juvenile steelhead were minor, after climate change was taken into consideration (Table C.5.4-8). Optimal temperatures occurred on average on 191 days under EBC1 and EBC2, and on 180–182 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 128 days under EBC1 and EBC2, and on 147–161 days under all other scenarios (i.e., EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

Water temperatures in the West Delta for rearing steelhead juveniles were generally similar among the different scenarios (considering climate change) (Table C.5.4-9). Under EBC1 and EBC2, optimal water temperatures occurred on 189 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 180–185 days per year, and on 182–185 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 129 days under EBC1 and EBC2, and on 147–162 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

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Table C.5.4-2. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	40	40	35	15	35	16		201	201	188	189	188	188
1977	60	60	49	30	48	35		190	192	179	176	181	172
1978	4	5	0	0	2	0		233	232	209	188	211	196
1979	52	51	46	25	62	38		161	162	161	173	146	163
1980	35	32	24	3	40	10		209	211	218	206	204	201
1981	42	41	30	4	32	4		182	183	179	208	180	207
1982	42	42	26	3	43	17		211	211	215	223	199	205
1983	48	48	34	17	38	19		187	187	183	198	182	196
1984	35	35	57	4	58	10		194	193	170	192	168	186
1985	61	61	27	55	25	56		192	193	203	153	209	153
1986	36	36	42	21	45	21		214	214	160	193	159	195
1987	48	48	40	28	41	27		178	179	180	160	183	163
1988	47	45	34	15	37	15		186	188	177	178	178	180
1989	63	63	53	28	55	26		179	179	159	156	162	157
1990	59	60	40	22	48	26		182	181	184	171	178	165
1991	42	43	31	25	30	25		196	195	188	195	189	195
Avg	45	44	36	18	40	22		193	194	185	185	182	183
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	125	125	143	162	143	162		0	0	0	0	0	0
1977	115	113	137	159	136	158		0	0	0	0	0	0
1978	128	128	156	177	152	169		0	0	0	0	0	0
1979	152	152	158	167	157	164		0	0	0	0	0	0
1980	122	123	124	157	122	155		0	0	0	0	0	0
1981	141	141	156	153	153	154		0	0	0	0	0	0
1982	112	112	124	139	123	143		0	0	0	0	0	0
1983	130	130	148	150	145	150		0	0	0	0	0	0
1984	137	138	139	170	140	170		0	0	0	0	0	0
1985	112	111	135	157	131	156		0	0	0	0	0	0
1986	115	115	163	151	161	149		0	0	0	0	0	0
1987	139	138	145	177	141	175		0	0	0	0	0	0
1988	133	133	155	173	151	171		0	0	0	0	0	0
1989	123	123	153	181	148	182		0	0	0	0	0	0
1990	124	124	141	172	139	174		0	0	0	0	0	0
1991	127	127	146	145	146	145		0	0	0	0	0	0
Avg	127	127	145	162	143	161		0	0	0	0	0	0

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Table C.5.4-3. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	39	39	30	5	32	6		189	190	185	199	185	198
1977	59	53	45	13	46	25		180	188	175	190	176	180
1978	4	4	0	0	0	0		219	220	205	194	204	185
1979	46	45	41	22	43	25		164	165	165	179	163	173
1980	31	30	32	9	27	5		199	200	204	192	211	195
1981	42	42	30	4	26	4		181	181	181	202	182	204
1982	45	47	29	8	25	6		200	198	195	204	201	207
1983	38	38	15	9	16	10		193	195	197	202	200	200
1984	41	41	55	9	55	5		184	185	175	185	170	186
1985	59	59	25	33	24	51		181	181	190	172	195	155
1986	24	23	23	20	33	17		213	213	185	189	163	193
1987	47	47	36	20	39	24		171	172	182	162	178	158
1988	20	20	14	7	21	12		210	209	204	186	193	180
1989	50	52	38	17	45	24		175	174	174	168	165	158
1990	46	47	39	16	28	19		187	186	177	174	192	169
1991	33	32	29	20	31	23		198	198	185	194	186	195
Avg	39	39	30	13	31	16		190	191	186	187	185	184
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	138	137	151	162	149	162		0	0	0	0	0	0
1977	126	124	145	162	143	160		0	0	0	0	0	0
1978	142	141	160	171	161	180		0	0	0	0	0	0
1979	155	155	159	164	159	167		0	0	0	0	0	0
1980	136	136	130	165	128	166		0	0	0	0	0	0
1981	142	142	154	159	157	157		0	0	0	0	0	0
1982	120	120	141	153	139	152		0	0	0	0	0	0
1983	134	132	153	154	149	155		0	0	0	0	0	0
1984	141	140	136	172	141	175		0	0	0	0	0	0
1985	125	125	150	160	146	159		0	0	0	0	0	0
1986	128	129	157	156	169	155		0	0	0	0	0	0
1987	147	146	147	183	148	183		0	0	0	0	0	0
1988	136	137	148	172	152	174		0	0	0	1	0	0
1989	140	139	153	180	155	183		0	0	0	0	0	0
1990	132	132	149	175	145	177		0	0	0	0	0	0
1991	134	135	151	151	148	147		0	0	0	0	0	0
Avg	136	136	149	165	149	166		0	0	0	0	0	0

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Table C.5.4-4. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	61	59	36	15	34	14		174	176	182	194	185	193
1977	63	63	51	23	51	29		179	177	181	188	181	182
1978	51	50	37	7	39	6		178	176	175	196	173	196
1979	70	67	62	34	62	34		149	150	151	168	150	170
1980	53	53	53	23	52	22		183	182	188	191	191	192
1981	48	48	53	12	52	13		181	181	166	201	166	201
1982	58	58	50	23	50	24		191	191	180	192	177	190
1983	62	62	52	22	52	22		164	165	162	190	162	190
1984	57	57	59	17	58	17		170	169	175	188	174	186
1985	68	67	63	42	64	45		174	175	159	174	159	171
1986	57	56	49	23	50	25		189	187	172	190	165	190
1987	67	67	51	30	53	28		155	155	173	165	170	167
1988	55	55	45	19	47	19		179	180	178	189	175	189
1989	63	63	63	28	61	29		158	159	154	168	154	164
1990	66	66	64	29	65	30		172	172	153	163	153	163
1991	60	60	49	24	48	22		164	165	174	190	176	194
Avg	60	59	52	23	52	24		173	173	170	184	169	184
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	131	131	148	157	147	159		0	0	0	0	0	0
1977	123	125	133	154	133	154		0	0	0	0	0	0
1978	136	139	153	162	153	163		0	0	0	0	0	0
1979	146	148	152	163	153	161		0	0	0	0	0	0
1980	130	131	125	150	123	152		0	0	0	2	0	0
1981	136	136	146	151	147	151		0	0	0	1	0	0
1982	116	116	135	150	138	151		0	0	0	0	0	0
1983	139	138	151	153	151	153		0	0	0	0	0	0
1984	139	140	132	159	134	160		0	0	0	2	0	3
1985	123	123	143	148	142	148		0	0	0	1	0	1
1986	119	122	144	152	150	150		0	0	0	0	0	0
1987	143	143	141	170	142	170		0	0	0	0	0	0
1988	132	131	143	154	144	157		0	0	0	4	0	1
1989	144	143	148	169	150	172		0	0	0	0	0	0
1990	127	127	148	173	147	172		0	0	0	0	0	0
1991	141	140	142	150	141	149		0	0	0	1	0	0
Avg	133	133	143	157	143	158		0	0	0	1	0	0

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Table C.5.4-5. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	37	38	37	15	35	12		189	191	184	195	184	196
1977	53	53	45	27	45	27		189	189	181	188	181	187
1978	0	1	0	0	0	0		222	222	208	209	210	210
1979	44	44	40	32	38	29		169	169	166	167	168	170
1980	24	24	18	8	16	8		204	206	216	213	216	212
1981	38	38	22	2	20	0		180	180	190	210	192	211
1982	25	25	17	14	15	12		216	216	206	216	208	217
1983	31	31	20	19	25	20		192	192	193	183	185	188
1984	24	24	50	8	48	8		198	198	170	191	170	189
1985	59	59	27	49	27	50		179	180	187	178	192	174
1986	27	26	30	15	30	15		203	205	173	203	173	199
1987	45	45	36	27	35	22		165	167	182	171	183	173
1988	40	40	25	14	25	12		190	193	186	201	189	195
1989	55	56	46	26	46	27		177	176	159	171	158	169
1990	46	47	30	19	30	19		194	193	189	184	189	179
1991	41	40	32	23	31	24		195	196	186	194	187	191
Avg	37	37	30	19	29	18		191	192	186	192	187	191
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	140	137	145	156	147	158		0	0	0	0	0	0
1977	123	123	139	150	139	151		0	0	0	0	0	0
1978	143	142	157	156	155	155		0	0	0	0	0	0
1979	152	152	159	166	159	166		0	0	0	0	0	0
1980	138	136	132	145	134	146		0	0	0	0	0	0
1981	147	147	153	153	153	154		0	0	0	0	0	0
1982	124	124	142	135	142	136		0	0	0	0	0	0
1983	142	142	152	163	155	157		0	0	0	0	0	0
1984	144	144	146	167	148	169		0	0	0	0	0	0
1985	127	126	151	138	146	141		0	0	0	0	0	0
1986	135	134	162	147	162	151		0	0	0	0	0	0
1987	155	153	147	167	147	170		0	0	0	0	0	0
1988	136	133	155	151	152	159		0	0	0	0	0	0
1989	133	133	160	168	161	169		0	0	0	0	0	0
1990	125	125	146	162	146	167		0	0	0	0	0	0
1991	129	129	147	148	147	150		0	0	0	0	0	0
Avg	137	136	150	155	150	156		0	0	0	0	0	0

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Table C.5.4-6. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	38	38	36	5	35	2		192	192	180	198	180	202
1977	52	52	44	16	44	17		182	182	173	188	173	189
1978	0	0	0	0	0	0		228	229	205	204	202	204
1979	51	49	36	25	35	24		159	160	170	171	170	172
1980	22	22	8	4	10	6		216	216	230	208	228	207
1981	38	38	15	0	11	0		180	181	190	206	195	208
1982	19	20	7	0	5	0		229	228	226	230	227	230
1983	30	31	12	15	18	16		200	198	201	192	193	193
1984	23	24	54	3	49	10		196	195	160	195	171	187
1985	60	60	25	51	25	51		185	187	200	156	200	156
1986	27	27	35	16	33	16		212	212	157	200	161	199
1987	46	46	36	17	33	14		168	169	180	170	183	173
1988	36	36	31	12	31	12		196	196	173	174	172	170
1989	58	59	39	27	39	24		174	174	152	157	153	161
1990	46	46	25	20	25	19		192	192	193	169	192	172
1991	36	36	30	23	29	23		203	203	178	187	180	186
Avg	36	37	27	15	26	15		195	195	186	188	186	188
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	136	136	150	163	151	162		0	0	0	0	0	0
1977	131	131	148	161	148	159		0	0	0	0	0	0
1978	137	136	160	161	163	161		0	0	0	0	0	0
1979	155	156	159	169	160	169		0	0	0	0	0	0
1980	128	128	128	154	128	153		0	0	0	0	0	0
1981	147	146	160	159	159	157		0	0	0	0	0	0
1982	117	117	132	135	133	135		0	0	0	0	0	0
1983	135	136	152	158	154	156		0	0	0	0	0	0
1984	147	147	152	168	146	169		0	0	0	0	0	0
1985	120	118	140	158	140	158		0	0	0	0	0	0
1986	126	126	173	149	171	150		0	0	0	0	0	0
1987	151	150	149	178	149	178		0	0	0	0	0	0
1988	134	134	162	180	163	184		0	0	0	0	0	0
1989	133	132	174	181	173	180		0	0	0	0	0	0
1990	127	127	147	176	148	174		0	0	0	0	0	0
1991	126	126	157	155	156	156		0	0	0	0	0	0
Avg	134	134	153	163	153	163		0	0	0	0	0	0

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Table C.5.4-7. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	37	35	42	22	41	21		194	196	175	185	176	186
1977	49	49	50	43	50	43		186	186	178	174	179	174
1978	10	10	3	0	1	0		215	215	205	203	207	203
1979	55	56	49	40	51	41		156	156	159	158	157	157
1980	36	37	33	16	33	17		203	203	206	191	203	190
1981	38	39	24	16	23	13		183	181	190	194	191	197
1982	51	51	40	22	41	22		195	197	197	193	196	193
1983	47	47	34	24	33	24		183	183	178	185	179	187
1984	38	37	57	17	57	16		183	185	167	183	166	185
1985	60	60	35	58	35	58		176	176	183	159	184	158
1986	35	36	36	29	37	31		207	207	166	188	164	190
1987	42	43	35	38	35	35		177	177	185	158	186	159
1988	43	44	36	23	37	24		183	182	178	184	178	183
1989	50	54	45	46	45	46		178	176	165	150	164	150
1990	55	55	41	36	39	34		186	186	182	168	185	168
1991	44	43	30	27	31	28		195	195	185	185	184	184
Avg	43	44	37	29	37	28		188	188	181	179	181	179
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	135	135	149	159	149	159		0	0	0	0	0	0
1977	130	130	137	148	136	148		0	0	0	0	0	0
1978	140	140	157	162	157	162		0	0	0	0	0	0
1979	154	153	157	167	157	167		0	0	0	0	0	0
1980	127	126	127	159	130	159		0	0	0	0	0	0
1981	144	145	151	155	151	155		0	0	0	0	0	0
1982	119	117	128	150	128	150		0	0	0	0	0	0
1983	135	135	153	156	153	154		0	0	0	0	0	0
1984	145	144	142	166	143	165		0	0	0	0	0	0
1985	129	129	147	148	146	149		0	0	0	0	0	0
1986	123	122	163	148	164	144		0	0	0	0	0	0
1987	146	145	145	169	144	171		0	0	0	0	0	0
1988	140	140	152	159	151	159		0	0	0	0	0	0
1989	137	135	155	169	156	169		0	0	0	0	0	0
1990	124	124	142	161	141	163		0	0	0	0	0	0
1991	126	127	150	153	150	153		0	0	0	0	0	0
Avg	135	134	147	158	147	158		0	0	0	0	0	0

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Table C.5.4-8. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	40	40	38	16	37	20		197	196	180	188	182	185
1977	53	52	48	39	49	41		189	191	178	168	176	168
1978	1	1	0	0	0	0		235	239	210	189	211	191
1979	62	63	60	37	57	40		151	149	147	160	149	158
1980	40	40	29	5	27	13		206	206	215	207	215	197
1981	40	40	22	4	24	16		181	181	186	204	185	194
1982	47	47	41	24	38	24		208	206	201	196	204	196
1983	64	65	35	29	34	29		171	170	184	191	185	190
1984	38	38	60	11	60	8		188	189	164	184	166	187
1985	63	62	28	55	27	57		192	195	199	153	201	155
1986	37	36	38	21	42	23		213	215	159	199	156	199
1987	49	49	39	30	39	31		175	175	180	162	181	162
1988	45	44	34	20	35	22		187	187	176	173	175	176
1989	60	59	51	36	52	41		184	183	151	149	149	150
1990	60	60	39	24	34	26		179	179	185	172	189	172
1991	47	43	31	25	31	27		193	197	186	191	186	193
Avg	47	46	37	24	37	26		191	191	181	180	182	180
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	129	130	148	162	147	161		0	0	0	0	0	0
1977	123	122	139	158	140	156		0	0	0	0	0	0
1978	129	125	155	176	154	174		0	0	0	0	0	0
1979	152	153	158	168	159	167		0	0	0	0	0	0
1980	120	120	122	154	124	156		0	0	0	0	0	0
1981	144	144	157	157	156	155		0	0	0	0	0	0
1982	110	112	123	145	123	145		0	0	0	0	0	0
1983	130	130	146	145	146	146		0	0	0	0	0	0
1984	140	139	142	171	140	171		0	0	0	0	0	0
1985	110	108	138	157	137	153		0	0	0	0	0	0
1986	115	114	168	145	167	143		0	0	0	0	0	0
1987	141	141	146	173	145	172		0	0	0	0	0	0
1988	134	135	156	173	156	168		0	0	0	0	0	0
1989	121	123	163	180	164	174		0	0	0	0	0	0
1990	126	126	141	169	142	167		0	0	0	0	0	0
1991	125	125	148	149	148	145		0	0	0	0	0	0
Avg	128	128	147	161	147	160		0	0	0	0	0	0

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Table C.5.4-9. Number of Days within Temperature Requirements for Steelhead Juvenile Rearing in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (>10°C)							Optimal (≥10°C and ≤18°C)					
1976	41	41	34	14	32	14		195	195	181	195	183	196
1977	54	53	48	24	47	34		184	187	176	184	179	173
1978	9	9	0	0	0	0		223	223	206	196	208	198
1979	60	61	58	26	56	28		153	152	150	171	151	170
1980	39	39	34	6	31	4		203	202	210	207	215	211
1981	43	44	24	0	20	0		177	175	184	206	188	207
1982	53	53	44	15	38	11		199	199	195	207	202	214
1983	48	48	34	17	33	16		188	188	181	191	184	196
1984	42	42	57	5	57	5		187	186	168	199	166	186
1985	62	62	35	53	32	53		188	188	190	165	194	162
1986	35	35	38	19	37	21		214	214	159	191	161	192
1987	48	49	37	29	36	29		174	172	186	155	187	158
1988	51	51	34	14	34	15		186	186	180	177	180	175
1989	58	58	54	30	53	29		185	185	155	153	156	155
1990	65	66	44	18	42	19		176	175	178	177	182	177
1991	48	42	31	25	31	25		196	202	176	180	178	183
Avg	47	47	38	18	36	19		189	189	180	185	182	185
	Supraoptimal (>18°C and ≤26°C)							Lethal (>26°C)					
1976	130	130	151	157	151	156		0	0	0	0	0	0
1977	127	125	141	157	139	158		0	0	0	0	0	0
1978	133	133	159	169	157	167		0	0	0	0	0	0
1979	152	152	157	168	158	167		0	0	0	0	0	0
1980	124	125	122	153	120	151		0	0	0	0	0	0
1981	145	146	157	159	157	158		0	0	0	0	0	0
1982	113	113	126	143	125	140		0	0	0	0	0	0
1983	129	129	150	157	148	153		0	0	0	0	0	0
1984	137	138	141	162	143	175		0	0	0	0	0	0
1985	115	115	140	147	139	150		0	0	0	0	0	0
1986	116	116	168	155	167	152		0	0	0	0	0	0
1987	143	144	142	181	142	178		0	0	0	0	0	0
1988	129	129	152	175	152	176		0	0	0	0	0	0
1989	122	122	156	182	156	181		0	0	0	0	0	0
1990	124	124	143	170	141	169		0	0	0	0	0	0
1991	121	121	158	160	156	157		0	0	0	0	0	0
Avg	129	129	148	162	147	162		0	0	0	0	0	0

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C.5.4.3.2 Steelhead—Smoltification

Water temperatures for steelhead smoltification in the Cache Slough subregion differed little among scenarios, considering climate change effects (Table C.5.4-10). Optimal temperatures occurred during 163 and 162 days under EBC1 and EBC2, averaged 120 and 147 days under EBC2_LLT and EBC2_ELT, and 148 and 123 days under PP_ELT and PP_LLT, respectively. Supraoptimal water temperature conditions averaged 200–201 days under EBC1 and EBC2, 216–237 days under EBC2_ELT and EBC2_LLT, and 215 and 235 days under PP_ELT and PP_LLT, respectively. Overall, model runs from 1976 to 1991 resulted in a total of 271 days with lethal water temperatures in Cache Slough. Annually, no lethal temperatures occurred under EBC1 and EBC2, but EBC2_ELT and EBC2_LLT and PP_ELT and PP_LLT averaged 1 to 7 days when water temperatures reached lethal levels.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in rearing temperatures for steelhead smolts in the East Delta subregion (Table C.5.4-11). Optimal water temperatures occurred on average on 160 days under both EBC scenarios, and on 148 and 122 days under EBC2_ELT and EBC2_LLT, respectively. The number of optimal days was slightly lower for both PP scenarios, 146 for PP_ELT and 120 days for PP_LLT. Supraoptimal temperature regimes were more frequent than optimal, but again the difference among scenarios was small. Supraoptimal temperatures for steelhead smolts occurred on 204 days for EBC1 and EBC2, and on 217 to 237 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). No lethal conditions occurred under EBC1, EBC2, and EBC2_ELT, but the average number of days with lethal temperatures for steelhead smolts was 13 under EBC2_LLT. In comparison, the average number of days with lethal temperatures was lower under PP_ELT (1) and under PP_LLT (9).

In the North Delta, water temperature regimes were similar across the scenarios for steelhead smolts, but minor differences due to climate change occurred (Table C.5.4-12). The average frequency of optimal temperature days for smolts was 166 (under EBC1 and EBC2), 159 and 133 days (under EBC2_ELT and EBC2_LLT) and 159 and 134 days (under PP_ELT and PP_LLT). Supraoptimal temperature patterns were similar: 198 days for EBC1 and EBC2, 204 and 211 days under EBC2_ELT and EBC2_LTT, and 204 and 214 days under PP_ELT and PP_LLT, respectively. The number of days of lethal temperature during the entire time period (1976 to 1991) was 642 days, and annual averages were 0 under EBC1 and EBC2, 1 and 21 days under EBC2_ELT and EBC2_LLT, and 1 and 18 days under PP_ELT and PP_LLT, respectively.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in smolt rearing temperatures for steelhead in the San Joaquin portion of the South Delta subregion (Table C.5.4-13). The average number of optimal days was 152 days under EBC1 and EBC2 and 139–129 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 212 under EBC1 and EBC2, 223–232 under EBC2_ELT and EBC2_LLT, and 223–235 under PP_ELT and PP_LLT. Lethal water temperatures for smolts occurred on average on 2–3 days under EBC2_ELT, EBC2_LLT, PP_ELT and PP_LLT, but no lethal temperature days occurred under EBC1 and EBC2.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in smolt rearing temperatures for steelhead in the South Delta subregion (Table C.5.4-14). Suboptimal water temperatures occurred on average on 1 days under EBC1, EBC2, EBC2_ELT, and PP_ELT scenarios and on 0 days under EBC2_LLT and PP_LLT. Optimal water temperatures occurred

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on average on 151-152 days under EBC1 and EBC2, on 121-134 days under EBC2_ELT and EBC2_LLT, and on 122-134 days under PP_ELT and PP_LLT. Supraoptimal temperatures for steelhead smolts occurred on 213 days for EBC1 and EBC2, and on 228 to 237 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). No lethal conditions occurred under EBC1, EBC2. Lethal water temperatures occurred on average on 3 to 7 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT).

There was little difference between EBC scenarios and PP scenarios in water temperatures for steelhead smolts in the Suisun Bay subregion (Table C.5.4-15) after accounting for climate change. The average number of optimal days was 155 days under EBC1 and EBC2, 143–134 days under EBC2_ELT and EBC2_LLT, respectively, and 143–133 days under PP_ELT and PP_LLT, respectively. The average number of supraoptimal days was 210 under EBC1 and EBC2. Under EBC2_ELT and PP_ELT, the average number of supraoptimal temperature days was 222–223. Supraoptimal days numbered 230–231 under EBC2_LLT and PP_LLT. There was on average 1 lethal day under the EBC_LLT and the PP_LLT scenarios.

In Suisun Marsh, the temperature regimes for steelhead smolts differed little between preliminary proposal and EBC2 scenarios (Table C.5.4-16) after the effects of climate change were accounted for. The average number of optimal temperature days in Suisun Marsh was 161 and 160 days under the EBC1 and EBC2 scenarios, respectively. The number of optimal days ranged from 123 to 143 for all other scenarios. Supraoptimal conditions occurred on average 204 days under EBC1 and EBC2 scenarios. Under EBC2_ELT and EBC2_LLT, supraoptimal temperature conditions occurred on 220 and 238 days, and on 220 and 235 days under PP_ELT and PP_LLT. The average number of days with lethal temperatures was zero for EBC1 and EBC2, and increased to 2 and 5 under the EBC2_ELT and PP_ELT and the EBC2_LLT and PP_LLT scenarios, respectively.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in smolt rearing temperatures for steelhead in the West Delta subregion (Table C.5.4-17). Optimal water temperatures occurred on average on 162 and 163 days under EBC1 and EBC2 scenarios, respectively, and on 146 and 123 days, respectively, under EBC2_ELT and EBC2_LLT. The number of optimal days was slightly lower for PP_ELT and PP_LLT scenarios at 145 and 121 days, respectively. Supraoptimal temperatures for steelhead smolts occurred on 203 days for EBC1 and EBC2, and on 219 to 240 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). No lethal conditions occurred under EBC1, EBC2, and EBC2_ELT, but the number of days with lethal temperatures for steelhead smolts was 5 under EBC2_LLT. In comparison, the average number of days with lethal temperatures was 1 for PP_ELT and 4 under PP_LLT.

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Table C.5.4-10. Number of Days within Temperature Requirements for Steelhead Smoltification in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		164	163	162	143	165	142
1977	0	0	0	0	0	0		172	172	135	117	136	120
1978	0	0	0	0	0	0		158	157	152	106	152	116
1979	5	6	0	0	0	0		175	173	160	121	158	122
1980	0	0	0	0	0	0		168	168	169	125	173	130
1981	0	0	0	0	0	0		181	181	166	119	165	121
1982	0	0	0	0	0	0		189	189	170	140	169	139
1983	0	0	0	0	0	0		185	187	151	133	156	147
1984	0	0	0	0	0	0		140	140	159	111	160	111
1985	4	5	2	0	6	0		163	161	133	140	133	138
1986	0	0	0	0	0	0		147	147	129	106	128	115
1987	0	0	0	0	0	0		136	136	132	107	133	107
1988	0	0	0	0	0	0		159	159	126	108	129	108
1989	4	6	0	0	6	0		161	159	133	113	131	115
1990	0	0	0	0	0	0		160	159	140	118	139	118
1991	17	17	15	3	16	4		147	147	136	117	136	119
Avg	2	2	1	0	2	0		163	162	147	120	148	123
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	202	203	204	220	201	222		0	0	0	3	0	2
1977	193	193	230	245	229	242		0	0	0	3	0	3
1978	207	208	213	241	213	232		0	0	0	18	0	17
1979	185	186	205	236	207	238		0	0	0	8	0	5
1980	198	198	197	232	193	228		0	0	0	9	0	8
1981	184	184	199	243	199	241		0	0	0	3	1	3
1982	176	176	195	225	196	226		0	0	0	0	0	0
1983	180	178	210	232	204	218		0	0	4	0	5	0
1984	224	224	206	230	204	231		2	2	1	25	2	24
1985	198	199	230	213	226	213		0	0	0	12	0	14
1986	218	218	236	259	237	250		0	0	0	0	0	0
1987	229	229	233	258	230	258		0	0	0	0	2	0
1988	207	207	231	240	226	240		0	0	9	18	11	18
1989	200	200	232	248	228	246		0	0	0	4	0	4
1990	205	206	225	231	226	232		0	0	0	16	0	15
1991	201	201	214	245	213	242		0	0	0	0	0	0
Avg	200	201	216	237	215	235		0	0	1	7	1	7

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Table C.5.4-11. Number of Days within Temperature Requirements for Steelhead Smoltification in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		169	167	160	143	162	139
1977	0	0	0	0	0	0		161	159	136	116	134	112
1978	0	0	0	0	0	0		158	157	148	112	146	104
1979	0	0	0	0	0	0		169	169	164	119	159	117
1980	0	0	0	0	0	0		162	162	164	129	167	127
1981	0	0	0	0	0	0		172	172	157	123	160	117
1982	0	0	0	0	0	0		173	173	159	137	160	139
1983	0	0	0	0	0	0		177	177	150	141	157	143
1984	0	0	0	0	0	0		149	149	151	118	158	112
1985	0	0	0	0	0	0		161	163	156	131	146	134
1986	0	0	0	0	0	0		154	155	140	115	131	114
1987	0	0	0	0	0	0		139	139	133	106	129	104
1988	0	0	0	0	0	0		146	147	130	111	126	106
1989	0	0	0	0	0	0		161	160	140	116	134	114
1990	0	0	0	0	0	0		157	158	139	125	131	121
1991	10	9	9	0	13	0		155	158	138	116	133	117
Avg	1	1	1	0	1	0		160	160	148	122	146	120
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	197	199	200	212	202	222		0	0	6	11	2	5
1977	204	206	229	245	231	249		0	0	0	4	0	4
1978	207	208	217	228	219	238		0	0	0	25	0	23
1979	196	196	201	231	206	242		0	0	0	15	0	6
1980	204	204	202	224	199	230		0	0	0	13	0	9
1981	193	193	208	238	205	246		0	0	0	4	0	2
1982	192	192	206	221	205	226		0	0	0	7	0	0
1983	188	188	215	218	208	220		0	0	0	6	0	2
1984	217	217	215	220	208	224		0	0	0	28	0	30
1985	204	202	209	214	219	216		0	0	0	20	0	15
1986	211	210	225	244	234	251		0	0	0	6	0	0
1987	226	226	232	250	236	261		0	0	0	9	0	0
1988	220	219	236	233	233	241		0	0	0	22	7	19
1989	204	205	225	236	231	247		0	0	0	13	0	4
1990	208	207	226	214	234	225		0	0	0	26	0	19
1991	200	198	218	245	219	248		0	0	0	4	0	0
Avg	204	204	217	230	218	237		0	0	0	13	1	9

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Table C.5.4-12. Number of Days within Temperature Requirements for Steelhead Smoltification in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		177	175	165	145	166	145
1977	0	0	2	0	2	0		164	166	150	127	147	128
1978	0	0	0	0	0	0		169	170	156	134	157	132
1979	3	3	0	1	0	1		175	174	167	134	168	134
1980	0	0	0	0	0	0		165	165	165	140	165	139
1981	0	0	0	0	0	0		174	173	164	133	166	135
1982	0	0	2	0	2	0		183	183	167	142	166	142
1983	4	4	1	0	2	0		171	172	158	145	158	145
1984	1	1	2	0	2	0		154	153	156	127	158	130
1985	2	2	0	0	0	0		170	171	174	140	175	145
1986	0	0	0	0	0	0		165	166	158	123	160	124
1987	1	0	0	0	0	0		150	151	150	128	149	128
1988	1	1	0	1	0	1		157	157	164	128	163	128
1989	4	4	0	2	0	2		161	161	149	119	149	119
1990	3	3	2	0	2	0		159	161	150	133	151	132
1991	7	7	7	2	8	2		160	160	152	132	151	131
Avg	2	2	1	0	1	0		166	166	159	133	159	134
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	189	191	189	201	192	208		0	0	12	20	8	13
1977	201	199	213	230	216	227		0	0	0	8	0	10
1978	196	195	209	200	208	201		0	0	0	31	0	32
1979	187	188	198	212	197	219		0	0	0	18	0	11
1980	201	201	201	210	201	213		0	0	0	16	0	14
1981	191	192	201	215	199	215		0	0	0	17	0	15
1982	182	182	196	206	197	212		0	0	0	17	0	11
1983	190	189	206	209	205	211		0	0	0	11	0	9
1984	211	212	208	205	206	206		0	0	0	34	0	30
1985	193	192	191	200	190	195		0	0	0	25	0	25
1986	200	199	207	225	205	228		0	0	0	17	0	13
1987	214	214	215	224	216	227		0	0	0	13	0	10
1988	208	208	202	204	203	209		0	0	0	33	0	28
1989	200	200	216	214	216	221		0	0	0	30	0	23
1990	203	201	212	206	211	208		0	0	1	26	1	25
1991	198	198	205	213	206	216		0	0	1	18	0	16
Avg	198	198	204	211	204	214		0	0	1	21	1	18

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Table C.5.4-13. Number of Days within Temperature Requirements for Steelhead Smoltification in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		163	162	165	143	165	137
1977	0	0	0	0	0	0		156	157	129	132	128	125
1978	0	0	0	0	0	0		145	145	142	127	139	125
1979	1	1	0	0	0	0		154	154	146	132	144	130
1980	0	0	0	0	0	0		155	155	152	145	152	141
1981	0	0	0	0	0	0		168	167	147	128	145	124
1982	0	0	0	0	0	0		170	170	142	146	144	142
1983	0	0	0	0	0	0		167	167	139	152	138	156
1984	0	0	0	0	0	0		128	128	153	116	153	114
1985	0	0	0	0	0	0		159	159	140	138	139	140
1986	0	0	0	0	0	0		126	127	117	133	116	133
1987	0	0	0	0	0	0		135	135	126	112	125	110
1988	0	0	0	0	0	0		142	144	126	116	125	113
1989	0	0	0	0	0	0		157	157	129	118	126	114
1990	0	0	0	0	0	0		157	157	136	118	138	117
1991	7	8	6	0	6	0		156	155	142	144	144	141
Avg	1	1	0	0	0	0		152	152	139	131	139	129
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	203	204	201	223	201	229		0	0	0	0	0	0
1977	209	208	236	233	237	240		0	0	0	0	0	0
1978	219	219	223	238	226	240		1	1	0	0	0	0
1979	210	210	219	233	221	235		0	0	0	0	0	0
1980	210	210	210	221	210	225		1	1	4	0	4	0
1981	197	198	218	237	220	241		0	0	0	0	0	0
1982	195	195	223	219	221	223		0	0	0	0	0	0
1983	197	197	207	213	205	209		1	1	19	0	22	0
1984	237	237	211	247	210	246		1	1	2	3	3	6
1985	206	206	225	226	226	223		0	0	0	1	0	2
1986	239	238	248	232	249	232		0	0	0	0	0	0
1987	230	230	236	253	233	255		0	0	3	0	7	0
1988	224	222	231	235	229	238		0	0	9	15	12	15
1989	208	208	236	247	239	251		0	0	0	0	0	0
1990	208	208	229	240	227	241		0	0	0	7	0	7
1991	202	202	217	221	215	224		0	0	0	0	0	0
Avg	212	212	223	232	223	235		0	0	2	2	3	2

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Table C.5.4-14. Number of Days within Temperature Requirements for Steelhead Smoltification in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		161	161	162	131	164	131
1977	0	0	0	0	0	0		160	160	123	114	123	114
1978	0	0	0	0	0	0		139	139	136	112	135	118
1979	0	0	0	0	0	0		163	163	138	124	142	127
1980	0	0	0	0	0	0		159	158	150	135	148	135
1981	0	0	0	0	0	0		168	166	150	114	151	112
1982	0	0	0	0	0	0		170	171	145	138	149	138
1983	0	0	0	0	0	0		168	169	143	152	139	150
1984	0	0	0	0	0	0		126	126	159	111	158	114
1985	0	0	0	0	0	0		162	162	116	139	115	136
1986	0	0	0	0	0	0		118	120	97	124	98	128
1987	0	0	0	0	0	0		126	128	121	103	120	103
1988	0	0	0	0	0	0		143	144	117	98	116	96
1989	0	0	0	0	0	0		151	151	122	113	121	114
1990	0	0	0	0	0	0		155	155	132	112	131	114
1991	11	11	10	0	9	0		152	152	126	119	128	121
Avg	1	1	1	0	1	0		151	152	134	121	134	122
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	205	205	204	233	202	233		0	0	0	2	0	2
1977	205	205	241	247	242	248		0	0	1	4	0	3
1978	226	226	229	237	229	233		0	0	0	16	1	14
1979	202	202	227	237	223	235		0	0	0	4	0	3
1980	207	208	215	223	215	227		0	0	1	8	3	4
1981	197	199	214	244	213	245		0	0	1	7	1	8
1982	195	194	220	227	216	227		0	0	0	0	0	0
1983	196	195	206	213	211	215		1	1	16	0	15	0
1984	235	235	203	225	201	227		5	5	4	30	7	25
1985	203	203	249	216	250	220		0	0	0	10	0	9
1986	247	245	268	241	267	237		0	0	0	0	0	0
1987	239	237	232	262	232	262		0	0	12	0	13	0
1988	223	222	235	250	236	252		0	0	14	18	14	18
1989	214	214	243	248	244	248		0	0	0	4	0	3
1990	210	210	233	238	234	241		0	0	0	15	0	10
1991	202	202	229	246	228	244		0	0	0	0	0	0
Avg	213	213	228	237	228	237		0	0	3	7	3	6

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Table C.5.4-15. Number of Days within Temperature Requirements for Steelhead Smoltification in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							**Optimal (≥7°C and ≤15°C)**					
1976	0	0	0	0	0	0		167	166	167	156	166	153
1977	0	0	0	0	0	0		149	149	132	134	132	133
1978	0	0	0	0	0	0		143	143	136	121	137	121
1979	0	0	0	0	0	0		167	170	156	129	154	128
1980	0	0	0	0	0	0		164	165	155	141	155	141
1981	0	0	0	0	0	0		167	170	157	133	156	132
1982	0	0	0	0	0	0		159	160	148	148	149	147
1983	0	0	0	0	0	0		182	181	150	144	151	147
1984	0	0	0	0	0	0		139	139	152	117	153	112
1985	0	0	0	0	0	0		156	156	144	148	144	146
1986	0	0	0	0	0	0		153	153	130	120	130	120
1987	0	0	0	0	0	0		135	134	128	125	127	125
1988	0	0	0	0	0	0		142	142	126	128	126	127
1989	0	0	0	0	0	0		151	152	136	121	135	120
1990	0	0	0	0	0	0		140	140	124	126	124	124
1991	0	0	0	0	0	0		163	163	143	147	143	146
Avg	0	0	0	0	0	0		155	155	143	134	143	133
	Supraoptimal (>15°C and ≤24°C)							**Lethal (>24°C)**					
1976	199	200	199	210	200	213		0	0	0	0	0	0
1977	216	216	233	231	233	232		0	0	0	0	0	0
1978	222	222	229	241	228	240		0	0	0	3	0	4
1979	198	195	209	236	211	237		0	0	0	0	0	0
1980	202	201	211	224	211	225		0	0	0	1	0	0
1981	198	195	208	232	209	233		0	0	0	0	0	0
1982	206	205	217	217	216	218		0	0	0	0	0	0
1983	183	184	214	221	212	218		0	0	1	0	2	0
1984	227	227	214	243	213	248		0	0	0	6	0	6
1985	209	209	221	217	221	218		0	0	0	0	0	1
1986	212	212	235	245	235	245		0	0	0	0	0	0
1987	230	231	237	240	238	240		0	0	0	0	0	0
1988	224	224	240	233	240	234		0	0	0	5	0	5
1989	214	213	229	244	230	245		0	0	0	0	0	0
1990	225	225	241	234	241	235		0	0	0	5	0	6
1991	202	202	222	218	222	219		0	0	0	0	0	0
Avg	210	210	222	230	223	231		0	0	0	1	0	1

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Table C.5.4-16. Number of Days within Temperature Requirements for Steelhead Smoltification in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		161	161	166	138	165	144
1977	0	0	0	0	0	0		165	165	126	127	131	124
1978	0	0	0	0	0	0		158	159	155	107	154	114
1979	0	1	0	0	0	0		180	177	143	120	144	124
1980	0	0	0	0	0	0		169	170	159	122	160	124
1981	0	0	0	0	0	0		178	177	163	120	160	125
1982	0	0	0	0	0	0		187	188	163	136	161	137
1983	0	2	0	0	0	0		188	185	158	145	157	141
1984	0	0	0	0	0	0		133	132	160	109	159	108
1985	8	10	0	0	0	0		156	154	120	145	119	144
1986	0	0	0	0	0	0		147	146	123	111	127	111
1987	0	0	0	0	0	0		129	132	124	105	125	107
1988	0	0	0	0	0	0		149	150	122	106	123	121
1989	0	0	0	0	0	0		155	155	124	114	124	117
1990	0	0	0	0	0	0		156	156	136	117	129	120
1991	6	8	6	0	11	0		157	155	140	140	136	145
Avg	1	1	0	0	1	0		161	160	143	123	142	125
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	205	205	200	228	201	222		0	0	0	0	0	0
1977	200	200	239	236	234	238		0	0	0	2	0	3
1978	207	206	210	248	211	242		0	0	0	10	0	9
1979	185	187	222	242	221	239		0	0	0	3	0	2
1980	197	196	207	239	206	238		0	0	0	5	0	4
1981	187	188	201	238	203	237		0	0	1	7	2	3
1982	178	177	202	229	204	228		0	0	0	0	0	0
1983	177	178	193	220	194	224		0	0	14	0	14	0
1984	229	230	201	237	202	239		4	4	5	20	5	19
1985	201	201	245	213	246	215		0	0	0	7	0	6
1986	218	219	242	254	238	254		0	0	0	0	0	0
1987	236	233	234	260	234	258		0	0	7	0	6	0
1988	217	216	233	245	232	229		0	0	11	15	11	16
1989	210	210	241	250	241	247		0	0	0	1	0	1
1990	209	209	229	238	236	234		0	0	0	10	0	11
1991	202	202	219	225	218	220		0	0	0	0	0	0
Avg	204	204	220	238	220	235		0	0	2	5	2	5

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Table C.5.4-17. Number of Days within Temperature Requirements for Steelhead Smoltification in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<7°C)							Optimal (≥7°C and ≤15°C)					
1976	0	0	0	0	0	0		167	167	163	139	162	133
1977	0	0	0	0	0	0		162	162	134	122	133	121
1978	0	0	0	0	0	0		157	158	151	108	147	108
1979	0	0	0	0	0	0		184	184	162	118	157	120
1980	0	0	0	0	0	0		167	167	158	131	158	129
1981	0	0	0	0	0	0		180	180	162	120	162	115
1982	0	0	0	0	0	0		185	187	159	141	159	138
1983	0	0	0	0	0	0		183	183	154	144	152	146
1984	0	0	0	0	0	0		144	144	157	116	158	112
1985	0	0	0	0	0	0		162	162	140	144	139	142
1986	0	0	0	0	0	0		153	153	121	114	120	113
1987	0	0	0	0	0	0		133	134	130	109	128	106
1988	0	0	0	0	0	0		149	149	124	105	125	102
1989	0	0	0	0	0	0		151	151	137	111	137	110
1990	0	0	0	0	0	0		158	158	140	116	140	115
1991	0	0	0	0	0	0		163	163	148	135	148	133
Avg	0	0	0	0	0	0		162	163	146	123	145	121
	Supraoptimal (>15°C and ≤24°C)							Lethal (>24°C)					
1976	199	199	203	227	204	233		0	0	0	0	0	0
1977	203	203	231	243	232	244		0	0	0	0	0	0
1978	208	207	214	242	218	246		0	0	0	15	0	11
1979	181	181	203	246	208	245		0	0	0	1	0	0
1980	199	199	208	226	208	234		0	0	0	9	0	3
1981	185	185	203	245	203	250		0	0	0	0	0	0
1982	180	178	206	224	206	227		0	0	0	0	0	0
1983	182	182	208	221	205	219		0	0	3	0	8	0
1984	222	222	209	233	207	237		0	0	0	17	1	17
1985	203	203	225	212	226	215		0	0	0	9	0	8
1986	212	212	244	251	245	252		0	0	0	0	0	0
1987	232	231	235	256	237	259		0	0	0	0	0	0
1988	217	217	240	246	235	249		0	0	2	15	6	15
1989	214	214	228	254	228	255		0	0	0	0	0	0
1990	207	207	225	241	225	243		0	0	0	8	0	7
1991	202	202	217	230	217	232		0	0	0	0	0	0
Avg	203	203	219	237	219	240		0	0	0	5	1	4

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C.5.4.3.3 Steelhead—Adult

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult steelhead in the Cache Slough subregion (Table C.5.4-18). The average number of optimal days was 186 days under EBC1 and EBC2 and varied from 189 to 197 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 11 and 12 under EBC1 and EBC2, 15 to 23 days under EBC2_ELT and PP_ELT, and 25 to 23 days under EBC2_LLT and PP_LLT. On average there were 2 lethal days under EBC2_LLT and 3 lethal days under the PP_LTT scenario.

EBC scenarios and PP scenarios in water temperatures for adult steelhead in the East Delta subregion (Table C.5.4-19) differed little when accounting for climate change. The average number of optimal days was 190 under EBC1 and EBC2, 195–199 under EBC2_ELT and EBC2_LLT, and 196 to 197 under PP_ELT and PP_LLT, respectively. The average number of supraoptimal days was 14 for EBC1 and EBC2, 17 and 27 days under EBC2_ELT and EBC2_LLT, and 16 and 26 days under PP_ELT and PP_LLT. There was an average of 3 lethal temperature days for EBC2_LLT and PP_LLT, respectively.

Water temperatures for adult steelhead in the North Delta subregion (Table C.5.4-20) were similar across scenarios, considering climate change effects on water temperature. The average number of optimal water temperature days was 169 for EBC1 and EBC2 and varied between 173 and 188 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 13 days under EBC1 and EBC2, and ranged from 17 to 28 days under EBC2_ELT, EBC2_LLT, and from 16 to 28 under PP_ELT and PP_LLT. There were no days with lethal temperatures under any scenario.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult steelhead in the San Joaquin portion of the South Delta subregion (Table C.5.4-21). A moderate difference was observed in the evaluation of suboptimal water temperatures for adult steelhead. Suboptimal water temperatures occurred on average on 16 days under EBC1 and EBC2. In the early long-term period, suboptimal conditions occurred on 19 and 29 days, respectively, under EBC2_ELT and PP_ELT, representing a moderate adverse effect of the preliminary proposal. In the late long-term, suboptimal conditions occurred on 23 and 18 days, respectively, under EBC2_LLT and PP_LLT, representing a small benefit of the preliminary proposal. Optimal water temperatures occurred on 189 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 195 to 201. Supraoptimal and lethal temperatures were not observed under any scenario.

Water temperatures in the South Delta for adult steelhead were generally similar among the different scenarios (considering climate change) (Table C.5.4-22). Suboptimal water temperatures occurred on 36 to 37 1 days on average under EBC1 and EBC2, and on 15-27 days under the remaining alternatives (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Under EBC1 and EBC2, optimal water temperatures occurred on 192 days per year, on average. Under EBC2_ELT, and EBC2_LLT, optimal temperature conditions occurred on 198 to 199 days per year; and on 198 to 200 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 14 days under EBC1 and EBC2, and on 17 to 26 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Lethal temperature days occurred on average on 0 to 3 days under model scenarios.

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In the Suisun Bay subregion, water temperatures for adult steelhead were similar among scenarios (Table C.5.4-23) after accounting for changing climate. Optimal water temperatures were reached on average on 189 and 188 days under EBC1 and EBC2 scenarios. The number of days of optimal water temperature conditions was 192 and 189 days for all other scenarios. EBC1 and EBC2 averaged 10 and 11 days of supraoptimal days, respectively, while the number of days for EBC2_ELT and EBC2_LTT and PP_ELT and PP_LLT varied from 13 to 25 days. There were no lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for adult steelhead were minor, after climate change was taken into consideration (Table C.5.4-24). Optimal temperatures occurred on average on 186 days under EBC1 and EBC2 and on 191 to 194 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 10 days under EBC1 and EBC2, and on 13 to 23 days under all other scenarios (i.e., EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did occur on average on only 2 days under the EBC2_LLT and PP_LLT scenarios.

Water temperatures in the West Delta for adult steelhead were generally similar among the different scenarios (considering climate change) (Table C.5.4-25). Under EBC1 and EBC2, optimal water temperatures occurred on 183 days per year, on average. Under EBC2_ELT, and EBC2_LLT, optimal temperature conditions occurred on 188 to 194 days per year; and on 190 to 194 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 13 and 12 days under EBC1 and EBC2, respectively, and on 16 to 29 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Lethal temperature days occurred on average once annually under the EBC2_LLT and PP_LLT scenarios.

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Table C.5.4-18. Number of Days within Temperature Requirements for Steelhead Adults in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	40	40	35	15	35	16		190	190	189	207	190	207
1977	60	60	49	30	48	35		169	169	179	189	181	185
1978	4	5	0	0	2	0		238	237	234	213	233	214
1979	52	51	46	25	62	38		166	167	170	174	153	164
1980	35	32	24	3	40	10		208	211	208	223	198	219
1981	42	41	30	4	32	4		181	182	185	203	184	203
1982	42	42	26	3	43	17		188	188	200	220	184	207
1983	48	48	34	17	38	19		177	177	178	198	175	196
1984	35	35	57	4	58	10		186	185	180	208	181	203
1985	61	61	27	55	25	56		178	178	205	169	209	170
1986	36	36	42	21	45	21		201	199	195	201	191	201
1987	48	48	40	28	41	27		192	192	184	187	183	190
1988	47	45	34	15	37	15		175	177	197	195	194	197
1989	63	63	53	28	55	26		173	173	181	193	181	196
1990	59	60	40	22	48	26		172	170	189	193	182	189
1991	42	43	31	25	30	25		184	183	198	176	200	177
Avg	45	44	36	18	40	22		186	186	192	197	189	195
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	13	13	19	21	18	20		0	0	0	0	0	0
1977	13	13	14	19	13	20		0	0	0	4	0	2
1978	0	0	8	28	7	27		0	0	0	1	0	1
1979	24	24	23	36	23	31		0	0	3	7	4	9
1980	0	0	11	17	5	14		0	0	0	0	0	0
1981	19	19	27	35	26	35		0	0	0	0	0	0
1982	12	12	16	16	15	14		0	0	0	3	0	4
1983	17	17	30	24	29	23		0	0	0	3	0	4
1984	22	23	6	19	4	14		0	0	0	12	0	16
1985	3	3	10	18	8	16		0	0	0	0	0	0
1986	5	7	5	20	6	20		0	0	0	0	0	0
1987	2	2	18	26	18	24		0	0	0	1	0	1
1988	18	18	12	26	12	24		3	3	0	7	0	7
1989	6	6	8	21	6	20		0	0	0	0	0	0
1990	11	12	13	27	12	27		0	0	0	0	0	0
1991	16	16	13	40	12	38		0	0	0	1	0	2
Avg	11	12	15	25	13	23		0	0	0	2	0	3

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Table C.5.4-19. Number of Days within Temperature Requirements for Steelhead Adults in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	39	39	30	5	32	6		193	193	194	216	192	217
1977	59	53	45	13	46	25		170	176	182	204	181	194
1978	4	4	0	0	0	0		229	229	225	214	230	213
1979	46	45	41	22	43	25		175	176	171	183	172	174
1980	31	30	32	9	27	5		205	204	197	206	203	217
1981	42	42	30	4	26	4		179	179	189	202	190	202
1982	45	47	29	8	25	6		182	180	198	209	201	217
1983	38	38	15	9	16	10		181	181	202	205	197	204
1984	41	41	55	9	55	5		178	178	176	197	179	206
1985	59	59	25	33	24	51		178	178	205	186	208	168
1986	24	23	23	20	33	17		210	211	209	201	204	205
1987	47	47	36	20	39	24		191	193	196	185	186	186
1988	20	20	14	7	21	12		206	205	216	202	210	196
1989	50	52	38	17	45	24		189	187	191	199	188	191
1990	46	47	39	16	28	19		175	174	183	194	196	192
1991	33	32	29	20	31	23		193	196	193	182	193	176
Avg	39	39	30	13	31	16		190	190	195	199	196	197
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	11	11	16	19	18	20		0	0	3	3	1	0
1977	13	13	15	20	15	19		0	0	0	5	0	4
1978	9	9	17	26	12	28		0	0	0	2	0	1
1979	21	21	30	31	27	35		0	0	0	6	0	8
1980	7	9	14	28	13	21		0	0	0	0	0	0
1981	21	21	23	35	26	36		0	0	0	1	0	0
1982	15	15	15	22	16	14		0	0	0	3	0	5
1983	23	23	25	28	29	25		0	0	0	0	0	3
1984	24	24	12	28	9	16		0	0	0	9	0	16
1985	5	5	12	23	10	23		0	0	0	0	0	0
1986	8	8	10	21	5	20		0	0	0	0	0	0
1987	4	2	10	36	17	29		0	0	0	1	0	3
1988	17	18	13	26	12	27		0	0	0	8	0	8
1989	3	3	13	26	9	27		0	0	0	0	0	0
1990	21	21	20	32	18	31		0	0	0	0	0	0
1991	16	14	20	35	18	40		0	0	0	5	0	3
Avg	14	14	17	27	16	26		0	0	0	3	0	3

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Table C.5.4-20. Number of Days within Temperature Requirements for Steelhead Adults in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤20°C)**					
1976	61	59	36	15	34	14		172	174	186	204	187	208
1977	63	63	51	23	51	29		169	169	176	192	177	187
1978	51	50	37	7	39	6		180	176	186	205	187	207
1979	70	67	62	34	62	34		151	155	150	171	151	170
1980	53	53	53	23	52	22		181	178	175	191	179	193
1981	48	48	53	12	52	13		174	177	170	194	168	194
1982	58	58	50	23	50	24		166	165	179	192	181	189
1983	62	62	52	22	52	22		160	160	169	191	169	189
1984	57	57	59	17	58	17		164	165	169	191	176	192
1985	68	67	63	42	64	45		168	170	166	175	166	173
1986	57	56	49	23	50	25		177	177	178	195	183	196
1987	67	67	51	30	53	28		164	170	180	178	178	180
1988	55	55	45	19	47	19		175	174	182	191	178	188
1989	63	63	63	28	61	29		173	174	166	183	168	184
1990	66	66	64	29	65	30		157	157	157	178	156	178
1991	60	60	49	24	48	22		170	170	175	180	177	182
Avg	60	59	52	23	52	24		169	169	173	188	174	188
	Supraoptimal (>20°C and ≤23°C)							**Lethal (>23°C)**					
1976	10	10	19	21	20	18		0	0	0	0	0	0
1977	10	10	15	22	14	21		0	0	0	0	0	0
1978	11	16	19	28	16	25		0	0	0	0	0	0
1979	21	20	30	33	29	35		0	0	0	0	0	0
1980	9	12	15	29	12	28		0	0	0	0	0	0
1981	20	17	19	34	22	33		0	0	0	0	0	0
1982	18	19	13	25	11	29		0	0	0	0	0	0
1983	20	20	21	26	21	29		0	0	0	0	0	0
1984	22	21	15	31	9	29		0	0	0	0	0	0
1985	6	5	13	25	12	24		0	0	0	0	0	0
1986	8	9	15	22	9	20		0	0	0	0	0	0
1987	11	5	11	33	11	33		0	0	0	0	0	0
1988	12	13	16	25	18	29		0	0	0	0	0	0
1989	6	5	13	31	13	29		0	0	0	0	0	0
1990	19	19	21	34	21	31		0	0	0	0	0	0
1991	12	12	18	33	17	33		0	0	0	0	0	0
Avg	13	13	17	28	16	28		0	0	0	0	0	0

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Table C.5.4-21. Number of Days within Temperature Requirements for Steelhead Adults in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	14	15	16	16	35	12		192	190	190	212	193	215
1977	12	12	13	16	45	27		177	177	184	199	183	199
1978	13	12	17	26	0	0		229	229	225	216	225	214
1979	28	29	34	35	38	29		170	169	168	175	170	176
1980	11	10	16	14	16	8		208	209	209	221	211	222
1981	23	23	30	33	20	0		181	181	190	207	194	208
1982	18	18	19	18	15	12		199	199	206	210	208	210
1983	27	27	29	26	25	20		184	184	193	197	187	196
1984	28	28	14	30	48	8		191	191	179	205	184	205
1985	7	7	18	12	27	50		176	176	197	181	198	178
1986	12	12	13	17	30	15		203	204	199	210	200	210
1987	7	6	20	19	35	22		190	191	186	196	188	200
1988	19	17	14	24	25	12		182	184	204	201	204	201
1989	6	6	12	16	46	27		181	180	184	200	184	196
1990	18	17	17	26	30	19		178	178	195	197	194	197
1991	17	15	20	35	31	24		184	187	190	184	194	181
Avg	16	16	19	23	29	18		189	189	194	201	195	201
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		2	2	0	4	0	4
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-22. Number of Days within Temperature Requirements for Steelhead Adults in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	38	38	36	5	35	2		192	192	188	215	189	219
1977	52	52	44	16	44	17		177	177	184	204	184	203
1978	0	0	0	0	0	0		240	240	231	213	229	214
1979	51	49	36	25	35	24		162	164	176	169	175	170
1980	22	22	8	4	10	6		221	221	216	222	214	223
1981	38	38	15	0	11	0		181	181	198	204	203	206
1982	19	20	7	0	5	0		209	208	219	221	221	222
1983	30	31	12	15	18	16		187	186	200	200	194	200
1984	23	24	54	3	49	10		194	193	180	208	187	201
1985	60	60	25	51	25	51		178	178	204	171	204	171
1986	27	27	35	16	33	16		208	207	199	205	201	205
1987	46	46	36	17	33	14		194	195	185	199	188	202
1988	36	36	31	12	31	12		186	186	197	195	197	196
1989	58	59	39	27	39	24		177	176	194	192	194	194
1990	46	46	25	20	25	19		180	180	197	194	200	195
1991	36	36	30	23	29	23		186	186	192	176	194	176
Avg	36	37	27	15	26	15		192	192	198	199	198	200
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	13	13	19	23	19	22		0	0	0	0	0	0
1977	13	13	14	18	14	18		0	0	0	4	0	4
1978	2	2	11	28	13	28		0	0	0	1	0	0
1979	29	29	25	40	27	40		0	0	5	8	5	8
1980	0	0	19	17	19	14		0	0	0	0	0	0
1981	23	23	29	38	28	36		0	0	0	0	0	0
1982	14	14	16	21	16	20		0	0	0	0	0	0
1983	25	25	26	25	25	24		0	0	4	2	5	2
1984	26	26	9	15	7	15		0	0	0	17	0	17
1985	4	4	13	20	13	20		0	0	0	0	0	0
1986	7	8	8	21	8	21		0	0	0	0	0	0
1987	2	1	21	25	21	25		0	0	0	1	0	1
1988	18	18	15	28	15	28		3	3	0	8	0	7
1989	7	7	9	23	9	24		0	0	0	0	0	0
1990	16	16	20	28	17	28		0	0	0	0	0	0
1991	20	20	20	41	19	41		0	0	0	2	0	2
Avg	14	14	17	26	17	25		0	0	1	3	1	3

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Table C.5.4-23. Number of Days within Temperature Requirements for Steelhead Adults in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	37	35	42	22	41	21		194	196	182	203	183	204
1977	49	49	50	43	50	43		181	181	179	181	179	180
1978	10	10	3	0	1	0		230	230	231	212	233	213
1979	55	56	49	40	51	41		164	163	171	165	169	163
1980	36	37	33	16	33	17		207	206	201	211	201	209
1981	38	39	24	16	23	13		194	192	200	192	200	194
1982	51	51	40	22	41	22		178	178	186	199	185	199
1983	47	47	34	24	33	24		177	177	178	190	179	191
1984	38	37	57	17	57	16		181	182	179	195	182	196
1985	60	60	35	58	35	58		179	179	197	166	198	166
1986	35	36	36	29	37	31		200	199	199	196	198	194
1987	42	43	35	38	35	35		198	197	195	182	194	185
1988	43	44	36	23	37	24		186	184	192	191	191	190
1989	50	54	45	46	45	46		187	182	190	177	190	177
1990	55	55	41	36	39	34		177	177	190	180	192	182
1991	44	43	30	27	31	28		186	187	202	180	200	179
Avg	43	44	37	29	37	28		189	188	192	189	192	189
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	12	12	19	18	19	18		0	0	0	0	0	0
1977	12	12	13	18	13	19		0	0	0	0	0	0
1978	2	2	8	30	8	29		0	0	0	0	0	0
1979	23	23	22	37	22	38		0	0	0	0	0	0
1980	0	0	9	16	9	17		0	0	0	0	0	0
1981	10	11	18	34	19	35		0	0	0	0	0	0
1982	13	13	16	21	16	21		0	0	0	0	0	0
1983	18	18	30	28	30	27		0	0	0	0	0	0
1984	24	24	7	31	4	31		0	0	0	0	0	0
1985	3	3	10	18	9	18		0	0	0	0	0	0
1986	7	7	7	17	7	17		0	0	0	0	0	0
1987	2	2	12	22	13	22		0	0	0	0	0	0
1988	14	15	15	27	15	26		0	0	0	2	0	3
1989	5	6	7	19	7	19		0	0	0	0	0	0
1990	10	10	11	26	11	26		0	0	0	0	0	0
1991	12	12	10	35	11	35		0	0	0	0	0	0
Avg	10	11	13	25	13	25		0	0	0	0	0	0

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Table C.5.4-24. Number of Days within Temperature Requirements for Steelhead Adults in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤20°C)**					
1976	40	40	38	16	37	20		190	190	186	210	188	207
1977	53	52	48	39	49	41		176	177	180	182	180	180
1978	1	1	0	0	0	0		241	241	238	214	236	214
1979	62	63	60	37	57	40		160	157	157	161	159	161
1980	40	40	29	5	27	13		203	203	206	226	208	218
1981	40	40	22	4	24	16		185	184	197	203	192	191
1982	47	47	41	24	38	24		184	184	185	200	188	200
1983	64	65	35	29	34	29		163	162	177	186	178	186
1984	38	38	60	11	60	8		182	182	180	202	180	205
1985	63	62	28	55	27	57		177	177	208	169	206	170
1986	37	36	38	21	42	23		200	201	199	201	193	200
1987	49	49	39	30	39	31		193	192	184	191	185	189
1988	45	44	34	20	35	22		182	182	197	192	197	190
1989	60	59	51	36	52	41		181	180	188	191	182	184
1990	60	60	39	24	34	26		175	174	193	192	197	190
1991	47	43	31	25	31	27		183	186	202	180	200	178
Avg	47	46	37	24	37	26		186	186	192	194	192	191
	Supraoptimal (>20°C and ≤23°C)							**Lethal (>23°C)**					
1976	13	13	19	17	18	16		0	0	0	0	0	0
1977	13	13	14	20	13	20		0	0	0	1	0	1
1978	0	0	4	28	6	28		0	0	0	0	0	0
1979	20	22	21	40	21	37		0	0	4	4	5	4
1980	0	0	8	12	8	12		0	0	0	0	0	0
1981	17	18	23	35	26	35		0	0	0	0	0	0
1982	11	11	16	18	16	18		0	0	0	0	0	0
1983	15	15	30	25	30	25		0	0	0	2	0	2
1984	23	23	3	17	3	21		0	0	0	13	0	9
1985	2	3	6	18	9	15		0	0	0	0	0	0
1986	5	5	5	20	7	19		0	0	0	0	0	0
1987	0	1	19	21	18	22		0	0	0	0	0	0
1988	15	16	12	24	11	24		1	1	0	7	0	7
1989	1	3	3	15	8	17		0	0	0	0	0	0
1990	7	8	10	26	11	26		0	0	0	0	0	0
1991	12	13	9	37	11	36		0	0	0	0	0	1
Avg	10	10	13	23	14	23		0	0	0	2	0	2

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Table C.5.4-25. Number of Days within Temperature Requirements for Steelhead Adults in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	41	41	34	14	32	14		188	188	189	203	191	204
1977	54	53	48	24	47	34		174	175	179	197	180	187
1978	9	9	0	0	0	0		233	233	235	212	237	212
1979	60	61	58	26	56	28		158	158	152	165	154	164
1980	39	39	34	6	31	4		204	204	192	220	199	223
1981	43	44	24	0	20	0		176	175	191	202	196	202
1982	53	53	44	15	38	11		176	176	181	203	187	205
1983	48	48	34	17	33	16		172	173	178	195	179	196
1984	42	42	57	5	57	5		176	178	177	203	179	204
1985	62	62	35	53	32	53		176	176	197	168	200	168
1986	35	35	38	19	37	21		199	199	197	202	199	200
1987	48	49	37	29	36	29		194	193	185	184	185	186
1988	51	51	34	14	34	15		174	174	192	193	193	192
1989	58	58	54	30	53	29		179	179	183	190	184	192
1990	65	66	44	18	42	19		164	163	180	194	184	193
1991	48	42	31	25	31	25		177	183	199	172	199	172
Avg	47	47	38	18	36	19		183	183	188	194	190	194
	Supraoptimal (>20°C and ≤23°C)							Lethal (>23°C)					
1976	14	14	20	26	20	25		0	0	0	0	0	0
1977	14	14	15	21	15	21		0	0	0	0	0	0
1978	0	0	7	30	5	30		0	0	0	0	0	0
1979	24	23	32	51	32	50		0	0	0	0	0	0
1980	0	0	17	17	13	16		0	0	0	0	0	0
1981	23	23	27	40	26	40		0	0	0	0	0	0
1982	13	13	17	24	17	26		0	0	0	0	0	0
1983	22	21	30	30	30	30		0	0	0	0	0	0
1984	25	23	9	24	7	19		0	0	0	11	0	15
1985	4	4	10	21	10	21		0	0	0	0	0	0
1986	8	8	7	21	6	21		0	0	0	0	0	0
1987	0	0	20	29	21	27		0	0	0	0	0	0
1988	18	18	17	28	16	28		0	0	0	8	0	8
1989	5	5	5	22	5	21		0	0	0	0	0	0
1990	13	13	18	30	16	30		0	0	0	0	0	0
1991	17	17	12	45	12	45		0	0	0	0	0	0
Avg	13	12	16	29	16	28		0	0	0	1	0	1

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.4 Winter-Run Chinook Salmon—Juvenile

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile winter-run Chinook salmon in the Cache Slough subregion (Table C.5.4-26). The average number of optimal days over the 16 simulated years was 76 and 77 days under EBC1 and EBC2 and 82 to 99 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. On average there were no supraoptimal or lethal days under any scenario, although 1 day in 1987 had supraoptimal conditions under EBC2_LLT and PP_LLT scenarios.

