SECTION 7.0
OVERVIEW OF CHINOOK SALMON EFH COMPONENTS IN THE ACTION AREA

As the first step of an EFH Assessment, NMFS (2009d) states that the existing habitat condition at time of consultation must be evaluated, and used as a point of reference for subsequent analyses. NMFS (2004a) also states that *"The adverse effects discussed in the BA can be referenced, and additional effects discussed… Unless it is clear that the effects to an individual species are unique, it is not necessary to discuss the adverse effects on a species-by-species basis…Instead, discuss the project's effects on EFH, generally."* In consideration of the above, the text below provides a description of the existing condition of EFH in the Action Area.

As part of an EFH assessment, NMFS (2004b) states that federal action agencies should indicate whether a proposed action may adversely affect HAPCs. As previously discussed, NMFS and PFMC (2011) developed five potential HAPCs for Pacific Coast salmon as part of the 2011 5-year review. Two of the five HAPCs occur in estuarine and marine environments and, thus, while these two HAPCs are important to the spring-run Chinook salmon ESU and the fall-/late fall-run Chinook salmon ESU, they are not found within the EFH Action Area for the Proposed Action. The other three potential HAPCs include: 1) spawning habitat; 2) thermal refugia; and 3) complex channels and floodplain habitats. These three HAPCs are included in the evaluation, below, of EFH in the Action Area. They are evaluated as subcomponents of the organizational components of migratory habitat (adult upstream and juvenile downstream), spawning and embryo incubation habitat, and juvenile rearing habitat. The Applicant-Prepared Draft EFH Assessment was organized according to these components because they correspond to the physical or biological features (PBFs) of designated critical habitat for Central Valley spring-run Chinook salmon ESU (i.e., freshwater migration corridors, freshwater spawning sites and freshwater rearing sites) that have the potential to be affected by the Proposed Action.

Characterization of the existing condition of EFH is presented for two primary geographical areas: 1) Yuba River watershed upstream of Englebright Dam; and 2) the lower Yuba River downstream of Englebright Dam.

7.1 Yuba River Watershed Upstream of Englebright Dam

Although EFH in the Yuba River watershed is designated both upstream and downstream of the USACE's Englebright Dam, Chinook salmon presently utilize only the lower Yuba River for migration, spawning and embryo incubation, juvenile rearing and downstream movement. Currently, Chinook salmon are prevented from accessing EFH located in the upper Yuba River watershed due to the presence of the USACE's Englebright Dam. For completeness in characterizing EFH components in the Action Area, available information from several recently conducted FERC relicensing studies in the upper Yuba River watershed was used to generally describe the potential suitability of aquatic habitat conditions for Chinook salmon upstream of Englebright Dam. Because there are no suitable existing migratory, spawning or juvenile rearing Chinook salmon habitats in New Bullards Bar Reservoir or in Englebright Reservoir, habitat conditions in these reservoirs are not further addressed in this Applicant-Prepared Draft EFH Assessment.

7.2 Yuba River Downstream of Englebright Dam

Because Chinook salmon occupy the lower Yuba River downstream of Englebright Dam, a large amount of information has been developed regarding the manner in which numerous stressors affect habitat, including EFH, in the lower Yuba River. Characterization of the existing condition of EFH in the lower Yuba River follows the same organizational structure of migratory habitat, spawning and embryo incubation habitat, and juvenile rearing habitat, incorporating evaluation and consideration of HAPCs. Within that organizational structure, additional information is presented for habitat-related stressors for Chinook salmon in the lower Yuba River.

According to NMFS (2014b), the key limiting factors, threats and stressors affecting Chinook salmon in the lower Yuba River include the following:

- Passage Impediments/Barriers
- Physical Habitat Alteration
- Entrainment
- Loss of Floodplain Habitat
- Loss of Riparian Habitat and Instream Cover (riparian vegetation, instream woody material)
- Harvest/Angling Impacts
- Predation
- Poaching
- Loss of Natural River Morphology and Function
- Hatchery Effects (FRFH genetic considerations, straying into the lower Yuba River, lower Yuba River genetic considerations)

This Applicant-Prepared Draft EFH Assessment addresses only habitat-related stressors that potentially could be affected by the Proposed Action. Therefore, the stressors identified by NMFS (2014b) of entrainment, harvest/angling impacts, poaching, and hatchery effects, are not evaluated in this Applicant-Prepared Draft EFH Assessment. Available information regarding the effects of these stressors on Chinook salmon, and spring-run Chinook salmon in particular, is provided in Section 5.0 of the Applicant-Prepared Draft BA. The existing characterization (i.e., conditions under the Environmental Baseline) of habitat-related stressors in the lower Yuba River, including passage impediments/barriers, predation, and physical habitat alteration (including natural river morphology, floodplain habitat and riparian habitat and instream cover), in addition to other key considerations regarding Chinook salmon EFH (including spawning habitat availability, potential effects of Narrows 2 operations on adult migration, fry and juvenile rearing habitat availability, fry and juvenile stranding and isolation, and water temperature suitabilities), are described below for Chinook salmon (and specifically for spring-run and fall-run Chinook salmon where applicable) lifestages.

7.3 Migratory Habitat (Adult Upstream and Juvenile Downstream)

Freshwater migration corridors provide upstream passage for adults to upstream spawning areas, and downstream passage of outmigrant juveniles to estuarine and marine areas. Migratory corridors are downstream of the spawning areas and include the lower reaches of the spawning tributaries.

Excluding the lower river reaches that were used as adult migration corridors (and, to a lesser degree, for juvenile rearing), it has been estimated that at least 72 percent of the original Chinook salmon spawning and holding habitat in the Central Valley drainage is no longer available due to the construction of non-passable dams (Yoshiyama et al. 2001). Adult migrations to the upper reaches of the Sacramento, Feather, and Yuba rivers were eliminated with the construction of major dams during the 1940s, 1950s and 1960s. After growth and maturation, whether in freshwater or the ocean, adult salmon generally return to their natal spawning areas for reproduction, though some straying into other basins is natural. As described in ISG (1996), the timing of adult entry and movement in rivers and tributary streams, and even the size, shape, and strength of adult fish represent adaptations to the physical and biological challenges presented by the upstream route to a specific spawning area.

Generally, adequate flow is an important component of adult upstream migration habitat because it can serve as an immigration cue and provide adequate depths for passage at critical locations (e.g., shallow riffles). Additionally, flow can provide outmigration cues for emigrating juveniles or smolts. Available cover is not necessarily an important migration corridor habitat component for adult immigrants, but serves as predator and thermal refugia for outmigrating juveniles.

Migratory habitat conditions in the Central Valley are strongly affected by the presence of barriers, which can include dams (i.e., hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration (Reclamation 2008). For example, physical barriers may be passable only at the range of flows that typically occur during one month of the year, and then only by fish that have the physical ability to jump over or otherwise ascend the barrier (NMFS 2008).

For fall-spawning Chinook salmon in the Central Valley, warm water conditions in late summer often present thermal barriers to movement and there may be little suitable habitat for resting (Berman and Quinn 1991, cited in ISG 1996). Thermal refugia include habitat areas where fish may escape high water temperatures, especially during hot, dry summers in California. Thermal refugia have been identified as an HAPC that provides important holding habitat for adult Chinook salmon (Goniea et al. 2006; Sutton et al. 2007 in NMFS 2010).

7.3.1 Yuba River Watershed Upstream of Englebright Dam

7.3.1.1 North Yuba River (New Bullards Bar Dam Reach)

7.3.1.1.1 Flow-Dependent Instream Habitat Conditions

Adequate flow is an important component of adult Chinook salmon upstream migration habitat because it can serve as an immigration cue and provide adequate depths for passage at critical locations (e.g., shallow riffles). Additionally, flow can provide outmigration cues for emigrating juveniles or smolts. Although not conducted specifically for Chinook salmon EFH, information presented in Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA may be used to provide an indication of flow-related physical instream habitat conditions upstream of Englebright Reservoir, as discussed below.

While the channel of the North Yuba River (New Bullards Bar Dam Reach) is dominated by gradients below 3 percent (average gradient of 2%), there is one short section where the gradient is greater than 3 percent and one short section that is above 5 percent. Just above the 5 percent section, the gradient flattens to less than 1 percent. The geology is composed of Mesozoic volcanic rocks of the Smartsville Complex. Most of the reach is composed of bedrock, car and house-sized boulders that separate large mid-channel pools. There are very short and infrequent areas of cobble-size deposits, but most of the substrate is large and immobile. There is no apparent floodplain or terrace development.

This 2.3-mi reach is largely inaccessible for conducting surveys. Two areas were ground-mapped: North Yuba upstream of the Middle Yuba River junction and just downstream of New Bullards Bar Dam; the remainder was mapped using the aerial video. This is a very rugged stream with large boulders that often cover the channel, and large, deep pools bounded by bedrock. The middle steeper section cannot be safely accessed by foot from upstream due to a deep bedrock gorge with vertical cliff walls blocking the way. The lower section is a rugged path through very large boulders that cover pocket water and separate deep pools.

Aquatic habitat is dominated by pocketwater and mid-channel pools (Table 7.3-1). Identified cover is exclusively boulders, but the depth of pools can also provide cover to resident trout. A summary of ground-mapped data for the New Bullards Bar Reach of the North Yuba River is presented in Table 7.3-2. Trout spawning-sized gravel accumulations were rare (511 ft2), as was LWM (one log in the diameter class 12-24 in, length class 25-50 ft, within the wetted channel), and potential natural barriers to resident trout upstream movement likely are very common in the confined, steep channel. Bank erosion was rare, given the bedrock/boulder channel margins.

Table 7.3-1. Length, frequency, width and depth of ground-mapped habitat units for the North Yuba River – New Bullards Bar Reach (between the junction with the Middle Yuba River and New Bullards Bar Dam). The shaded cells are characteristics of pools that do not apply to non-pool habitat types.

Unit Type	Total Length (ft)	Length Relative Frequency	Number	Number of Units (frequency)	Average width (ft)	Average pool depth (ft)	Average maximum pool depth (ft)	Average pooltail embeddedness (%)
Fall	63	1.1%	3	8.8%	66.0			
Cascade	22	.04%	1	2.9%	55.0			
Chute	--	--	--	--	--			
Rapid	778	13.1%	2	5.9%	81.5			
High Gradient Riffle	455	7.7%	3	8.8%	66.2			
Low Gradient Riffle	399	6.7%	3	8.8%	59.8			
Glide	--	--	--	--	--			
Run	--	--	--	--	--			
Step Run	639	10.8%	3	8.8%	76.1			
Pocket Water	687	11.6%	5	14.7%	49.3			
Sheet	--	--	--	--	--			
Convergence Pool	--	--	--	--	--	--	--	--
Mid-Channel Pool	2,894	48.7%	14	41.2%	72.7	3.8	7.3	--
Lateral Scour Pool	--	--	--	--	--	--	--	--
Trench Pool	--	--	--	--	--	--	--	--
Plunge Pool	--	--	--	--	--	--	--	--
Total	5,937	100.0%	34	100.0%	70.0	3.8	7.3	--

Source: Technical Memorandum 3-10

Table 7.3-2. Summary of ground mapped data for the North Yuba River – New Bullards Bar Reach (between the junction with the Middle Yuba River and New Bullards Bar Dam).

Total Reach Length	2.3 mi
Total Ground Mapped Length	1.12 mi (49.0%)
Average Bankfull Width	70 ft
Average Bankfull Depth	3.5 ft
Average Width:Depth	20
Total Spawnable Gravel	511 ft2 - trout
Average Largest Patch Size	31 ft2 - trout
LWD Density	1 / mi (within bankfull width)
Wetted LWD Density	1 / mi (within wetted width)
Parent Material	Mesozoic rocks of the Smartsville Complex
Total No. Passage Barriers	4

Source: Technical Memorandum 3-10

7.3.1.1.2 Thermal Refugia (Water Temperatures)

Water Temperature Monitoring

Water temperature is an important habitat component of migration corridors, and water temperature changes may result in a gradation of potential effects on migrating adults and emigrating juveniles. As described in Technical Memorandum 2-5, *Water Temperature Monitoring*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA, YCWA monitored water temperature at 38 sites potentially affected by the Proposed Action from 2008 through 2012, including 3 sites on the North Yuba River. Mean daily water temperatures monitored in EFH reaches of the North Yuba River potentially affected by the Proposed Action (i.e., below New Bullards Bar Dam (RM 2.3) and above the confluence with the Middle Yuba River (RM 0.1)) during WYs 2009 through 2012 are presented in Table 7.3-3. The goals of the water temperature monitoring study were to characterize water temperature conditions in the reservoirs and river reaches potentially affected by continued Project O&M, and to facilitate development of water temperature models to provide useful tools in the Project Relicensing. Input water temperatures used for model calibration were, as much as possible, historical water temperatures from data collected by YCWA to support the model development as part of Study 2-5, Water Temperature Monitoring. Calibration of the water temperature models focused on making adjustments to the models so that simulated water temperatures were as close as possible to historically-measured water temperatures for the calibration period. Each model's calibration period was selected based on the availability of historical input data for the model and was generally between 2008 and 2012.

In general, water temperatures below New Bullards Bar Dam were cooler than those in the North Yuba River 0.1 RM above the confluence with the Middle Yuba River. During the winter, the temperature difference was usually only a few degrees. From May to October, the difference was between 3°C and 12°C, with the greatest difference in June and July. Mean daily water temperatures below project facilities in the North Yuba River were less than 68°F (20°C) except for approximately 23 percent of the days from June through October below New Bullards Bar Reservoir and 50 percent of the days from June through October near the confluence with the Middle Yuba River. The maximum mean daily water temperature recorded in the North Yuba River was 75.0°F (23.9°C) during July 2010.

During August 2009, there was a sharp decrease in water temperatures in the North Yuba River above the confluence with the Middle Yuba River, which was caused when the low-level outlet at New Bullards Bar Dam increased releases to over 1,000 cfs due to an outage downstream at New Colgate Powerhouse. The outage was related to a forest fire that burned in the vicinity of the powerhouse and associated structures.

Table 7.3-3. Summary of minimum and maximum daily average water temperatures (°C) by month in the upper Yuba River watershed potentially affected by the Proposed Action during WYs 2009 through 2012. Shaded cells indicate values over 20°C (68°F).

Location	River Mile	Water Year	October		November		December		January		February		March		April		May		June		July		August		September	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
NORTH YUBA RIVER																										
NYR at Low Flow Releases from New Bullards Bar Dam	NYR 2.3	2009	8.0	8.9	8.7	9.5	8.6	9.6	8.4	9.1	7.8	8.8	7.5	8.4	7.6	9.2	8.0	10.0	8.8	10.1	9.6	10.1	No Data	No Data	No Data	No Data
		2010	7.7	8.9	7.4	8.0	6.5	7.6	7.4	7.9	7.6	8.1	7.7	8.8	7.7	9.4	8.7	9.6	9.4	10.6	10.3	10.9	10.0	10.7	9.5	10.3
		2011	8.7	9.9	7.6	8.9	7.7	9.3	7.5	8.1	7.0	8.0	7.4	8.4	7.4	8.5	7.4	8.6	7.6	9.1	8.9	9.8	9.4	9.7	8.7	9.5
		2012	7.8	8.8	7.2	7.8	6.7	7.3	6.7	7.6	7.1	7.9	7.2	8.8	7.3	9.4	8.6	9.8	9.0	10.4	9.9	10.5	9.7	10.5	9.2	9.9
NYR upstream of Middle Yuba River	NYR 0.0	2009	8.1	13.6	8.7	9.6	9.1	9.6	No Data	No Data	No Data	No Data	10.7	11.7	10.4	16.0	10.3	20.7	17.2	22.5	20.2	23.8	8.3	23.5	15.1	19.8
		2010	7.4	14.0	7.8	9.3	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	8.1	14.1	11.2	16.1	13.8	22.3	20.7	23.9	18.0	22.5	15.9	19.5
		2011	10.3	17.2	10.1	11.8	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	19.7	22.5	20.2	22.5	17.1	20.0
		2012	10.0	17.1	8.2	10.2	2.2	5.6	2.9	7.3	5.0	8.1	6.3	10.6	8.4	14.8	11.7	18.3	16.2	21.3	20.2	22.0	18.6	22.4	16.4	19.3
MIDDLE YUBA RIVER																										
MYR downstream of Our House Diversion Dam	MYR 11.9	2009	10.2	11.0	6.3	11.4	1.0	6.4	2.2	6.7	2.4	6.4	4.8	8.8	6.8	11.6	8.0	16.6	14.0	21.9	20.2	24.6	20.1	24.3	15.8	21.2
		2010	8.3	14.9	3.9	10.2	0.7	5.6	3.7	7.0	5.1	7.2	4.8	8.6	5.2	9.6	6.9	10.6	9.5	18.8	17.5	23.3	17.6	21.9	16.0	19.8
		2011	8.3	17.4	2.9	10.7	3.7	7.2	2.9	6.5	1.2	6.1	3.5	7.5	5.0	9.0	5.6	9.8	7.6	13.5	13.7	21.5	19.4	21.6	16.8	19.8
		2012	9.1	16.8	5.0	9.1	0.5	4.5	0.6	5.5	2.9	6.3	2.4	8.1	4.9	10.5	9.0	16.7	13.5	20.7	20.6	23.2	20.3	24.2	17.6	20.8
MYR upstream of North Yuba River	MYR 0.0	2009	9.1	18.0	6.4	12.6	1.4	6.7	No Data	No Data	No Data	No Data	10.4	11.8	9.7	16.9	9.2	21.6	17.6	24.4	21.5	25.9	20.5	25.5	15.2	21.5
		2010	8.1	15.2	8.5	11.3	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	6.8	13.5	10.2	15.6	13.8	23.9	21.7	26.0	18.7	23.3	16.3	20.7
		2011	9.3	18.3	3.5	11.6	3.9	8.7	3.7	7.5	2.9	6.8	4.5	10.4	6.4	12.8	6.6	14.2	10.0	17.7	17.3	24.1	20.9	24.0	17.6	20.9
		2012	9.6	17.6	7.5	9.9	0.3	5.1	0.6	6.6	3.5	7.5	4.9	10.3	7.5	14.6	11.9	19.3	16.7	23.2	21.7	24.4	20.0	25.1	17.3	21.1
YUBA RIVER UPSTREAM OF ENGLEBRIGHT RESERVOIR																										
Yuba River downstream of Confluence of North Yuba River and Middle Yuba River	YR 39.7	2009	8.6	15.1	8.0	11.4	4.8	8.3	No Data	No Data	No Data	No Data	10.5	11.8	9.9	16.9	9.4	21.5	17.5	23.9	21.2	25.4	11.5	25.0	15.5	21.0
		2010	9.2	14.3	8.6	10.2	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	6.9	13.6	10.3	15.7	13.9	23.5	21.5	25.4	18.6	22.8	16.3	20.4
		2011	9.6	18.1	9.6	11.8	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	20.1	23.7	20.7	23.6	17.6	20.8
		2012	9.7	17.6	7.5	10.0	No Data	No Data	No Data	No Data	No Data	No Data	5.9	10.3	7.7	14.7	12.0	18.6	16.7	23.0	21.8	24.1	20.1	24.4	17.5	20.9
Yuba River upstream of New Colgate Powerhouse	YR 34.1	2009	8.4	18.2	9.1	10.8	7.8	9.6	No Data	No Data	No Data	No Data	11.8	12.8	11.2	18.1	10.0	22.7	18.9	24.5	21.6	25.9	9.6	25.7	17.0	21.8
		2010	8.0	16.0	8.9	10.7	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	7.8	14.6	11.8	16.9	14.8	24.6	22.5	26.4	19.8	23.9	17.6	21.5
		2011	10.9	19.2	4.7	13.0	4.7	10.5	4.6	8.3	4.9	7.8	5.9	11.4	8.2	13.3	9.9	12.7	11.3	14.8	14.3	24.9	20.8	24.9	18.9	22.0
		2012	11.0	19.0	5.9	11.2	0.4	5.2	1.0	6.3	4.0	7.5	5.1	10.3	7.5	15.3	12.2	19.8	17.5	22.6	21.3	23.5	19.6	24.2	17.5	20.8
Yuba River downstream of New Colgate Powerhouse	YR 33.8	2009	8.4	13.7	9.0	10.8	7.8	9.6	No Data	No Data	No Data	No Data	7.5	9.8	7.1	9.3	7.7	8.6	7.3	8.1	7.6	7.9	7.9	11.7	8.4	12.0
		2010	8.7	9.1	9.0	9.0	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	7.9	8.4	7.9	8.2	8.2	8.5	8.5	8.8	8.8	9.4	10.0	16.5
		2011	9.5	14.5	8.1	10.6	8.1	9.8	7.8	8.4	7.3	7.8	6.7	7.4	6.7	7.1	6.9	7.4	7.2	7.6	7.5	7.8	7.8	9.1	8.6	11.7
		2012	8.7	11.1	8.8	9.2	7.4	9.1	8.2	9.2	8.0	8.6	7.4	8.6	7.4	8.1	7.6	9.7	8.3	11.4	8.1	10.5	8.7	10.7	9.6	14.0
Yuba River downstream of Dobbins Creek	YR 33.6	2009	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	8.0	8.7	7.7	8.5	8.0	10.7	7.8	9.2	8.0	8.4	8.3	11.9	8.8	11.3
		2010	8.8	10.1	9.0	10.3	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	8.1	9.5	8.3	9.9	8.5	9.2	8.7	9.1	9.1	9.8	9.9	14.1
		2011	9.7	13.4	10.1	11.1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	6.8	9.0	7.6	9.4	7.6	10.5	7.8	9.4	8.1	9.6	9.4	11.4
		2012	8.9	12.6	8.9	13.0	7.7	9.0	7.8	8.8	7.5	8.6	7.4	9.2	7.6	9.7	7.9	9.4	8.3	10.4	8.4	10.2	8.9	10.3	9.7	10.9

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Water temperatures in the North Yuba River 0.1 RM above the confluence with the Middle Yuba River were further evaluated by comparison with water temperatures in the North Yuba River upstream of New Bullards Bar Reservoir. Figure 7.3-1 shows mean daily temperatures in the North Yuba River at RMs 0.1 and 22.4 for WYs 2009, 2010, 2011 and 2012. In general, water temperature trends in the North Yuba River near the Middle Yuba River confluence were similar to those seen above New Bullards Bar Reservoir in an unregulated stream reach. Water temperatures tended to be the highest during the spring when upstream runoff flows were being captured by the reservoir. Once the runoff period ended, water temperatures were very similar through the summer. As described above, the sharp decrease in water temperatures during August was caused when the low-level outlet at New Bullards Bar Dam increased releases to over 1,000 cfs due to an outage downstream at New Colgate Powerhouse, which was caused by a forest fire that burned in the vicinity of the powerhouse and associated structures.

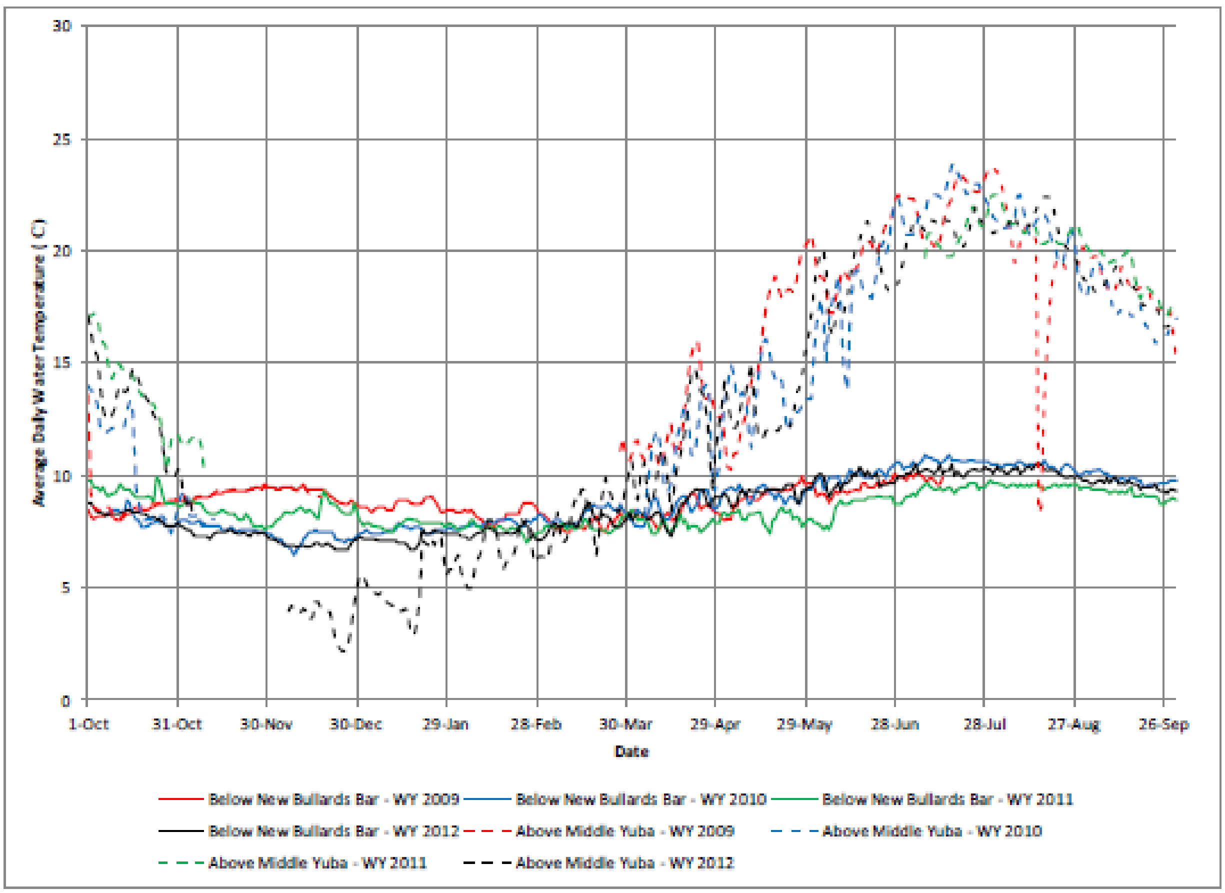

Figure 7.3-1. Mean daily water temperatures in the North Yuba River downstream of New Bullards Bar Dam (RM 22.4) and upstream of the Middle Yuba River confluence (RM 0.1) in WYs 2009, 2010, 2011 and 2012.