EBC scenarios and PP scenarios in water temperatures for juvenile winter-run Chinook salmon in the East Delta subregion (Table C.5.4-27) differed little when accounting for climate change. The average number of optimal days was 70 days under EBC1 and EBC2 and 77 and 100 days under EBC2_ELT and EBC2_LLT, respectively, and 83 and 102 days under PP_ELT and PP_LLT, respectively. The average number of supraoptimal and lethal temperature days was zero under all scenarios.

EBC scenarios and PP scenarios in water temperatures for juvenile winter-run Chinook salmon in the North Delta subregion (Table C.5.4-28) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 58 for EBC1 and EBC2, and between 64 and 88 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). No supraoptimal or lethal water temperatures were reached during the modeling period under any scenario.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile winter-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-29). Optimal water temperatures occurred on 79 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the average number of days with optimal water temperatures ranged from 86 to 95. Supraoptimal or lethal temperatures were not reached under any scenario.

Water temperatures in the South Delta for juvenile winter-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-30). Suboptimal water temperatures occurred on 95 days per year on average under EBC1 and EBC2, and on 80–87 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Under EBC1 and EBC2, optimal water temperatures occurred on 86 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 94 and 102 days per year, respectively; and on 94 and 101 days under PP_ELT and PP_LLT. There were no days with supraoptimal or lethal temperatures under any scenario.

In the Suisun Bay subregion, water temperatures for juvenile winter-run Chinook salmon were similar among scenarios (Table C.5.4-31) after accounting for changing climate. Optimal water temperatures were reached on average on 75 and 74 days under EBC1 and EBC2. The average number of optimal days for all other scenarios ranged from 80 to 87. There were no supraoptimal or lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for juvenile winter-run Chinook salmon were minor, after climate change was taken into consideration (Table C.5.4-32). Optimal temperatures occurred on average on 78 days under EBC1 and EBC2, and on 86 to 96 days

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal or lethal water temperature conditions did not occur under any scenario.

Water temperatures in the West Delta for juvenile winter-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-33). Under EBC1 and EBC2, optimal water temperatures occurred on 73 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 80 and 96 days per year, respectively; and on 85 and 98 days under PP_ELT and PP_LLT. Days with supraoptimal or lethal temperatures did not occur under any scenario.

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Table C.5.4-26. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	123	121	104	90	108	89		59	61	78	92	74	93
1977	96	95	83	80	84	80		85	86	98	101	97	101
1978	91	91	82	57	85	70		90	90	99	124	96	111
1979	112	112	111	92	113	99		69	69	70	89	68	82
1980	104	104	94	75	103	86		78	78	88	107	79	96
1981	106	102	89	79	91	78		75	79	92	102	90	103
1982	111	112	101	81	109	82		70	69	80	100	72	99
1983	115	115	108	88	117	92		66	66	73	93	64	89
1984	105	106	103	92	108	92		77	76	79	90	74	90
1985	108	106	97	90	96	91		73	75	84	91	85	90
1986	98	97	83	84	98	91		83	84	98	97	83	90
1987	102	101	90	77	89	78		79	80	91	103	92	102
1988	91	88	85	75	86	73		91	94	97	107	96	109
1989	111	111	102	94	102	93		70	70	79	87	79	88
1990	105	105	100	89	99	88		76	76	81	92	82	93
1991	108	108	98	80	104	81		73	73	83	101	77	100
Avg	105	105	96	83	100	85		76	77	86	99	82	96
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	1	0	1		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-27. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	114	112	103	89	98	84		68	70	79	93	84	98
1977	97	101	86	77	82	79		84	80	95	104	99	102
1978	91	91	83	59	76	55		90	90	98	122	105	126
1979	119	118	116	91	111	86		62	63	65	90	70	95
1980	118	118	120	76	108	73		64	64	62	106	74	109
1981	124	121	99	72	91	77		57	60	82	109	90	104
1982	119	119	115	87	111	82		62	62	66	94	70	99
1983	133	133	108	85	113	84		48	48	73	96	68	97
1984	109	109	119	92	108	89		73	73	63	90	74	93
1985	113	113	113	89	103	89		68	68	68	92	78	92
1986	117	117	111	80	102	80		64	64	70	101	79	101
1987	103	103	97	71	86	74		78	78	84	110	95	107
1988	89	90	89	67	86	69		93	92	93	115	96	113
1989	113	113	104	90	102	90		68	68	77	91	79	91
1990	110	111	106	90	96	87		71	70	75	91	85	94
1991	104	106	100	78	95	77		77	75	81	103	86	104
Avg	111	111	104	81	98	80		70	70	77	100	83	102
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-28. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	125	124	108	98	108	99		57	58	74	84	74	83
1977	131	132	117	86	118	83		50	49	64	95	63	98
1978	115	115	108	82	110	83		66	66	73	99	71	98
1979	131	130	125	103	123	102		50	51	56	78	58	79
1980	125	125	128	93	126	92		57	57	54	89	56	90
1981	131	130	117	92	119	93		50	51	64	89	62	88
1982	127	127	118	96	118	96		54	54	63	85	63	85
1983	141	141	113	99	112	99		40	40	68	82	69	82
1984	117	117	126	93	125	92		65	65	56	89	57	90
1985	123	124	137	102	135	102		58	57	44	79	46	79
1986	123	123	114	93	114	93		58	58	67	88	67	88
1987	113	112	116	87	116	87		68	69	65	94	65	94
1988	104	106	109	77	110	77		78	76	73	105	72	105
1989	122	122	110	100	110	101		59	59	71	81	71	80
1990	116	117	110	103	109	101		65	64	71	78	72	80
1991	128	127	123	89	121	89		53	54	58	92	60	92
Avg	123	123	117	93	117	93		58	58	64	88	64	88
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-29. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	108	107	109	95	110	91		74	75	73	87	72	91
1977	98	99	82	81	82	77		83	82	99	100	99	104
1978	92	92	81	78	80	78		89	89	100	103	101	103
1979	113	113	108	95	107	92		68	68	73	86	74	89
1980	101	100	91	89	92	88		81	82	91	93	90	94
1981	96	94	91	77	89	76		85	87	90	104	92	105
1982	101	101	92	102	89	100		80	80	89	79	92	81
1983	108	107	103	96	103	96		73	74	78	85	78	85
1984	104	104	106	92	103	92		78	78	76	90	79	90
1985	110	109	104	91	104	92		71	72	77	90	77	89
1986	104	104	84	94	80	92		77	77	97	87	101	89
1987	96	96	91	86	88	76		85	85	90	95	93	105
1988	89	90	87	73	84	68		93	92	95	109	98	114
1989	111	110	102	98	101	94		70	71	79	83	80	87
1990	105	105	98	87	96	84		76	76	83	94	85	97
1991	98	100	90	83	87	77		83	81	91	98	94	104
Avg	102	102	95	89	93	86		79	79	86	93	88	95
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-30. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	114	117	102	85	104	83		68	65	80	97	78	99
1977	89	89	81	79	81	79		92	92	100	102	100	102
1978	78	78	66	54	63	57		103	103	115	127	118	124
1979	110	110	107	95	107	95		71	71	74	86	74	86
1980	92	92	86	77	86	81		90	90	96	105	96	101
1981	84	84	82	73	82	71		97	97	99	108	99	110
1982	92	92	83	87	85	97		89	89	98	94	96	84
1983	103	103	105	99	106	98		78	78	76	82	75	83
1984	102	102	92	92	95	89		80	80	90	90	87	93
1985	96	97	91	90	91	90		85	84	90	91	90	91
1986	91	91	66	74	63	78		90	90	115	107	118	103
1987	91	91	79	65	79	62		90	90	102	116	102	118
1988	81	82	82	64	81	63		101	100	100	118	101	119
1989	107	108	96	87	96	86		74	73	85	94	85	95
1990	102	102	94	78	92	79		79	79	87	103	89	102
1991	86	86	79	77	79	76		95	95	102	104	102	105
Avg	95	95	87	80	87	80		86	86	94	102	94	101
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	1		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-31. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	108	111	112	102	110	101		74	71	70	80	72	81
1977	105	107	98	100	96	98		76	74	83	81	85	83
1978	83	84	82	80	82	80		98	97	99	101	99	101
1979	107	107	105	99	105	103		74	74	76	82	76	78
1980	110	111	99	90	93	89		72	71	83	92	89	93
1981	109	109	97	88	94	89		72	72	84	93	87	92
1982	114	115	109	85	104	83		67	66	72	96	77	98
1983	127	128	114	99	113	98		54	53	67	82	68	83
1984	106	106	109	96	102	94		76	76	73	86	80	88
1985	113	111	100	106	100	105		68	70	81	75	81	76
1986	108	106	95	93	87	90		73	75	86	88	94	91
1987	102	103	97	95	95	93		79	78	84	86	86	88
1988	93	93	92	86	93	85		89	89	90	96	89	97
1989	107	108	102	103	100	102		74	73	79	78	81	79
1990	107	107	105	109	105	104		74	74	76	72	76	77
1991	109	109	99	96	99	91		72	72	82	85	82	90
Avg	107	107	101	95	99	94		75	74	80	86	83	87
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-32. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	117	123	111	95	107	98		65	59	71	87	75	84
1977	95	93	84	81	84	82		86	88	97	100	97	99
1978	81	81	80	73	78	73		100	100	101	108	103	108
1979	112	111	110	96	111	102		69	70	71	85	70	79
1980	102	102	94	82	92	85		80	80	88	100	90	97
1981	86	86	83	77	83	83		95	95	98	104	98	98
1982	116	116	113	85	109	84		65	65	68	96	72	97
1983	126	125	111	91	110	91		55	56	70	90	71	90
1984	104	105	95	90	93	89		78	77	87	92	89	93
1985	107	106	94	96	95	96		74	75	87	85	86	85
1986	101	102	84	89	89	89		80	79	97	92	92	92
1987	99	98	85	78	82	81		82	83	96	103	99	100
1988	91	90	89	75	84	76		91	92	93	107	98	106
1989	111	110	104	96	101	98		70	71	77	85	80	83
1990	107	107	97	83	97	94		74	74	84	98	84	87
1991	100	101	91	81	92	85		81	80	90	100	89	96
Avg	103	104	95	86	94	88		78	78	86	96	87	93
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-33. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Juvenile Rearing in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	117	117	107	94	106	89		65	65	75	88	76	93
1977	101	101	85	78	84	77		80	80	96	103	97	104
1978	81	81	83	72	77	69		100	100	98	109	104	112
1979	111	112	109	94	106	92		70	69	72	87	75	89
1980	115	115	103	84	92	83		67	67	79	98	90	99
1981	113	113	100	76	89	76		68	68	81	105	92	105
1982	121	119	115	82	102	81		60	62	66	99	79	100
1983	127	127	112	95	112	92		54	54	69	86	69	89
1984	107	107	113	97	105	96		75	75	69	85	77	86
1985	115	113	102	93	100	93		66	68	79	88	81	88
1986	104	103	92	87	84	88		77	78	89	94	97	93
1987	104	105	93	76	91	70		77	76	88	105	90	111
1988	91	91	89	77	88	71		91	91	93	105	94	111
1989	112	112	104	97	104	96		69	69	77	84	77	85
1990	110	110	106	82	103	82		71	71	75	99	78	99
1991	107	107	101	75	99	75		74	74	80	106	82	106
Avg	109	108	101	85	96	83		73	73	80	96	85	98
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.5 Winter-Run Chinook Salmon—Smoltification

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt winter-run Chinook salmon in the Cache Slough subregion (Table C.5.4-34). The average number of optimal days was 137 days under EBC1 and EBC2 and 146 to 162 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was zero under EBC1 and EBC2, 0 under EBC2_ELT and PP_ELT, and 1 to 2 under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in water temperatures for smolt winter-run Chinook salmon in the East Delta subregion (Table C.5.4-35) differed little when accounting for climate change. The average number of optimal days was 142 and 143 days under EBC1 and EBC2, respectively; 151 and 167 days under EBC2_ELT and EBC2_LLT, respectively, and 151 and 164 under PP_ELT, and PP_LLT, respectively. The average number of supraoptimal days was 0 for EBC1 and EBC2, 0 under EBC2_ELT and PP_ELT, and 1 under EBC2_LLT and PP_LLT. There were no days with lethal temperatures.

EBC scenarios and PP scenarios in water temperatures for smolt winter-run Chinook salmon in the North Delta subregion (Table C.5.4-36) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 121 and 122 for EBC1 and EBC2, respectively, and between 129 and 157 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 0 days under EBC1 and EBC2, and ranged from 0 to 1 day under EBC2_ELT EBC2_LLT and from 0 to 1 under PP_ELT and PP_LLT. No days with lethal temperatures occurred during the modeling period.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt winter-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-37). Optimal water temperatures occurred on 144 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 152 to 163. There were no supraoptimal or lethal temperature average days under any scenario.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt winter-run Chinook salmon in the South Delta subregion (Table C.5.4-38). Suboptimal water temperatures occurred on 36-37 days per year on average under EBC1 and EBC2, and 15-26 days per year under the remaining model scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Optimal water temperatures occurred on 145 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 154 to 166. There were no days in which supraoptimal temperatures occurred on average under EBC1, EBC2, EBC2_ELT, and PP_ELT. There was 1 day per year on average on which supraoptimal temperatures occurred under EBC2_LLT and PP_LLT. There were no supraoptimal or lethal temperature average days under any scenario.

In the Suisun Bay subregion, water temperatures for smolt winter-run Chinook salmon were similar among scenarios (Table C.5.4-39) after accounting for changing climate. Optimal water temperatures were reached on average on 138 days under EBC1 and EBC2 and 144 to 153 days under all other scenarios. There were no supraoptimal or lethal temperature average days under any scenario.

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In Suisun Marsh, the differences among scenarios of water temperatures for smolt winter-run Chinook salmon were minor, after climate change was taken into consideration (Table C.5.4-40). Optimal temperatures occurred on average on 135 days under EBC1 and EBC2, and on 144 to 157 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on average on 0 days under EBC1 and EBC2, and on 0 to 1 day under all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

Water temperatures in the West Delta for smolt winter-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-41). Under EBC1 and EBC2, optimal water temperatures occurred on 134 days per year, on average. Under EBC2_ELT, and PP_ELT, optimal temperature conditions occurred on 143 to 145 days per year; and on 163 to 162 days under PP_ELT and PP_LLT, respectively. There were no supraoptimal or lethal temperature average days under any scenario.

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Table C.5.4-34. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	40	40	35	15	35	16		142	142	147	167	147	166
1977	60	60	49	30	48	35		121	121	132	148	133	143
1978	4	5	0	0	2	0		177	176	181	181	179	181
1979	52	51	46	25	62	38		129	130	135	156	119	143
1980	35	32	24	3	40	10		147	150	158	179	142	172
1981	42	41	30	4	32	4		139	140	151	177	149	177
1982	42	42	26	3	43	17		139	139	155	178	138	164
1983	48	48	34	17	38	19		133	133	147	164	143	162
1984	35	35	57	4	58	10		147	147	125	178	124	172
1985	61	61	27	55	25	56		120	120	154	126	156	123
1986	36	36	42	21	45	21		145	145	138	160	135	160
1987	48	48	40	28	41	27		133	133	141	147	140	147
1988	47	45	34	15	37	15		135	137	148	162	145	161
1989	63	63	53	28	55	26		118	118	128	150	126	151
1990	59	60	40	22	48	26		122	121	141	158	133	152
1991	42	43	31	25	30	25		139	138	150	156	151	156
Avg	45	44	36	18	40	22		137	137	146	162	141	158
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	2		0	0	0	0	0	0
1986	0	0	1	0	1	0		0	0	0	0	0	0
1987	0	0	0	6	0	7		0	0	0	0	0	0
1988	0	0	0	5	0	6		0	0	0	0	0	0
1989	0	0	0	3	0	4		0	0	0	0	0	0
1990	0	0	0	1	0	3		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	1	0	2		0	0	0	0	0	0

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Table C.5.4-35. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	39	39	30	5	32	6		143	143	152	177	150	176
1977	59	53	45	13	46	25		122	128	136	165	135	153
1978	4	4	0	0	0	0		177	177	181	181	181	181
1979	46	45	41	22	43	25		135	136	140	159	138	156
1980	31	30	32	9	27	5		151	152	150	173	155	177
1981	42	42	30	4	26	4		139	139	151	177	155	177
1982	45	47	29	8	25	6		136	134	152	173	156	175
1983	38	38	15	9	16	10		143	143	166	172	165	171
1984	41	41	55	9	55	5		141	141	127	173	127	177
1985	59	59	25	33	24	51		122	122	156	148	157	130
1986	24	23	23	20	33	17		157	158	158	161	148	164
1987	47	47	36	20	39	24		134	134	145	154	142	151
1988	20	20	14	7	21	12		162	162	168	175	161	167
1989	50	52	38	17	45	24		131	129	143	163	136	155
1990	46	47	39	16	28	19		135	134	142	161	153	161
1991	33	32	29	20	31	23		148	149	152	161	150	158
Avg	39	39	30	13	31	16		142	143	151	167	151	164
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	7	0	6		0	0	0	0	0	0
1988	0	0	0	0	0	3		0	0	0	0	0	0
1989	0	0	0	1	0	2		0	0	0	0	0	0
1990	0	0	0	4	0	1		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	1	0	1		0	0	0	0	0	0

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Table C.5.4-36. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	61	59	36	15	34	14		121	123	146	167	148	168
1977	63	63	51	23	51	29		118	118	130	158	130	152
1978	51	50	37	7	39	6		130	131	144	173	142	175
1979	70	67	62	34	62	34		111	114	119	147	119	147
1980	53	53	53	23	52	22		129	129	129	159	130	160
1981	48	48	53	12	52	13		133	133	128	169	129	168
1982	58	58	50	23	50	24		123	123	131	158	131	157
1983	62	62	52	22	52	22		119	119	129	159	129	159
1984	57	57	59	17	58	17		125	125	123	164	124	164
1985	68	67	63	42	64	45		113	114	118	137	117	134
1986	57	56	49	23	50	25		124	125	132	157	131	155
1987	67	67	51	30	53	28		114	114	130	149	127	150
1988	55	55	45	19	47	19		127	127	137	163	135	163
1989	63	63	63	28	61	29		118	118	118	150	120	152
1990	66	66	64	29	65	30		115	115	117	146	116	145
1991	60	60	49	24	48	22		121	121	132	157	133	159
Avg	60	59	52	23	52	24		121	122	129	157	129	157
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	1	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	1	0	1		0	0	0	0	0	0
1985	0	0	0	2	0	2		0	0	0	0	0	0
1986	0	0	0	1	0	1		0	0	0	0	0	0
1987	0	0	0	2	1	3		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	3	0	0		0	0	0	0	0	0
1990	0	0	0	6	0	6		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	1	0	1		0	0	0	0	0	0

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Table C.5.4-37. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	37	38	37	15	35	12		145	144	145	167	147	170
1977	53	53	45	27	45	27		128	128	136	154	136	154
1978	0	1	0	0	0	0		181	180	181	181	181	181
1979	44	44	40	32	38	29		137	137	141	149	143	152
1980	24	24	18	8	16	8		158	158	164	174	166	174
1981	38	38	22	2	20	0		143	143	159	179	161	181
1982	25	25	17	14	15	12		156	156	164	167	166	169
1983	31	31	20	19	25	20		150	150	161	162	156	161
1984	24	24	50	8	48	8		158	158	132	174	134	174
1985	59	59	27	49	27	50		122	122	154	132	154	131
1986	27	26	30	15	30	15		154	155	151	166	151	166
1987	45	45	36	27	35	22		136	136	145	153	146	157
1988	40	40	25	14	25	12		142	142	157	168	157	170
1989	55	56	46	26	46	27		126	125	135	155	135	154
1990	46	47	30	19	30	19		135	134	151	162	151	162
1991	41	40	32	23	31	24		140	141	149	158	150	157
Avg	37	37	30	19	29	18		144	144	152	163	152	163
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	1	0	2		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-38. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	38	38	36	5	35	2		144	144	146	177	147	180
1977	52	52	44	16	44	17		129	129	136	162	137	162
1978	0	0	0	0	0	0		181	181	181	181	181	181
1979	51	49	36	25	35	24		130	132	145	156	146	157
1980	22	22	8	4	10	6		160	160	174	178	172	176
1981	38	38	15	0	11	0		143	143	166	181	170	181
1982	19	20	7	0	5	0		162	161	174	181	176	181
1983	30	31	12	15	18	16		151	150	169	166	163	165
1984	23	24	54	3	49	10		159	158	128	179	133	172
1985	60	60	25	51	25	51		121	121	156	130	156	130
1986	27	27	35	16	33	16		154	154	146	165	148	165
1987	46	46	36	17	33	14		135	135	145	157	148	160
1988	36	36	31	12	31	12		146	146	151	168	151	167
1989	58	59	39	27	39	24		123	122	139	151	139	154
1990	46	46	25	20	25	19		135	135	156	159	156	161
1991	36	36	30	23	29	23		145	145	151	158	152	158
Avg	36	37	27	15	26	15		145	145	154	166	155	166
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	1	3	0	2		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	7	0	7		0	0	0	0	0	0
1988	0	0	0	2	0	3		0	0	0	0	0	0
1989	0	0	3	3	3	3		0	0	0	0	0	0
1990	0	0	0	2	0	1		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	1	0	1		0	0	0	0	0	0

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Table C.5.4-39. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	37	35	42	22	41	21		145	147	140	160	141	161
1977	49	49	50	43	50	43		132	132	131	138	131	138
1978	10	10	3	0	1	0		171	171	178	181	180	181
1979	55	56	49	40	51	41		126	125	132	141	130	140
1980	36	37	33	16	33	17		146	145	149	166	149	165
1981	38	39	24	16	23	13		143	142	157	165	158	168
1982	51	51	40	22	41	22		130	130	141	159	140	159
1983	47	47	34	24	33	24		134	134	147	157	148	157
1984	38	37	57	17	57	16		144	145	125	165	125	166
1985	60	60	35	58	35	58		121	121	146	123	146	123
1986	35	36	36	29	37	31		146	145	145	152	144	150
1987	42	43	35	38	35	35		139	138	146	141	146	144
1988	43	44	36	23	37	24		139	138	146	159	145	158
1989	50	54	45	46	45	46		131	127	136	135	136	135
1990	55	55	41	36	39	34		126	126	140	144	142	146
1991	44	43	30	27	31	28		137	138	151	154	150	153
Avg	43	44	37	29	37	28		138	138	144	153	144	153
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	2	0	2		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	1	0	1		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-40. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	40	40	38	16	37	20		142	142	144	166	145	162
1977	53	52	48	39	49	41		128	129	133	140	132	138
1978	1	1	0	0	0	0		180	180	181	181	181	181
1979	62	63	60	37	57	40		119	118	121	144	124	141
1980	40	40	29	5	27	13		142	142	153	177	155	169
1981	40	40	22	4	24	16		141	141	159	177	157	165
1982	47	47	41	24	38	24		134	134	140	157	143	157
1983	64	65	35	29	34	29		117	116	146	152	147	152
1984	38	38	60	11	60	8		144	144	122	171	122	174
1985	63	62	28	55	27	57		118	119	153	126	154	124
1986	37	36	38	21	42	23		144	145	139	160	136	158
1987	49	49	39	30	39	31		132	132	142	145	142	144
1988	45	44	34	20	35	22		137	138	148	162	147	160
1989	60	59	51	36	52	41		121	122	129	142	128	138
1990	60	60	39	24	34	26		121	121	142	156	147	154
1991	47	43	31	25	31	27		134	138	150	156	150	154
Avg	47	46	37	24	37	26		135	135	144	157	144	154
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	2	0	2		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	4	0	3	0		0	0	0	0	0	0
1987	0	0	0	6	0	6		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	1	3	1	2		0	0	0	0	0	0
1990	0	0	0	1	0	1		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	1	0	1		0	0	0	0	0	0

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Table C.5.4-41. Number of Days within Temperature Requirements for Winter-Run Chinook Salmon Smoltification in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	41	41	34	14	32	14		141	141	148	168	150	168
1977	54	53	48	24	47	34		127	128	133	157	134	147
1978	9	9	0	0	0	0		172	172	181	181	181	181
1979	60	61	58	26	56	28		121	120	123	155	125	153
1980	39	39	34	6	31	4		143	143	148	176	151	178
1981	43	44	24	0	20	0		138	137	157	181	161	181
1982	53	53	44	15	38	11		128	128	137	166	143	170
1983	48	48	34	17	33	16		133	133	147	164	148	165
1984	42	42	57	5	57	5		140	140	125	177	125	177
1985	62	62	35	53	32	53		119	119	146	128	149	128
1986	35	35	38	19	37	21		146	146	143	162	144	160
1987	48	49	37	29	36	29		133	132	144	150	145	150
1988	51	51	34	14	34	15		131	131	148	168	148	167
1989	58	58	54	30	53	29		123	123	127	150	128	151
1990	65	66	44	18	42	19		116	115	137	163	139	162
1991	48	42	31	25	31	25		133	139	150	156	150	156
Avg	47	47	38	18	36	19		134	134	143	163	145	162
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	2	0	2		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	1	0	1		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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C.5.4.3.6 Winter-Run Chinook Salmon—Adult

Modeling results for adult Chinook salmon did not differ between late-fall runs and winter runs. Therefore, only winter–run results are reported here.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult winter–run Chinook salmon in the Cache Slough subregion (Table C.5.4-42). The average number of optimal days was 46 and 47 days under EBC1 and EBC2, respectively; 55 and 72 days under EBC2_ELT and EBC2_LLT, respectively; and 51 and 69 days under PP_ELT and PP_LLT, respectively. There were no supraoptimal or lethal temperature days under any scenario.

EBC scenarios and PP scenarios in water temperatures for adult winter–run Chinook salmon in the East Delta subregion (Table C.5.4-43) differed little when accounting for climate change. The average number of optimal days was 51 and 52 days under EBC1 and EBC2, respectively. Optimal temperatures occurred on average on 60 and 77 days under EBC2_ELT and EBC2_LLT, respectively. Under PP_ELT and PP_LLT, that number was 60 and 74 days, respectively. There were no supraoptimal or lethal temperature days under any scenario for the entire modeling period.

EBC scenarios and PP scenarios in water temperatures for adult winter–run Chinook salmon in the North Delta subregion (Table C.5.4-44) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 32 for EBC1 and EBC2, and between 39 and 68 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). The number of supraoptimal or lethal temperature days under any scenario was zero.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult winter–run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-45). Optimal water temperatures occurred on 53 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 61 to 72. There were no supraoptimal or lethal temperature days under any scenario.

Water temperatures in the South Delta for adult winter–run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-46). Suboptimal water temperatures occurred on 36 and 37 days per year on average for EBC1 and EBC2, respectively, 27 and 15 days under EBC2_ELT and EBC2_LLT, respectively, and 26 and 15 days for PP_ELT and PP_LLT respectively. Under EBC1 and EBC2, optimal water temperatures occurred on 54 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 76 and 64 days per year, respectively and on 64 and 76 days under PP_ELT and PP_LLT, respectively. There were no supraoptimal or lethal temperature days under any scenario.

In the Suisun Bay subregion, water temperatures for adult winter–run Chinook salmon were similar among scenarios (Table C.5.4-47) after accounting for changing climate. Optimal water temperatures were reached on average on 47 days under EBC1 and EBC2, on 53 days for both ELT other scenarios, and on 62 days under the two LLT scenarios. There were no supraoptimal or lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for adult winter–run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-48). Optimal temperatures occurred on average on 44 and 45 days under EBC1 and EBC2, respectively; on 53 to 67 days under EBC2_ELT and EBC2_LLT, respectively, and on 54 and 64 days under PP_ELT

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and PP_LLT, respectively. There were no supraoptimal or lethal temperature days under any scenario.

Water temperatures in the West Delta for adult winter–run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-49). Under EBC1 and EBC2, optimal water temperatures occurred on 43 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 52 and 72 days per year and under PP_ELT and PP_LLT on 54 to 71 days. There were no supraoptimal or lethal temperature days under any scenario.

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Table C.5.4-42. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	40	40	35	15	35	16		51	51	56	76	56	75
1977	60	60	49	30	48	35		30	30	41	60	42	55
1978	4	5	0	0	2	0		86	85	90	90	88	90
1979	52	51	45	25	59	38		38	39	45	65	31	52
1980	35	32	24	3	40	10		56	59	67	88	51	81
1981	42	41	30	4	32	4		48	49	60	86	58	86
1982	42	42	26	3	43	17		48	48	64	87	47	73
1983	46	46	34	17	38	19		44	44	56	73	52	71
1984	35	35	57	4	58	9		56	56	34	87	33	82
1985	61	61	27	55	24	56		29	29	63	35	66	34
1986	31	28	42	21	45	21		59	62	48	69	45	69
1987	48	48	40	28	41	27		42	42	50	62	49	63
1988	47	45	34	15	37	15		44	46	57	76	54	76
1989	63	63	53	28	55	26		27	27	37	62	35	64
1990	59	60	40	22	48	26		31	30	50	68	42	64
1991	42	43	31	25	30	25		48	47	59	65	60	65
Avg	44	44	35	18	40	22		46	47	55	72	51	69
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-43. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	39	39	30	5	32	6		52	52	61	86	59	85
1977	59	53	45	13	46	25		31	37	45	77	44	65
1978	4	4	0	0	0	0		86	86	90	90	90	90
1979	46	45	41	22	43	25		44	45	49	68	47	65
1980	31	30	32	9	27	5		60	61	59	82	64	86
1981	42	42	30	4	26	4		48	48	60	86	64	86
1982	45	47	29	8	25	6		45	43	61	82	65	84
1983	38	38	15	9	16	10		52	52	75	81	74	80
1984	41	41	55	9	55	5		50	50	36	82	36	86
1985	59	59	25	33	24	51		31	31	65	57	66	39
1986	22	21	23	20	33	17		68	69	67	70	57	73
1987	47	47	36	20	39	24		43	43	54	70	51	66
1988	20	20	14	7	21	12		71	71	77	84	70	79
1989	50	52	38	17	45	24		40	38	52	73	45	66
1990	46	47	39	16	28	19		44	43	51	74	62	71
1991	33	32	29	20	31	23		57	58	61	70	59	67
Avg	39	39	30	13	31	16		51	52	60	77	60	74
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-44. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	59	57	35	15	34	14		32	34	56	76	57	77
1977	63	62	51	23	51	29		27	28	39	67	39	61
1978	50	49	37	7	39	6		40	41	53	83	51	84
1979	67	64	61	34	61	34		23	26	29	56	29	56
1980	51	51	52	21	51	20		40	40	39	70	40	71
1981	48	48	53	12	52	13		42	42	37	78	38	77
1982	57	57	50	23	50	24		33	33	40	67	40	66
1983	59	59	51	22	51	22		31	31	39	68	39	68
1984	57	57	57	15	56	15		34	34	34	76	35	76
1985	62	63	60	42	62	45		28	27	30	48	28	45
1986	54	53	49	22	50	23		36	37	41	68	40	67
1987	65	65	51	29	53	28		25	25	39	61	37	62
1988	55	55	43	19	45	19		36	36	48	72	46	72
1989	61	61	61	26	59	28		29	29	29	64	31	62
1990	66	66	64	29	65	30		24	24	26	61	25	60
1991	58	58	47	24	47	22		32	32	43	66	43	68
Avg	58	58	51	23	52	23		32	32	39	68	39	67
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-45. Number of Days within Temperature Requirements for Winter-Run and Late Fall–Run Chinook Salmon Adults in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	37	38	37	15	35	12		54	53	54	76	56	79
1977	53	53	45	27	45	27		37	37	45	63	45	63
1978	0	1	0	0	0	0		90	89	90	90	90	90
1979	44	44	38	32	37	29		46	46	52	58	53	61
1980	24	24	18	8	16	8		67	67	73	83	75	83
1981	38	38	22	2	20	0		52	52	68	88	70	90
1982	25	25	17	14	15	12		65	65	73	76	75	78
1983	31	31	20	19	25	20		59	59	70	71	65	70
1984	24	24	50	8	48	8		67	67	41	83	43	83
1985	59	59	27	49	27	50		31	31	63	41	63	40
1986	27	26	30	15	30	15		63	64	60	75	60	75
1987	45	45	36	27	35	22		45	45	54	63	55	68
1988	40	40	25	14	25	12		51	51	66	77	66	79
1989	55	56	46	26	46	27		35	34	44	64	44	63
1990	46	47	30	19	30	19		44	43	60	71	60	71
1991	41	40	32	23	31	24		49	50	58	67	59	66
Avg	37	37	30	19	29	18		53	53	61	72	61	72
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-46. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	38	38	36	5	35	2		53	53	55	86	56	89
1977	52	52	44	16	44	17		38	38	46	74	46	73
1978	0	0	0	0	0	0		90	90	90	90	90	90
1979	51	49	36	25	35	24		39	41	54	65	55	66
1980	22	22	8	4	10	6		69	69	83	87	81	85
1981	38	38	15	0	11	0		52	52	75	90	79	90
1982	19	20	7	0	5	0		71	70	83	90	85	90
1983	30	31	12	15	18	16		60	59	78	75	72	74
1984	23	24	54	3	49	10		68	67	37	88	42	81
1985	60	60	25	51	25	51		30	30	65	39	65	39
1986	27	27	35	16	33	16		63	63	55	74	57	74
1987	46	46	36	17	33	14		44	44	54	73	57	76
1988	36	36	31	12	31	12		55	55	60	79	60	79
1989	58	59	39	27	39	24		32	31	51	63	51	66
1990	46	46	25	20	25	19		44	44	65	70	65	71
1991	36	36	30	23	29	23		54	54	60	67	61	67
Avg	36	37	27	15	26	15		54	54	63	76	64	76
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-47. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	37	35	42	22	41	21		54	56	49	69	50	70
1977	49	49	50	43	50	43		41	41	40	47	40	47
1978	10	10	3	0	1	0		80	80	87	90	89	90
1979	55	56	49	40	51	41		35	34	41	50	39	49
1980	36	37	33	16	33	17		55	54	58	75	58	74
1981	38	39	24	16	23	13		52	51	66	74	67	77
1982	51	51	40	22	41	22		39	39	50	68	49	68
1983	47	47	34	24	33	24		43	43	56	66	57	66
1984	38	37	57	17	57	16		53	54	34	74	34	75
1985	60	60	35	58	35	58		30	30	55	32	55	32
1986	35	36	36	29	37	31		55	54	54	61	53	59
1987	42	43	35	38	35	35		48	47	55	52	55	55
1988	43	44	36	23	37	24		48	47	55	68	54	67
1989	50	54	45	46	45	46		40	36	45	44	45	44
1990	55	55	41	36	39	34		35	35	49	54	51	56
1991	44	43	30	27	31	28		46	47	60	63	59	62
Avg	43	44	37	29	37	28		47	47	53	62	53	62
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-48. Number of Days within Temperature Requirements for Winter-Run and Late Fall-Run Chinook Salmon Adults in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	40	40	38	16	37	20		51	51	53	75	54	71
1977	53	52	48	39	49	41		37	38	42	51	41	49
1978	1	1	0	0	0	0		89	89	90	90	90	90
1979	62	63	60	37	57	40		28	27	30	53	33	50
1980	40	40	29	5	27	13		51	51	62	86	64	78
1981	40	40	22	4	24	16		50	50	68	86	66	74
1982	47	47	41	24	38	24		43	43	49	66	52	66
1983	55	54	35	29	34	29		35	36	55	61	56	61
1984	38	38	60	11	60	8		53	53	31	80	31	83
1985	63	62	28	55	27	57		27	28	62	35	63	33
1986	37	36	38	21	42	23		53	54	52	69	48	67
1987	49	49	39	30	39	31		41	41	51	60	51	59
1988	45	44	34	20	35	22		46	47	57	71	56	69
1989	60	59	51	36	52	41		30	31	39	54	38	49
1990	60	60	39	24	34	26		30	30	51	66	56	64
1991	47	43	31	25	31	27		43	47	59	65	59	63
Avg	46	46	37	24	37	26		44	45	53	67	54	64
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-49. Number of Days within Temperature Requirements for Winter-Run and Late Fall–Run Chinook Salmon Adults in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	41	41	34	14	32	14		50	50	57	77	59	77
1977	54	53	48	24	47	34		36	37	42	66	43	56
1978	9	9	0	0	0	0		81	81	90	90	90	90
1979	60	61	58	26	56	28		30	29	32	64	34	62
1980	39	39	34	6	31	4		52	52	57	85	60	87
1981	43	44	24	0	20	0		47	46	66	90	70	90
1982	53	53	44	15	38	11		37	37	46	75	52	79
1983	48	48	34	17	33	16		42	42	56	73	57	74
1984	42	42	57	5	57	5		49	49	34	86	34	86
1985	62	62	35	53	32	53		28	28	55	37	58	37
1986	35	35	38	19	37	21		55	55	52	71	53	69
1987	48	49	37	29	36	29		42	41	53	61	54	61
1988	51	51	34	14	34	15		40	40	57	77	57	76
1989	58	58	54	30	53	29		32	32	36	60	37	61
1990	65	66	44	18	42	19		25	24	46	72	48	71
1991	48	42	31	25	31	25		42	48	59	65	59	65
Avg	47	47	38	18	36	19		43	43	52	72	54	71
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.7 Spring-Run Chinook Salmon—Juvenile

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile spring-run Chinook salmon in the Cache Slough subregion (Table C.5.4-50). The average number of optimal days was 86 and 87 days, respectively under EBC1 and EBC2 and varied from 89 to 100 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 2 under EBC1 and EBC2, 3 and 4 under EBC2_ELT and PP_ELT, and 5 under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios for water temperatures for juvenile spring-run Chinook salmon in the East Delta subregion (Table C.5.4-51) differed little when accounting for climate change. The average number of optimal days was 80 days under EBC1 and EBC2, 83 to 102 days under EBC2_ELT, EBC2_LLT, and 89 to 103 under PP_ELT, and PP_LLT, respectively. The average number of supraoptimal days was 2 for EBC1 and EBC2, 3 and 4 days under EBC2_ELT and PP_ELT, and 6 days under EBC2_LLT and PP_LLT. The average number of lethal days was zero.

EBC scenarios and PP scenarios in water temperatures for juvenile spring-run Chinook salmon in the North Delta subregion (Table C.5.4-52) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 69 for EBC1 and EBC2, and between 71 and 94 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 2 days under EBC1 and EBC2, and ranged from 4 to 5 days under EBC2_ELT, EBC2_LLT, and from 4 to 5 under PP_ELT, and PP_LLT. No days with lethal temperatures occurred during the modeling period.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile spring-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-53). Optimal water temperatures occurred on 89 and 90 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 93 to 97. Supraoptimal temperatures were reached on average for 2 days under EBC1 and EBC2. Under all other scenarios, this number ranged from 2 to 3 days. There were zero lethal temperature days under any scenario.

Water temperatures in the South Delta for juvenile spring-run Chinook salmon were largely similar among the different scenarios (considering climate change) (Table C.5.4-54). Suboptimal water temperatures were reached on average on 86 days under EBC1 and EBC2, and 76 to 80 days for all other scenarios. Under EBC1 and EBC2, optimal water temperatures occurred on 94 days per year, on average. Optimal temperature conditions occurred on 99 to 102 days per year under all other scenarios. Supraoptimal temperatures occurred on 2 days under EBC1 and EBC2, and on 4 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

In the Suisun Bay subregion, water temperatures for juvenile spring-run Chinook salmon were similar among scenarios (Table C.5.4-55) after accounting for changing climate. Optimal water temperatures were reached on average on 82 days under EBC1 and EBC2, and 85 to 92 days for all other scenarios. EBC1 and EBC2 averaged 1 day of supraoptimal conditions, while the number of days for EBC_ELT, EBC1_LLT, PP_ELT, and PP_LLT varied from 2 to 4 days. There were zero lethal temperature days under any scenario.

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In Suisun Marsh, the differences among scenarios of water temperatures for juvenile spring-run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-56). Optimal temperatures occurred on average on 87 days under EBC1 and EBC2, and on 91 to 97 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 1 and 2 days under EBC1 and EBC2, respectively, and on 3 to 5 days under all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

Water temperatures in the West Delta for juvenile spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (

Table C.5.4-57). Under EBC1 and EBC2, optimal water temperatures occurred on 81 days per year, on average. Under EBC2_ELT, and EBC2_LLT, optimal temperature conditions occurred on 86 to 99 days per year and under PP_ELT and PP_LLT on 90 to 100 days. Supraoptimal temperatures occurred on 1 day under EBC1 and EBC2, and on 2 to 3 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

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Table C.5.4-50. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	100	99	90	79	90	79		83	84	88	95	88	93
1977	90	89	78	76	78	76		92	93	104	106	104	106
1978	85	85	79	57	82	70		96	96	101	123	98	109
1979	96	96	95	78	96	85		84	84	85	95	84	87
1980	93	93	84	67	92	79		90	90	99	116	91	104
1981	95	91	83	73	85	71		83	87	94	101	91	103
1982	106	107	97	79	104	79		75	74	83	100	75	100
1983	95	95	90	71	97	75		87	87	83	106	73	100
1984	95	96	94	83	96	82		82	81	89	89	87	89
1985	97	95	81	80	78	80		85	87	98	102	101	102
1986	82	81	81	71	95	75		100	101	89	109	76	105
1987	98	97	84	76	83	76		75	76	98	92	99	92
1988	83	80	76	71	75	69		100	103	107	106	108	108
1989	98	98	92	88	91	87		82	82	86	91	86	92
1990	100	100	97	86	95	84		82	82	76	89	79	92
1991	99	99	93	76	97	76		83	83	89	106	85	106
Avg	95	94	87	76	90	78		86	87	92	102	89	99
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	5	9	5	11		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	2	2	3		0	0	0	0	0	0
1979	2	2	2	9	2	10		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	5	8	6	8		0	0	0	0	0	0
1982	1	1	2	3	3	3		0	0	0	0	0	0
1983	0	0	9	5	12	7		0	0	0	0	0	0
1984	6	6	0	11	0	12		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	12	2	11	2		0	0	0	0	0	0
1987	9	9	0	14	0	14		0	0	0	0	0	0
1988	0	0	0	6	0	6		0	0	0	0	0	0
1989	2	2	4	3	5	3		0	0	0	0	0	0
1990	0	0	9	7	8	6		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	2	2	3	5	4	5		0	0	0	0	0	0

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Table C.5.4-51. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	100	100	90	78	85	73		82	82	87	91	93	98
1977	90	94	80	74	77	75		92	88	102	108	105	107
1978	86	86	82	57	76	55		94	94	97	122	104	123
1979	102	101	98	74	95	73		78	79	78	97	83	99
1980	107	107	109	68	98	68		76	76	74	115	85	115
1981	114	111	93	69	85	71		64	67	83	106	92	104
1982	114	114	110	84	107	81		66	66	70	94	71	97
1983	114	114	101	76	100	74		65	65	71	95	71	97
1984	99	99	109	83	100	80		77	77	74	91	83	94
1985	104	104	95	79	86	79		78	78	83	103	93	103
1986	99	99	100	64	99	65		83	83	79	115	74	113
1987	98	98	93	70	81	73		76	76	89	99	101	96
1988	84	84	79	63	76	65		99	99	104	113	107	112
1989	100	100	95	83	92	85		82	82	83	95	85	94
1990	105	106	103	86	94	84		77	76	71	89	80	91
1991	95	96	95	73	90	73		87	86	86	106	92	109
Avg	101	101	96	74	90	73		80	80	83	102	89	103
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	1	1	6	14	5	12		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	2	3	3	2	4		0	0	0	0	0	0
1979	2	2	6	11	4	10		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	7	5	7		0	0	0	0	0	0
1982	2	2	2	4	4	4		0	0	0	0	0	0
1983	3	3	10	11	11	11		0	0	0	0	0	0
1984	7	7	0	9	0	9		0	0	0	0	0	0
1985	0	0	4	0	3	0		0	0	0	0	0	0
1986	0	0	3	3	9	4		0	0	0	0	0	0
1987	8	8	0	13	0	13		0	0	0	0	0	0
1988	0	0	0	7	0	6		0	0	0	0	0	0
1989	0	0	4	4	5	3		0	0	0	0	0	0
1990	0	0	8	7	8	7		0	0	0	0	0	0
1991	0	0	1	3	0	0		0	0	0	0	0	0
Avg	2	2	3	6	4	6		0	0	0	0	0	0

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Table C.5.4-52. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	109	110	94	87	94	87		72	71	86	93	86	93
1977	121	121	111	80	112	77		61	61	71	102	70	105
1978	107	107	101	76	103	76		72	72	76	99	74	100
1979	114	114	110	88	107	86		67	67	64	87	67	89
1980	112	112	115	83	114	83		70	71	67	97	68	97
1981	120	118	106	86	108	86		61	63	68	94	65	94
1982	121	121	112	91	112	91		58	58	66	89	67	88
1983	118	118	103	82	103	82		60	60	70	89	70	89
1984	104	104	115	83	114	82		72	72	67	93	68	93
1985	111	113	118	90	118	90		71	69	57	91	56	90
1986	104	104	101	75	101	76		76	76	79	103	79	101
1987	106	106	108	84	109	84		74	74	72	95	71	95
1988	97	97	99	71	100	71		85	85	79	104	78	104
1989	108	108	100	90	100	90		71	71	78	84	79	84
1990	110	111	104	95	104	94		72	71	73	81	73	82
1991	117	117	114	82	112	82		64	64	67	96	69	96
Avg	111	111	107	84	107	84		69	69	71	94	71	94
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	2	2	3	3	3	3		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	3	3	5	7	5	6		0	0	0	0	0	0
1979	1	1	8	7	8	7		0	0	0	0	0	0
1980	1	0	1	3	1	3		0	0	0	0	0	0
1981	1	1	8	2	9	2		0	0	0	0	0	0
1982	3	3	4	2	3	3		0	0	0	0	0	0
1983	4	4	9	11	9	11		0	0	0	0	0	0
1984	7	7	1	7	1	8		0	0	0	0	0	0
1985	0	0	7	1	8	2		0	0	0	0	0	0
1986	2	2	2	4	2	5		0	0	0	0	0	0
1987	2	2	2	3	2	3		0	0	0	0	0	0
1988	1	1	5	8	5	8		0	0	0	0	0	0
1989	3	3	4	8	3	8		0	0	0	0	0	0
1990	0	0	5	6	5	6		0	0	0	0	0	0
1991	1	1	1	4	1	4		0	0	0	0	0	0
Avg	2	2	4	5	4	5		0	0	0	0	0	0

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Table C.5.4-53. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	94	94	96	87	95	85		89	89	84	92	85	93
1977	90	91	77	77	77	76		92	91	105	105	105	106
1978	82	82	77	78	77	78		97	97	102	104	102	104
1979	95	95	90	91	90	90		83	83	89	91	89	91
1980	90	89	80	86	81	85		93	94	103	97	102	98
1981	88	86	84	77	84	76		93	95	91	105	91	106
1982	96	96	88	101	86	100		83	83	88	81	90	82
1983	88	87	89	95	89	94		91	92	83	87	84	88
1984	92	92	94	86	92	86		84	84	89	90	91	90
1985	98	97	85	84	85	85		84	85	92	98	92	97
1986	86	86	80	83	77	82		96	96	99	99	102	100
1987	92	92	87	84	84	75		84	84	95	88	98	96
1988	81	82	77	70	75	65		102	101	105	113	107	117
1989	97	96	91	93	91	90		85	86	90	88	90	91
1990	100	100	94	87	93	84		82	82	81	91	82	93
1991	89	90	84	82	83	77		93	92	98	100	99	105
Avg	91	91	86	85	85	83		89	90	93	96	94	97
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	3	4	3	5		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	3	3	3	0	3	0		0	0	0	0	0	0
1979	4	4	3	0	3	1		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	1	1	7	0	7	0		0	0	0	0	0	0
1982	3	3	6	0	6	0		0	0	0	0	0	0
1983	3	3	10	0	9	0		0	0	0	0	0	0
1984	7	7	0	7	0	7		0	0	0	0	0	0
1985	0	0	5	0	5	0		0	0	0	0	0	0
1986	0	0	3	0	3	0		0	0	0	0	0	0
1987	6	6	0	10	0	11		0	0	0	0	0	0
1988	0	0	1	0	1	1		0	0	0	0	0	0
1989	0	0	1	1	1	1		0	0	0	0	0	0
1990	0	0	7	4	7	5		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	2	2	3	2	3	2		0	0	0	0	0	0

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Table C.5.4-54. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	96	96	86	76	85	76		86	86	92	94	93	95
1977	83	83	77	76	77	77		99	99	105	106	105	105
1978	78	78	66	54	63	57		102	102	113	126	116	123
1979	95	95	91	89	91	91		82	82	87	86	89	85
1980	81	81	76	74	77	78		102	102	107	109	106	105
1981	78	78	77	72	77	71		100	100	99	103	99	104
1982	89	89	81	87	83	97		90	90	95	95	92	85
1983	83	83	88	93	88	93		96	98	83	89	82	89
1984	92	92	82	87	85	84		85	85	100	86	97	89
1985	86	86	78	81	78	81		96	96	101	101	101	101
1986	76	76	66	63	63	67		106	106	109	117	109	113
1987	88	87	75	65	75	62		85	86	107	103	107	105
1988	75	76	76	61	75	61		108	107	107	116	108	120
1989	95	96	89	84	89	83		86	85	89	95	89	96
1990	97	97	93	78	91	79		85	85	80	97	82	97
1991	81	81	77	74	77	73		101	101	104	108	104	109
Avg	86	86	80	76	80	77		94	94	99	102	99	101
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	1	1	5	13	5	12		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	2	3	2	3	2		0	0	0	0	0	0
1979	5	5	4	7	2	6		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	7	6	7		0	0	0	0	0	0
1982	3	3	6	0	7	0		0	0	0	0	0	0
1983	3	1	11	0	12	0		0	0	0	0	0	0
1984	6	6	1	10	1	10		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	7	2	10	2		0	0	0	0	0	0
1987	9	9	0	14	0	15		0	0	0	0	0	0
1988	0	0	0	6	0	2		0	0	0	0	0	0
1989	1	1	4	3	4	3		0	0	0	0	0	0
1990	0	0	9	7	9	6		0	0	0	0	0	0
1991	0	0	1	0	1	0		0	0	0	0	0	0
Avg	2	2	4	4	4	4		0	0	0	0	0	0

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Table C.5.4-55. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	99	98	99	93	99	91		84	85	83	86	82	88
1977	101	102	91	93	89	91		81	80	91	89	93	91
1978	83	84	82	79	82	78		98	97	98	100	98	101
1979	96	96	96	92	95	92		86	86	86	82	87	81
1980	104	104	97	84	90	83		79	79	86	99	93	100
1981	104	103	93	84	90	84		78	79	87	96	90	96
1982	110	111	106	83	101	81		72	71	76	98	81	100
1983	109	109	98	84	97	84		73	73	76	95	77	97
1984	98	98	101	88	94	86		79	79	82	87	89	89
1985	103	101	87	95	87	94		79	81	95	86	95	87
1986	93	91	94	78	87	77		89	91	79	101	87	103
1987	99	100	94	92	92	90		79	78	88	80	90	82
1988	89	89	87	81	88	80		94	94	96	96	95	97
1989	99	99	97	96	95	96		83	83	84	86	85	85
1990	103	103	104	104	104	99		79	79	74	72	74	77
1991	105	105	97	92	96	87		77	77	85	86	86	91
Avg	100	100	95	89	93	87		82	82	85	90	88	92
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	1	4	2	4		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	3	2	3		0	0	0	0	0	0
1979	0	0	0	8	0	9		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	2	2	2		0	0	0	0	0	0
1982	0	0	0	1	0	1		0	0	0	0	0	0
1983	0	0	8	3	8	1		0	0	0	0	0	0
1984	6	6	0	8	0	8		0	0	0	0	0	0
1985	0	0	0	1	0	1		0	0	0	0	0	0
1986	0	0	9	3	8	2		0	0	0	0	0	0
1987	4	4	0	10	0	10		0	0	0	0	0	0
1988	0	0	0	6	0	6		0	0	0	0	0	0
1989	0	0	1	0	2	1		0	0	0	0	0	0
1990	0	0	4	6	4	6		0	0	0	0	0	0
1991	0	0	0	4	0	4		0	0	0	0	0	0
Avg	1	1	2	4	2	4		0	0	0	0	0	0

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Table C.5.4-56. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	99	99	94	85	94	87		84	84	85	87	84	87
1977	90	87	79	78	78	77		92	95	103	104	104	105
1978	81	81	80	73	77	70		100	100	100	107	103	110
1979	97	96	95	88	95	87		84	84	86	87	86	84
1980	92	92	85	79	82	79		91	91	98	104	101	104
1981	80	80	78	76	78	77		99	98	99	97	98	98
1982	113	113	111	84	106	83		69	69	69	96	74	93
1983	107	106	92	74	91	74		75	76	79	102	80	102
1984	95	95	85	83	83	82		82	82	98	88	99	90
1985	93	91	80	85	79	85		89	91	99	97	100	97
1986	86	86	84	76	88	74		96	96	85	104	82	105
1987	96	95	81	78	77	79		77	78	101	90	105	90
1988	85	84	83	72	76	72		98	99	100	105	107	104
1989	99	98	97	91	92	92		83	82	81	88	86	87
1990	103	102	96	83	95	90		79	80	79	93	79	86
1991	96	96	89	78	89	80		86	86	93	104	92	102
Avg	95	94	88	80	86	81		87	87	91	97	93	97
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	4	11	5	9		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	2	2	2		0	0	0	0	0	0
1979	1	2	1	7	1	11		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	3	4	5	9	6	7		0	0	0	0	0	0
1982	0	0	2	2	2	6		0	0	0	0	0	0
1983	0	0	11	6	11	6		0	0	0	0	0	0
1984	6	6	0	12	1	11		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	13	2	12	3		0	0	0	0	0	0
1987	9	9	0	14	0	13		0	0	0	0	0	0
1988	0	0	0	6	0	7		0	0	0	0	0	0
1989	0	2	4	3	4	3		0	0	0	0	0	0
1990	0	0	7	6	8	6		0	0	0	0	0	0
1991	0	0	0	0	1	0		0	0	0	0	0	0
Avg	1	2	3	5	4	5		0	0	0	0	0	0

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Table C.5.4-57. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Juvenile Rearing in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	102	102	94	85	93	84		81	81	89	91	90	93
1977	97	97	83	78	82	77		85	85	99	104	100	105
1978	81	81	83	72	77	69		101	101	98	109	104	112
1979	97	98	96	88	96	88		85	84	86	89	86	89
1980	106	106	95	81	86	80		77	77	88	102	97	103
1981	108	107	95	76	85	76		74	75	85	103	95	102
1982	116	115	111	81	99	80		66	67	71	101	83	102
1983	108	108	96	80	96	79		74	74	79	96	78	98
1984	98	98	104	88	97	87		80	80	79	88	86	89
1985	105	103	88	84	86	84		77	79	94	98	96	98
1986	91	90	92	77	84	76		91	92	79	105	86	106
1987	102	103	89	76	88	70		72	71	93	94	94	100
1988	87	87	85	77	84	71		96	96	98	106	99	112
1989	101	101	99	94	99	94		81	81	83	88	83	88
1990	107	107	106	82	103	82		75	75	71	97	74	96
1991	105	105	101	75	99	75		77	77	81	107	83	107
Avg	101	101	95	81	91	80		81	81	86	99	90	100
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	7	0	6		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	1	1	1	1		0	0	0	0	0	0
1979	0	0	0	5	0	5		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	3	2	4		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	7	6	8	5		0	0	0	0	0	0
1984	5	5	0	7	0	7		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	11	0	12	0		0	0	0	0	0	0
1987	8	8	0	12	0	12		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	5	3	5	4		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	1	1	2	3	2	3		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.8 Spring-Run Chinook Salmon—Smoltification

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt spring-run Chinook salmon in the Cache Slough subregion (Table C.5.4-58). The average number of optimal days was 134 under EBC1 and EBC2 and 135 to 151 under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 4 under EBC1 and EBC2, 8 under EBC2_ELT and PP_ELT, and 13 under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in water temperatures for smolt spring-run Chinook salmon in the East Delta subregion (Table C.5.4-59) differed little when accounting for climate change. The average number of optimal days was 138 under EBC1 and EBC2, 143 to 156 under EBC2_ELT and EBC2_LLT, and 143 to 154 under PP_ELT, and PP_LLT, respectively. The average number of supraoptimal days was 5 for EBC1 and EBC2, 10 to 13 days under EBC2_ELT and EBC2_LLT, and 9 to 13 under PP_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in water temperatures for smolt spring-run Chinook salmon in the North Delta subregion (Table C.5.4-60) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 118 for EBC1 and EBC2, and between 121 and 148 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 5 days under EBC1 and EBC2, and ranged from 9 to 12 days under EBC2_ELT and EBC2_LLT, and from 9 to 11 under PP_ELT and PP_LLT. Lethal water temperatures were not reached under any scenario.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt spring-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-61). Optimal water temperatures occurred on 141 and 140 days under the EBC1 and EBC2 scenarios, respectively. Under all other scenarios, the number of days with optimal water temperatures ranged from 145 to 158. Supraoptimal temperatures were reached on average for 5 days under EBC1 and EBC2. Under all other scenarios, this number ranged from 7 to 8 days. There were no lethal temperature days under any scenario.