Water temperatures in the North Yuba River generally increased during May or June through August and early September before declining in late September and October – a temperature trend that is consistent with the Mediterranean climate patterns of inland northern California. On a daily scale, monitoring locations showed a widely varying amount of diurnal influence as seen in the plots found in Technical Memorandum 2-5, *Water Temperature Monitoring*, Attachment 2-5. Diurnal variance was increasingly evident in locations with lower flows and/or increasing distance from low-level reservoir outlets. In addition, the trends in the water temperature data tended to closely follow trends seen in mean daily air temperatures observed regionally; this trend was also stronger at those locations with lower flows or increased distance from reservoir outlets as water temperatures began to approach equilibrium with the surrounding environment.

Monitoring results during the July through December fall-run Chinook salmon adult immigration and staging period indicated that, if fish were able to access areas upstream of Englebright Dam, maximum daily average water temperatures in the North Yuba River upstream of the Middle Yuba River equaled or exceeded the upper tolerable WTI of 68°F (20°C) during July and August of all years (2009 through 2012) and during September 2011. During the December through June fall-run Chinook salmon juvenile rearing and downstream movement period, maximum daily average water temperatures in the North Yuba River upstream of the confluence with the Middle Yuba River equaled or exceeded the upper tolerable WTI of 65°F (18.3°C) during May 2009 and 2012, and during June 2009, 2010 and 2012.

Similarly, monitoring results indicate that during the April through September spring-run Chinook salmon adult immigration and holding period, maximum daily average water temperatures in the North Yuba River upstream of the confluence with the Middle Yuba River exceeded the upper tolerable WTI of 68°F during May 2009, June 2009, July and August 2009 through 2012, and September 2011. Monitoring during the year-round spring-run Chinook salmon juvenile rearing and downstream movement period suggest that if fish were able to access areas upstream of Englebright Dam, maximum daily average water temperatures in the North Yuba River upstream of the Middle Yuba River equaled or exceeded the upper tolerable WTI of 65°F during May 2009 and 2012, June 2009, 2010 and 2012, and during all sampled years in July, August and September. Additionally, minimum daily average water temperatures in the North Yuba River upstream of the Middle Yuba River during July, August and September usually exceeded 65°F. Detailed analyses of WTI exceedances are provided in the following sections.

Water Temperature Modeling

The water temperature suitability evaluation conducted for this Applicant-Prepared Draft EFH Assessment utilizes lifestage-specific periodicities and WTI values specified in RMT (2013a) for fall-run and spring-run Chinook salmon, and YCWA's Relicensing Water Temperature Model to evaluate simulated daily water temperatures over the modeled period of record (WY 1970-2010). Additional detail on the species-specific lifestage periodicities and WTI values is provided in Section 6.0 of the Applicant-Prepared Draft BA.

Output from the relicensing water temperature model is comprised of mean daily water temperatures occurring over a 41-year simulation period (WY 1970-2010). For this evaluation, simulated mean daily water temperatures were used for the following locations: 1) North Yuba River below New Bullards Bar Dam; 2) Middle Yuba River above North Yuba River; 3) Yuba River below Middle Yuba River; 4) Yuba River above Colgate Powerhouse; and 5) Yuba River below Colgate Powerhouse. For efficiency of presentation, this section evaluates water temperature suitabilities for adult migration and holding-related lifestages of Chinook salmon for the North Yuba River, the Middle Yuba River and the Yuba River upstream of Englebright Dam. Evaluation of water temperature suitabilities for juvenile rearing and migration are provided in Section 7.5 (Juvenile Rearing Habitat), below.

Water temperature cumulative probability distributions have been developed for each half-month over the 41–year simulation period. Half-month water temperature cumulative probability distributions represent the probability, as a percent of time, that modeled water temperature values would be met or exceeded at an indicator location. For this evaluation, half-month cumulative probability distributions were used to examine the probability that the WTI values would be exceeded for the individual half-month periods within the identified lifestages, at the specified locations, for the target species.

Consistent with the Applicant-Prepared Draft BA, the evaluation of water temperatures in the lower Yuba River in this Applicant-Prepared Draft EFH Assessment primarily focuses on the identification of those periods during which the water temperature model results estimate a probability of exceeding the species- and lifestage-specific WTI values. An exceedance value of 10 percent or greater was used as an indicator of potentially impactive conditions for a specific species/run and lifestage. The following sections discuss spring-run and fall-run Chinook salmon lifestages and associated periodicities where model results indicate that water temperatures could exceed specified WTI values by 10 percent or more of the time, consistent with the approach used by RMT (2010b; 2013a) for the lower Yuba River. Evaluation of water temperature suitabilities in this Applicant-Prepared Draft EFH Assessment first presents results of the water temperature modeling for each target species under the Environmental Baseline scenario, followed by the Without-Project scenario, which is further described below.

For the purposes of this Applicant-Prepared Draft EFH Assessment, simulated aquatic habitat conditions under the Without-Project model scenario are used to characterize aquatic habitat conditions under a hypothetical reference condition that reflects existing aquatic habitat conditions without operations of the Project. Comparison of simulated habitat conditions under the Environmental Baseline scenario, relative to the Without-Project scenario, is carried out in this section to characterize potential "ongoing effects" of the Project under the Environmental Baseline. These effects would not be expected to occur if the Project did not exist. Comparison of the Environmental Baseline scenario to the Without-Project scenario is conducted to estimate the Project's incremental effects to existing aquatic habitat conditions under the Environmental Baseline.

Environmental Baseline Scenario compared to Without-Project Scenario

Tables 7.3-4 and 7.3-5 display the differences in the spring-run and fall-run Chinook salmon lifestage-specific upper tolerable WTI value exceedance probabilities under the Environmental Baseline scenario relative to the Without-Project scenario (i.e., the probability of exceeding a WTI value under the Environmental Baseline scenario minus the probability of exceeding that WTI value under the Without-Project scenario).

Table 7.3-4. Difference in simulated upper tolerable water temperature exceedance probabilities for spring-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Spring-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Immigration	NYR	68°F							0.0	0.0	0.0	0.0	0.0	-23.4	-68.1	-99.8	-100.0	-93.8	-62.1	-20.7						
	MYR	68°F							0.0	0.0	0.0	11.6	24.1	25.4	4.1	0.0	0.0	-0.3	-5.2	-8.0						
	YR BLW MYR	68°F							0.0	0.0	0.0	12.3	40.0	41.0	20.2	0.0	-0.2	-4.0	-27.8	-34.3						
	YR ABV COLGATE	68°F							0.0	0.0	2.3	25.9	60.2	46.5	13.3	0.0	0.0	-1.8	-2.6	-12.2						
	YR BLW COLGATE	68°F							0.0	0.0	0.0	-0.3	-3.6	-41.0	-82.3	-100.0	-100.0	-100.0	-78.9	-18.4						
Adult Holding	NYR	65°F							0.0	0.0	0.0	0.0	-0.7	-43.6	-82.0	-100.0	-100.0	-99.8	-87.5	-53.8						
	MYR	65°F							0.0	0.0	1.5	25.2	25.5	20.3	0.0	0.0	0.0	0.0	-1.5	-4.7						
	YR BLW MYR	65°F							0.0	0.0	1.3	32.9	55.8	35.9	8.0	0.0	0.0	0.0	-5.2	-26.8						
	YR ABV COLGATE	65°F							0.0	0.2	16.1	51.1	60.5	32.0	4.6	0.0	0.0	0.0	0.5	-14.8						
	YR BLW COLGATE	65°F							0.0	0.0	0.0	-1.7	-17.6	-56.7	-92.8	-100.0	-100.0	-100.0	-97.7	-64.9						

Table 7.3-5. Difference in simulated upper tolerable water temperature exceedance probabilities for fall-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Fall-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Immigration and Staging	NYR	68°F													-68.1	-99.8	-100.0	-93.8	-62.1	-20.7	0.0	0.0	0.0	0.0	0.0	0.0
	MYR	68°F													4.1	0.0	0.0	-0.3	-5.2	-8.0	0.0	0.0	0.0	0.0	0.0	0.0
	YR BLW MYR	68°F													20.2	0.0	-0.2	-4.0	-27.8	-34.3	0.2	0.0	0.0	0.0	0.0	0.0
	YR ABV COLGATE	68°F													13.3	0.0	0.0	-1.8	-2.6	-12.2	0.7	0.0	0.0	0.0	0.0	0.0
	YR BLW COLGATE	68°F													-82.3	-100.0	-100.0	-100.0	-78.9	-18.4	0.0	0.0	0.0	0.0	0.0	0.0

Water temperature exceedance probabilities are generally similar under the Environmental Baseline and Without-Project scenarios during Aprils and October through December of the migration-related lifestages of spring-run and fall-run Chinook salmon.

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario are generally substantially more suitable for spring-run Chinook salmon adult immigration and holding during late June through September in the North Yuba River below New Bullards Bar Dam and below New Colgate Powerhouse, in addition to during primarily late September in the Yuba River below the Middle Yuba River and above New Colgate Powerhouse. Water temperatures are substantially more suitable for fall-run Chinook salmon adult immigration and staging during July through September in the North Yuba River below New Bullards Bar Dam and in the Yuba River below New Colgate Powerhouse, in addition to during September in the Yuba River below the Middle Yuba River and during late September in the Yuba River above New Colgate Powerhouse.

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario are generally substantially less suitable for spring-run Chinook salmon adult immigration and holding during late May through June or early July in the Middle Yuba River, Yuba River below the Middle Yuba River, and in the Yuba River above New Colgate Powerhouse. Water temperatures are generally substantially less suitable for fall-run Chinook salmon adult immigration and staging only during early July in the Yuba River below the Middle Yuba River and in the Yuba River above New Colgate Powerhouse.

7.3.1.1.3 Habitat Access - Physical Barriers

Although not conducted specifically for Chinook salmon EFH, a channel morphology study in the river reaches upstream of Englebright Reservoir that are potentially affected by the Proposed Action was undertaken by YCWA during 2011 and 2012. The study focused on channel morphology, riparian vegetation and sediment mobility (Technical Memorandum 1-1, *Channel Morphology Upstream of Englebright Reservoir*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA). As discussed below, information from the channel morphology study provides an indication of North Yuba River channel conditions and physical barriers in areas of EFH that could be potentially affected by the Proposed Action upstream of Englebright Reservoir.

- Project-affected reaches in the North Yuba River are mostly transport reaches, with few response reaches where depositional processes dominate within or adjacent to the channel. In the North Yuba River, there is significant bedrock control and the mainstem channel often travels through bedrock gorges.
- The channel is characterized by large substrate, steep gradients, vertical confinement, low bank erodibility, and low fine sediment accumulation.
- The North Yuba River exhibited gradients >1 percent and were composed of coarse and generally resistant bed and bank material. Gradients generally were between 1 and 2.9 percent, except for the site on the mainstem Yuba River below the New Colgate Powerhouse. The North Yuba River site was the steepest at almost 3 percent.
- Bedrock/boulder controls were the greatest in the North Yuba River (66%). Because of the amount of bedrock and boulder control, channel stability was determined to be good, and bank erosion hazard was determined to be low to very low.

As described in Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, four passage barriers (i.e., significant waterfalls, high velocity chutes, weirs or other man-made obstacles, or features with a vertical drop exceeding 2.5 ft) were identified in the North Yuba River.

7.3.1.2 Middle Yuba River (with Emphasis on the ~1.5 Miles of EFH Upstream from the Confluence of the Middle Yuba River and the North Yuba River)

7.3.1.2.1 Flow-Dependent Instream Habitat Conditions

Based on studies conducted for Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, the 12-mi reach surveyed in the Middle Yuba River flows through a variety of parent materials, most notably resistant granitic rocks, and is bisected by the Big Bend-Wolf Creek fault within 1-mi of the junction with the North Yuba River. The overall gradient is 1.2 percent, with one break at the Big Bend/Wolf Fault (2.5% below the fault, and

1.1% above). There are numerous lower gradient sections, many of which are upstream of sharp bends that form "knickpoints".[1] However, in any of these lower gradient sections where it appears that there is floodplain and side-channel development, sinuosity does not exceed 1.1 (i.e., valley length and channel length through the valley are approximately equal). There is a hydrologic break at Oregon Creek, separating the reach into Our House Diversion Dam Reach (Middle Yuba River upstream of Oregon Creek) and the Oregon Creek Reach (Middle Yuba River downstream of Oregon Creek). This is a confined channel, with extensive sections of bedrock forming the channel; specifically, RM 8.8-10, and RM 11.2-11.5 where the channel is almost exclusively bedrock. Trench pools are indicative of the bedrock-dominated sections, though shallow, mid-channel pools also form in the bedrock sections. Cobble or boulder bars and resistant bedrock and boulder banks resist lateral and vertical movement of the channel.

Heavy recreation, rural housing, and mining have modified the channel and riparian zone in the area of Freemans Crossing. Through this low gradient (about 1%) section, the channel is very wide and shallow, and has substantial amounts of finer material (e.g., gravel in the channel and sand on the banks). A multi-thread channel splits around an area known as "Emory Island" (~RM 6.8), though sinuosity is still fairly low at 1.1, and map-based gradient is about 1 percent. The habitat was mapped within the main channel, but it is a split channel and at high flow, about 30 percent of the flow will divert to the right channel (ascending).

Ground-based habitat mapping was performed at four locations within the Middle Yuba Reach: at the junction with the North Yuba (RM 0); above and below Oregon Creek (RM 4.7); and below Our House Diversion Dam (RM 12.2). Table 7.3-6 summarizes the habitat frequency for the reach. The habitat frequency is based on the total number of "hits" on a habitat using the aerial video method, with the ground-based data (16% of the reach) used to interpret the habitat. Habitat is dominated by mid-channel pools, low gradient riffles, and runs; additional habitat types that exceed 5 percent include high gradient riffles, lateral pools and trench pools. Instream cover is limited to boulders. Table 7.3-7 also summarizes the data for physical parameters measured in the field. There is over 2,000 sq ft of trout spawning-sized gravel accumulations within the mapped sections. There was very limited large woody debris identified during ground-based assessments. The ground-based data collected in the Middle Yuba River indicate there are spawning-sized gravel accumulations. Upstream trout migration may by limited by permanent falls or other barriers, large woody debris is an uncommon element, and does not modify channel form or fish habitat in the active channel.

[1] A knickpoint is a term used to describe a location in a river or channel where there is a sharp change, resulting from differential rates of erosion above and below the knickpoint.

Table 7.3-6. Length, frequency, width and depth of ground-mapped habitat units in the Middle Yuba River – Oregon Creek and Our House Diversion Dam Reaches (between the junction with North Yuba River to Our House Diversion Dam). The shaded cells are characteristics of pools that do not apply to non-pool habitat types.

Unit Type	Total Length (ft)	Length Relative Frequency	Number	Number of Units (frequency)	Average width (ft)	Average pool depth (ft)	Average maximum pool depth (ft)	Average pooltail embeddedness (%)
Fall	--	--	--	--	--			
Cascade	421	2.7%	7	6.4%	63.4			
Chute	47	0.3%	1	0.9%	22.3			
Rapid	70	0.5%	1	0.9%	26.5			
High Gradient Riffle	1,014	6.5%	9	8.2%	53.1			
Low Gradient Riffle	1,997.5	12.9%	17	15.5%	62.0			
Glide	531	3.4%	2	1.8%	53.8			
Run	2,269	14.6%	23	20.9%	52.9			
Step Run	1,225	7.9%	8	7.3%	69.2			
Pocket Water	654	4.2%	5	4.5%	55.5			
Sheet	--	--	--	--	--			
Convergence Pool	--	--	--	--	--	--	--	--
Mid-Channel Pool	6,182.5	39.8%	30	27.3%	56.8	3.7	6.9	7.9
Lateral Scour Pool	469	3.0%	2	1.8%	101.9	1.8	3.5	25.0
Trench Pool	216	1.4%	1	0.9%	75.3	4.0	8.0	--
Plunge Pool	446	2.9%	4	3.6%	53.3	5.8	7.0	5.0
Total	**15,542**	**100.0%**	**110**	**100.0%**	**58.9**	**3.8**	**6.3**	**12.6**

Table 7.3-7. Reach summary of ground mapped data for the Middle Yuba River – Oregon Creek and Our House Diversion Dam Reaches (between the junction with North Yuba River to Our House Diversion Dam).

Total Reach Length	12.2 mi
Total Ground Mapped Length	2.94 mi (16.0%)
Average Bankfull Width	58.9 ft
Average Bankfull Depth	2.5 ft
Average Width:Depth	24
Total Spawnable Gravel	2,311 ft2 - trout
Average Largest Patch Size	44 ft2 - trout
LWD Density	5 / mi (within bankfull width)
Wetted LWD Density	4 / mi (within wetted width)
Parent Material	Volcanic, granite/granodiorite, metasedimentary
Total No. Passage Barriers	2

7.3.1.2.2 Thermal Refugia (Water Temperatures)

Mean daily water temperatures monitored in the Middle Yuba River potentially affected by the Proposed Action (i.e., from Our House Diversion Dam (RM 12.6) to the confluence with the North Yuba River (RM 40.0) during WYs 2009 through 2012 are presented in Figure 7.3-2.

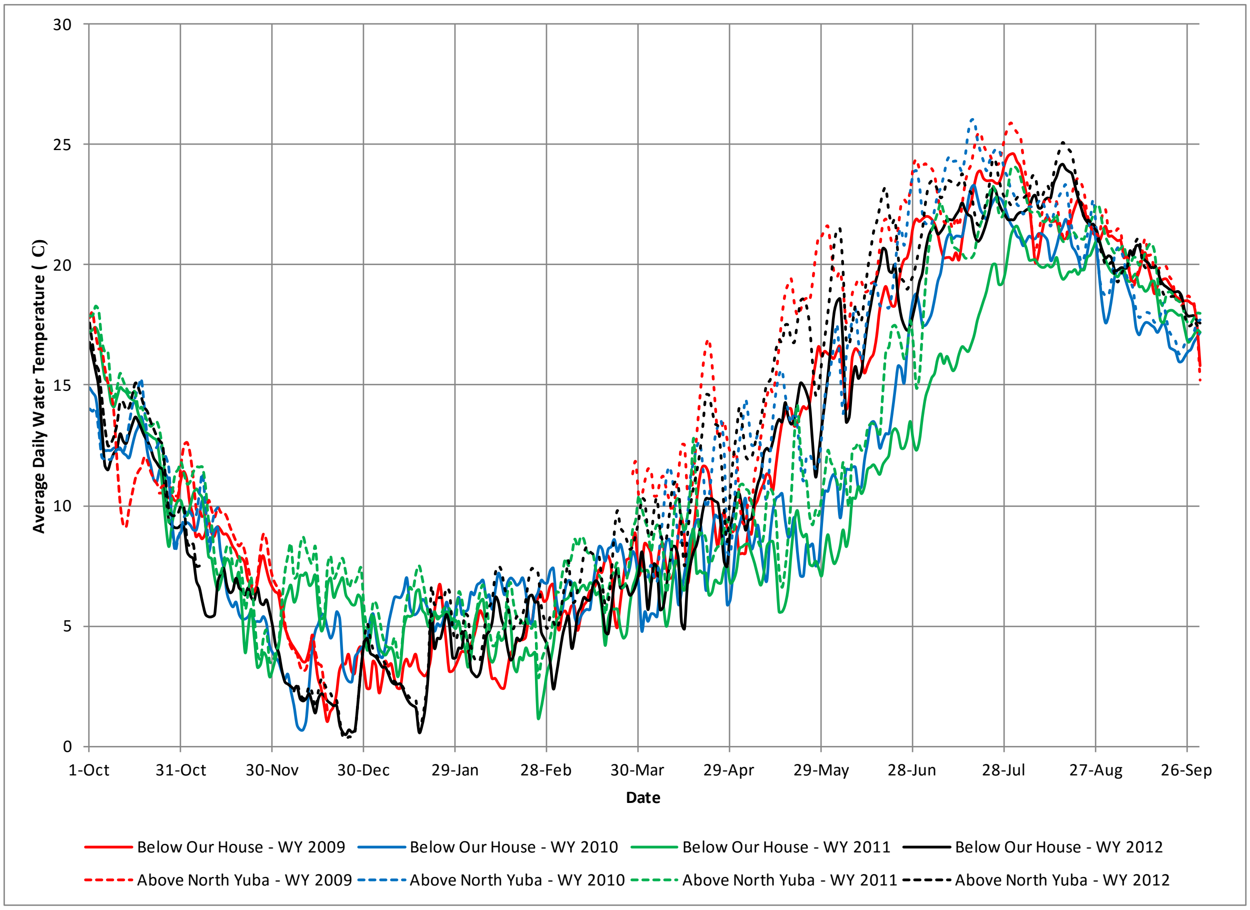

Figure 7.3-2. Mean daily water temperatures in the Middle Yuba River from Our House Diversion Dam to the North Yuba River confluence during WYs 2009, 2010, 2011 and 2012.

In general, water temperatures below Our House Diversion Dam in the Middle Yuba River were lower than those above the North Yuba River confluence. Mean daily water temperatures tended to exceed 68°F (20°C) from June through September throughout the entire reach, including about 65 percent of the time near the confluence with the North Yuba River. The maximum mean daily water temperature recorded in the Middle Yuba River was 78.8°F (26.0°C) during July 2010.

Monitoring results during the July through December fall-run Chinook salmon adult immigration and staging period indicate that, if fish were able to access areas upstream of Englebright Dam, maximum daily average water temperatures in the Middle Yuba River upstream of its confluence with the North Yuba River equaled or exceeded the upper tolerable WTI of 68°F (20°C) during July and August of all years (2009 through 2012) and during September 2011.

Similarly, monitoring results indicate that during the April through September spring-run Chinook salmon adult immigration and holding period, maximum daily average water temperatures in the Middle Yuba River upstream of the confluence with the North Yuba River exceeded the upper tolerable WTI of 68°F during May 2009, June 2009, 2010, and 2012, and July through September 2009, 2010, 2011 and 2012.

Simulated water temperatures in the Middle Yuba River during the adult migration and holding-related lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented in Section 7.3.1.1 above.

7.3.1.2.3 Habitat Access - Physical Barriers

Although not specifically for Chinook salmon EFH, a channel morphology study focusing on channel morphology, riparian vegetation and sediment mobility in the river reaches upstream of Englebright Reservoir that are potentially affected by the Proposed Action was undertaken by YCWA during 2011 and 2012 (see Technical Memorandum 1-1). The information summarized below provides an indication of Middle Yuba River channel conditions and physical barriers that could be potentially affected by the Proposed Action upstream of Englebright Reservoir.

- The Middle Yuba River has a coarse and resistant bed and banks in most of its length, with few possibilities of lateral or vertical shifting. Locations on the upstream side of bends and within and downstream of long-term depositional areas are more alluvially dominated, but sediment transport is still very high and particles move with fairly high frequency. Sediment is available to the channel and being transported at a higher rate than it is replaced. The sediment deficit estimates highlight the fact that bedload transport equations rely on the ability of the channel to transport sediment as well as the availability of sediment for transport.
- The Log Cabin and Our House diversion dams are passive-spillway dams that spill regularly; these spills do not cause erosion of a spillway. There is pass-through of coarse and fine sediment downstream during large flood events below Our House Diversion Dam, and there may be pass-through over Log Cabin Diversion Dam of fine-grained material (e.g., washload).
- The quantity of mobile material (i.e., D84, which is generally less than 128 mm) in the Middle Yuba River downstream of Oregon Creek was 6.9 m3/m.
- Armoring ratio is strongest below Oregon Creek at 5.4 and considered strongly armored, but is moderate (between 1.4 and 2.7) at all other Middle Yuba River sites. The weakest armoring ratio is just above the Middle Yuba River/North Yuba River confluence, though it is still considered moderate.

In 2002, Vogel conducted a survey via helicopter of the Middle Yuba River to identify potential natural barriers to upstream steelhead and salmon passage for spawning. In August 2003 and 2005, he also conducted field assessments of the potential barriers identified from the helicopter. Vogel identified two types of barriers - high and low flow barriers, and considered the break between the two to be flows of about 100 to 200 cfs.

Gast et al. (2005) identified natural, low flow-only barriers to small fish passage at RM 0.2 and 3.2, and an estimated 13-ft high cascade at RM 0.4 that would be a major obstacle to upstream migration. At this location, several very large boulders blocking the narrow bedrock channel created the barrier, and sediment has filled in upstream of the boulders forming a dam. Although large fish may be able to pass at certain flows, the height of the cascade and narrowness of the canyon is expected to at least impede passage at all flows.

More recently, where access allowed, YCWA field crews identified potential barriers to upstream fish movement, as described in Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, and Technical Memorandum 3-8, *Stream Fish Populations Upstream of Englebright Reservoir*. Identification of potential natural upstream fish passage barriers was very general. The criteria included: 1) vertical height exceeding 2.5-ft; 2) waterfalls; or 3) high-velocity chutes. The analysis was performed for resident rainbow trout. YCWA's Study 3.8, *Stream Fish Populations Upstream of Englebright Reservoir*, included sampling two sites downstream of the confluence with Oregon Creek on the Middle Yuba River at RM 3.3 (downstream of Moonshine Creek) and at RM 1.0 (downstream of Yellowjacket Creek). The RM 3.3 site reportedly was devoid of LWM and fish passage impediments. Fish passage impediments were not detected at the RM 1.0 site.

According to Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, although there may be additional barriers upstream and downstream of the mapped section, the number of barriers within the mapped section can be used as an indicator of the relative restrictions to upstream salmonid movement. Two potential natural barriers to upstream movement of resident trout were mapped on the ground, and Vogel (2006) also identified two low-flow barriers in the Middle Yuba River – Oregon Creek and Our House Diversion Dam Reach.

7.3.1.3 Yuba River Upstream of Englebright Reservoir

7.3.1.3.1 Flow-Dependent Instream Habitat Conditions

The 7.1 mi channel of the Yuba River, comprised of the Middle/North Yuba River and New Colgate Powerhouse reaches, is dominantly bedrock-controlled, with only very short boulder/cobble sections. The channel is laterally and vertically stable due to dominant bedrock control. Sinuosity is very low as there are no plan and profile sections strongly influenced by alluvial deposition. Pools are large and deep, and separated by long sections of pocketwater that runs through and under very large boulders. Finer sediment (cobble and finer) accumulations are not common.

This confined bedrock-dominated reach is very inaccessible. Though not very steep, according to the mapped gradient of 1.8 percent, high gradient riffles dominate the gradient "steps." The river flows through bedrock canyons, and the vertical walls inhibit ground access. The only location that was ground-mapped was the area just above and below New Colgate Powerhouse (25% of the reach). Habitat is dominated by mid-channel pools and pocket water formed between large boulders (Table 7.3-8). Boulders are the only instream cover identified; though deep pools likely also provide cover. Large woody debris was not found and trout spawning-sized gravel accumulations were uncommon (Table 7.3-9).

Table 7.3-8. Length, frequency, width and depth of ground-mapped habitat units for the Mainstem Yuba River – New Colgate Powerhouse and Middle/North Yuba River Reaches (between the New Colgate Powerhouse and the Middle/North Yuba junction). The shaded cells are characteristics of pools that do not apply to non-pool habitat types.