Water temperatures in the South Delta for smolt spring-run Chinook salmon were generally similar among the different scenarios (considering climate change)(Table C.5.4-62). Suboptimal water temperature conditions occurred on 36 to 37 days per year on average under EBC1 and EBC2, and 15-27 days under all other model scenarios. Under EBC1 and EBC2, optimal water temperatures occurred on 141 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 146 and 156 days per year, respectively; and on 147 to 157 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 5 days under EBC1 and EBC2, and on 9 to 12 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

In the Suisun Bay subregion, water temperatures for smolt spring-run Chinook salmon were similar among scenarios (Table C.5.4-63) after accounting for changing climate. Optimal water temperatures were reached on average on 136 days under EBC1 and 135 days under EBC2. The number of optimal temperature conditions was 139 and 143 for all other scenarios. EBC1 and EBC2 averaged 3 days of supraoptimal days, while the number of days for EBC2_ELT and EBC2_LLT and PP_ELT and PP_LLT varied from 6 to 11 days. There were no lethal temperature days under any scenario.

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In Suisun Marsh, the differences among scenarios of water temperatures for smolt spring-run Chinook salmon were minor, after climate change was taken into consideration (Table C.5.4-64). Optimal temperatures occurred on average on 132 and 133 days under EBC1 and EBC2, on 137 to 146 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 4 days under EBC1 and EBC2, and on 8 to 12 days under all other scenarios (i.e., EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

Water temperatures in the West Delta for smolt spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-65). Under EBC1 and EBC2, optimal water temperatures occurred on 133 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 138 and 154 days per year, respectively; and on 140 to 154 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 3 days under EBC1 and EBC2, and on 6 to 10 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

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Table C.5.4-58. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	40	40	35	15	35	16		140	140	135	146	137	145
1977	60	60	49	30	48	35		122	122	133	149	134	144
1978	4	5	0	0	2	0		176	175	178	170	176	170
1979	52	51	45	25	59	38		121	122	129	142	114	130
1980	35	32	24	3	40	10		148	151	159	175	143	168
1981	42	41	30	4	32	4		132	133	140	165	137	165
1982	42	42	26	3	43	17		136	136	148	165	132	151
1983	46	46	34	17	38	19		128	128	131	149	127	147
1984	35	35	57	4	58	9		141	141	120	160	120	155
1985	61	61	27	55	24	56		121	121	146	123	148	121
1986	31	28	42	21	45	21		147	150	124	150	121	150
1987	48	48	40	28	41	27		121	121	137	132	137	132
1988	47	45	34	15	37	15		135	137	144	153	141	152
1989	63	63	53	28	55	26		114	114	123	145	120	145
1990	59	60	40	22	48	26		116	115	131	146	124	140
1991	42	43	31	25	30	25		140	139	145	151	148	150
Avg	44	44	35	18	40	22		134	134	139	151	135	148
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	3	3	13	22	11	22		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	2	2	4	12	4	12		0	0	0	0	0	0
1979	9	9	8	15	9	14		0	0	0	0	0	0
1980	0	0	0	5	0	5		0	0	0	0	0	0
1981	8	8	12	13	13	13		0	0	0	0	0	0
1982	4	4	8	14	7	14		0	0	0	0	0	0
1983	8	8	17	16	17	16		0	0	0	0	0	0
1984	7	7	6	19	5	19		0	0	0	0	0	0
1985	0	0	9	4	10	5		0	0	0	0	0	0
1986	4	4	16	11	16	11		0	0	0	0	0	0
1987	13	13	5	22	4	23		0	0	0	0	0	0
1988	1	1	5	15	5	16		0	0	0	0	0	0
1989	5	5	6	9	7	11		0	0	0	0	0	0
1990	7	7	11	14	10	16		0	0	0	0	0	0
1991	0	0	6	6	4	7		0	0	0	0	0	0
Avg	4	4	8	13	8	13		0	0	0	0	0	0

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Table C.5.4-59. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	39	39	30	5	32	6		140	140	134	156	134	155
1977	59	53	45	13	46	25		123	129	137	166	136	154
1978	4	4	0	0	0	0		175	174	174	167	176	169
1979	46	45	41	22	43	25		126	127	129	143	129	141
1980	31	30	32	9	27	5		150	151	148	168	156	172
1981	42	42	30	4	26	4		133	133	139	165	143	165
1982	45	47	29	8	25	6		132	130	140	163	145	166
1983	38	38	15	9	16	10		135	135	149	157	147	156
1984	41	41	55	9	55	5		130	130	124	155	124	159
1985	59	59	25	33	24	51		123	123	146	144	148	127
1986	22	21	23	20	33	17		154	156	143	149	136	153
1987	47	47	36	20	39	24		122	122	141	138	138	135
1988	20	20	14	7	21	12		161	161	162	165	156	158
1989	50	52	38	17	45	24		128	126	138	155	130	149
1990	46	47	39	16	28	19		129	128	130	148	141	148
1991	33	32	29	20	31	23		147	147	148	155	145	152
Avg	39	39	30	13	31	16		138	138	143	156	143	154
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	4	4	19	22	17	22		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	3	4	8	15	6	13		0	0	0	0	0	0
1979	10	10	12	17	10	16		0	0	0	0	0	0
1980	2	2	3	6	0	6		0	0	0	0	0	0
1981	7	7	13	13	13	13		0	0	0	0	0	0
1982	5	5	13	11	12	10		0	0	0	0	0	0
1983	9	9	18	16	19	16		0	0	0	0	0	0
1984	12	12	4	19	4	19		0	0	0	0	0	0
1985	0	0	11	5	10	4		0	0	0	0	0	0
1986	6	5	16	13	13	12		0	0	0	0	0	0
1987	13	13	5	24	5	23		0	0	0	0	0	0
1988	2	2	7	11	6	13		0	0	0	0	0	0
1989	4	4	6	10	7	9		0	0	0	0	0	0
1990	7	7	13	18	13	15		0	0	0	0	0	0
1991	2	3	5	7	6	7		0	0	0	0	0	0
Avg	5	5	10	13	9	13		0	0	0	0	0	0

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Table C.5.4-60. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	60	58	35	15	34	14		117	119	132	150	134	152
1977	63	62	51	23	51	29		119	120	131	159	131	153
1978	51	50	37	7	39	6		126	127	134	162	132	164
1979	68	65	61	34	61	34		106	109	106	133	107	132
1980	51	51	53	21	52	20		129	129	127	157	128	159
1981	48	48	53	12	52	13		126	126	117	159	118	159
1982	57	57	50	23	50	24		120	120	121	150	121	149
1983	60	60	51	22	51	22		116	115	114	146	114	146
1984	57	57	59	15	58	15		116	116	120	154	121	155
1985	68	67	61	42	63	45		112	112	109	131	107	128
1986	54	53	49	22	50	23		124	125	125	150	125	148
1987	66	66	51	29	53	28		106	106	128	139	125	139
1988	55	55	43	19	45	19		125	126	127	152	125	151
1989	61	61	63	26	61	28		115	115	110	140	110	142
1990	66	66	64	29	65	30		110	110	110	136	109	137
1991	60	60	49	24	48	22		119	119	129	151	131	153
Avg	59	59	52	23	52	23		118	118	121	148	121	148
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	6	6	16	18	15	17		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	5	5	11	13	11	12		0	0	0	0	0	0
1979	8	8	15	15	14	16		0	0	0	0	0	0
1980	3	3	3	5	3	4		0	0	0	0	0	0
1981	8	8	12	11	12	10		0	0	0	0	0	0
1982	5	5	11	9	11	9		0	0	0	0	0	0
1983	6	7	17	14	17	14		0	0	0	0	0	0
1984	10	10	4	14	4	13		0	0	0	0	0	0
1985	2	3	12	9	12	9		0	0	0	0	0	0
1986	4	4	8	10	7	11		0	0	0	0	0	0
1987	10	10	3	14	4	15		0	0	0	0	0	0
1988	3	2	13	12	13	13		0	0	0	0	0	0
1989	6	6	9	16	11	12		0	0	0	0	0	0
1990	6	6	8	17	8	15		0	0	0	0	0	0
1991	3	3	4	7	3	7		0	0	0	0	0	0
Avg	5	5	9	12	9	11		0	0	0	0	0	0

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Table C.5.4-61. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	37	38	37	15	35	12		144	143	138	147	140	150
1977	53	53	45	27	45	27		129	129	137	155	137	155
1978	0	1	0	0	0	0		177	176	174	177	174	177
1979	44	44	38	32	37	29		129	129	133	142	134	145
1980	24	24	18	8	16	8		159	159	164	175	166	175
1981	38	38	22	2	20	0		137	136	146	173	148	174
1982	25	25	17	14	15	12		149	149	153	166	155	168
1983	31	31	20	19	25	20		141	141	146	156	142	157
1984	24	24	50	8	48	8		148	148	129	164	131	163
1985	59	59	27	49	27	50		123	123	144	132	144	131
1986	27	26	30	15	30	15		151	152	136	162	135	162
1987	45	45	36	27	35	22		123	123	143	139	145	141
1988	40	40	25	14	25	12		142	142	151	162	151	164
1989	55	56	46	26	46	27		124	122	131	152	131	150
1990	46	47	30	19	30	19		133	132	143	154	143	154
1991	41	40	32	23	31	24		140	141	148	156	149	154
Avg	37	37	30	19	29	18		141	140	145	157	145	158
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	2	2	8	21	8	21		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	5	5	8	5	8	5		0	0	0	0	0	0
1979	9	9	11	8	11	8		0	0	0	0	0	0
1980	0	0	1	0	1	0		0	0	0	0	0	0
1981	7	8	14	7	14	8		0	0	0	0	0	0
1982	8	8	12	2	12	2		0	0	0	0	0	0
1983	10	10	16	7	15	5		0	0	0	0	0	0
1984	11	11	4	11	4	12		0	0	0	0	0	0
1985	0	0	11	1	11	1		0	0	0	0	0	0
1986	4	4	16	5	17	5		0	0	0	0	0	0
1987	14	14	3	16	2	19		0	0	0	0	0	0
1988	1	1	7	7	7	7		0	0	0	0	0	0
1989	3	4	5	4	5	5		0	0	0	0	0	0
1990	3	3	9	9	9	9		0	0	0	0	0	0
1991	1	1	2	3	2	4		0	0	0	0	0	0
Avg	5	5	8	7	8	7		0	0	0	0	0	0

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Table C.5.4-62. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	38	38	36	5	35	2		141	141	129	156	130	159
1977	52	52	44	16	44	17		130	130	137	162	138	162
1978	0	0	0	0	0	0		177	177	174	171	174	172
1979	51	49	36	25	35	24		123	125	136	143	138	145
1980	22	22	8	4	10	6		161	161	175	176	173	174
1981	38	38	15	0	11	0		135	135	154	169	158	169
1982	19	20	7	0	5	0		159	158	165	177	166	177
1983	30	31	12	15	18	16		141	140	155	159	149	158
1984	23	24	54	3	49	10		151	150	122	160	127	153
1985	60	60	25	51	25	51		122	122	147	127	147	127
1986	27	27	35	16	33	16		151	151	130	155	132	156
1987	46	46	36	17	33	14		123	123	141	138	144	141
1988	36	36	31	12	31	12		146	146	147	159	147	159
1989	58	59	39	27	39	24		120	119	134	146	134	149
1990	46	46	25	20	25	19		130	130	145	147	145	150
1991	36	36	30	23	29	23		146	146	146	152	147	153
Avg	36	37	27	15	26	15		141	141	146	156	147	157
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	4	4	18	22	18	22		0	0	0	0	0	0
1977	0	0	1	4	0	3		0	0	0	0	0	0
1978	5	5	8	11	8	10		0	0	0	0	0	0
1979	8	8	10	14	9	13		0	0	0	0	0	0
1980	0	0	0	3	0	3		0	0	0	0	0	0
1981	9	9	13	13	13	13		0	0	0	0	0	0
1982	4	4	10	5	11	5		0	0	0	0	0	0
1983	11	11	15	8	15	8		0	0	0	0	0	0
1984	9	9	7	20	7	20		0	0	0	0	0	0
1985	0	0	10	4	10	4		0	0	0	0	0	0
1986	4	4	17	11	17	10		0	0	0	0	0	0
1987	13	13	5	27	5	27		0	0	0	0	0	0
1988	1	1	5	12	5	12		0	0	0	0	0	0
1989	4	4	9	9	9	9		0	0	0	0	0	0
1990	6	6	12	15	12	13		0	0	0	0	0	0
1991	0	0	6	7	6	6		0	0	0	0	0	0
Avg	5	5	9	12	9	11		0	0	0	0	0	0

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Table C.5.4-63. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	37	35	42	22	41	21		145	146	130	146	131	146
1977	49	49	50	43	50	43		133	133	132	138	132	138
1978	10	10	3	0	1	0		169	169	176	173	178	174
1979	55	56	49	40	51	41		119	118	126	127	124	126
1980	36	37	33	16	33	17		147	146	150	162	150	161
1981	38	39	24	16	23	13		137	136	150	156	150	159
1982	51	51	40	22	41	22		129	128	134	151	134	149
1983	47	47	34	24	33	24		131	131	133	142	134	142
1984	38	37	57	17	57	16		138	139	124	150	124	151
1985	60	60	35	58	35	58		122	122	139	121	139	121
1986	35	36	36	29	37	31		144	143	130	144	129	141
1987	42	43	35	38	35	35		128	127	147	125	147	128
1988	43	44	36	23	37	24		140	139	142	149	143	147
1989	50	54	45	46	45	46		129	124	132	129	132	129
1990	55	55	41	36	39	34		125	125	133	133	134	135
1991	44	43	30	27	31	28		138	139	150	148	149	147
Avg	43	44	37	29	37	28		136	135	139	143	139	143
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	1	2	11	15	11	16		0	0	0	0	0	0
1977	0	0	0	1	0	1		0	0	0	0	0	0
1978	3	3	3	9	3	8		0	0	0	0	0	0
1979	8	8	7	15	7	15		0	0	0	0	0	0
1980	0	0	0	5	0	5		0	0	0	0	0	0
1981	7	7	8	10	9	10		0	0	0	0	0	0
1982	2	3	8	9	7	11		0	0	0	0	0	0
1983	4	4	15	16	15	16		0	0	0	0	0	0
1984	7	7	2	16	2	16		0	0	0	0	0	0
1985	0	0	8	3	8	3		0	0	0	0	0	0
1986	3	3	16	9	16	10		0	0	0	0	0	0
1987	12	12	0	19	0	19		0	0	0	0	0	0
1988	0	0	5	11	3	12		0	0	0	0	0	0
1989	3	4	5	7	5	7		0	0	0	0	0	0
1990	2	2	8	13	9	13		0	0	0	0	0	0
1991	0	0	2	7	2	7		0	0	0	0	0	0
Avg	3	3	6	10	6	11		0	0	0	0	0	0

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Table C.5.4-64. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	40	40	38	16	37	20		140	140	128	145	133	141
1977	53	52	48	39	49	41		129	130	134	141	133	139
1978	1	1	0	0	0	0		179	179	179	171	179	171
1979	62	63	60	37	57	40		113	112	115	129	118	127
1980	40	40	29	5	27	13		143	143	154	172	156	164
1981	40	40	22	4	24	16		133	132	147	165	145	153
1982	47	47	41	24	38	24		132	132	134	141	136	141
1983	55	54	35	29	34	29		123	123	132	140	132	139
1984	38	38	60	11	60	8		138	137	117	153	117	156
1985	63	62	28	55	27	57		119	120	145	123	146	122
1986	37	36	38	21	42	23		143	142	121	151	120	148
1987	49	49	39	30	39	31		119	119	138	126	138	128
1988	45	44	34	20	35	22		137	138	143	153	143	151
1989	60	59	51	36	52	41		118	119	123	138	123	133
1990	60	60	39	24	34	26		116	115	133	143	138	143
1991	47	43	31	25	31	27		135	139	145	151	145	148
Avg	46	46	37	24	37	26		132	133	137	146	138	144
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	3	3	17	22	13	22		0	0	0	0	0	0
1977	0	0	0	2	0	2		0	0	0	0	0	0
1978	2	2	3	11	3	11		0	0	0	0	0	0
1979	7	7	7	16	7	15		0	0	0	0	0	0
1980	0	0	0	6	0	6		0	0	0	0	0	0
1981	9	10	13	13	13	13		0	0	0	0	0	0
1982	3	3	7	17	8	17		0	0	0	0	0	0
1983	4	5	15	13	16	14		0	0	0	0	0	0
1984	7	8	6	19	6	19		0	0	0	0	0	0
1985	0	0	9	4	9	3		0	0	0	0	0	0
1986	2	4	23	10	20	11		0	0	0	0	0	0
1987	14	14	5	26	5	23		0	0	0	0	0	0
1988	1	1	6	10	5	10		0	0	0	0	0	0
1989	4	4	8	8	7	8		0	0	0	0	0	0
1990	6	7	10	15	10	13		0	0	0	0	0	0
1991	0	0	6	6	6	7		0	0	0	0	0	0
Avg	4	4	8	12	8	12		0	0	0	0	0	0

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Table C.5.4-65. Number of Days within Temperature Requirements for Spring-Run Chinook Salmon Smoltification in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	41	41	34	14	32	14		142	142	131	148	133	148
1977	54	53	48	24	47	34		128	129	134	158	135	148
1978	9	9	0	0	0	0		172	172	179	172	179	173
1979	60	61	58	26	56	28		115	114	119	143	121	142
1980	39	39	34	6	31	4		144	144	149	177	152	179
1981	43	44	24	0	20	0		134	133	150	171	154	171
1982	53	53	44	15	38	11		127	127	130	160	137	161
1983	48	48	34	17	33	16		126	126	133	150	134	152
1984	42	42	57	5	57	5		135	135	125	161	125	161
1985	62	62	35	53	32	53		120	120	142	129	146	129
1986	35	35	38	19	37	21		147	147	126	156	127	154
1987	48	49	37	29	36	29		123	122	145	131	146	131
1988	51	51	34	14	34	15		132	132	147	160	147	159
1989	58	58	54	30	53	29		124	124	123	147	124	147
1990	65	66	44	18	42	19		117	116	127	150	129	149
1991	48	42	31	25	31	25		134	140	151	156	151	156
Avg	47	47	38	18	36	19		133	133	138	154	140	154
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	18	21	18	21		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	3	10	3	9		0	0	0	0	0	0
1979	7	7	5	13	5	12		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	5	5	8	11	8	11		0	0	0	0	0	0
1982	2	2	8	7	7	10		0	0	0	0	0	0
1983	8	8	15	15	15	14		0	0	0	0	0	0
1984	6	6	1	17	1	17		0	0	0	0	0	0
1985	0	0	5	0	4	0		0	0	0	0	0	0
1986	0	0	18	7	18	7		0	0	0	0	0	0
1987	11	11	0	22	0	22		0	0	0	0	0	0
1988	0	0	2	9	2	9		0	0	0	0	0	0
1989	0	0	5	5	5	6		0	0	0	0	0	0
1990	0	0	11	14	11	14		0	0	0	0	0	0
1991	0	0	0	1	0	1		0	0	0	0	0	0
Avg	3	3	6	10	6	10		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.9 Spring-Run Chinook Salmon—Adult

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult spring-run Chinook salmon in the Cache Slough subregion (Table C.5.4-66, Table C.5.4-67). The average number of optimal days was 59 under EBC1 and EBC2 and between 56 and 58 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 1 under EBC1 and EBC2, 2 under EBC2_ELT and PP_ELT, and 4 under EBC2_LLT and PP_LLT. There was on average 1 lethal day under all scenarios except for PP_LLT where there were 2.

EBC scenarios and PP scenarios in water temperatures for adult spring-run Chinook salmon in the East Delta subregion (Table C.5.4-68, Table C.5.4-69) differed little when accounting for climate change. The average number of optimal days was 59 under EBC1 and EBC2, 58 and 55 under EBC2_ELT and EBC2_LLT, respectively, and 58 and 55 under PP_ELT and PP_LLT, respectively. The average number of supraoptimal days was 1 for EBC1 and EBC2, 3 under EBC2_ELT and PP_ELT, and 4 under EBC2_LLT and PP_LLT. There was 1 lethal day under EBC1 and EBC2, 0 and 1 under EBC2_ELT and PP2_ELT and 2 days under EBC2_LLT and PP_LLT, respectively.

EBC scenarios and PP scenarios in water temperatures for adult spring-run Chinook salmon in the North Delta subregion (Table C.5.4-70, Table C.5.4-71) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 59 for EBC1 and EBC2, and between 56 and 57 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 2 and 1 days under EBC1 and EBC2, respectively, and on 3 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. No average days with lethal temperatures occurred under EBC1 and EBC2, but 1 day of lethal temperatures was observed under EBC2_ELT and PP_ELT, and 2 days were observed under EBC2_LLT and PP_LLT.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult spring-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-72, Table C.5.4-73). Optimal water temperatures occurred on 59 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 58 to 59 days. Supraoptimal temperatures were reached on average for 1 day under EBC1 and EBC2, and 1 to 2 days for all other scenarios. There were no lethal temperature days under EBC1 and EBC2 scenarios, but 1 day of lethal temperatures occurred on average under all remaining scenarios.

Water temperatures in the South Delta for adult spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-74, Table C.5.4-75). There were no days in any model scenario in which water temperatures were suboptimal. Under EBC1 and EBC2, optimal water temperatures occurred on 59 days per year, on average. Water temperatures were optimal on 57 days per year on average for the rest of the model scenarios. Supraoptimal temperatures occurred on 1 day per year on average under EBC1 and EBC2, and on 3 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Lethal water temperatures occurred on 1 day per year on average under EBC1, EBC2, EBC2_ELT, PP_ELT, and PP_LLT and on 2 days per year under EBC2_LLT.

In the Suisun Bay subregion, water temperatures for adult spring-run Chinook salmon were similar among scenarios (Table C.5.4-76, Table C.5.4-77) after accounting for changing climate. Optimal water temperatures were reached on average on 60 days under EBC1 and EBC2, and 57 to 59 days

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for all other scenarios. Supraoptimal conditions occurred on average on 1 day under EBC1 and EBC2 as well as under EBC2_ELT and PP_ELT. Supraoptimal conditions occurred on average for 3 days under EBC2_LLT and PP_LLT. Lethal conditions occurred on average for 1 day in all model scenarios except EBC1 and EBC2.

In Suisun Marsh, the differences among scenarios of water temperatures for adult spring-run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-78, Table C.5.4-79). Optimal temperatures occurred on average on 60 days under EBC1 and EBC2, and on 56 to 58 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 1 day under EBC1 and EBC2, and on 2 to 4 days under all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures occurred on average on 1 day per year for all scenarios, except PP_ELT, where the number of days was 2.

Water temperatures in the West Delta for adult spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-80, Table C.5.4-81). Under EBC1 and EBC2, optimal water temperatures occurred on 60 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 59 and 58 days per year and under PP_ELT and PP_LLT on 59 and 58 days, respectively. Supraoptimal temperatures occurred on 1 day under EBC1 and EBC2 and from 1 to 2 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under EBC1 and EBC2, but 1 day with lethal temperatures occurred on average annually under all other scenarios.

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Table C.5.4-66. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	56	52	56	50
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		60	60	59	59	59	58
1979	0	0	0	0	0	0		59	59	59	52	59	51
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		57	57	56	53	55	53
1982	0	0	0	0	0	0		60	60	59	58	58	58
1983	0	0	0	0	0	0		61	61	52	56	49	54
1984	0	0	0	0	0	0		55	55	61	50	61	49
1985	0	0	0	0	0	0		61	61	58	61	58	61
1986	0	0	0	0	0	0		61	61	49	59	50	59
1987	0	0	0	0	0	0		52	52	61	47	61	47
1988	0	0	0	0	0	0		61	61	61	55	61	55
1989	0	0	0	0	0	0		59	59	57	58	56	58
1990	0	0	0	0	0	0		61	61	52	54	53	55
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		59	59	58	56	57	56
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	5	9	5	10		0	0	0	0	0	1
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	1	1	1	2		0	0	1	1	1	1
1979	2	2	2	5	2	5		0	0	0	4	0	5
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	5	8	6	7		0	0	0	0	0	1
1982	1	1	2	3	3	3		0	0	0	0	0	0
1983	0	0	2	5	5	7		0	0	7	0	7	0
1984	1	1	0	5	0	5		5	5	0	6	0	7
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	3	2	1	2		0	0	9	0	10	0
1987	5	5	0	5	0	5		4	4	0	9	0	9
1988	0	0	0	6	0	6		0	0	0	0	0	0
1989	2	2	3	2	2	1		0	0	1	1	3	2
1990	0	0	7	5	6	4		0	0	2	2	2	2
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	1	1	2	4	2	4		1	1	1	1	1	2

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Table C.5.4-67. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	60	61	60
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	1	0	1		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-68. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		60	60	55	47	56	49
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		59	59	58	58	59	57
1979	0	0	0	0	0	0		59	59	55	50	57	51
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		57	57	55	54	56	54
1982	0	0	0	0	0	0		59	59	59	57	57	57
1983	0	0	0	0	0	0		58	58	51	50	50	50
1984	0	0	0	0	0	0		54	54	61	52	61	52
1985	0	0	0	0	0	0		61	61	57	61	58	61
1986	0	0	0	0	0	0		61	61	58	58	52	57
1987	0	0	0	0	0	0		53	53	61	48	61	48
1988	0	0	0	0	0	0		61	61	61	54	61	55
1989	0	0	0	0	0	0		61	61	57	57	56	58
1990	0	0	0	0	0	0		61	61	53	54	53	54
1991	0	0	0	0	0	0		61	61	60	58	61	61
Avg	0	0	0	0	0	0		59	59	58	55	58	55
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	1	1	6	13	5	11		0	0	0	1	0	1
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	2	2	3		1	1	1	1	0	1
1979	2	2	6	8	4	6		0	0	0	3	0	4
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	7	5	7		0	0	0	0	0	0
1982	2	2	2	3	4	4		0	0	0	1	0	0
1983	3	3	6	8	7	10		0	0	4	3	4	1
1984	2	2	0	2	0	2		5	5	0	7	0	7
1985	0	0	4	0	3	0		0	0	0	0	0	0
1986	0	0	2	3	7	4		0	0	1	0	2	0
1987	3	3	0	6	0	4		5	5	0	7	0	9
1988	0	0	0	7	0	6		0	0	0	0	0	0
1989	0	0	4	4	4	2		0	0	0	0	1	1
1990	0	0	7	5	6	5		0	0	1	2	2	2
1991	0	0	1	3	0	0		0	0	0	0	0	0
Avg	1	1	3	4	3	4		1	1	0	2	1	2

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Table C.5.4-69. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-70. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		59	59	58	58	58	58
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		58	58	56	54	56	55
1979	0	0	0	0	0	0		60	60	53	54	53	54
1980	0	0	0	0	0	0		60	61	60	58	60	58
1981	0	0	0	0	0	0		60	60	53	59	52	59
1982	0	0	0	0	0	0		58	58	57	59	58	58
1983	0	0	0	0	0	0		57	57	52	50	52	50
1984	0	0	0	0	0	0		54	54	60	54	60	53
1985	0	0	0	0	0	0		61	61	54	60	53	59
1986	0	0	0	0	0	0		59	59	59	57	59	56
1987	0	0	0	0	0	0		59	59	59	58	59	58
1988	0	0	0	0	0	0		60	60	56	53	56	53
1989	0	0	0	0	0	0		58	58	57	53	58	53
1990	0	0	0	0	0	0		61	61	56	55	56	55
1991	0	0	0	0	0	0		60	60	60	57	60	57
Avg	0	0	0	0	0	0		59	59	57	56	57	56
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	2	2	3	3	3	3		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	1	3	5	3	4		1	2	2	2	2	2
1979	1	1	7	2	7	3		0	0	1	5	1	4
1980	1	0	1	3	1	3		0	0	0	0	0	0
1981	1	1	6	2	7	2		0	0	2	0	2	0
1982	2	2	4	0	3	1		1	1	0	2	0	2
1983	3	3	4	7	4	7		1	1	5	4	5	4
1984	5	5	1	1	1	2		2	2	0	6	0	6
1985	0	0	5	1	5	2		0	0	2	0	3	0
1986	2	2	2	4	2	5		0	0	0	0	0	0
1987	1	1	2	3	2	3		1	1	0	0	0	0
1988	1	1	5	6	5	6		0	0	0	2	0	2
1989	3	3	2	6	2	5		0	0	2	2	1	3
1990	0	0	5	4	5	4		0	0	0	2	0	2
1991	1	1	1	2	1	2		0	0	0	2	0	2
Avg	2	1	3	3	3	3		0	0	1	2	1	2

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Table C.5.4-71. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	1	1	0	0	0	0		60	60	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	1	1	0	0	0	0		60	60	61	61	61	61
1979	1	1	0	0	0	0		60	60	61	61	61	61
1980	0	0	1	0	1	0		61	61	60	61	60	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	1	1	0	0	0	0		60	60	61	61	61	61
1984	0	0	2	0	2	0		61	61	59	61	59	61
1985	6	4	1	0	1	0		55	57	60	61	60	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	1	1	0	0	0	0		60	60	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	2	0	2	0		61	61	59	61	59	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	2	2	2	0	1	0		59	59	59	61	60	61
Avg	1	1	1	0	0	0		60	60	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-72. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	58	57	58	56
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		58	58	58	61	58	61
1979	0	0	0	0	0	0		57	57	58	61	58	60
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		60	60	54	61	54	61
1982	0	0	0	0	0	0		58	58	55	61	55	61
1983	0	0	0	0	0	0		58	58	51	61	52	61
1984	0	0	0	0	0	0		54	54	61	54	61	54
1985	0	0	0	0	0	0		61	61	56	61	56	61
1986	0	0	0	0	0	0		61	61	58	61	58	61
1987	0	0	0	0	0	0		55	55	61	51	61	50
1988	0	0	0	0	0	0		61	61	60	61	60	60
1989	0	0	0	0	0	0		61	61	60	60	60	60
1990	0	0	0	0	0	0		61	61	54	57	54	56
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		59	59	58	59	58	59
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	3	4	3	5		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	2	0	0	0	0		1	1	3	0	3	0
1979	4	4	3	0	3	1		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	1	1	6	0	6	0		0	0	1	0	1	0
1982	3	3	6	0	6	0		0	0	0	0	0	0
1983	3	3	2	0	1	0		0	0	8	0	8	0
1984	3	3	0	2	0	2		4	4	0	5	0	5
1985	0	0	3	0	3	0		0	0	2	0	2	0
1986	0	0	3	0	3	0		0	0	0	0	0	0
1987	5	5	0	6	0	7		1	1	0	4	0	4
1988	0	0	1	0	1	1		0	0	0	0	0	0
1989	0	0	1	1	1	1		0	0	0	0	0	0
1990	0	0	7	4	7	5		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	1	1	2	1	2	1		0	0	1	1	1	1

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Table C.5.4-73. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-74. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		60	60	56	48	56	49
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		59	59	58	59	58	59
1979	0	0	0	0	0	0		56	56	57	54	59	55
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		57	57	55	54	55	54
1982	0	0	0	0	0	0		58	58	55	61	54	61
1983	0	0	0	0	0	0		58	60	50	61	49	61
1984	0	0	0	0	0	0		55	55	60	51	60	51
1985	0	0	0	0	0	0		61	61	58	61	58	61
1986	0	0	0	0	0	0		61	61	54	59	51	59
1987	0	0	0	0	0	0		52	52	61	47	61	46
1988	0	0	0	0	0	0		61	61	61	55	61	59
1989	0	0	0	0	0	0		60	60	57	58	57	58
1990	0	0	0	0	0	0		61	61	52	54	52	55
1991	0	0	0	0	0	0		61	61	60	61	60	61
Avg	0	0	0	0	0	0		59	59	57	57	57	57
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	1	1	5	9	5	10		0	0	0	4	0	2
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	1	1	1	1		1	1	2	1	2	1
1979	5	5	3	7	2	6		0	0	1	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	6	6	6		0	0	0	1	0	1
1982	3	3	6	0	6	0		0	0	0	0	1	0
1983	3	1	3	0	4	0		0	0	8	0	8	0
1984	1	1	1	4	1	3		5	5	0	6	0	7
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	4	2	4	2		0	0	3	0	6	0
1987	3	3	0	4	0	5		6	6	0	10	0	10
1988	0	0	0	6	0	2		0	0	0	0	0	0
1989	1	1	4	3	4	3		0	0	0	0	0	0
1990	0	0	6	5	6	4		0	0	3	2	3	2
1991	0	0	1	0	1	0		0	0	0	0	0	0
Avg	1	1	3	3	3	3		1	1	1	2	1	1

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Table C.5.4-75. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	60
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	1		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-76. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	60	57	59	57
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		60	60	59	58	59	58
1979	0	0	0	0	0	0		61	61	61	53	61	52
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	59	59	59	59
1982	0	0	0	0	0	0		61	61	61	60	61	60
1983	0	0	0	0	0	0		61	61	53	58	53	60
1984	0	0	0	0	0	0		55	55	61	53	61	53
1985	0	0	0	0	0	0		61	61	61	60	61	60
1986	0	0	0	0	0	0		61	61	52	58	53	59
1987	0	0	0	0	0	0		57	57	61	51	61	51
1988	0	0	0	0	0	0		61	61	61	55	61	55
1989	0	0	0	0	0	0		61	61	60	61	59	60
1990	0	0	0	0	0	0		61	61	57	55	57	55
1991	0	0	0	0	0	0		61	61	61	57	61	57
Avg	0	0	0	0	0	0		60	60	59	57	59	57
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	1	4	2	4		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	3	2	3		0	0	0	0	0	0
1979	0	0	0	8	0	9		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	2	2	2		0	0	0	0	0	0
1982	0	0	0	1	0	1		0	0	0	0	0	0
1983	0	0	2	3	2	1		0	0	6	0	6	0
1984	6	6	0	3	0	2		0	0	0	5	0	6
1985	0	0	0	1	0	1		0	0	0	0	0	0
1986	0	0	7	3	6	2		0	0	2	0	2	0
1987	4	3	0	8	0	7		0	1	0	2	0	3
1988	0	0	0	5	0	4		0	0	0	1	0	2
1989	0	0	1	0	2	1		0	0	0	0	0	0
1990	0	0	4	6	4	6		0	0	0	0	0	0
1991	0	0	0	4	0	4		0	0	0	0	0	0
Avg	1	1	1	3	1	3		0	0	1	1	1	1

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Table C.5.4-77. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-78. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	57	50	56	52
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		60	60	59	59	59	59
1979	0	0	0	0	0	0		60	59	60	54	60	50
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		58	57	56	52	55	54
1982	0	0	0	0	0	0		61	61	59	59	59	55
1983	0	0	0	0	0	0		61	61	50	55	50	55
1984	0	0	0	0	0	0		55	55	61	49	60	50
1985	0	0	0	0	0	0		61	61	58	61	58	61
1986	0	0	0	0	0	0		61	61	48	59	49	58
1987	0	0	0	0	0	0		52	52	61	47	61	48
1988	0	0	0	0	0	0		61	61	61	55	61	54
1989	0	0	0	0	0	0		61	59	57	58	57	58
1990	0	0	0	0	0	0		61	61	54	55	53	55
1991	0	0	0	0	0	0		61	61	61	61	60	61
Avg	0	0	0	0	0	0		60	60	58	56	58	56
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	4	11	5	9		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	1	1	1	1		0	0	1	1	1	1
1979	1	2	1	6	1	9		0	0	0	1	0	2
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	3	4	5	8	6	6		0	0	0	1	0	1
1982	0	0	2	2	2	6		0	0	0	0	0	0
1983	0	0	4	6	4	6		0	0	7	0	7	0
1984	2	2	0	6	1	5		4	4	0	6	0	6
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	3	2	2	3		0	0	10	0	10	0
1987	4	4	0	4	0	4		5	5	0	10	0	9
1988	0	0	0	6	0	7		0	0	0	0	0	0
1989	0	2	4	3	2	3		0	0	0	0	2	0
1990	0	0	5	4	4	3		0	0	2	2	4	3
1991	0	0	0	0	1	0		0	0	0	0	0	0
Avg	1	1	2	4	2	4		1	1	1	1	2	1

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Table C.5.4-79. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-80. Number of Days within Temperature Requirements for Sacramento River–Origin Spring-Run Chinook Salmon Adults in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	54	61	55
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	60	60	60	60
1979	0	0	0	0	0	0		61	61	61	56	61	56
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	59	58	59	57
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	54	55	53	56
1984	0	0	0	0	0	0		56	56	61	54	61	54
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	50	61	49	61
1987	0	0	0	0	0	0		53	53	61	49	61	49
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	56	58	56	57
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		60	60	59	58	59	58
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	7	0	6		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	1	1	1	1		0	0	0	0	0	0
1979	0	0	0	5	0	5		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	3	2	4		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	1	6	2	5		0	0	6	0	6	0
1984	3	3	0	2	0	2		2	2	0	5	0	5
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	7	0	8	0		0	0	4	0	4	0
1987	6	6	0	6	0	6		2	2	0	6	0	6
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	5	3	5	4		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	1	1	1	2	1	2		0	0	1	1	1	1

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Table C.5.4-81. Number of Days within Temperature Requirements for San Joaquin River–Origin Spring-Run Chinook Salmon Adults in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		61	61	61	61	61	61
1977	0	0	0	0	0	0		61	61	61	61	61	61
1978	0	0	0	0	0	0		61	61	61	61	61	61
1979	0	0	0	0	0	0		61	61	61	61	61	61
1980	0	0	0	0	0	0		61	61	61	61	61	61
1981	0	0	0	0	0	0		61	61	61	61	61	61
1982	0	0	0	0	0	0		61	61	61	61	61	61
1983	0	0	0	0	0	0		61	61	61	61	61	61
1984	0	0	0	0	0	0		61	61	61	61	61	61
1985	0	0	0	0	0	0		61	61	61	61	61	61
1986	0	0	0	0	0	0		61	61	61	61	61	61
1987	0	0	0	0	0	0		61	61	61	61	61	61
1988	0	0	0	0	0	0		61	61	61	61	61	61
1989	0	0	0	0	0	0		61	61	61	61	61	61
1990	0	0	0	0	0	0		61	61	61	61	61	61
1991	0	0	0	0	0	0		61	61	61	61	61	61
Avg	0	0	0	0	0	0		61	61	61	61	61	61
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.10 Fall-Run Chinook Salmon—Juvenile

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile fall-run Chinook salmon in the Cache Slough subregion (Table C.5.4-82). The average number of optimal days was 86 and 87 under EBC1 and EBC2, and ranged from 89 to 100 under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 2 under EBC1 and EBC2, 3 to 4 under EBC2_ELT and PP_ELT, respectively, and 5 under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios for water temperatures for juvenile fall-run Chinook salmon in the East Delta subregion (Table C.5.4-83) differed little when accounting for climate change. The average number of optimal days was 80 days under EBC1 and EBC2 and 83 to 100 under EBC2_ELT and EBC2_LLT, and 88 to 101 days under PP_ELT and PP_LLT, respectively. The average number of supraoptimal days was 2 days for EBC1 and EBC2, 3 to 4 days under EBC2_ELT and PP_ELT, respectively, and 6 days under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios for water temperatures for juvenile fall-run Chinook salmon in the North Delta subregion (Table C.5.4-84) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 69 for EBC1 and EBC2, and between 71 and 92 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 2 days under EBC1 and EBC2, and ranged from 4 to 5 days under EBC2_ELT and EBC2_LLT, and from 4 to 5 days under PP_ELT and PP_LLT, respectively. No days with lethal temperatures occurred during the modeling period under any of the scenarios considered.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile fall-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-85). Optimal water temperatures occurred on 89 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 93 to 94 days. Supraoptimal temperatures were reached on average on 2 days under EBC1 and EBC2. Under all other scenarios, this number ranged from 2 to 3 days. There were no lethal temperature days under any scenario.

Water temperatures in the South Delta for juvenile fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-86). Suboptimal water temperature conditions occurred on 24 days per year on average under EBC1 and EBC2, and 18–20 days under all other model scenarios. optimal water temperatures occurred on 94 days per year, on average under EBC1 and EBC2, and on 97-98 days per year for all other scenarios. Supraoptimal temperatures occurred on 2 days under EBC1 and EBC2, and on 4 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days

In the Suisun Bay subregion, water temperatures for juvenile fall-run Chinook salmon were similar among scenarios (Table C.5.4-87) after accounting for changing climate. Optimal water temperatures were reached on average on 81 and 82 days under EBC1 and EBC2, respectively, and ranged from 84 to 91 days for all other scenarios. EBC1 and EBC2 both averaged 1 day of supraoptimal temperature, while the number of days for all other scenarios varied from 2 to 4 days. There were no lethal temperature days under any scenario.

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In Suisun Marsh, the differences among scenarios of water temperatures for juvenile fall-run Chinook salmon were minor, after climate change was taken into consideration (Table C.5.4-88). Optimal temperatures occurred on average on 86 and 87 days under EBC1 and EBC2, respectively. Under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT, the number of optimal temperature days varied from 90 to 96. Supraoptimal water temperature conditions on average occurred on 1 and 2 days under EBC1 and EBC2, respectively, and on 3 to 5 days under all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

Water temperatures in the West Delta for juvenile fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-89). Under EBC1 and EBC2, optimal water temperatures occurred on 80 days per year, on average. Under EBC2_ELT, and EBC2_LLT, optimal temperature conditions occurred on 85 and 97 days per year, respectively, and on 89 to 98 days under PP_ELT and PP_LLT, respectively. Supraoptimal temperatures occurred on average on 1 day under EBC1 and EBC2, and on 2 and 3 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

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Table C.5.4-82. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	38	37	28	18	28	18		83	84	88	94	88	92
1977	28	27	16	14	16	14		92	93	104	106	104	106
1978	23	23	26	13	29	18		96	96	92	105	89	99
1979	34	34	33	16	34	23		84	84	85	95	84	87
1980	31	31	22	5	30	17		90	90	99	116	91	104
1981	33	29	21	11	23	9		83	87	94	101	91	103
1982	44	45	35	17	42	17		75	74	83	100	75	100
1983	33	33	28	9	35	13		87	87	83	106	73	100
1984	33	34	32	21	34	20		82	81	89	89	87	89
1985	35	33	19	18	16	18		85	87	98	102	101	102
1986	20	19	19	9	33	13		100	101	89	109	76	105
1987	36	35	22	14	21	14		75	76	98	92	99	92
1988	21	18	14	11	13	10		100	103	107	104	108	105
1989	36	36	30	26	29	25		82	82	86	91	86	92
1990	38	38	35	26	33	26		82	82	76	87	79	88
1991	37	37	31	14	35	14		83	83	89	106	85	106
Avg	33	32	26	15	28	17		86	87	91	100	89	98
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	5	9	5	11		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	2	2	3		0	0	0	0	0	0
1979	2	2	2	9	2	10		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	5	8	6	8		0	0	0	0	0	0
1982	1	1	2	3	3	3		0	0	0	0	0	0
1983	0	0	9	5	12	7		0	0	0	0	0	0
1984	6	6	0	11	0	12		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	12	2	11	2		0	0	0	0	0	0
1987	9	9	0	14	0	14		0	0	0	0	0	0
1988	0	0	0	6	0	6		0	0	0	0	0	0
1989	2	2	4	3	5	3		0	0	0	0	0	0
1990	0	0	9	7	8	6		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	2	2	3	5	4	5		0	0	0	0	0	0

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Table C.5.4-83. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	38	38	28	18	23	13		82	82	87	89	93	96
1977	28	32	18	12	15	13		92	88	102	108	105	107
1978	26	26	29	11	24	11		92	92	88	106	94	105
1979	40	39	36	12	33	11		78	79	78	97	83	99
1980	45	45	47	8	36	7		76	76	74	113	85	114
1981	52	49	31	7	23	9		64	67	83	106	92	104
1982	52	52	48	22	45	19		66	66	70	94	71	97
1983	52	52	39	14	38	12		65	65	71	95	71	97
1984	37	37	47	21	38	18		77	77	74	91	83	94
1985	42	42	33	17	24	17		78	78	83	103	93	103
1986	37	37	38	5	37	5		83	83	79	112	74	111
1987	36	36	31	10	19	11		76	76	89	97	101	96
1988	22	22	18	10	14	10		99	99	103	104	107	105
1989	38	38	33	22	30	23		82	82	83	94	85	94
1990	43	44	41	24	32	25		77	76	71	89	80	88
1991	33	34	33	11	28	11		87	86	86	106	92	109
Avg	39	39	34	14	29	13		80	80	83	100	88	101
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	1	1	6	14	5	12		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	2	3	3	2	4		0	0	0	0	0	0
1979	2	2	6	11	4	10		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	7	5	7		0	0	0	0	0	0
1982	2	2	2	4	4	4		0	0	0	0	0	0
1983	3	3	10	11	11	11		0	0	0	0	0	0
1984	7	7	0	9	0	9		0	0	0	0	0	0
1985	0	0	4	0	3	0		0	0	0	0	0	0
1986	0	0	3	3	9	4		0	0	0	0	0	0
1987	8	8	0	13	0	13		0	0	0	0	0	0
1988	0	0	0	7	0	6		0	0	0	0	0	0
1989	0	0	4	4	5	3		0	0	0	0	0	0
1990	0	0	8	7	8	7		0	0	0	0	0	0
1991	0	0	1	3	0	0		0	0	0	0	0	0
Avg	2	2	3	6	4	6		0	0	0	0	0	0

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Table C.5.4-84. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	47	48	32	27	32	27		72	71	86	91	86	91
1977	59	59	49	18	50	15		61	61	71	102	70	105
1978	45	45	42	18	44	18		72	72	73	95	71	96
1979	52	52	48	26	45	24		67	67	64	87	67	89
1980	50	50	53	24	52	24		70	71	67	94	68	94
1981	58	56	44	25	46	25		61	63	68	93	65	93
1982	60	60	50	29	50	29		57	57	66	89	67	88
1983	56	56	41	20	41	20		60	60	70	89	70	89
1984	42	42	53	21	52	20		72	72	67	93	68	93
1985	49	51	56	29	56	29		71	69	57	90	56	89
1986	42	42	40	17	40	17		76	76	78	99	78	98
1987	44	44	46	24	47	24		74	74	72	93	71	93
1988	35	35	38	12	39	12		85	85	78	101	77	101
1989	46	46	38	30	38	30		71	71	78	82	79	82
1990	48	49	42	34	42	34		72	71	73	80	73	80
1991	55	55	52	20	50	20		64	64	67	96	69	96
Avg	49	49	45	23	45	23		69	69	71	92	71	92
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	2	2	3	3	3	3		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	3	3	5	7	5	6		0	0	0	0	0	0
1979	1	1	8	7	8	7		0	0	0	0	0	0
1980	1	0	1	3	1	3		0	0	0	0	0	0
1981	1	1	8	2	9	2		0	0	0	0	0	0
1982	3	3	4	2	3	3		0	0	0	0	0	0
1983	4	4	9	11	9	11		0	0	0	0	0	0
1984	7	7	1	7	1	8		0	0	0	0	0	0
1985	0	0	7	1	8	2		0	0	0	0	0	0
1986	2	2	2	4	2	5		0	0	0	0	0	0
1987	2	2	2	3	2	3		0	0	0	0	0	0
1988	1	1	5	8	5	8		0	0	0	0	0	0
1989	3	3	4	8	3	8		0	0	0	0	0	0
1990	0	0	5	6	5	6		0	0	0	0	0	0
1991	1	1	1	4	1	4		0	0	0	0	0	0
Avg	2	2	4	5	4	5		0	0	0	0	0	0

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Table C.5.4-85. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	32	32	34	25	33	23		89	89	84	92	85	93
1977	28	29	15	15	15	15		92	91	105	105	105	105
1978	23	23	24	25	23	25		94	94	93	95	94	95
1979	33	33	28	31	28	31		83	83	89	89	89	88
1980	28	27	18	24	19	26		93	94	103	97	102	95
1981	26	24	22	16	22	15		93	95	91	104	91	105
1982	34	34	26	39	24	39		83	83	88	81	90	81
1983	26	25	27	36	27	35		91	92	83	84	84	85
1984	30	30	32	25	30	25		84	84	89	89	91	89
1985	36	35	23	22	23	23		84	85	92	98	92	97
1986	24	24	18	21	16	21		96	96	99	99	101	99
1987	30	30	25	23	22	20		84	84	95	87	98	89
1988	19	20	15	14	13	13		102	101	105	107	107	107
1989	35	34	29	32	29	32		85	86	90	87	90	87
1990	38	38	32	30	31	30		82	82	81	86	82	85
1991	27	28	22	20	21	16		93	92	98	100	99	104
Avg	29	29	24	25	24	24		89	89	93	94	94	94
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	3	4	3	5		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	3	3	3	0	3	0		0	0	0	0	0	0
1979	4	4	3	0	3	1		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	1	1	7	0	7	0		0	0	0	0	0	0
1982	3	3	6	0	6	0		0	0	0	0	0	0
1983	3	3	10	0	9	0		0	0	0	0	0	0
1984	7	7	0	7	0	7		0	0	0	0	0	0
1985	0	0	5	0	5	0		0	0	0	0	0	0
1986	0	0	3	0	3	0		0	0	0	0	0	0
1987	6	6	0	10	0	11		0	0	0	0	0	0
1988	0	0	1	0	1	1		0	0	0	0	0	0
1989	0	0	1	1	1	1		0	0	0	0	0	0
1990	0	0	7	4	7	5		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	2	2	3	2	3	2		0	0	0	0	0	0

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Table C.5.4-86. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	34	34	24	14	23	15		86	86	92	94	93	94
1977	21	21	15	14	15	15		99	99	105	106	105	105
1978	23	23	22	16	20	18		95	95	95	102	97	100
1979	33	33	29	27	29	29		82	82	87	86	89	85
1980	19	19	14	17	15	22		102	102	107	104	106	99
1981	16	16	15	11	15	11		100	100	99	102	99	102
1982	27	27	19	25	21	35		90	90	95	95	92	85
1983	21	21	26	32	26	32		96	98	83	88	82	88
1984	30	30	20	25	23	25		85	85	100	86	97	86
1985	24	24	16	19	16	19		96	96	101	101	101	101
1986	14	14	9	3	8	7		106	106	104	115	102	111
1987	26	25	13	12	13	10		85	86	107	94	107	95
1988	13	14	14	10	13	10		108	107	107	105	108	109
1989	33	34	27	25	27	26		86	85	89	92	89	91
1990	35	35	31	26	29	27		85	85	80	87	82	87
1991	19	19	15	12	15	11		101	101	104	108	104	109
Avg	24	24	19	18	19	20		94	94	97	98	97	97
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	1	1	5	13	5	12		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	2	2	3	2	3	2		0	0	0	0	0	0
1979	5	5	4	7	2	6		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	4	4	6	7	6	7		0	0	0	0	0	0
1982	3	3	6	0	7	0		0	0	0	0	0	0
1983	3	1	11	0	12	0		0	0	0	0	0	0
1984	6	6	1	10	1	10		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	7	2	10	2		0	0	0	0	0	0
1987	9	9	0	14	0	15		0	0	0	0	0	0
1988	0	0	0	6	0	2		0	0	0	0	0	0
1989	1	1	4	3	4	3		0	0	0	0	0	0
1990	0	0	9	7	9	6		0	0	0	0	0	0
1991	0	0	1	0	1	0		0	0	0	0	0	0
Avg	2	2	4	4	4	4		0	0	0	0	0	0

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Table C.5.4-87. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	37	36	37	31	37	29		84	85	83	86	82	88
1977	39	40	29	31	27	29		81	80	91	89	93	91
1978	28	28	29	23	29	23		91	91	89	94	89	94
1979	34	34	34	30	33	30		86	86	86	82	87	81
1980	42	42	36	22	30	21		79	79	85	99	91	100
1981	42	41	31	22	28	22		78	79	87	96	90	96
1982	48	49	44	21	39	19		72	71	76	98	81	100
1983	47	47	36	22	35	22		73	73	76	95	77	97
1984	36	36	39	26	32	24		79	79	82	87	89	89
1985	41	39	25	33	25	32		79	81	95	86	95	87
1986	31	29	34	16	28	15		89	91	77	101	84	103
1987	38	38	33	31	31	29		78	78	87	79	89	81
1988	27	27	26	21	26	20		94	94	95	94	95	95
1989	37	37	35	34	33	34		83	83	84	86	85	85
1990	43	43	43	42	42	38		77	77	73	72	74	76
1991	43	43	36	30	34	25		77	77	84	86	86	91
Avg	38	38	34	27	32	26		81	82	84	89	87	91
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	1	4	2	4		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	3	2	3		0	0	0	0	0	0
1979	0	0	0	8	0	9		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	2	2	2		0	0	0	0	0	0
1982	0	0	0	1	0	1		0	0	0	0	0	0
1983	0	0	8	3	8	1		0	0	0	0	0	0
1984	6	6	0	8	0	8		0	0	0	0	0	0
1985	0	0	0	1	0	1		0	0	0	0	0	0
1986	0	0	9	3	8	2		0	0	0	0	0	0
1987	4	4	0	10	0	10		0	0	0	0	0	0
1988	0	0	0	6	0	6		0	0	0	0	0	0
1989	0	0	1	0	2	1		0	0	0	0	0	0
1990	0	0	4	6	4	6		0	0	0	0	0	0
1991	0	0	0	4	0	4		0	0	0	0	0	0
Avg	1	1	2	4	2	4		0	0	0	0	0	0

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Table C.5.4-88. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	37	37	32	23	32	25		84	84	85	87	84	87
1977	28	25	17	16	16	15		92	95	103	104	104	105
1978	27	26	28	20	25	20		92	93	90	98	93	98
1979	35	34	33	26	33	25		84	84	86	87	86	84
1980	30	30	23	17	20	17		91	91	98	104	101	104
1981	18	18	16	14	16	15		99	98	99	97	98	98
1982	51	51	49	22	44	21		69	69	69	96	74	93
1983	45	44	30	12	29	12		75	76	79	102	80	102
1984	33	33	23	21	21	20		82	82	98	88	99	90
1985	31	29	18	23	17	23		89	91	99	97	100	97
1986	24	24	28	14	28	12		96	96	79	104	80	105
1987	34	33	19	17	15	17		77	78	101	89	105	90
1988	23	22	21	12	14	12		98	99	100	103	107	102
1989	37	36	35	29	30	30		83	82	81	88	86	87
1990	41	40	34	29	33	29		79	80	79	85	79	85
1991	34	34	27	16	27	18		86	86	93	104	92	102
Avg	33	32	27	19	25	19		86	87	90	96	92	96
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	4	11	5	9		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	2	2	2	2		0	0	0	0	0	0
1979	1	2	1	7	1	11		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	3	4	5	9	6	7		0	0	0	0	0	0
1982	0	0	2	2	2	6		0	0	0	0	0	0
1983	0	0	11	6	11	6		0	0	0	0	0	0
1984	6	6	0	12	1	11		0	0	0	0	0	0
1985	0	0	3	0	3	0		0	0	0	0	0	0
1986	0	0	13	2	12	3		0	0	0	0	0	0
1987	9	9	0	14	0	13		0	0	0	0	0	0
1988	0	0	0	6	0	7		0	0	0	0	0	0
1989	0	2	4	3	4	3		0	0	0	0	0	0
1990	0	0	7	6	8	6		0	0	0	0	0	0
1991	0	0	0	0	1	0		0	0	0	0	0	0
Avg	1	2	3	5	4	5		0	0	0	0	0	0

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Table C.5.4-89. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Juvenile Rearing in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	40	40	32	23	31	22		81	81	89	91	90	93
1977	35	35	21	17	20	16		85	85	99	103	100	104
1978	27	27	34	20	28	20		93	93	85	99	91	99
1979	35	36	34	26	34	26		85	84	86	89	86	89
1980	44	44	33	19	24	18		77	77	88	102	97	103
1981	46	45	33	14	23	14		74	75	85	103	95	102
1982	54	53	49	19	37	18		66	67	71	101	83	102
1983	46	46	34	18	34	17		74	74	79	96	78	98
1984	36	36	42	26	35	25		80	80	79	88	86	89
1985	43	41	26	22	24	22		77	79	94	98	96	98
1986	29	28	31	15	25	14		91	92	78	105	83	106
1987	40	41	27	17	26	16		72	71	93	91	94	92
1988	25	25	23	15	22	14		96	96	98	106	99	107
1989	39	39	37	32	37	32		81	81	83	88	83	88
1990	45	45	44	30	42	30		75	75	71	87	73	86
1991	43	43	40	14	38	14		77	77	80	106	82	106
Avg	39	39	34	20	30	20		80	80	85	97	89	98
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	7	0	6		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	1	1	1	1		0	0	0	0	0	0
1979	0	0	0	5	0	5		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	2	3	2	4		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	7	6	8	5		0	0	0	0	0	0
1984	5	5	0	7	0	7		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	11	0	12	0		0	0	0	0	0	0
1987	8	8	0	12	0	12		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	5	3	5	4		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	1	1	2	3	2	3		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.11 Fall-Run Chinook Salmon—Smoltification

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt fall-run Chinook salmon in the Cache Slough subregion (Table C.5.4-90). The average number of optimal days was 111 days under EBC1 and EBC2 and 106 to 110 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 4 under EBC1 and EBC2, 8 under EBC2_ELT and PP_ELT, and 13 under EBC2_LLT and PP_LLT. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in water temperatures for smolt fall-run Chinook salmon in the East Delta subregion (Table C.5.4-91) differed little when accounting for climate change. The average number of optimal days was 111 days under EBC1 and EBC2, 108 and 109 days under EBC2_ELT and PP_ELT, respectively, and 107 days under EBC2_LLT and PP_LLT. The average number of supraoptimal days was 5 for EBC1 and EBC2, 10 to 9 days under EBC2_ELT and PP_ELT, and 13 to 9 days under EBC2_LLT and PP_LLT. There were no lethal days observed under any scenario.

EBC scenarios and PP scenarios in water temperatures for smolt fall-run Chinook salmon in the North Delta subregion (Table C.5.4-92) were similar, considering climate change effects on water temperature. The average number of days of optimal water temperatures was 102 for EBC1 and EBC2 and between 102 and 108 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on average on 5 days under EBC1 and EBC2, on 9 days under EBC2_ELT and PP_ELT, and on 12 and 11 days under EBC2_LLT and PP_LLT, respectively. No days with lethal temperatures occurred during the modeling period.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt fall-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-93). Optimal water temperatures occurred on average on 113 and 112 days under the EBC1 and EBC2 scenarios, respectively. Under all other scenarios, the number of days with optimal water temperatures ranged from 111 to 113. Supraoptimal temperatures were reached on average for 5 days under EBC1 and EBC2. Under all other scenarios, this number ranged from 7 to 8 days. There were no lethal temperature days under any scenario.

Water temperatures in the South Delta for smolt fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-94). Suboptimal water temperature conditions occurred on 3 days per year on average under EBC1 and EBC2, and on 1 day under all other model scenarios. Under EBC1 and EBC2, optimal water temperatures occurred on 112 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 110 and 108 days per year, respectively; and on 110 to 108 days under PP_ELT and PP_LLT, respectively. Supraoptimal temperatures occurred on 5 days under EBC1 and EBC2, and on 9 to 12 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days

In the Suisun Bay subregion, water temperatures for smolt fall-run Chinook salmon were similar among scenarios (Table C.5.4-95) after accounting for changing climate. Optimal water temperatures were reached on average on 111 days under EBC1 and 107 to 111 days for all other scenarios. EBC1 and EBC2 averaged 3 days of supraoptimal days, while the number of days for EBC_ELT andEBC1_LLT and PP_ELT and PP_LLT varied from 6 to 11 days. There were no lethal temperature days under any scenario.

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Water temperatures in the Suisun Marsh for smolt fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-96). Under EBC1 and EBC2, optimal water temperatures occurred on 110 days per year, on average. Under EBC2_ELT, and PP_ELT, optimal temperature conditions occurred on 108 to 109 days per year; and on 106 days under PP_ELT and PP_LLT. Supraoptimal temperatures occurred on 4 days under EBC1 and EBC2, and on 8 to 12 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no lethal temperature days under any scenario.

In the West Delta, the differences among scenarios of water temperatures for smolt fall-run Chinook salmon were minor, after climate change was taken into consideration (Table C.5.4-97). Optimal temperatures occurred on average on 110 days under EBC1 and EBC2 and on 109 to 111 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal water temperature conditions occurred on 3 days under EBC1 and EBC2 and on 6 to 10 days under all other scenarios (i.e., EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures did not occur under any scenario.

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Table C.5.4-90. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	0	0	0	0	0	0		118	118	108	99	110	99
1977	9	9	8	2	7	5		111	111	112	115	113	112
1978	0	0	0	0	0	0		118	118	116	108	116	108
1979	5	5	5	2	6	6		106	106	107	103	105	100
1980	2	1	0	0	2	0		119	120	121	116	119	116
1981	2	1	0	0	1	0		110	111	108	107	106	107
1982	8	8	0	0	5	0		108	108	112	106	108	106
1983	0	0	0	0	0	0		112	112	103	104	103	104
1984	1	1	13	0	12	0		113	113	102	102	104	102
1985	14	14	0	10	0	10		106	106	111	106	110	105
1986	0	0	0	0	1	0		116	116	104	109	103	109
1987	0	0	0	0	0	0		107	107	115	98	116	97
1988	4	3	0	0	0	0		116	117	116	106	116	105
1989	17	17	12	0	13	0		98	98	102	111	100	109
1990	14	14	7	2	11	3		99	99	102	104	99	101
1991	3	4	0	0	0	0		117	116	114	114	116	113
Avg	5	5	3	1	4	2		111	111	110	107	109	106
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	3	3	13	22	11	22		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	2	2	4	12	4	12		0	0	0	0	0	0
1979	9	9	8	15	9	14		0	0	0	0	0	0
1980	0	0	0	5	0	5		0	0	0	0	0	0
1981	8	8	12	13	13	13		0	0	0	0	0	0
1982	4	4	8	14	7	14		0	0	0	0	0	0
1983	8	8	17	16	17	16		0	0	0	0	0	0
1984	7	7	6	19	5	19		0	0	0	0	0	0
1985	0	0	9	4	10	5		0	0	0	0	0	0
1986	4	4	16	11	16	11		0	0	0	0	0	0
1987	13	13	5	22	4	23		0	0	0	0	0	0
1988	1	1	5	15	5	16		0	0	0	0	0	0
1989	5	5	6	9	7	11		0	0	0	0	0	0
1990	7	7	11	14	10	16		0	0	0	0	0	0
1991	0	0	6	6	4	7		0	0	0	0	0	0
Avg	4	4	8	13	8	13		0	0	0	0	0	0

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Table C.5.4-91. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		117	117	102	99	104	99
1977	8	7	6	0	6	0		112	113	114	117	114	117
1978	0	0	0	0	0	0		117	116	112	105	114	107
1979	3	2	2	0	2	0		107	108	106	103	108	104
1980	1	1	0	0	0	0		118	118	118	115	121	115
1981	2	2	3	0	0	0		111	111	104	107	107	107
1982	11	11	5	0	1	0		104	104	102	109	107	110
1983	0	0	0	0	0	0		111	111	102	104	101	104
1984	5	5	12	0	12	0		104	104	105	102	105	102
1985	13	13	0	1	0	7		107	107	109	114	110	109
1986	0	0	0	0	0	0		114	115	104	107	107	108
1987	0	0	0	0	0	0		107	107	115	96	115	97
1988	0	0	0	0	0	0		119	119	114	110	115	108
1989	8	9	6	0	7	0		108	107	108	110	106	111
1990	7	7	7	0	6	0		106	106	100	102	101	105
1991	0	0	0	0	0	0		118	117	115	113	114	113
Avg	4	4	3	0	2	0		111	111	108	107	109	107
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	4	4	19	22	17	22		0	0	0	0	0	0
1977	0	0	0	3	0	3		0	0	0	0	0	0
1978	3	4	8	15	6	13		0	0	0	0	0	0
1979	10	10	12	17	10	16		0	0	0	0	0	0
1980	2	2	3	6	0	6		0	0	0	0	0	0
1981	7	7	13	13	13	13		0	0	0	0	0	0
1982	5	5	13	11	12	10		0	0	0	0	0	0
1983	9	9	18	16	19	16		0	0	0	0	0	0
1984	12	12	4	19	4	19		0	0	0	0	0	0
1985	0	0	11	5	10	4		0	0	0	0	0	0
1986	6	5	16	13	13	12		0	0	0	0	0	0
1987	13	13	5	24	5	23		0	0	0	0	0	0
1988	2	2	7	11	6	13		0	0	0	0	0	0
1989	4	4	6	10	7	9		0	0	0	0	0	0
1990	7	7	13	18	13	15		0	0	0	0	0	0
1991	2	3	5	7	6	7		0	0	0	0	0	0
Avg	5	5	10	13	9	13		0	0	0	0	0	0

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Table C.5.4-92. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	11	10	1	1	1	1		104	105	104	102	105	103
1977	13	12	7	1	6	1		107	108	113	119	114	119
1978	16	16	8	0	8	0		99	99	101	107	101	108
1979	17	16	9	5	9	5		95	96	96	100	97	99
1980	11	11	6	0	6	0		107	107	112	116	112	117
1981	4	4	7	0	7	0		108	108	101	109	101	110
1982	15	15	9	0	9	0		100	100	100	111	100	111
1983	9	9	13	0	13	0		105	104	90	106	90	106
1984	15	15	14	0	14	0		96	96	103	107	103	108
1985	19	17	10	4	11	5		99	100	98	107	97	106
1986	8	8	7	0	7	0		108	108	105	110	106	109
1987	14	14	6	0	6	0		96	96	111	106	110	105
1988	7	7	5	0	6	0		111	112	103	109	102	108
1989	16	16	19	3	17	3		98	98	92	101	92	105
1990	23	23	18	5	18	5		91	91	94	98	94	100
1991	13	13	9	0	8	0		104	104	107	113	109	113
Avg	13	13	9	1	9	1		102	102	102	108	102	108
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	6	6	16	18	15	17		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	5	5	11	13	11	12		0	0	0	0	0	0
1979	8	8	15	15	14	16		0	0	0	0	0	0
1980	3	3	3	5	3	4		0	0	0	0	0	0
1981	8	8	12	11	12	10		0	0	0	0	0	0
1982	5	5	11	9	11	9		0	0	0	0	0	0
1983	6	7	17	14	17	14		0	0	0	0	0	0
1984	10	10	4	14	4	13		0	0	0	0	0	0
1985	2	3	12	9	12	9		0	0	0	0	0	0
1986	4	4	8	10	7	11		0	0	0	0	0	0
1987	10	10	3	14	4	15		0	0	0	0	0	0
1988	3	2	13	12	13	13		0	0	0	0	0	0
1989	6	6	9	16	11	12		0	0	0	0	0	0
1990	6	6	8	17	8	15		0	0	0	0	0	0
1991	3	3	4	7	3	7		0	0	0	0	0	0
Avg	5	5	9	12	9	11		0	0	0	0	0	0

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Table C.5.4-93. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		119	119	113	100	113	100
1977	7	7	5	0	5	1		113	113	115	120	115	119
1978	0	0	0	0	0	0		115	115	112	115	112	115
1979	3	3	2	5	2	4		108	108	107	107	107	108
1980	0	0	0	1	0	1		121	121	120	120	120	120
1981	0	0	0	0	0	0		113	112	106	113	106	112
1982	0	0	0	0	0	0		112	112	108	118	108	118
1983	0	0	0	0	0	0		110	110	104	113	105	115
1984	0	0	5	0	4	0		110	110	112	110	113	109
1985	12	12	0	8	0	9		108	108	109	111	109	110
1986	0	0	0	0	0	0		116	116	104	115	103	115
1987	0	0	0	0	0	0		106	106	117	104	118	101
1988	1	1	0	0	0	0		119	119	114	114	114	114
1989	13	14	7	0	7	0		104	102	108	116	108	115
1990	8	8	8	0	8	1		109	109	103	111	103	110
1991	2	2	0	0	0	0		117	117	118	117	118	116
Avg	3	3	2	1	2	1		113	112	111	113	111	112
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	2	2	8	21	8	21		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	5	5	8	5	8	5		0	0	0	0	0	0
1979	9	9	11	8	11	8		0	0	0	0	0	0
1980	0	0	1	0	1	0		0	0	0	0	0	0
1981	7	8	14	7	14	8		0	0	0	0	0	0
1982	8	8	12	2	12	2		0	0	0	0	0	0
1983	10	10	16	7	15	5		0	0	0	0	0	0
1984	11	11	4	11	4	12		0	0	0	0	0	0
1985	0	0	11	1	11	1		0	0	0	0	0	0
1986	4	4	16	5	17	5		0	0	0	0	0	0
1987	14	14	3	16	2	19		0	0	0	0	0	0
1988	1	1	7	7	7	7		0	0	0	0	0	0
1989	3	4	5	4	5	5		0	0	0	0	0	0
1990	3	3	9	9	9	9		0	0	0	0	0	0
1991	1	1	2	3	2	4		0	0	0	0	0	0
Avg	5	5	8	7	8	7		0	0	0	0	0	0

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Table C.5.4-94. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		117	117	103	99	103	99
1977	8	8	6	0	6	0		112	112	113	116	114	117
1978	0	0	0	0	0	0		115	115	112	109	112	110
1979	4	4	2	4	2	4		108	108	108	102	109	103
1980	0	0	0	0	0	0		121	121	121	118	121	118
1981	0	0	0	0	0	0		111	111	107	107	107	107
1982	0	0	0	0	0	0		116	116	110	115	109	115
1983	0	0	0	0	0	0		109	109	105	112	105	112
1984	0	0	9	0	5	0		112	112	105	101	109	101
1985	14	14	0	10	0	10		106	106	110	106	110	106
1986	0	0	0	0	0	0		116	116	103	109	103	110
1987	0	0	0	0	0	0		107	107	115	93	115	93
1988	0	0	0	0	0	0		120	120	116	109	116	109
1989	14	15	3	0	3	0		102	101	108	111	108	111
1990	7	7	3	1	3	1		107	107	105	104	105	106
1991	0	0	0	0	0	0		120	120	114	113	114	114
Avg	3	3	1	1	1	1		112	112	110	108	110	108
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	4	4	18	22	18	22		0	0	0	0	0	0
1977	0	0	1	4	0	3		0	0	0	0	0	0
1978	5	5	8	11	8	10		0	0	0	0	0	0
1979	8	8	10	14	9	13		0	0	0	0	0	0
1980	0	0	0	3	0	3		0	0	0	0	0	0
1981	9	9	13	13	13	13		0	0	0	0	0	0
1982	4	4	10	5	11	5		0	0	0	0	0	0
1983	11	11	15	8	15	8		0	0	0	0	0	0
1984	9	9	7	20	7	20		0	0	0	0	0	0
1985	0	0	10	4	10	4		0	0	0	0	0	0
1986	4	4	17	11	17	10		0	0	0	0	0	0
1987	13	13	5	27	5	27		0	0	0	0	0	0
1988	1	1	5	12	5	12		0	0	0	0	0	0
1989	4	4	9	9	9	9		0	0	0	0	0	0
1990	6	6	12	15	12	13		0	0	0	0	0	0
1991	0	0	6	7	6	6		0	0	0	0	0	0
Avg	5	5	9	12	9	11		0	0	0	0	0	0

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Table C.5.4-95. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		120	119	110	106	110	105
1977	7	7	7	5	7	5		113	113	113	114	113	114
1978	3	3	0	0	0	0		114	114	117	111	117	112
1979	8	8	6	6	6	6		104	104	107	99	107	99
1980	3	3	2	1	2	2		118	118	119	115	119	114
1981	2	2	3	0	2	0		111	111	109	110	109	110
1982	13	13	3	0	4	0		105	104	109	111	109	109
1983	1	1	0	0	0	0		115	115	105	104	105	104
1984	1	1	12	0	12	0		113	113	107	105	107	105
1985	13	13	0	13	0	13		107	107	112	104	112	104
1986	1	1	0	0	0	0		116	116	104	111	104	110
1987	1	1	1	2	1	0		107	107	119	99	119	101
1988	5	6	3	0	4	0		116	115	113	110	114	109
1989	12	15	6	9	6	9		105	101	109	104	109	104
1990	16	16	7	7	7	7		102	102	105	100	104	100
1991	3	3	0	0	0	0		117	117	118	113	118	113
Avg	6	6	3	3	3	3		111	111	111	107	111	107
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	1	2	11	15	11	16		0	0	0	0	0	0
1977	0	0	0	1	0	1		0	0	0	0	0	0
1978	3	3	3	9	3	8		0	0	0	0	0	0
1979	8	8	7	15	7	15		0	0	0	0	0	0
1980	0	0	0	5	0	5		0	0	0	0	0	0
1981	7	7	8	10	9	10		0	0	0	0	0	0
1982	2	3	8	9	7	11		0	0	0	0	0	0
1983	4	4	15	16	15	16		0	0	0	0	0	0
1984	7	7	2	16	2	16		0	0	0	0	0	0
1985	0	0	8	3	8	3		0	0	0	0	0	0
1986	3	3	16	9	16	10		0	0	0	0	0	0
1987	12	12	0	19	0	19		0	0	0	0	0	0
1988	0	0	5	11	3	12		0	0	0	0	0	0
1989	3	4	5	7	5	7		0	0	0	0	0	0
1990	2	2	8	13	9	13		0	0	0	0	0	0
1991	0	0	2	7	2	7		0	0	0	0	0	0
Avg	3	3	6	10	6	11		0	0	0	0	0	0

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Table C.5.4-96. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		118	118	104	99	108	99
1977	10	9	8	6	7	6		110	111	112	112	113	112
1978	0	0	0	0	0	0		118	118	117	109	117	109
1979	9	9	7	7	7	7		104	104	106	97	106	98
1980	5	5	4	2	3	2		116	116	117	113	118	113
1981	0	0	0	0	0	0		111	110	107	107	107	107
1982	14	14	11	0	9	0		103	103	102	103	103	103
1983	5	4	0	0	0	0		111	111	105	107	104	106
1984	0	0	13	0	13	0		114	113	102	102	102	102
1985	16	15	0	12	0	12		104	105	111	104	111	105
1986	0	0	0	0	0	0		118	116	97	110	100	109
1987	0	0	0	0	0	0		106	106	115	94	115	97
1988	6	6	0	0	0	0		114	114	115	111	116	111
1989	18	17	13	4	12	6		98	99	99	108	101	106
1990	15	15	8	4	8	5		99	98	102	101	102	102
1991	4	3	1	0	0	0		116	117	113	114	114	113
Avg	6	6	4	2	4	2		110	110	108	106	109	106
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	3	3	17	22	13	22		0	0	0	0	0	0
1977	0	0	0	2	0	2		0	0	0	0	0	0
1978	2	2	3	11	3	11		0	0	0	0	0	0
1979	7	7	7	16	7	15		0	0	0	0	0	0
1980	0	0	0	6	0	6		0	0	0	0	0	0
1981	9	10	13	13	13	13		0	0	0	0	0	0
1982	3	3	7	17	8	17		0	0	0	0	0	0
1983	4	5	15	13	16	14		0	0	0	0	0	0
1984	7	8	6	19	6	19		0	0	0	0	0	0
1985	0	0	9	4	9	3		0	0	0	0	0	0
1986	2	4	23	10	20	11		0	0	0	0	0	0
1987	14	14	5	26	5	23		0	0	0	0	0	0
1988	1	1	6	10	5	10		0	0	0	0	0	0
1989	4	4	8	8	7	8		0	0	0	0	0	0
1990	6	7	10	15	10	13		0	0	0	0	0	0
1991	0	0	6	6	6	7		0	0	0	0	0	0
Avg	4	4	8	12	8	12		0	0	0	0	0	0

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Table C.5.4-97. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Smoltification in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	0	0	0	0	0	0		121	121	103	100	103	100
1977	12	12	10	0	9	5		108	108	110	120	111	115
1978	3	3	0	0	0	0		116	116	117	110	117	111
1979	9	9	7	5	7	5		104	104	108	102	108	103
1980	3	3	3	0	2	0		118	118	118	121	119	121
1981	3	4	1	0	0	0		112	111	111	109	112	109
1982	14	14	7	0	2	0		104	104	105	113	111	110
1983	1	1	0	0	0	0		111	111	105	105	105	106
1984	4	4	13	0	13	0		111	111	107	104	107	104
1985	16	16	0	11	0	12		104	104	115	109	116	108
1986	0	0	1	0	0	0		120	120	101	113	102	113
1987	1	1	0	0	0	0		108	108	120	98	120	98
1988	8	8	0	0	0	0		113	113	119	112	119	112
1989	19	19	15	0	14	0		101	101	100	115	101	114
1990	22	23	7	0	7	0		98	97	102	106	102	106
1991	4	4	0	0	0	0		116	116	120	119	120	119
Avg	7	8	4	1	3	1		110	110	110	110	111	109
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	18	21	18	21		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	1	1	3	10	3	9		0	0	0	0	0	0
1979	7	7	5	13	5	12		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	5	5	8	11	8	11		0	0	0	0	0	0
1982	2	2	8	7	7	10		0	0	0	0	0	0
1983	8	8	15	15	15	14		0	0	0	0	0	0
1984	6	6	1	17	1	17		0	0	0	0	0	0
1985	0	0	5	0	4	0		0	0	0	0	0	0
1986	0	0	18	7	18	7		0	0	0	0	0	0
1987	11	11	0	22	0	22		0	0	0	0	0	0
1988	0	0	2	9	2	9		0	0	0	0	0	0
1989	0	0	5	5	5	6		0	0	0	0	0	0
1990	0	0	11	14	11	14		0	0	0	0	0	0
1991	0	0	0	1	0	1		0	0	0	0	0	0
Avg	3	3	6	10	6	10		0	0	0	0	0	0

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C.5.4.3.12 Fall-Run Chinook Salmon—Adult

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult fall-run Chinook salmon in the Cache Slough subregion (Table C.5.4-98). The average number of optimal days was 50 and 49 days under EBC1 and EBC2, respectively, and 34 to 47 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was 7 under EBC1 and EBC2, 8 and 7 under EBC2_ELT and PP_ELT, respectively, and 10 and 9 under EBC2_LLT and PP_LLT, respectively. On average lethal water temperatures occurred during 5 days under EBC1 and EBC2. Lethal conditions occurred under EBC2_ELT and PP_ELT on 7 and 6 days, respectively. Lethal temperatures occurred on 17 and 16 days under EBC2_LLT and PP_LLT, respectively.

EBC scenarios and PP scenarios in water temperatures for adult fall-run Chinook salmon in the East Delta subregion (Table C.5.4-99) differed little when accounting for climate change. The average number of optimal days was 47 days under EBC1 and EBC2, 44 and 45 days under EBC2_ELT and PP_ELT, respectively, and 31 and 32 days under EBC2_LLT and PP_LLT, respectively. The average number of supraoptimal days was 9 for EBC1 and EBC2, 11 and 9 days under EBC2_ELT and PP_ELT, and 10 and 11 under EBC2_LLT and PP_LLT, respectively. There were 5 lethal days under EBC1 and EBC2. The average number of lethal days ranged from 6 to 7 for EBC2_ELT and PP_ELT and 20 and 18 for EBC2_LLT and PP_LLT, respectively.

EBC scenarios and PP scenarios in water temperatures for adult fall-run Chinook salmon in the North Delta subregion (Table C.5.4-100) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 48 for EBC1 and EBC2 and between 30 and 45 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal water temperatures were reached on 10 and 9 days under EBC1 and EBC2, and ranged from 10 to 13 days under all other scenarios. A total of 4 days with lethal temperatures occurred under EBC1 and EBC2 during the modeling period, and on average, lethal water temperatures were reached on 4 and 21 days under the EBC2_ELT and EBC2_LLT scenarios, and on 4 to 20 days under PP_ELT and PP_LLT, respectively.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for adult fall-run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-101). Optimal water temperatures occurred on 45 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 37 to 43. Supraoptimal temperatures were reached on average for 10 and 9 days under EBC1 and EBC2, respectively. Under all other scenarios, this number ranged from 11 to 12 days. There were 7 lethal temperature days under the EBC1 and EBC2 scenarios. Under EBC2_ELT and EBC2_LLT, lethal temperatures occurred on 8 and 11 days, respectively. For PP_ELT and PP_LLT scenarios, the number of lethal temperature days was 7 and 12, respectively.

Water temperatures in the South Delta for adult fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-102). There were no days with suboptimal water temperature conditions. Under EBC1 and EBC2, optimal water temperatures occurred on 47 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 43 and 33 days per year, respectively; and on 44 to 33 days under PP_ELT and PP_LLT, respectively. Supraoptimal temperatures occurred on 8 days under EBC1 and EBC2, and on 10 to 11 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Lethal temperature occurred

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on 6 days per year on average under EBC1 and EBC2, 8 to 18 days per year under EBC2_ELT and EBC2-LLT, and on 8 to 17 days per year under PP_ELT and PP_LLT.

In the Suisun Bay subregion, water temperatures for adult fall-run Chinook salmon were similar among scenarios (Table C.5.4-103) after accounting for changing climate. Optimal water temperatures were reached on average on 51 and 50 days under EBC1 and EBC2, and from 36 to 48 days under all other scenarios. There were 8 supraoptimal temperature days recorded under EBC1 and EBC2, 9 and 11 supraoptimal temperature days under EBC2_ELT and EBC2_LLT, respectively, and 8 and 11 days under PP_ELT and PP_LLT. Three lethal temperature days occurred under EBC1 and EBC2. Lethal conditions under EBC2_ELT and PP_ELT occurred for an average of 5 days, and under EBC2_LLT and PP_LLT for an average of 14 days.

In Suisun Marsh, the differences among scenarios of water temperatures for adult fall-run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-104). Optimal temperatures occurred on average on 51 days under EBC1 and EBC2 and ranged from 36 to 48 days for all other scenarios. Supraoptimal water temperature conditions occurred on 5 and 6 days under EBC1 and EBC2, respectively, and on 7 to 10 days under all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Lethal temperatures occurred on 4 days on average for EBC1 and EBC2 and between 6 and 15 days for all other scenarios.

Water temperatures in the West Delta for adult fall-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-105). Under EBC1 and EBC2, optimal water temperatures occurred on 49 days per year on average. Under EBC2_ELT and PP_ELT, optimal temperature conditions occurred on 45, and under EBC2_LLT and PP_LLT, optimal temperatures occurred for an average of 31 days. Supraoptimal temperatures occurred on 8 and 7 days under EBC1 and EBC2, respectively, and on 9 to 13 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Lethal temperature average days were 5 under EBC1 and EBC2, 7 under EBC2_ELT and PP_ELT, and 18 and 17 under EBC2_LLT and PP_LLT, respectively.

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Table C.5.4-98. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		48	48	42	40	43	41
1977	0	0	0	0	0	0		48	48	47	38	48	39
1978	0	0	0	0	0	0		61	61	53	32	54	33
1979	0	0	0	0	0	0		37	37	35	18	34	21
1980	0	0	0	0	0	0		61	61	50	44	56	47
1981	0	0	0	0	0	0		42	42	34	26	35	26
1982	0	0	0	0	0	0		49	49	45	42	46	43
1983	0	0	0	0	0	0		44	44	31	34	32	34
1984	0	0	0	0	0	0		39	38	55	30	57	31
1985	0	0	0	0	0	0		58	58	51	43	53	45
1986	0	0	0	0	0	0		56	54	56	41	55	41
1987	0	0	0	0	0	0		59	59	43	35	43	37
1988	0	0	0	0	0	0		40	40	49	28	49	30
1989	0	0	0	0	0	0		55	55	53	40	55	41
1990	0	0	0	0	0	0		50	49	48	34	49	34
1991	0	0	0	0	0	0		45	45	48	20	49	21
Avg	0	0	0	0	0	0		50	49	46	34	47	35
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	3	3	7	5	7	4		10	10	12	16	11	16
1977	2	2	3	9	4	8		11	11	11	14	9	14
1978	0	0	8	12	7	14		0	0	0	17	0	14
1979	13	13	10	14	11	13		11	11	16	29	16	27
1980	0	0	11	14	5	14		0	0	0	3	0	0
1981	18	19	21	9	22	10		1	0	6	26	4	25
1982	5	4	6	6	4	5		7	8	10	13	11	13
1983	13	13	8	3	6	3		4	4	22	24	23	24
1984	3	7	5	1	3	1		19	16	1	30	1	29
1985	3	3	10	11	8	9		0	0	0	7	0	7
1986	5	7	1	6	3	7		0	0	4	14	3	13
1987	2	2	7	15	8	12		0	0	11	11	10	12
1988	10	10	4	11	5	10		11	11	8	22	7	21
1989	6	6	8	14	6	13		0	0	0	7	0	7
1990	11	12	11	8	9	8		0	0	2	19	3	19
1991	11	11	10	21	9	20		5	5	3	20	3	20
Avg	7	7	8	10	7	9		5	5	7	17	6	16

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Table C.5.4-99. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		50	50	42	39	42	41
1977	0	0	0	0	0	0		48	48	46	36	46	38
1978	0	0	0	0	0	0		52	52	44	33	49	32
1979	0	0	0	0	0	0		40	40	31	24	34	18
1980	0	0	0	0	0	0		54	52	47	33	48	40
1981	0	0	0	0	0	0		40	40	38	25	35	25
1982	0	0	0	0	0	0		46	46	46	36	45	42
1983	0	0	0	0	0	0		38	38	36	33	32	33
1984	0	0	0	0	0	0		37	37	49	24	52	29
1985	0	0	0	0	0	0		56	56	49	38	51	38
1986	0	0	0	0	0	0		53	53	51	40	56	41
1987	0	0	0	0	0	0		57	59	51	24	44	29
1988	0	0	0	0	0	0		44	43	48	27	49	26
1989	0	0	0	0	0	0		58	58	48	35	52	34
1990	0	0	0	0	0	0		40	40	41	29	43	30
1991	0	0	0	0	0	0		45	47	41	21	43	18
Avg	0	0	0	0	0	0		47	47	44	31	45	32
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	1	1	6	6	7	4		10	10	13	16	12	16
1977	5	5	6	11	6	9		8	8	9	14	9	14
1978	9	9	17	9	12	14		0	0	0	19	0	15
1979	10	11	17	3	12	10		11	10	13	34	15	33
1980	7	9	12	13	13	18		0	0	2	15	0	3
1981	19	19	17	9	18	10		2	2	6	27	8	26
1982	10	10	10	8	5	4		5	5	5	17	11	15
1983	16	16	10	3	7	3		7	7	15	25	22	25
1984	14	10	10	7	8	2		10	14	2	30	1	30
1985	3	3	12	13	10	16		2	2	0	10	0	7
1986	6	4	7	5	1	4		2	4	3	16	4	16
1987	3	2	2	21	8	21		1	0	8	16	9	11
1988	8	9	6	12	4	12		9	9	7	22	8	23
1989	3	3	13	12	9	18		0	0	0	14	0	9
1990	21	21	15	12	15	11		0	0	5	20	3	20
1991	9	8	16	12	14	22		7	6	4	28	4	21
Avg	9	9	11	10	9	11		5	5	6	20	7	18

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Table C.5.4-100. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		51	51	40	37	39	40
1977	0	0	0	0	0	0		51	51	46	34	47	35
1978	0	0	0	0	0	0		50	45	42	31	45	32
1979	0	0	0	0	0	0		40	41	31	24	32	23
1980	0	0	0	0	0	0		52	49	46	32	49	33
1981	0	0	0	0	0	0		41	44	42	25	39	26
1982	0	0	0	0	0	0		43	42	48	34	50	32
1983	0	0	0	0	0	0		41	41	40	32	40	30
1984	0	0	0	0	0	0		39	40	46	26	52	27
1985	0	0	0	0	0	0		55	56	48	36	49	37
1986	0	0	0	0	0	0		53	52	46	37	52	40
1987	0	0	0	0	0	0		50	56	50	27	50	27
1988	0	0	0	0	0	0		48	47	45	28	43	25
1989	0	0	0	0	0	0		55	56	48	30	48	32
1990	0	0	0	0	0	0		42	42	40	26	40	27
1991	0	0	0	0	0	0		49	49	43	23	44	23
Avg	0	0	0	0	0	0		48	48	44	30	45	31
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	4	3	9	8	10	5		6	7	12	16	12	16
1977	3	3	8	12	7	12		7	7	7	15	7	14
1978	11	13	15	9	14	11		0	3	4	21	2	18
1979	17	15	24	7	23	6		4	5	6	30	6	32
1980	9	11	12	10	11	13		0	1	3	19	1	15
1981	18	15	12	12	16	10		2	2	7	24	6	25
1982	12	14	13	8	11	11		6	5	0	19	0	18
1983	10	10	18	7	17	8		10	10	3	22	4	23
1984	16	13	11	8	8	8		6	8	4	27	1	26
1985	5	4	12	12	12	12		1	1	1	13	0	12
1986	5	4	13	9	6	7		3	5	2	15	3	14
1987	9	5	6	13	6	14		2	0	5	21	5	20
1988	6	7	11	11	13	11		7	7	5	22	5	25
1989	6	5	13	13	12	12		0	0	0	18	1	17
1990	19	19	15	14	15	13		0	0	6	21	6	21
1991	6	6	14	8	13	8		6	6	4	30	4	30
Avg	10	9	13	10	12	10		4	4	4	21	4	20

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Table C.5.4-101. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		47	46	45	45	46	45
1977	0	0	0	0	0	0		49	49	48	45	47	45
1978	0	0	0	0	0	0		48	49	44	35	44	33
1979	0	0	0	0	0	0		33	32	27	26	27	24
1980	0	0	0	0	0	0		50	51	45	47	45	48
1981	0	0	0	0	0	0		38	38	31	28	33	27
1982	0	0	0	0	0	0		43	43	42	43	42	41
1983	0	0	0	0	0	0		34	34	32	35	31	35
1984	0	0	0	0	0	0		33	33	47	31	50	31
1985	0	0	0	0	0	0		54	54	43	49	44	47
1986	0	0	0	0	0	0		49	49	48	44	49	44
1987	0	0	0	0	0	0		54	55	41	42	42	41
1988	0	0	0	0	0	0		40	42	47	33	47	31
1989	0	0	0	0	0	0		55	55	49	45	49	42
1990	0	0	0	0	0	0		43	44	44	35	43	35
1991	0	0	0	0	0	0		44	46	41	26	44	24
Avg	0	0	0	0	0	0		45	45	42	38	43	37
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	4	5	5	2	8	1		10	10	11	14	7	15
1977	4	5	3	4	3	3		8	7	10	12	11	13
1978	13	12	14	18	17	20		0	0	3	8	0	8
1979	16	17	16	15	18	16		12	12	18	20	16	21
1980	11	10	15	14	15	13		0	0	1	0	1	0
1981	17	17	19	17	17	17		6	6	11	16	11	17
1982	6	6	3	5	3	7		12	12	16	13	16	13
1983	10	11	6	11	6	11		17	16	23	15	24	15
1984	7	7	12	11	9	8		21	21	2	19	2	22
1985	6	6	14	6	15	8		1	1	4	6	2	6
1986	6	7	8	12	8	11		6	5	5	5	4	6
1987	7	6	12	12	11	11		0	0	8	7	8	9
1988	10	8	7	13	7	13		11	11	7	15	7	17
1989	6	6	11	12	12	16		0	0	1	4	0	3
1990	18	17	16	10	17	8		0	0	1	16	1	18
1991	12	10	17	23	14	22		5	5	3	12	3	15
Avg	10	9	11	12	11	12		7	7	8	11	7	12

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Table C.5.4-102. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		48	48	42	38	42	39
1977	0	0	0	0	0	0		48	48	47	39	47	39
1978	0	0	0	0	0	0		59	59	50	32	48	33
1979	0	0	0	0	0	0		32	32	31	13	29	13
1980	0	0	0	0	0	0		61	61	42	44	42	47
1981	0	0	0	0	0	0		38	38	32	23	33	25
1982	0	0	0	0	0	0		47	47	45	40	45	41
1983	0	0	0	0	0	0		36	36	31	34	31	35
1984	0	0	0	0	0	0		35	35	52	29	54	29
1985	0	0	0	0	0	0		57	57	48	41	48	41
1986	0	0	0	0	0	0		54	53	53	40	53	40
1987	0	0	0	0	0	0		59	60	40	35	40	36
1988	0	0	0	0	0	0		40	40	46	25	46	26
1989	0	0	0	0	0	0		54	54	52	38	52	37
1990	0	0	0	0	0	0		45	45	41	33	44	33
1991	0	0	0	0	0	0		41	41	41	18	42	18
Avg	0	0	0	0	0	0		47	47	43	33	44	33
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	3	3	7	7	7	6		10	10	12	16	12	16
1977	2	2	2	8	3	8		11	11	12	14	11	14
1978	2	2	11	12	13	14		0	0	0	17	0	14
1979	15	15	13	16	15	18		14	14	17	32	17	30
1980	0	0	19	16	19	14		0	0	0	1	0	0
1981	20	20	19	9	18	8		3	3	10	29	10	28
1982	5	5	1	7	1	7		9	9	15	14	15	13
1983	14	14	2	3	4	5		11	11	28	24	26	21
1984	5	5	8	2	6	2		21	21	1	30	1	30
1985	4	4	13	13	13	13		0	0	0	7	0	7
1986	5	6	4	8	4	7		2	2	4	13	4	14
1987	2	1	8	15	7	13		0	0	13	11	14	12
1988	9	9	6	13	6	11		12	12	9	23	9	24
1989	7	7	9	14	9	17		0	0	0	9	0	7
1990	16	16	18	8	15	8		0	0	2	20	2	20
1991	14	14	16	22	16	23		6	6	4	21	3	20
Avg	8	8	10	11	10	11		6	6	8	18	8	17

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Table C.5.4-103. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		49	49	42	43	42	43
1977	0	0	0	0	0	0		49	49	48	43	48	42
1978	0	0	0	0	0	0		59	59	53	31	53	32
1979	0	0	0	0	0	0		38	38	39	24	39	23
1980	0	0	0	0	0	0		61	61	52	45	52	44
1981	0	0	0	0	0	0		51	50	43	27	42	26
1982	0	0	0	0	0	0		48	48	45	40	45	40
1983	0	0	0	0	0	0		43	43	31	33	31	34
1984	0	0	0	0	0	0		37	37	54	30	57	30
1985	0	0	0	0	0	0		58	58	51	43	52	43
1986	0	0	0	0	0	0		54	54	54	44	54	44
1987	0	0	0	0	0	0		59	59	49	39	48	39
1988	0	0	0	0	0	0		47	46	46	32	46	32
1989	0	0	0	0	0	0		56	55	54	42	54	42
1990	0	0	0	0	0	0		51	51	50	35	50	35
1991	0	0	0	0	0	0		49	49	51	26	50	26
Avg	0	0	0	0	0	0		51	50	48	36	48	36
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	6	6	7	4	7	4		6	6	12	14	12	14
1977	6	6	6	5	6	6		6	6	7	13	7	13
1978	2	2	8	16	8	15		0	0	0	14	0	14
1979	18	17	10	12	10	13		5	6	12	25	12	25
1980	0	0	9	15	9	16		0	0	0	1	0	1
1981	10	11	16	17	17	17		0	0	2	17	2	18
1982	9	9	6	7	6	7		4	4	10	14	10	14
1983	16	16	11	5	10	4		2	2	19	23	20	23
1984	12	12	7	5	4	6		12	12	0	26	0	25
1985	3	3	10	12	9	12		0	0	0	6	0	6
1986	7	7	4	9	4	10		0	0	3	8	3	7
1987	2	2	5	12	5	12		0	0	7	10	8	10
1988	6	7	10	12	10	11		8	8	5	17	5	18
1989	5	6	7	14	7	14		0	0	0	5	0	5
1990	10	10	11	10	11	9		0	0	0	16	0	17
1991	11	11	10	23	11	20		1	1	0	12	0	15
Avg	8	8	9	11	8	11		3	3	5	14	5	14

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Table C.5.4-104. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤20°C)**					
1976	0	0	0	0	0	0		48	48	42	44	43	45
1977	0	0	0	0	0	0		48	48	47	40	48	40
1978	0	0	0	0	0	0		61	61	57	33	55	33
1979	0	0	0	0	0	0		41	39	36	17	35	20
1980	0	0	0	0	0	0		61	61	53	49	53	49
1981	0	0	0	0	0	0		44	43	38	26	35	26
1982	0	0	0	0	0	0		50	50	45	43	45	43
1983	0	0	0	0	0	0		46	46	31	34	31	34
1984	0	0	0	0	0	0		38	38	58	31	58	31
1985	0	0	0	0	0	0		59	58	55	43	52	46
1986	0	0	0	0	0	0		56	56	56	41	54	42
1987	0	0	0	0	0	0		61	60	42	40	43	39
1988	0	0	0	0	0	0		45	44	49	30	50	30
1989	0	0	0	0	0	0		60	58	58	46	53	44
1990	0	0	0	0	0	0		54	53	51	35	50	35
1991	0	0	0	0	0	0		49	48	52	24	50	24
Avg	0	0	0	0	0	0		51	51	48	36	47	36
	Supraoptimal (>20°C and ≤21°C)							**Lethal (>21°C)**					
1976	3	3	8	2	7	1		10	10	11	15	11	15
1977	3	3	3	8	4	8		10	10	11	13	9	13
1978	0	0	4	18	6	16		0	0	0	10	0	12
1979	10	12	11	18	12	15		10	10	14	26	14	26
1980	0	0	8	12	8	12		0	0	0	0	0	0
1981	17	18	20	11	23	11		0	0	3	24	3	24
1982	4	4	4	4	5	5		7	7	12	14	11	13
1983	15	13	5	3	6	3		0	2	25	24	24	24
1984	4	4	2	1	2	3		19	19	1	29	1	27
1985	2	3	6	11	9	8		0	0	0	7	0	7
1986	5	5	2	10	3	9		0	0	3	10	4	10
1987	0	1	9	12	8	12		0	0	10	9	10	10
1988	8	9	5	12	4	10		8	8	7	19	7	21
1989	1	3	3	10	8	11		0	0	0	5	0	6
1990	7	8	10	10	10	8		0	0	0	16	1	18
1991	8	9	7	22	9	20		4	4	2	15	2	17
Avg	5	6	7	10	8	10		4	4	6	15	6	15

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Table C.5.4-105. Number of Days within Temperature Requirements for Fall-Run Chinook Salmon Adults in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤20°C)					
1976	0	0	0	0	0	0		47	47	41	35	41	36
1977	0	0	0	0	0	0		47	47	46	40	46	40
1978	0	0	0	0	0	0		61	61	54	31	56	31
1979	0	0	0	0	0	0		37	38	29	10	29	11
1980	0	0	0	0	0	0		61	61	44	44	48	45
1981	0	0	0	0	0	0		38	38	34	21	35	21
1982	0	0	0	0	0	0		48	48	44	37	44	35
1983	0	0	0	0	0	0		39	40	31	31	31	31
1984	0	0	0	0	0	0		36	38	52	26	54	27
1985	0	0	0	0	0	0		57	57	51	40	51	40
1986	0	0	0	0	0	0		53	53	54	40	55	40
1987	0	0	0	0	0	0		61	61	41	32	40	34
1988	0	0	0	0	0	0		43	43	44	25	45	25
1989	0	0	0	0	0	0		56	56	56	39	56	40
1990	0	0	0	0	0	0		48	48	43	31	45	31
1991	0	0	0	0	0	0		44	44	49	16	49	16
Avg	0	0	0	0	0	0		49	49	45	31	45	31
	Supraoptimal (>20°C and ≤21°C)							Lethal (>21°C)					
1976	3	3	5	10	6	9		11	11	15	16	14	16
1977	2	2	2	6	2	6		12	12	13	15	13	15
1978	0	0	7	14	5	18		0	0	0	16	0	12
1979	14	13	18	16	17	19		10	10	14	35	15	31
1980	0	0	17	17	13	16		0	0	0	0	0	0
1981	23	23	20	11	22	12		0	0	7	29	4	28
1982	5	5	6	8	4	10		8	8	11	16	13	16
1983	20	19	7	4	1	4		2	2	23	26	29	26
1984	5	4	8	5	7	4		20	19	1	30	0	30
1985	4	4	10	13	10	13		0	0	0	8	0	8
1986	8	8	3	7	2	8		0	0	4	14	4	13
1987	0	0	10	18	11	17		0	0	10	11	10	10
1988	6	6	8	11	7	13		12	12	9	25	9	23
1989	5	5	5	15	5	16		0	0	0	7	0	5
1990	13	13	18	10	16	10		0	0	0	20	0	20
1991	14	14	12	28	12	27		3	3	0	17	0	18
Avg	8	7	10	12	9	13		5	5	7	18	7	17

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.13 Late Fall–Run Chinook Salmon—Juvenile

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile late fall–run Chinook salmon in the Cache Slough subregion (Table C.5.4-106). The average number of optimal days was 28 days under EBC1 and EBC2 and between 32 and 45 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. The average number of supraoptimal days was zero under all scenarios. There were no lethal days under any scenario.

EBC scenarios and PP scenarios in water temperatures for juvenile late fall–run Chinook salmon in the East Delta subregion (Table C.5.4-107) differed little when accounting for climate change. The average number of optimal days was 21 days under EBC1 and EBC2, 25 to 46 days under EBC2_ELT and EBC2_LLT, respectively, and 31 and 47 under PP_ELT, and PP_LLT, respectively. The average number of supraoptimal and lethal days was zero for all model scenarios.

EBC scenarios and PP scenarios in water temperatures for juvenile late fall–run Chinook salmon in the North Delta subregion (Table C.5.4-108) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 12 for EBC1 and EBC2, and between 16 and 36 days for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal or lethal water temperatures were not reached during the modeling period under any scenario.

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for juvenile late fall–run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-109). Optimal water temperatures occurred on 30–31 days under the EBC1 and EBC2 scenarios. Under all other scenarios, the number of days with optimal water temperatures ranged from 34 to 36. Supraoptimal or lethal temperatures were not reached on any days under any scenario.

Water temperatures in the South Delta for smolt spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-110). Suboptimal water temperature conditions occurred on 55 days per year on average under EBC1 and EBC2, and 48–50 days under all other model scenarios. Under EBC1 and EBC2, optimal water temperatures occurred on 35 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 40 and 42 days per year, respectively; and on 40 to 41 days under PP_ELT and PP_LLT, respectively. There were no supraoptimal or lethal temperature days under any scenario.

In the Suisun Bay subregion, water temperatures for juvenile late fall–run Chinook salmon were similar among scenarios (Table C.5.4-111) after accounting for changing climate. Optimal water temperatures were reached on average on 22 days under EBC1 and EBC2 and 25 to 34 days for all other scenarios. There were no supraoptimal or lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for juvenile late fall–run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-112). Optimal temperatures occurred on average on 27 and 28 days under EBC1 and EBC2, respectively. On 33 and 40 days, temperatures reached an optimal level under EBC2_ELT and EBC2_LLT, and on 35 and 40 days under the PP_ELT and PP_LLT scenarios, respectively. Supraoptimal or lethal water temperature conditions did not occur under any scenario.

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Water temperatures in the West Delta for juvenile late fall–run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-113). Under EBC1 and EBC2, optimal water temperatures occurred on 21 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on an average of 26 and 39 days per year, and under PP_ELT and PP_LLT on 30 and 39 days, respectively. There were no supraoptimal or lethal temperature days under any scenario.

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Table C.5.4-106. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	69	68	59	47	59	46		22	23	32	44	32	45
1977	56	55	47	45	47	45		34	35	43	45	43	45
1978	54	54	57	35	59	48		36	36	33	55	31	42
1979	65	65	64	47	64	54		25	25	26	43	26	36
1980	62	62	53	36	61	48		29	29	38	55	30	43
1981	61	58	52	42	54	40		29	32	38	48	36	50
1982	69	70	62	48	70	48		21	20	28	42	20	42
1983	64	64	59	40	64	44		26	26	31	50	26	46
1984	64	65	63	52	65	51		27	26	28	39	26	40
1985	66	64	50	49	47	49		24	26	40	41	43	41
1986	51	50	50	40	64	44		39	40	40	50	26	46
1987	67	66	53	45	52	45		23	24	37	45	38	45
1988	52	49	45	42	44	41		39	42	46	49	47	50
1989	67	67	61	57	60	56		23	23	29	33	30	34
1990	69	69	66	57	64	57		21	21	24	33	26	33
1991	64	64	62	45	66	45		26	26	28	45	24	45
Avg	63	62	56	45	59	48		28	28	34	45	32	43
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-107. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	69	69	59	47	54	42		22	22	32	44	37	49
1977	57	60	49	43	46	44		33	30	41	47	44	46
1978	57	57	60	35	55	33		33	33	30	55	35	57
1979	71	70	67	43	64	42		19	20	23	47	26	48
1980	76	76	77	39	67	38		15	15	14	52	24	53
1981	79	76	62	38	54	40		11	14	28	52	36	50
1982	77	77	76	53	73	50		13	13	14	37	17	40
1983	83	83	68	45	67	43		7	7	22	45	23	47
1984	67	67	78	52	69	49		24	24	13	39	22	42
1985	73	73	64	48	55	48		17	17	26	42	35	42
1986	68	68	69	36	68	35		22	22	21	54	22	55
1987	67	67	62	41	50	42		23	23	28	49	40	48
1988	53	53	49	40	45	41		38	38	42	51	46	50
1989	68	68	64	53	61	54		22	22	26	37	29	36
1990	74	75	72	55	63	56		16	15	18	35	27	34
1991	63	64	64	42	59	42		27	26	26	48	31	48
Avg	69	69	65	44	59	44		21	21	25	46	31	47
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-108. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	73	74	63	58	63	58		18	17	28	33	28	33
1977	86	86	80	49	81	46		4	4	10	41	9	44
1978	72	72	69	49	70	49		18	18	21	41	20	41
1979	82	82	78	57	76	55		8	8	12	33	14	35
1980	81	81	80	55	79	55		10	10	11	36	12	36
1981	86	84	75	56	77	56		4	6	15	34	13	34
1982	85	85	78	60	78	60		5	5	12	30	12	30
1983	85	85	68	51	68	51		5	5	22	39	22	39
1984	71	71	84	52	83	51		20	20	7	39	8	40
1985	80	81	82	60	82	60		10	9	8	30	8	30
1986	73	73	71	48	71	48		17	17	19	42	19	42
1987	75	75	77	55	77	55		15	15	13	35	13	35
1988	66	66	69	43	70	43		25	25	22	48	21	48
1989	75	75	68	61	68	61		15	15	22	29	22	29
1990	76	76	72	65	72	65		14	14	18	25	18	25
1991	82	82	81	51	79	51		8	8	9	39	11	39
Avg	78	78	75	54	75	54		12	12	16	36	16	36
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-109. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	63	63	65	56	64	54		28	28	26	35	27	37
1977	58	58	46	46	46	46		32	32	44	44	44	44
1978	54	54	55	56	54	56		36	36	35	34	36	34
1979	64	64	59	62	59	62		26	26	31	28	31	28
1980	59	58	49	55	50	57		32	33	42	36	41	34
1981	57	55	53	47	53	46		33	35	37	43	37	44
1982	63	63	57	70	55	70		27	27	33	20	35	20
1983	57	56	58	67	58	66		33	34	32	23	32	24
1984	61	61	63	56	61	56		30	30	28	35	30	35
1985	67	66	54	53	54	54		23	24	36	37	36	36
1986	55	55	49	52	47	52		35	35	41	38	43	38
1987	61	61	56	54	53	51		29	29	34	36	37	39
1988	50	51	46	45	44	44		41	40	45	46	47	47
1989	66	65	60	63	60	63		24	25	30	27	30	27
1990	69	69	63	61	62	61		21	21	27	29	28	29
1991	57	57	53	51	52	47		33	33	37	39	38	43
Avg	60	60	55	56	55	55		30	31	35	34	36	35
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-110. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	65	65	55	44	54	43		26	26	36	47	37	48
1977	50	50	46	45	46	46		40	40	44	45	44	44
1978	54	54	48	36	45	39		36	36	42	54	45	51
1979	64	64	60	58	60	60		26	26	30	32	30	30
1980	50	50	45	48	46	53		41	41	46	43	45	38
1981	47	47	46	42	46	42		43	43	44	48	44	48
1982	55	55	50	56	52	65		35	35	40	34	38	25
1983	52	52	57	63	57	63		38	38	33	27	33	27
1984	61	61	51	56	54	56		30	30	40	35	37	35
1985	55	55	47	50	47	50		35	35	43	40	43	40
1986	45	45	40	32	39	36		45	45	50	58	51	54
1987	57	56	44	43	44	41		33	34	46	47	46	49
1988	44	45	45	41	44	41		47	46	46	50	47	50
1989	64	65	58	56	58	57		26	25	32	34	32	33
1990	66	66	62	57	60	58		24	24	28	33	30	32
1991	48	48	46	43	46	42		42	42	44	47	44	48
Avg	55	55	50	48	50	50		35	35	40	42	40	41
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-111. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	68	67	68	62	68	60		23	24	23	29	23	31
1977	69	70	60	62	58	60		21	20	30	28	32	30
1978	59	59	60	54	60	54		31	31	30	36	30	36
1979	65	65	65	61	64	61		25	25	25	29	26	29
1980	73	73	67	53	61	52		18	18	24	38	30	39
1981	72	71	62	53	59	53		18	19	28	37	31	37
1982	74	74	71	52	66	50		16	16	19	38	24	40
1983	78	78	67	53	66	53		12	12	23	37	24	37
1984	67	67	70	57	63	55		24	24	21	34	28	36
1985	72	70	56	64	56	63		18	20	34	26	34	27
1986	62	60	65	47	59	46		28	30	25	43	31	44
1987	69	69	64	62	62	60		21	21	26	28	28	30
1988	58	58	57	52	57	51		33	33	34	39	34	40
1989	68	68	66	65	64	65		22	22	24	25	26	25
1990	74	74	74	73	73	69		16	16	16	17	17	21
1991	72	72	67	61	65	56		18	18	23	29	25	34
Avg	69	68	65	58	63	57		22	22	25	32	28	34
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-112. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	68	68	63	53	63	54		23	23	28	38	28	37
1977	58	55	48	47	47	46		32	35	42	43	43	44
1978	58	57	59	51	56	48		32	33	31	39	34	42
1979	66	65	64	57	64	56		24	25	26	33	26	34
1980	61	61	54	48	51	48		30	30	37	43	40	43
1981	49	49	47	45	47	46		41	41	43	45	43	44
1982	72	72	66	48	61	47		18	18	24	42	29	43
1983	76	75	61	43	60	43		14	15	29	47	30	47
1984	64	64	54	52	52	51		27	27	37	39	39	40
1985	62	60	49	54	48	54		28	30	41	36	42	36
1986	55	55	59	45	59	43		35	35	31	45	31	47
1987	65	64	50	48	46	48		25	26	40	42	44	42
1988	54	53	52	43	45	43		37	38	39	48	46	48
1989	68	67	66	60	61	61		22	23	24	30	29	29
1990	72	71	65	60	64	60		18	19	25	30	26	30
1991	62	62	58	47	58	49		28	28	32	43	32	41
Avg	63	62	57	50	55	50		27	28	33	40	35	40
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-113. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Juvenile Rearing in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<13°C)							Optimal (≥13°C and ≤20°C)					
1976	71	71	63	54	62	53		20	20	28	37	29	38
1977	66	66	52	48	51	47		24	24	38	42	39	43
1978	58	58	65	51	59	51		32	32	25	39	31	39
1979	66	67	65	57	65	57		24	23	25	33	25	33
1980	75	75	64	50	55	49		16	16	27	41	36	42
1981	74	73	64	45	54	45		16	17	26	45	36	45
1982	78	77	76	50	64	49		12	13	14	40	26	41
1983	77	77	65	49	65	48		13	13	25	41	25	42
1984	67	67	73	57	66	56		24	24	18	34	25	35
1985	74	72	57	53	55	53		16	18	33	37	35	37
1986	60	59	62	46	56	45		30	31	28	44	34	45
1987	71	72	58	48	57	47		19	18	32	42	33	43
1988	56	56	54	46	53	45		35	35	37	45	38	46
1989	70	70	68	63	68	63		20	20	22	27	22	27
1990	76	76	75	61	73	61		14	14	15	29	17	29
1991	74	74	71	45	69	45		16	16	19	45	21	45
Avg	70	69	65	51	61	51		21	21	26	39	30	39
	Supraoptimal (>20°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

C.5.4.3.14 Late Fall–Run Chinook Salmon—Smoltification

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt late fall–run Chinook salmon in the Cache Slough subregion (Table C.5.4-114). The average number of optimal days was 62 and 63 under EBC1 and EBC2, respectively and 68 to 79 under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. There were no supraoptimal or lethal temperature days on average under any scenario, although 4 actual days under EBC2_LLT and 5 actual days under PP_LLT had supraoptimal conditions in 1988.

EBC scenarios and PP scenarios in water temperatures for smolt late fall–run Chinook salmon in the East Delta subregion (Table C.5.4-115) differed little when accounting for climate change. The average number of optimal days was 67 under EBC1 and EBC2, 73 to 72 under EBC2_ELT and PP_ELT, respectively, and 84 to 81 under EBC2_LLT and PP_LLT, respectively. No supraoptimal or lethal temperature average days occurred during the modeling period under any scenario, but 2 actual supraoptimal days occurred under PP_LLT in 1988.

EBC scenarios and PP scenarios in water temperatures for smolt late fall–run Chinook salmon in the North Delta subregion (Table C.5.4-116) were similar, considering climate change effects on water temperature. The average number of optimal water temperature days was 50 and 51 for EBC1 and EBC2, respectively, and between 55 and 79 for all other scenarios (EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT). Supraoptimal or lethal water temperatures were not reached during the modeling period except for 1 supraoptimal day under EBC2_LLT and PP_LLT in 1986.

After accounting for climate change, there was little difference between EBC scenarios and PP scenarios in water temperatures for smolt late fall–run Chinook salmon in the San Joaquin portion of the South Delta subregion (Table C.5.4-117). Optimal water temperatures occurred on 68 days on average under the EBC1 and EBC2 scenarios. Under all other scenarios, the average number of days with optimal water temperatures ranged from 73 to 78. Supraoptimal or lethal temperatures were not reached on any days under any scenario.

Water temperatures in the South Delta for smolt spring-run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-118). Suboptimal water temperature conditions occurred on 23 days per year on average under EBC1 and EBC2, and 10 to 17 days under all other model scenarios. Under EBC1 and EBC2, optimal water temperatures occurred on 68 days per year, on average. Under EBC2_ELT and EBC2_LLT, optimal temperature conditions occurred on 73 and 80 days per year, respectively; and on 74 to 80 days under PP_ELT and PP_LLT, respectively. There were no supraoptimal or lethal temperature days under any scenario.

In the Suisun Bay subregion, water temperatures for smolt late fall–run Chinook salmon were similar among scenarios (Table C.5.4-119) after accounting for changing climate. Optimal water temperatures were reached on average on 59 days under EBC1 and EBC2 and 63 to 70 days for all other scenarios. There were no supraoptimal or lethal temperature days under any scenario.

In Suisun Marsh, the differences among scenarios of water temperatures for smolt late fall–run Chinook salmon were minor after climate change was taken into consideration (Table C.5.4-120). Optimal temperatures occurred on average on 58 and 59 days under EBC1 and EBC2, respectively, and on 64 to 73 days under EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT. Supraoptimal or lethal water temperature conditions did not occur under any scenario.

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Water temperatures in the West Delta for smolt late fall–run Chinook salmon were generally similar among the different scenarios (considering climate change) (Table C.5.4-121). Under EBC1 and EBC2, optimal water temperatures occurred on 56 days per year, on average. Under EBC2_ELT, and EBC2_LLT, optimal temperature conditions occurred on 63 and 77 days per year, respectively; and under PP_ELT and PP_LLT on 64 to 76 days, respectively. No supraoptimal or lethal temperature days were recorded under any scenario.

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Table C.5.4-114. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the Cache Slough Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	21	21	18	13	17	14		70	70	73	78	74	77
1977	40	40	39	25	38	30		50	50	51	65	52	60
1978	0	0	0	0	1	0		90	90	90	90	89	90
1979	29	28	22	10	35	20		61	62	68	80	55	70
1980	22	19	12	0	24	4		69	72	79	91	67	87
1981	19	18	15	0	18	0		71	72	75	90	72	90
1982	39	39	22	3	36	16		51	51	68	87	54	74
1983	27	27	22	9	22	10		63	63	68	81	68	80
1984	26	26	44	2	43	5		65	65	47	89	48	86
1985	45	45	6	41	3	41		45	45	84	49	87	49
1986	11	9	26	2	26	2		79	81	64	88	64	88
1987	27	27	25	21	25	20		63	63	65	69	65	70
1988	31	29	22	9	22	9		60	62	69	78	69	77
1989	48	48	41	21	41	18		42	42	49	69	49	72
1990	42	43	24	10	30	14		48	47	66	80	60	76
1991	23	24	16	13	14	12		67	66	74	77	76	78
Avg	28	28	22	11	25	13		62	63	68	79	66	77
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	4	0	5		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-115. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the East Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	19	19	14	4	16	5		72	72	77	87	75	86
1977	39	38	36	10	37	22		51	52	54	80	53	68
1978	2	2	0	0	0	0		88	88	90	90	90	90
1979	24	23	19	5	19	8		66	67	71	85	71	82
1980	18	17	17	5	15	2		73	74	74	86	76	89
1981	18	18	18	0	14	0		72	72	72	90	76	90
1982	38	38	22	8	19	6		52	52	68	82	71	84
1983	22	22	6	3	7	5		68	68	84	87	83	85
1984	32	32	43	5	43	4		59	59	48	86	48	87
1985	44	44	5	20	4	38		46	46	85	70	86	52
1986	2	1	8	0	18	1		88	89	82	90	72	89
1987	25	25	19	10	23	17		65	65	71	80	67	73
1988	12	12	8	4	13	8		79	79	83	87	78	81
1989	38	39	26	11	33	18		52	51	64	79	57	72
1990	27	28	22	4	15	7		63	62	68	86	75	83
1991	14	13	13	9	15	12		76	77	77	81	75	78
Avg	23	23	17	6	18	10		67	67	73	84	72	81
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	2		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-116. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the North Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	40	38	18	8	17	8		51	53	73	83	74	83
1977	44	43	38	14	37	20		46	47	52	76	53	70
1978	35	35	28	3	29	2		55	55	62	87	61	88
1979	45	44	38	16	38	16		45	46	52	74	52	74
1980	36	36	33	8	32	8		55	55	58	83	59	83
1981	23	23	30	6	30	7		67	67	60	84	60	83
1982	44	44	36	17	36	18		46	46	54	73	54	72
1983	39	39	37	10	37	10		51	51	53	80	53	80
1984	44	44	45	8	44	8		47	47	46	83	47	83
1985	48	47	39	26	41	28		42	43	51	64	49	62
1986	29	28	32	2	33	2		61	62	58	87	57	87
1987	44	44	32	13	33	13		46	46	58	77	57	77
1988	35	35	29	6	31	6		56	56	62	85	60	85
1989	46	46	47	14	45	16		44	44	43	76	45	74
1990	48	48	44	13	46	13		42	42	46	77	44	77
1991	38	38	31	9	30	8		52	52	59	81	60	82
Avg	40	40	35	11	35	11		50	51	55	79	55	79
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	1	0	1		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-117. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the San Joaquin River Portion of the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	19	19	20	14	18	12		72	72	71	77	73	79
1977	38	38	36	22	36	24		52	52	54	68	54	66
1978	0	0	0	0	0	0		90	90	90	90	90	90
1979	21	21	15	20	16	18		69	69	75	70	74	72
1980	11	11	8	6	6	7		80	80	83	85	85	84
1981	15	15	11	2	11	0		75	75	79	88	79	90
1982	25	25	14	14	13	12		65	65	76	76	77	78
1983	18	18	11	13	15	14		72	72	79	77	75	76
1984	15	15	35	8	33	7		76	76	56	83	58	84
1985	43	43	7	39	7	40		47	47	83	51	83	50
1986	7	6	15	1	16	1		83	84	75	89	74	89
1987	25	25	22	20	21	18		65	65	68	70	69	72
1988	24	24	17	9	17	8		67	67	74	82	74	83
1989	42	43	34	20	34	21		48	47	56	70	56	69
1990	30	30	17	8	17	8		60	60	73	82	73	82
1991	22	21	15	12	15	13		68	69	75	78	75	77
Avg	22	22	17	13	17	13		68	68	73	77	73	78
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-118. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the South Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	19	19	19	5	18	2		72	72	72	86	73	89
1977	39	39	37	16	37	17		51	51	53	74	53	73
1978	0	0	0	0	0	0		90	90	90	90	90	90
1979	28	26	13	13	13	13		62	64	77	77	77	77
1980	9	9	2	4	5	6		82	82	89	87	86	85
1981	17	17	12	0	10	0		73	73	78	90	80	90
1982	19	20	7	0	5	0		71	70	83	90	85	90
1983	17	17	6	10	7	10		73	73	84	80	83	80
1984	14	15	39	3	34	9		77	76	52	88	57	82
1985	45	45	5	41	5	41		45	45	85	49	85	49
1986	8	8	25	1	24	1		82	82	65	89	66	89
1987	27	27	24	13	21	10		63	63	66	77	69	80
1988	25	25	22	9	22	9		66	66	69	80	69	80
1989	45	46	29	21	29	19		45	44	61	69	61	71
1990	32	32	13	9	13	9		58	58	77	81	77	81
1991	18	18	16	12	15	12		72	72	74	78	75	78
Avg	23	23	17	10	16	10		68	68	73	80	74	80
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	2	0	2		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-119. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the Suisun Bay Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							Optimal (≥10°C and ≤19°C)					
1976	26	24	29	17	28	17		65	67	62	74	63	74
1977	38	38	38	36	38	36		52	52	52	54	52	54
1978	10	10	3	0	1	0		80	80	87	90	89	90
1979	39	39	36	26	37	27		51	51	54	64	53	63
1980	26	26	24	8	24	8		65	65	67	83	67	83
1981	22	22	21	10	20	10		68	68	69	80	70	80
1982	44	44	33	22	34	22		46	46	57	68	56	68
1983	31	31	23	18	23	18		59	59	67	72	67	72
1984	28	27	43	14	43	13		63	64	48	77	48	78
1985	44	44	17	44	16	44		46	46	73	46	74	46
1986	18	18	26	11	26	11		72	72	64	79	64	79
1987	30	30	27	28	27	26		60	60	63	62	63	64
1988	32	33	27	14	28	15		59	58	64	77	63	76
1989	42	45	35	37	35	37		48	45	55	53	55	53
1990	44	44	30	22	28	21		46	46	60	68	62	69
1991	30	29	17	12	18	13		60	61	73	78	72	77
Avg	32	32	27	20	27	20		59	59	63	70	64	70
	Supraoptimal (>19°C and ≤24°C)							Lethal (>24°C)					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-120. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the Suisun Marsh Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	22	22	21	16	20	16		69	69	70	75	71	75
1977	41	40	39	35	38	34		49	50	51	55	52	56
1978	1	1	0	0	0	0		89	89	90	90	90	90
1979	40	40	38	25	37	25		50	50	52	65	53	65
1980	27	27	21	2	18	4		64	64	70	89	73	87
1981	19	19	15	4	16	12		71	71	75	86	74	78
1982	45	45	40	24	38	24		45	45	50	66	52	66
1983	36	35	24	23	23	23		54	55	66	67	67	67
1984	28	28	44	7	44	7		63	63	47	84	47	84
1985	47	46	7	43	6	43		43	44	83	47	84	47
1986	18	17	27	5	27	4		72	73	63	85	63	86
1987	31	31	26	25	25	24		59	59	64	65	65	66
1988	34	33	25	14	25	15		57	58	66	77	66	76
1989	49	48	42	30	41	32		41	42	48	60	49	58
1990	46	46	27	13	21	14		44	44	63	77	69	76
1991	31	27	18	14	16	13		59	63	72	76	74	77
Avg	32	32	26	18	25	18		58	59	64	73	66	72
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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Table C.5.4-121. Number of Days within Temperature Requirements for Late Fall–Run Chinook Salmon Smoltification in the West Delta Subregion, Based on DSM2-QUAL Modeling

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT		EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
	Suboptimal (<10°C)							**Optimal (≥10°C and ≤19°C)**					
1976	24	24	21	14	19	14		67	67	70	77	72	77
1977	43	43	41	24	40	34		47	47	49	66	50	56
1978	9	9	0	0	0	0		81	81	90	90	90	90
1979	40	40	38	16	38	17		50	50	52	74	52	73
1980	28	28	26	3	24	2		63	63	65	88	67	89
1981	23	24	19	0	16	0		67	66	71	90	74	90
1982	45	45	37	15	31	11		45	45	53	75	59	79
1983	31	31	22	10	22	10		59	59	68	80	68	80
1984	33	33	44	3	44	3		58	58	47	88	47	88
1985	47	47	16	42	13	43		43	43	74	48	77	47
1986	17	17	28	5	27	6		73	73	62	85	63	84
1987	32	32	27	25	27	25		58	58	63	65	63	65
1988	39	39	26	10	26	11		52	52	65	81	65	80
1989	50	50	45	25	44	24		40	40	45	65	46	66
1990	53	54	33	9	31	9		37	36	57	81	59	81
1991	34	27	19	15	19	15		56	63	71	75	71	75
Avg	34	34	28	14	26	14		56	56	63	77	64	76
	Supraoptimal (>19°C and ≤24°C)							**Lethal (>24°C)**					
1976	0	0	0	0	0	0		0	0	0	0	0	0
1977	0	0	0	0	0	0		0	0	0	0	0	0
1978	0	0	0	0	0	0		0	0	0	0	0	0
1979	0	0	0	0	0	0		0	0	0	0	0	0
1980	0	0	0	0	0	0		0	0	0	0	0	0
1981	0	0	0	0	0	0		0	0	0	0	0	0
1982	0	0	0	0	0	0		0	0	0	0	0	0
1983	0	0	0	0	0	0		0	0	0	0	0	0
1984	0	0	0	0	0	0		0	0	0	0	0	0
1985	0	0	0	0	0	0		0	0	0	0	0	0
1986	0	0	0	0	0	0		0	0	0	0	0	0
1987	0	0	0	0	0	0		0	0	0	0	0	0
1988	0	0	0	0	0	0		0	0	0	0	0	0
1989	0	0	0	0	0	0		0	0	0	0	0	0
1990	0	0	0	0	0	0		0	0	0	0	0	0
1991	0	0	0	0	0	0		0	0	0	0	0	0
Avg	0	0	0	0	0	0		0	0	0	0	0	0

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C.5.4.3.15 Late Fall–Run Chinook Salmon—Adult

Due to similarities in model results between late fall–run and winter-run Chinook salmon adults, see Section C.5.4.3.6 for late fall–run adult results.