Unit Type	Total Length (ft)	Length Relative Frequency	Number	Number of Units (frequency)	Average width (ft)	Average pool depth (ft)	Average maximum pool depth (ft)	Average pooltail embeddedness (%)
Fall	--	--	--	--	--			
Cascade	--	--	--	--	--			
Chute	--	--	--	--	--			
Rapid	989	10.1%	4	12.1%	117.5			
High Gradient Riffle	791	8.1%	5	15.2%	73.3			
Low Gradient Riffle	845	8.6%	6	18.2%	92.4			
Glide	235	2.4%	1	3.0%	176.5			
Run	1,148	11.7%	5	15.2%	121.3			
Step Run	--	--	--	--	--			
Pocket Water	812	8.3%	3	9.1%	89.5			
Sheet	--	--	--	--	--			
Convergence Pool	--	--	--	--	--	--	--	--
Mid-Channel Pool	4,978	50.8%	9	27.3%	104.7	6.6	11.1	Too Deep
Lateral Scour Pool	--	--	--	--	--	--	--	--
Trench Pool	--	--	--	--	--	--	--	--
Plunge Pool	--	--	--	--	--	--	--	--
	9,798	**100.0%**	**33**	**100.0%**	**104.8**	**6.6**	**11.1**	**Likely Not**

Table 7.3-9. Summary of ground mapped data for the Mainstem Yuba River – New Colgate Powerhouse and Middle/North Yuba River Reaches (between the New Colgate Powerhouse and the Middle/North Yuba junction).

Total Reach Length	7.5 mi
Total Ground Mapped Length	1.86 mi (24.7%)
Average Bankfull Width	104.8 ft
Average Bankfull Depth	6.5 ft
Average Width:Depth	16
Total Spawnable Gravel	1,405 ft2 - trout
Average Largest Patch Size	93 ft2 - trout
LWD Density	0 / mi (within bankfull width)
Wetted LWD Density	0 / mi (within wetted width)
Parent Material	Volcanic (Smartsville Complex), gabbro (Pleasant Valley Pluton), quartz diorite
Total No. Passage Barriers	0

7.3.1.3.2 Thermal Refugia (Water Temperatures)

Mean daily water temperatures monitored in EFH reaches of the Yuba River upstream of Englebright Dam potentially affected by the Proposed Action (i.e., three locations in the Yuba River: below the Middle Yuba and North Yuba confluence, above New Colgate Powerhouse and above Englebright Reservoir) during WYs 2009 through 2012 are presented in Figure 7.3-3. In general, water temperatures between the sites at the confluence and above the powerhouse were similar. Mean daily water temperatures below project facilities in the Yuba River upstream of Englebright Reservoir were less than 68°F (20°C) except for approximately 66 percent of days from June through September near the Middle Yuba-North Yuba rivers confluence, and 67 percent of the days from June through October upstream of New Colgate Powerhouse release. The maximum mean daily water temperature recorded in the Yuba River upstream of Englebright Reservoir was 79.5°F (26.4°C) during July 2010.

Differences from year to year were likely the result of spill timing and intensity from New Bullards Bar Reservoir, Our House Diversion Dam and Log Cabin Diversion Dam. Water temperatures below New Colgate Powerhouse were cooled by the release of cold water drawn from the intake structure at New Bullards Bar Reservoir, usually about 50°F (10°C). During the summer, water temperatures in the reach between New Colgate Powerhouse and Englebright Reservoir were 10°C-15°C cooler than those observed upstream of the powerhouse. As described above, the sharp decrease in water temperatures in August was caused when the low-level outlet at New Bullards Bar Dam increased releases to over 1,000 cfs due to an outage downstream at New Colgate Powerhouse, which was caused by a forest fire that burned in the vicinity of the powerhouse and associated structures.

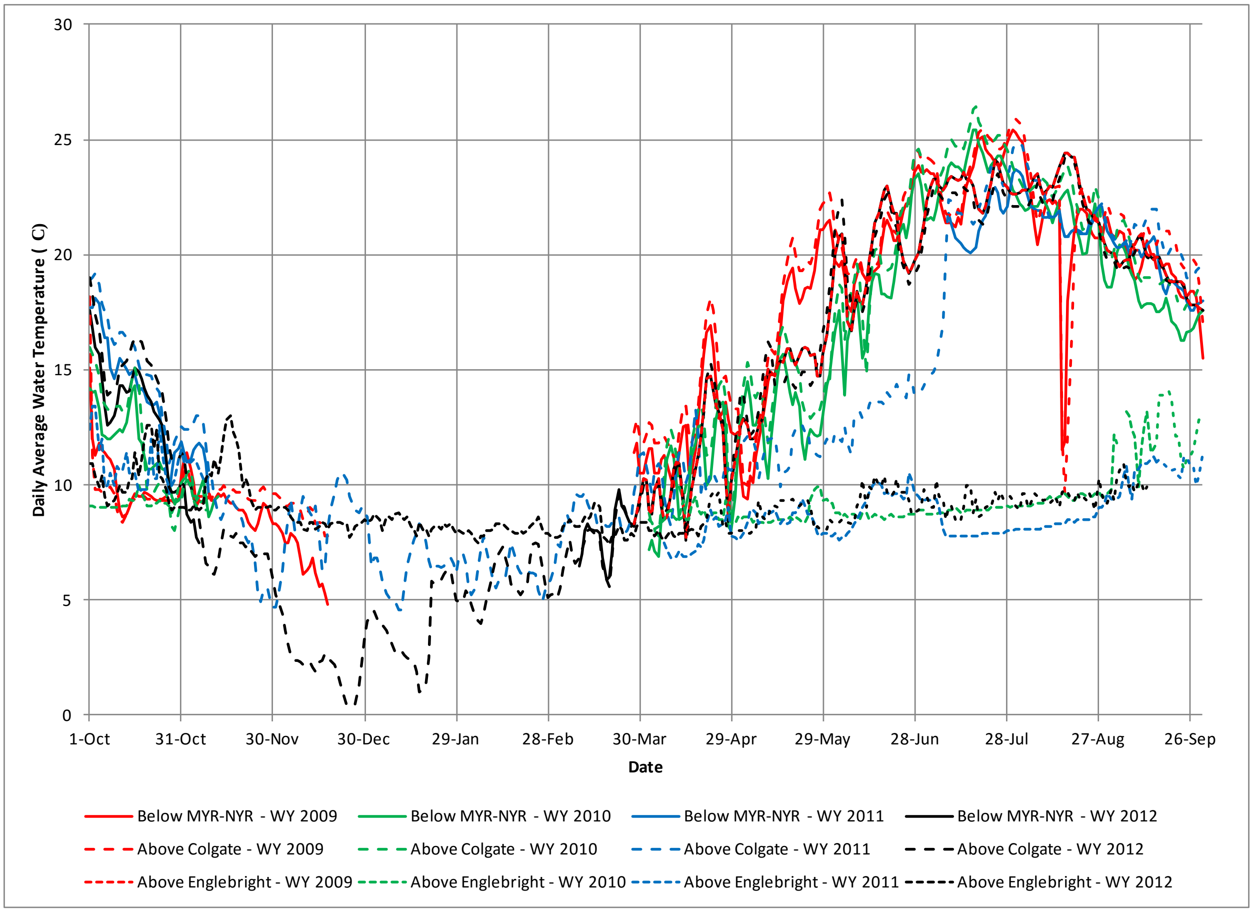

Figure 7.3-3. Mean daily water temperatures in the Yuba River from the Middle and North Yuba rivers downstream to above the normal-maximum water-surface elevation of the USACE's Englebright Reservoir during WYs 2009, 2010, 2011 and 2012.

Monitoring results during the July through December fall-run Chinook salmon adult immigration and staging period indicated that, if fish were able to access areas upstream of Englebright Dam, maximum daily average water temperatures in the Yuba River downstream of Dobbins Creek (i.e., the lowermost monitoring site) did not exceed the upper tolerable WTI of 68°F (20°C) during any of the years (2009 through 2012) sampled. However, the 68°F upper tolerable WTI value was exceeded during all years in July, August and September at the Yuba River site downstream of the confluence of North Yuba River and Middle Yuba River, and at the Yuba River site upstream of New Colgate Powerhouse.

Similarly, monitoring results indicate that during the April through September spring-run Chinook salmon adult immigration and holding period, maximum daily average water temperatures exceeded the upper tolerable WTI of 68°F during most months at the two upstream sites (Yuba River downstream of the confluence of the North Yuba River and Middle Yuba River, and the Yuba River upstream of New Colgate Powerhouse).

Simulated water temperatures in the Yuba River upstream of Englebright Dam during the adult migration and holding-related lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented in Section 7.3.1.1 above.

7.3.1.3.3 Habitat Access - Physical Barriers

Although not specifically for Chinook salmon EFH, a channel morphology study in the river reaches upstream of Englebright Reservoir that are potentially affected by the Proposed Action was undertaken by YCWA during 2011 and 2012. The information summarized below provides an indication of Yuba River channel conditions and physical barriers in areas of EFH that could be potentially affected by the Proposed Action upstream of Englebright Reservoir.

- The Yuba River upstream of the New Colgate Powerhouse generally exhibits coarse bed and banks resistant to movement, and storage of sediment in small areas in deep pools, in velocity shadows, and on lateral bars. Mid-channel bars are uncommon, but do exist, although whether or not they have been reduced in size or frequency since New Bullards Bar Dam construction is unknown.
- The Yuba River downstream of the New Colgate Powerhouse is a reach that appears to be accumulating sediment. The long-term bars (e.g., Rice's, French and Condemned) that existed before the Project will continue to exist, though there are some indications that the channel could shift to occupy French and Rice's bars. Because there are numerous floods within this most downstream section of the upper Yuba River, shifting is not only possible, but likely.
- The banks downstream of New Colgate Powerhouse are generally stable, mostly bedrock and boulder, with only a minor amount of bank erosion that could be due to peaking flows from the New Colgate Powerhouse.
- The Yuba River below the New Colgate Powerhouse has a gradient of 0.2 percent, which reportedly decreases as floodprone flows increase depth, indicating a likely influence of

backwater effects from Englebright Reservoir that extends into the survey site (see Section 3.3 of Exhibit E).

Vogel also surveyed, via helicopter during 2002 and by field assessments during 2003 and 2005, the Yuba River above the USACE's Englebright Reservoir to identify potential natural barriers to upstream steelhead and salmon passage. Vogel (2006) did not identify any barriers in this reach of the Yuba River upstream of Englebright Reservoir. More recently, YCWA surveyed (see Study 3.8, *Stream Fish Populations Upstream of Englebright Reservoir* and Study 3-10, *Instream Flow Upstream of Englebright Reservoir*) two sites on the Yuba River upstream of New Colgate Powerhouse: 1) at RM 39.6, below the confluence of Middle Yuba and North Yuba rivers; and 2) at RM 35.0, upstream of New Colgate Powerhouse. Both sites reportedly were devoid of fish passage impediments. The Yuba River (RM 33.7) between New Colgate Powerhouse and Englebright Reservoir was also surveyed, but fish passage impediments were not documented. While there were no natural barriers to upstream resident trout movement noted during ground-based habitat mapping of the 7.1 mi channel of the Yuba River between the Middle/North Yuba River confluence and New Colgate Powerhouse, this confined bedrock-dominated reach is very inaccessible and it is reported that barriers are likely to occur in this reach of the Yuba River (see Technical Memorandum 3-10).

7.3.2 Downstream of Englebright Dam

7.3.2.1 Lower Yuba River

7.3.2.1.1 Flow-Dependent Instream Habitat Conditions

The NMFS Draft Recovery Plan (NMFS 2009b) states that "For currently occupied habitats below Englebright Dam, it is unlikely that habitats can be restored to pre-dam conditions, but many of the processes and conditions that are necessary to support a viable independent population of spring-run Chinook salmon can be improved with provision of appropriate instream flow regimes, water temperatures, and habitat availability. Continued implementation of the Yuba Accord is expected to address these factors and considerably improve conditions in the lower Yuba River." As acknowledged by NMFS in this statement, stressors associated with instream flows and water temperatures affecting Chinook salmon migration habitat in the lower Yuba River have been addressed, to the extent feasible within hydrological constraints, by the Yuba Accord. However, because the Proposed Action has the potential to change instream habitat conditions in the lower Yuba River, characterization of existing flow-dependent habitat conditions (and water temperature suitabilities) is provided in the following sections.

Flow schedules specified in the Fisheries Agreement of the Yuba Accord were first implemented on a pilot program basis in 2006 and 2007, and early 2008, and then were implemented on a long-term basis in 2008, after the SWRCB made the necessary changes to YCWA's water right permits. Continued implementation of the Yuba Accord addresses flow-related major stressors, including flow-dependent habitat availability, flow-related habitat complexity and diversity, water temperatures, and considerably improves conditions in the lower Yuba River (NMFS 2009b).

Narrows 2 Operations, Flow Changes and Potential Effects to Anadromous Chinook Salmon

YCWA's continued operation of the Project has the potential to affect anadromous salmonid fish species in the Yuba River near the Project's Narrows 2 Powerhouse.

During 2012 and 2013, YCWA conducted a series of assessments in proximity to the Narrows 2 Powerhouse for Technical Memorandum 7-11, *Fish Behavior and Hydraulics Near Narrows 2 Powerhouse*, and Technical Memorandum 7-13, *Fish Stranding Associated with Shutdown of Narrows 2 Powerhouse Partial Bypass*, both of which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA.

Technical Memorandum 7-11 addressed various aspects related to the interaction of Narrows 2 Powerhouse operations and Chinook salmon. The presence, potential for exposure, and resultant behavior of salmonids proximate to the Narrows 2 Powerhouse were assessed by summarizing historical operational data, conducting operational monitoring and characterization of the powerhouse, and monitoring fish behavior and abundance in the vicinity of the powerhouse during different operational events.

Operations of Narrows 2

YCWA and PG&E coordinate releases from YCWA's Yuba River Development Project facilities downstream of Englebright Dam (i.e., Narrows 2 Powerhouse, Narrows 2 Partial Bypass and Narrows 2 Full Bypass) and PG&E's Narrows Project (Narrows 1 Powerhouse)[2] in accordance with the streamflow requirements in Article 33 in the existing license for the Yuba River Development Project, terms in YCWA's water rights and irrigation diversions. Compliance with Article 33 is measured at the USGS gage 11418000, Yuba River Below Englebright Dam, Near Smartsville (Smartsville gage), which is located approximately 300 ft downstream of the Narrows 1 Powerhouse; and at USGS Streamflow Gage 11421000, Yuba River near Marysville, which is located downstream of Daguerre Point Dam. Figure 7.3-4 shows the locations of the Narrows 1 and 2 powerhouses, Narrows 2 Full and Partial bypasses and Smartsville gage in relation to the USACE's Englebright Dam.

For a detailed description of operations of the Narrows 2 (and Narrows 1) facilities, refer to Section 4.0 of this Applicant-Prepared Draft EFH Assessment.

[2] The Narrows 1 Powerhouse has a maximum release capacity of 730 cfs.

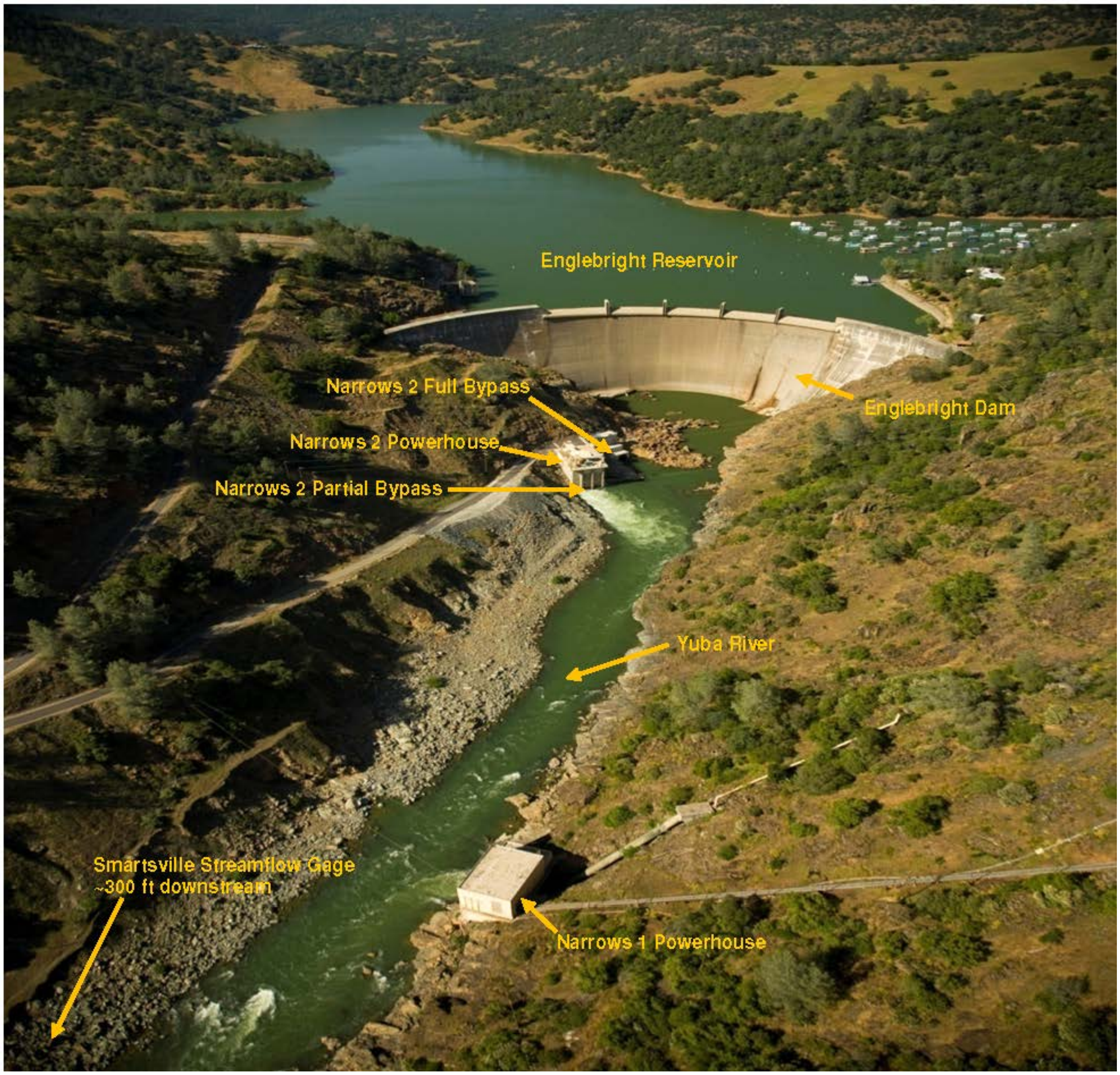

Figure 7.3-4. Locations of Narrows 2 Powerhouse, Narrows 2 Partial Bypass, Narrows 2 Full Bypass and Narrows 1 Powerhouse on the Yuba River in relation to Englebright Dam. In this photo, flow is being released from the Narrows 1 and 2 powerhouses, and no flow is being released from the Narrows 2 Partial Bypass or the Full Bypass.

Potential Effects of Narrows 2 Operations on Anadromous Salmonids

<u>Presence and Behavior of Salmonids near Narrows 2 Powerhouse</u>

Technical Memorandum 7-11 reviews available information and describes hydrological and fisheries surveys conducted in the vicinity of the Narrows 2 Powerhouse during different operational events. The following three Narrows 2 Powerhouse operational scenarios were collaboratively selected with NMFS for velocity characterization: 1) Narrows 2 powerhouse generation; 2) Full Bypass operation, and 3) power generation combined with low Full Bypass discharge. The study determined whether anadromous fish were reaching the Narrows 2 area, and evaluated relative fish abundance and behavior patterns through a variety of methods, including: 1) snorkeling; 2) DIDSON™, ARIS™, and video monitoring; and 3) incidental surface observations. All three methods documented the presence of both resident rainbow trout (mostly juveniles) and adult anadromous Chinook salmon in the vicinity of the Narrows 2 Powerhouse, indicating that these fish have access to this Project facility. Fish abundance and use of habitat features near the Narrows 2 facility were found to be variable based on season and operational conditions.

Technical Memorandum 7-11a (which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA) examined fine-scale movements of adult Chinook salmon in the Yuba River downstream of the Narrows 2 Powerhouse to just upstream of the Narrows 1 Powerhouse. Acoustic telemetry was used to track adult Chinook salmon from August until late October of 2015 under two operational conditions: flow from the Full Bypass, and no discharge from any Narrows 2 facilities. The study documented the timing of Chinook salmon arrival at the Narrows 2 Powerhouse and approximate times that fish may be present in the area of the Narrows 2 Powerhouse.

The abundance of adult Chinook present in the Narrows 2 pool was estimated based on data collected during behavior monitoring using the DIDSON™ (in 2012) and ARIS™ (in 2013) sonar cameras, as well as underwater videography (in 2013), surface observations, and snorkeling. The DIDSON™ camera generally did not produce consistent or clear footage of fish due to entrained air and turbulence in the upper Narrows 2 pool, resulting in the inability to make reliable comparisons of abundance and behavior at different operational conditions. While adult Chinook salmon presence was documented in 2012, there did not appear to be a large group of fish that remained in the study area for a prolonged period in late-summer. The ARIS™ and GoPro® combination employed in 2013 provided improved digital imagery, and better allowed for documenting fish presence and behavior in the study area. Imagery from 2013, coupled with relative abundance modeling yielded an estimate of about 50 adult Chinook salmon present from early September to mid-October near the Narrows 2 Powerhouse. This is a small portion of the 9,791 adult Chinook salmon observations passing upstream of Daguerre Point Dam (as identified by the VAKI Riverwatcher™ system) in 2013 (RMT, unpublished data), but provides evidence that Chinook salmon traveled as far as the Narrows 2 Powerhouse during 2013 and remained there for a period of time prior to spawning. Based on the RMT's 3-year Chinook salmon acoustic tagging study (2009-2011), in general, acoustically-tagged spring-run Chinook salmon exhibited an extended holding period, followed by a rapid movement into upstream areas (upper Timbuctoo Reach, Narrows Reach, and Englebright Reach) during September. Then, a period encompassing approximately one week was observed when fish held at one specific location, followed by rapid downstream movement. The approximate 1-week period appeared to be indicative of spawning events, which ended by the first week in October (RMT 2013a).

A total of 11 operational events (operational changes) occurred in 2013, 9 of which were captured by ARIS™ and/or GoPro® (videography) and analyzed to evaluate behavior of adult Chinook salmon and relative abundance when possible. Surface observations also were made during these events. There were habitat selection and behavioral differences associated with different operational configurations of the Narrows 2 Powerhouse, but those differences may be attributed in part to the capacity of monitoring techniques during different operational configurations. Powerhouse generation was the operational condition at which the range of the ARIS™ was most compromised due to aeration and turbulence. However, available imagery suggests that adult Chinook salmon prefer to hold in the velocity refugia provided by the substrate within the non-aerated lower 40 percent of the water column. While fish were briefly observed in other areas, including the aerated whitewater and the Bypass Pool, their presence in these areas was brief and their behavior in these areas was variable.

During Narrows 2 Full Bypass operation, adult Chinook salmon appeared to be attracted to the Bypass Pool, but did not spend prolonged periods of time in this area. Fish observed in the Narrows 2 Pool during Full Bypass operation utilized the entire pool and were observed milling, roaming, and holding. The Partial Bypass is not operated frequently, but when it did operate in 2013, Chinook salmon behavior did not appear different than during normal generation operations, with the exception of a few fish that were observed jumping at or into the Partial Bypass outlet "spray".

To measure the velocities that may be encountered by adult Chinook salmon during various operational conditions at the Narrows 2 Powerhouse, a velocity characterization effort was made in November of 2013. This proved difficult because the Narrows 2 pool, even at moderate flows, presents a boat handling challenge, particularly when measurement instrumentation requires maintaining a fixed position for 20 seconds or more. The data that were successfully collected indicate that water velocities near the Narrows 2 Powerhouse were generally within the range of normal cruising speed of adult Chinook salmon (and steelhead) during all operational conditions tested. Full Bypass flows yielded the highest velocities measured during monitoring but were well below the burst speed capacity for Chinook salmon. Most measurements recorded during the velocity characterization were within the preferential range for Chinook salmon holding (0.5 fps to 2.6 fps) (Moyle 2002) indicating that there is suitable holding habitat for adult fish at a variety of powerhouse operational configurations (within the range measured).

A total of six fish were tagged and tracked during Study 7.11a, *Radio Telemetry of Spring- and Fall-Run Chinook Migratory Behavior Downstream of Narrows 2 Powerhouse.*[3] Fish lengths ranged from 630 mm to 910 mm fork length (FL) and weights ranged from 2.5 kilograms to 10.0 kilograms. All of the fish captured were adult males with intact adipose fins. Five fish were captured in the Narrows 2 pool and one was captured in the pool at the confluence with Deer Creek. One fish had marks resembling a bite on its ventral area posterior to the pectoral fins, but overall fish appeared healthy with dark coloration. One fish was much smaller and brighter than the others and may have been a jack (i.e., early return life history).

The Narrows 2 Powerhouse generated power from April 2 through August 8, 2015, a critically dry water year. Generation at Narrows 2 Powerhouse peaked in late April. On August 8, 2015

3 YCWA originally intended to use radio telemetry, and thus named the Study 7.11a, *Radio Telemetry of Spring- and Fall-Run Chinook Migratory Behavior Downstream of Narrows 2 Powerhouse*. However, after a field test of three preferred technologies, YCWA agreed to use acoustic telemetry at the request of relicensing participants.

operators observed a warning signal from the generator and diverted flow to the Full Bypass. Mechanical issues with the powerhouse resulted in a lack of Narrows 2 Powerhouse operations for the remainder of 2015.

Fish were tracked in the study area for a total of 59 days, from August 25 through October 22, 2015. Fish displayed transitory behavior in the downstream portion of the study site, generally moving quickly to the upstream portion of the site. Once there, fish displayed milling behavior in the deep pool near the powerhouse. The highest concentrations of fish positions for each fish were in the pool immediately downstream of Narrows 2 Powerhouse, with greater than 90 percent of all positions recorded in said pool. However, as was seen in the previous studies, no fish were observed entering the Narrows 2 draft tube. The estimated nearest approach to the face of the powerhouse for each fish ranged from 10.7 to 10.8 ft. These estimates have an unknown level of error due to the many sources involved in GPS data collection, geo-rectification of aerial images with the overlaying GPS coordinate systems, and multipath associated with both the GPS and acoustic tag signals near the face of the powerhouse. All of the fish made trips out of the study area ranging from 37 minutes to 74.5 hours.

GIS analysis of fish positions indicate little difference in fish behavior between the two operational conditions (i.e., none of the Narrows 2 Facilities operating, and only the Full Bypass operating) observed. Six of the tagged fish were present in the study site when flows were being released from the Full Bypass. Density plots indicate fish were most often found in the pool immediately downstream of the Narrows 2 Powerhouse when the Full Bypass was operating. Only one fish was recorded in the study site when both the Full Bypass was operating and when no Narrows 2 Facilities were operating. A density plot of 2D positions during outage conditions for this fish showed a similar distribution of positions to those observed under Full Bypass operation.

Overall, fish behavior and usage of the study area did not appear to be strongly related to the operational configuration of the powerhouse. During Study 7.11, fish were observed investigating the Bypass Pool, and jumping near the surface water disturbance area of the partial bypass plume, but generally were most often observed in the Narrows 2 Pool milling, roaming, and utilizing low velocity refugia. Density plots of fish positions collected for Study 7.11a indicated similar behavior. Based on the studies conducted for Technical Memorandum 7-11/7.11a, it is apparent that the conditions present in the vicinity of the Narrows 2 Powerhouse, while variable and often dynamic, are within the boundaries of adult Chinook salmon tolerable.

Potential Effects of Narrows 2 Operations on Fish Migratory Behavior in the Lower Yuba River

For this Applicant-Prepared Draft EFH Assessment, additional analyses of available data were undertaken to address potential relationships between Project operations and resultant flow changes in the lower Yuba River and adult salmonid behavior. YCWA obtained data from the RMT to plot daily locations of each individual acoustically-tagged fish with monitored mean daily flows at the Smartsville gage. Daily locations of each fish for each of the three study years (2009, 2010 and 2011) were plotted using both the static receiver data and the roving survey data. To first visually examine generalized daily locations of all acoustically-tagged fish in a given year, the location of each acoustically-tagged fish was averaged on a daily basis and plotted with mean daily flow at the Smartsville gage for each study year separately (2009, 2010 and 2011). To investigate potential relationships between individual fish movements and mean daily flow, daily time series of individual fish movements and mean daily flow at the Smartsville gage were visually examined to identify generalized patterns of movement in relation to flow. Attachment B of the Applicant-Prepared Draft BA provides figures of individual acoustically-tagged fish and flow at the Smartsville gage, grouped by apparent relationships between individual fish movement and changes in flow. Individuals that that did not exhibit any readily apparent movement-flow relationships were excluded from this evaluation. Visual examination of changes in fish location and changes in flow was then used to quantify changes in individual fish movement (river miles) and associated changes in mean daily flow (cfs) over a specific time period (days) for a given individual.

Analyses conducted by YCWA in this Applicant-Prepared Draft EFH Assessment found that most of the individual movements of acoustically-tagged spring-run Chinook salmon potentially associated with a change in flow at the Smartsville gage were upstream movements occurring concurrently with a noticeable decrease in flow. Additional notable observations included some individuals that moved upstream in the days following a reduction in flow.

The mean location of acoustically-tagged fish generally moved upstream of Daguerre Point Dam during mid-August to mid-September in 2009, during early to late September in 2010, and during early September to early October in 2011. The upstream shift in the mean position of individuals during 2009 started just prior to a large reduction in flow over the period of approximately mid-August to early September. During 2010, the upstream shift in mean fish location started immediately after a large flow reduction over the period of approximately late August to early September. During 2011, the upstream shift in mean fish location started during late August, which coincided with the approximate midpoint of the large flow reduction over the period of mid-August and early September. During each of the three years, the average fish location continued to move upstream after the mid-August to early September flow reduction (into mid- to late September during 2009 and 2010, and into early October in 2011).

Observed movements identified during 2009 generally occurred within the time period from about mid-May to early September, and generally occurred over a period ranging from 1 to 9 days. Most of the observed movements identified during 2010 occurred during early to mid-June, with a few movements occurring during August, and generally occurred over a period ranging from about 1 to 7 days. The movements identified during 2011 generally occurred during late August into early September, and generally occurred over a period ranging from about 1 to 5 days. Because spring-running Chinook salmon immigrated into the lower Yuba River later than during 2009 and 2010, and were not captured and acoustically-tagged until July, no potential relationships between fish movement and flow reductions during the spring months could be evaluated.

More than half (40 out of 60) of the identified movements of Chinook salmon over the 3 years that were potentially associated with a concurrent change in flow consisted of upstream movements coinciding with a large decrease in flow (measured at the Smartsville gage). Most of the identified upstream movements occurring coincident to a decrease in flow occurred when flow decreased substantially during a 1 to 2 week period in late August to early September and/or during a 1 to 2 week period during May or June, depending on the year. In other words, the most common potential relationship identified between spring-run Chinook salmon movement and flow was movement upstream to the upper reaches during a large reduction in mean daily Smartsville flow (38 to 68%) occurring over about 1 to 2 weeks. Due to limitations in the available data, potential intra-daily relationships between fish movement and flow could not be evaluated. For additional detail on acoustically-tagged Chinook salmon movements, refer to Section 6.0 of the Applicant-Prepared Draft BA.

Potential for Injury or Mortality to Anadromous Salmonids Associated with Narrows 2 Operations

Technical Memorandum 7-11 specifically evaluated whether conditions resulting from Project operations at Narrows 2 may result in an increased potential for fish mortality. Possible scenarios that could result in fish mortality were identified as: 1) interaction with the powerhouse turbine; 2) exposure to poor water quality; and 3) stranding. Stranding potential was evaluated independently as part of Technical Memorandum 7-13, *Fish Stranding Associated with Shutdown of Narrows 2 Powerhouse Partial Bypass*, which is discussed in subsequent sections, below.

Operation of the Narrows 2 Powerhouse results in high velocity discharge at the base of the turbine during power generation. The lowest velocities modeled in this study were within the common range of adult salmonid burst-speed swimming capacity, but most modeled velocities during operations were outside of this range, indicating that fish were generally unable to swim against the flow discharging from the draft tubes. Additionally, DIDSON™ and ARIS™ digital imagery, along with underwater videography, indicated that it was uncommon for fish to orient themselves towards the discharge flow from the draft tubes. Behavior was generally characterized as milling, and attraction of fish to the area surrounding the draft tubes appeared to be rare. Fish were observed holding near the turbine outflow, but were not observed attempting to ascend the draft tubes. Therefore, the risk of injury or mortality of fish associated with interaction with the turbine or draft tube appeared to be negligible.

Dissolved oxygen and water temperature monitoring conducted for Technical Memorandum 7-11 found that the water that is released from the Narrows 2 Powerhouse facilities (during bypass and generation operations) in the Narrows Pool and Bypass Pool is suitable year-round for anadromous salmonids. However, water temperature conditions immediately below Englebright

Dam in the Dam Pool can reach unsuitable (> 68°F) water temperatures during the summer when the Dam Pool becomes disconnected from the Bypass Pool during generation operations. Exposure of fish to these elevated water temperatures, however, is limited due to the reduced ability of fish to be able to access the Dam Pool during low flow conditions. Even when the Dam Pool is connected to the Bypass Pool, the water temperature gradient would likely be immediately sensed by approaching salmonids and avoided. During all surveys conducted, salmonids were not observed in the Dam Pool, indicating that the potential for stress or mortality associated with exposure to the Dam Pool is also negligible. During Full Bypass operations, the cooler water in the Bypass Pool mixed with the water in the Dam Pool, reducing water temperatures to suitable conditions (~ 55°F).

Stranding and Isolation Near the Narrows 2 Powerhouse

YCWA is aware of five salmon observations that may be related to stranding in the Yuba River in the vicinity of the Narrows 2 Development facilities. Four of these were incidental observations made during data collection activities for YCWA's Study 7.11, *Fish Behavior and Hydraulics Near Narrows 2 Powerhouse*. Two occurred prior to initiation of Study 7.13, *Fish Stranding Associated with Shutdowns of Narrows 2 Powerhouse Partial Bypass*, and included an observation by YCWA operators on October 23, 2012 of a fish carcass on the bank near the Bypass Pool and an observation by Relicensing Participants on October 25, 2012 of a fish carcass on the bank near the Partial Bypass. Two other incidental observations occurred in 2013. The first of these observations was of a fish carcass near the Narrows 2 Powerhouse on October 7, 2013. The second observation involved multiple fish apparently confined in an isolated pool in the channel near Narrows 2 Powerhouse on October 13, 2013. The fifth observation was made during fish stranding monitoring as part of YCWA's Narrows 2 Facilities Prioritized Operations and Monitoring Plan (Prioritized Operations Plan) and Streambed Monitoring Below Englebright Dam Plan (Streambed Monitoring Plan) in October of 2015. These observations are described in detail in Section 6.0 of the Applicant-Prepared Draft BA.

7.3.2.1.2 Thermal Refugia (Water Temperatures)

Water temperature is an important habitat component of migration corridors. Water temperature suitability evaluations conducted in the Applicant-Prepared Draft BA present an integrated lifestage-specific representation. This Applicant-Prepared Draft EFH Assessment maintains that presentation format. Hence, in addition to the migration-related lifestages of Chinook salmon, this section also provides characterization of existing water temperature conditions for spawning and embryo incubation, and for juvenile rearing and downstream movement lifestages. Summary discussions of "thermal refugia" corresponding to each of the other organizational components (i.e., spawning and embryo incubation habitat, and juvenile rearing habitat) are provided in those sections.

During November 2010, the RMT prepared a Technical Memorandum (RMT 2010b) to review the appropriateness of the water temperature regime associated with implementation of the Yuba Accord using previously available data and information, updated in consideration of recent and ongoing monitoring activities conducted by the RMT since the pilot programs were initiated in 2006. The RMT's objectives for that memorandum were to review and update the lifestage periodicities of target species in the lower Yuba River, identify the appropriate thermal regime for target fish species taking into account individual species and lifestage water temperature requirements, identify WTI values, assess the probability of occurrence that those WTI values would be achieved with implementation of the Yuba Accord, and to evaluate whether alternative water temperature regimes are warranted.

Since November 2010, additional water temperature monitoring and life history investigations of anadromous salmonids in the lower Yuba River have been conducted by the RMT. An update to the water temperature suitability evaluation in RMT (2010b) was recently presented by the RMT in their M&E Program Interim Report (RMT 2013a). The water temperature suitability evaluation conducted for this Applicant-Prepared Draft EFH Assessment incorporates lifestage periodicity refinements presented in RMT (2013a) and additional water temperature monitoring data collected since that report was prepared, and utilizes YCWA's Relicensing Water Temperature Model to evaluate simulated daily water temperatures over the modeled period of record (1970-2010) presented in the addendum (RMT 2013b) to RMT 2010b. Interim Technical Memorandum 7.2 described the sequence of water temperature monitoring, modeling and evaluation by the RMT. In the 2013 addendum to the 2010 RMT Water Temperature Objectives Memorandum, the RMT utilized the updated lifestage periodicities and water temperature index values identified in RMT (2013a) to evaluate water temperature suitabilities using updated water temperature monitoring and the YRDP daily water temperature model.

The water temperature index values evaluated in Technical Memorandum 7-2 are the updated water temperature index values evaluated by the RMT (2013a) in their Monitoring and Evaluation Interim Report, as was anticipated in the RMT 2010 report. Therefore, the upper tolerable WTI values (and associated species-specific lifestage periodicities) evaluated in Technical Memorandum 7-2, *Narrows 2 Powerhouse Intake Extension*, represent the most recent WTI values identified by the RMT, consistent with the FERC-approved Study Plan 7-2.

Through review of previously conducted studies, as well as recent and currently ongoing data collection activities of the M&E Program, the RMT (2013a) developed the following representative lifestage-specific periodicities for spring-run and fall-run Chinook salmon and primary locations for water temperature suitability evaluations. The locations used for water temperature evaluations correspond to Smartsville, Daguerre Point Dam, and Marysville.

- **Spring-run Chinook Salmon**
  - Adult immigration and holding (April through September) – Smartsville, Daguerre Point Dam, and Marysville
  - Spawning (September through mid-October) – Smartsville
  - Embryo incubation (September through December) – Smartsville
  - Juvenile rearing and downstream movement (Year-round) – Daguerre Point Dam and Marysville
  - Smolt (yearling+) emigration (October through mid-May) – Daguerre Point Dam and Marysville

- **Fall-run Chinook Salmon**
  - Adult immigration and staging (July through December) – Daguerre Point Dam and Marysville
  - Spawning (October through December) - Smartsville and Daguerre Point Dam
  - Embryo incubation (October through March) - Smartsville and Daguerre Point Dam
  - Juvenile rearing and downstream movement (late-December through June) – Daguerre Point Dam and Marysville

Lifestage-specific upper tolerable WTI values used as evaluation guidelines for Chinook salmon were developed based on the information described in Attachment A to RMT (2010b), as well as additional updated information provided in Bratovich et al. (2012). These documents present the results of literature reviews that were conducted to: 1) interpret the literature on the effects of water temperature on the various lifestages of spring-run and fall-run Chinook salmon; 2) consider the effects of short-term and long-term exposure to constant or fluctuating temperatures; and 3) establish WTI values to be used as guidelines for evaluation. Specifically, this present evaluation adopts the approach established by Bratovich et al. (2012), which uses the lifestage and species-specific upper optimum and upper tolerable WTI values. These WTI values were not meant to be significance thresholds, but instead provide a mechanism by which to compare the suitability of the water temperature regimes associated with implementation of the Yuba Accord. Spring-run Chinook salmon and fall-run Chinook salmon lifestage-specific WTI values are provided in Tables 7.3-10 and 7.3-11.

Table 7.3-10. Spring-run Chinook salmon lifestage-specific upper tolerable water temperature index values.

Spring-run Chinook Salmon Lifestage	Upper Tolerable WTI	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Migration	68°F							■	■	■	■	■	■	■	■	■	■	■	■						
Adult Holding	65°F							■	■	■	■	■	■	■	■	■	■	■	■						
Spawning	58°F																	■	■	■					
Embryo Incubation	58°F																	■	■	■	■	■	■	■	■
Juvenile Rearing and Downstream Movement	65°F	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Smolt (Yearling+) Emigration	68°F	■	■	■	■	■	■	■	■	■										■	■	■	■	■	■

Table 7.3-11. Fall-run Chinook salmon lifestage-specific upper tolerable water temperature index values.

Fall-run Chinook Salmon Lifestage	Upper Tolerable WTI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Immigration and Staging	68°F	□□	□□	□□	□□	□□	□□	■■	■■	■■	■■	■■	■■
Spawning	58°F	□□	□□	□□	□□	□□	□□	□□	□□	□□	■■	■■	■■
Embryo Incubation	58°F	■■	■■	■■	□□	□□	□□	□□	□□	□□	■■	■■	■■
Juvenile Rearing and Downstream Movement	65°F	■■	■■	■■	■■	■■	■■	□□	□□	□□	□□	□□	□■

Water Temperature Monitoring

Recent water temperature monitoring data in the lower Yuba River are available for the period extending from 2006 into July 2016, during which time operations have complied with the Yuba Accord. In general, the lowest water temperatures in the lower Yuba River are observed during January and February, and water temperatures steadily increase until mid-June or July, remain at relatively high values through September and steadily decrease thereafter. The coldest water temperatures are observed upstream at the Smartsville gage, intermediate water temperatures occur at Daguerre Point Dam, and the warmest temperatures are observed downstream at the Marysville gage for most months of the year. The least amount of spatial variation in water temperature is observed during late fall through winter months (i.e., late November through February), when water temperatures are similar at the three monitoring locations.

Figure 7.3-5 displays daily water temperature monitoring results, which extend from October 2006 into June 2016 at the Smartsville water temperature gage, and from October 2006 into July 2016 at the Daguerre Point Dam and Marysville water temperature gages. Although the water temperature monitoring station is referred to as "above Daguerre Point Dam", it represents water temperatures at Daguerre Point Dam. The water temperature monitoring data are superimposed with spring-run Chinook salmon lifestage-specific upper tolerable WTI values. Water temperatures at all three gages during the period evaluated are generally below the upper tolerable WTI values for smolt (yearling+) emigration. Water temperatures at all three gages are generally always below the upper tolerable WTI value for adult immigration, with the exception of during the summer of 2015 (after a multi-year drought period) at the Marysville gage. The upper tolerable WTI values for adult holding, and juvenile rearing and outmigration also have rarely been exceeded, with the exception of two days during 2013, 23 days during 2014, and during approximately June through September of 2015 at the Marysville gage. However, it is not expected that holding adults or juveniles would spend extended periods of time at downstream locations (e.g., Marysville). For example, adult spring-run Chinook salmon were found to primarily exhibit holding behavior just downstream of Daguerre Point Dam or above Daguerre Point Dam during their adult holding period (RMT 2013a), and juvenile Chinook salmon primarily rear where water temperatures are suitable in more upstream reaches of the lower Yuba River (RMT 2013a). The upper tolerable spawning and embryo incubation WTI value is never exceeded at Smartsville (which is the only location evaluated for spring-run Chinook salmon spawning and embryo incubation), with the exception of during 11 days in September of 2015. However, during these 11 days, mean daily water temperatures only exceeded 58°F by an average of 0.2°F.

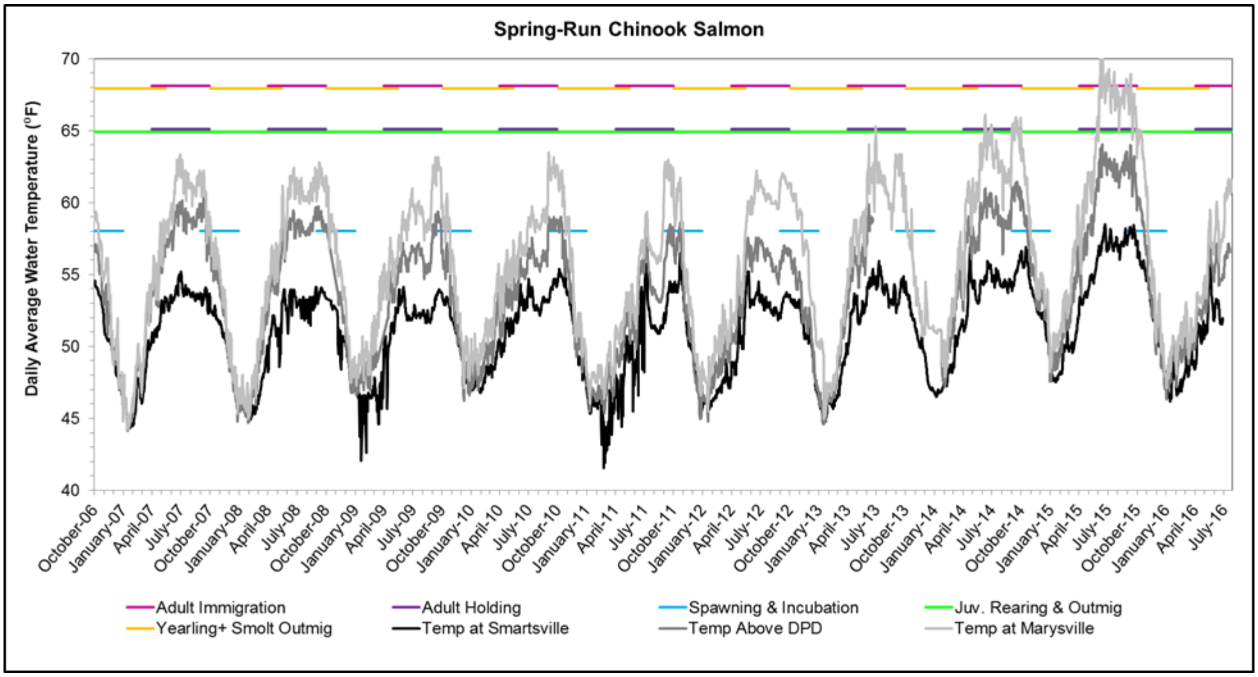

Figure 7.3-5. Monitored lower Yuba River water temperatures and spring-run Chinook salmon upper tolerable water temperature index values.

Figure 7.3-6 displays the daily water temperature monitoring results at the Smartsville, Daguerre Point Dam, and Marysville water temperature gages, with fall-run Chinook salmon lifestage-specific upper tolerable WTI values. Water temperatures at all three gages during the period evaluated are always below the upper tolerable WTI values for adult immigration and staging, and juvenile rearing and downstream movement, except for during 2014 when Marysville water temperatures briefly exceed the juvenile rearing and downstream movement WTI value, and during 2015 when Marysville water temperatures exceed the juvenile rearing and downstream movement WTI value during late May through June and exceed the adult immigration and staging WTI value during 19 days from July through September of 2015. The upper tolerable spawning and embryo incubation WTI value is never exceeded at Smartsville, and water temperatures at Daguerre Point Dam generally remain below that value by the first few days of this lifestage in early October for all years, except for during 2014 and 2015 when water temperatures do not exceed the WTI value after mid- to late October.

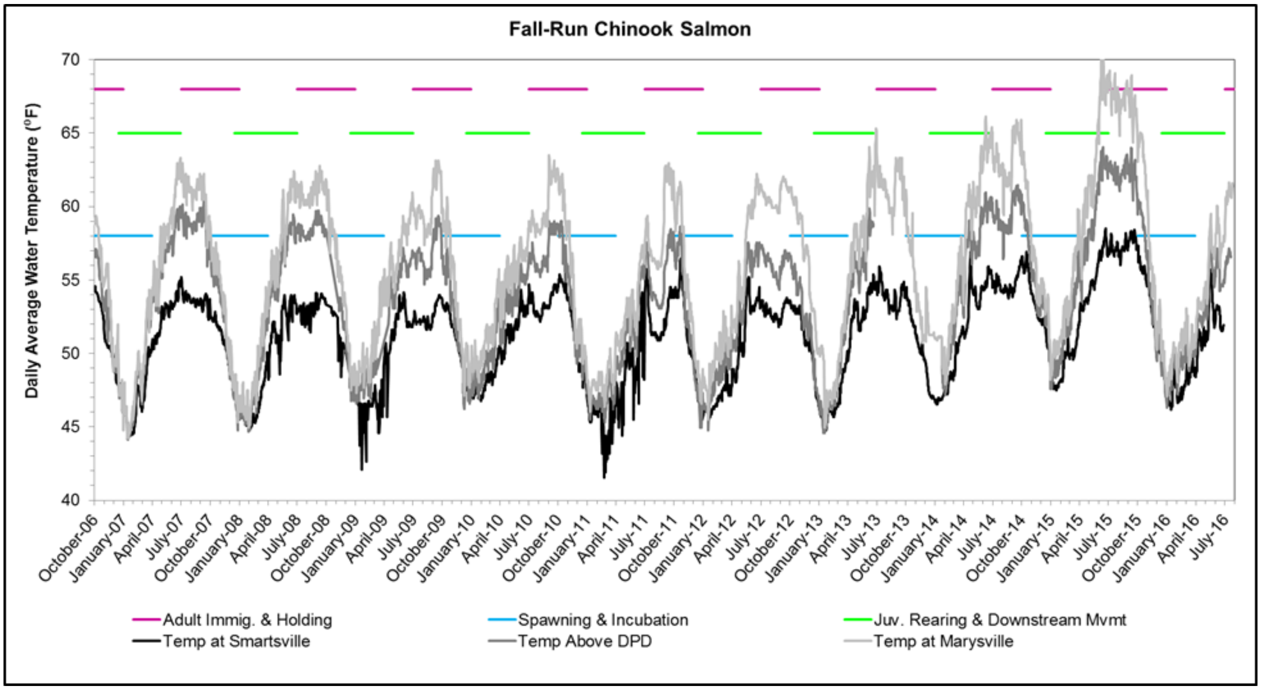

Figure 7.3-6. Monitored lower Yuba River water temperatures and fall-run Chinook salmon upper tolerable water temperature index values.

Water Temperature Modeling

Species and lifestage-specific target WTI values were initially evaluated by the RMT (2010b) using the monthly time-step statistical water temperature model results used in the Yuba Accord EIR/EIS (YCWA et al. 2007). As stated by RMT (2010b), the water temperature suitability evaluation conducted at that time would be updated with application of a daily time-step water temperature model, when such a model became available, to provide greater resolution and to validate the exceedance estimates of the Yuba Accord Water Temperature Model. As previously mentioned, YCWA recently developed a daily HEC-5Q water temperature model for the lower Yuba River for the Project FERC Relicensing process. Documentation for that model, including details of model construction and validation, can be found on the YCWA Relicensing web site at www.ycwa-relicensing.com.

Output from the relicensing water temperature model is comprised of mean daily water temperatures occurring over a 41-year simulation period (WY 1970-2010). For this evaluation, simulated mean daily water temperatures were used for the following locations: 1) the Smartsville gage; 2) Daguerre Point Dam; and 3) the Marysville gage. Water temperature output nodes include both above and below Daguerre Point Dam, although both nodes present the same water temperature values. For evaluation purposes, water temperatures at Daguerre Point Dam used the output node designated as below Daguerre Point Dam.

Water temperature cumulative probability distributions have been developed for each half-month over the 41–year simulation period. Half-month water temperature cumulative probability distributions represent the probability, as a percent of time, that modeled water temperature values would be met or exceeded at an indicator location. For this evaluation, half-month cumulative probability distributions were used to examine the probability that the upper tolerable WTI values would be exceeded for the individual half-month periods within the identified lifestages, at the specified locations, for the target species.

Simulated mean daily water temperature model output has provided greater resolution than the previously available monthly Project Relicensing Water Temperature Models. The daily water temperature model exhibits the same seasonal and longitudinal trends in water temperature in the lower Yuba River observed through application of the monthly Yuba Accord Water Temperature Model, as well as trends observed from water temperature monitoring. Additionally, consistent with the monitoring results, simulated mean daily water temperatures (averaged by half-month period) during the summer can be up to approximately 4°F warmer at Daguerre Point Dam and 9°F warmer at the Marysville gage, relative to the Smartsville gage. As demonstrated by both the monitoring results and model results, the range of temperatures at Marysville is seasonally dependent because of the rate of warming in the lower Yuba River, and is greatly influenced by air temperature, solar radiation, and volume of flow in the river (RMT 2010b).