C.5.4.3.16 Delta Smelt

Median Spawning Day (Adult)

For delta smelt, the median spawning day of the year (based on a 15–20°C temperature range for spawning) (Wagner et al. 2011) was essentially the same for EBC1 and EBC2 scenarios (Table C.5.4-122 to Table C.5.4-129), ranging from an average of day 125 (South Delta and San Joaquin) to day 136 (West Delta). Median spawning day shifted earlier in the year between EBC1/EBC2 and PP_ELT by averages ranging from 3 days (North Delta) to 8 days (Suisun Marsh). Between EBC1/EBC2 and PP_LLT, median spawning day shifted earlier in the year by an average of 2 days (San Joaquin) to 19 days (West Delta). Accounting for climate change (i.e., comparing EBC2_ELT with PP_ELT and comparing EBC2_LLT with PP_LLT), there generally was very little change in the median spawning day between existing biological conditions and preliminary proposal scenarios: average changes were always below 2 days (Table C.5.4-122 to Table C.5.4-129).

Table C.5.4-122. Median Spawning Day for Delta Smelt in the Cache Slough Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	125	125	122	119	122	119
1977	139	140	127	118	127	119
1978	128	128	127	119	128	120
1979	125	125	121	122	123	122
1980	132	132	140	118	140	118
1981	126	126	127	111	118	111
1982	143	143	127	123	144	125
1983	125	125	119	107	120	108
1984	122	122	127	114	127	113
1985	134	134	119	108	119	107
1986	118	118	129	106	129	107
1987	133	133	122	121	124	121
1988	119	119	116	111	118	111
1989	132	132	126	117	125	117
1990	126	125	125	119	125	119
1991	150	150	139	115	138	115
Average	130	130	126	116	127	116

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Table C.5.4-123. Median Spawning Day for Delta Smelt in the East Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	125	125	119	119	120	118
1977	128	128	127	111	127	111
1978	129	129	128	116	128	115
1979	138	138	133	122	128	122
1980	131	131	140	115	140	118
1981	132	132	126	114	126	108
1982	141	141	136	123	136	123
1983	142	142	116	107	117	107
1984	127	127	133	112	126	111
1985	135	135	130	106	119	107
1986	126	126	127	106	128	106
1987	131	131	126	118	124	120
1988	122	122	124	111	116	111
1989	138	138	125	124	125	117
1990	129	129	125	123	125	113
1991	135	135	135	114	138	115
Average	132	132	128	115	126	114

Table C.5.4-124. Median Spawning Day for Delta Smelt in the North Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	125	125	119	116	119	116
1977	127	127	128	120	127	120
1978	129	129	127	120	126	113
1979	140	140	132	121	132	121
1980	130	130	136	115	136	115
1981	125	125	124	113	124	113
1982	140	140	135	123	135	122
1983	135	142	119	120	119	120
1984	128	128	133	111	131	111
1985	135	135	140	106	142	114
1986	130	130	127	113	127	113
1987	132	132	127	118	127	118
1988	124	124	125	111	125	111
1989	136	136	125	123	125	123
1990	130	130	125	106	125	106
1991	135	135	135	119	135	119
Average	131	132	129	116	128	116

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Table C.5.4-125. Median Spawning Day for Delta Smelt in the San Joaquin Portion of the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	124	124	124	120	124	120
1977	127	127	126	120	126	119
1978	122	122	127	126	122	122
1979	124	124	119	124	119	124
1980	130	130	117	128	118	128
1981	125	125	118	118	107	112
1982	124	124	118	133	120	143
1983	113	113	115	120	114	122
1984	118	120	124	120	124	120
1985	127	127	118	121	118	121
1986	113	113	113	124	113	124
1987	130	130	123	122	123	122
1988	118	118	118	120	118	115
1989	133	132	125	117	125	117
1990	129	129	125	124	125	124
1991	138	138	119	136	119	136
Average	125	125	121	123	120	123

Table C.5.4-126. Median Spawning Day for Delta Smelt in the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	124	124	123	119	123	119
1977	127	127	121	117	121	117
1978	122	122	123	120	122	121
1979	124	124	119	124	119	124
1980	130	119	118	128	118	128
1981	125	125	107	107	107	100
1982	125	125	125	126	125	127
1983	113	113	116	114	116	118
1984	121	121	127	113	126	116
1985	128	128	115	108	115	109
1986	114	114	114	112	115	119
1987	123	123	116	121	116	121
1988	118	118	115	112	115	111
1989	123	123	125	117	125	117
1990	125	125	125	114	125	122
1991	150	150	119	115	119	115
Average	125	124	119	117	119	118

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Table C.5.4-127. Median Spawning Day for Delta Smelt in the Suisun Bay Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	127	124	123	120	123	120
1977	127	127	127	126	127	125
1978	129	129	128	122	128	122
1979	142	142	132	120	131	120
1980	142	141	139	119	139	119
1981	137	137	128	124	120	118
1982	145	145	144	126	144	126
1983	151	151	121	110	121	111
1984	126	126	127	114	127	114
1985	128	128	128	119	128	119
1986	128	128	129	113	129	113
1987	132	132	126	125	126	123
1988	124	124	123	122	123	122
1989	138	138	131	117	131	117
1990	128	128	125	124	125	124
1991	149	149	138	137	138	137
Average	135	134	129	121	129	121

Table C.5.4-128. Median Spawning Day for Delta Smelt in the Suisun Marsh Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	125	125	124	120	123	120
1977	140	139	127	120	127	119
1978	129	129	129	119	128	119
1979	127	126	121	123	120	123
1980	135	135	133	120	131	120
1981	127	127	108	108	118	112
1982	145	145	145	126	127	126
1983	152	135	121	109	121	109
1984	122	122	127	115	127	112
1985	128	128	116	109	116	108
1986	120	120	130	109	130	108
1987	133	132	116	122	116	122
1988	119	119	117	112	116	112
1989	133	132	126	118	126	117
1990	126	126	125	118	125	124
1991	150	150	139	119	138	119
Average	132	131	125	117	124	117

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Table C.5.4-129. Median Spawning Day for Delta Smelt in the West Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	128	128	124	121	124	120
1977	141	140	130	120	130	120
1978	130	130	129	121	128	121
1979	152	152	130	123	129	124
1980	133	133	141	119	141	119
1981	141	141	126	112	126	109
1982	145	145	144	126	144	126
1983	149	149	118	111	118	111
1984	128	128	128	107	128	106
1985	129	129	128	122	129	122
1986	129	129	129	108	129	108
1987	133	133	126	122	125	122
1988	124	124	124	116	124	114
1989	132	132	124	118	124	118
1990	130	130	128	119	128	119
1991	150	150	139	136	139	119
Average	136	136	129	119	129	117

Number of Stressful Days (Juvenile)

The number of stressful days (daily average temperatures of 20°C–25°C) for juvenile delta smelt in each of the subregions increased into the future under both EBC and PP scenarios but was little changed between preliminary proposal and existing biological conditions scenarios when accounting for climate change, i.e., when comparing EBC2_ELT to PP_ELT and EBC2_LLT to PP_LLT (Table C.5.4-130 to Table C.5.4-137). The average number of stressful days under EBC1 and EBC2 scenarios was very similar and ranged from 72 days in Suisun Marsh to 91 days in the San Joaquin. The average increase in the number of stressful days from the EBC1/EBC2 scenarios to the PP_ELT scenario ranged from 8 (San Joaquin) to 16 (Suisun Marsh). The average increase in the number of stressful days from the EBC1/EBC2 scenarios to the PP_LLT scenario ranged from 12 (San Joaquin) to 38 (Suisun Bay). However, accounting for climate change, there was very little difference in the number of stressful days when comparing EBC2_ELT to PP_ELT and EBC2_LLT to PP_LLT: the average change ranged from an increase of 2 days (PP_LLT compared to the EBC2_LLT in the San Joaquin) to a decrease of 4 days (PP_ELT compared to the EBC2_ELT in Cache Slough).

If, as a result of upstream shifts in X2 under the preliminary proposal, juvenile delta smelt were found mostly in the West Delta subregion rather than the Suisun Bay subregion, there generally would be little difference in the number of stressful days between PP and EBC scenarios (Table C.5.4-138). There was an average of 2 more stressful days per year under PP_ELT (West Delta subregion) compared to EBC2_ELT (Suisun Bay subregion), with a range from 4 fewer stressful days under PP_ELT in 1976 to 15 more stressful days under PP_ELT in 1979. There was no difference in the average number of stressful days per year under PP_LLT (West Delta subregion) compared to EBC2_LLT (Suisun Bay subregion), with a range from 7 fewer stressful days under PP_ELT in 1980 to 14 more stressful days under PP_ELT in 1981 (Table C.5.4-138).

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Table C.5.4-130. Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the Cache Slough Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	64	64	97	109	93	108
1977	83	81	91	105	88	105
1978	57	57	75	112	71	113
1979	86	87	110	134	107	129
1980	42	44	66	79	54	67
1981	103	104	118	132	111	131
1982	59	59	75	92	71	88
1983	80	81	118	122	118	123
1984	97	98	84	124	81	124
1985	73	73	88	102	85	100
1986	73	76	87	106	81	106
1987	60	59	97	120	94	116
1988	93	92	92	110	89	109
1989	76	76	79	104	73	102
1990	73	74	94	114	92	112
1991	62	61	74	111	71	110
Average	74	74	90	111	86	109

Table C.5.4-131. Number of Stressful Days (Daily Average Temperature of 20–25°C) for Delta Smelt in the East Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	82	82	104	117	101	113
1977	88	88	92	111	92	108
1978	72	72	91	114	80	118
1979	94	95	122	136	116	138
1980	68	70	79	100	75	88
1981	109	109	117	130	120	135
1982	73	73	79	103	85	99
1983	103	98	116	130	122	130
1984	106	107	95	129	89	127
1985	80	81	93	107	90	108
1986	76	77	87	109	88	109
1987	69	64	90	138	95	128
1988	96	97	92	110	92	111
1989	73	73	93	111	87	112
1990	89	90	103	118	102	120
1991	77	75	90	119	82	114
Average	85	84	96	118	95	116

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Table C.5.4-132. Number of Stressful Days (Daily Average Temperature of 20–25°C) for Delta Smelt in the North Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	82	82	104	102	105	98
1977	83	83	90	110	90	109
1978	77	82	95	111	92	114
1979	91	90	114	127	113	131
1980	69	71	77	101	72	104
1981	103	100	111	114	116	113
1982	69	71	77	100	74	109
1983	89	89	110	129	111	131
1984	99	97	96	121	93	126
1985	81	80	97	109	97	108
1986	72	74	86	114	82	110
1987	69	61	92	124	93	124
1988	93	94	95	111	97	114
1989	79	78	95	117	93	117
1990	83	83	100	117	99	117
1991	79	79	86	117	87	117
Average	82	82	95	114	95	115

Table C.5.4-133. Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the San Joaquin Portion of the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	79	80	87	97	86	98
1977	84	83	89	96	90	97
1978	91	89	102	102	101	106
1979	106	107	125	114	125	117
1980	81	80	91	69	88	68
1981	109	109	127	120	126	122
1982	94	94	104	81	100	83
1983	115	115	123	111	119	109
1984	115	114	101	118	98	122
1985	89	88	101	94	98	96
1986	89	89	102	98	101	97
1987	78	74	97	105	96	108
1988	94	92	93	106	93	109
1989	79	78	85	95	87	99
1990	83	82	96	112	97	113
1991	68	62	85	102	82	105
Average	91	90	101	101	99	103

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Table C.5.4-134. Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	73	73	96	117	95	115
1977	86	86	90	108	90	107
1978	64	63	86	116	88	112
1979	99	99	118	137	117	133
1980	54	54	86	75	85	68
1981	111	111	124	137	123	133
1982	76	76	88	87	88	86
1983	113	111	122	116	119	112
1984	105	105	89	124	87	124
1985	81	81	93	105	91	103
1986	80	81	92	108	94	107
1987	75	74	100	120	100	118
1988	96	96	95	113	95	109
1989	85	85	88	109	87	108
1990	84	84	101	116	98	115
1991	74	74	87	114	85	113
Average	85	85	97	113	96	110

Table C.5.4-135. Number of Stressful Days (Daily Average Temperature of 20–25°C) for Delta Smelt in the Suisun Bay Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	66	97	103	98	104
1977	86	86	88	104	89	105
1978	57	57	76	120	75	118
1979	85	86	100	135	100	134
1980	40	41	65	81	64	79
1981	86	87	106	122	107	124
1982	58	59	72	84	72	84
1983	90	89	116	122	116	119
1984	104	104	86	126	83	126
1985	76	76	81	107	80	107
1986	77	78	86	105	87	104
1987	55	58	89	117	90	116
1988	88	89	93	116	94	116
1989	67	68	74	103	75	104
1990	71	72	87	115	87	115
1991	57	59	72	111	75	111
Average	73	73	87	111	87	110

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Table C.5.4-136. Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the Suisun Marsh Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	63	63	93	106	94	102
1977	85	85	91	104	89	106
1978	57	59	70	114	72	114
1979	82	84	109	132	108	132
1980	40	41	63	69	61	70
1981	100	103	115	133	115	129
1982	57	57	76	81	78	86
1983	82	82	119	123	118	123
1984	99	100	80	128	82	129
1985	73	73	83	103	86	101
1986	74	74	87	106	89	107
1987	63	64	98	116	97	115
1988	88	88	91	112	91	116
1989	67	72	69	98	74	100
1990	71	72	89	116	91	112
1991	54	55	69	108	73	109
Average	72	73	88	109	89	109

Table C.5.4-137. Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the West Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	65	95	111	93	109
1977	82	83	88	101	88	101
1978	57	56	76	113	74	113
1979	85	84	117	147	115	140
1980	41	41	72	81	66	74
1981	104	104	120	134	118	136
1982	63	63	73	85	73	85
1983	96	95	119	125	119	124
1984	103	100	88	134	86	133
1985	79	79	79	103	79	103
1986	76	76	83	104	81	104
1987	63	63	97	123	97	117
1988	92	92	92	112	91	112
1989	80	80	76	101	75	100
1990	75	77	92	116	90	117
1991	67	67	76	113	75	112
Average	77	77	90	113	89	111

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Table C.5.4-138. Comparison of Number of Stressful Days (Daily Average Temperature of 20°C–25°C) for Delta Smelt in the Suisun Bay and West Delta Subregions during the Early and Late Long-Term Periods

	Early Long-Term				Late Long-Term			
	Suisun Bay EBC2_ELT	West Delta PP_ELT	Difference	% Difference	Suisun Bay EBC2_LLT	West Delta PP_LLT	Difference	% Difference
1976	97	93	-4	-4%	103	109	6	6%
1977	88	88	0	0%	104	101	-3	-3%
1978	76	74	-2	-3%	120	113	-7	-6%
1979	100	115	15	15%	135	140	5	4%
1980	65	66	1	2%	81	74	-7	-9%
1981	106	118	12	11%	122	136	14	11%
1982	72	73	1	1%	84	85	1	1%
1983	116	119	3	3%	122	124	2	2%
1984	86	86	0	0%	126	133	7	6%
1985	81	79	-2	-2%	107	103	-4	-4%
1986	86	81	-5	-6%	105	104	-1	-1%
1987	89	97	8	9%	117	117	0	0%
1988	93	91	-2	-2%	116	112	-4	-3%
1989	74	75	1	1%	103	100	-3	-3%
1990	87	90	3	3%	115	117	2	2%
1991	72	75	3	4%	111	112	1	1%
Average	87	89	2	2%	111	111	0.6	0%

Number of Lethal Days

There were no lethal days (daily average temperatures greater than 25°C) in any of the subregions for the EBC1 and EBC2 scenarios (Table C.5.4-139 to Table C.5.4-144), and there were no lethal days under any scenario in the Suisun Bay and West Delta subregions. The only lethal days in the ELT occurred in 1983 in the South Delta and San Joaquin, wherein the number of lethal days increased from 2 under EBC2_ELT to 6 under PP_ELT. In the LLT, the average number of lethal days was generally similar between PP_LLT and EBC2_LLT and when differences did occur, they generally consisted of decreases under PP_LLT relative to EBC2_LLT.

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Table C.5.4-139. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the Cache Slough Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	3	0	1
1979	0	0	0	0	0	0
1980	0	0	0	1	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	3	0	3
1985	0	0	0	1	0	1
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	7	0	6
1989	0	0	0	0	0	0
1990	0	0	0	2	0	3
1991	0	0	0	0	0	0
Average	0	0	0	1	0	1

Table C.5.4-140. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the East Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	7	0	4
1979	0	0	0	1	0	0
1980	0	0	0	3	0	1
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	4	0	2
1985	0	0	0	3	0	1
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	14	0	9
1989	0	0	0	0	0	0
1990	0	0	0	7	0	3
1991	0	0	0	0	0	0
Average	0	0	0	2	0	1

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Table C.5.4-141. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the North Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	2	6	2	5
1977	0	0	0	2	0	2
1978	0	0	0	11	0	11
1979	0	0	0	5	0	1
1980	0	0	0	7	0	4
1981	0	0	0	5	0	5
1982	0	0	0	2	0	1
1983	0	0	0	1	0	1
1984	0	0	0	8	0	4
1985	0	0	0	5	0	5
1986	0	0	0	0	0	0
1987	0	0	0	2	0	1
1988	0	0	0	14	0	14
1989	0	0	0	5	0	3
1990	0	0	0	12	0	11
1991	0	0	0	3	0	2
Average	0	0	0	6	0	4

Table C.5.4-142. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the San Joaquin Portion of the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	2	0	6	0
1984	0	0	0	0	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Average	0	0	0	0	0	0

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Table C.5.4-143. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the South Delta Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	1	0	1
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	2	0	6	0
1984	0	0	0	7	0	6
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	8	0	6
1989	0	0	0	0	0	0
1990	0	0	0	3	0	2
1991	0	0	0	0	0	0
Average	0	0	0	1	0	1

Table C.5.4-144. Number of Lethal Days (Daily Average Temperature >25°C) for Delta Smelt in the Suisun Marsh Subregion

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	3	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	3	0	1
1989	0	0	0	0	0	0
1990	0	0	0	0	0	2
1991	0	0	0	0	0	0
Average	0	0	0	0	0	0

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C.5.4.3.17 Longfin Smelt—Juvenile

Temperature exceedance data for juvenile longfin smelt were applicable only to the San Joaquin River, the Joaquin River portion of the South Delta subregion, Suisun Bay, Suisun Marsh, and the West Delta.

In the San Joaquin River, exceedance of the 20°C temperature threshold for longfin smelt juveniles (August–May) differed little between EBC and PP scenarios. On average, the number of days exceeding this threshold was 47 and 46 under EBC1 and EBC2, respectively, 52 and 55 under EBC2_ELT and EBC2_LLT, respectively, and 51 and 57 under PP_ELT and PP_LLT, respectively (Table C.5.4-145).

Table C.5.4-145. Number of Days Exceeding 20°C in the San Joaquin River Portion of the South Delta Subregion during the Longfin Smelt Juvenile Period (August–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	38	39	44	49	43	50
1977	43	43	44	47	45	47
1978	47	46	51	57	51	59
1979	63	64	68	66	68	69
1980	41	40	47	43	46	42
1981	52	52	67	62	65	63
1982	52	52	56	49	56	51
1983	61	61	70	57	70	57
1984	66	66	45	68	42	68
1985	38	37	54	43	53	45
1986	43	43	46	48	45	48
1987	33	30	51	60	50	62
1988	50	48	46	59	46	62
1989	36	35	42	48	43	51
1990	44	43	55	61	56	62
1991	39	33	44	66	41	68
Avg	47	46	52	55	51	57

Accounting for climate change, there was little difference between EBC scenarios and PP scenarios in the number of days exceeding 20°C in the San Joaquin River portion of the South Delta subregion during the longfin smelt juvenile period (March–June). The number of days exceeding this threshold was 16 under EBC1 and EBC2, 21 and 18 under EBC2_ELT and EBC2_LLT, respectively, and 21 and 19 days under PP_ELT and PP_LLT, respectively (Table C.5.4-146).

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Table C.5.4-146. Number of Days Exceeding 20°C in the San Joaquin River Portion of the South Delta Subregion during the Longfin Smelt Juvenile Period (March–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	10	10	15	21	15	22
1977	11	11	14	18	14	19
1978	16	15	23	14	23	16
1979	26	26	29	21	29	22
1980	10	10	14	4	12	4
1981	27	27	36	27	37	28
1982	14	14	23	4	19	4
1983	26	26	34	23	33	21
1984	25	24	25	26	25	30
1985	20	20	21	20	19	20
1986	15	15	28	19	28	18
1987	21	20	15	27	15	29
1988	13	13	17	16	17	17
1989	12	12	16	19	17	19
1990	9	9	17	24	17	25
1991	2	2	11	6	11	7
Avg	16	16	21	18	21	19

Comparing the number of days exceeding 20°C in the South Delta subregion during the longfin smelt juvenile period (March–June) suggested little difference between EBC scenarios and PP scenarios. The number of days exceeding 20°C was 15 under EBC1 and EBC2, 20 and 25 under EBC2_ELT and EBC2_LLT, respectively, and 20 and 23 days under PP_ELT and PP_LLT, respectively (Table C.5.4-147).

Table C.5.4-147. Number of Days Exceeding 20°C in the South Delta Subregion during the Longfin Smelt Juvenile Period (March–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	13	13	19	32	19	31
1977	11	11	14	24	14	23
1978	12	12	20	26	20	23
1979	24	24	29	30	26	27
1980	4	4	9	5	8	4
1981	31	31	36	37	36	37
1982	4	4	10	8	10	8
1983	26	24	32	27	33	24
1984	20	20	22	37	22	36
1985	19	19	18	23	16	21
1986	11	11	26	25	28	24
1987	27	27	17	35	17	34
1988	13	13	18	23	18	18
1989	18	18	20	24	20	23
1990	10	10	19	29	19	27
1991	1	1	12	10	12	9
Avg	15	15	20	25	20	23

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The differences between EBC scenarios and PP scenarios in the exceedance of the 20°C threshold for longfin smelt juveniles in Suisun Bay year-round were minor when accounting for climate change. On average, the 20°C threshold was exceeded 73 days under EBC1 and EBC2, 87 and 111 days under EBC2_ELT and EBC2_LLT, respectively, and 87 and 110 days under PP_ELT and PP_LLT, respectively (Table C.5.4-148).

Table C.5.4-148. Number of Days Exceeding 20°C in the Suisun Bay Subregion during the Longfin Smelt Juvenile Period (Year-Round)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	66	97	103	98	104
1977	86	86	88	104	89	105
1978	57	57	76	120	75	118
1979	85	86	100	135	100	134
1980	40	41	65	81	64	79
1981	86	87	106	122	107	124
1982	58	59	72	84	72	84
1983	90	89	116	122	116	119
1984	104	104	86	126	83	126
1985	76	76	81	107	80	107
1986	77	78	86	105	87	104
1987	55	58	89	117	90	116
1988	88	89	93	116	94	116
1989	67	68	74	103	75	104
1990	71	72	87	115	87	115
1991	57	59	72	111	75	111
Avg	73	73	87	111	87	110

For longfin smelt juveniles in the West Delta, there was little difference between EBC and PP scenarios for the number of days when water temperatures exceeded 20°C during August and May. The number of days exceeding 20°C was 40 and 39 under EBC1 and EBC2, respectively. Exceedances were 48 and 64 days under EBC2_ELT and EBC2_LLT, respectively, and 47 and 63 days under PP_ELT and PP_LLT, respectively (Table C.5.4-149).

Table C.5.4-149. Number of Days Exceeding 20°C in the West Delta Subregion during the Longfin Smelt Juvenile Period (August–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	26	26	51	64	50	62
1977	45	45	46	52	46	52
1978	27	26	37	62	35	62
1979	51	50	63	87	63	86
1980	21	21	45	48	40	47
1981	51	51	59	74	57	75
1982	43	43	48	55	48	57
1983	52	51	68	67	69	66
1984	60	57	37	73	35	72
1985	30	30	41	52	41	52

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1986	39	39	45	52	43	52
1987	25	25	51	72	52	70
1988	49	49	48	67	47	67
1989	36	36	35	53	34	52
1990	40	40	54	64	52	65
1991	39	39	39	76	38	76
Avg	40	39	48	64	47	63

C.5.4.3.18 Longfin Smelt—Adult

Water temperature exceedance (>20°C) data for adult longfin smelt were modeled for Cache Slough, the North Delta, the East Delta, the San Joaquin River, South Delta, Suisun Bay, Suisun Marsh, and the West Delta.

There were no days exceeding the 20°C threshold for any scenario during December–April for adult longfin smelt in the North Delta subregion, East Delta subregion, and San Joaquin portion of the South Delta subregion. There was a single exceedance of the threshold in 1987 in the Cache Slough subregion under both the EBC2_LLT and PP_LLT scenarios. There was also a single exceedance of the threshold in 1987 in the South Delta subregion PP_LLT scenario alone.

In the San Joaquin River, December through April temperature thresholds for adult longfin smelt were exceeded on average on 45 and 44 days under the EBC1 and EBC2 scenarios, on 44 and 49 days under EBC2_ELT and EBC2_LLT, and on 48 and 55 days under PP_ELT and PP_LLT scenarios (Table C.5.4-150).

Table C.5.4-150. Number of Days Exceeding 20°C in the San Joaquin River Portion of the South Delta Subregion during the Longfin Smelt Adult Period (August–March)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	38	39	41	45	40	45
1977	43	43	44	47	45	47
1978	44	43	48	57	48	59
1979	59	60	65	66	65	68
1980	41	40	47	43	46	42
1981	51	51	60	62	58	63
1982	49	49	50	49	50	51
1983	58	58	60	57	61	57
1984	59	59	45	61	42	61
1985	38	37	49	43	48	45
1986	43	43	43	48	42	48
1987	27	24	51	50	50	51
1988	50	48	45	59	45	61
1989	36	35	41	47	42	50
1990	44	43	48	57	49	57
1991	39	33	44	66	41	68
Avg	45	44	49	54	48	55

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In Suisun Bay, the number of days when water temperatures exceeded 20°C year-round for adult longfin smelt was 73 for EBC1 and EBC2. Under EBC2_ELT and PP_ELT the number of temperature exceedance days was 87, and under EBC2_LLT and PP_LLT, 111 and 110 days, respectively (Table C.5.4-151).

Table C.5.4-151. Number of Days Exceeding 20°C in the Suisun Bay Subregion during the Longfin Smelt Adult Period (Year-Round)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	66	97	103	98	104
1977	86	86	88	104	89	105
1978	57	57	76	120	75	118
1979	85	86	100	135	100	134
1980	40	41	65	81	64	79
1981	86	87	106	122	107	124
1982	58	59	72	84	72	84
1983	90	89	116	122	116	119
1984	104	104	86	126	83	126
1985	76	76	81	107	80	107
1986	77	78	86	105	87	104
1987	55	58	89	117	90	116
1988	88	89	93	116	94	116
1989	67	68	74	103	75	104
1990	71	72	87	115	87	115
1991	57	59	72	111	75	111
Avg	73	73	87	111	87	110

Year-round temperature in Suisun Marsh exceeded the threshold on 72 and 73 days under EBC1 and EBC2, respectively, on 88 and 110 days under EBC2_ELT and EBC_LLT, respectively, and on 89 and 110 days under PP_ELT and PP_LLT (Table C.5.4-152).

Table C.5.4-152. Number of Days Exceeding 20°C in the Suisun Marsh Subregion during the Longfin Smelt Adult Period (Year-Round)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	63	63	93	106	94	102
1977	85	85	91	104	89	106
1978	57	59	70	114	72	114
1979	82	84	109	132	108	132
1980	40	41	63	69	61	70
1981	100	103	115	133	115	129
1982	57	57	76	81	78	86
1983	82	82	119	123	118	123
1984	99	100	80	131	82	129
1985	73	73	83	103	86	101
1986	74	74	87	106	89	107
1987	63	64	98	116	97	115

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1988	88	88	91	115	91	117
1989	67	72	69	98	74	100
1990	71	72	89	116	91	114
1991	54	55	69	108	73	109
Avg	72	73	88	110	89	110

In the West Delta, August–March water temperatures were generally similar among EBC and PP scenarios. Under EBC1 and EBC2, the number of exceedance days was 39 and 38 days respectively. Under EBC2_ELT and EBC2_LLT, the number was 46 and 61 days, respectively. For the PP scenarios, the number of days with water temperatures above 20°C was 45 for PP_ELT and 111 for PP_LLT (Table C.5.4-153).

Table C.5.4-153. Number of Days Exceeding 20°C in the West Delta Subregion during the Longfin Smelt Adult Period (August–March)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	26	26	51	57	50	56
1977	45	45	46	52	46	52
1978	27	26	36	61	34	61
1979	51	50	63	82	63	81
1980	21	21	45	48	40	47
1981	51	51	57	71	55	71
1982	43	43	48	55	48	57
1983	52	51	61	61	61	61
1984	55	52	37	66	35	65
1985	30	30	41	52	41	52
1986	39	39	34	52	31	52
1987	17	17	51	60	52	58
1988	49	49	48	67	47	67
1989	36	36	35	53	34	52
1990	40	40	49	61	47	61
1991	39	39	39	76	38	76
Avg	39	38	46	61	45	61

C.5.4.3.19 White Sturgeon—Juvenile

Water temperatures during June through October in the Cache Slough area exceeded the 20°C threshold for juvenile white sturgeon on 72 and 73 days, respectively under EBC1 and EBC2. Differences between EBC and PP scenarios were also minor: 87 versus 83 days under EBC2_ELT and PP_ELT, and 107 and 105 days under EBC2_LLT and PP_LLT (Table C.5.4-154).

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Table C.5.4-154. Number of Days Exceeding 20°C in the Cache Slough Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	64	64	92	100	88	97
1977	83	81	91	105	88	105
1978	56	56	73	113	69	111
1979	84	85	108	125	105	119
1980	42	44	66	80	54	67
1981	99	100	113	124	105	123
1982	58	58	73	89	68	85
1983	80	81	109	117	106	116
1984	91	92	84	116	81	115
1985	73	73	85	103	82	101
1986	73	76	75	104	70	104
1987	51	50	97	106	94	102
1988	93	92	92	111	89	109
1989	74	74	75	101	68	99
1990	73	74	85	109	84	109
1991	62	61	74	111	71	110
Avg	72	73	87	107	83	105

In the east Delta, exceedance frequency for water temperatures above 20°C during June through October was 83 days for EBC1 and EBC2. On 93 and 114 days, water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT, respectively, and on 91 and 112 days under PP_ELT and PP_LLT (Table C.5.4-155).

Table C.5.4-155. Number of Days Exceeding 20°C in the East Delta Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	81	81	98	103	96	101
1977	88	88	92	111	92	108
1978	70	70	88	118	78	118
1979	92	93	116	126	112	128
1980	68	70	79	103	75	89
1981	105	105	111	123	115	128
1982	71	71	77	99	81	95
1983	100	95	106	119	111	119
1984	99	100	95	124	89	120
1985	80	81	89	110	87	109
1986	76	77	84	106	79	105
1987	61	56	90	125	95	115
1988	96	97	92	117	92	114
1989	73	73	89	107	82	109
1990	89	90	95	118	94	116
1991	77	75	89	116	82	114
Avg	83	83	93	114	91	112

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For the North Delta, the frequency at which water temperatures exceeded 20°C during June through October was 80 days for EBC1 and EBC2. On 91 and 115 days, water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT. Under the PP scenarios, these numbers remained unchanged (Table C.5.4-156).

Table C.5.4-156. Number of Days Exceeding 20°C in the North Delta Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	80	80	103	105	104	100
1977	83	83	90	112	90	111
1978	74	79	90	115	87	119
1979	90	89	106	125	105	125
1980	68	71	76	105	71	105
1981	102	99	103	117	107	116
1982	66	68	73	100	71	107
1983	85	85	101	119	102	121
1984	92	90	95	122	92	122
1985	81	80	90	113	89	111
1986	70	72	84	110	80	105
1987	67	59	90	123	91	122
1988	92	93	90	117	92	120
1989	76	75	91	114	90	112
1990	83	83	95	123	94	122
1991	78	78	85	116	86	115
Avg	80	80	91	115	91	115

Water temperatures during June through October in the San Joaquin area exceeded the 20° threshold for juvenile white sturgeon on 89 and 88 days, respectively under EBC1 and EBC2. Differences between EBC and PP scenarios were also minor: 98 versus 97 days under EBC2_ELT and PP_ELT, and 100 and 101 days under EBC2_LLT and PP_LLT (Table C.5.4-157).

Table C.5.4-157. Number of Days Exceeding 20°C in the San Joaquin River Portion of the South Delta Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	79	80	84	93	83	93
1977	84	83	89	96	90	97
1978	88	86	99	102	98	106
1979	102	103	122	114	122	116
1980	81	80	91	69	88	68
1981	108	108	120	120	119	122
1982	91	91	98	81	94	83
1983	112	112	115	111	116	109
1984	108	107	101	111	98	115
1985	89	88	96	94	93	96
1986	89	89	99	98	98	97

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1987	72	68	97	95	96	97
1988	94	92	92	106	92	108
1989	79	78	84	94	86	98
1990	83	82	89	108	90	108
1991	68	62	85	102	82	105
Avg	89	88	98	100	97	101

June through October water temperature in the South Delta exceeded the 20°C threshold for juvenile white sturgeon on 83 days under EBC1 and EBC2, on 94 and 109 days under EBC2_ELT and EBC_LLT, respectively, and on 93 and 107 days under PP_ELT and PP_LLT (Table C.5.4-158).

Table C.5.4-158. Number of Days Exceeding 20°C in the South Delta Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	72	72	91	104	90	103
1977	86	86	90	108	90	107
1978	62	61	83	115	85	111
1979	94	94	114	130	115	127
1980	54	54	86	75	85	68
1981	107	107	118	130	117	126
1982	73	73	82	87	81	86
1983	110	110	113	116	113	112
1984	99	99	88	121	86	120
1985	81	81	90	105	88	103
1986	80	81	85	106	84	105
1987	66	65	100	106	100	103
1988	96	96	95	115	95	113
1989	84	84	84	106	83	105
1990	84	84	92	112	89	111
1991	74	74	86	114	84	113
Avg	83	83	94	109	93	107

Water temperatures during June through October in Suisun Bay area exceeded the 20° threshold for juvenile white sturgeon on 72 and 73 days, respectively under EBC1 and EBC2. There were no differences in the frequency of exceedance days between EBC and PP scenarios: 85 days under EBC2_ELT and PP_ELT, and 107 days under EBC2_LLT and PP_LLT (Table C.5.4-159).

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Table C.5.4-159. Number of Days Exceeding 20°C in the Suisun Bay Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	66	96	99	96	100
1977	86	86	88	104	89	105
1978	56	56	74	117	73	115
1979	85	86	100	127	100	125
1980	40	41	65	81	64	79
1981	86	87	104	120	105	122
1982	58	59	72	83	72	83
1983	90	89	108	119	108	118
1984	98	98	86	118	83	118
1985	76	76	81	106	80	106
1986	77	78	77	102	79	102
1987	51	54	89	107	90	106
1988	88	89	93	110	94	110
1989	67	68	73	103	73	103
1990	71	72	83	109	83	109
1991	57	59	72	107	75	107
Avg	72	73	85	107	85	107

For the Suisun Marsh, the frequency at which water temperatures exceeded 20°C during June through October was 71 and 72 days for EBC1 and EBC2, respectively. Water temperatures exceeded this threshold on 84 and 105 days under EBC2_ELT and EBC2_LLT, and on 85 and 104 days under PP_ELT and PP_LLT scenarios, respectively (Table C.5.4-160).

Table C.5.4-160. Number of Days Exceeding 20°C in the Suisun Marsh Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	63	63	89	95	89	93
1977	85	85	91	104	89	106
1978	56	58	68	112	70	112
1979	81	82	108	125	107	121
1980	40	41	63	69	61	70
1981	97	99	110	124	109	122
1982	57	57	74	79	76	80
1983	82	82	108	117	107	117
1984	93	94	80	119	81	118
1985	73	73	80	103	83	101
1986	74	74	74	104	77	104
1987	54	55	98	102	97	102
1988	88	88	91	109	91	110
1989	67	70	65	95	70	97
1990	71	72	82	110	83	108
1991	54	55	69	108	72	109
Avg	71	72	84	105	85	104

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Lastly, water temperatures in the West Delta reached levels above the exceedance threshold of 20°C on 76 days under EBC1 and EBC2. On average, 89 and 110 days of exceedance occurred under the EBC2_ET and EBC2_LLT scenarios. Water temperatures exceeded the threshold on 87 and 109 days under PP_ELT and PPL_LLT (Table C.5.4-161).

Table C.5.4-161. Number of Days Exceeding 20°C in the West Delta Subregion during the White Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	65	65	95	104	93	103
1977	82	83	88	101	88	101
1978	57	56	75	112	73	112
1979	85	84	117	142	115	135
1980	41	41	72	81	66	74
1981	104	104	118	131	116	132
1982	63	63	73	85	73	85
1983	96	95	112	119	111	119
1984	98	95	88	127	86	126
1985	79	79	79	103	79	103
1986	76	76	72	104	69	104
1987	55	55	97	111	97	105
1988	92	92	92	112	91	112
1989	80	80	76	101	75	100
1990	75	77	87	113	85	113
1991	67	67	76	113	75	112
Avg	76	76	89	110	87	109

C.5.4.3.20 White Sturgeon—Adult

In Cache slough, the number of days when water temperatures exceeded 20°C for adult white sturgeon was small: 2 days under EBC1 and EBC2, 3 and 5 days under EBC2_ELT and EBC_LLT, and 4 and 5 days under PP_ELT and PP_LLT (Table C.5.4-162).

Table C.5.4-162. Number of Days Exceeding 20°C in the Cache Slough Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	5	9	5	11
1977	0	0	0	0	0	0
1978	1	1	2	2	2	3
1979	2	2	2	9	2	10
1980	0	0	0	0	0	0
1981	4	4	5	8	6	8
1982	1	1	2	3	3	3
1983	0	0	9	5	12	7
1984	6	6	0	11	0	12
1985	0	0	3	0	3	0

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1986	0	0	12	2	11	2
1987	9	9	0	14	0	14
1988	0	0	0	6	0	6
1989	2	2	4	3	5	3
1990	0	0	9	7	8	6
1991	0	0	0	0	0	0
Avg	2	2	3	5	4	5

The number of days when water temperatures exceeded 20°C for adult white sturgeon from January through May in the North Delta was similar under EBC and PP scenarios. Temperature thresholds were exceeded on 2 days under EBC1 and EBC2 and on 4 and 5 days under EBC2_ELT and EBC_LLT. These numbers remained unchanged under the PP_ELT and PP_LLT scenarios (Table C.5.4-163).

Table C.5.4-163. Number of Days Exceeding 20°C in the East Delta Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	1	1	6	14	5	12
1977	0	0	0	0	0	0
1978	2	2	3	3	2	4
1979	2	2	6	11	4	10
1980	0	0	0	0	0	0
1981	4	4	6	7	5	7
1982	2	2	2	4	4	4
1983	3	3	10	11	11	11
1984	7	7	0	9	0	9
1985	0	0	4	0	3	0
1986	0	0	3	3	9	4
1987	8	8	0	13	0	13
1988	0	0	0	7	0	6
1989	0	0	4	4	5	3
1990	0	0	8	7	8	7
1991	0	0	1	3	0	0
Avg	2	2	3	6	4	6

Comparing the number of days exceeding 20°C in the North Delta subregion during January through May suggested little difference between EBC scenarios and PP scenarios. The number of days exceeding 20°C was 2 under EBC1 and EBC2, 4 and 5 under EBC2_ELT and EBC2_LLT, respectively, and 4 and 5 days under PP_ELT and PP_LLT, respectively (Table C.5.4-164).

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Table C.5.4-164. Number of Days Exceeding 20°C in the North Delta Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	2	2	3	3	3	3
1977	0	0	0	0	0	0
1978	3	3	5	7	5	6
1979	1	1	8	7	8	7
1980	1	0	1	3	1	3
1981	1	1	8	2	9	2
1982	3	3	4	2	3	3
1983	4	4	9	11	9	11
1984	7	7	1	7	1	8
1985	0	0	7	1	8	2
1986	2	2	2	4	2	5
1987	2	2	2	3	2	3
1988	1	1	5	8	5	8
1989	3	3	4	8	3	8
1990	0	0	5	6	5	6
1991	1	1	1	4	1	4
Avg	2	2	4	5	4	5

In the San Joaquin River, the number of days when water temperatures exceeded 20°C for adult white sturgeon was small: 2 days under EBC1 and EBC2, 3 and 2 days under EBC2_ELT and EBC_LLT, and 3 and 2 days under PP_ELT and PP_LLT (Table C.5.4-165).

Table C.5.4-165. Number of Days Exceeding 20°C in the San Joaquin River Portion of the South Delta Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	3	4	3	5
1977	0	0	0	0	0	0
1978	3	3	3	0	3	0
1979	4	4	3	0	3	1
1980	0	0	0	0	0	0
1981	1	1	7	0	7	0
1982	3	3	6	0	6	0
1983	3	3	10	0	9	0
1984	7	7	0	7	0	7
1985	0	0	5	0	5	0
1986	0	0	3	0	3	0
1987	6	6	0	10	0	11
1988	0	0	1	0	1	1
1989	0	0	1	1	1	1
1990	0	0	7	4	7	5
1991	0	0	0	0	0	0
Avg	2	2	3	2	3	2

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For the South Delta, the frequency at which water temperatures exceeded 20°C during January through May was 2 days for EBC1 and EBC2. Water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT on 4 days, and under PP_ELT and PP_LLT scenarios on 5 days (Table C.5.4-166).

Table C.5.4-166. Number of Days Exceeding 20°C in the South Delta Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	1	1	5	13	5	12
1977	0	0	0	0	0	0
1978	2	2	3	2	3	2
1979	5	5	4	7	2	6
1980	0	0	0	0	0	0
1981	4	4	6	7	6	7
1982	3	3	6	0	7	0
1983	3	1	11	0	12	0
1984	6	6	1	10	1	10
1985	0	0	3	0	3	0
1986	0	0	7	2	10	2
1987	9	9	0	14	0	15
1988	0	0	0	6	0	2
1989	1	1	4	3	4	3
1990	0	0	9	7	9	6
1991	0	0	1	0	1	0
Avg	2	2	4	4	4	4

For Suisun Bay, the frequency at which water temperatures exceeded 20°C during January through May was 1 day for EBC1 and EBC2. Water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT on 2 and 4 days, respectively. The number of exceedance days was identical for PP_ELT and PP_LLT scenarios (Table C.5.4-167).

Table C.5.4-167. Number of Days Exceeding 20°C in the Suisun Bay Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	1	4	2	4
1977	0	0	0	0	0	0
1978	1	1	2	3	2	3
1979	0	0	0	8	0	9
1980	0	0	0	0	0	0
1981	0	0	2	2	2	2
1982	0	0	0	1	0	1
1983	0	0	8	3	8	1
1984	6	6	0	8	0	8
1985	0	0	0	1	0	1
1986	0	0	9	3	8	2

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1987	4	4	0	10	0	10
1988	0	0	0	6	0	6
1989	0	0	1	0	2	1
1990	0	0	4	6	4	6
1991	0	0	0	4	0	4
Avg	1	1	2	4	2	4

In Suisun Marsh, water temperatures rarely reached levels above 20°C during January to May. The numbers were 1 and 2 days for EBC1 and EBC2, respectively, 3 and 5 days under EBC2_ELT and EBC2_LLT, respectively, and 4 and 5 days under PP_ELT and PP_LLT scenarios, respectively (Table C.5.4-168).

Table C.5.4-168. Number of Days Exceeding 20°C in the Suisun Marsh Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	4	11	5	9
1977	0	0	0	0	0	0
1978	1	1	2	2	2	2
1979	1	2	1	7	1	11
1980	0	0	0	0	0	0
1981	3	4	5	9	6	7
1982	0	0	2	2	2	6
1983	0	0	11	6	11	6
1984	6	6	0	12	1	11
1985	0	0	3	0	3	0
1986	0	0	13	2	12	3
1987	9	9	0	14	0	13
1988	0	0	0	6	0	7
1989	0	2	4	3	4	3
1990	0	0	7	6	8	6
1991	0	0	0	0	1	0
Avg	1	2	3	5	4	5

The number of days when water temperatures exceeded 20°C for adult white sturgeon from January through May in the North Delta was similar under EBC and PP scenarios. Temperature thresholds were exceeded on 1 day under EBC1 and EBC2 and on 2 and 3 days under EBC2_ELT and EBC_LLT, respectively. These numbers remained unchanged under the PP_ELT and PP_LLT scenarios (Table C.5.4-169).

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Table C.5.4-169. Number of Days Exceeding 20°C in the West Delta Subregion during the White Sturgeon Adult Period (January–May)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	7	0	6
1977	0	0	0	0	0	0
1978	0	0	1	1	1	1
1979	0	0	0	5	0	5
1980	0	0	0	0	0	0
1981	0	0	2	3	2	4
1982	0	0	0	0	0	0
1983	0	0	7	6	8	5
1984	5	5	0	7	0	7
1985	0	0	0	0	0	0
1986	0	0	11	0	12	0
1987	8	8	0	12	0	12
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	5	3	5	4
1991	0	0	0	0	0	0
Avg	1	1	2	3	2	3

Exceedances in January–May of the >25°C threshold were not examined for adult white sturgeon under any of the modeled scenarios or in any subregion.

C.5.4.3.21 Green Sturgeon—Juvenile

The critical temperature threshold for juvenile green sturgeon is 18.9°C. This threshold was exceeded on 103 and 104 days under EBC1 and EBC2, respectively, from June through October. Under EBC2_ELT and EBC2_LLT, the number of exceedance days was 113 and 127, respectively. The PP scenarios showed slightly lower exceedance frequencies: 110 and 126 days for PP_ELT and PP_LLT (Table C.5.4-170).

Table C.5.4-170. Number of Days Exceeding 18.9°C in the Cache Slough Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	106	107	111	120	108	119
1977	91	91	107	131	106	131
1978	92	93	113	129	107	129
1979	121	121	138	144	134	143
1980	96	93	104	114	99	111
1981	124	125	129	134	127	133
1982	96	96	94	109	91	107
1983	114	114	121	122	118	122
1984	113	113	108	135	103	135
1985	92	91	101	122	101	119

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1986	95	95	113	117	111	115
1987	99	99	116	131	113	129
1988	111	111	115	126	112	124
1989	99	99	108	139	103	136
1990	100	100	109	123	108	126
1991	106	106	124	131	119	129
Avg	103	103	113	127	110	126

In the East Delta, water temperatures rarely reached levels above 18.9°C during June to May. The exceedance frequencies were 109 days for EBC1 and EBC2, 117 and 130 days under EBC2_ELT and EBC2_LLT, respectively, and 127 and 129 days under PP_ELT and PP_LLT scenarios, respectively (Table C.5.4-171).

Table C.5.4-171. Number of Days Exceeding 18.9°C in the East Delta Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	106	104	117	124	116	120
1977	94	93	110	135	112	133
1978	108	109	115	133	116	129
1979	125	123	133	140	137	144
1980	104	104	107	122	108	120
1981	122	122	127	132	131	133
1982	100	101	109	124	100	117
1983	115	115	119	128	122	122
1984	114	116	115	133	111	136
1985	105	105	115	128	108	128
1986	98	100	119	124	123	119
1987	116	115	124	133	120	131
1988	111	111	118	128	118	129
1989	105	104	112	136	113	139
1990	108	109	116	130	115	128
1991	115	116	122	133	121	132
Avg	109	109	117	130	117	129

The number of days when water temperatures exceeded 18.9°C for juvenile green sturgeon from January through May in the North Delta was similar under EBC and PP scenarios. Temperature thresholds were exceeded on 108 days under EBC1 and EBC2, and on 116 and 129 days under EBC2_ELT and EBC2_LLT, respectively. These numbers remained virtually unchanged under the PP_ELT and PP_LLT scenarios: 116 and 130 days (Table C.5.4-172).

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Table C.5.4-172. Number of Days Exceeding 18.9°C in the North Delta Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	99	99	117	122	117	123
1977	96	96	113	134	115	136
1978	109	107	115	133	116	132
1979	125	125	128	136	128	136
1980	103	106	104	119	103	122
1981	118	119	122	130	123	130
1982	98	97	109	121	108	125
1983	110	109	119	126	119	127
1984	111	110	116	128	111	127
1985	104	104	117	127	118	128
1986	97	97	114	123	113	126
1987	111	112	119	133	119	133
1988	113	113	119	127	119	127
1989	106	107	114	132	111	132
1990	104	103	113	132	113	135
1991	119	117	122	133	121	134
Avg	108	108	116	129	116	130

For the San Joaquin River, the frequency at which water temperatures exceeded 18.9°C during June to October was 111 and 110 days for EBC1 and EBC2, respectively. Water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT on 120 and 125 days. The number of exceedance days was similar for PP_ELT and PP_LLT scenarios: 119 and 126 days, respectively (Table C.5.4-173).

Table C.5.4-173. Number of Days Exceeding 18.9°C in the San Joaquin River Portion of the South Delta Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	109	109	112	119	113	120
1977	91	91	109	130	109	135
1978	119	119	124	125	121	127
1979	127	127	135	142	136	143
1980	111	111	113	116	112	116
1981	124	124	131	133	131	133
1982	108	107	123	109	121	109
1983	118	118	128	121	128	120
1984	118	117	123	132	122	133
1985	104	104	111	122	107	125
1986	102	102	126	114	125	115
1987	116	115	121	130	120	125
1988	113	112	121	124	119	125
1989	105	103	113	135	108	136
1990	100	99	110	120	110	121
1991	107	106	122	126	121	129
Avg	111	110	120	125	119	126

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For the South Delta, the frequency at which water temperatures exceeded 18.9°C during June through October was 108 days for EBC1 and EBC2. Water temperatures exceeded this threshold under EBC2_ELT and EBC2_LLT on 108 and 128 days, respectively, and on 118 and 127 days under PP_ELT and PP_LLT scenarios, respectively (Table C.5.4-174).

Table C.5.4-174. Number of Days Exceeding 18.9°C in the South Delta Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	110	110	118	121	117	121
1977	94	94	113	138	112	131
1978	99	97	114	129	113	128
1979	125	125	140	145	139	145
1980	104	103	107	120	105	118
1981	125	125	133	134	133	133
1982	104	104	105	108	104	107
1983	117	117	121	120	122	120
1984	120	118	116	136	115	135
1985	92	92	108	126	106	125
1986	100	100	125	117	124	117
1987	104	103	118	128	118	128
1988	116	116	121	129	121	126
1989	104	104	113	143	112	140
1990	104	104	110	124	110	123
1991	109	109	133	133	133	132
Avg	108	108	118	128	118	127

Water temperatures during June through October in Suisun Bay area exceeded the 19.8° threshold for juvenile green sturgeon on 107 days under EBC1 and EBC2. There were no differences in the frequency of exceedance days between EBC and PP scenarios: 116 days under EBC2_ELT and PP_ELT, and 127 days under EBC2_LLT and PP_LLT (Table C.5.4-175).

Table C.5.4-175. Number of Days Exceeding 18.9°C in the Suisun Bay Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	108	111	114	124	114	124
1977	97	96	109	138	110	138
1978	105	103	119	128	119	128
1979	126	126	134	141	134	141
1980	99	98	108	118	108	117
1981	123	123	130	133	130	133
1982	98	99	100	111	100	110
1983	116	115	122	122	122	122
1984	118	118	115	132	115	131
1985	98	98	108	125	107	124
1986	98	98	119	116	119	117

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1987	107	107	122	130	121	132
1988	114	113	115	130	116	130
1989	101	101	108	132	108	132
1990	103	105	111	125	111	124
1991	108	108	118	134	118	133
Avg	107	107	116	127	116	127

Water temperatures during June through October in Suisun Marsh exceeded the water temperature threshold for juvenile green sturgeon on 103 days under EBC1 and EBC2. The frequency of exceedance days did not differ greatly between EBC and PP scenarios. Under EBC2_ELT and PP_ELT, water temperatures exceeded the threshold on 113 and 112 days, and under EBC2_LLT and PP_LLT on 126 days (Table C.5.4-176).

Table C.5.4-176. Number of Days Exceeding 18.9°C in the Suisun Marsh Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	108	108	115	120	108	120
1977	91	91	110	131	109	132
1978	93	92	110	126	109	129
1979	123	123	138	145	136	144
1980	89	88	99	114	103	113
1981	124	124	129	134	129	133
1982	96	97	92	108	93	107
1983	108	109	121	122	121	122
1984	116	116	105	136	106	135
1985	90	90	102	122	101	120
1986	96	96	113	116	117	114
1987	96	97	115	126	116	128
1988	112	109	113	128	113	128
1989	102	101	106	137	108	134
1990	99	100	108	121	108	122
1991	104	105	124	132	121	128
Avg	103	103	113	126	112	126

In the West Delta, water temperatures reached levels above 18.9°C during June to May on 106 days for EBC1 and EBC2, respectively, 117 days under EBC2_ELT and EBC2_LLT, and 130 and 127 days under PP_ELT and PP_LLT scenarios, respectively (Table C.5.4-177).

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Table C.5.4-177. Number of Days Exceeding 18.9°C in the West Delta Subregion during the Green Sturgeon Juvenile Period (June–October)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	109	109	115	124	117	122
1977	92	92	112	143	112	143
1978	94	98	118	126	117	127
1979	130	131	141	147	141	145
1980	91	95	102	120	100	119
1981	127	127	135	137	135	136
1982	99	99	101	110	99	109
1983	117	117	120	122	120	122
1984	122	122	118	136	111	138
1985	94	93	108	128	107	129
1986	95	96	119	122	121	121
1987	103	99	115	128	116	126
1988	117	117	116	129	116	129
1989	104	104	113	145	113	144
1990	103	103	110	122	109	122
1991	105	105	132	134	131	133
Avg	106	107	117	130	117	129

C.5.4.3.22 Green Sturgeon—Adult

There were no exceedances in November–May of the two thresholds (>24°C and >27°C) examined for adult green sturgeon under any of the modeled scenarios or in any subregion.

C.5.4.3.23 Pacific Lamprey—Macropthalmia

There were no exceedances in December–March of the >25°C threshold examined for Pacific lamprey macropthalmia under any of the modeled scenarios or in any subregion.

C.5.4.3.24 Pacific Lamprey—Adult

For a temperature threshold of 22°C, model scenarios were examined for adult Pacific lamprey for the period from January through August.

In Cache Slough, the frequency of exceedances averaged 13 days for EBC1 and EBC2, 25 and 23 days for EBC2_ELT and PP_ELT, respectively, and 47 and 44 days for EBC2_LLT and PP_LLT, respectively (Table C.5.4-178).

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Table C.5.4-178. Number of Days Exceeding 22°C in the Cache Slough Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	7	7	28	40	25	39
1977	7	7	28	44	25	43
1978	18	18	27	48	26	45
1979	12	12	29	42	27	43
1980	12	12	12	34	11	25
1981	14	14	29	63	26	56
1982	0	0	14	41	14	37
1983	15	15	51	40	51	35
1984	23	23	33	71	31	71
1985	15	15	4	53	3	56
1986	1	0	11	58	10	50
1987	4	4	30	30	28	27
1988	36	36	36	63	29	62
1989	13	13	25	44	24	42
1990	27	27	30	45	28	45
1991	2	2	9	28	8	26
Avg	13	13	25	47	23	44

In the East Delta, average exceedances of the 22˚C threshold were 12 days under EBC1 and EBC2, 21 and 60 days under EBC2_ELT and EBC2_LLT, respectively, and 25 and 53 days under PP_ELT and PP_LLT, respectively (Table C.5.4-179).

Table C.5.4-179. Number of Days Exceeding 22°C in the East Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	16	16	50	58	36	44
1977	13	14	24	61	29	52
1978	13	13	20	56	26	51
1979	9	9	17	52	29	44
1980	11	12	15	42	15	35
1981	10	10	16	65	22	65
1982	6	6	7	53	14	49
1983	12	13	35	66	49	63
1984	15	15	28	76	35	74
1985	11	11	5	66	7	63
1986	1	1	9	70	8	60
1987	6	5	8	47	27	34
1988	31	34	29	69	36	66
1989	11	11	26	66	28	55
1990	23	23	26	57	30	46
1991	4	4	15	52	11	40
Avg	12	12	21	60	25	53

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Similarly, exceedances in the North Delta were 10 and 11 days, respectively for EBC1 and EBC2, 18 and 64 days for EBC2_ELT and EBC2_LLT, respectively, and 18 and 63 days for PP_ELT and PP_LLT, respectively (Table C.5.4-180).

Table C.5.4-180. Number of Days Exceeding 22°C in the North Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	18	19	64	67	56	66
1977	13	13	13	66	13	66
1978	10	10	13	65	14	64
1979	7	7	11	64	13	56
1980	7	8	17	54	17	44
1981	7	8	14	62	11	59
1982	9	8	5	59	5	59
1983	10	11	21	61	24	58
1984	11	11	14	77	13	80
1985	8	8	11	71	13	73
1986	3	6	11	68	8	68
1987	6	4	7	59	10	53
1988	21	23	23	66	26	67
1989	12	12	28	70	24	67
1990	17	16	22	66	22	68
1991	6	5	17	54	16	52
Avg	10	11	18	64	18	63

In the San Joaquin River, temperatures exceeded the threshold of 22°C for Pacific lamprey adults on 22 and 21 days, respectively, under EBC1 and EBC2 scenarios. Exceedance frequencies under EBC2_ELT and EBC2_LLT (31 days each) were similar to those under PP_ELT and PP_LLT (32 days) (Table C.5.4-181).

Table C.5.4-181. Number of Days Exceeding 22°C in the San Joaquin River Portion of the South Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	13	12	21	33	17	32
1977	6	7	25	34	29	44
1978	35	35	40	30	43	34
1979	19	17	37	30	37	30
1980	22	22	27	14	27	17
1981	24	23	31	46	32	46
1982	28	28	38	19	38	17
1983	48	44	68	14	71	14
1984	36	33	44	48	47	49
1985	23	23	13	38	12	46
1986	19	18	17	21	16	19
1987	3	3	30	16	32	13

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1988	36	35	31	55	36	59
1989	14	14	25	37	24	36
1990	29	28	34	44	38	44
1991	1	1	7	18	7	19
Avg	22	21	31	31	32	32

Temperature exceedance in the South Delta for Pacific lamprey adults occurred on 19 days on average under EBC1 and EBC2. Under the near term, EBC2_ELT was identical to PP_ELT (32 days), but long-term averages were higher under EBC2_LLT (47 days) than under PP_LLT (43 days) (Table C.5.4-182).