Consistent with the RMT (2010b), the evaluation of water temperatures in the lower Yuba River in this Applicant-Prepared Draft EFH Assessment primarily focuses on the identification of those periods during which the water temperature model results estimate a probability of exceeding the species- and lifestage-specific WTI values. An exceedance value of 10 percent or greater was used as an indicator of potentially impactive conditions for a specific species/run and lifestage. For example, the spring-run Chinook salmon spawning period is characterized as extending from September through mid-October. Application of model results (41 years) to this species/run and lifestage would indicate a potentially impactive condition if daily water temperatures exceeded the specified WTI value for 10 percent of the days evaluated during each one-half month period of this lifestage (41 years X 15 days = 615 days; 10% = 61 days). It should be noted that the sequential duration of exceedance of a WTI value was not considered, and a single day in a month where the average daily temperature exceeded the index value would likely be less impactive than a multi-day sequence where the average daily temperature exceeded the water temperature index value. However, all occasions where the average daily water temperature exceeded the index value are included in the calculation of exceedance probabilities. The following sections discuss specific species/runs/lifestages/months where model results indicate that water temperatures could exceed specified water temperature index values by 10 percent or more of the time, consistent with the approach used by RMT (2010b).

Environmental Baseline Compared to Without-Project Scenario

Tables 7.3-12 and 7.3-13 display the differences in the species and lifestage-specific upper tolerable WTI value exceedance probabilities under the Environmental Baseline scenario relative to the Without-Project scenario (i.e., the probability of exceeding a WTI value under the Environmental Baseline scenario minus the probability of exceeding that WTI value under the Without-Project scenario).

Table 7.3-12. Difference in simulated upper tolerable water temperature exceedance probabilities for spring-run Chinook salmon lifestages under the Environmental Baseline, relative to the Without-Project scenario.

Spring-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Immigration	SMRT	68°F							0.0	0.0	0.0	0.0	0.0	-2.1	-29.4	-73.2	-100.0	-100.0	-100.0	-97.2						
	Below DPD	68°F							0.0	0.0	0.0	0.0	-8.0	-42.8	-78.5	-97.6	-97.6	-97.6	-97.6	-97.7						
	MRY	68°F							-2.3	-2.4	-0.2	-6.4	-35.1	-61.8	-90.9	-97.6	-97.6	-97.6	-97.4	-97.6						
Adult Holding	SMRT	65°F							0.0	0.0	0.0	0.0	-0.5	-15.4	-55.4	-90.7	-100.0	-100.0	-100.0	-99.7						
	Below DPD	65°F							0.0	0.0	0.0	-1.2	-31.1	-60.3	-92.7	-97.6	-97.6	-97.6	-97.6	-97.6						
	MRY	65°F							-2.3	-2.3	-2.0	-15.4	-48.0	-68.0	-87.0	-86.4	-91.7	-91.8	-90.2	-96.3						
Spawning	SMRT	58°F																	-97.6	-97.6	-95.1					
Embryo Incubation	SMRT	58°F																	-97.6	-97.6	-95.1	-94.2	-45.0	-1.3	0.0	0.0
Juvenile Rearing and Downstream Movement	Below DPD	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	-31.1	-60.3	-92.7	-97.6	-97.6	-97.6	-97.6	-97.6	-96.3	-57.6	-2.0	0.0	0.0	0.0
	MRY	65°F	0.0	0.0	0.0	0.0	0.0	0.0	-2.3	-2.3	-2.0	-15.4	-48.0	-68.0	-87.0	-86.4	-91.7	-91.8	-90.2	-96.3	-97.6	-94.8	-10.1	0.0	0.0	0.0
Yearling+ Smolt Emigration	Below DPD	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										-90.4	-20.6	0.0	0.0	0.0	0.0
	MRY	68°F	0.0	0.0	0.0	0.0	0.0	0.0	-2.3	-2.4	-0.2										-99.2	-88.4	-2.1	0.0	0.0	0.0

Water temperature exceedance probabilities are generally similar and very low under the Environmental Baseline and Without-Project scenarios during the winter through spring months (i.e., late November through early May) for most lifestages of spring-run and fall-run Chinook salmon.

Table 7.3-13. Difference in simulated upper tolerable water temperature exceedance probabilities for fall-run Chinook salmon lifestages under the Environmental Baseline, relative to the Without-Project scenario.

Fall-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Adult Immigration and Staging	Below DPD	68°F													-78.5	-97.6	-97.6	-97.6	-97.6	-97.7	-90.4	-20.6	0.0	0.0	0.0	0.0
	MRY	68°F													-90.9	-97.6	-97.6	-97.6	-97.4	-97.6	-99.2	-88.4	-2.1	0.0	0.0	0.0
Spawning	SMRT	58°F																			-95.1	-94.2	-45.0	-1.3	0.0	0.0
	Below DPD	58°F																			-56.4	-91.8	-62.9	-4.1	0.0	0.0
Embryo Incubation	SMRT	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-95.1	-94.2	-45.0	-1.3	0.0	0.0
	Below DPD	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-56.4	-91.8	-62.9	-4.1	0.0	0.0
Juvenile Rearing and Downstream Movement	Below DPD	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	-31.1	-60.3												0.0
	MRY	65°F	0.0	0.0	0.0	0.0	0.0	0.0	-2.3	-2.3	-2.0	-15.4	-48.0	-68.0												0.0

During spring through fall months (i.e., May through October), in general water temperatures are substantially more suitable for all lifestages of spring-run and fall-run Chinook salmon that are evaluated during that time period under the Environmental Baseline scenario relative to the Without-Project scenario. Specifically, water temperatures are substantially more suitable for the following lifestages and associated time periods for at least one location.

- **Spring-run Chinook salmon**
  - Adult Migration (June – September)
  - Adult Holding (late May – September)
  - Spawning (September – mid October)
  - Embryo Incubation (September – mid November)
  - Juvenile Rearing and Downstream Movement (late May – mid November)
  - Smolt (Yearling+) Emigration (October)
- **Fall-run Chinook salmon**
  - Adult Immigration and Staging (July – October)
  - Spawning (October – mid November)
  - Embryo Incubation (October – mid November)
  - Juvenile Rearing and Downstream Movement (late May – June)

7.3.2.1.3 Habitat Access - Physical Barriers

Englebright Dam presents an impassable barrier to the upstream migration of anadromous salmonids, and marks the upstream extent of currently accessible Chinook salmon habitat in the lower Yuba River, whereas Daguerre Point Dam presents a potential impediment to upstream migration.

Englebright Dam

According to NMFS (2007, 2009b), the greatest impact to listed anadromous salmonids in the Yuba River watershed is the complete blockage of access for these species to their historical spawning and rearing habitat above Englebright Dam. Because this historic habitat is no longer accessible, fall-run Chinook salmon are relegated to the lower 24-mi of the lower Yuba River from Englebright Dam to the confluence with the lower Feather River. Since construction of Englebright Dam in 1941, fall-run Chinook salmon are required to complete all of their riverine lifestages in the lower 24-mi of the lower Yuba River, which previously served primarily as a migratory corridor to upstream spawning and rearing habitats.

The 2007 NMFS BO identified the following non-flow related stressors associated with Englebright Dam: 1) blocking access of listed salmonids to the habitat above the dam; 2) forcing overlapping use of the same spawning areas by spring- and fall-run Chinook salmon below the dam; 3) forcing fish to spawn in a limited area without the benefit of smaller tributaries, which can provide some level of refuge in the event of catastrophic events; and 4) preventing the recruitment of spawning gravel and large woody material from upstream of the dam into the lower river.

Daguerre Point Dam

Adult Upstream Migration

Daguerre Point Dam is recognized as an impediment to upstream migration of adult salmon under certain conditions. When high flow conditions occur during winter and spring, adult Chinook salmon can experience difficulty in finding the entrances to the ladders because of the relatively low amount of attraction flows exiting the fish ladders, compared to the magnitude of the sheet-flow spilling over the top of Daguerre Point Dam. The angles of the fish ladder entrance orifices and their proximities to the plunge pool also increase the difficulty for fish to find the entrances to the ladders. However, because fall-run Chinook salmon migrate upstream in the lower Yuba River from mid-summer through fall, this is not believed to represent nearly as much of a stressor to fall-run Chinook salmon by contrast to spring-run Chinook salmon, as thoroughly described in the Applicant-Prepared Draft BA. In addition, periodic obstruction of the ladders by sediment and woody debris has blocked passage or substantially reduced attraction flows at the ladder entrances in recent years.

Sheet flow across the dam's spillway, particularly during high-flow periods, may obscure ladder entrances and, thus, makes it difficult for immigrating adult salmonids to find the entrances (NMFS 2007). For example, fall-run Chinook salmon have been observed attempting to leap over the dam, demonstrating that these fish may have difficulty in finding the fish ladder entrances (USACE 2000). This phenomenon may particularly affect spring-run Chinook salmon, because peak spring-run adult Chinook salmon upstream migration occurs primarily during the relatively high-flow periods of spring through early summer. Since 2001, wooden flashboards have been periodically affixed to the crest of the dam during low flow periods to aid in directing the flows towards the fish ladder entrances. Fish passage monitoring data from 2006 indicates that the installation of the flashboards resulted in an immediate and dramatic increase in the passage of salmon up the ladders, and is thought to have improved the ability of salmon to locate and enter the ladders (NMFS 2007).

Both the north and south fish ladders at Daguerre Point Dam, particularly the north ladder, historically tended to clog with woody debris and sediment, which had the potential to block passage or substantially reduce attraction flows at the ladder entrances. Additionally: 1) the north and south ladders' exits are close to the spillway, potentially resulting in adult fish exiting the ladder being immediately swept by flow back over the dam; 2) sediment accumulates at the upstream exits of the fish ladders, reducing the unimpeded passage from the ladders to the main channel, and may cause potential "fall-back" into the ladders; and 3) fish could jump out of the upper bays of the fishway, resulting in direct mortality. Many of the past issues associated with woody debris accumulation have either been eliminated or minimized since locking metal grates were installed over the unscreened bays on the north and south fish ladders during 2011.

The RMT (2013a) examined passage of adult Chinook upstream of Daguerre Point Dam and corresponding flow data during 8 years of available data. Chinook salmon passage was observed over a variety of flow conditions, including ascending or descending flows, as well as during extended periods of stable flows. Flow thresholds prohibiting passage of Chinook salmon through the ladders at Daguerre Point Dam were not apparent in the data (RMT 2013a).

Phenotypic spring-run Chinook salmon (those entering the lower Yuba River during spring months) may remain in the lower Yuba River in areas downstream (and proximate) to Daguerre Point Dam for extended periods of time during the spring and summer. It is uncertain whether, or to what extent, the duration of residency in the large pool located downstream of Daguerre Point Dam is associated with upstream passage impediment and delay, or volitional habitat utilization prior to spawning in upstream areas. However, RMT (2013a) reported that temporal migrations of adult phenotypic spring-run Chinook salmon to areas upstream of Daguerre Point Dam occurred over an extended period of time. The tagged spring-run Chinook salmon in the lower Yuba River actually migrated upstream of Daguerre Point Dam from May through September, and utilized a broad expanse of the lower Yuba River during the phenotypic summer holding period, including areas as far downstream as Simpson Lane Bridge (i.e., about RM 1.8), and as far upstream as the area just below Englebright Dam. A longitudinal analysis of acoustic tag detection data indicated that distributions were non-random, and that the tagged spring-run Chinook salmon were selecting locations for holding (RMT 2013a).

It is not possible to assess if, or the manner in which, extended duration of holding below Daguerre Point Dam could potentially change spawning distribution, because no base data are available for conditions without the presence of Daguerre Point Dam. However, during the extensive pilot redd survey conducted during 2008-2009 (RMT 2010d), 33 percent of all Chinook salmon redds were observed by the first week of October, compared to 37 percent of all Chinook salmon redds observed by the first week of October during the redd surveys conducted in 2009-2010 (RMT 2010d). Moreover, 74 percent of all Chinook salmon redds were observed upstream of Daguerre Point Dam during the extensive pilot redd survey conducted during 2008-2009, and the same exact percentage (74%) of all Chinook salmon redds were observed upstream of Daguerre Point Dam during the redd surveys conducted in 2009-2010. The similar distribution in timing and the same percentage distribution of Chinook salmon redds located upstream of Daguerre Point Dam occurred despite considerable differences in flow (monthly average cfs) that occurred from late spring into fall of 2008 compared to flow during 2009.

NMFS (2007) suggested that delays resulting from adult spring-run Chinook salmon adult passage impediments could weaken fish by requiring additional use of fat stores prior to spawning, and potentially could result in reduced spawning success (i.e., production) from reduced resistance to disease, increased pre-spawning mortality, and reduced egg viability. However, these statements suggesting biological effects associated with fish passage issues at Daguerre Point Dam are not supported by studies or referenced literature. For example, the RMT (2010b) included evaluation of water temperatures at Daguerre Point Dam during the spring-run Chinook salmon adult upstream immigration and holding lifestage, which addressed considerations regarding both water temperature effects to pre-spawning adults and egg viability. RMT (2010b) concluded that during this lifestage, characterized as extending from April through August, water temperatures [modeled] at Daguerre Point Dam are suitable and remain below the reported optimum water temperature index value of 60°F at least 97 percent of the time over all WYTs during these months. Thus, it is unlikely that this represents a significant source of mortality to spring-run Chinook salmon. Moreover, actual data monitored since the Yuba Accord has been implemented (October 2006 to June 2013) demonstrates that water temperatures at Daguerre Point Dam actually remained at about or below 60°F during the adult immigration and holding period each of the 6 years (RMT 2013a).

Juvenile Downstream Migration

As reported by NMFS (2007), Daguerre Point Dam may adversely affect outmigration success of juvenile salmonids. During downstream migration, juvenile Chinook salmon (and steelhead) may be disoriented or injured as they plunge over the spillway, increasing their exposure and vulnerability to predators in the large pool at the base of the dam (NMFS 2007).

NMFS (2007) and other documents (NMFS 2002a; CALFED and YCWA 2005) suggest that juvenile salmonids may be adversely affected by Daguerre Point Dam on their downstream migrations, because Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool below. The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005). It has been suggested that the rates of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, may be unnaturally high (NMFS 2007). However, DWR and USACE (2003) stated that there is no substantial evidence of predation on emigrating juvenile salmon by warmwater fish, and that temperature and habitat conditions in the lower Yuba River are not conducive to the establishment of significant populations of such fish, except perhaps in the Marysville area. Daguerre Point Dam may influence predation rates on emigrant juvenile anadromous salmonids, although DWR and USACE (2003) stated that there are no data indicating that such predation is significant, whether predation at the dam is offset by lower predation rates downstream, or even what percentage of juvenile salmonids are taken by predators. Presently, there is a paucity of studies or data regarding predation rates on juvenile anadromous salmonids in the vicinity of Daguerre Point Dam or elsewhere in the lower Yuba River.

Other than the dams, there are no known physical obstructions or passage barriers for adult upstream migrating Chinook salmon, or downstream migrating juvenile Chinook salmon in the lower Yuba River.

Although areas of EFH downstream of the lower Yuba River are not anticipated to be affected by the Proposed Action, the waterways (i.e., Feather and Sacramento rivers, Delta) discussed below are included for completeness in characterizing Pacific Coast salmon EFH in the region.

7.3.2.2 Feather River

For the purposes of this Applicant-Prepared Draft EFH Assessment, EFH in the Feather River reach extending from the confluence of the Yuba River downstream to the confluence of the Sacramento River has the remote potential to be affected by the Proposed Action. However, it is not anticipated that substantial changes in lower Yuba River flows would occur under the Project. Therefore, changes in aquatic habitat conditions downstream of the mouth of the lower Yuba River would not be expected to occur.

EFH in this reach of the lower Feather River is primarily used as a migration corridor by adult and juvenile Chinook salmon. As previously discussed, it is not anticipated that direct or indirect effects would occur to managed species or EFH downstream of the mouth of the lower Yuba River (e.g., in the lower Feather River or Sacramento River). Because SWP operations control relatively large flows in the lower Feather River, which is a larger river than the Yuba River, even if measurable changes to flows in the lower Yuba River were to occur, it would not be practicable to attempt to segregate potential changes in lower Feather River flow downstream of the lower Yuba River associated with potential changes in lower Yuba River outflow (see Section 4.0 of the Applicant-Prepared Draft BA for further discussion).

7.3.2.3 Sacramento River

EFH in the lower Sacramento River is primarily used as a migration corridor by both adult and juvenile Chinook salmon. For the purposes of this Applicant-Prepared Draft EFH Assessment, only EFH in the Sacramento River extending from the confluence of the Feather River downstream to the Delta would have a remote potential to be affected by the Proposed Action. However, it is not anticipated that substantial changes in lower Yuba River flows would occur under the Project. Therefore, changes in aquatic habitat conditions downstream of the mouth of the lower Yuba River would not be expected to occur. Moreover, because CVP/SWP operations control relatively large flows in the lower Feather and Sacramento rivers, even if measurable changes to flows in the lower Yuba River were to occur, it would not be practicable to attempt to segregate potential changes in lower Feather and Sacramento river flows downstream of the lower Yuba River (see Section 4.0 of the Applicant-Prepared Draft BA for further discussion).

7.3.2.4 Sacramento-San Joaquin Delta

Estuaries are important migration habitat for adult and juvenile Chinook salmon (NMFS and PFMC 2011). Although lower Yuba River adult and juvenile Chinook salmon would utilize EFH in the Delta during migration and juvenile rearing, the Proposed Action will not affect EFH in the Delta.

7.4 Spawning and Embryo Incubation Habitat

As described in NMFS and PFMC (2011), spawning habitat is an HAPC that has an extremely high ecological importance, and it is especially sensitive to stress and degradation by a number of land- and water-use activities that affect the quality, quantity and stability of spawning habitat (e.g., water withdrawals, sediment deposition from land disturbance, streambank armoring) (SRSRB 2011). Salmon spawning habitat is typically defined as low gradient stream reaches (<3%), containing clean gravel with low levels of fine sediment and high inter-gravel flow (NMFS and PFMC 2011). All salmon require cold, highly oxygenated, flowing water as suitable spawning habitat. Spawning habitat consists of the combination of gravel, depth, flow, temperature, and dissolved oxygen (NMFS and PFMC 2011). Adverse effects to any of these factors can inhibit the spawning success of Chinook salmon. The availability and selection of suitable habitat leading to successful spawning can mean the difference between a successful recruitment year or a less than desirable one (NMFS and PFMC 2011).

7.4.1 Yuba River Watershed Upstream of Englebright Dam

7.4.1.1 North Yuba River (New Bullards Bar Dam Reach)

7.4.1.1.1 Spawning Habitat Availability

Although not specifically conducted for Chinook salmon EFH, studies on resident rainbow trout spawning habitat availability were conducted in the river reaches upstream of Englebright Reservoir that are potentially affected by the Proposed Action. Because Chinook salmon are not present upstream of Englebright Dam, the results of these studies are used to provide a general overview of spawning-related EFH that may be present in the Yuba River watershed upstream of Englebright Dam, although it is recognized that suitable conditions for resident trout do not necessarily imply suitable conditions for Chinook salmon.

During 2011, 2012 and early 2013, YCWA conducted instream flow studies in six study reaches (totaling 25.9-mi) that included all river segments downstream of Project facilities that are located upstream of Englebright Reservoir (see Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*). Using PHABSIM, flow-habitat relationships were developed for four target fish species, including the spawning, juvenile and adult lifestages of rainbow trout. Weighted Usable Area (WUA) results present the relationship between discharge and the availability of suitable habitat for target species (e.g., rainbow trout). Rainbow trout spawning WUA was limited in most study reaches due to patchy and limited distribution of suitable spawning substrate. Where suitable substrate was recorded, the preferred combination of depths and velocities were often not present. Rainbow trout juvenile and adult WUA functions were consistent in magnitude and discharge between study sub-reaches, increasing as channel size increased. The only exception was on the North Yuba River downstream of New Bullards Bar Dam. In this reach, simulated maximum adult rainbow trout WUA occurred at 600 cfs. Maximum spawning WUA for rainbow trout in the New Bullards Bar Dam reach was calculated to correspond to a discharge of 120 cfs.

Technical Memorandum 3-10, *Instream Flow Upstream of Englebright Reservoir*, developed "Area Under the Curve" (AUC) estimates of rainbow trout spawning WUA by summing the habitat value associated with each percentile along the habitat duration curve from 1 to 100 percent. For the North Yuba River, only one PHABSIM site (RM 0.2) was selected, due to the reach being characterized by large 'car-sized' boulders and only interstitial streamflow. The resulting AUC estimate of rainbow trout spawning habitat availability in the North Yuba River below New Bullards Bar Dam under the Environmental Baseline (With-Project scenario) is provided in Figure 7.4-1.

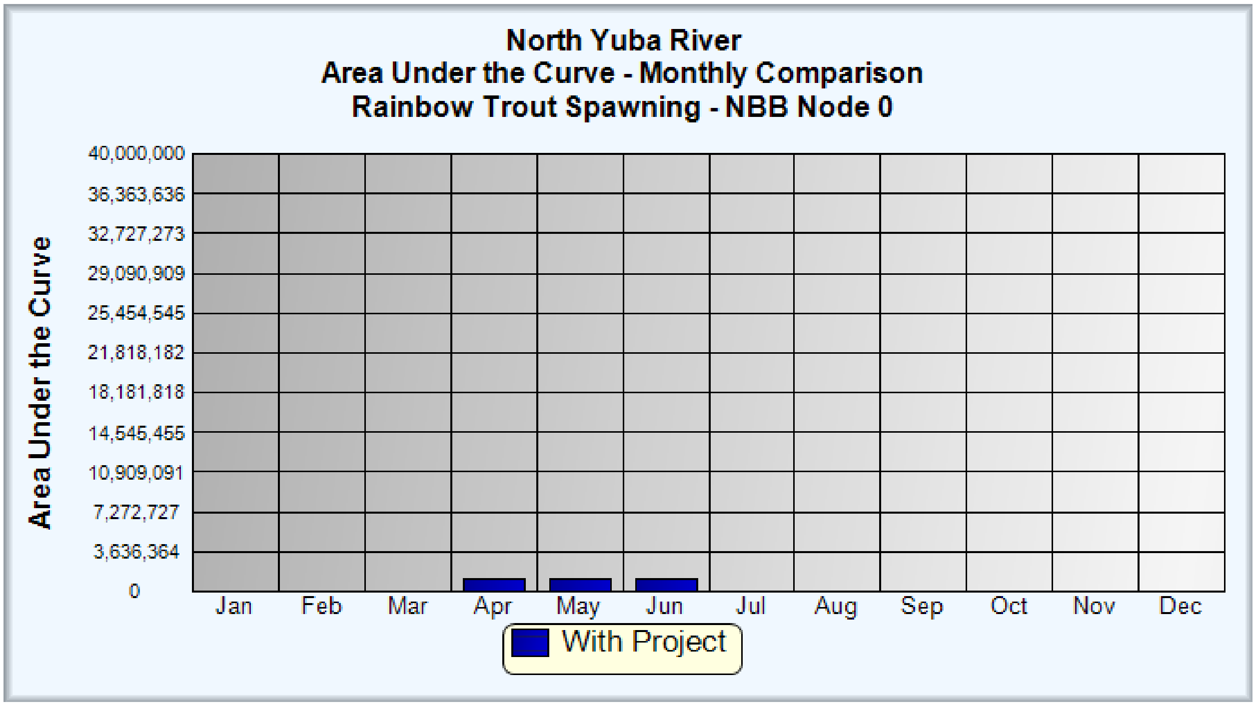

Figure 7.4-1. North Yuba River – New Bullards Bar Dam Reach – Monthly habitat exceedance results shown as AUC for rainbow trout spawning – Node 0.

The North Yuba River below New Bullards Bar Dam was sampled for spawning gravel at one site (RM 0.2), which was subsequently found to be devoid of suitable spawning gravel for resident trout (see Technical Memorandum 3-8, *Stream Fish Populations Upstream of Englebright Reservoir*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA).

7.4.1.1.2 Thermal Refugia

Monitoring results during the months of October, November and December indicate that water temperatures were highest during October of the 2009 through 2012 sampling period, and maximum average daily water temperatures in the North Yuba River upstream of the Middle Yuba River during October ranged from 56.5°F (13.6°C) during 2009 up to 63.0°F (17.2°C) during 2011.

As discussed above for Migratory Habitat (Section 7.3), the water temperature suitability evaluation conducted for this Applicant-Prepared Draft EFH Assessment utilizes lifestage-specific periodicities and upper tolerable WTI values specified in RMT (2013a) for fall-run and spring-run Chinook salmon, and YCWA's Relicensing Water Temperature Model to evaluate simulated daily water temperatures over the modeled period of record (WY 1970-2010). Additional details on the species-specific lifestage periodicities and WTI values are provided in Section 6.0 of the Applicant-Prepared Draft BA.

For efficiency of presentation, this section evaluates water temperature suitabilities for spawning and embryo incubation lifestages of spring-run and fall-run Chinook salmon for the North Yuba River, the Middle Yuba River and the Yuba River upstream of Englebright Dam. Evaluations of water temperature suitabilities for juvenile rearing and migration are provided in Section 7.5 (Juvenile Rearing Habitat) below.

Environmental Baseline Scenario compared to Without-Project Scenario

Tables 7.4-1 and 7.4-2 display the differences in the spring-run and fall-run Chinook salmon spawning and embryo incubation upper tolerable WTI value exceedance probabilities under the Environmental Baseline scenario relative to the Without-Project scenario (i.e., the probability of exceeding a WTI value under the Environmental Baseline scenario minus the probability of exceeding that WTI value under the Without-Project scenario).

Table 7.4-1. Difference in simulated upper tolerable water temperature exceedance probabilities for spring-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Spring-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Spawning	NYR	58°F																	-100.0	-100.0	-54.5					
	MYR	58°F																	0.0	0.0	-6.5					
	YR BLW MYR	58°F																	0.0	-0.2	-10.2					
	YR ABV COLGATE	58°F																	0.0	0.0	12.0					
	YR BLW COLGATE	58°F																	-100.0	-100.0	-77.7					
Embryo Incubation	NYR	58°F																	-100.0	-100.0	-54.5	-4.1	0.0	0.0	0.0	0.0
	MYR	58°F																	0.0	0.0	-6.5	-1.5	0.0	0.0	0.0	0.0
	YR BLW MYR	58°F																	0.0	-0.2	-10.2	-5.3	0.0	0.0	0.0	0.0
	YR ABV COLGATE	58°F																	0.0	0.0	12.0	3.8	0.0	0.0	0.0	0.0
	YR BLW COLGATE	58°F																	-100.0	-100.0	-77.7	-9.9	0.0	0.0	0.0	0.0

Table 7.4-2. Difference in simulated upper tolerable water temperature exceedance probabilities for fall-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Fall-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Spawning	NYR	58°F																			-54.5	-4.1	0.0	0.0	0.0	0.0
	MYR	58°F																			-6.5	-1.5	0.0	0.0	0.0	0.0
	YR BLW MYR	58°F																			-10.2	-5.3	0.0	0.0	0.0	0.0
	YR ABV COLGATE	58°F																			12.0	3.8	0.0	0.0	0.0	0.0
	YR BLW COLGATE	58°F																			-77.7	-9.9	0.0	0.0	0.0	0.0
Embryo Incubation	NYR	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-54.5	-4.1	0.0	0.0	0.0	0.0
	MYR	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-6.5	-1.5	0.0	0.0	0.0	0.0
	YR BLW MYR	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-10.2	-5.3	0.0	0.0	0.0	0.0
	YR ABV COLGATE	58°F	0.0	0.0	0.0	0.0	0.0	0.0													12.0	3.8	0.0	0.0	0.0	0.0
	YR BLW COLGATE	58°F	0.0	0.0	0.0	0.0	0.0	0.0													-77.7	-9.9	0.0	0.0	0.0	0.0

Water temperature exceedance probabilities are generally similar under the Environmental Baseline and Without-Project scenario during November through March for the spawning and embryo incubation lifestages of spring-run and fall-run Chinook salmon.