Table C.5.4-182. Number of Days Exceeding 22°C in the South Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	15	15	30	42	26	41
1977	10	10	35	50	34	47
1978	25	25	36	41	38	41
1979	14	14	34	45	35	39
1980	13	13	16	29	17	25
1981	29	29	35	65	34	58
1982	5	5	20	37	21	33
1983	32	30	70	33	73	28
1984	33	33	46	75	46	72
1985	29	29	13	59	11	55
1986	5	4	9	58	8	52
1987	6	6	41	30	41	26
1988	41	43	42	65	43	63
1989	14	14	34	47	31	42
1990	36	34	39	46	39	46
1991	1	1	7	29	8	26
Avg	19	19	32	47	32	43

Water temperatures exceeded the 22°C threshold for adult Pacific lamprey on 4 and 5 days under EBC1 and EBC2. On average the threshold was exceeded under EBC2_ELT and EBC2_LLT on 13 and 38 days, respectively. These numbers remained the same under PP_ELT and PP_LLT (Table C.5.4-183).

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Table C.5.4-183. Number of Days Exceeding 22°C in the Suisun Bay Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	17	36	18	36
1977	1	2	7	44	8	44
1978	9	11	15	40	15	41
1979	0	0	16	37	17	37
1980	8	8	9	25	9	24
1981	8	8	15	44	16	44
1982	0	0	1	34	1	31
1983	8	8	45	32	45	32
1984	9	10	23	60	23	60
1985	3	3	0	43	0	44
1986	0	0	0	34	1	34
1987	0	0	15	18	16	18
1988	13	16	17	59	17	60
1989	1	1	5	41	5	40
1990	6	7	20	43	20	44
1991	0	0	0	23	0	22
Avg	4	5	13	38	13	38

In Suisun Marsh, water temperatures were warmer than 22° on 12 and 13 days on average under EBC1 and EBC2. The exceedance frequency under EBC2_ELT (25 days) and EBC2_LLT (41 days) was similar to frequencies under PP_ELT (24 days) and PP_LLT (41 days) (Table C.5.4-184).

Table C.5.4-184. Number of Days Exceeding 22°C in the Suisun Marsh Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	3	5	24	39	26	39
1977	5	5	29	45	27	46
1978	19	19	30	36	27	37
1979	10	11	30	40	30	42
1980	12	11	11	24	12	24
1981	21	22	29	52	28	52
1982	0	0	14	31	15	31
1983	14	15	59	33	56	31
1984	24	25	35	68	35	67
1985	18	19	1	50	3	49
1986	0	0	11	49	10	44
1987	0	2	30	23	31	24
1988	31	35	31	61	28	61
1989	13	14	23	39	23	38
1990	26	26	33	44	29	45
1991	0	0	6	23	8	24
Avg	12	13	25	41	24	41

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Water temperatures in the West Delta reached temperatures exceeding the threshold for adult Pacific lamprey on 10 days under EBC1 and EBC2. The frequencies under EBC2_ELT and EBC2_LLT (22 and 24 days, respectively) were similar to frequencies under PP_ELT (22 days) and PP_LLT (41 days) (Table C.5.4-185).

Table C.5.4-185. Number of Days Exceeding 22°C in the West Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	30	39	25	39
1977	4	4	18	47	18	44
1978	18	18	30	44	30	40
1979	4	6	30	39	30	37
1980	11	11	11	33	11	28
1981	14	15	24	61	27	53
1982	0	0	8	45	8	34
1983	14	14	57	45	61	41
1984	16	16	30	69	31	67
1985	13	13	0	52	0	51
1986	0	0	7	58	5	52
1987	0	0	24	20	25	16
1988	26	26	28	62	28	61
1989	6	7	17	50	15	40
1990	28	28	33	45	35	45
1991	0	0	0	24	0	15
Avg	10	10	22	46	22	41

Under a 25°C threshold, only Cache Slough, the North, East, and South Delta subregions had days when water temperatures exceeded this threshold. In Cache Slough, the frequency of exceedance was 1 day each under EBC2_LLT and PP_LLT. No exceedances were noted under any other scenario (Table C.5.4-186).

Table C.5.4-186. Number of Days Exceeding 25°C in the Cache Slough Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	3	0	1
1979	0	0	0	0	0	0
1980	0	0	0	1	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	3	0	3
1985	0	0	0	1	0	1
1986	0	0	0	0	0	0

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1987	0	0	0	0	0	0
1988	0	0	0	7	0	6
1989	0	0	0	0	0	0
1990	0	0	0	2	0	3
1991	0	0	0	0	0	0
Avg	0	0	0	1	0	1

Temperature exceedance in the East Delta occurred on 2 days and 1 day under EBC2_LLT and PP_LLT, respectively. All other scenarios did not exceed this threshold (Table C.5.4-187).

Table C.5.4-187. Number of Days Exceeding 25°C in the East Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	7	0	4
1979	0	0	0	1	0	0
1980	0	0	0	3	0	1
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	4	0	2
1985	0	0	0	3	0	1
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	14	0	9
1989	0	0	0	0	0	0
1990	0	0	0	7	0	3
1991	0	0	0	0	0	0
Avg	0	0	0	2	0	1

In the North Delta, water temperatures were warmer than 25°C on 5 and 4 days under EBC2_LLT and PP_LLT, respectively. Exceedances were zero for all other scenarios (Table C.5.4-188).

Table C.5.4-188. Number of Days Exceeding 25°C in the North Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	2	6	2	5
1977	0	0	0	2	0	2
1978	0	0	0	11	0	11
1979	0	0	0	5	0	1
1980	0	0	0	7	0	4
1981	0	0	0	5	0	5

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1982	0	0	0	2	0	1
1983	0	0	0	1	0	1
1984	0	0	0	7	0	4
1985	0	0	0	5	0	5
1986	0	0	0	0	0	0
1987	0	0	0	2	0	1
1988	0	0	0	14	0	14
1989	0	0	0	5	0	3
1990	0	0	0	12	0	11
1991	0	0	0	3	0	2
Avg	0	0	0	5	0	4

In the San Joaquin portion of the South Delta, there were no days in any model scenario when temperatures exceeded 25°C (Table C.5.4-189)

Table C.5.4-189. Number of Days Exceeding 25°C in the San Joaquin River Portion of the South Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	2	0	6	0
1984	0	0	0	0	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	0	0	0	0	0	0

In the South Delta, water temperatures warmer than 25°C occurred on average on 1 day under EBC2_LLT and PP_LLT, and all other scenario exceedances averaged zero (Table C.5.4-190).

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Table C.5.4-190. Number of Days Exceeding 25°C in the South Delta Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	1	0	1
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	2	0	6	0
1984	0	0	0	7	0	6
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	8	0	6
1989	0	0	0	0	0	0
1990	0	0	0	3	0	2
1991	0	0	0	0	0	0
Avg	0	0	0	1	0	1

Although the average exceedance for Suisun Marsh was zero days, there were 3 days on which water temperatures exceeding 25˚C in EBC2_LLT in both 1984 and 1988. Also, under PP_LLT, there were 1 and 2 days exceeding 25˚C in 1988 and 1990, respectively. On average, however, these frequencies are zero (Table C.5.4-191).

Table C.5.4-191. Number of Days Exceeding 25°C in the Suisun Marsh Subregion during the Pacific Lamprey Adult Period (January–August)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	3	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	3	0	1
1989	0	0	0	0	0	0
1990	0	0	0	0	0	2
1991	0	0	0	0	0	0
Avg	0	0	0	0	0	0

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C.5.4.3.25 River Lamprey—Macropthalmia

There were no exceedances in December–March of the >25°C threshold examined for river lamprey macropthalmia under any of the modeled scenarios or in any subregion.

C.5.4.3.26 River Lamprey—Adult

For adult river lamprey from February through June, the number of days when water temperatures exceeded a 22°C threshold in Cache Slough was 2 for EBC1 and EBC2, 4 and 6 days for EBC2_ELT and EBC2_LLT, respectively, and 4 and 7 days for PP_ELT and PP_LLT, respectively (Table C.5.4-192).

Table C.5.4-192. Number of Days Exceeding 22°C in the Cache Slough Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	4	4	7	8	7	7
1977	2	2	4	8	3	8
1978	0	0	0	2	1	2
1979	0	0	2	8	2	9
1980	0	0	0	0	0	0
1981	11	11	16	15	16	15
1982	0	0	0	0	0	0
1983	0	0	7	3	8	4
1984	2	2	9	14	9	14
1985	3	3	0	11	0	11
1986	0	0	3	6	2	6
1987	1	1	1	7	2	8
1988	7	7	3	12	2	12
1989	2	2	5	9	4	9
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	2	2	4	6	4	7

In the East Delta, temperature exceedances for adult river lamprey were 2 days for EBC1 and EBC2, 3 and 9 days for EBC2_ELT and EBC2_LLT respectively, and 3 and 8 days for PP_ELT and PP_LLT, respectively (Table C.5.4-193).

Table C.5.4-193. Number of Days Exceeding 22°C in the East Delta Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	5	5	7	11	7	10
1977	6	6	3	11	4	8
1978	0	0	0	4	0	3
1979	0	0	0	9	1	8
1980	0	0	0	2	0	0
1981	6	6	12	11	16	14

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1982	0	0	0	0	0	0
1983	0	0	3	17	5	15
1984	0	0	9	17	11	15
1985	1	1	0	12	0	12
1986	0	0	0	10	0	7
1987	1	1	1	10	3	7
1988	6	6	3	12	3	12
1989	1	1	3	11	5	9
1990	0	0	0	4	0	1
1991	0	0	0	0	0	0
Avg	2	2	3	9	3	8

Water temperatures in the North Delta exceeded the threshold for adult river lamprey on 1 and 2 days under EBC1 and EBC2, respectively. Under near-term scenarios, frequencies were 2 days for EBC2_ELT and PP_ELT, and in long-term scenarios, the threshold was exceeded on 10 days under EBC2_LLT and PP_LLT (Table C.5.4-194).

Table C.5.4-194. Number of Days Exceeding 22°C in the North Delta Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	6	6	10	12	10	12
1977	5	5	3	11	3	11
1978	0	0	1	7	1	8
1979	0	0	1	11	1	11
1980	0	0	0	3	0	3
1981	2	3	8	5	7	5
1982	1	1	0	2	0	2
1983	0	0	1	16	1	15
1984	0	0	4	18	5	21
1985	3	3	0	15	0	15
1986	1	1	0	10	0	11
1987	0	0	3	11	3	11
1988	4	4	3	9	3	9
1989	1	1	3	11	4	11
1990	0	0	0	12	0	11
1991	0	0	0	0	0	0
Avg	1	2	2	10	2	10

For the San Joaquin River, the water temperature threshold was exceeded on 2 days on average under EBC1 and EBC2, respectively. Warmer temperatures occurred on 4 and 3 days, respectively under the near-term (EBC2_ELT and PP_ELT) and long-term scenarios (EBC2_LLT and PP_LLT) (Table C.5.4-195).

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Table C.5.4-195. Number of Days Exceeding 22°C in the San Joaquin River Portion of the South Delta Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	4	4	6	6	6	6
1977	0	0	3	7	3	7
1978	3	3	6	0	6	0
1979	2	2	5	0	5	0
1980	0	0	2	0	2	0
1981	12	12	16	11	17	13
1982	0	0	0	0	0	0
1983	2	0	10	0	12	0
1984	1	1	8	4	11	3
1985	2	2	0	6	0	7
1986	1	1	0	0	0	1
1987	0	0	1	2	2	2
1988	5	5	1	8	2	8
1989	2	2	3	8	3	8
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	2	2	4	3	4	3

Water temperature thresholds for adult river lamprey were exceeded on average on 3 days during February through June under the EBC1 and EBC2 scenarios. Frequencies of exceedance days were 4 and 7 days under EBC2_ELT and PP_ELT, respectively, and 5 and 6 days under EBC2_LLT and PP_LLT, respectively (Table C.5.4-196).

Table C.5.4-196. Number of Days Exceeding 22°C in the South Delta Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	6	6	7	9	7	8
1977	0	0	3	8	3	7
1978	1	1	4	2	4	2
1979	3	3	2	9	3	6
1980	0	0	0	0	0	0
1981	12	12	17	16	16	16
1982	0	0	0	0	0	0
1983	1	1	11	0	14	0
1984	5	5	12	13	11	12
1985	5	5	0	12	0	11
1986	0	0	0	6	0	6
1987	3	3	5	9	5	8
1988	8	8	5	11	5	9
1989	2	2	4	9	4	9
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	3	3	4	7	5	6

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In Suisun Bay, the number of days with water temperatures warmer than 22°C was 1 under EBC1 and EBC2, 2 under EBC2_ELT and PP_ELT, and 4 under EBC2_LLT and PP_LLT (Table C.5.4-197).

Table C.5.4-197. Number of Days Exceeding 22°C in the Suisun Bay Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	6	7	6	7
1977	0	0	0	6	0	6
1978	0	0	0	0	0	0
1979	0	0	0	6	0	7
1980	0	0	0	0	0	0
1981	8	8	12	9	13	9
1982	0	0	0	0	0	0
1983	0	0	5	1	5	0
1984	0	0	3	7	3	7
1985	0	0	0	5	0	6
1986	0	0	0	0	0	1
1987	0	0	0	1	0	2
1988	0	0	0	9	0	9
1989	0	0	0	7	0	7
1990	0	0	0	1	0	1
1991	0	0	0	0	0	0
Avg	1	1	2	4	2	4

Suisun Marsh water temperatures exceeded the adult river lamprey temperature threshold of 22°C on 2 days under EBC1 and EBC2, on 4 days under EBC2_ELT and PP_ELT, and on 6 days under EBC2_LLT and PP_LLT (Table C.5.4-198).

Table C.5.4-198. Number of Days Exceeding 22°C in the Suisun Marsh Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	3	5	7	7	7	10
1977	0	0	4	8	5	10
1978	0	0	0	0	1	2
1979	0	0	2	9	3	9
1980	0	0	0	0	0	0
1981	11	11	16	15	16	15
1982	0	0	0	0	0	0
1983	0	0	9	1	10	2
1984	0	1	8	13	9	12
1985	4	5	0	11	0	10
1986	0	0	4	7	3	6
1987	0	1	1	7	2	7
1988	5	6	3	12	3	12
1989	1	2	3	9	3	8

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	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	2	2	4	6	4	6

Water temperatures in the West Delta exceeded the threshold on 1 day under EBC1 and EBC2. These exceedances were 2 days (for EC2_ELT and PP_ELT) and 4 days (for EBC2_LLT and PP_LLT) (Table C.5.4-199).

Table C.5.4-199. Number of Days Exceeding 22°C in the West Delta Subregion during the River Lamprey Adult Period (February–June)

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1976	0	0	5	6	5	6
1977	0	0	0	5	0	5
1978	0	0	0	0	0	0
1979	0	0	0	5	0	5
1980	0	0	0	0	0	0
1981	9	9	14	11	14	11
1982	0	0	0	0	0	0
1983	0	0	5	3	7	0
1984	0	0	4	7	4	7
1985	0	0	0	8	0	8
1986	0	0	0	5	0	5
1987	0	0	0	0	0	2
1988	0	0	0	8	0	8
1989	0	0	0	6	0	6
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
Avg	1	1	2	4	2	4

There were no exceedances in February–June of the >25°C threshold examined for river lamprey adults under any of the modeled scenarios or in any subregion.

C.5.4.4 Dissolved Oxygen

The simulations of dissolved oxygen (DO) concentrations in the eight regions of the Delta for the six different scenarios using DSM-QUAL found only minor differences among the scenarios. The greatest difference in the mean DO value for any day of the year was 0.95 milligrams per liter (mg/L) in Suisun Marsh during March. For most of the regions, differences due to climate change were larger than those due to the effects of the preliminary proposal. Furthermore, except for the preliminary proposal in the San Joaquin River region, differences due to climate change were consistently negative while those due to the preliminary proposal were positive or close to zero. There were no estimates of daily mean DO below 4.85 mg/L, an assumed threshold for increased stress for sturgeons.

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C.5.4.4.1 Cache Slough Subregion

The lowest DO concentration for the Cache Slough subregion with any of the preliminary proposal scenarios is 7.8 mg/L, for both the existing biological conditions in the late long-term (EBC2_LLT) and the preliminary proposal in the late long-term (PP_LLT). This DO value exceeds the Basin Plan objectives for all areas of the Delta. Most of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-34). The two late long-term scenarios, EBC2_LLT and PP_LLT, consistently show lower values for any given probability of exceedance than the other scenarios, whereas the preliminary proposal in the early long-term (PP_ELT) generally shows the highest value. The largest difference among all scenarios is about 0.8 mg/L.

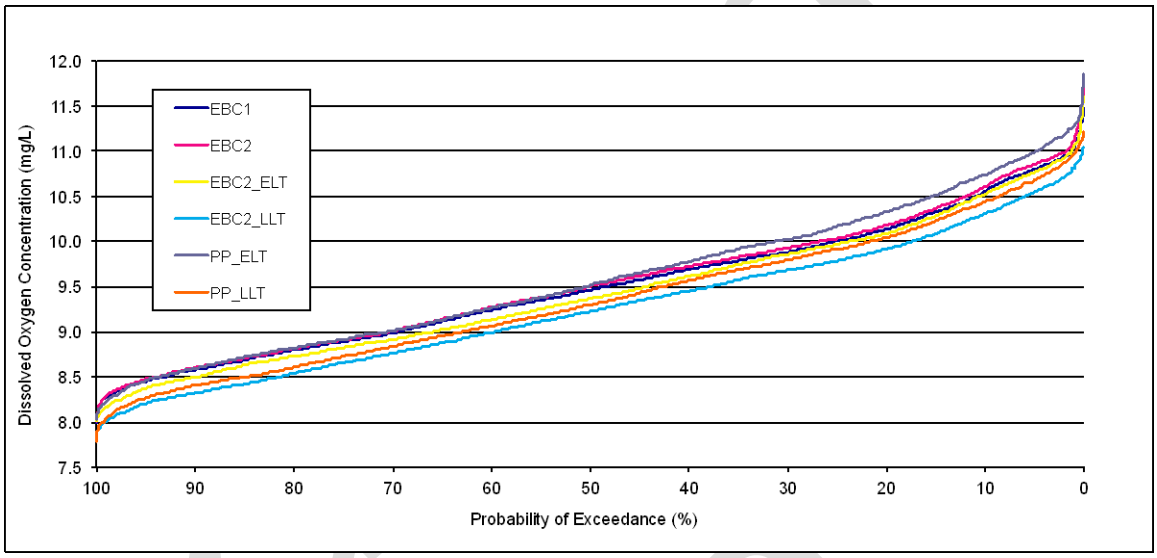

Figure C.5.4-34. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, Cache Slough

Figure C.5.4-35 shows the daily DO concentrations in the Cache Slough subregion for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations are similar for all scenarios, with the lowest values occurring in late July (Figure C.5.4-35). The two late long-term scenarios, EBC2_LLT and PP_LLT, exhibit the lowest mean DO values during most of the year. PP_ELT shows the highest value during the majority of days. The greatest difference among all scenarios for any day is about 0.5 mg/L.

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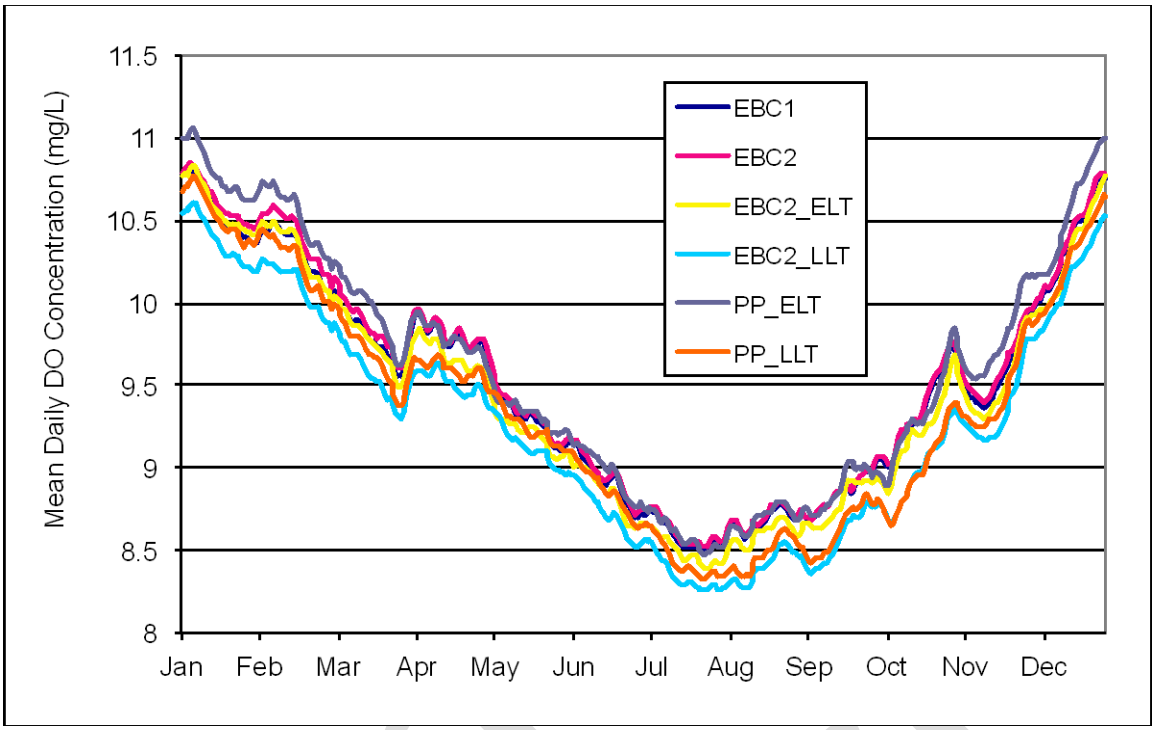

Figure C.5.4-35. Mean Daily Dissolved Oxygen Concentrations for Each Model Scenario, Cache Slough

For the Cache Slough subregion, differences in the mean daily DO values resulting from climate change are greater than those resulting from the preliminary proposal (Table C.5.4-200). The changes due to climate change for both the preliminary proposal (from PP_ELT to PP_LLT) and existing biological conditions (from EBC2_ELT to EBC2_LLT) are greater than those due to the preliminary proposal for both the early long-term (from EBC2_ELT to PP_ELT) and the late long-term (from EBC2_LLT to PP_LLT). Also, the changes due to the preliminary proposal are positive, whereas those due to climate change are negative (Table C.5.4-200).

Table C.5.4-200. Mean Changes between Model Scenarios, Cache Slough

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.151
From EBC2_LLT to PP_LLT	0.095
From PP_ELT to PP_LLT	-0.229
From EBC2_ELT to EBC2_LLT	-0.174

C.5.4.4.2 North Delta Subregion

The lowest DO concentration for the North Delta subregion with any of the preliminary proposal scenarios is 7.1 mg/L, for the existing biological conditions in the late long-term (EBC2_LLT). This DO value exceeds the Basin Plan objectives for all areas of the Delta. Most of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-36). The two late long-term scenarios, EBC2_LLT and PP_LLT, consistently show lower values for any given probability of exceedance than the other scenarios, whereas there is essentially no difference among the other scenarios. The largest difference among all scenarios is only about 0.3 mg/L.

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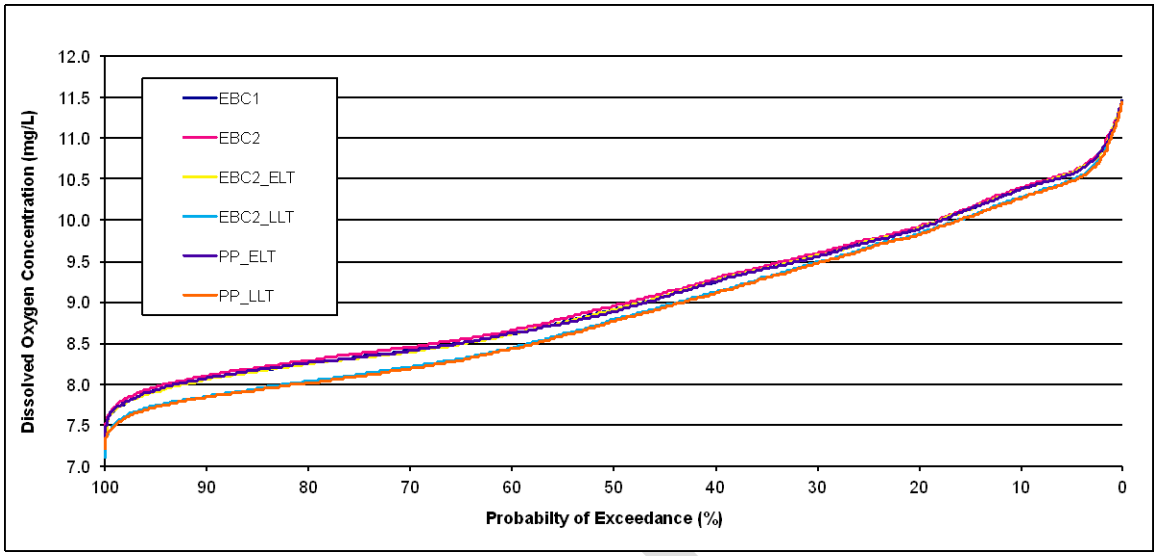

Figure C.5.4-36. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, North Delta

Figure C.5.4-37 shows the daily DO concentrations in the North Delta subregion for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations are similar for all scenarios, with the lowest values occurring in late August or early September (Figure C.5.4-37). The two late long-term scenarios, EBC2_LLT and PP_LLT, exhibit the lowest mean DO values during most of the year. There is little difference among the other scenarios. The greatest difference among all scenarios for any day is about 0.4 mg/L.

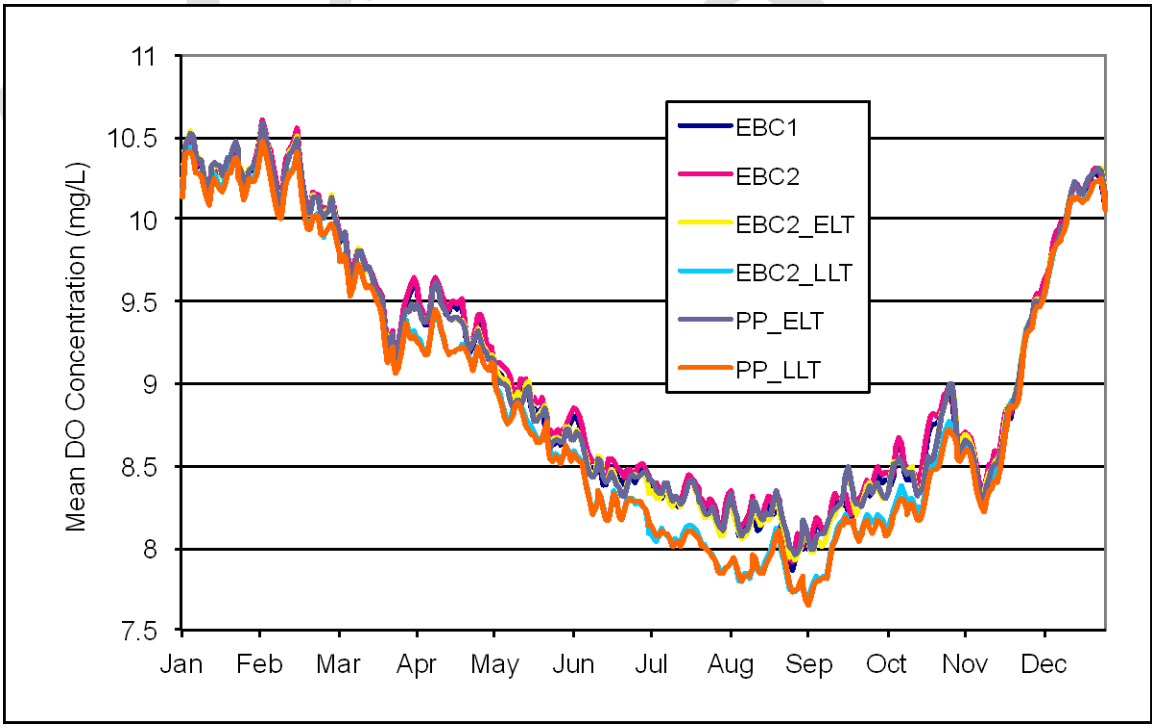

Figure C.5.4-37. Daily Average Dissolve Oxygen Concentrations for Each Model Scenario, North Delta

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For the North Delta subregion, differences in mean daily DO values resulting from climate change are greater than those resulting from the preliminary proposal (Table C.5.4-201). The changes due to climate change for both the preliminary proposal (from PP_ELT to PP_LLT) and existing biological conditions (from EBC2_ELT to EBC2_LLT) are greater than those due to the preliminary proposal for both the early long-term (from EBC2_ELT to PP_ELT) and the late long-term (from EBC2_LLT to PP_LLT). The changes due to climate change are negative, whereas those due to the preliminary proposal are close to zero (Table C.5.4-201).

Table C.5.4-201. Mean Changes between Model Scenarios, North Delta

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.001
From EBC2_LLT to PP_LLT	-0.015
From PP_ELT to PP_LLT	-0.153
From EBC2_ELT to EBC2_LLT	-0.138

C.5.4.4.3 East Delta Subregion

The lowest DO concentration for the East Delta subregion with any of the preliminary proposal scenarios is 7.0 mg/L, for the existing biological conditions in the late long-term (EBC2_LLT). This DO value meets the Basin Plan objectives for all areas of the Delta. Most of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-38). EBC2_LLT consistently shows the lowest value for any given probability of exceedance, whereas the preliminary proposal in the early long-term (PP_ELT) consistently shows the highest value. The largest difference among all scenarios is about 0.8 mg/L.

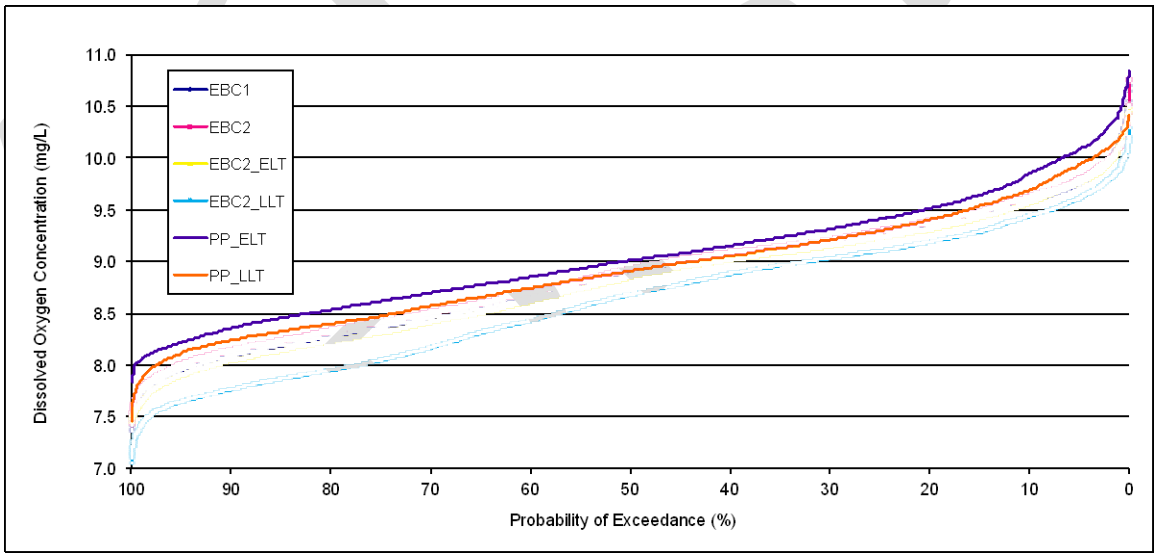

Figure C.5.4-38. Probability of Exceedances of Daily Dissolve Oxygen Concentrations for Each Model Scenario, East Delta

Figure C.5.4-39 shows the daily DO concentrations in the East Delta subregion for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations vary among scenarios, with the low values occurring from late July to early September for existing biological conditions in the late long-term (EBC2_LLT),

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in late August and early November for the other three existing biological conditions scenarios (EBC1, EBC2, and EBC2_ELT), from late July through early October for the preliminary proposal in the late long-term (PP_LLT), and in late July and early November for the preliminary proposal in the early long-term (PP_ELT) (Figure C.5.4-39). EBC2_LLT exhibits the lowest mean DO values during most of the year, whereas PP_ELT has the highest value on most days. The greatest difference among all scenarios is about 0.9 mg/L between PP_ELT and EBC2_LLT on September 5.

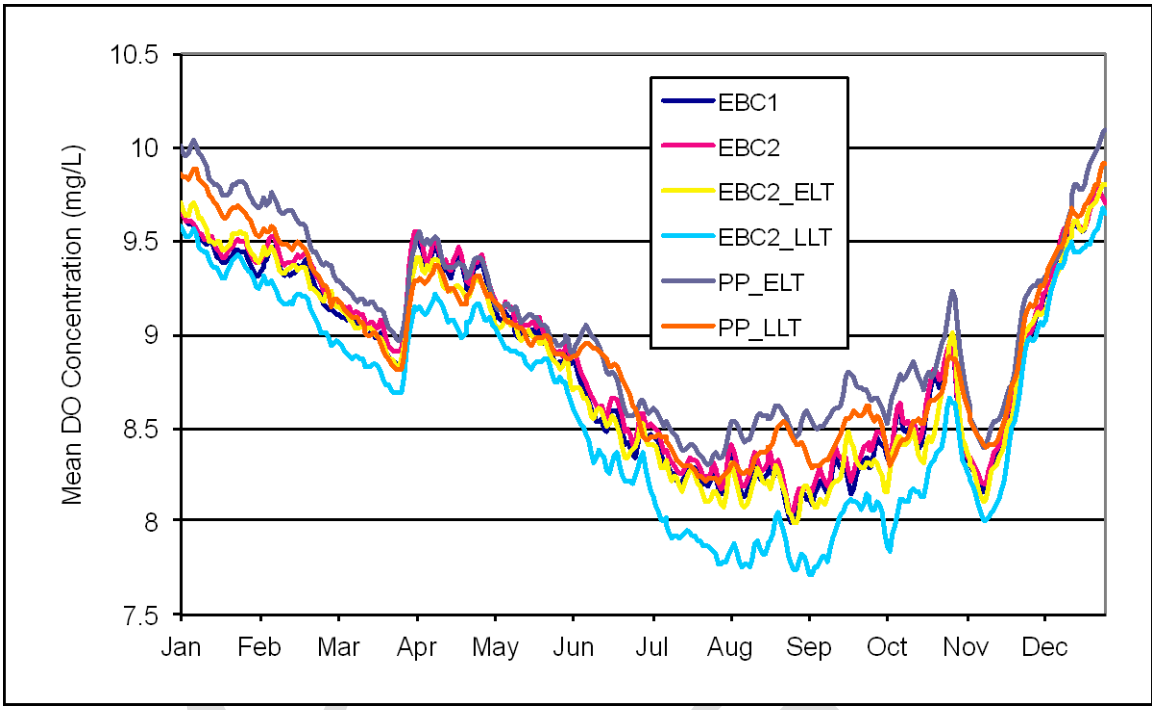

Figure C.5.4-39. Daily Average Dissolve Oxygen Concentrations for Each Model Scenario, East Delta

For the East Delta subregion, unlike most other regions, differences in mean daily DO values resulting from climate change are smaller than those resulting from the preliminary proposal (Table C.5.4-202). The changes due to climate change for both the preliminary proposal (from PP_ELT to PP_LLT) and existing biological conditions (from EBC2_ELT to EBC2_LLT) are smaller than those due to the preliminary proposal for both the early long-term (from EBC2_ELT to PP_ELT) and the late long-term (from EBC2_LLT to PP_LLT). The changes due to climate change are negative and those due to the preliminary proposal are positive (Table C.5.4-202).

Table C.5.4-202. Mean Changes between Model Scenarios, East Delta

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.239
From EBC2_LLT to PP_LLT	0.311
From PP_ELT to PP_LLT	-0.122
From EBC2_ELT to EBC2_LLT	-0.194

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C.5.4.4.4 South Delta Subregion

The lowest DO concentration for the South Delta subregion (minus the San Joaquin River, which is analyzed separately below) with any of the preliminary proposal scenarios is 7.0 mg/L, for the existing biological conditions in the late long-term (EBC2_LLT). This DO value meets the Basin Plan objectives for all areas of the Delta. Most of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-40). EBC2_LLT consistently shows the lowest values for any given probability of exceedance. The preliminary proposal in the late long-term (PP_LLT) generally shows the highest value, although differences among the five scenarios other than EBC2_LLT are small. The largest difference among all scenarios is about 0.5 mg/L.

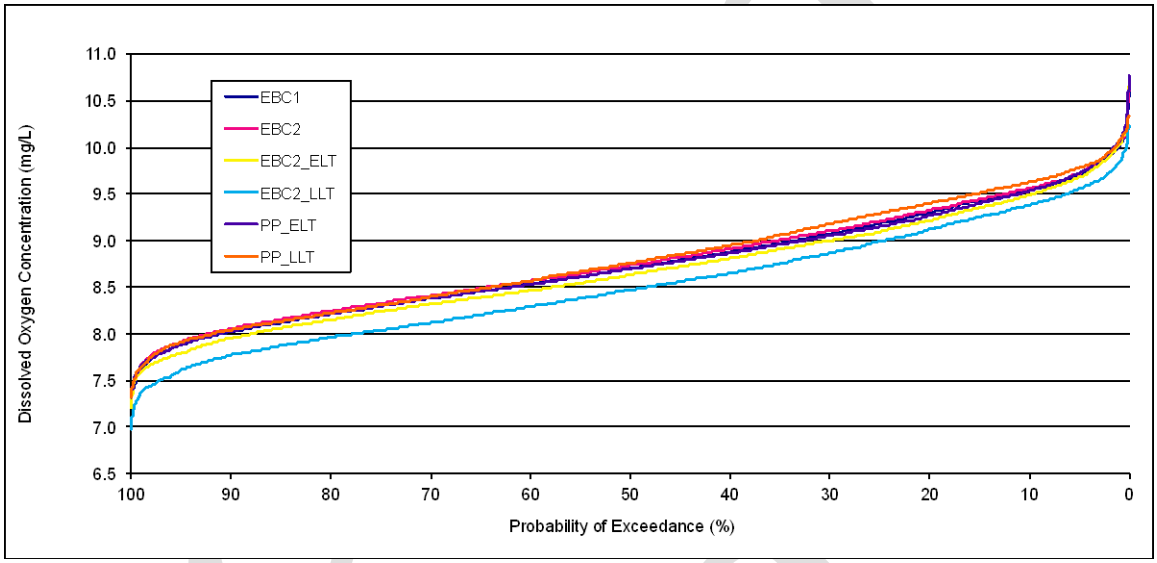

Figure C.5.4-40. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, South Delta

Figure C.5.4-41 shows the daily DO concentrations in the South Delta subregion for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations vary among scenarios, with the lowest values occurring in November for all the existing biological conditions scenarios (EBC1, EBC2, EBC2_ELT, and EBC2_LLT), in late July for the preliminary proposal in the early long-term (PP_ELT), and in September for the preliminary proposal in the late long-term (PP_LLT) (Figure C.5.4-41). The existing biological conditions in the late long-term (EBC2_LLT) exhibit the lowest mean DO values during almost every day of the year. There is no consistent ranking among the other scenarios. The greatest difference among all scenarios for any day is about 0.7 mg/L.

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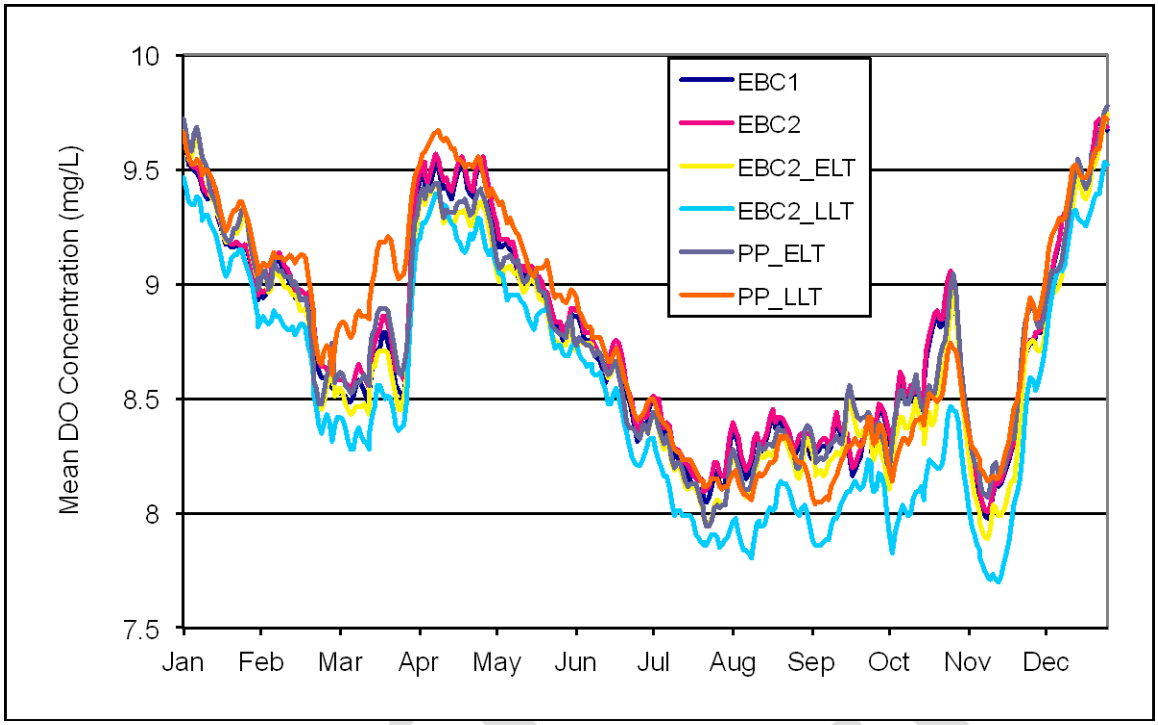

Figure C.5.4-41. Daily Average Dissolve Oxygen Concentrations for Each Model Scenario, South Delta

For the South Delta subregion, results with regard to the relative effect of the preliminary proposal and climate change on DO value were inconsistent (Table C.5.4-203). The largest difference between means, 0.277 mg/L, is between the existing biological conditions and the preliminary proposal in the late long-term (from EBC2_LLT to PP_LLT), while the second largest, -0.161 mg/L, is between the existing biological conditions in the early and late long-terms (from EBC2_ELT to EBC2_LLT). The other two changes are both close to zero (Table C.5.4-203). For the two scenarios with the larger changes in mean DO value, the change due to climate change is negative and that due to the preliminary proposal is positive (Table C.5.4-203).

Table C.5.4-203. Mean Changes between Model Scenarios, South Delta

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.059
From EBC2_LLT to PP_LLT	0.277
From PP_ELT to PP_ELT	0.057
From EBC2_ELT to EBC2_LLT	-0.161

C.5.4.4.5 West Delta Subregion

The lowest DO concentration for the West Delta subregion with any of the preliminary proposal scenarios is 7.4 mg/L, for the existing conditions in the late long-term (EBC2_LLT). This DO value exceeds the Basin Plan objectives for all areas of the Delta. Most of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-42). EBC2_LLT consistently shows the lowest values for any given probability of exceedance, and the preliminary proposal in the late long-term (PP_LLT) consistently shows the second-lowest values. The largest difference among all scenarios is only about 0.4 mg/L.

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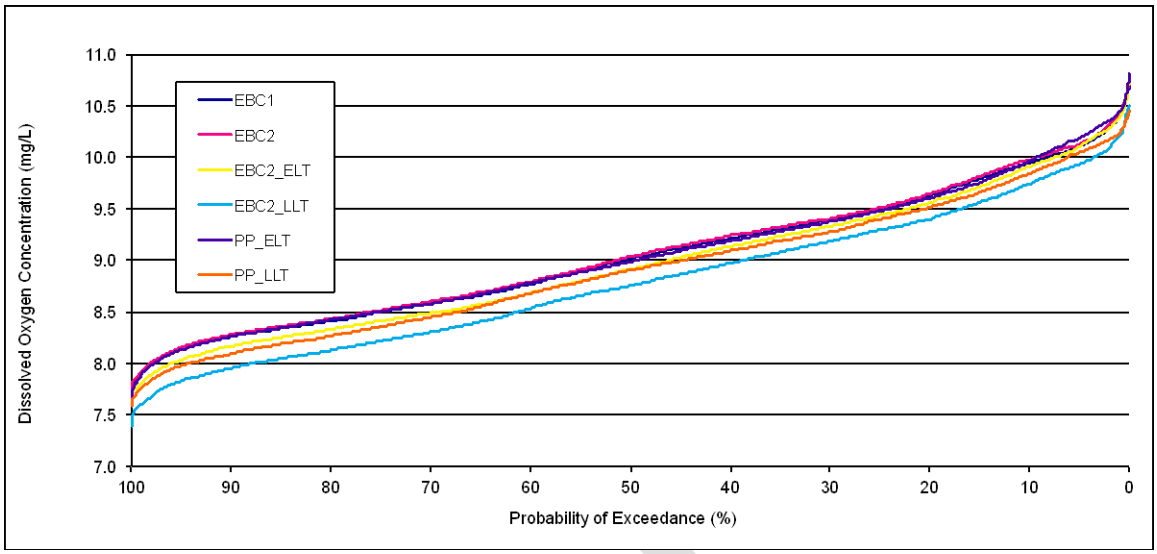

Figure C.5.4-42. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, West Delta

Figure C.5.4-43 shows the daily DO concentrations in the West Delta subregion for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations are similar for all scenarios, with the lowest values occurring in late July for all of the scenarios, and also in early August and early September for the two late long-term scenarios (EBC2_LLT and PP_LLT) (Figure C.5.4-43). EBC2_LLT and PP_LLT exhibit the lowest mean DO values during most of the year. The greatest difference among all scenarios for any day is about 0.5 mg/L.

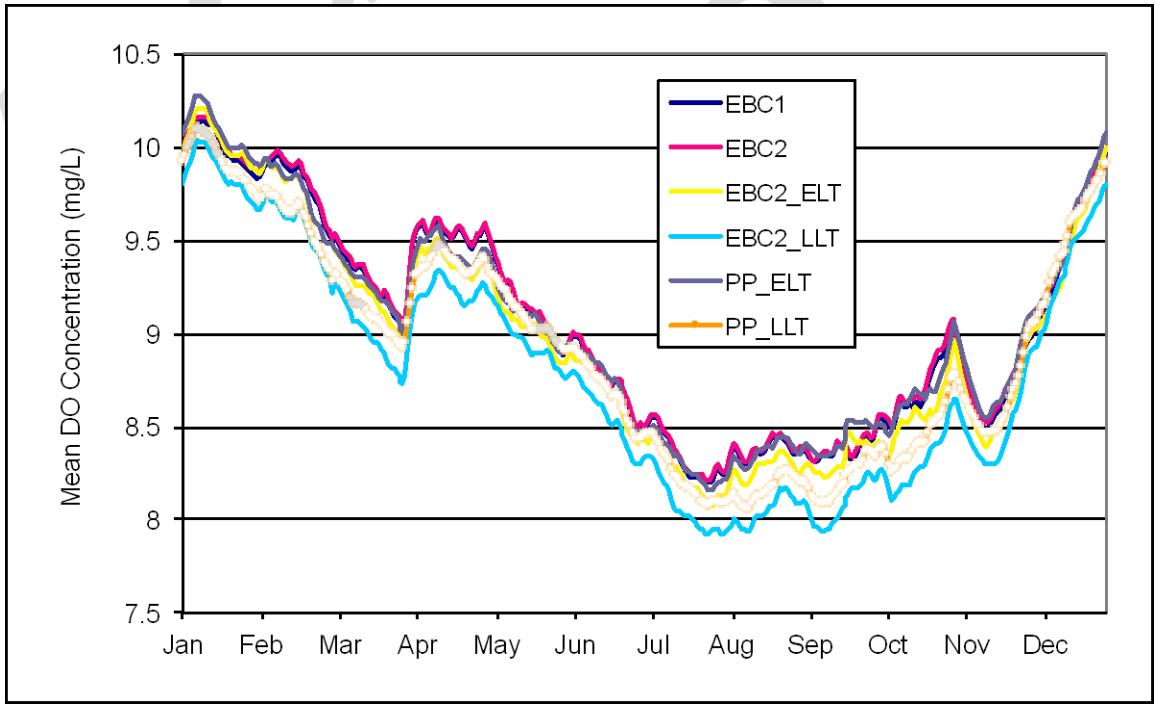

Figure C.5.4-43. Daily Average Dissolved Oxygen Concentrations for Each Model Scenario, West Delta

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For the West Delta subregion, differences in mean daily DO values resulting from climate change are greater than those resulting from the preliminary proposal (Table C.5.4-204). The changes due to climate change for both the preliminary proposal (from PP_ELT to PP_LLT) and existing biological conditions (from EBC2_ELT to EBC2_LLT) are much greater than those due to the preliminary proposal for both the early long-term (from EBC2_ELT to PP_ELT) and the late long-term (from EBC2_LLT to PP_LLT). The changes due to climate change are negative, whereas those due to the preliminary proposal are close to zero (Table C.5.4-204).

Table C.5.4-204. Mean Changes between Model Scenarios, West Delta

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.001
From EBC2_LLT to PP_LLT	-0.015
From PP_ELT to PP_LLT	-0.153
From EBC2_ELT to EBC2_LLT	-0.138

C.5.4.4.6 Suisun Marsh Subregion

The lowest DO concentration for the Suisun Marsh subregion with any of the preliminary proposal scenarios is 6.6 mg/L, for the existing biological conditions in the late long-term (EBC2_LLT). This DO value falls below the Basin Plan objective of 7.0 mg/L for all waters of the Delta west of the Antioch Bridge. The existing biological conditions in the early long-term scenario (EBC2_ELT) also has several DO values below 7.0 mg/L, but for both scenarios 99.8% of the DO values are greater than 7.0 mg/L. The majority of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-44). EBC2_LLT consistently shows the lowest values for any given probability of exceedance. The largest difference among all scenarios is about 0.6 mg/L.

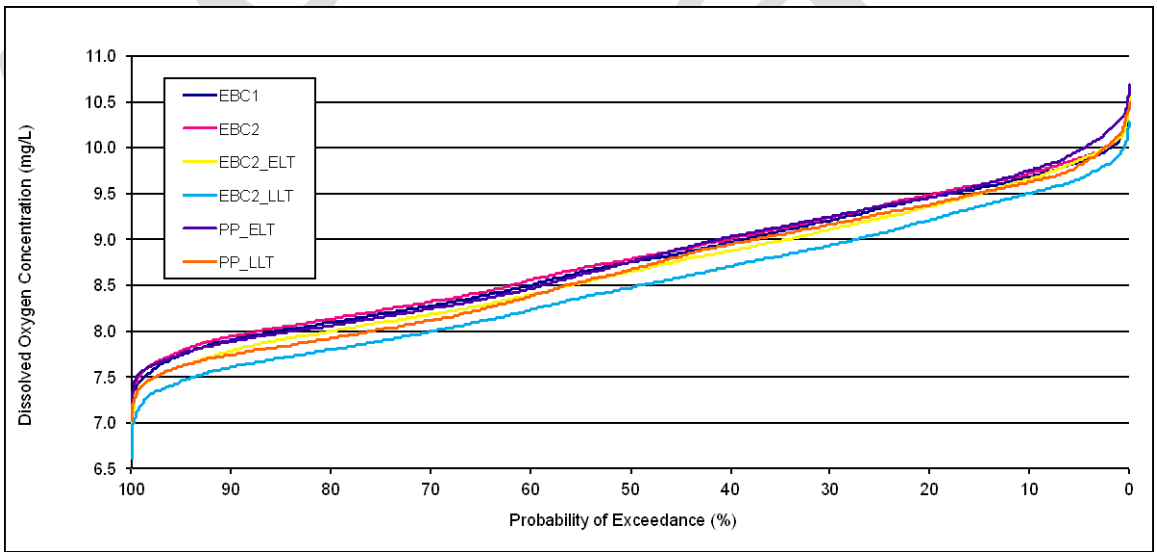

Figure C.5.4-44. Probability of Exceedances of Daily Dissolve Oxygen Concentrations for Each Model Scenario, Suisun Marsh

Figure C.5.4-45 shows the daily DO concentrations in Suisun Marsh for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations

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in the mean daily DO concentrations varied among the scenarios. The lowest values for both existing biological conditions in the near-term scenarios (EBC1 and EBC2) and both late long-term scenarios (EBC2_LLT and PP_LLT) fall in September, while the lowest values for both early long-term scenarios (EBC2_ELT and PP_ELT) occur in late July (Figure C.5.4-45). EBC2_LLT exhibits the lowest mean DO values during most of the year. All of the scenarios show a rapid drop and recovery in DO concentration during March, although the DO values remain above 8.0 mg/L. The greatest difference among all scenarios for any day, about 0.95 mg/L, occurs during this month.

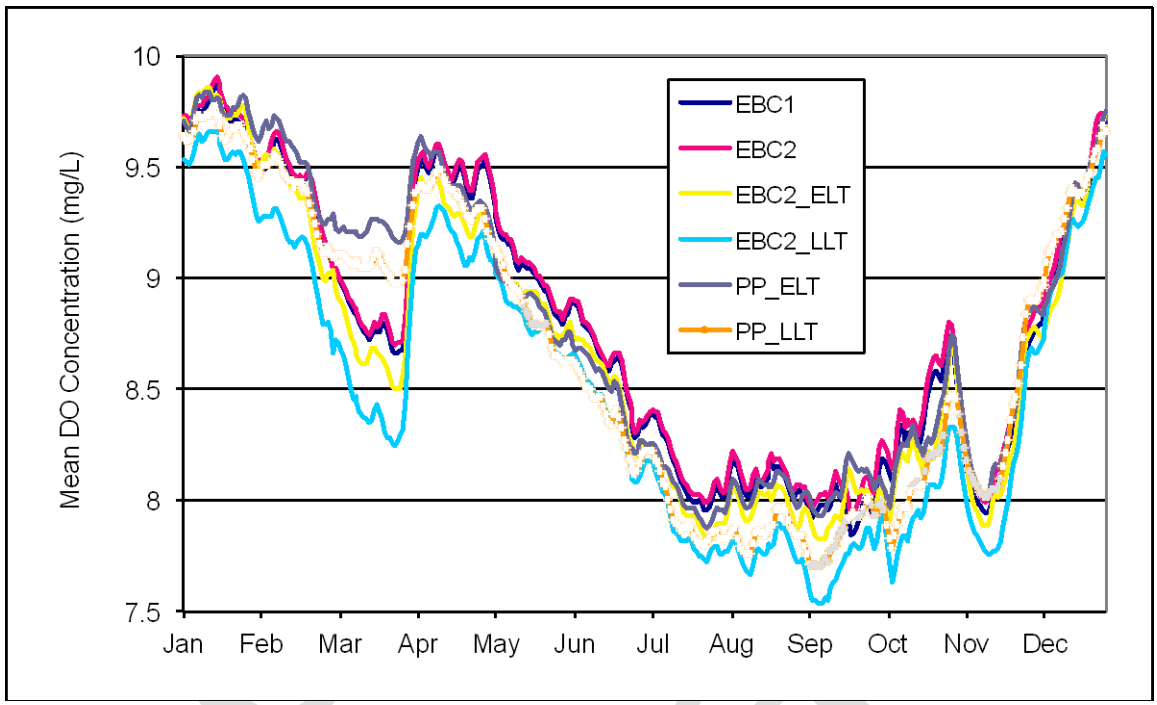

Figure C.5.4-45. Daily Average Dissolved Oxygen Concentrations for Each Model Scenario, Suisun Marsh

For Suisun Marsh, differences in mean daily DO values resulting from climate change are similar in magnitude to those resulting from the preliminary proposal (Table C.5.4-205). However, the changes due to climate change (from PP_ELT to PP_LLT and from EBC2_ELT to EBC2_LLT) are negative, while those due to the preliminary proposal are positive (from EBC2_ELT to PP_ELT and from EBC2_LLT to PP_LLT).

Table C.5.4-205. Mean Changes between Model Scenarios, Suisun Marsh

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.103
From EBC2_LLT to PP_LLT	0.169
From PP_ELT to PP_LLT	-0.109
From EBC2_ELT to EBC2_LLT	-0.175

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C.5.4.4.7 Suisun Bay Subregion

The lowest DO concentration for the Suisun Bay subregion with any of the preliminary proposal scenarios is 7.3 mg/L, for the existing biological conditions in the both the early and the late long-term (EBC2_ELT and EBC2_LLT) and the preliminary proposal in the early long-term (PP_ELT). This DO value exceeds the Basin Plan objectives of 7.0 mg/L for all waters of the Delta west of the Antioch Bridge. The majority of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-46). EBC2_LLT consistently shows the lowest values for any given probability of exceedance, although there is little difference among the scenarios (<0.3 mg/L).

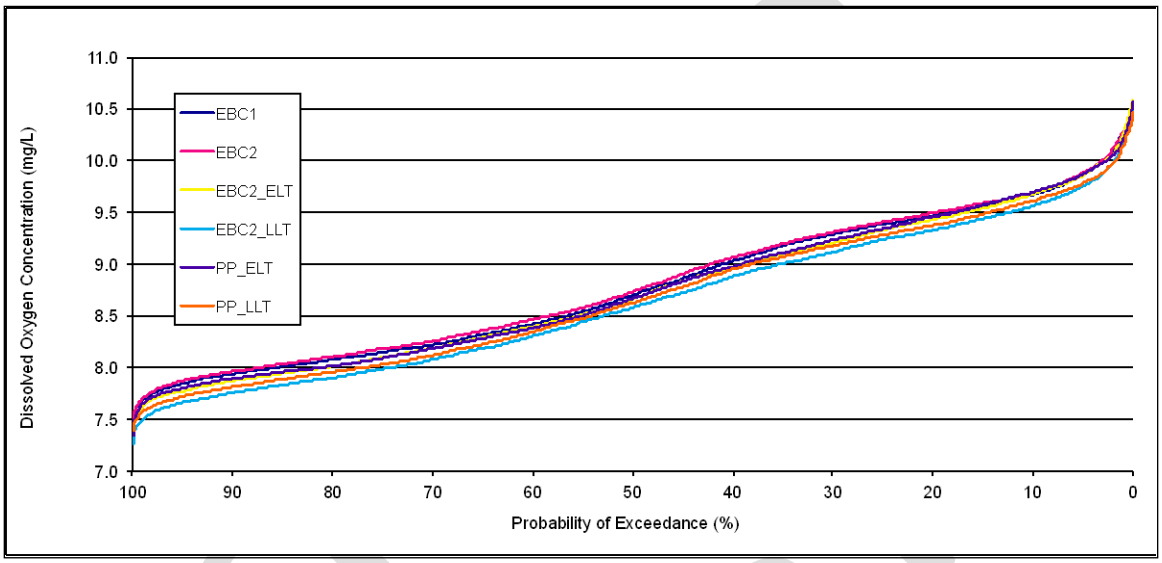

Figure C.5.4-46. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, Suisun Bay

Figure C.5.4-47 shows the daily DO concentrations in Suisun Bay for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations are similar for all scenarios, with the lowest values occurring in late July through early September for all of the scenarios (Figure C.5.4-47). EBC2_LLT and PP_LLT exhibit the lowest mean DO values during most of the year. The greatest difference among all scenarios for any day is only about 0.3 mg/L.

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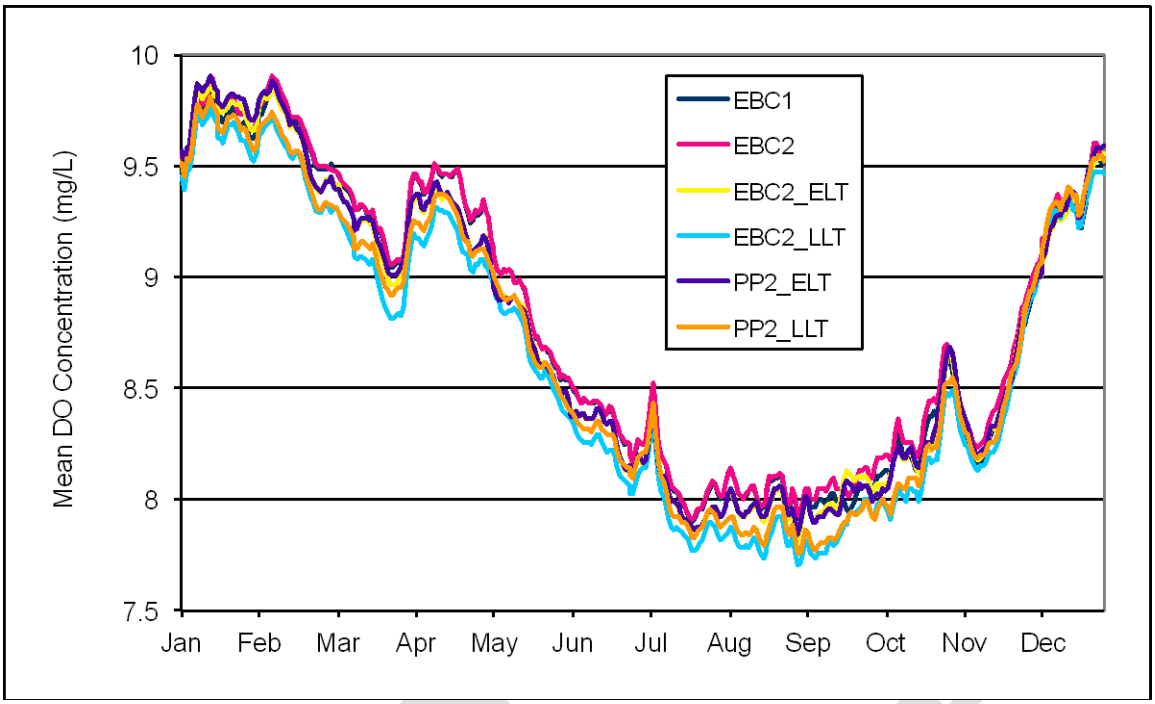

Figure C.5.4-47. Daily Average Dissolved Oxygen Concentrations for Each Model Scenario, Suisun Bay

For Suisun Bay, differences in mean daily DO values resulting from climate change are greater than those resulting from the preliminary proposal, although all of the changes are small (Table C.5.4-206). The changes due to climate change are negative and those due to the preliminary proposal are positive, although close to zero (Table C.5.4-206).