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario are generally substantially more suitable for spring-run Chinook salmon spawning and embryo incubation during September through mid-October in the North Yuba River below New Bullards Bar Dam and in the Yuba River below New Colgate Powerhouse, during early October in the Yuba River below the Middle Yuba River, and during late October in the Yuba River below New Colgate Powerhouse. Water temperatures are substantially more suitable for fall-run Chinook salmon spawning and embryo incubation during early October in the North Yuba River below New Bullards Bar Dam and below the Middle Yuba River, and during October in the Yuba River below New Colgate Powerhouse.

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario are generally substantially less suitable for both spring-run and fall-run Chinook salmon spawning and embryo incubation lifestages only during early October in the Yuba River above New Colgate Powerhouse.

7.4.1.2 Middle Yuba River (with Emphasis on the ~1.5 Miles of EFH Upstream from the Confluence of the Middle Yuba River and the North Yuba River)

7.4.1.2.1 Spawning Habitat Availability

Rainbow trout spawning WUA was limited in most of the Project reaches upstream of Englebright Dam, including in the Middle Yuba River, due to patchy and limited distribution of suitable spawning substrate. Where suitable substrate was recorded, the preferred combination of depths and velocities were often not present. Optimal spawning discharges varied significantly between streams and in some cases, between sub-reaches. In the Middle Yuba River, maximum spawning WUA downstream of the Oregon Creek confluence was 345 cfs. Upon further review, it was determined that much of the available spawning gravel downstream of the Oregon Creek confluence was perched (i.e., on the stream margin and/or out of the wetted channel at the high flow calibration measurements of 327 and 345 cfs) and was deposited during high flow events. Therefore, the perched gravels only become suitable when flows are high enough to inundate them. The resulting AUC estimate of rainbow trout spawning habitat availability in the lowermost reach (Oregon Creek Reach) of the Middle Yuba River under the Environmental Baseline (With-Project scenario) is provided in Figure 7.4-2 (see Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*).

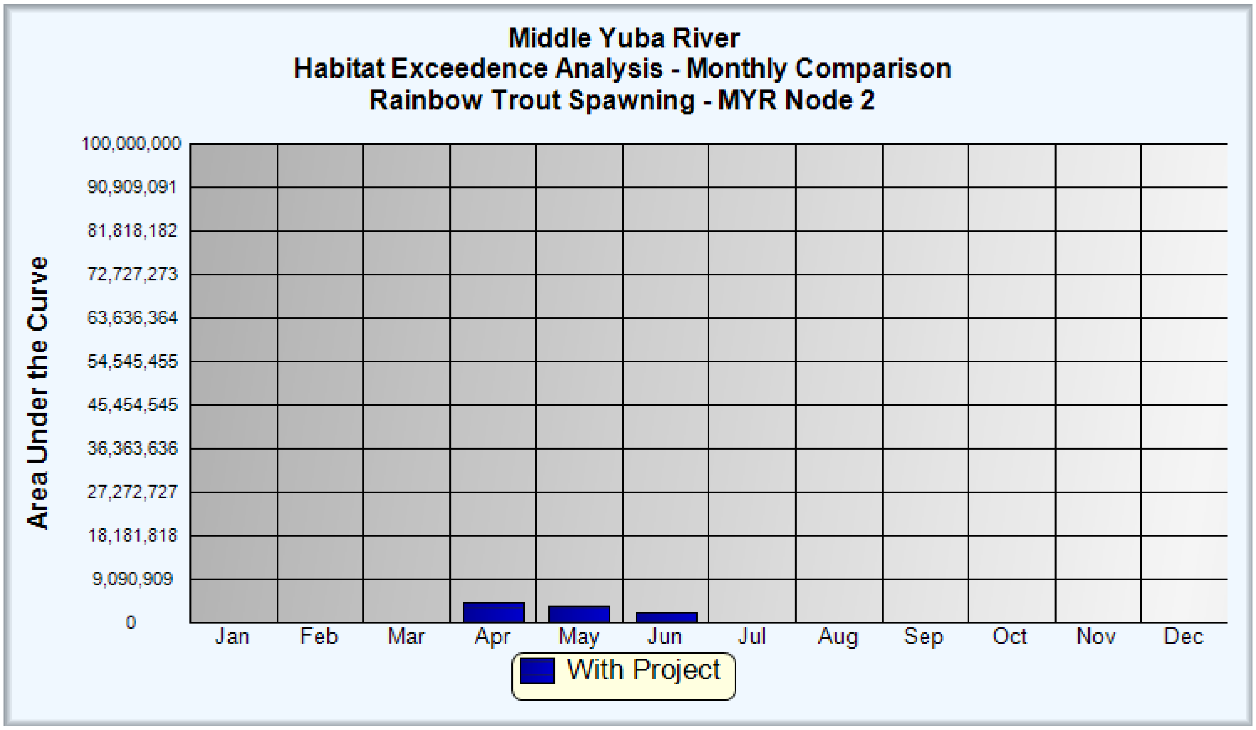

Figure 7.4-2. Middle Yuba River – Oregon Creek Reach – Monthly habitat exceedence results shown as AUC for rainbow trout spawning.

Several sites were identified for sampling spawning gravel in the Middle Yuba River (see Technical Memorandum 3-8, *Stream Fish Populations Upstream of Englebright Reservoi*r) and include: 1) 2 sites in the Our House Diversion Dam Reach at RM 12.5 and 5.0; and 2) 2 sites downstream of the confluence with Oregon Creek on the Middle Yuba River at RM 3.3 (downstream of Moonshine Creek) and at RM 1.0 (downstream of Yellowjacket Creek).

- At the RM 12.5 site (upstream of the EFH Action Area), approximately 20 and 29 sq ft of gravel suitable for resident trout were observed in 2012 and 2013, respectively.
- At the RM 5.0 site (upstream of the EFH Action Area), approximately 12 sq ft of gravel suitable for spawning resident trout was observed in 2012, whereas none were documented in 2013.
- At the RM 3.3 site (upstream of the EFH Action Area), approximately 200 sq ft of suitable spawning gravel for resident trout was observed in 2012, but was not documented in 2013.
- At the RM 1.0 site, the only site in the Middle Yuba River located within the EFH Action Area, suitable spawning gravel for resident trout was not observed in 2012, but 200 sq ft of gravel was documented in 2013.

7.4.1.2.2 Thermal Refugia

Monitoring results during the months of October, November and December indicate that water temperatures were highest during October of the 2009 through 2012 sampling period, and maximum average daily water temperatures in the Middle Yuba River upstream of the North Yuba River during October ranged from 59.4°F (15.2°C) during 2010 up to 64.9°F (18.3°C) during 2011.

Simulated water temperatures in the Middle Yuba River during the spawning and embryo incubation lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented under the North Yuba River in Section 7.4.1.1 above.

7.4.1.3 Yuba River Upstream of Englebright Reservoir

7.4.1.3.1 Spawning Habitat Availability

The maximum adult rainbow trout WUA was identified as 160 cfs upstream and 482 cfs downstream of New Colgate Powerhouse, respectively. Maximum spawning WUA for rainbow trout in the Middle/North Yuba River reach was calculated to correspond to a discharge of 70 cfs. In the New Colgate Powerhouse reach of the Yuba River upstream of Englebright Reservoir, the maximum spawning WUA for rainbow trout was calculated to correspond to a discharge of 253 cfs. The resulting AUC estimate of rainbow trout spawning habitat availability in the Middle/North Yuba River Reach and the New Colgate Powerhouse Reach of the Yuba River under the Environmental Baseline (With-Project scenario) is provided in Figure 7.4-3 and 7.4-4 (see Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*), respectively.

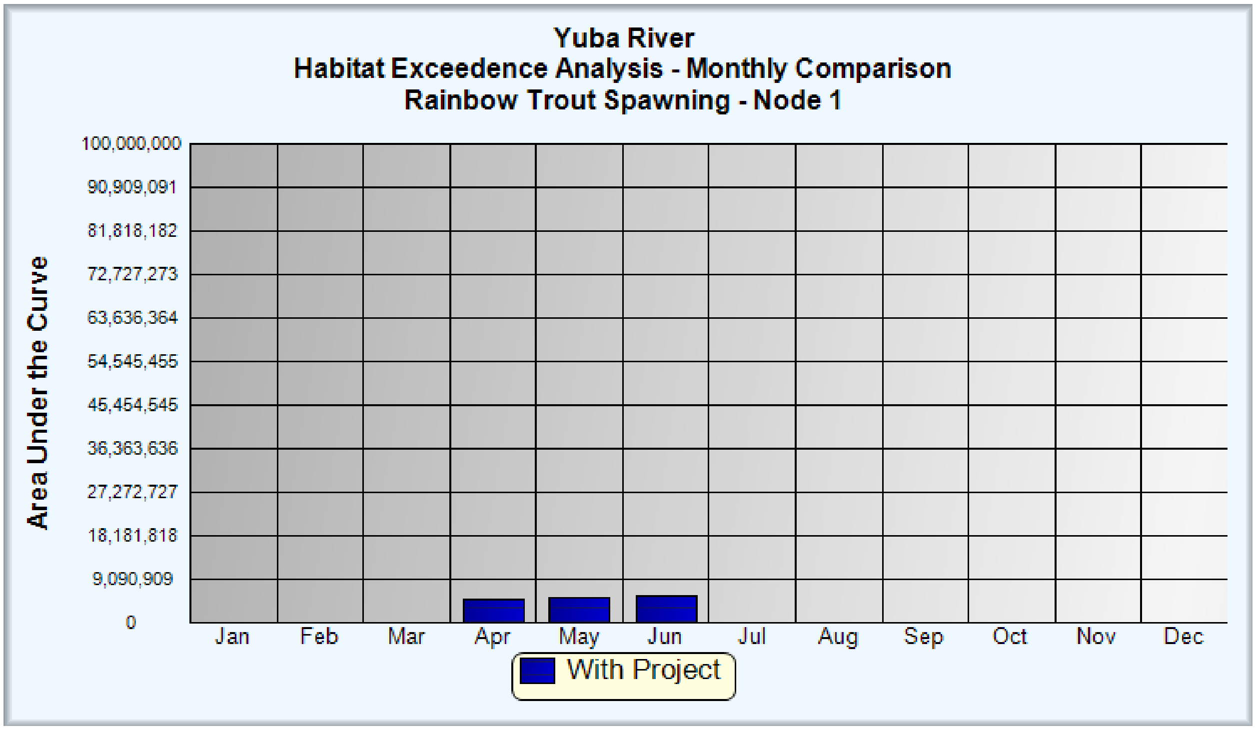

Figure 7.4-3. Yuba River – Middle/North Yuba Reach – Monthly habitat exceedance results shown as AUC for rainbow trout spawning.

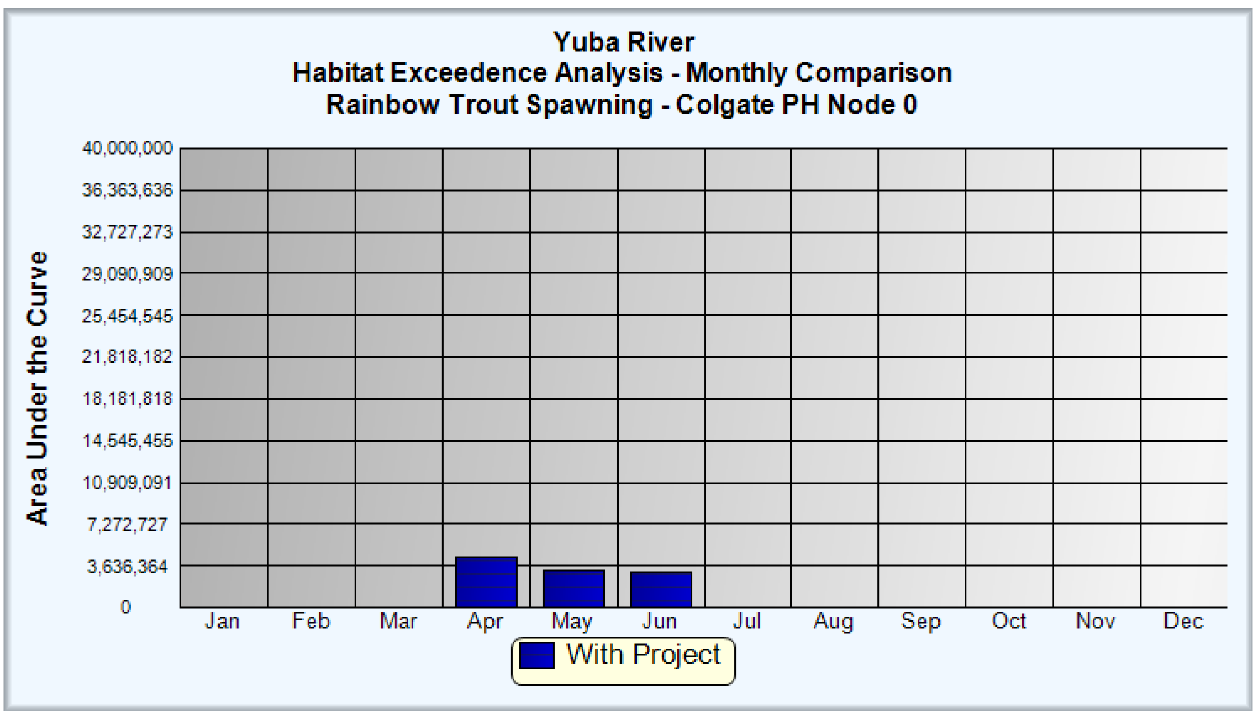

Figure 7.4-4. Yuba River – New Colgate Powerhouse Reach – Monthly habitat exceedance results shown as AUC for rainbow trout spawning.

YCWA's Study 3.8, *Stream Fish Populations Upstream of Englebright Reservoir*, included spawning gravel surveys at two sites on the Yuba River upstream of New Colgate Powerhouse: 1) at RM 39.6, below the confluence of Middle Yuba and North Yuba rivers; and 2) at RM 35.0, upstream of New Colgate Powerhouse. Study 3.8 also included spawning gravel surveys at one site (RM 33.7) on the Yuba River between New Colgate Powerhouse and Englebright Reservoir.

- The site at RM 39.6 was devoid of suitable spawning gravel for resident trout during 2012 and 2013.
- At the RM 35.0 site, approximately 10 sq ft of suitable resident trout spawning gravel was identified during 2012, and slightly more (50 sq ft) was identified during 2013.
- At the RM 33.7 site, approximately 83 sq ft of suitable spawning gravel for resident trout was identified during 2012, whereas a greater amount (225 sq ft) was documented during 2013.

7.4.1.3.2 Thermal Refugia

In the Yuba River upstream of Englebright Reservoir, monitoring results during the months of October, November and December indicate that water temperatures were highest during October of the 2009 through 2012 sampling period, and daily average water temperatures were higher in the reach located between the confluence of the North Yuba River, Middle Yuba River and upstream of New Colgate Powerhouse. Maximum average daily water temperatures in the Yuba River downstream of the confluence of the North Yuba River and Middle Yuba River during October ranged from 57.7°F (14.3°C) during 2010 up to 64.6°F (18.1°C) during 2011. Maximum average daily water temperatures in the Yuba River upstream of New Colgate Powerhouse during October ranged from 60.8°F (16.0°C) during 2010 up to 66.6°F (19.2°C) during 2011.

Simulated water temperatures in the Yuba River upstream of Englebright Dam during the spawning and embryo incubation lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented under the North Yuba River in Section 7.4.1.1 above.

7.4.2 Downstream of Englebright Dam

7.4.2.1 Lower Yuba River

7.4.2.1.1 Spawning Physical Habitat Overview

According to Pasternack (2010), no known records of conditions prior to placer gold mining in the mid-nineteenth century are available that describe the hydrologic conditions in the river reach of the canyon where Englebright Dam and Reservoir are located. During the era of placer gold mining, Malay Camp on the northern bank of the lower Yuba River near the confluence of Deer Creek served as a base of operations for miners working Landers Bar, an alluvial deposit in the nearby canyon. The historical records of the existence of this camp and placer-mining site proves that coarse sediment was stored in the canyon prior to hydraulic mining in a large enough quantity to produce emergent alluvial bars (Pasternack 2010).

During the period of hydraulic gold mining, vast quantities of sand, gravel, and cobble entered the Yuba River (Gilbert 1917) and deposited throughout the system. This human impact completely transformed the river. Historical photos from 1909 and 1937 document that the canyon was filled with alluvial sediment with an assemblage of river features including riffles (Pasternack et al. 2010). Conditions downstream of the canyon during that period were described by James et al. (2009). Even though Daguerre Point Dam was built on the valley floor to prevent the transport of hydraulic mining debris in 1906, it is too small to block sediment migration during floods (Pasternack 2010).

Following the construction of Englebright Dam, historic photographs show that the amount of alluvium in the entire lower Yuba River, including the canyon, decreased (Pasternack et al. 2010). At the Marysville gaging station, the river incised about 20 ft from 1905-1979, while 0.5 mi downstream of the Highway 20 Bridge it incised about 35 ft over the same period (Beak Consultants, Inc. 1989). Landform adjustments continue to occur - as illustrated by Pasternack (2008), who estimated that about 605,000 yds3 of sediment (primarily gravel and cobble) were exported out of Timbuctoo Bend from 1999 to 2006. Further investigations of landform and sediment-storage changes are on-going.

The reported changes conform with the expected, natural response of a river to blockage of downstream sediment passage (e.g. Williams and Wolman 1984). For most rivers, such geomorphic changes represent a harmful human impact on a river, but here, where there is a pre-existing, unnatural condition of the river corridor influenced by mining debris, the dam is actually contributing to the restoration of the river toward its historical geomorphic condition, in the truest meaning of the term - going back to the pre-existing state prior to hydraulic gold mining (Pasternack 2010).

On the lower Yuba River, there is strong evidence that Englebright Dam has helped to evacuate sediment without harming important channel processes (Pasternack 2010). For example, despite evidence that Timbuctoo Bend is undergoing significant sediment export and river-corridor incision, White et al. (2010) reported that 8 riffles persisted in the same locations over the last 26 years, and possibly longer. Most of these persistent riffles are positioned in the locally wide areas in the valley, while intervening pools are located at valley constrictions. Thus, incision and sediment export do not necessarily translate into harmful degradation of fluvial landforms. At Timbuctoo Bend, the existence of undular valley walls preserves riffle-pool morphology in the face of on-going geomorphic change. Given the vast quantity of waste material still present in the upper system and the ability of many unhealed hillsides to generate more, Englebright Dam continues to serve as an important protection for the environment of the lower Yuba River (Pasternack 2010).

Confounding the natural response of the river to the potentially restorative impact of Englebright Dam, the lower Yuba River has been subjected to harmful in-channel human activities that further altered it. The greatest impact came from dredgers processing and re-processing most of the alluvium in the river valley in the search for residual gold and to control the river (James et al. 2009). First, there was the formation of the approximately 10,000-ac Yuba Goldfields in the ancestral migration belt. Subsequently, there was the relocation of the river to the Yuba Goldfield's northern edge and its isolation from most of the Goldfields by large "gravel berms" of piled-up dredger spoils. Dredger-spoil gravel berms also exist further upstream in Timbuctoo Bend off the Yuba Goldfields; these berms provide no flood-control benefit (Pasternack 2010).

Although no gravel berms exist in the canyon downstream of Englebright Dam, mechanized gold mining facilitated by bulldozers beginning in about 1960 completely reworked the alluvial deposits in the vicinity of the confluence with Deer Creek, changing the lower Yuba River geomorphology (Pasternack et al. 2010). Prior to mechanized mining, glide-riffle transitions were gradual, enabling fish to select among a diverse range of local hydraulic conditions. Bulldozer debris constricted the channel significantly, induced abrupt hydraulic transitioning, and caused the main riffle at the apex of the bar to degrade into a chute. In addition, mining operations evacuated the majority of alluvium at the mouth of Deer Creek, and the 1997 flood caused angular hillside rocks and "shot rock" debris from the canyon bottom to be deposited on top of the hydraulic-mining alluvium in the canyon (Pasternack 2010).

Presently, the lower Yuba River downstream of Englebright Dam continues to change in response to the complex assemblage of natural processes and human impacts. The legacy of hydraulic mining is the first and foremost impact to the system. Englebright Dam blocks further impacts from upstream mining debris, and is directing the river on a trajectory toward restoration of the preexisting landform (Pasternack 2010). Daguerre Point Dam serves as a stabilizer in the system, providing a base level for the extent of incision between Daguerre Point and Englebright dams. Mechanized reworking of alluvium and associated channelization have dictated the lateral bounds of the river, and also impact the diversity and distribution of river-corridor landforms. The fluvial geomorphology of the Yuba River is so unique that it is crucial to evaluate it on its own terms and not to apply simple generalizations and concepts from other rivers with dams (Pasternack 2010).

Overall, gravel for spawning anadromous salmonids does not appear to be limiting in the lower Yuba River. According to the RMT (2013a), spawning habitat does not appear to be limited by an inadequate supply of gravel in the lower Yuba River due to ample storage of mining sediments in the banks, bars, and dredger-spoil gravel berms (RMT 2013a). Beak Consultants, Inc. (1989) stated…*"The spawning gravel resources in the river are considered to be excellent based on the abundance of suitable gravels, particularly in the Garcia Gravel Pit and Daguerre Point Dam reaches. The tremendous volumes of gravel remaining in the river as a result of hydraulic mining make it unlikely that spawning gravel will be in short supply in the foreseeable future. Armoring of the channel bed is possible, but has not developed to date, probably due to periodic flushing by floods comparable to the 1986 event."*

Similarly, Pasternack (2008) reported that…In Timbuctoo Bend "…*there is adequate physical habitat to support spawning of Chinook salmon and steelhead trout in their present population size. Furthermore, all of the preferred morphological units in the [Timbuctoo Bend Reach] TBR have a lot of unutilized area and adequate substrates to serve larger populations."*

Farther downstream, spawning habitat does not appear to be limited by an inadequate supply of gravel within the Parks Bar and Hammon Bar reach of the lower Yuba River due to ample storage of mining sediments in the banks, bars, and dredger-spoil gravel berms (cbec and McBain & Trush 2010).

As reported by the RMT (2013a), the overall mean substrate diameter (Dmean) within the bankfull channel is 97.4 mm. On the lower Yuba River salmonids tend to spawn in mean substrate sizes ranging from about 50-150 mm. The average Dmean at each cross-section was calculated and plotted as a longitudinal distribution (Figure 7.4-5). This analysis shows that most of the channel is characterized by average Dmean values within the acceptable spawning substrate size. The exceptions are sand/silt areas near the confluence of the Feather River and the boulder/bedrock regions in the upper sections of Timbuctoo Bend and most of Englebright Dam reaches.

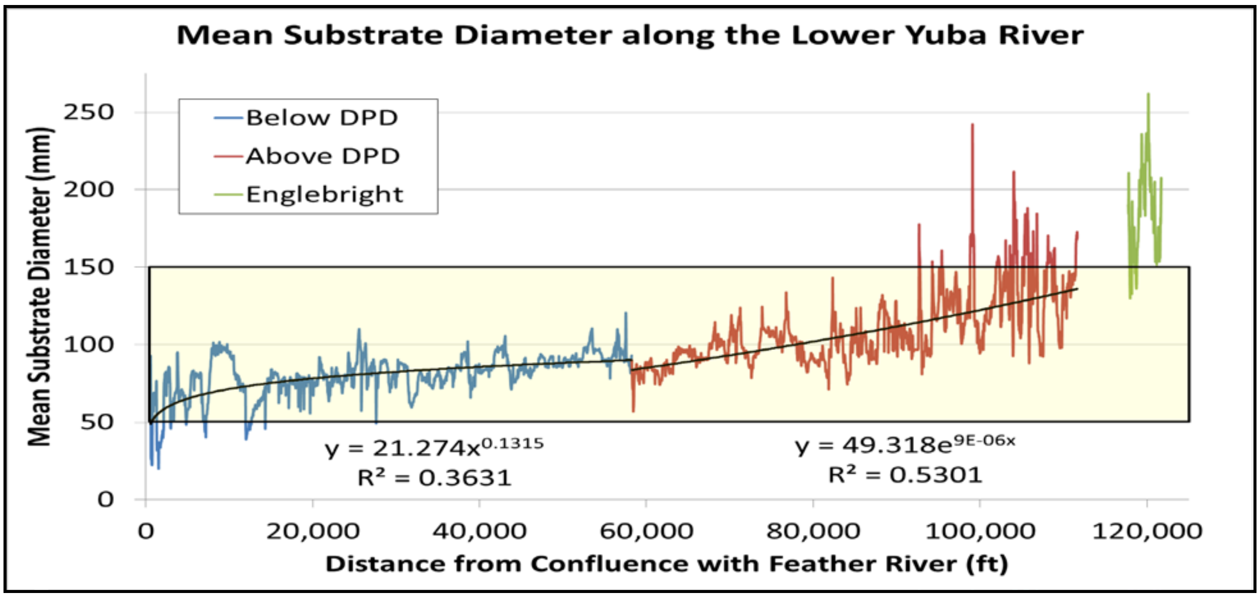

Figure 7.4-5. Longitudinal distribution of the mean substrate diameter. The box represents the typical range of spawning substrate sizes observed on the lower Yuba River.

Gravel Augmentation

The USACE has been injecting a mixture of coarse sediment in the gravel (2-64 mm) and cobble (64-256 mm) size ranges into the Englebright Dam Reach, as part of their voluntary conservation measures associated with ESA consultations regarding Daguerre Point Dam. Since the USACE began to implement its gravel augmentation project in 2007, seven separate gravel injection efforts have been undertaken from 2007-2016, with approximately 32,700 tons of gravel/cobble placed into the Englebright Dam Reach. During the 2007 pilot program, 500 tons were injected, whereas about 5,000 tons were injected each year from 2011-2015. Due to favorable flow conditions and evacuation of gravel during the previous year from the Englebright Dam Reach, the Corps injected about 7,200 tons during the summer of 2016.

The site of the USACE's gravel placement from 2011-2016 was located downstream of Englebright Dam, approximately 115-ft downstream of the Narrows 1 Powerhouse (Brown and Pasternack 2013; USACE 2013; Pasternack 2010). Before that, during November 2007, the USACE injected about 500 tons in the Narrows 2 pool as a pilot study. Surveys have been conducted to assess the temporal and spatial distribution of Chinook salmon (and steelhead) spawning in an approximately 1-mi reach in the lower Yuba River located from the Narrows 2 Powerhouse to approximately 0.25 mi downstream of the confluence with Deer Creek (Campos et al. 2013). With the exception of the first gravel augmentation, subsequent redd monitoring and mapping surveys conducted in the Englebright Dam Reach have indicated that Chinook salmon spawning occurs downstream of the Narrows 1 Powerhouse (Campos et al. 2013; Campos and Massa 2012). Therefore, operations associated with the Narrows 2 Partial Bypass or the Full Bypass would not dewater redds upstream of the Narrows 1 Powerhouse because the Englebright Dam Reach between the Narrows 2 and Narrows 1 powerhouses is not used by anadromous salmonids for spawning.

Future gravel injections are anticipated as one of the USACE voluntary conservation measures. The USACE's Gravel Augmentation Implementation Plan (GAIP) provides guidance for a long-term gravel injection program to provide Chinook salmon spawning habitat in the bedrock canyon downstream of Englebright Dam. The USACE has contracted bathymetric survey monitoring to compare volumetric differences between pre-gravel and post-gravel injection distributions, to further evaluate the disposition of the injected gravels. Additionally, the USACE has funded the Pacific States Marine Fisheries Commission (PSMFC) to conduct redd surveys in the Englebright Dam Reach to investigate whether Chinook salmon) are utilizing areas where gravel placement occurred.

The GAIP (Pasternack 2010) describes present and proposed future gravel injection efforts, based on information available in 2010. The long-term plan calls for continuing gravel/cobble injection into the Englebright Dam Reach until the estimated coarse sediment storage deficit for the reach is eradicated, and then it calls for subsequent injections as needed to maintain the sediment storage volume in the event that floods export material downstream of the reach. The USACE does not currently have the authority to completely eradicate the deficit created by various causes in one placement, nor is that the intent of the USACE gravel injection program (USACE 2013). For more detailed discussion of physical habitat conditions for spawning Chinook salmon in the lower Yuba River, refer to Section 6.0 of the Applicant-Prepared Draft BA prepared for the Proposed Action.

7.4.2.1.2 Modeled Spring-run Chinook Salmon Spawning Habitat Availability

YCWA (2013) calculated spring-run and fall-run Chinook salmon spawning habitat availability using WUA-discharge relationships developed by the Relicensing Participants. The Relicensing Participants' WUA-discharge relationships were developed based on reaching consensus among the Relicensing Participants on the use of depth, velocity, and substrate habitat suitability criteria (HSCs). The HSCs were subjectively modified from other relationships. The resulting WUA-discharge relationships were intended to represent a more broad measure of spawning habitat, including potential spawning habitat that is not currently utilized in the lower Yuba River. Spawning WUA-discharge relationships were developed for four HZs – Daguerre Point Dam

HZ, Deer Creek HZ, Dry Creek HZ, and Englebright Dam HZ. The spring-run Chinook salmon spawning habitat evaluation was conducted only upstream of Daguerre Point Dam. The Englebright Dam HZ WUA-discharge relationship was only developed for flows at and above 700 cfs, and at and above 300 cfs for the Deer Creek and Dry Creek HZs. For flows lower than these lowest modeled flows, linear extrapolation was applied from those values to the origin of the distributions.

Table 7.4-3 displays the long-term average and average by WYT spring-run Chinook salmon spawning WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average spring-run Chinook salmon spawning habitat availability (WUA) in the lower Yuba River is substantially higher under the Environmental Baseline scenario relative to the Without-Project scenario (long-term average of 98.8% versus 75.1% of the maximum WUA). The Environmental Baseline (i.e., "With Project" scenario) results in 12.7 percent more maximum spawning habitat during wet WYs, 19.9 percent more during above normal WYs, 25.3 percent more during below normal WYs, 32.9 percent more during dry WYs, and 39.8 percent more during critical WYs. The Environmental Baseline scenario provides an average of over 80 percent (and even over 90%) of maximum spawning WUA during all WYTs, whereas the Without-Project scenario provides an average of only about 56 to 87 percent of maximum spawning WUA during any WYT.

Table 7.4-3. Long-term and WYT average spring-run Chinook salmon spawning WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	98.8	99.3	99.4	99.6	99.6	96.1
Without-Project	75.1	86.6	79.5	74.3	66.7	56.3
Difference	23.7	12.7	19.9	25.3	32.9	39.8

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Habitat duration for spring-run Chinook salmon spawning under the Environmental Baseline and Without-Project scenarios are presented in Figure 7.4-6. The Environmental Baseline scenario provides substantially greater amounts of spawning habitat availability over the entire exceedance probability distribution. Also, the Environmental Baseline scenario achieves over 80 percent (and even about 95%) of maximum spawning WUA with about a 98 percent probability, by contrast to the Without-Project scenario which achieves 80 percent or more of maximum spawning WUA with about a 48 percent probability.

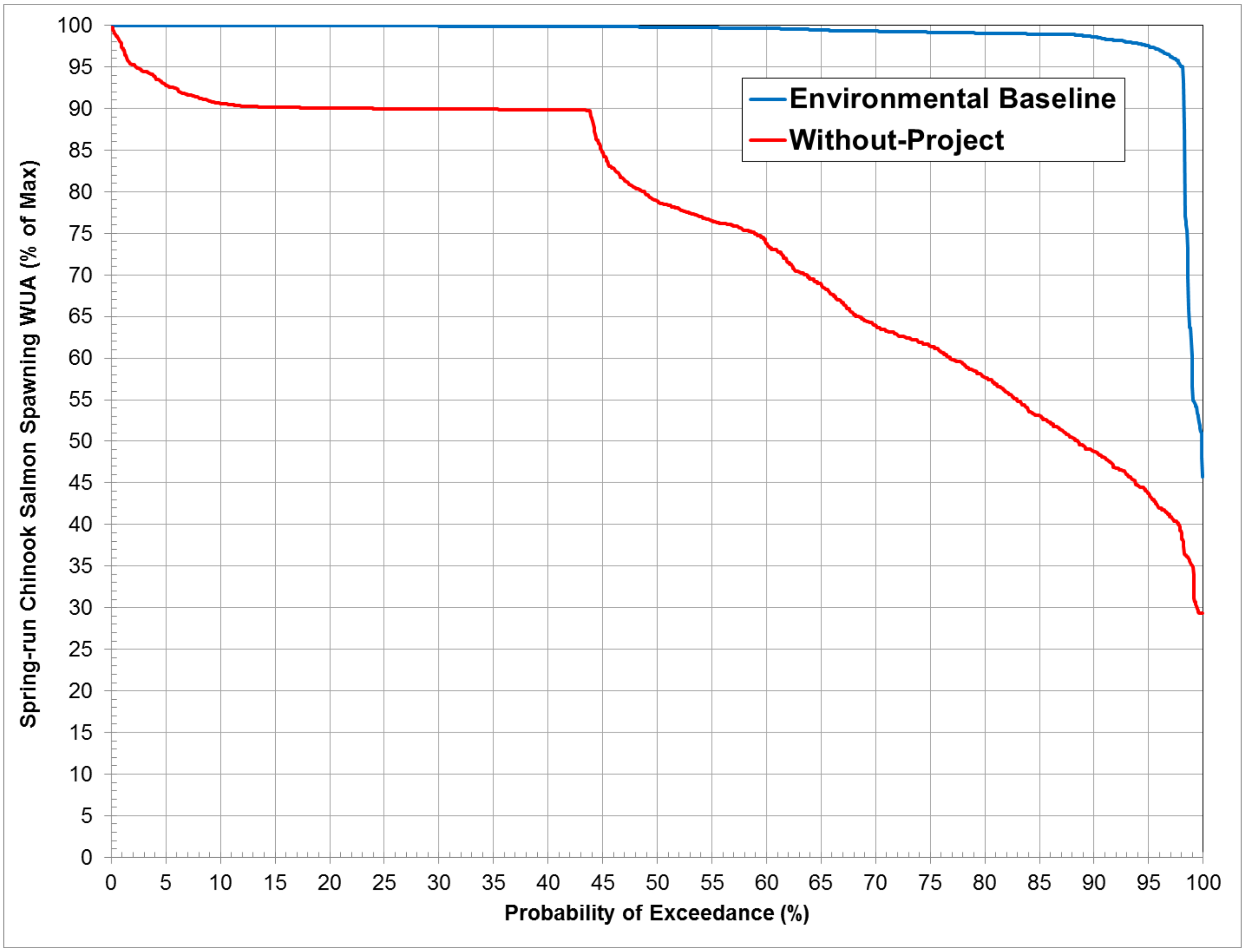

Figure 7.4-6. Spring-run Chinook salmon spawning habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

7.4.2.1.3 Modeled Fall-run Chinook Salmon Spawning Habitat Availability

Table 7.4-4 displays the long-term average and average by WYT of fall-run Chinook salmon spawning WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average fall-run Chinook salmon spawning habitat availability (WUA) in the lower Yuba River is substantially higher under the Environmental Baseline relative to the Without-Project scenario (long-term average of 95.8% versus 72.3% of the maximum WUA). The Environmental Baseline results in substantially more maximum spawning habitat during all WYTs, ranging from 19.8 percent more during wet WYs, to 28.7 percent more during critical WYs. The Environmental Baseline scenario provides over 80 percent (and even over 90%) of maximum spawning WUA during all WYTs, whereas the Without-Project scenario provides an average of only about 69 to 74 percent of maximum spawning WUA during any WYT.

Table 7.4-4. Long-term and WYT average fall-run Chinook salmon spawning WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	95.8	93.8	95.6	96.6	97.6	97.8
Without-Project	72.3	74.0	70.2	73.5	73.8	69.1
Difference	23.5	19.8	25.4	23.1	23.8	28.7

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Habitat duration for fall-run Chinook salmon spawning under the Environmental Baseline and Without-Project scenarios are presented in Figure 7.4-7. The Environmental Baseline scenario provides substantially greater amounts of spawning habitat availability over most of the exceedance probability distribution. Also, the Environmental Baseline achieves over 80 percent of maximum spawning WUA with about a 94 percent probability, by contrast to the Without-Project scenario which achieves over 80 percent or more of maximum spawning WUA with about a 50 percent probability.

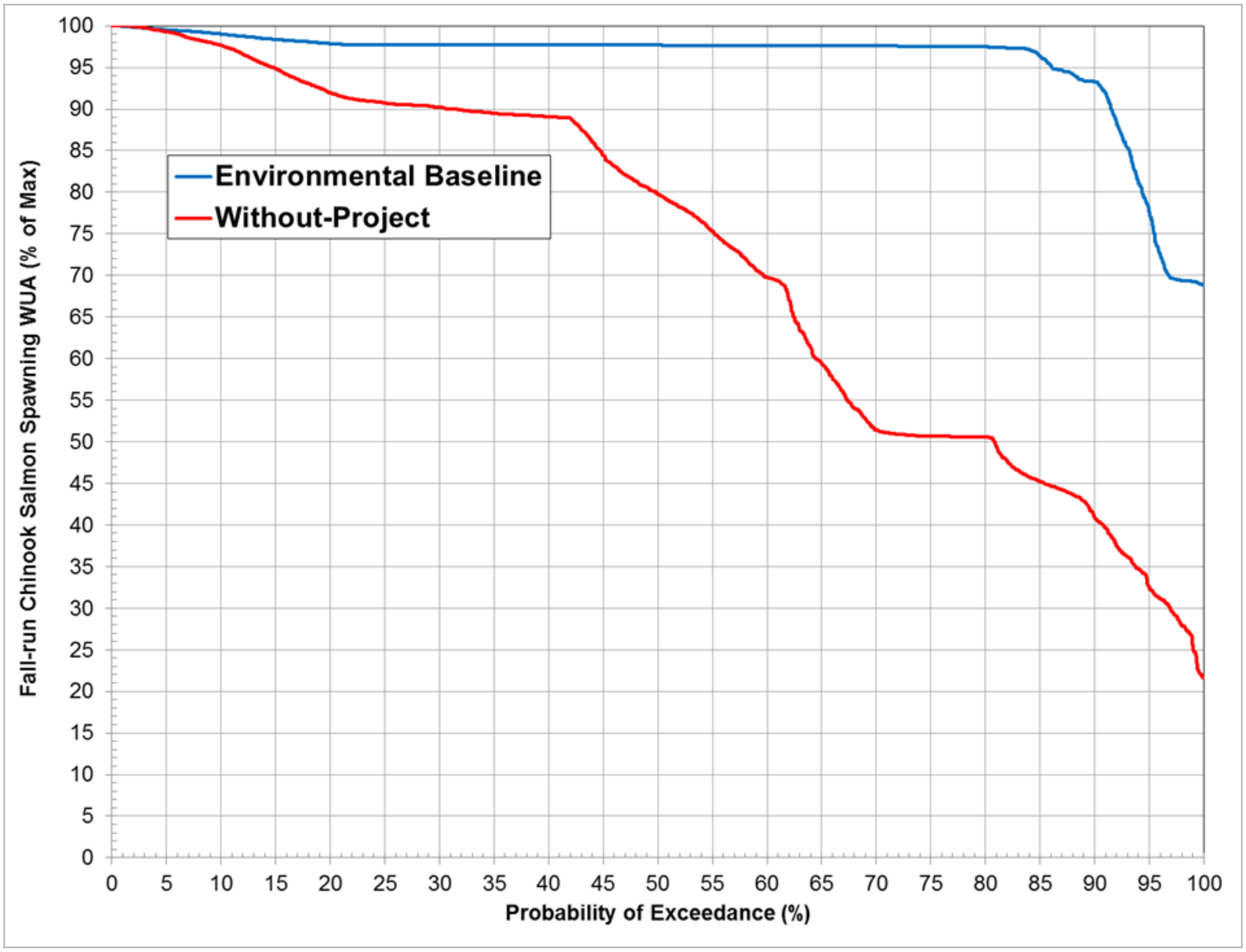

Figure 7.4-7. Fall-run Chinook salmon spawning habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

7.4.2.1.4 Lower Yuba River Chinook Salmon Redd Dewatering

In this Applicant-Prepared Draft EFH Assessment, evaluation of ongoing effects of the Project also examines the potential impacts on spring-run and fall-run Chinook salmon redd dewatering due to modeled daily flow fluctuations in the lower Yuba River under the Environmental Baseline scenario (existing conditions scenario), compared to the Without-Project scenario.

The potential for redd dewatering associated with changes in modeled mean daily flows and corresponding changes in water surface elevations is evaluated during the spring-run and fall-run Chinook salmon spawning and embryo incubation periods (i.e., September 1 through December 31, and October 1 through March 31, respectively). The spawning periods for spring-run and fall-run Chinook salmon used in this redd dewatering analysis were obtained from RMT (2013a). The embryo incubation period for redds constructed on a given day during the respective spawning period is calculated using modeled mean daily water temperatures and accumulated thermal units (ATUs).

Potential dewatering effects on spring-run and fall-run Chinook salmon under the Environmental Baseline and Without-Project scenarios are conducted using two annual dewatering indices - the annual redd dewatering index, and the annual egg pocket dewatering index, described below.

The annual redd dewatering index (WRDY) used in this Applicant-Prepared Draft EFH Assessment to assess the potential effects of flow fluctuations on Chinook salmon redd dewatering incorporates information on the spatial and temporal distribution of spawning activity, redd depth distribution, duration of embryo incubation through fry emergence, and maximum reduction in river stage throughout the incubation periods. The annual redd dewatering index (WRDY) estimates the proportion of all redds constructed during a particular spawning season potentially affected by river stage reductions from the date of a given redd's construction through the end of the corresponding incubation period. The WRDY index includes all redds that are exposed at least one day from the date of their construction through the end of their corresponding incubation period.

Define Potential Redd Dewatering

For the purposes of this redd dewatering comparative analysis, a redd is considered to be potentially dewatered using two different expressions. The first expression (for both spring-run and fall-run Chinook salmon) is when flow is reduced to the undisturbed bed surface elevation at which the redd was constructed. If the maximum change in depth is greater than the expected depth of a redd, then the redd is considered to be potentially dewatered.

The second expression is when flow is reduced below the estimated surface of the egg pocket. The estimated surface of the egg pocket of a given Chinook salmon redd is estimated using the relative location and mean depth of egg pockets identified for Chinook salmon in the Trinity River by Evenson (2001). The mean depth of the egg pocket was found to be 22.5 cm (0.74 ft) beneath the undisturbed bed surface (Figure 7.4-8). Therefore, to estimate the change in water depth (between date of spawning and the end of the calculated incubation period for a given redd) required to potentially dewater incubating embryos, the expected depth of a given redd (using the redd distribution based on measured redd water depths previously described) is added to the value of 22.5 cm (0.74 ft). If the maximum change in depth (described in the previous step) is greater than the sum of the expected depth of a redd + 0.74 ft, then the redd egg pocket is considered to be potentially dewatered.

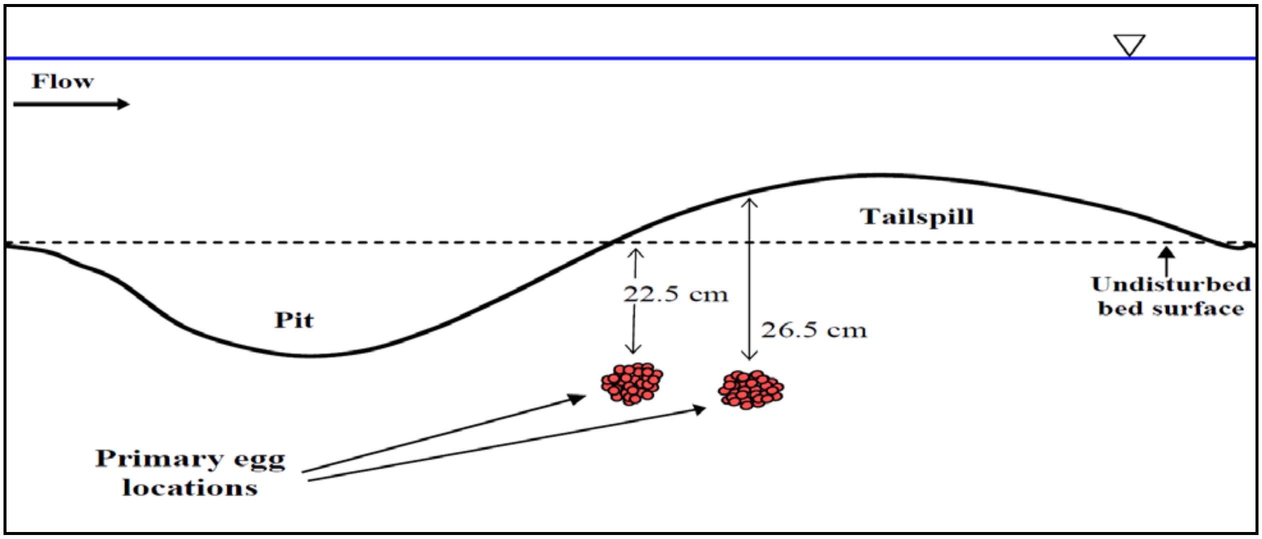

Figure 7.4-8. Diagrammatic side view of a Chinook salmon redd showing the relative location and mean depth of egg pockets on the Trinity River, CA, as reported in Evenson (2001).

Identify "Redd Cohorts" Categorized by Date of Redd Construction and Morphological Unit

All phenotypic spring-run Chinook salmon and fall-run Chinook salmon redds identified in the lower Yuba River during the weekly near-census 2009 and 2010 Chinook salmon redd surveys were combined into one dataset for each run. Spring-run Chinook salmon redds were separated by morphological units (MUs) upstream of Daguerre Point Dam, and a proportion of total redds by MU was calculated (wh). Fall-run Chinook salmon redds were separated by MUs both upstream and downstream of Daguerre Point Dam, and proportions of total redds by morphological unit upstream (wh U) and downstream of Daguerre Point Dam (wh D) were calculated.

The weekly observations of newly-built spring-run and fall-run Chinook salmon redds for both the 2009 and 2010 Chinook salmon redd surveys were used to fit asymmetric logistic functions describing the expected distribution of newly-built redds per day for each day of the spring-run Chinook salmon spawning period (September 1 through October 15), and for each day of the fall-run Chinook salmon spawning period (October 1 through December 31) upstream of Daguerre Point Dam (for spring-run Chinook salmon), and upstream and downstream of Daguerre Point Dam (for fall-run Chinook salmon). The expected distribution of newly-built redds per day is expressed as a proportion of all of the redds built during the spawning period, represented by the coefficient wd for spring-run Chinook salmon redds and by the coefficients wd U and wd D for fall-run Chinook salmon built upstream and downstream of Daguerre Point Dam, respectively. Expected redds built on the same day are referred to as a "redd cohort".

This analysis was conducted by MU type in the lower Yuba River because spring-run and fall-run Chinook salmon have been observed to exhibit preference for spawning in particular MU types, and different MU types exhibit characteristic stage-discharge relationships (RMT 2013a). The MU types utilized in this analysis are described in RMT (2013a).

Spring-run Chinook Salmon

Table 7.4-5 displays the frequency of Chinook salmon newly-built redds observed in the lower Yuba River upstream of Daguerre Point Dam during the 2009 and 2010 Chinook salmon weekly redd surveys. This information was used to derive the temporal (wd) weighting coefficients for the spring-run Chinook salmon redd dewatering indices.

Table 7.4-5. Number and proportion of newly-built Chinook salmon redds observed in the reaches upstream of Daguerre Point Dam during the 2009 and 2010 weekly redd surveys used to derive the temporal weighting coefficients (wd) for the spring-run Chinook salmon redd dewatering indices.

Newly-built Redds by Week and Reach, Upstream of Daguerre Point Dam							Redd Proportions	
Sampling Week End Date	Englebright Dam	Narrows	Timbuctoo Bend	Parks Bar	Dry Creek	Weekly Total	Weekly	Cumulative
09/09/09	0	0	5	2	0	7	0.005877	0.005877
09/17/09	0	2	76	21	2	101	0.084803	0.090680
09/24/09	0	8	157	75	5	245	0.205709	0.296390
10/01/09	4	6	211	112	5	338	0.283795	0.580185
10/08/09	9	13	269	170	19	480	0.403023	0.983207
10/12/09	6	14	0	0	0	20	0.016793	1.000000
2009 Totals	**19**	***43***	***718***	***380***	***31***	***1,191***	***1***	
09/14/10		1	6	4	1	12	0.007979	0.007979
09/23/10		4	83	87	12	186	0.123670	0.131649
09/30/10		3	196	206	26	431	0.286569	0.418218
10/07/10		6	251	204	33	494	0.328457	0.746676
10/14/10		2	160	183	36	381	0.253324	1.000000
2010 Totals	**0**	***16***	***696***	***684***	***108***	***1,504***	***1***	

Notes
[yellow box] Proportions used to derive the temporal weighting coefficients (w_d)

The cumulative proportions of newly-built redds observed weekly upstream of Daguerre Point Dam during the weekly Chinook salmon surveys performed in 2009 and 2010 were used to fit a common asymmetric logistic curve to describe the expected cumulative temporal distribution for spring-run Chinook salmon spawning in the lower Yuba River upstream of Daguerre Point Dam (Figure 7.4-9).

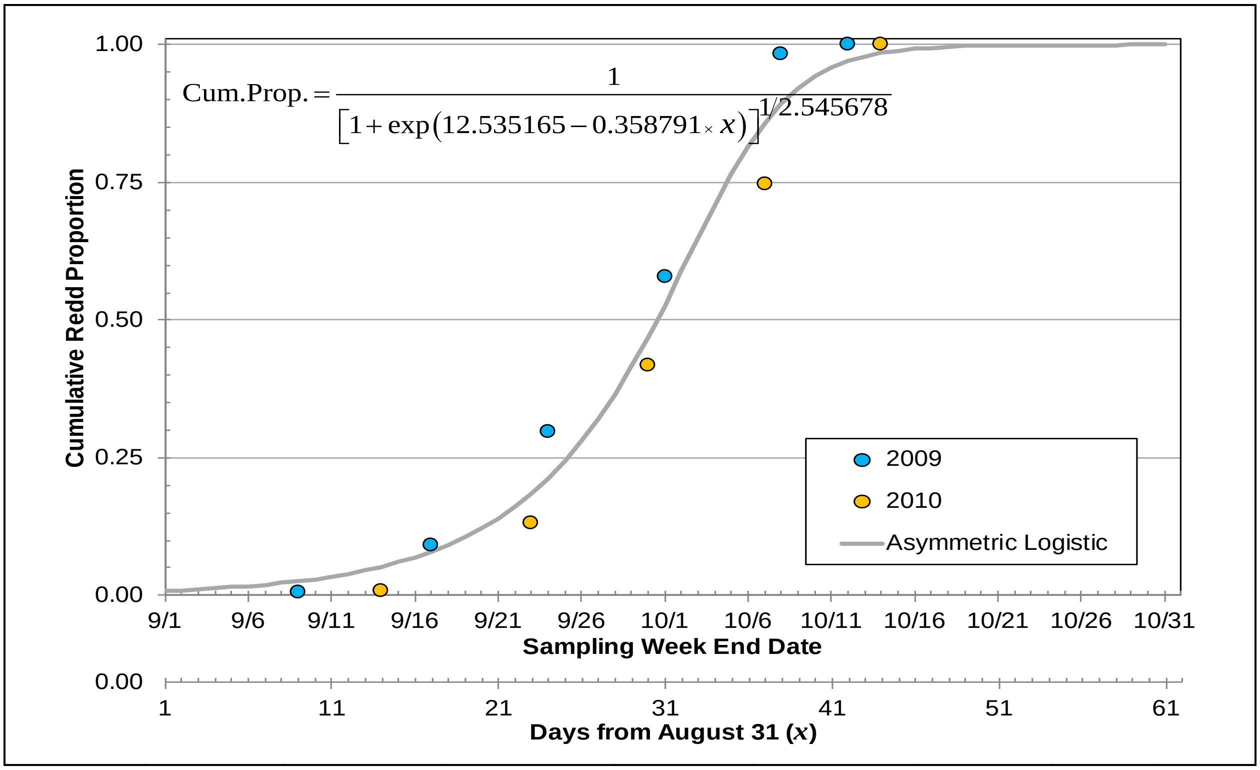

Figure 7.4-9. Cumulative proportions of spring-run Chinook salmon newly-built redds observed in lower Yuba River reaches upstream of Daguerre Point Dam during the 2009 and 2010 redd surveys.1

[1] Circles represent the observed cumulative temporal distribution, and the curve is the fitted asymmetric logistic function used to derive the temporal (wd) weighting coefficients for the spring-run Chinook salmon redd dewatering indices.