Table C.5.4-206. Mean Changes between Model Scenarios, Suisun Bay

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	0.009
From EBC2_LLT to PP_LLT	0.049
From PP_ELT to PP_LLT	-0.061
From EBC2_ELT to EBC2_LLT	-0.101

C.5.4.4.8 San Joaquin River

The lowest DO concentration for the San Joaquin River portion of the South Delta subregion with any of the preliminary proposal scenarios is 6.8 mg/L, for the preliminary proposal in the early long-term (PP_ELT). This DO value exceeds the Basin Plan objectives of 6.0 mg/L for the San Joaquin River (between Turner Cut and Stockton from September 1 through November 30) and 5.0 mg/L for all Delta waters other than the Sacramento River and the Delta west of the Antioch Bridge. The majority of the DO values for all the scenarios are above 8 mg/L (Figure C.5.4-48). EBC2_LLT shows the lowest DO values for all probability of exceedances, except for the lowest 2% of the values, for which PP_ELT has the lowest values. The largest difference among all scenarios is about 0.5 mg/L.

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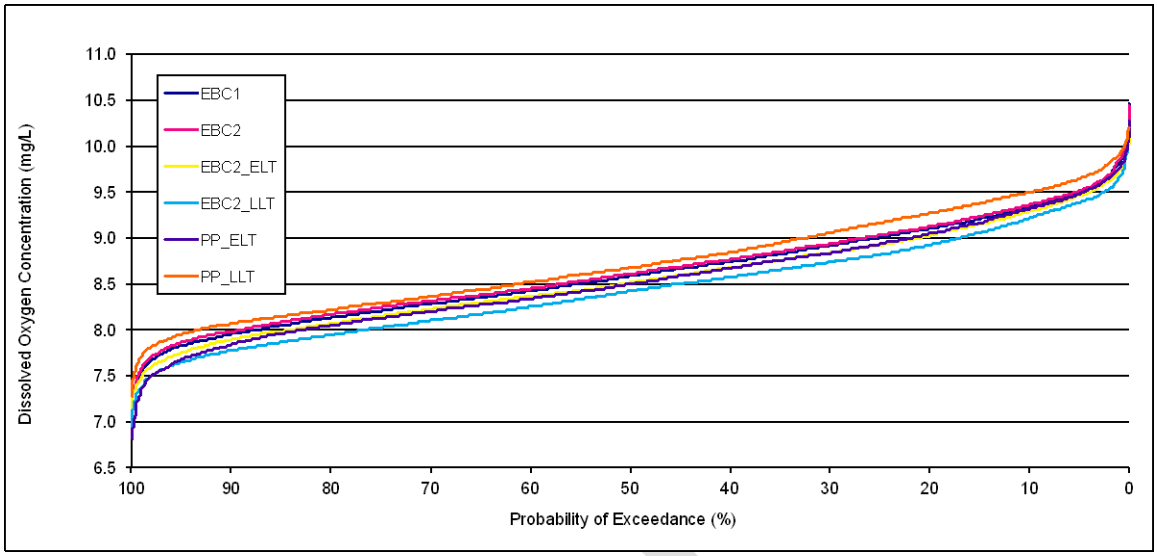

Figure C.5.4-48. Probability of Exceedances of Daily Dissolved Oxygen Concentrations for Each Model Scenario, San Joaquin River

Figure C.5.4-49 shows the daily DO concentrations in the San Joaquin River region for the preliminary proposal scenarios, averaged by day of the month over the 16-year period of simulation. Seasonal variations in the mean daily DO concentrations varied among the scenarios. The lowest values for both existing biological conditions in the near-term scenarios (EBC1 and EBC2) fall in August and September, the lowest for the preliminary proposal in the early long-term (PP_ELT) fall in November, the lowest for the preliminary proposal in the late long-term (PP_LLT) occur in late July and early August, and the lowest values for the existing biological conditions in both the early long-term and late long-term (EBC2_ELT and EBC2_LLT) are in August (Figure C.5.4-49). EBC2_LLT and PP_ELT exhibit the lowest mean DO values during most of the year. All of the scenarios show a rapid drop in DO concentration from late February to early March, followed by a sharp recovery in late March, although the DO values remain above 8.0 mg/L. The greatest difference among all scenarios for any day, about 0.7 mg/L, occurs during December.

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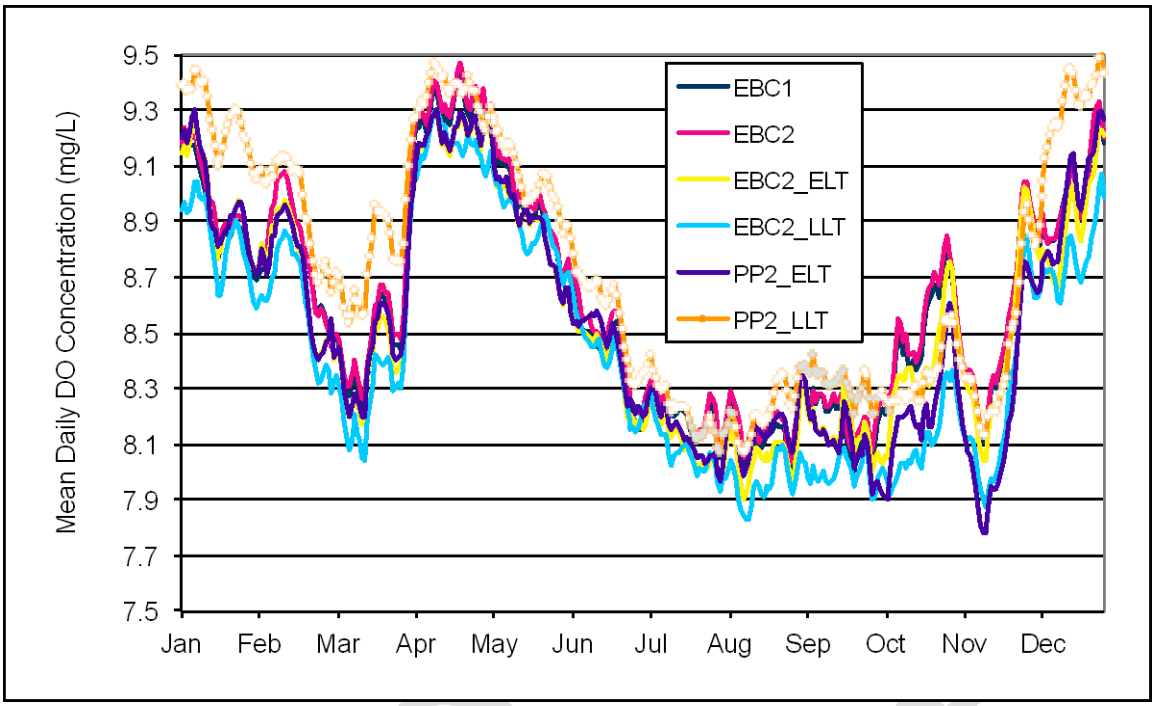

Figure C.5.4-49. Daily Average Dissolved Oxygen Concentrations for Each Model Scenario, San Joaquin River

For the San Joaquin River Region, results with regard to the relative effect of the preliminary proposal and climate change on changes in DO value were inconsistent (Table C.5.4-207). The largest difference between means, 0.285 mg/L, is between the existing biological conditions and the preliminary proposal in the late long-term (from EBC2_LLT to PP_LLT). The second largest difference, 0.196 mg/L, is between the preliminary proposal early and late long-terms (from PP_ELT to PP_LLT). This difference was the only positive change due to climate change found in this analysis of preliminary proposal effects on DO (see Table C.5.4-200 through Table C.5.4-207). The other San Joaquin River difference due to climate change, from the existing biological conditions in the early long-term to the late long-term (from EBC2_ELT to EBC2_LLT), was -0.104.

Table C.5.4-207. Mean Changes between Model Scenarios, San Joaquin River

Change	Difference (mg/L)
From EBC2_ELT to PP_ELT	-0.014
From EBC2_LLT to PP_LLT	0.285
From PP_ELT to PP_LLT	0.196
From EBC2_ELT to EBC2_LLT	-0.104

C.5.4.5 Residence Time (DSM2-PTM)

To provide an indication of effects of preliminary proposal operations on smaller-scale DO concentrations, DSM2 results were used near existing impaired waterways in the Delta. These impaired waterways include the Stockton Deep Water Ship Channel and locations near Stockton. The DSM2 node in the San Joaquin River just downstream of Rough and Ready Island represents the location closest to these impaired waterways for the analysis.

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Table C.5.4-208 presents the residence time of particles released at this location (n=4,000 particles). Residence time is calculated up to the time at which 50% of the particles leave the Delta (by exiting the west end at Martinez, CVP/SWP exports, or agricultural diversions). Although averages are presented in these results, caution should be used in interpretation because, while the 16 year DSM2 simulation period is generally representative of most hydrologic conditions, it does not represent the entire hydrologic history of the Delta. For example, based on the entire 82-year period of hydrologic data, the DSM2 hydrologic period does not include the worst-case scenario in terms of river flows. Residence times vary widely among hydrologic scenarios, indicating the strong association of residence time with flow rates and south Delta exports.

Table C.5.4-209 presents differences between model scenario pairs. There is wide variation among hydrologic scenarios in the differences between model scenarios. Average residence times for EBC1 and EBC2 were very similar. Differences in residence time between EBC1/EBC2 and PP_ELT ranged from -6 to +25 days (-25% to 132%) (Table C.5.4-209). Average residence time was 6–7 days (30%–43%) longer in the PP_ELT relative to EBC1/EBC2. Differences in residence time between EBC1/EBC2 and PP_LLT ranged from -7 to +45 days (-14% to 300%) (Table C.5.4-209). Average residence time was 8–9 days (39%–49%) longer in the PP_ELT relative to EBC1/EBC2. Isolating the effect of the preliminary proposal from climate change effects, differences in residence time between EBC2_ELT and PP_ELT ranged from -7 to +22 days (-19% to 100%) (Table C.5.4-209). Average residence time was 4 days (19%) longer in the PP_ELT relative to EBC2_ELT. Differences in residence time between EBC2_LLT and PP_LLT ranged from -12 to +26 days (-22% to 124%). Average residence time was 3 days (9%) longer in the PP_LLT relative to EBC2_LLT. (Table C.5.4-209)

These results indicate that residence time will increase by 3–4 days (9%–19%) as a result of the preliminary proposal on average for the hydrologic modeling scenarios used in the DSM2 analyses. There is large variation among hydrologic scenarios in these results, which reduces the certainty of the conclusions (compounding the existing uncertainty of DSM2 outputs). Increased residence time can lead to both positive and negative effects on the Delta ecosystem depending on its location and length. It is generally believed that an increase in residence time would cause an increase in primary production because the phytoplankton population would spend more time integrating light and nutrients within Delta channels and growing. Depending on the residence time, as well as other factors including temperature and nutrient ratios, this primary production could be in the form of diatoms, cyanobacteria, or flagellates. However, the small average increases of 3 to 4 days predicted by this analysis are unlikely to cause major changes in primary production, particularly with respect to the large level of uncertainty and large variation in results.

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Table C.5.4-208. Residence Time (Number of Days to When 50% of Particles Leave the Delta) of Particles Injected in the San Joaquin River Downstream of Rough and Ready Island[1]

Hydrological Scenario	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
Aug-87	24	23	36	32	46	49
Sep-39	12	14	17	21	26	26
Feb-48	55	55	55	51	59	67
Apr-29	72	75	66	75	75	82
May-66	48	48	47	52	51	47
Apr-70	49	50	52	55	46	43
Jun-34	29	31	36	37	41	47
Jan-29	20	20	20	21	20	47
Dec-33	15	15	18	24	16	14
Oct-53	10	20	20	27	27	16
Jun-40	15	15	16	18	19	29
May-37	33	31	36	36	29	51
Mar-61	21	21	26	28	26	23
Nov-67	10	24	17	17	18	18
Nov-41	11	15	17	27	20	19
May-35	45	45	47	46	50	57
Apr-86	19	19	19	21	24	25
Jul-57	21	19	22	37	44	30
Jul-48	16	15	18	45	33	60
Dec-31	11	11	12	13	10	8
Jan-79	17	17	18	20	23	17
Mar-01	25	25	26	28	27	27
Jun-93	17	17	18	17	33	21
Feb-40	24	23	23	22	21	18
Average	26	27	28	32	33	35

[1] n = 4,000 particles

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Table C.5.4-209. Differences and Percent Difference between Model Scenarios in the Residence Time (Number of Days to When 50% of Particles Leave the Delta) of Particles Injected in the San Joaquin River Downstream of Rough and Ready Island

Hydrological Scenario	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Aug-87	22 (93%)	25 (106%)	23 (100%)	26 (113%)	10 (28%)	17 (53%)
Sep-39	14 (111%)	14 (111%)	12 (86%)	12 (86%)	9 (53%)	5 (24%)
Feb-48	4 (8%)	12 (22%)	4 (7%)	12 (22%)	4 (7%)	16 (31%)
Apr-29	3 (4%)	10 (14%)	0 (0%)	7 (9%)	9 (14%)	7 (9%)
May-66	3 (6%)	-1 (-3%)	3 (6%)	-1 (-2%)	4 (9%)	-5 (-10%)
Apr-70	-3 (-7%)	-6 (-13%)	-4 (-8%)	-7 (-14%)	-6 (-12%)	-12 (-22%)
Jun-34	12 (42%)	18 (63%)	10 (32%)	16 (52%)	5 (14%)	10 (27%)
Jan-29	0 (2%)	27 (140%)	0 (0%)	27 (135%)	0 (0%)	26 (124%)
Dec-33	1 (5%)	-1 (-8%)	1 (7%)	-1 (-7%)	-2 (-11%)	-10 (-42%)
Oct-53	17 (181%)	6 (67%)	7 (35%)	-4 (-20%)	7 (35%)	-11 (-41%)
Jun-40	4 (25%)	14 (91%)	4 (27%)	14 (93%)	3 (19%)	11 (61%)
May-37	-4 (-11%)	19 (57%)	-2 (-6%)	20 (65%)	-7 (-19%)	15 (42%)
Mar-61	5 (24%)	2 (10%)	5 (24%)	2 (10%)	0 (0%)	-5 (-18%)
Nov-67	8 (88%)	8 (88%)	-6 (-25%)	-6 (-25%)	1 (6%)	1 (6%)
Nov-41	9 (79%)	8 (70%)	5 (33%)	4 (27%)	3 (18%)	-8 (-30%)
May-35	5 (10%)	12 (26%)	5 (11%)	12 (27%)	3 (6%)	11 (24%)
Apr-86	5 (28%)	6 (34%)	5 (26%)	6 (32%)	5 (26%)	4 (19%)
Jul-57	23 (114%)	9 (46%)	25 (132%)	11 (58%)	22 (100%)	-7 (-19%)
Jul-48	17 (110%)	44 (282%)	18 (120%)	45 (300%)	15 (83%)	15 (33%)
Dec-31	-1 (-9%)	-3 (-27%)	-1 (-9%)	-3 (-27%)	-2 (-17%)	-5 (-38%)
Jan-79	6 (33%)	0 (-2%)	6 (35%)	0 (0%)	5 (28%)	-3 (-15%)
Mar-01	2 (9%)	2 (9%)	2 (8%)	2 (8%)	1 (4%)	-1 (-4%)
Jun-93	16 (93%)	4 (23%)	16 (94%)	4 (24%)	15 (83%)	4 (24%)
Feb-40	-3 (-11%)	-6 (-23%)	-2 (-9%)	-5 (-22%)	-2 (-9%)	-4 (-18%)
Average	7 (43%)	9 (49%)	6 (30%)	8 (39%)	4 (19%)	3 (9%)

Note: A positive result indicates that the value in the preliminary proposal is higher than the value in the existing biological conditions scenarios.

C.5.4.6 Turbidity (Water Clarity)

Turbidity is an easily measured indication of water clarity, and automated devices have been installed in many Delta locations since 2009. Governing equations for mass conservation and force balance for suspended sediment concentration (SSC)[2] can be solved by a numerical model of suspended sediment transport, and these results can be used to estimate turbidity by establishing empirical relationships between the suspended sediment measurements and turbidity measurements at a given location. The data requirements for developing suspended sediment model boundary conditions and model parameters are numerous, and adequate data are not yet available in the Delta. A simpler approach is to assume a linear relationship between SSC and turbidity and

[2] <http://www.deltacouncil.ca.gov/sites/default/files/documents/files/workshop_OCAP_2010_presentation_16_Wright_Shoellhamer.pdf>.

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approximate the effect of deposition on turbidity. This form of turbidity model has been developed and applied (RMA 2010a, 2010b). In order to represent the additional processes discussed below, a full suspended sediment model is required.

In the following section, the DRERIP Ecosystem Conceptual Model for Sedimentation (Schoellhamer et al. 2007) is used as a primary resource to guide the summary of factors influencing water clarity, and to evaluate the potential changes to the Delta in the late long-term (LLT) timeframe that includes sea level rise (45 cm) and PP operations, in comparison to current conditions, which are assumed comparable to existing biological conditions (EBC2). These bookend changes are focused on herein, although it is acknowledged that the story may be different when considering an interim timeframe.

It is assumed in what follows that an increase in SSC is linearly related to an increase in turbidity, although the relationship likely will differ by location. The range of sediment size available in the water column influences water clarity, with fine sediment (less than 63 micrometers [µm] diameter) being the most easily mobilized; the larger size fraction is called *coarse sediment*. SSC is the dominant contributor to turbidity. Colored dissolved organic material (CDOM) and phytoplankton/chlorophyll are important in some systems but are probably negligible contributions in the Delta (Kimmerer 2004).

C.5.4.6.1 Sediment Supply and Water Clarity—General Background on Transport and Local Conditions in the Delta

Water clarity in the Delta is determined primarily by the amount of suspended sediment transported in the water column (Kimmerer 2004). As rivers enter estuaries, sediment eroded from upstream areas is deposited in the estuary in varying degrees, depending on factors such as flow rate, tidal forcing, and local conditions. The patterns of geomorphic change occur on time scales varying from episodic, as storm flows can transport large volumes of sediment, to decadal, for example due to changes in climate patterns, the damming of rivers, and land usage.

The major source of sediment to the Delta is the Sacramento River plus the Yolo Bypass, which accounted for up to 85% of the sediment supply over the period 1999–2002 (Wright and Schoellhamer 2005). The San Joaquin River accounted for about 13%, with the eastside inflows (Cosumnes, Calaveras, and Mokelumne) accounting for the remaining 2% over the same period. Although in recent history (since 1957) sediment supply to the Delta has been decreasing, the Delta remains depositional (Wright and Schoellhamer 2005; Schoellhamer et al. 2007), with approximately two thirds of sediment entering the Delta remaining in the Delta during the period 1999–2002. Suisun Bay and Grizzly Bay both were calculated to be erosional in the period 1867–1990 (Cappiella et al. 1999), with both areas sustaining losses to tidal flats. However, Wright and Schoellhamer (2004) state that the Delta is likely to remain net depositional independent of decreases in sediment supply because of tidal influences (slack tide deposition) and the availability of large depositional areas, although depositional pattern will vary sediment supply (Ganju and Schoellhamer 2010).

The great majority of Sacramento River sediment (more than 80%) enters the Delta episodically during high-flow events in the wet periods, with sediment concentrations generally higher during "first flush" events (Schoellhamer et al. 2007). Wright and Schoellhamer (2005) estimated that during the 4-year period 1999–2002, this accounted for about 31% of the total time. In comparing the proportion of the available sediment actually deposited, about 69% of the available sediment

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was deposited during wet periods, in comparison with about 56% of the available sediment deposited during dry periods. In other words, conditions are more conducive to sediment deposition during the wet season than during the dry season.

The decreasing trend in sediment supply from the Sacramento River since 1957 (Wright and Schoellhamer 2004) is due to a variety of factors. The construction of reservoirs has resulted in an upstream accumulation of sediment within the reservoirs. In addition, previous stores of hydraulic mining–derived sediments have been depleted, and there have been various changes associated with channel adjustments downstream of dams and bank protection measures that decrease sediment supply. However, other factors such as land use changes (e.g., logging, grazing) and urbanization can increase sediment supply.

The current balance between the factors regulating sediment supply to the Sacramento River is unknown (Wright and Schoellhamer 2004), so it is not possible to predict the evolution of sediment supply in the coming decades with any certainty. Thus, it is hard to predict whether sufficient sediment will enter the Delta to be available for all preliminary proposal ROAs. In addition, sea level rise requires sediment deposition to maintain the elevation of current wet lands above tidal water levels. Potential consequences for sediment deposition and water clarity due to sea level rise and the development of ROAs are discussed in greater detail below.

The range of sediment size available in the water column influences water clarity. Fine sediment (less than 63 µm diameter) is the primary component of suspended sediment in the San Francisco estuary (Schoellhamer et al. 2007). Turbidity and SSC are well-correlated in the San Francisco estuary, as suspended sediment is predominantly fine sediment, and flocculated sediment sizes are relatively homogeneous in the estuary (Schoellhamer et al. 2007; Ganju et al. 2007). Sand and coarse sediment (greater than 63 µm diameter) can be transported both as suspended load (in the water column) or bed load (rolling along the bed). Bed load is a small fraction of sediment load in the Delta, estimated as two orders of magnitude less than total suspended sediment load (Schoellhamer et al. 2007). Coarse sediment is found primarily in deeper channels with high flows, such as along the Sacramento River or the deeper channels in Suisun Bay.

Sediment is a critical resource in habitat creation. Tidal marsh and floodplain restoration efforts may require a sediment source as the substrate for the restoration effort, so knowledge of sediment transport patterns can enable the optimal siting of restoration areas for maximum sediment trapping from local waterborne sources (Ganju et al. 2004). Sediments are advected downstream into transitional areas where tidal forcing can mobilize the mass of fine sediments in an oscillation, the net direction of which (landward or seaward) is dictated by a variety factors such as net outflow, tidal strength (e.g., timing in the spring-neap cycle), and timing within the diurnal tidal cycle (Ganju et al. 2004). Deposition typically occurs at slack after ebb and flood tides. More generally, deposition occurs as flow velocity decreases, as coarser, heavier sediments fall out of the water column.

On a local scale, erosion increases SSC and reduces water clarity, and deposition decreases SSC and increases water clarity (Schoellhamer et al. 2007). Several factors can stabilize or resuspend the sediments in place in the beds of rivers and estuaries. Wind waves can resuspend bed sediment, and the magnitude of decrease in water clarity (i.e., increase in turbidity) is affected by depth and areal extent of the open water (fetch length), which influence the magnitude of the wind waves and the resulting turbidity. Benthic creatures can increase water clarity both by filtering the water column and by stabilizing bed sediments when populations become locally dense. Macrophytes generally are associated with sediment deposition and increased water clarity, as they reduce water velocity,

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attenuate waves, reduce vertical mixing in the water column, and reduce bed shear stress (Schoellhamer et al. 2007).

Water depth is another factor in the regulation of water clarity, both in regulating the local hydrodynamics and as a determinant in the ability of vegetation to colonize a given location. As discussed by Schoellhamer et al. (2007), brackish vegetation can colonize locations where elevation is greater than mean tide level, while freshwater emergent vegetation colonizes in water depths up to up to 0.2 m (0.66 feet).

Accretion of sediment to the bed removes sediment from the erodible pool of sediment, thereby increasing water clarity. Strong accretion of sediment, in the range of 10 mm per year at Browns Island, 30 mm per year at Donlon Island, and even higher local rates of localized deposition, has been observed in the Delta (Reed 2002). In contrast, several open water regions, including Franks Tract, appear to be at open water equilibrium (Simenstad et al. 2000). These different results are attributed to the influence of wind waves on sediment resuspension.

Wind resuspension of fine sediments increases turbidity both episodically during winter storms and seasonally in the spring and summer because of diurnal westerly winds (Ganju et al. 2006). Newly deposited sediment (unconsolidated) is more easily brought into suspension (Ganju et al. 2006), so spring winds may increase turbidity locally more than summer winds of the same velocity. However, peak wind strength occurs in the summer Delta-wide, although the average strength varies by location. Figure C.5.4-50 illustrates monthly averaged wind speed and direction at four in-Delta locations (see also Figure C.5.4-51 for the locations). In the spring and summer, winds are typically westerly at ~250°, with maximum speed in the afternoon. Figure C.5.4-52 illustrates hourly wind direction data at the Twitchell station.

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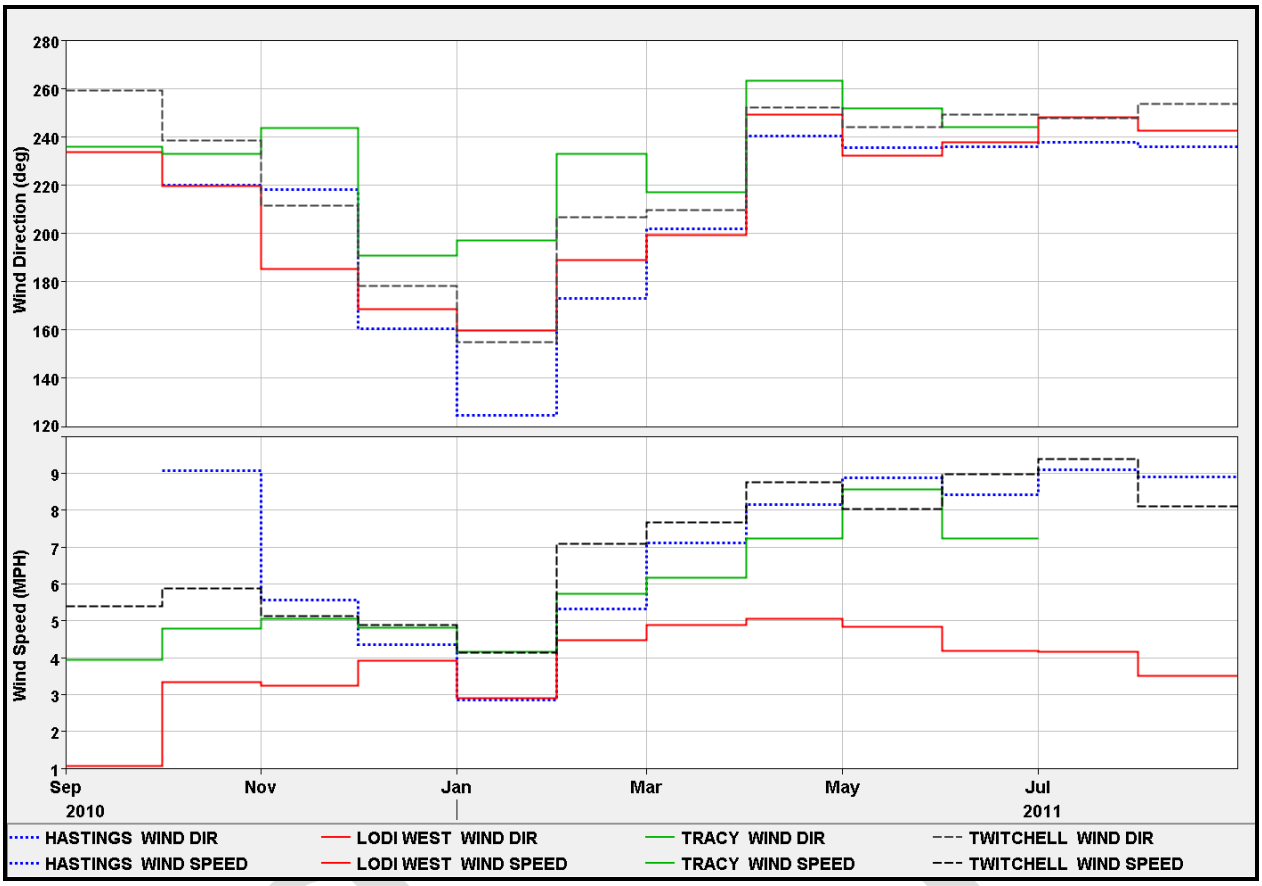

Figure C.5.4-50. Monthly-Averaged Wind Speed and Direction from CIMIS Data at Four in-Delta Locations in Water Year 2010

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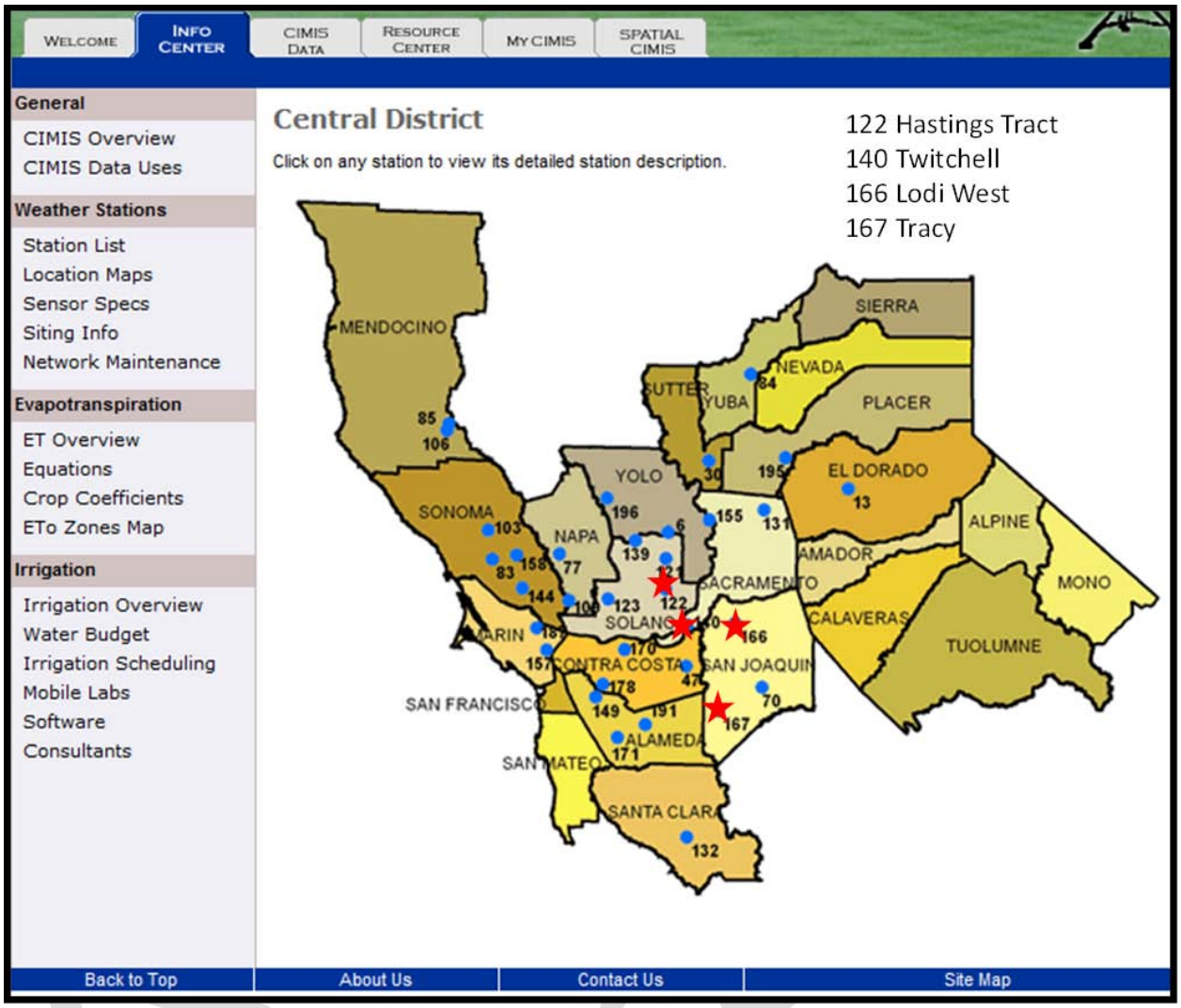

Figure C.5.4-51. Meteorological Measurements Were Taken from CIMIS Locations That Are Indicated by Red Stars

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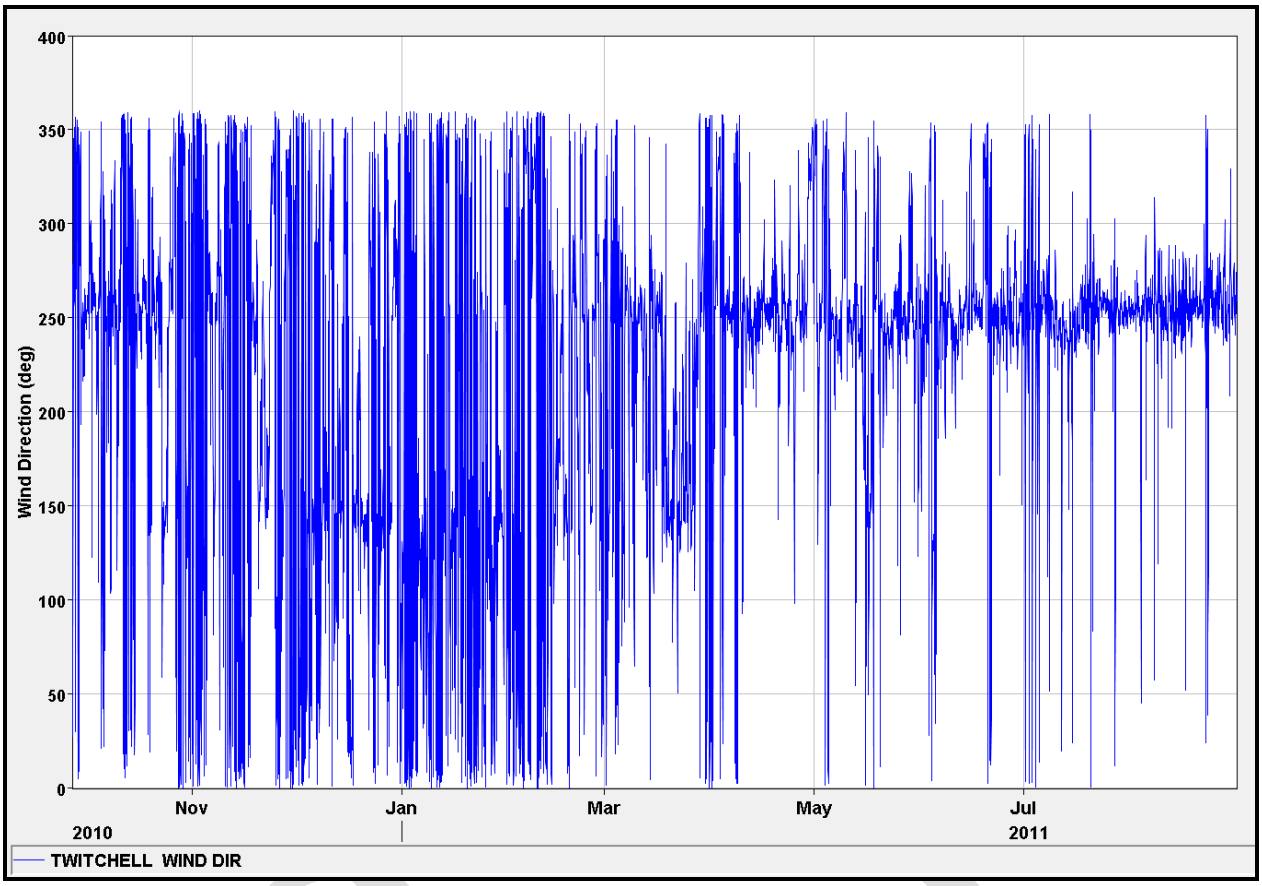

Figure C.5.4-52. Hourly Wind Direction at Twitchell CIMIS Station

Wind blowing over an open water area will result in wind waves. The wave height is dependent primarily on the wind speed, fetch, and water depth, with larger waves generally developing in deeper areas. These waves then may propagate into shallow areas and possibly steepen, further increasing wave height. Wind waves in channel areas are typically small because of limited fetch. However, larger wind waves can occur in open water areas, including ROAs. Wave heights and periods depend on primarily water depth and fetch, and approximate relationships have been developed to describe this variation. Equations from the U.S. Army Corps of Engineers Shore Protection Manual (Coastal Engineering Research Center 1984) have been used to estimate wave heights in the San Francisco estuary (e.g., Ganju and Schoellhamer 2007). These equations neglect effects of wave shoaling, refraction, and breaking (whitecapping) and other processes that are represented by more sophisticated approaches, such as the Simulation WAves Nearshore (SWAN) model (SWAN team 2009). Bricker (2003) compared predictions made with the two approaches in south San Francisco Bay and found them to match closely at some locations, although the simpler approach tended to underestimate amplitude and large fetch because of neglect of energy loss associated with wave breaking. Wave heights predicted using these equations for multiple fetch lengths are given for a wind speed of 4 m/s in Figure C.5.4-53 and for 10 m/s in Figure C.5.4-54.

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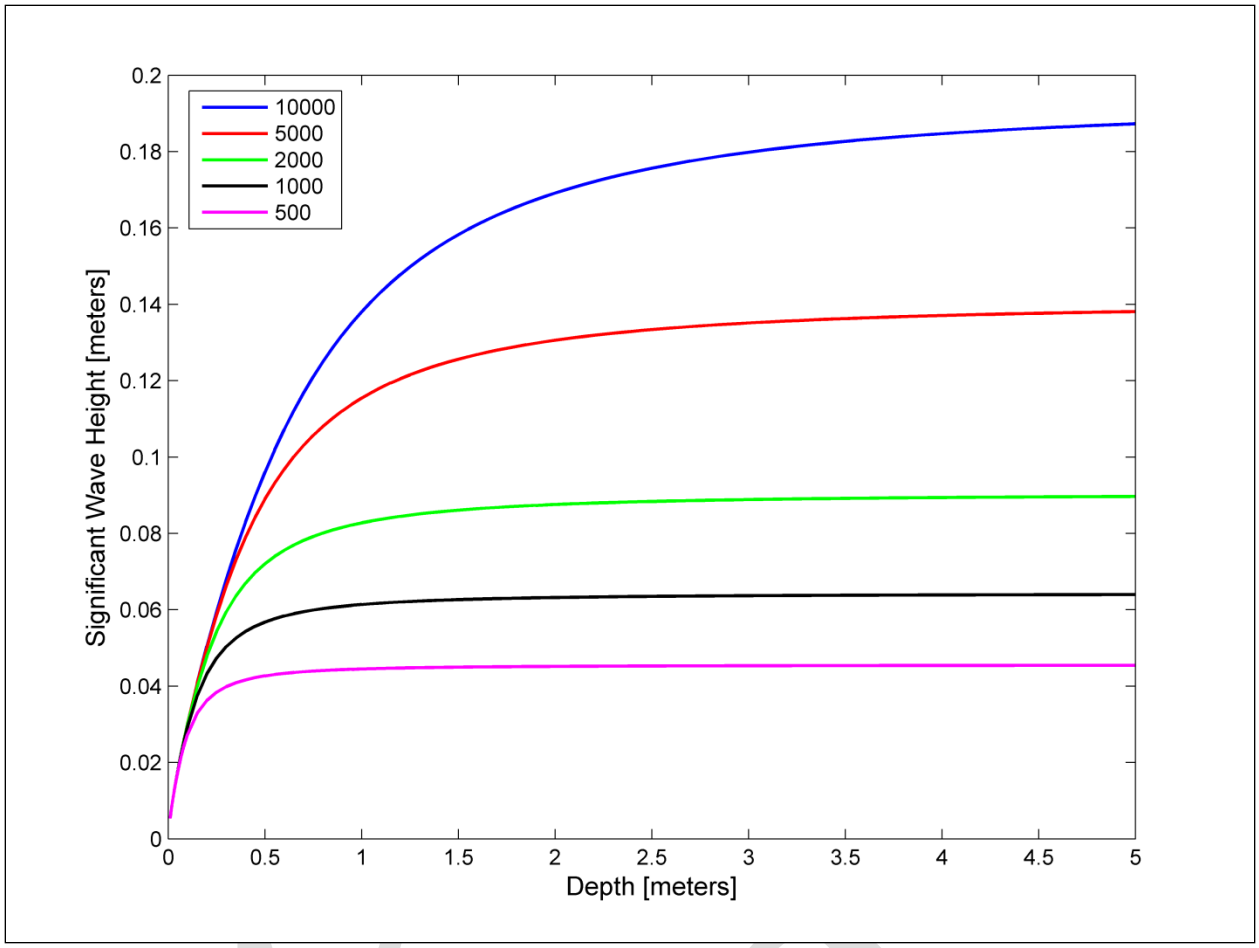

Figure C.5.4-53. Estimated Significant Wave Height for Wind Speed of 4 Meters per Second and Multiple Fetch Lengths (Meters)

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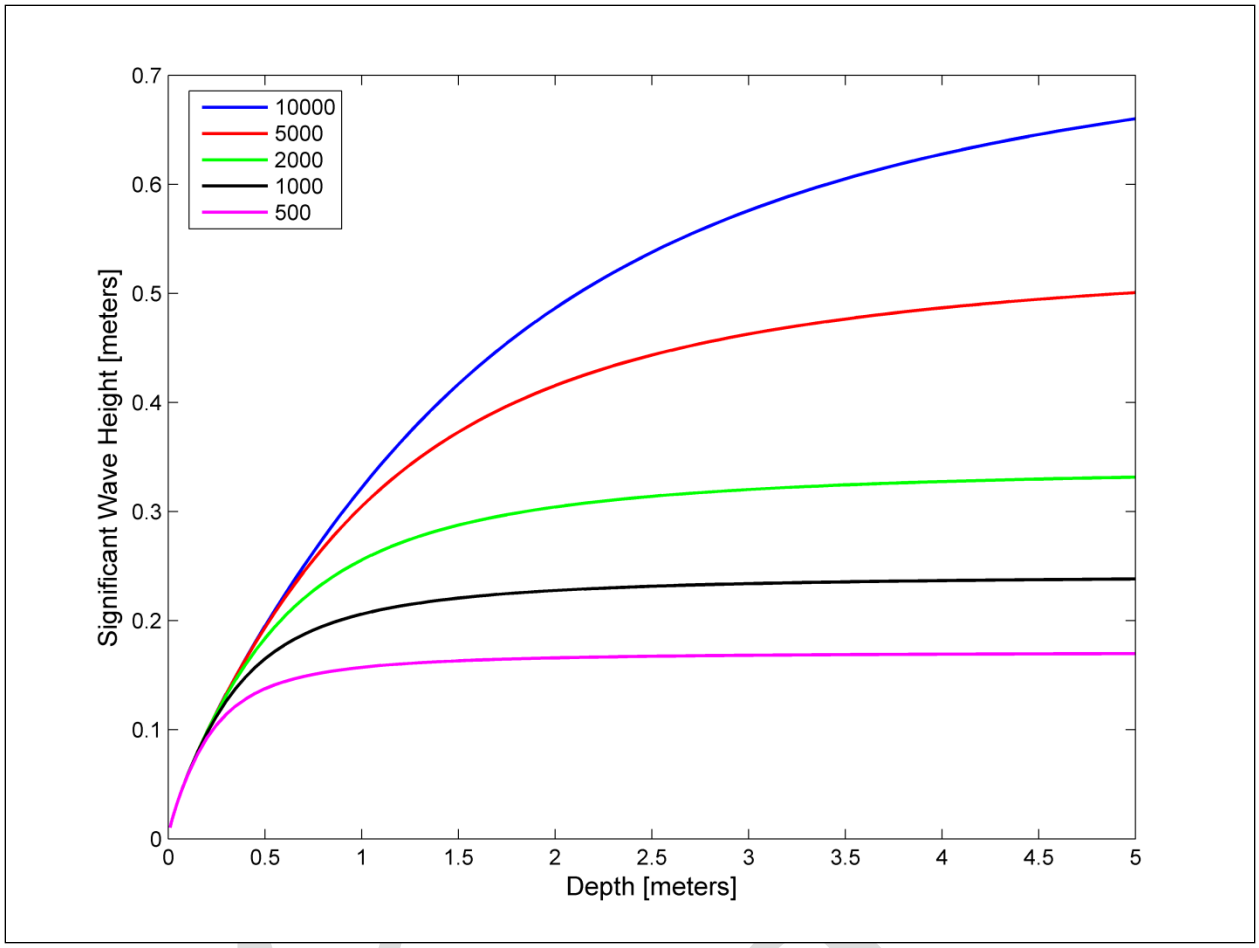

Figure C.5.4-54. Estimated Significant Wave Height for Wind Speed of 10 Meters per Second and Multiple Fetch Lengths (Meters)

The wind waves induce water particles to move in orbital paths throughout the water column (Dean and Dalrymple 2002). In addition, wind waves may break (whitecap), causing turbulence at the water surface. In shallow water columns this turbulence can extend down to the bed (Jones and Monismith 2008).

Wind waves affect turbidity in several ways. The most direct is through the local resuspension of sediment resulting from bed shear stress. Sediment is eroded from the bed when shear stress exceeds a critical shear stress, where the critical shear stress is dependent primarily on sediment size for non-cohesive sediment and additional bed properties for cohesive sediment. The bed shear stress associated with wind waves is proportional to the square of the orbital velocities at the bed. The orbital velocities decrease with depth. Therefore, deep water columns experience less bed shear stress than shallow water columns for a given wind wave. In places where the turbulent kinetic energy associated with whitecapping waves extends down to the bed, this can cause sediment resuspension. This typically occurs in shallow regions with large fetch, such as Grizzly Bay (Jones and Monismith 2008). Wind waves also have less direct effects on sediment. For example, wind waves can break or remove biofilms that bind sediment to the bed, thereby increasing the erodibility of the bed.

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Through these multiple mechanisms, wind waves can strongly influence the morphology of coastal lagoons observed in many locations. For example, in Venice Lagoon wind waves cause a bimodal distribution of depth in which most regions of Venice Lagoon are at either marsh elevations or subtidal elevations (Fagherazzi et al. 2007). Relatively little intertidal area is present in Venice Lagoon. As discussed above, this distribution occurs because the shear stress associated with wind waves peaks at a certain depth, very roughly 1 m with the exact "critical depth" depending on fetch and wind climate (Fagherazzi et al. 2007). If deposition decreases water depths below this critical value, a positive feedback loop results in smaller waves and reduced bed shear stress, which further decreases deposition, allowing the region to evolve to marsh elevation. In deeper regions, wind waves are larger and wind wave resuspension slows deposition and may cause net erosion, leading to gradual deepening.

The linear wave relationships used by Fagherazzi et al. (2007) to relate shear stress to wind speed, fetch length, and water depth can be applied for a range of parameters representative of present Delta conditions. Figure C.5.4-55 and Figure C.5.4-56show the estimated bed shear stress as a function of depth for multiple fetch lengths for a wind speed of 4 m/s and 10 m/s. Wind waves will result in sediment resuspension when the critical shear stress of erosion is exceeded. The weak critical shear stress of erosion value (0.1 Pascals [Pa]) and a strong critical shear stress of erosion value (1.0 Pa), used by Ganju and Schoellhamer (2007) to represent two different size classes in their sediment transport modeling in Suisun Bay, are labeled on the figures. Delta sediments consisting largely of sand (Ganju and Schoellhamer 2007) correspond to the higher value of critical shear stress of erosion. Therefore, at the lower wind speed of 4 m/s, resuspension would be expected only in shallow regions of unconsolidated silt and clay, while at the higher wind speed of 10 m/s, all shallow regions that are not sheltered from the wind are likely to experience significant wind wave–driven resuspension of sediment. More specifically, for long fetch distances, the predicted bottom shear stress exceeds the "strong" critical shear stress of erosion for depths greater than 0.1 m and less than 2 m. This corresponds roughly with the observed depths in Franks Tract and other large open water areas. Deeper than 2 meters, the critical shear stress of erosion decreases below the strong critical shear stress of erosion for all fetch lengths.

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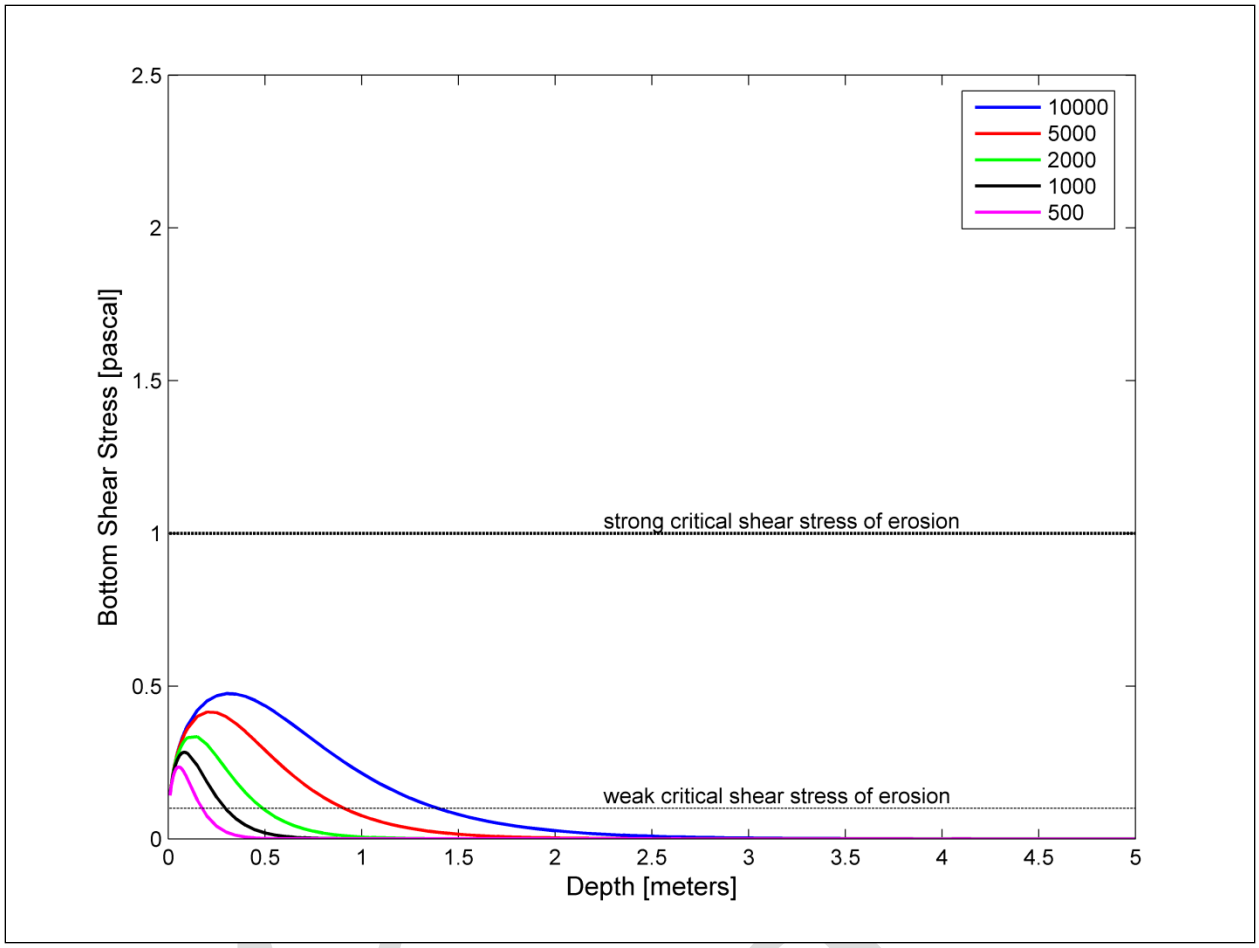

Figure C.5.4-55. Estimated Bed Shear Stress for Wind Speed of 4 Meters per Second and Multiple Fetch Lengths (Meters)

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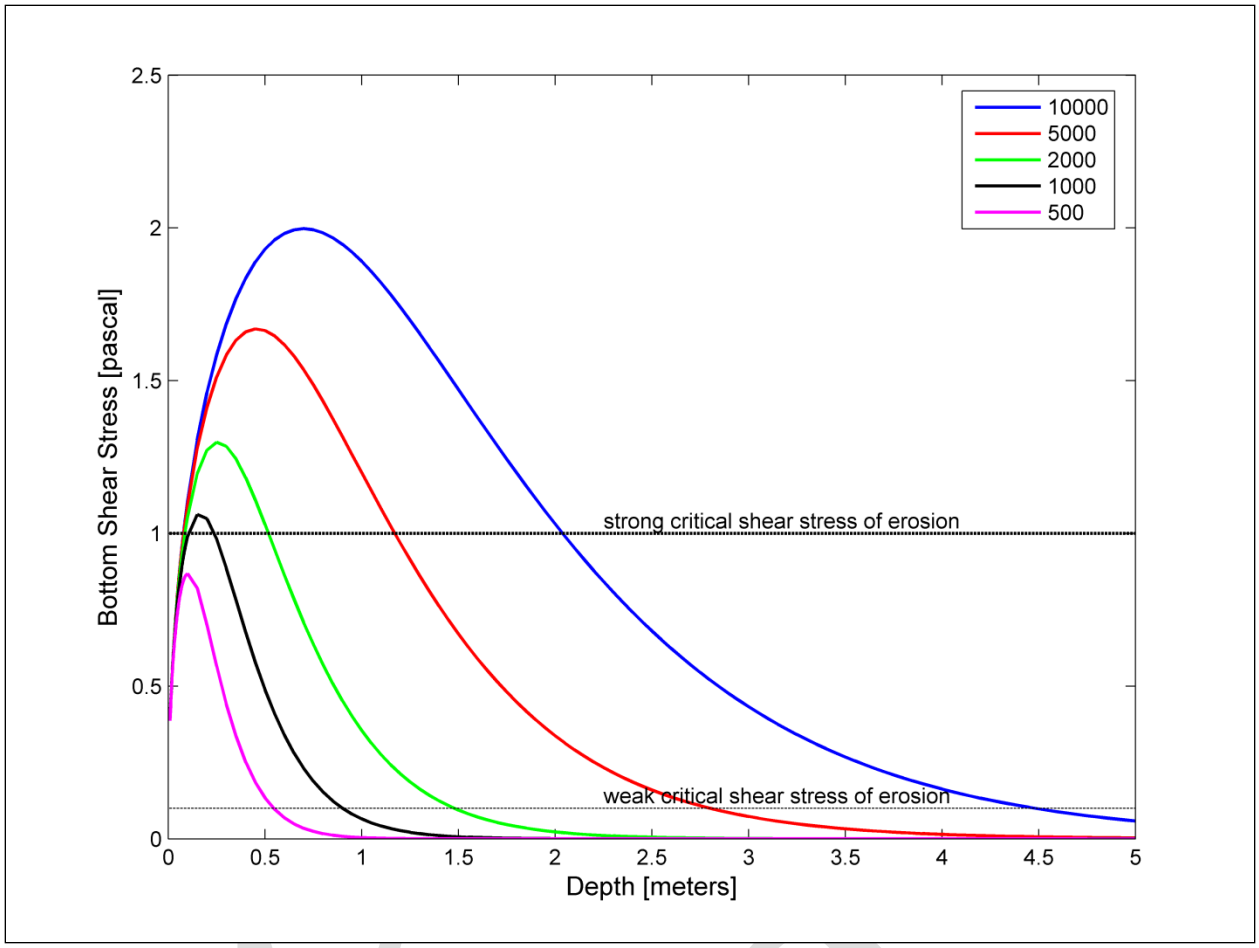

Figure C.5.4-56. Estimated Bed Shear Stress for Wind Speed of 10 Meters per Second and Multiple Fetch Lengths (Meters)

These figures largely explain the open water geomorphology observations discussed by Simenstad and others (2000). High rates of sediment accumulation have been observed in Mildred Island (47–51 mm/yr) and Rhode Island (44 mm/yr) because those deeply subsided areas are too deep for wind wave–driven sediment resuspension to be effective. Similarly, high rates of sediment accumulation have been observed in upstream portions of the Yolo Bypass and other bypasses (Singer et al. 2008) due to the combination of high sediment load and deep water. However, Sherman Island, Big Break, and Franks Tract appear to have reached open-water equilibrium with associated slow accretion rates (Simenstad et al. 2000). In those regions, resuspension from wind waves is understood to result in bed elevations remaining more than 2 m below mean lower low water (Simenstad et al. 2000).

The Suisun Bay subregion is particularly important as habitat because it typically contains the LSZ that is associated with peak observed abundance of several species of plankton and epibenthos, as well as larval and juvenile fish (Kimmerer et al. 2002). The important habitat indicator X2 (the location of the 2 psu contour for bottom salinity) frequently is located in Suisun Bay. Suisun Bay has extensive areas of shallow water (less than 2 m deep) with predominance of fine suspended and bed sediment, as well as channels 9–11 m deep with sandy bed sediment (Ganju et al. 2006). A large volume of sediment was deposited historically in Suisun Bay from hydraulic mining activities, but Suisun Bay has been consistently erosional for more than a century and experienced major loss of

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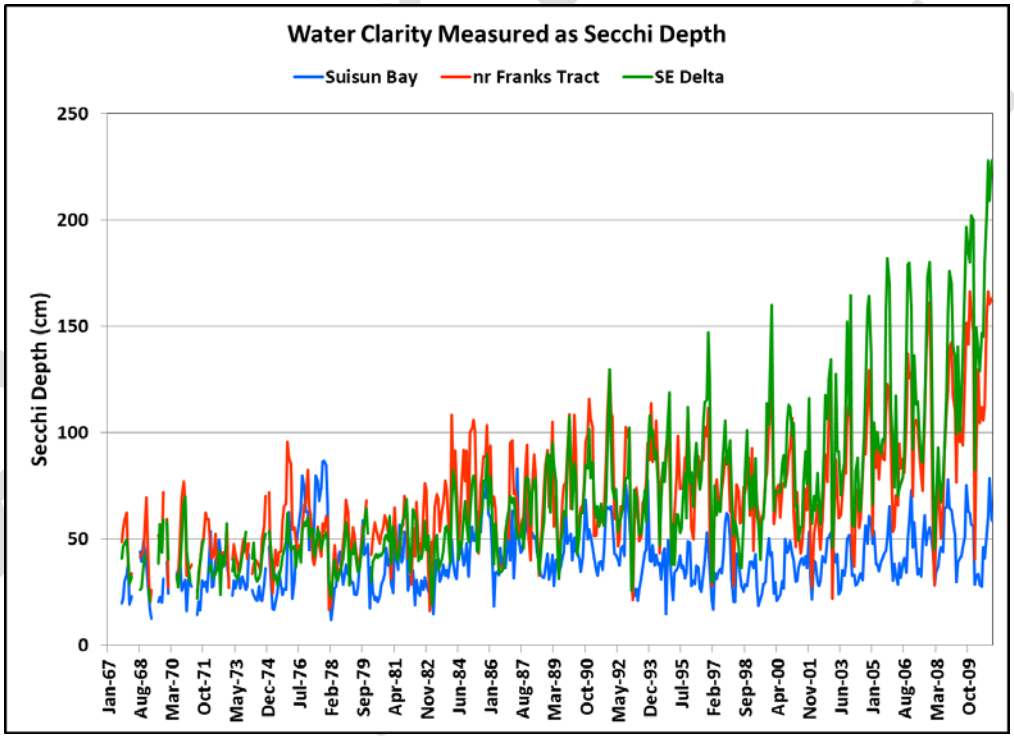
tidal flat area (Cappiella et al. 1999). However, the last bathymetric survey used in the analysis of Cappiella et al. (1999) was performed in 1990. Because the overall sediment supply to the Delta has decreased (Wright and Schoellhamer 2004) from 1957 through 2001, it is likely that Suisun Bay will continue to be erosional. However, as Suisun Bay deepens and intertidal regions are lost, wind waves will become less effective at suspending sediment, so erosion rates may slow even in the presence of reduced sediment supply.

Water clarity has been increasing in the Delta, particularly in the central and south Delta, as illustrated in Figure C.5.4-57 (see also Figure C.5.4-58 for locations) using Secchi disk data gathered from monitoring programs (B.J. Miller pers. comm.). (Note an increase in water clarity corresponds to a decrease in turbidity and in SSC.) While some of this decrease could be due to a decrease in sediment supply, the role of submerged aquatic vegetation (SAV) also has been considered (Kimmerer 2004). The SAV *Egeria densa* has been mentioned, in particular, as their presence is known to slow water velocity, which can induce sediment deposition. Although *E. densa* beds can trap fine sediment, neither the geographic distribution of *E. densa* nor the seasonal timing of *E. densa* growth (late summer and fall) closely matches the historical changes in Secchi depth (Kimmerer 2004). However, the relationship between increases in water clarity and the presence of *E. densa* has been well-established (Yarrow et al. 2009).



Source: Data taken from B.J. Miller analysis pers. comm.

Figure C.5.4-57. Secchi Depth Measured during Regular Monitoring and Fish Surveys—Monthly Averaged Data Averaged Regionally

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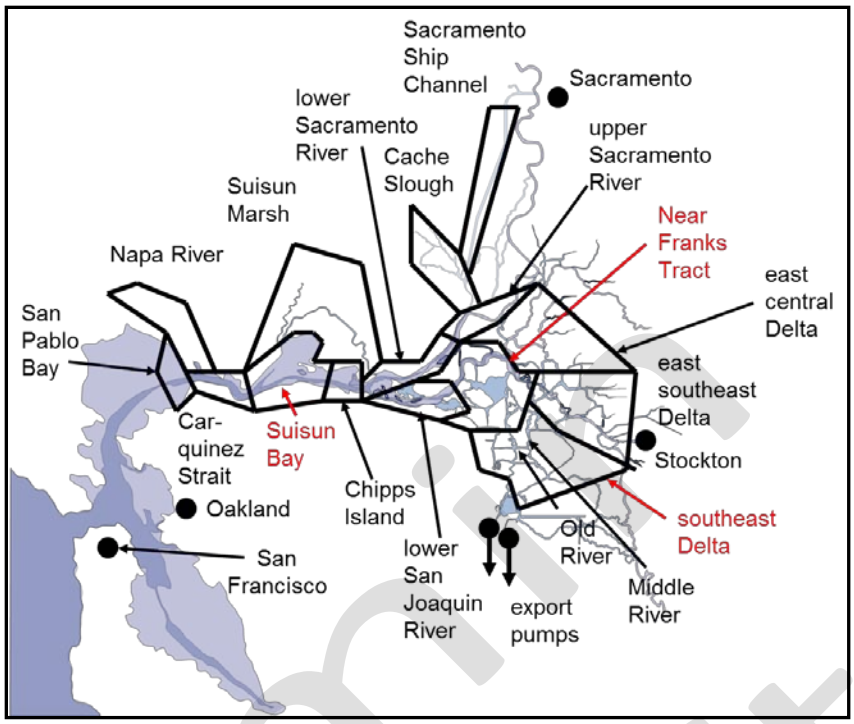

Source: Data taken from B.J. Miller analysis pers. comm.

Figure C.5.4-58. The Regions Used in Averaging Secchi Data (Red Font) Illustrated in Figure C.5.4-57

In summary, aside from some localized regions, the Delta is understood to be a depositional environment and is likely to remain that way into the future (Simenstad et al. 2000). However, the rate of accretion is spatially variable. High rates have been observed in marsh regions and deep open water areas, while much lower accretion rates are associated with shallow subtidal open water areas, such as Franks Tract. Therefore, marshes and deep open water areas reduce turbidity by accreting sediment, whereas shallow open water areas temporarily can increase turbidity during strong wind periods. Because of the strong influence of fetch on wind-wave growth, resuspension could be reduced by design features such as wind wave–break islands in ROAs.

Several factors that are known to affect sediment transport, and thus water clarity, have not been addressed in this section. Because there is a high level of uncertainty in the major driver of sediment supply, factors such as wetting and drying of sediments at the outer ranges of tidal inundation (sediment hardening), the role of bioturbation, and contributions from organic matter (Ganju et al. 2009), although important, are not considered here. However, it should be noted that the critical shear stress of erosion has been observed to vary substantially with changes in benthic algae and macrofauna (Ysebaert et al. 2005). Changes to the community of benthic organisms in the estuary could lead to substantial and unpredictable changes in water clarity. In addition, the role of benthic filter feeders is not considered, although they potentially could result in a seasonal and regional decrease in water clarity.

C.5.4.6.2 Factors Affecting Sediment Supply in the PP_LLT Model due to Shift in Export Location

In the preliminary proposal alternatives, water export is shifted to the Sacramento River near Freeport as export from the locations in the south Delta decreases. The question that arises is

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whether exporting more water near the major source of sediment supply will affect depositional characteristics of the Delta—i.e., whether this change will cause the Delta to significantly reduce deposition or in the long-term cease to be depositional. It is unlikely that this single factor will substantially alter sediment supply to the Delta for the following reasons.

- Most of the sediment supply is episodic in nature during the wet period, occurring over less than a third of the total timeframe on average.
- Sediment concentrations are generally higher during first flush events, which occur over a period of days to weeks annually (sometimes not at all during low-flow years).
- More water is being directed down the Yolo Bypass, which occurs upstream of the new export locations, in the LLT timeframe.

In the east Delta, decreased Sacramento River flow because of exports from the preliminary proposal means that less flow is directed through Georgiana Slough and through the Delta Cross Channel, the latter due in part to increased operation of the Delta Cross Channel, potentially having some effect on sediment supply to downstream areas and depositional characteristics there. However, the magnitude of the overall effect is uncertain.

Less water is being diverted from San Joaquin River flows in the preliminary proposal alternatives, as exports in the south Delta diminish. Wright and Schoellhamer (2005) found that there is a significant diminution of sediment supply downstream of Vernalis before Stockton, indicating that deposition is occurring along the San Joaquin River and thus potentially also along Old River and Middle River. As exports decrease in the south Delta, the portion of the sediment supply that previously was exported is available for deposition in the south and central Delta. Although the future rate of sediment deposition is unclear, it is likely that depositional (or erosional) changes would be small because of the change in export conditions alone.

C.5.4.6.3 Factors Affecting Sediment Supply and Water Clarity in the EBC2_LLT and PP_LLT Models due to Climate Change and Sea Level Rise

Although the current trend is for decreasing sediment supply to the Delta, the uncertainty in change in sediment supply in coming decades, as discussed above, is high (Wright and Schoellhamer 2004). Change in the timing and volume of flow patterns due to climate change has the potential to alter sediment supply and the timing of the supply as spring snowmelt sediment concentrations are lower than first flush events at the same flow rates (Schoellhamer et al. 2007). The timing of the bulk of sediment deposition may affect resuspension during the seasonal period of high winds. As newly deposited sediment is resuspended more easily, earlier deposition of sediment as a result of earlier snowmelt may result in less resuspension in the summer, and a seasonal increase in water clarity (Ganju and Schoellhamer 2010).

Sediment supply could increase because of climate change–induced changes in land use patterns from urbanization, shifts in agriculture, grazing, and logging. Sediment supply to the Delta could decrease with upstream removal of levees or replacement of armored levees with setback levees, as deposition then would occur along upstream reaches. Overall, Schoellhamer and others (2007) have concluded that those factors that modify the flow regime alone, such as climate change, are less likely to affect sediment supply to the Delta than factors that change both flow regime and upstream supply.

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Ganju and Schoellhamer (2010) conducted a series of modeling exercises to evaluate the effects of sea level rise (6 cm sea level rise at the seaward boundary), climate change (effects of increased air temperature), and changes in sediment supply in Suisun Bay for several 2030 scenarios. In Suisun Bay, the authors found that increases of water depth due to sea level rise reduced sediment resuspension, thereby increasing water clarity. Sediment deposition actually showed a net increase in areas with depths of 0–2 meters, although this was not quite enough to keep pace with sea level rise, so the shallowest areas deepened despite this deposition. All other areas showed net erosion. When assuming a reduced sediment supply of 34%, the authors found that the shallowest areas still experienced an increase in deposition with all other areas showing a net loss. In dry years, landward transport of existing unconsolidated sediment supply in San Pablo Bay was more prevalent, favoring an increase in deposition on the seaward end of Suisun Bay. Increased tributary flows in wet years overall resulted in greater sediment export from the Delta, although off-channel shoals were still depositional from this upstream sediment supply.

However, many of the observations by Ganju and Schoellhamer (2010) are general enough to inform discussion about the Delta as a whole as applied to the EBC2 LLT scenario (45 cm sea level rise, no development of ROAs) in comparison with the PP_LLT scenario (with ROA development). Much of the discussion of sediment transport in Suisun Bay under sea level rise scenarios in Ganju and Schoellhamer (2010) informs expected effects of the EBC2_LLT and PP_LLT scenarios on turbidity. If sediment supplies are reduced in the future, there will be a net decrease in deposition in the estuary, which is likely to be linear with distance from the sediment source or weakly nonlinear. An increase in mean water depth due to sea level rise will result in a reduction in shear stress due to wind waves, and potentially lead to a (local) increase in water clarity as sediment resuspension is decreased. On the other hand, an increase in tidal prism, as would occur with the increase in the mean volume of the Delta in the PP_LLT scenario with the development of the ROAs, could result in increased tidal velocity and increased shear stresses, and potentially a (local) decrease in water clarity due to increased resuspension. However, the complex geometry of the Delta precludes an overly simplistic interpretation of these generalizations (Ganju and Schoellhamer 2010).

C.5.4.6.4 General Factors Affecting Sediment Supply and Water Clarity in the Restoration Opportunity Areas

Geomorphic changes resulting from patterns of erosion and deposition at the decadal time scale ultimately will determine the overall changes to water clarity in the Delta in each region. In what follows, it is assumed that all local changes due to the breaching of levees have stabilized (i.e., have come into partial equilibrium) and that full tidal exchange is available at each restoration site (Schoellhamer et al. 2007).

The assumption in what follows is that the depositional and erosional changes under consideration are due in large part to the availability of upstream sediment supply, and that the Delta or at least portions of the Delta remain depositional, although the mass of sediment supply is unknown. Because the sediment supply is unknown (Wright and Schoellhamer 2004), the timeframe for any restoration area to reach a state of equilibrium or dynamic equilibrium (in a decadal sense) also is unknown.

Schoellhamer and others (2007) proposed that the location of the restoration site in relation to sediment supply and other areas, such as existing marsh or wetlands, that are currently depositional should be considered. Because each of these areas is a sink for sediment, if the restoration site is upstream of the existing depositional area, it will receive sediment supplies formerly deposited in

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the existing site, and the potential exists for the existing site to become erosional as sediment supply diminishes there. Also, if the existing depositional site is between the restoration site and the ocean, increases in tidal prism and energy may erode the existing site (e.g., if the existing site is tidal marsh) (Schoellhamer et al. 2007).

This presents a complex picture for predicting changes to water clarity due to the large scale changes in ROAs proposed for the Delta in the LLT timeframe. In what follows, changes are hypothesized in each of the subregions below, given the conceptual models proposed in Schoellhamer et al. (2007) as well as the specific references identified in each section. The Cache Slough and Yolo Bypass subregions are combined for this discussion.

North Delta Subregion

Potential changes to turbidity in this region include episodic change due to seasonal shifts in outflow timing and volume due to climate change (such as earlier snowmelt). Changes to sediment supply in the Sacramento River are uncertain, as mentioned previously. There are no ROAs in this subregion. Sediment accretion may increase with sea level rise because the present channel geometry may be roughly in equilibrium with present flow rates (Simenstad et al. 2000). Under the PP_LLT scenario flows may decrease because of exports near Freeport while, cross-sectional area will increase because of sea level rise.

Cache Slough and Yolo Bypass Subregions

Figure C.5.4-59 illustrates the changes in tidal datum in the Cache Slough ROA in the PP_LLT scenario—this ROA constitutes 20,330 acres. Because strong deposition currently is observed in the Yolo Bypass (Singer et al. 2008), these areas likely will be depositional in the PP_LLT scenario, as increases in Yolo Bypass flows increase the available sediment both in the Cache Slough and in the Yolo Bypass subregions. Some landward (north and west) portions of the Cache Slough ROA are near mean sea level so are likely to become vegetated rapidly and accrete sediment effectively (Simenstad et al. 2000). Increased flows and sediment load passing through the Yolo Bypass may result in increased turbidity in portions of the Sacramento River Deep Water Ship Channel. It is possible that deposition in these areas will decrease deposition in downstream areas along the Sacramento River and Suisun Bay, and thus preclude the development of additional tidal marsh (McKee et al. 2006).

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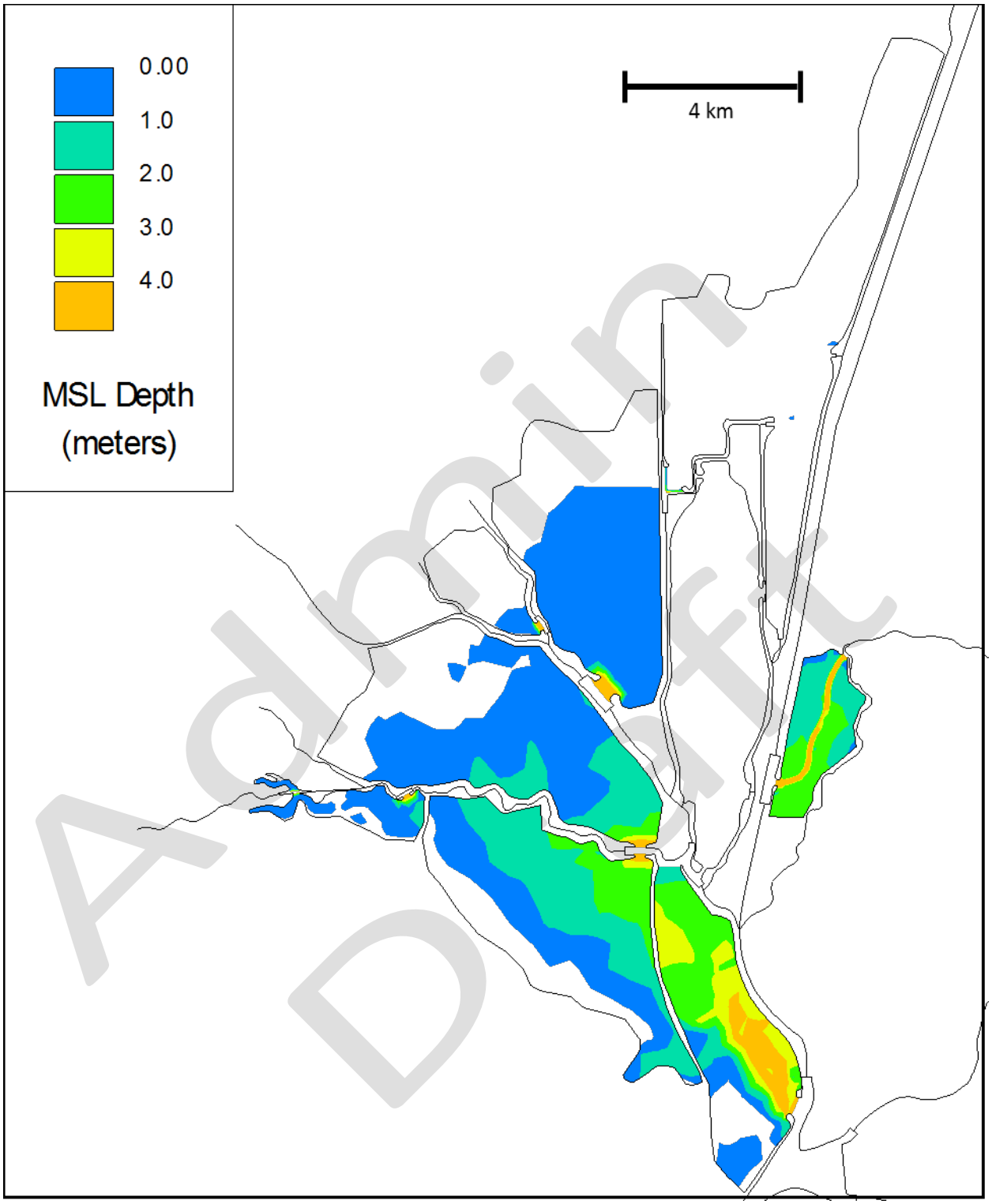

Figure C.5.4-59. Depth at Mean Sea Level in the Cache Slough ROA for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

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West Delta Subregion

Figure C.5.4-60 illustrates the depth at mean sea level in the West Delta ROA, PP_LLT scenario; this ROA constitutes 4,240 acres. Emmaton sees reduced tidal flow as a result of the downstream restoration in Suisun Marsh and increased tidal flow as a result of the upstream restoration in Cache Slough, resulting in a small increase (about 2%) for the PP_LLT scenario. Most of the change at this location is associated with sea level rise. Rio Vista is under similar influence, but the impacts from sea level rise and Cache Slough restoration are larger. Some regions along the Sacramento River and Threemile Slough may be shallow enough for rapid establishment of a vegetated marshplain, which could lead to rapid accretion of sediment and decreases in turbidity.

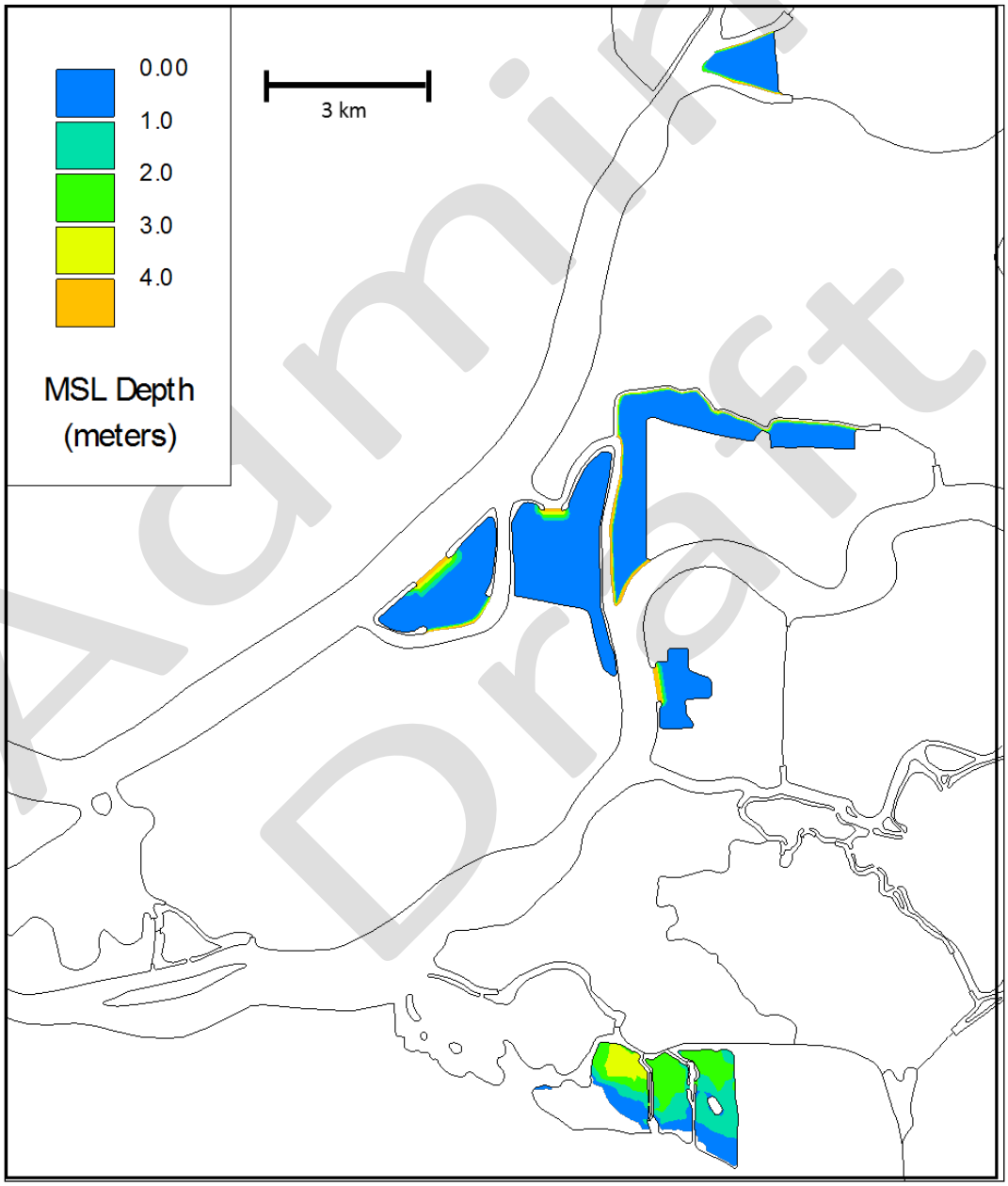

Figure C.5.4-60. Depth at Mean Sea Level in the West Delta ROA for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

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Suisun Marsh Subregion

Figure C.5.4-61 illustrates the depth at mean sea level for the Suisun Marsh Slough ROA, PP_LLT scenario; this ROA constitutes 14,390 acres. The impact of restoration on tidal range in Suisun Marsh is significant for the PP_LLT scenario. In particular, this results in significant changes in tidal flow in Montezuma Slough. In the higher elevations of the Suisun Bay ROAs, marsh accretion can be expected, which would lead to further decreases in turbidity. Because this ROA is divided into several small regions separated by channels and levees, fetch will be limited, so wind-wave resuspension may be smaller than in larger open water regions.

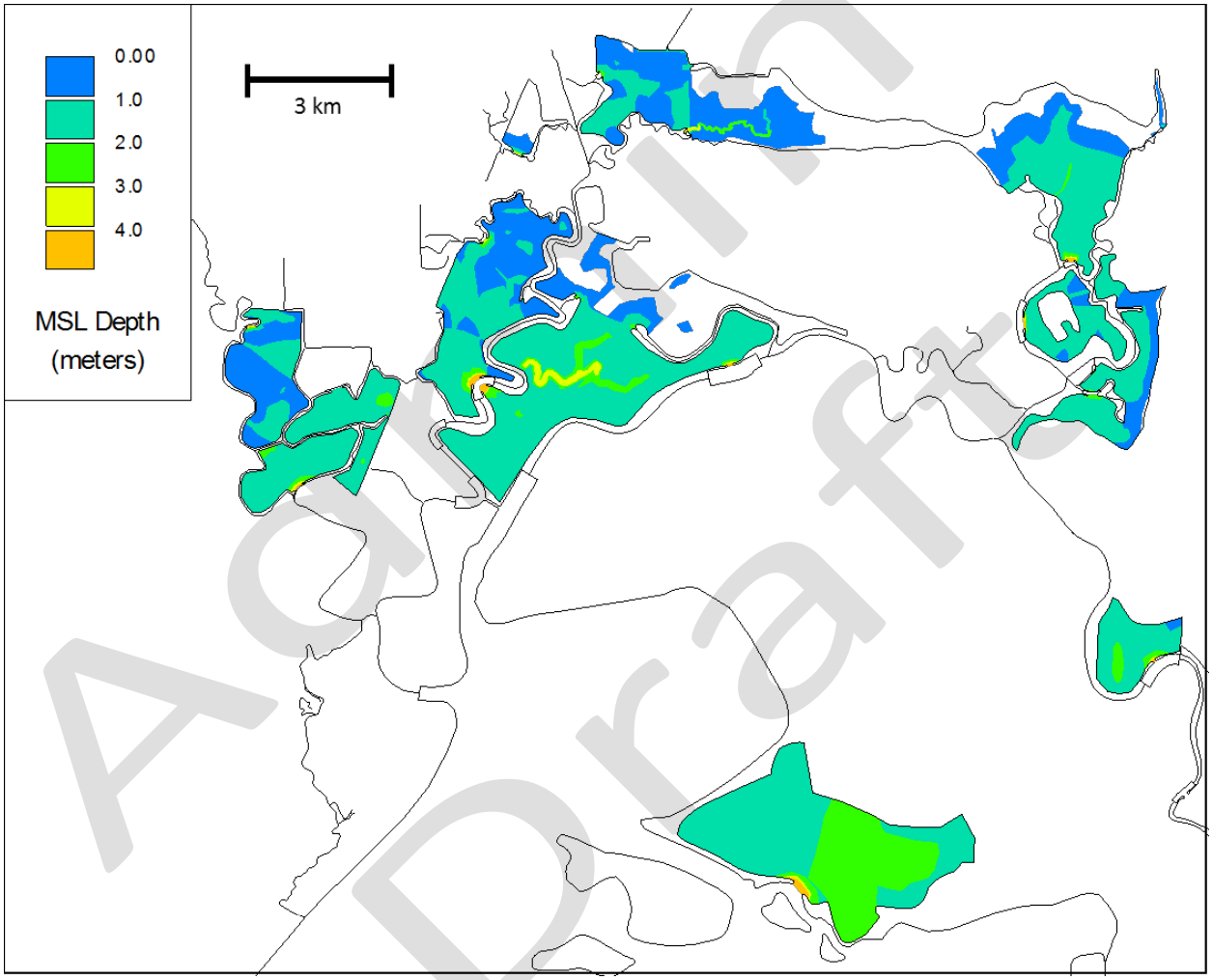

Figure C.5.4-61. Depth at Mean Sea Level in the Suisun Marsh ROA for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

East Delta Subregion

Figure C.5.4-62 illustrates the depth at mean sea level in the Cosumnes-Mokelumne ROA in the PP_LLT scenario; this ROA constitutes 3,290 acres. Figure C.5.4-63 illustrates the depth at mean sea level in the East Delta ROA in the PP_LLT scenario; this ROA constitutes 2,160 acres.

Sediment supply from the Sacramento River into the East Delta subregion will be reduced under the PP_LLT scenario as flows through the Delta Cross Channel plus Georgiana Slough are significantly

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reduced because of added restoration area. This is due to a combination of decreased tidal range in the Sacramento River near Georgiana Slough and the Delta Cross Channel and the connection of Miner Slough to the Sacramento Deep Water Ship Channel through the restoration of Prospect Island.

The location of the ROAs downstream of the Mokelumne and Cosumnes Rivers means the potential exists for deposition to occur from sediment supplied by these watersheds. However, this has been estimated to be a very small percentage of the overall sediment supply in the Delta, composing only about 3.3% of the sediment discharge on the Sacramento River at Freeport (Schoellhamer et al. 2007).

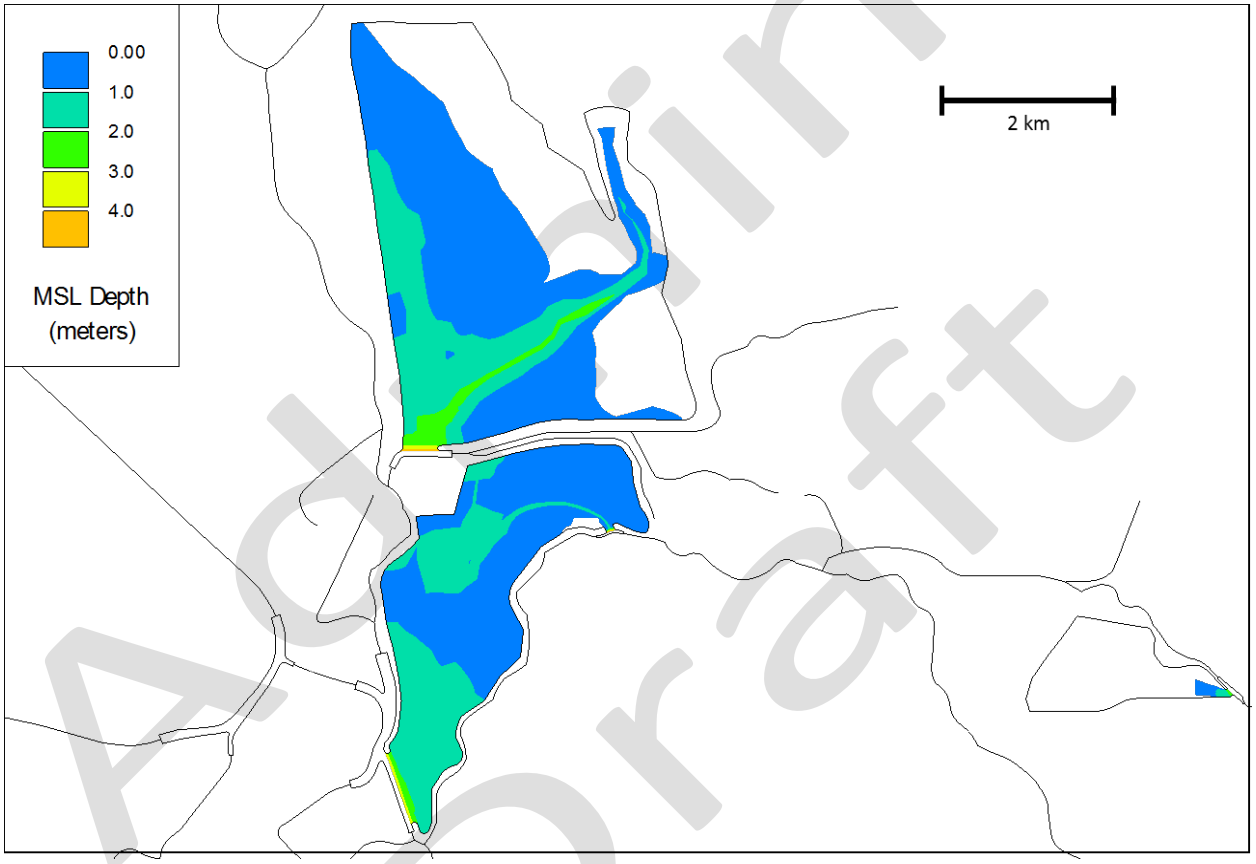

Figure C.5.4-62. Depth at Mean Sea Level in the Mokelumne-Cosumnes Restoration Opportunity Area for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

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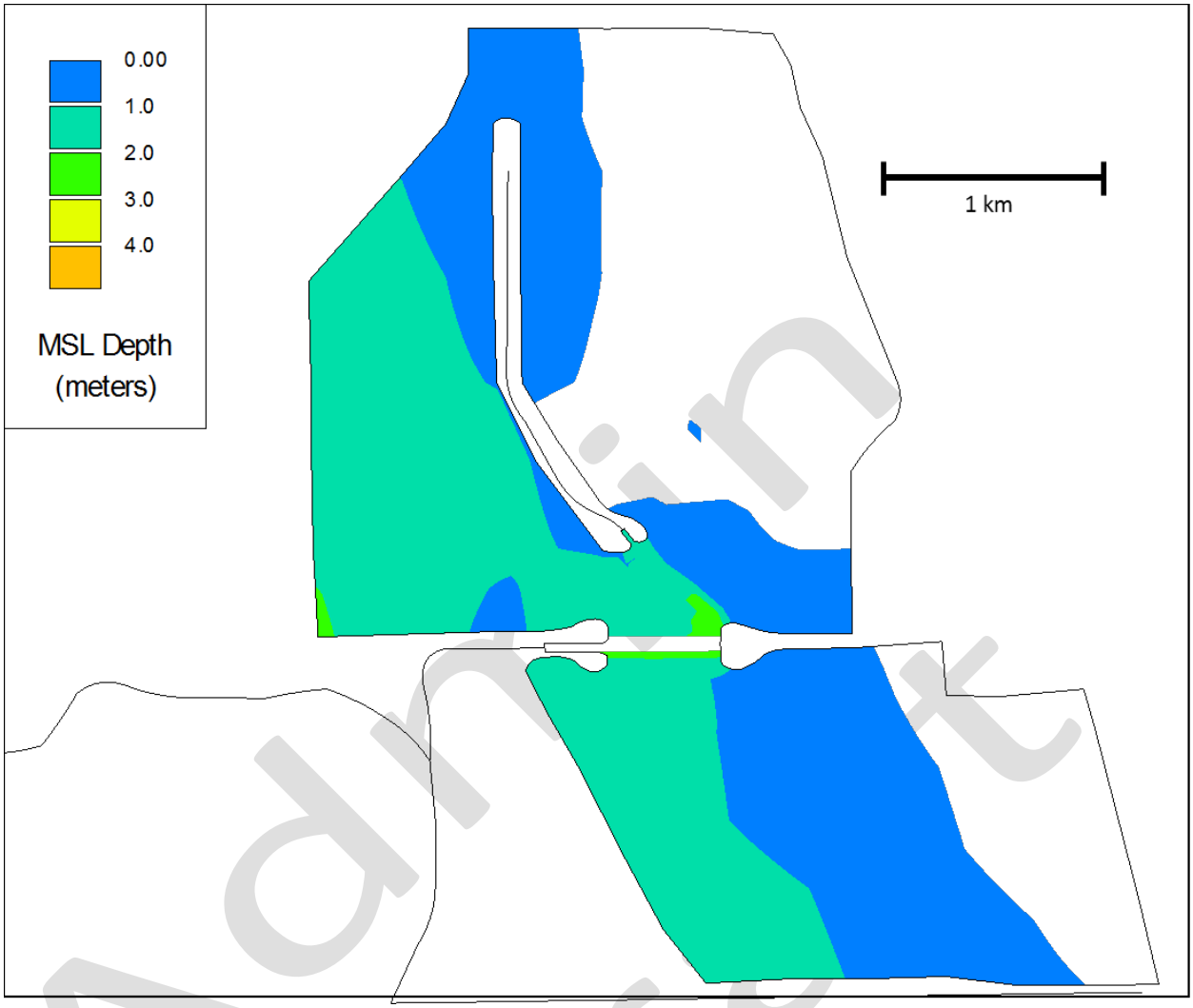

Figure C.5.4-63. Depth at Mean Sea Level in the East Delta Restoration Opportunity Area for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

South Delta Subregion

Figure C.5.4-64 illustrates the depth at mean sea level in the South Delta ROA in the PP_LLT scenario; this ROA constitutes 22,480 acres. At Jersey Point, tidal flow increases because of sea level rise but decreases as a result of restoration, indicating that tidal flows at this location are affected by downstream restoration in Suisun Marsh. Previous modeling analyses (RMA 2010) for the January 1989–December 1990 time period showed that tidal flow in Middle River is reduced by downstream restoration. Tidal range is severely diminished near the Union Island restoration area because of limited channel capacity in Middle River. Sea level rise increases tidal flow at all locations.

Because this ROA consists of large open water areas, fetch length will be large, leading to large wind waves in deep regions. These waves will limit accretion rates and periodically may increase turbidity locally during strong wind periods that resuspend previously deposited but unconsolidated sediment.

As mentioned in the export discussion, less water is being diverted from San Joaquin River flows in the preliminary proposal alternatives, as exports in the south Delta diminish. The small amount of

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sediment supply not being exported is now available for deposition in the south and central Delta. Although the future rate of sediment deposition from either the Sacramento or San Joaquin River is unclear, it is likely that depositional or erosional changes would be small because of the changed export conditions.

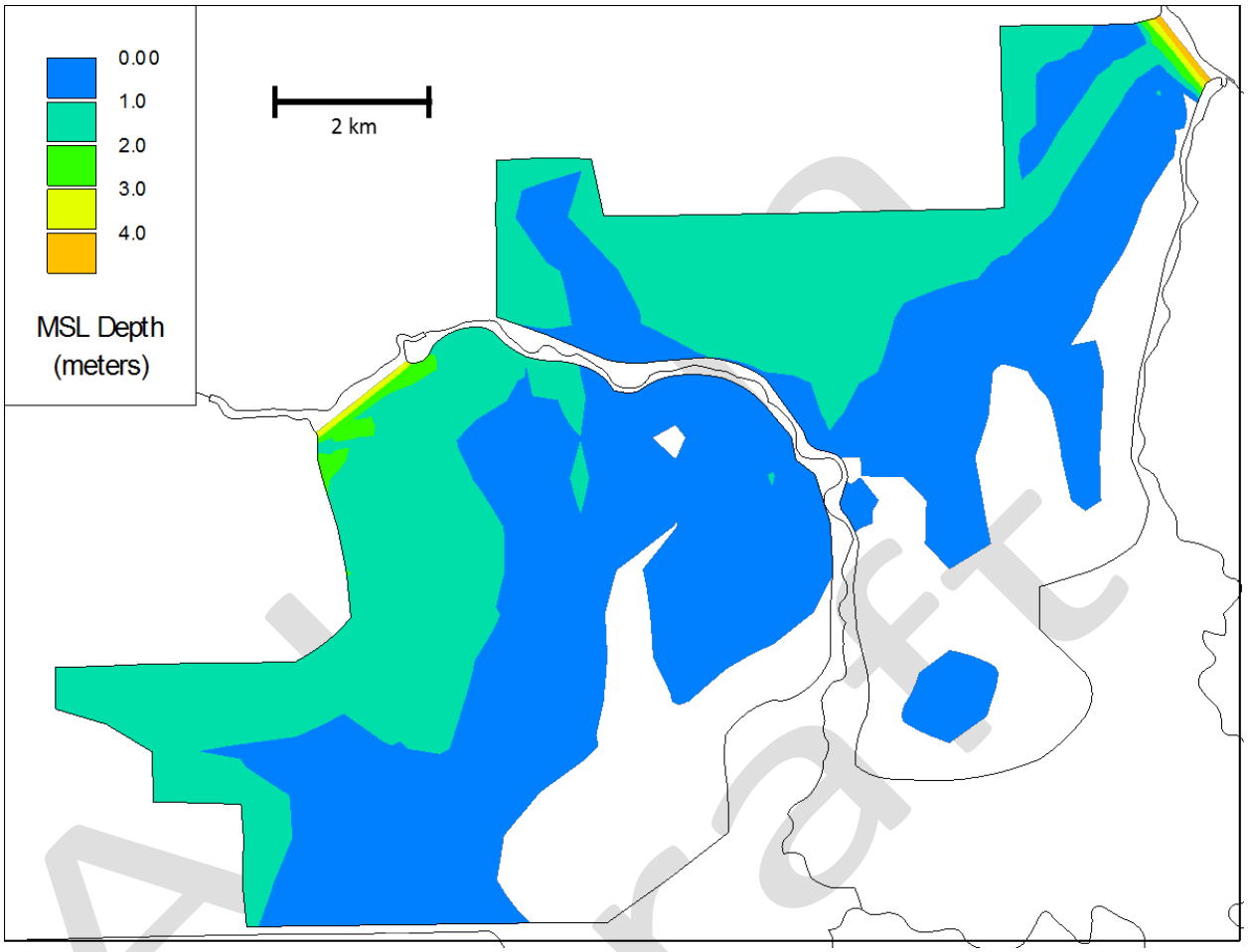

Figure C.5.4-64. Depth at Mean Sea Level in the South Delta Restoration Opportunity Area for the PP_LLT Case (with 45 Centimeters of Sea Level Rise)

C.5.4.6.5 Summary

Table C.5.4-210 and Table C.5.4-211 summarize the potential effects of two of the major contributors to water clarity in the Delta under the PP_LLT scenario due to the establishment of the ROAs—whether each region is likely to become a depositional or an erosional environment and the specific effect of seasonal summer winds on sediment resuspension within the ROAs. Uncertainty in sediment supply in the future is high, and factors such as the timing of establishing the ROAs and the potential use of options such as fill-in materials or wind breaks in the ROAs to reduce wind-driven resuspension preclude all but the most general analysis. The roles of SAV, benthic filter feeders, organic materials, and other factors have not been considered. In addition, it should be noted that the critical shear stress of erosion has been observed to vary substantially with changes in benthic algae and macrofauna (Ysebaert et al. 2005), so their effects on water clarity could be substantial.

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Table C.5.4-210. Potential Subregional Effects of the Restoration Opportunity Areas in the PP_LLT Scenario in Comparison to the EBC2_LLT Scenario

Delta Subregions	Depositional or Erosional Change as a Result of ROAs	Effect of D/E on Water Clarity in Subregions
North Delta	U	U
Cache/Yolo	D	M
West Delta	M	I
Suisun Bay	M	U
Suisun Marsh	D	I
East Delta	M/U	I
South Delta	D	I
Note: Subregional water clarity is influenced by the "D"epositional or "E"rosional characteristics within the region. Some regions are "M"ixed (some deposition and some erosion), "U"ncertainty is too high to estimate the characteristics; "I"ncrease in water clarity. ROA = restoration opportunity area.		

Table C.5.4-211. Potential Effects of Seasonal Winds on Water Clarity within the Restoration Opportunity Areas in the PP_LLT Scenario

Delta Subregions	Seasonal Wind Resuspension in the ROAs	Effect of Seasonal Wind on Water Clarity in the ROAs
North Delta	N	N/A
Cache/Yolo	Y	D
West Delta	ME	ME
Suisun Bay	Y	D
Suisun Marsh	Y	D
East Delta	ME	ME
South Delta	Y	D
Seasonal winds influence water clarity depending on fetch, wind strength, and water depth as discussed in the text. Symbols are: "Y"es, "N"o, "ME" ~ Minor effect, "D" ~ decrease in water clarity. ROA = restoration opportunity area.		

The Delta will remain regionally depositional in the LLT timeframe, in both the EBC2 and the PP scenarios, although the location of the depositional regions will differ. The effects of sea level rise will depend on the balance between sediment supply from the watersheds and the rate of sea level rise, so it is unclear whether sediment supply will be sufficient to maintain the current extent of tidal marsh. The initial effect of the ROAs in the preliminary proposal is to decrease sediment supply downstream, but the longer-term effects are uncertain as the ROAs reach a dynamic equilibrium.

Under the PP, the North Delta subregion will receive less sediment because of increased flows through the Yolo Bypass, but this may not be a large enough factor to differentiate these effects from the overall effects due to sea level rise and climate change alone in the EBC2_LLT scenario. The Cache Slough/Yolo Bypass subregion ROAs will become depositional with sediment that otherwise would be carried down the Sacramento River. While the ROAs have the potential to increase water clarity in existing open water areas such as Liberty Island at least initially, wind resuspension of unconsolidated sediment during the summer is likely to decrease water clarity in the region seasonally. The West Delta ROAs will accrete sediment, resulting in a local increase in water clarity

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in combination with decreased supply due to sediment deposition in the Cache Slough/Yolo Bypass Regions. However, decreased sediment supply could result in erosion and a decrease in water clarity, leaving a mixed picture for this region. The East Delta subregion is likely to experience increased water clarity due to the ROAs, because of decreased flow through Georgiana Slough and deposition in the East Delta ROAs of the small amount of sediment originating from the Mokelumne and Cosumnes Rivers. The effect of seasonal winds will be minor as the ROAs are not large in the East Delta. The South Delta ROAs consist of large open water areas that (barring establishment of SAV such as *Egeria densa*) likely will experience decreased water clarity due to wind resuspension in the summer. However, deposition in the ROAs also could increase water clarity, resulting in an overall mixed picture.

The effect of the Suisun Bay subregion ROAs, both locally and because of effects from upstream ROAs, is complicated. Suisun Bay is currently erosional and the opening of ROAs upstream is likely to increase this erosion (Schoellhamer et al. 2007). As mentioned in previous sections, if Suisun Bay continues to deepen and intertidal regions are lost, wind waves will become less effective at suspending sediment, so erosion rates may slow even in the presence of reduced sediment supply. The new ROAs may exert a local decrease in water clarity from seasonal resuspension due to wind. However, predicting the balance between the depositional environment in the ROAs and increased regional erosion is very complicated, so the overall result for water clarity is uncertain. The ROAs in Suisun Marsh likely will be depositional because of local sediment supply, resulting in local increases in water clarity. The effects of wind resuspension on decreasing water clarity likely will be limited to the larger ROAs in this region, depending on wind direction.

C.5.4.7 Delta Smelt Fall Abiotic Habitat Index

This section analyzes the changes in abiotic habitat with and without restoration. Section C.5.4.7.2 includes the analysis of changes in abiotic habitat with the restoration included in the Preliminary Proposal.

C.5.4.7.1 Abiotic Habitat without Restoration

The results of the delta smelt fall abiotic habitat index analyses based on the method of Feyrer and coauthors (2011) suggested that the abiotic habitat index under preliminary proposal (PP_ELT and PP_LLT) scenarios would be similar to EBC1 in the driest 50% of years and similar to EBC2, EBC2_ELT, and EBC2_LLT in just under the driest 40% of years (Figure C.5.4-65). There was estimated to be less than a 1% difference in the habitat index at the 80% exceedance level between the preliminary proposal scenarios and both the EBC1 and EBC2. For the wettest 50% of years, the preliminary proposal had an approximately 4 to 20% lower abiotic habitat index than EBC1 (Table C.5.4-212 and

Table C.5.4-213). Relative to the EBC2, the abiotic habitat index under the preliminary proposal was around 30 to 40% lower in the wettest 60% of years (i.e., at the 40% exceedance level and above) (Figure C.5.4-65). There was estimated to be a 30 to 35% greater abiotic habitat index at the 50% exceedance level and about a 35 to 40% difference at the 20% exceedance level (Table C.5.4-212,

Table C.5.4-213). Expressed by water year type, the average abiotic habitat index under PP scenarios was around 3,800 hectares (ranging from an average of 3,000 hectares in critical years to around 4,000 hectares in wet years) and was on average 170–240 hectares lower than the average

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habitat index under EBC1 (around 4,000 hectares on average, ranging from 3,000 hectares in critical years to 4,700 hectares in wet years) (Table C.5.4-214, Table C.5.4-215).

The average habitat index under the PP scenarios was not greatly different from the average habitat index under EBC1 in all water year types except wet, for which the PP habitat indices were on average 560–660 hectares (12–14%) less (Table C.5.4-214, Table C.5.4-215). The PP scenarios had an overall average habitat index that was around 1,000–1,300 hectares less than the three EBC2 scenarios, with little average difference in critical, dry, and below-normal years (Table C.5.4-215). In above-normal years the average habitat index under PP scenarios was 1,500–2,000 hectares (27–35%) less than the EBC2 scenarios, and in wet years the average habitat index under PP scenarios was around 3,000 hectares (over 40%) less.

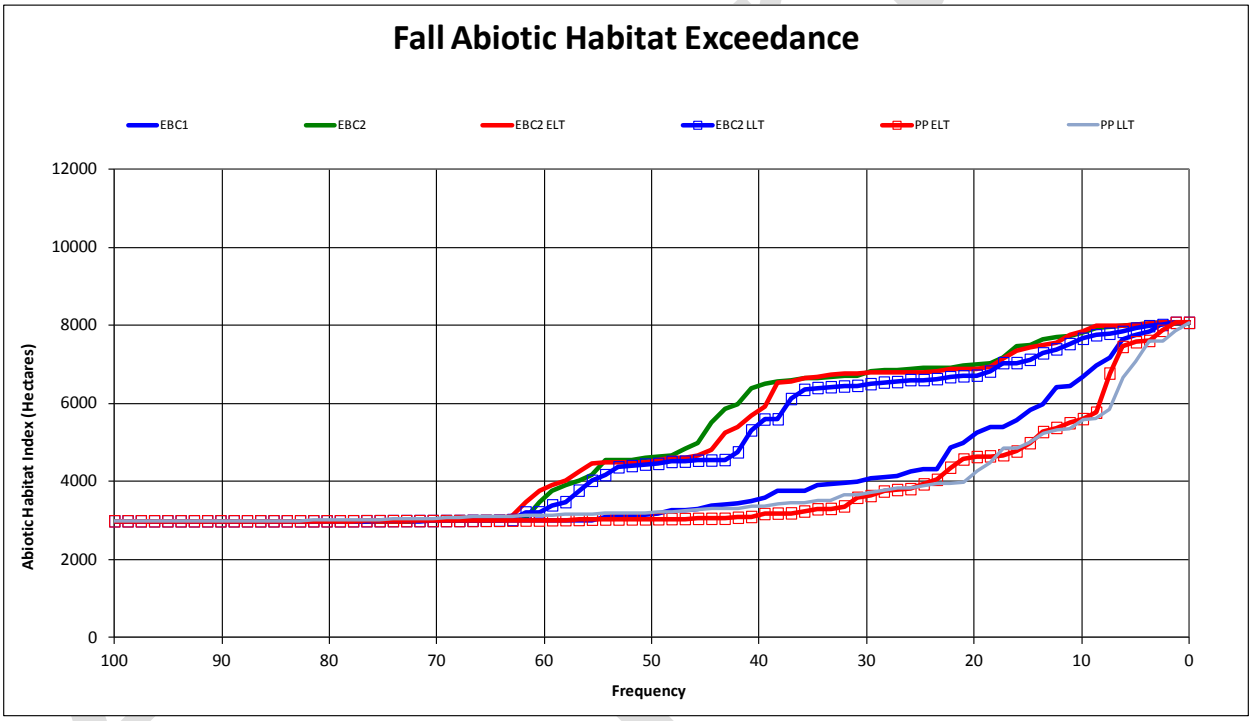

Figure C.5.4-65. Exceedance Plot of Delta Smelt Fall Abiotic Habitat Index (Hectares) without Restoration, September through December

Table C.5.4-212. Delta Smelt Fall Abiotic Habitat Index without Restoration (Hectares)

Percent Exceedance	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
80th	2,987	2,987	2,987	2,987	2,987	3,015
50th	3,160	4,626	4,530	4,448	3,038	3,210
20th	5,190	6,995	6,881	6,713	4,619	4,209

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Table C.5.4-213. Difference between Preliminary Proposal and Existing Biological Conditions Scenarios in Delta Smelt Fall Abiotic Habitat Index without Restoration (Percent)

Percent Exceedance	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
80th	0.0	0.9	0.0	0.9	0.0	0.9
50th	-3.9	1.6	-34.3	-30.6	-33.0	-27.8
20th	-11.0	-18.9	-34.0	-39.8	-32.9	-37.3
Note: Negative values indicate lower habitat indices under preliminary proposal scenarios.						

Table C.5.4-214. Delta Smelt Fall Abiotic Index (Hectares) without Restoration under the Preliminary Proposal, Averaged by Water-Year Type

Water Year	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
All	3,979	5,035	5,031	4,865	3,736	3,812
Wet	4,704	7,253	7,143	6,900	4,142	4,038
Above normal	3,823	5,644	5,768	5,491	3,762	3,993
Below normal	4,138	4,090	4,177	3,990	3,914	4,115
Dry	3,566	3,559	3,555	3,475	3,493	3,674
Critical	2,987	2,987	2,987	2,987	2,991	3,008
Note. Water year 1922 was omitted because water year classification for prior year was not available.						

Table C.5.4-215. Differences in Delta Smelt Fall Abiotic Index (Hectares) between Preliminary Proposal and Existing Biological Conditions Scenarios, without Habitat Restoration under the Preliminary Proposal, Averaged by Prior Water Year Type

Water Year	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
All	-243 (-6%)	-168 (-4%)	-1,299 (-26%)	-1,223 (-24%)	-1,295 (-26%)	-1,053 (-22%)
Wet	-562 (-12%)	-666 (-14%)	-3,112 (-43%)	-3,215 (-44%)	-3,002 (-42%)	-2,862 (-41%)
Above normal	-60 (-2%)	170 (4%)	-1,882 (-33%)	-1,651 (-29%)	-2,005 (-35%)	-1,498 (-27%)
Below normal	-224 (-5%)	-23 (-1%)	-176 (-4%)	26 (1%)	-262 (-6%)	125 (3%)
Dry	-74 (-2%)	108 (3%)	-66 (-2%)	115 (3%)	-63 (-2%)	199 (6%)
Critical	4 (0%)	21 (1%)	4 (0%)	21 (1%)	4 (0%)	20 (1%)
Note: Negative values indicate lower habitat indices under preliminary proposal scenarios. Water year 1922 was omitted because water year classification for prior year was not available.						

C.5.4.7.2 Delta Smelt Fall Abiotic Habitat Index with Restoration

When assuming augmentation of the delta smelt fall abiotic habitat index by habitat restoration in the Suisun Marsh and West Delta ROAs, implementation of the preliminary proposal was estimated to provide a greater abiotic habitat index than EBC1. The magnitude of this increase in habitat index was up to 2,000 hectares (30%) and reached the highest values in the driest 50% and wettest 8% of years, depending on assumed use of restored habitat (Figure C.5.4-66, Table C.5.4-216, Table C.5.4-217). This analysis is limited to tidal restoration in the low salinity zone and doesn't necessarily account for delta smelt use of inshore areas or areas outside the low salinity zone, such

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as Cache Slough. Relative to EBC2, the abiotic habitat index was estimated to be 5% to 26% greater under the PP_LLT in the 40% of years when X2 is farthest upstream (drier conditions) depending on the assumed use of restored habitat. The preliminary proposal also was estimated to have up to a 25% greater abiotic habitat index than the EBC2 in the wettest 2% to 8% of years, when habitat restoration is taken into account. During the remaining periods (the ~5 to 60%–exceedance conditions), the EBC2 had as much as a 50% greater abiotic habitat index than the preliminary proposal with habitat restoration included, although this is the maximum value observed within this band and the average difference within this band would be lower. At the 20% exceedance level, the difference would be 20% to 33%, lower under the preliminary proposal, depending on the assumed habitat use by delta smelt, or about half to three quarters of the 40% difference observed in similar water years in the absence of habitat restoration.

Expressed in terms of water year types, the average delta smelt abiotic habitat index under the PP_LLT scenario ranged from approximately 3,300 hectares in critical water years assuming 25% habitat use to 4,800 hectares in wet years assuming 100% habitat use(Table C.5.4-218). For all water year types combined, this was between 136 and 840 hectares more than under EBC1, depending on assumed habitat use by delta smelt and between 215 and 920 hectares less than the average under EBC2 (Table C.5.4-219). The average abiotic habitat index under PP_LLT was between 329 hectares (7%) lower and 419 hectares (9%) higher than EBC1 in wet water years and higher than EBC1 in above normal, below normal, dry, and critical water years by 258 to 1,271 hectares (6% to 33%) depending on assumed percent habitat use by delta smelt. The average abiotic habitat index under PP_LLT was lower than EBC2 in wet and above normal water years by 550 to 2,878 hectares (10% to 40%) and higher than EBC1 in below normal, dry, and critical water years by 307 to 1,150 hectares (7% to 30%) depending on assumed percent habitat use by delta smelt. The average abiotic habitat index under PP_LLT was lower than EBC2_ELT in wet and above normal water years by 46 to 2525 hectares (1% to 37%) and higher than EBC1 in below normal, dry, and critical water years by 316 to 1,249 hectares (10% to 33%) depending on assumed percent habitat use regardless of assumed percent habitat use by delta smelt.

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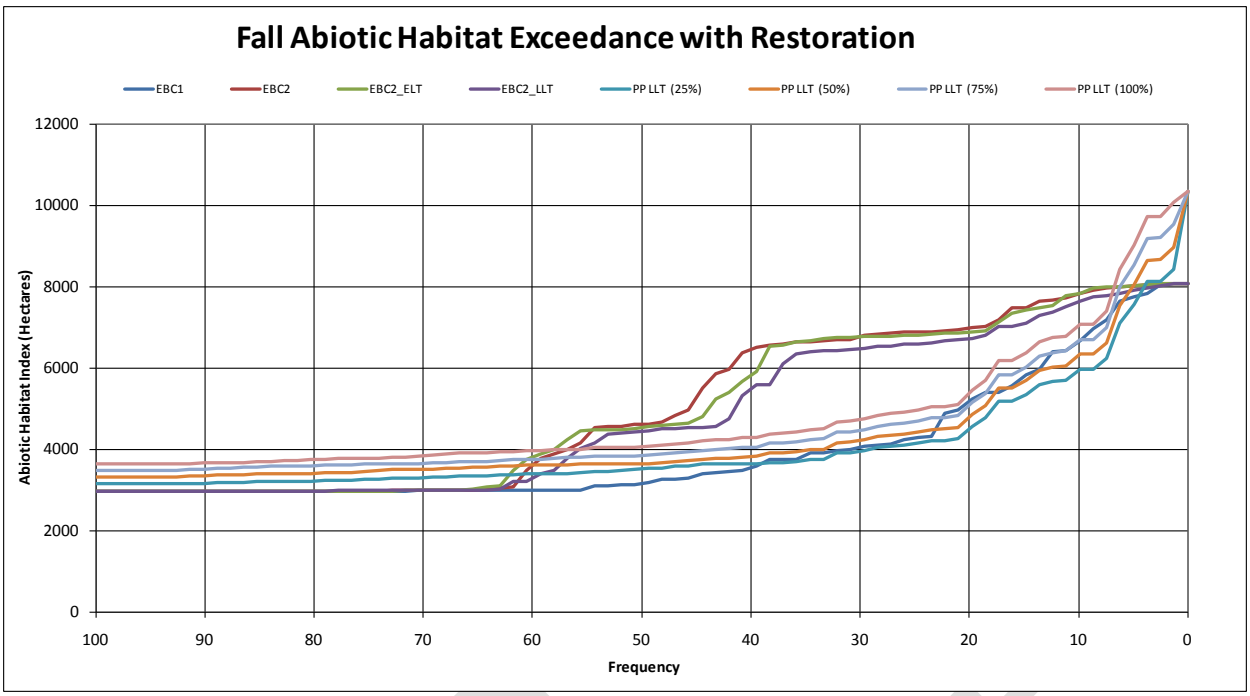

Figure C.5.4-66. Exceedance Plot of Fall Abiotic Habitat Index (Hectares) with Restoration, September through December

Table C.5.4-216. Delta Smelt Fall Abiotic Habitat Index with Habitat Restoration under the Preliminary Proposal (Hectares)

Percent Exceedance	EBC1	EBC2	EBC2_LLT	PP_LLT (25% Use)[1]	PP_LLT (50% Use)[1]	PP_LLT (75% Use)[1]	PP_LLT (100% Use)[1]
80th	2,987	2,987	2,987	3,225	3,415	3,605	3,752
50th	3,160	4,626	4,448	3,534	3,649	3,862	4,079
20th	5,190	6,995	6,713	4,502	4,796	5,090	5,383

[1] Assumed percent use of restored habitat by delta smelt.

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Table C.5.4-217. Difference between Preliminary Proposal and Existing Biological Conditions Scenarios in Delta Smelt Fall Abiotic Habitat Index with Habitat Restoration under the Preliminary Proposal (Percent)

Percent Exceedance	PP_LLT vs. EBC1	PP_LLT vs. EBC2	PP_LLT vs. EBC2_LLT
25% Use of Restored Habitat by Delta Smelt			
80th	8.0	8.0	8.0
50th	11.8	-23.6	-20.5
20th	-13.2	-35.6	-32.9
50% Use of Restored Habitat by Delta Smelt			
80th	14.3	14.3	14.3
50th	15.4	-21.1	-18.0
20th	-7.6	-31.4	-28.6
75% Use of Restored Habitat by Delta Smelt			
80th	20.7	20.7	20.7
50th	22.2	-16.5	-13.2
20th	-1.9	-27.2	-24.2
100% Use of Restored Habitat by Delta Smelt			
80th	25.6	25.6	25.6
50th	29.1	-11.8	-8.3
20th	3.7	-23.0	-19.8
Note: Negative values indicate lower habitat indices under preliminary proposal scenarios.			

Table C.5.4-218. Delta Smelt Fall Abiotic Index (Hectares) with Restoration under the Preliminary Proposal, Averaged by Prior Water Year Type

Water Year	EBC1	EBC2	EBC2_LLT	PP_LLT (25% Use)[1]	PP_LLT (50% Use)[1]	PP_LLT (75% Use)[1]	PP_LLT (100% Use)[1]
All	3,979	5,035	4,865	4,115	4,350	4,585	4,819
Wet	4,704	7,253	6,900	4,375	4,624	4,873	5,123
Above normal	3,823	5,644	5,491	4,268	4,544	4,819	5,094
Below normal	4,138	4,090	3,990	4,396	4,677	4,958	5,239
Dry	3,566	3,559	3,475	3,969	4,190	4,412	4,634
Critical	2,987	2,987	2,987	3,303	3,435	3,567	3,699

Note. Water year 1922 was omitted because water year classification for prior year was not available.
[1] Assumed percent use of restored habitat by delta smelt.

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Table C.5.4-219. Differences in Delta Smelt Fall Abiotic Index (Hectares) between Preliminary Proposal and Existing Biological Conditions Scenarios, with Habitat Restoration under the Preliminary Proposal, Averaged by Prior Water Year Type

Water Year	EBC1 vs. PP_LLT	EBC2 vs. PP_LLT	EBC2_LLT vs. PP_LLT
25% Use of Restored Habitat by Delta Smelt			
All	136 (3%)	-920 (-18%)	-750 (-15%)
Wet	-329 (-7%)	-2,878 (-40%)	-2,525 (-37%)
Above normal	445 (12%)	-1,376 (-24%)	-1,223 (-22%)
Below normal	258 (6%)	307 (7%)	406 (10%)
Dry	402 (11%)	410 (12%)	494 (14%)
Critical	316 (11%)	316 (11%)	316 (11%)
50% Use of Restored Habitat by Delta Smelt			
All	371 (9%)	-685 (-14%)	-515 (-11%)
Wet	-80 (-2%)	-2,629 (-36%)	-2,276 (-33%)
Above normal	721 (19%)	-1,101 (-19%)	-947 (-17%)
Below normal	539 (13%)	588 (14%)	687 (17%)
Dry	624 (17%)	632 (18%)	716 (21%)
Critical	448 (15%)	448 (15%)	448 (15%)
75% Use of Restored Habitat by Delta Smelt			
All	605 (15%)	-450 (-9%)	-280 (-6%)
Wet	170 (4%)	-2,380 (-33%)	-2,027 (-29%)
Above normal	996 (26%)	-825 (-15%)	-672 (-12%)
Below normal	820 (20%)	869 (21%)	968 (24%)
Dry	846 (24%)	853 (24%)	937 (27%)
Critical	580 (19%)	580 (19%)	580 (19%)
100% Use of Restored Habitat by Delta Smelt			
All	840 (21%)	-215 (-4%)	-46 (-1%)
Wet	419 (9%)	-2,131 (-29%)	-1,778 (-26%)
Above normal	1,271 (33%)	-550 (-10%)	-397 (-7%)
Below normal	1,101 (27%)	1,150 (28%)	1,249 (31%)
Dry	1,068 (30%)	1,075 (30%)	1,159 (33%)
Critical	712 (24%)	712 (24%)	712 (24%)
Note: Negative values indicate lower habitat indices under preliminary proposal scenarios. Water year 1922 was omitted because water year classification for prior year was not available.			

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