The asymmetric logistic curve was used to calculate daily cumulative proportion values from September 1 through October 16. The resulting daily proportions were scaled by dividing by their sum (which equaled 0.984307, or 98.43%) of the cumulative temporal distribution. The final daily temporal weighting coefficients describing the temporal distribution of adult spring-run Chinook salmon spawning in the lower Yuba River is presented in Figure 7.4-10.

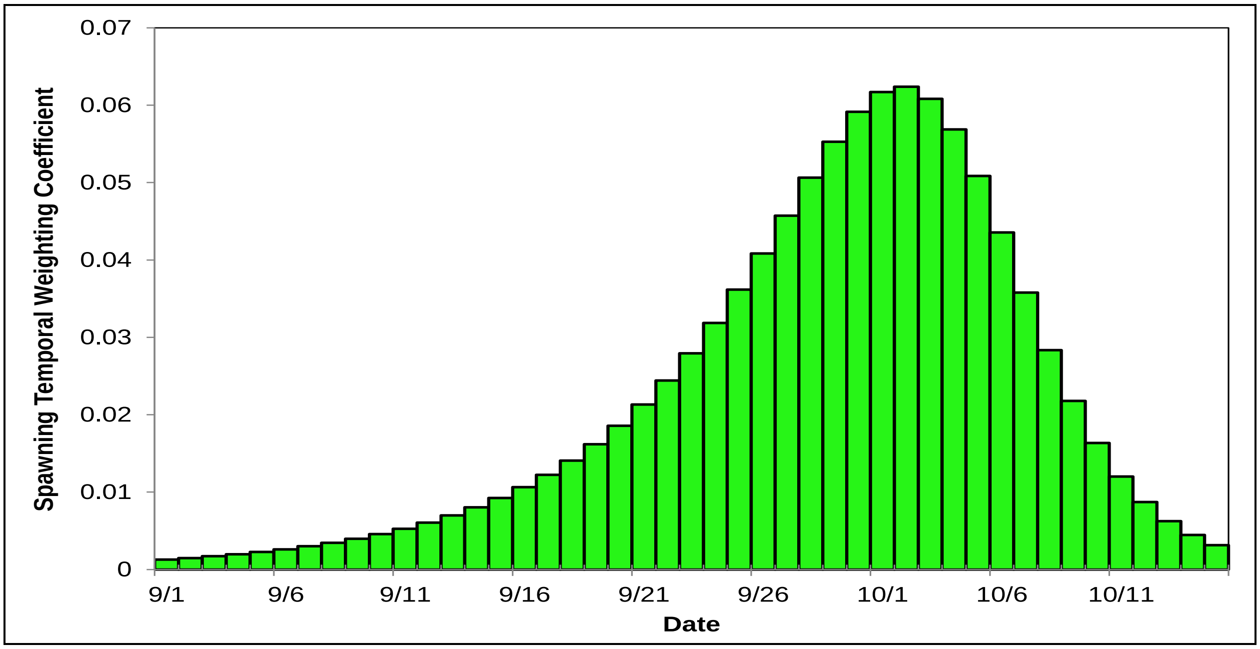

Figure 7.4-10. Daily distribution of spawning temporal weighting coefficients (wd) used in the spring-run Chinook salmon redd dewatering indices.

Table 7.4-6 displays the percentage of Chinook salmon newly-built redds observed in the lower Yuba River by MU type upstream of Daguerre Point Dam during the 2009 and 2010 weekly Chinook salmon redd surveys. This information was used to derive the spatial (wh) weighting coefficients for the spring-run Chinook salmon redd dewatering indices. The spatial weighting coefficients for the MUs upstream of Daguerre Point Dam were calculated as the proportion of redds per MU relative to the total number of redds observed during the combined 2009 and 2010 surveys.

Table 7.4-6. Number and proportion of newly-built Chinook salmon redds observed in morphological units located upstream of Daguerre Point Dam during the 2009 and 2010 weekly redd surveys used as the spatial weighting coefficients (wh).

Chinook salmon redds by morhological unit type, built upstream of Daguerre Point Dam from September 1 through October 15				Redd Proportions
Morhological Unit	2009	2010	2009 + 2010	
Chute	60	77	137	0.052430
Fast glide	115	244	359	0.137390
Hillside	0	0	0	0.000000
Lateral bar	15	12	27	0.010333
Medial bar	0	6	6	0.002296
Point bar	1	7	8	0.003062
Pool	8	14	22	0.008419
Riffle	445	418	863	0.330272
Riffle transition	174	267	441	0.168772
Run	287	351	638	0.244164
Slackwater	19	18	37	0.014160
Slow glide	24	51	75	0.028703
Swale	0	0	0	0.000000
Total Assigned Redds	***1,148***	***1,465***	***2,613***	***1***
Not Assigned Redds (1)	43	39	82	

Notes

(1) The redds observed in the Narrows reach were not assigned to any morphological unit type.

[yellow box] Proportions used as the spatal weighting coefficients (w_h)

Fall-run Chinook Salmon

Table 7.4-7 displays the frequency of Chinook salmon newly-built redds observed in the lower Yuba River upstream of Daguerre Point Dam during the 2009 and 2010 Chinook salmon weekly redd surveys used to derive the temporal weighting coefficients for the fall-run Chinook spawning upstream (wdU) and downstream (wdD) of Daguerre Point Dam. The weekly cumulative redd proportions (yellow highlighted cells in the table) were utilized to fit one asymmetric logistic curve for the reach upstream of Daguerre Point Dam that provides the temporal weighting coefficients wdU and another logistic curve for the reach downstream of Daguerre Point Dam that provides the temporal weighting coefficients wdD. Although redds were observed upstream of Daguerre Point Dam during the first two sampling weeks, these redds were not used in the fit of the asymmetric logistic curves because those redds were assumed to be spring-run Chinook salmon redds and as such were used to fit the asymmetric logistic curve used in the calculation of the temporal weighting coefficients for spring-run Chinook salmon. These redds likely included some unknown number of fall-run Chinook salmon redds. However, the inclusion of all the redds observed upstream of Daguerre Point Dam during the first two weeks of 2009 and 2010 surveys (i.e., 10/08/2009, 10/12/2009, 10/07/2010 and 10/14/2010) in the estimation of the asymmetric logistic for fall-run Chinook salmon upstream of Daguerre Point Dam would have led to a likely biased estimate.

Table 7.4-7. Number and proportion of newly-built Chinook salmon redds observed in the reaches upstream of Daguerre Point Dam during the 2009 and 2010 weekly redd surveys used to derive the temporal weighting coefficients (wdU and wdD) for the fall-run Chinook salmon redd dewatering indices.

Sampling Week End Date	Newly-built Redds by Week and Reach			Weekly Redd Proportions			Cumulative Weekly Redd Proportions		
	Upstream Daguerre Point Dam	Downstream Daguerre Point Dam	Weekly Total	Upstream Daguerre Point Dam	Downstream Daguerre Point Dam	Weekly Total	Upstream Daguerre Point Dam	Downstream Daguerre Point Dam	Weekly Total
10/08/09	(480)*	35	35	---	0.016835	0.016835	---	0.016835	0.016835
10/12/09	(20)*	---		---	---	---	---	---	---
10/22/09	458	110	568	0.220298	0.052910	0.273208	0.220298	0.069745	0.290043
10/29/09	354	153	507	0.170274	0.073593	0.243867	0.390572	0.143338	0.533911
11/06/09	179	146	325	0.086099	0.070226	0.156325	0.476671	0.213564	0.690236
11/13/09	105	85	190	0.050505	0.040885	0.091390	0.527177	0.254449	0.781626
11/20/09	48	87	135	0.023088	0.041847	0.064935	0.550265	0.296296	0.846561
11/25/09	34	101	135	0.016354	0.048581	0.064935	0.566619	0.344877	0.911496
12/04/09	24	40	64	0.011544	0.019240	0.030784	0.578163	0.364117	0.942280
12/11/09	19	35	54	0.009139	0.016835	0.025974	0.587302	0.380952	0.968254
12/18/09	15	19	34	0.007215	0.009139	0.016354	0.594517	0.390091	0.984608
12/24/09	11	5	16	0.005291	0.002405	0.007696	0.599808	0.392496	0.992304
12/31/09	11	5	16	0.005291	0.002405	0.007696	0.605099	0.394901	1.000000
2009 Totals	**1,258**	**821**	**2,079**	**0.605099**	**0.394901**	**1**			
10/07/10	(494)*	28	28	---	0.017960	0.017960	---	0.017960	0.017960
10/14/10	(381)*	41	41	---	0.026299	0.026299	---	0.044259	0.044259
10/21/10	287	86	373	0.184092	0.055164	0.239256	0.184092	0.099423	0.283515
11/11/10	406	227	633	0.260423	0.145606	0.406030	0.444516	0.245029	0.689545
11/17/10	187	86	273	0.119949	0.055164	0.175112	0.564464	0.300192	0.864657
11/24/10	95	29	124	0.060936	0.018602	0.079538	0.625401	0.318794	0.944195
12/02/10	45	42	87	0.028865	0.026940	0.055805	0.654266	0.345734	1.000000
2010 Totals	**1,020**	**539**	**1,559**	**0.654266**	**0.345734**	**1**			

Notes

* Redds not used in the estimation of temporal weighting coefficients for fall-run Chinook salmon. These observations were assumed to be all spring-run Chinook salmon redds for the derivation of the spring-run weighting coefficients, although an unknown proportion of the redds were likely fall-run Chinook salmon redds.

[yellow box] Proportions used to derive the temporal weighting coefficients (W_d)

The cumulative proportions of newly-built redds observed weekly upstream and downstream of Daguerre Point Dam during the weekly Chinook salmon surveys performed in 2009 and 2010 were used to fit the common asymmetric logistic curves that describe the expected cumulative temporal distribution for fall-run Chinook salmon spawning in the lower Yuba River upstream or downstream of Daguerre Point Dam (Figure 7.4-11). As an additional clarification, please notice that the two asymmetric logistic curves complement each other. The daily cumulative proportions derived from each asymmetric logistic curve increase with time toward respective asymptotic values indicated by the number in the numerators of the equations embedded in the figure (i.e., 0.603055 and 0.396945, for the reaches upstream and downstream of Daguerre Point Dam). The mean square error of the fitted common asymmetric logistic curves was 0.02 (indicating a relatively minor amount of variability in the data set not accounted for by the fitted model).

The asymmetric logistic curves were used to calculate daily cumulative proportion values from October 1 through December 31. The resulting daily proportions were scaled by dividing by their sum that equaled to 0.992594 (or 99.26%) of the cumulative temporal distributions. The final daily temporal weighting coefficients describing the temporal distribution of adult fall-run Chinook salmon spawning in the lower Yuba River is presented in Figure 7.4-12.

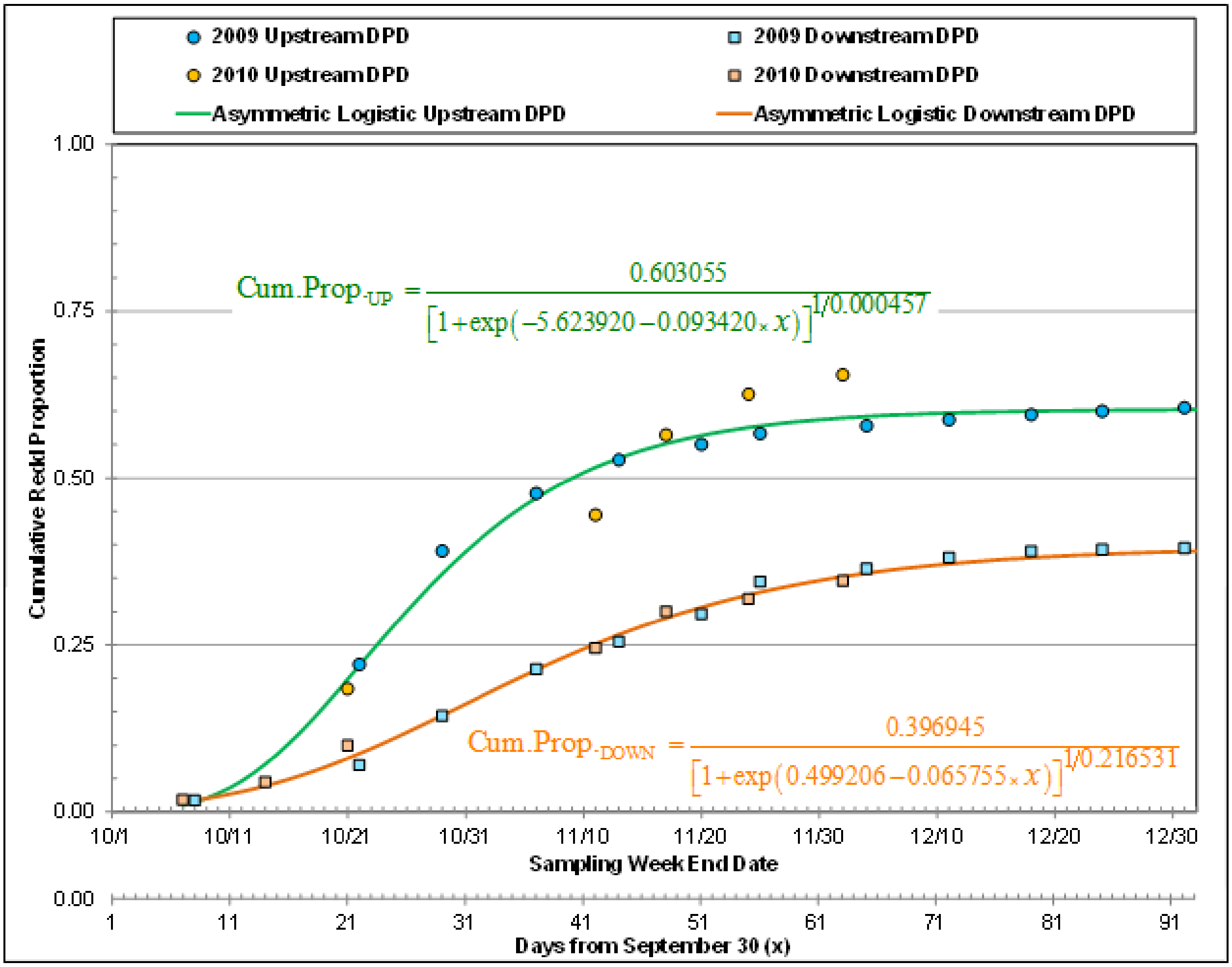

Figure 7.4-11. Cumulative proportions of Chinook salmon newly-built redds observed in lower Yuba River reaches upstream and downstream Daguerre Point Dam during the 2009 and 2010 redd surveys (circles and squares) and corresponding fitted asymmetric logistic curves used to derive the temporal weighting coefficients for the fall-run Chinook salmon redd dewatering indices.

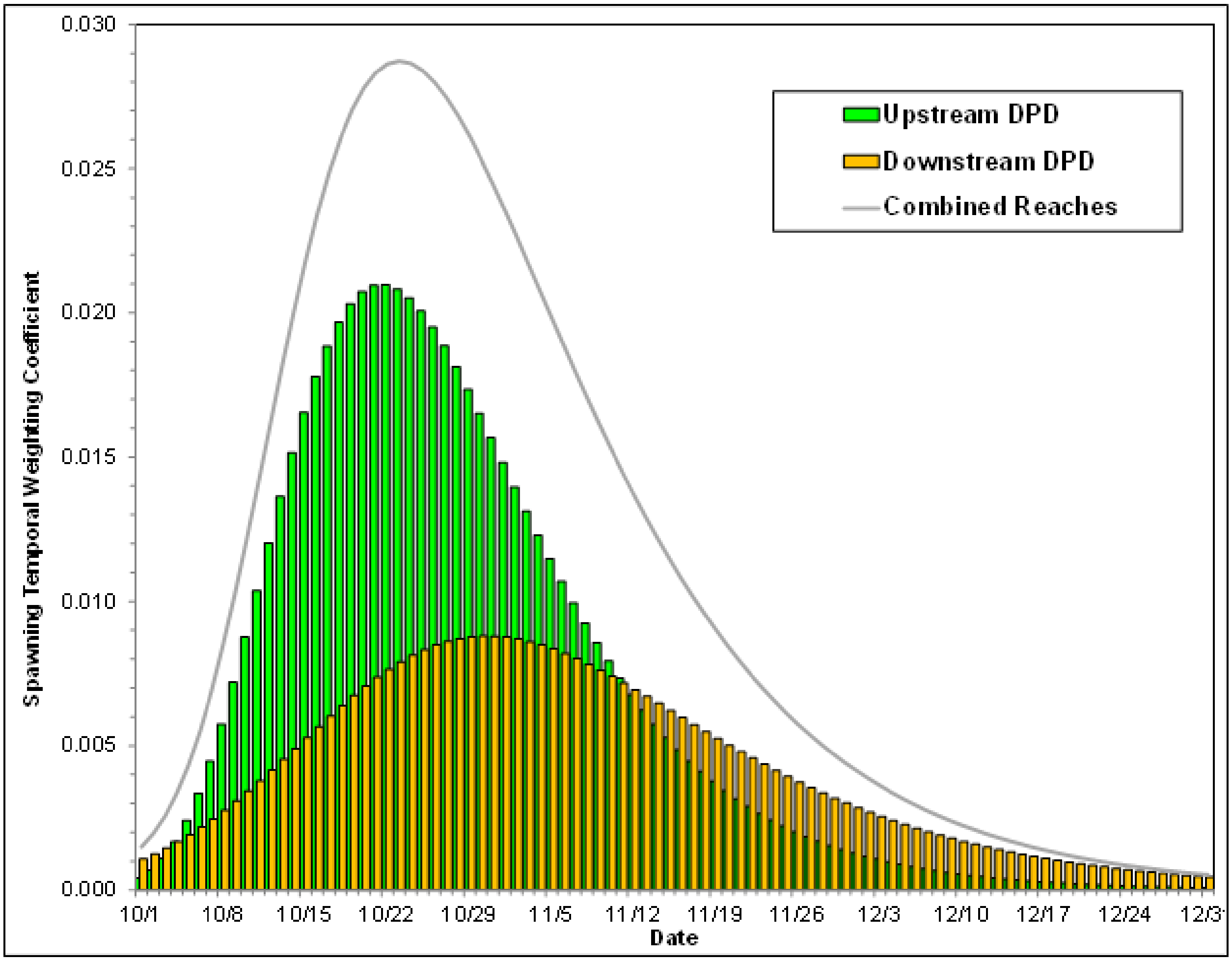

Figure 7.4-12. Distributions of daily temporal weighting coefficients used in the calculation of redd dewatering indices for fall-run Chinook salmon spawning upstream (green bars, $w_{d\ U}$) and downstream (orange bars, $w_{d\ D}$) of Daguerre Point Dam. The distribution of daily temporal weighting coefficients for the combined reach is described by the gray line ($w_d = w_{d\ U} + w_{d\ D}$).

Table 7.4-8 displays the percentage of Chinook salmon newly-built redds observed in the lower Yuba River by MU type, both upstream and downstream of Daguerre Point Dam, during the 2009 and 2010 weekly Chinook salmon redd surveys. This information was used to calculate the spatial weighting coefficients for the fall-run Chinook salmon spawning upstream (wh U) and downstream of Daguerre Point Dam (wh D) that are used in the fall-run Chinook salmon redd dewatering indices. The spatial weighting coefficients for the MUs upstream of Daguerre Point Dam were calculated as the proportion of redds per MU relative to the total number of redds observed upstream of Daguerre Point Dam during the combined 2009 and 2010 surveys. Similarly, spatial weighting coefficients for the MUs downstream of Daguerre Point Dam were calculated as the proportion of redds per MU relative to the total number of redds observed downstream of Daguerre Point Dam during the combined 2009 and 2010 surveys.

Table 7.4-8. Number and proportion of newly-built Chinook salmon redds observed in morphological units located upstream (UP) and downstream (DOWN) of Daguerre Point Dam during the 2009 and 2010 weekly redd surveys used in the calculation of the spatial weighting coefficients wh U and wh D in the fall-run Chinook salmon redd dewatering indices.

Morhological Unit	Chinook salmon redds by morphological unit type, built upstream (UP) and downstream (DOWN) of Daguerre Point Dam from October 1 through December 31						Redd Proportions	
	2009		2010		2009 + 2010			
	UP	DOWN	UP	DOWN	UP	DOWN	UP	DOWN
Chute	99	17	70	2	169	19	0.047606	0.013889
Fast glide	129	15	255	21	384	36	0.108169	0.026316
Hillside	1	0	0	0	1	0	0.000282	0.000000
Lateral bar	21	13	21	11	42	24	0.011831	0.017544
Medial bar	2	0	7	1	9	1	0.002535	0.000731
Point bar	20	2	8	3	28	5	0.007887	0.003655
Pool	7	0	14	1	21	1	0.005915	0.000731
Riffle	651	474	640	317	1,291	791	0.363662	0.578216
Riffle transition	264	190	381	121	645	311	0.181690	0.227339
Run	414	69	349	38	763	107	0.214930	0.078216
Slackwater	34	17	25	14	59	31	0.016620	0.022661
Slow glide	62	24	76	18	138	42	0.038873	0.030702
Total Assigned Redds	1,704	821	1,846	547	3,550	1,368	1	1
Not Assigned Redds (1)	54		49					

Notes

(1) The redds observed in the Narrows reach were not assigned to any morphological unit type.

[yellow box] Proportions used as the spatial weighting coefficients (w_h)

Because different MU types can exhibit differing stage-discharge relationships, different stage-discharge relationships are calculated for each MU type, as discussed below.

Develop Redd Depth Distributions

To determine whether a given redd is potentially dewatered, an expected redd depth is required. The measured redd depths collected during the Chinook salmon spawning period for the 2011 Chinook salmon redd survey were fitted to a distribution. [*Note: Redd depths for Chinook salmon were not collected during the 2009 and 2010 near-census Chinook salmon redd surveys*].

The distributions of redd depths expected over the spring-run Chinook salmon spawning period and over the fall-run Chinook salmon spawning period are expressed as the cumulative proportions of newly-built redds per 0.1-ft depth intervals, relative to the total number of newly-built redds. These distributions were obtained by fitting available data on redd depths to a lognormal distribution.

The 2011 Chinook salmon redd depth measurements were taken immediately upstream of the redd pot in the undisturbed substrate to indicate site condition prior to spawning, for 492 redds observed from September 1, 2011 through December 22, 2011. The redd depths utilized for developing the spring-run Chinook salmon redd depth distribution were not restricted to the phenotypic spring-run Chinook salmon spawning period (September 1 through October 15), because only 49 redds were observed from September 1 through October 15 of 2011, which would have likely resulted in an unreliable and potentially biased fitted redd depth distribution associated with such a small sample size. Figure 7.4-13 shows the cumulative redd proportions by redd depth (in ft) for the 492 redds observed during the weekly Chinook salmon redd surveys and the resulting fitted asymmetric logistic curve.

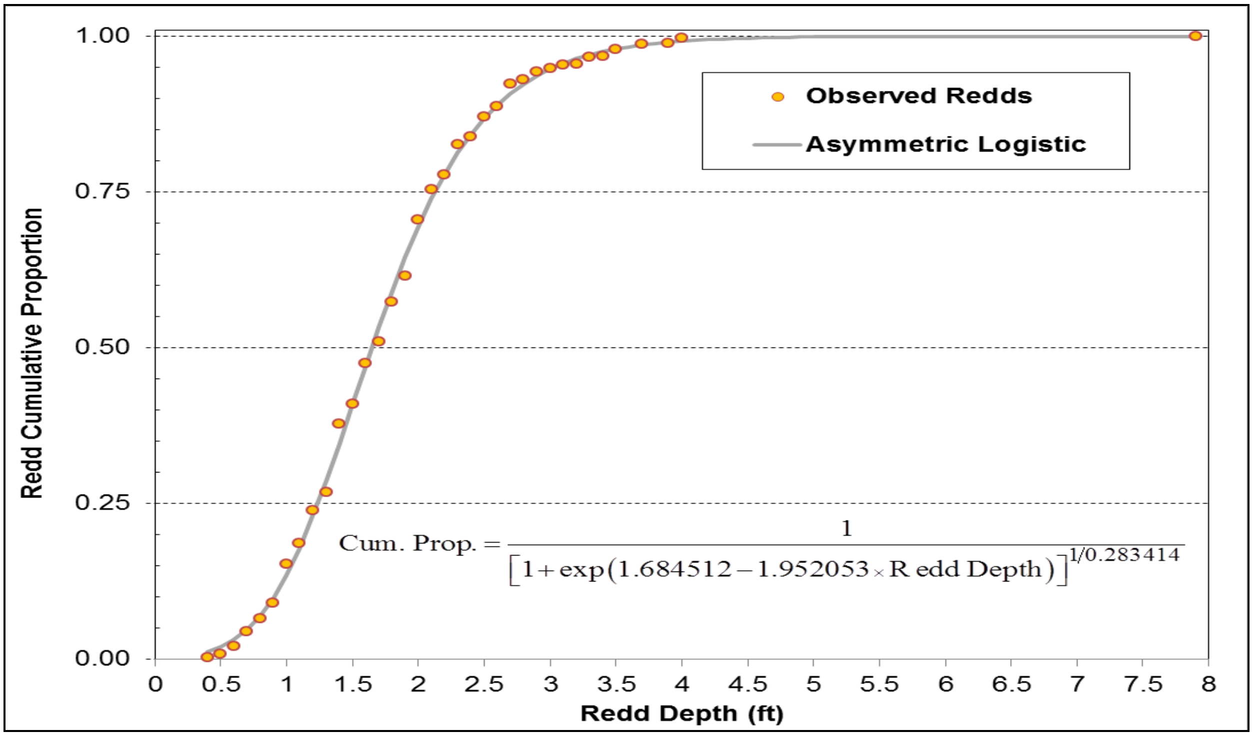

Figure 7.4-13. Cumulative proportions of redd depths measured in the lower Yuba River during the 2011 weekly Chinook salmon redd surveys, and derived asymmetric logistic curve used to assess the expected redd depths of both spring-run and fall-run Chinook salmon spawning in the lower Yuba River.

Figure 7.4-14 represents the cumulative distribution of the depths of the eggs within redds, which was developed by adding 0.74 ft (the previously described estimated depth of Chinook salmon eggs relative to the riverbed) to each of the 492 depths measured during the 2011 redd surveys, and fitting a new asymmetric logistic function to the cumulative distribution of the resulting depths.

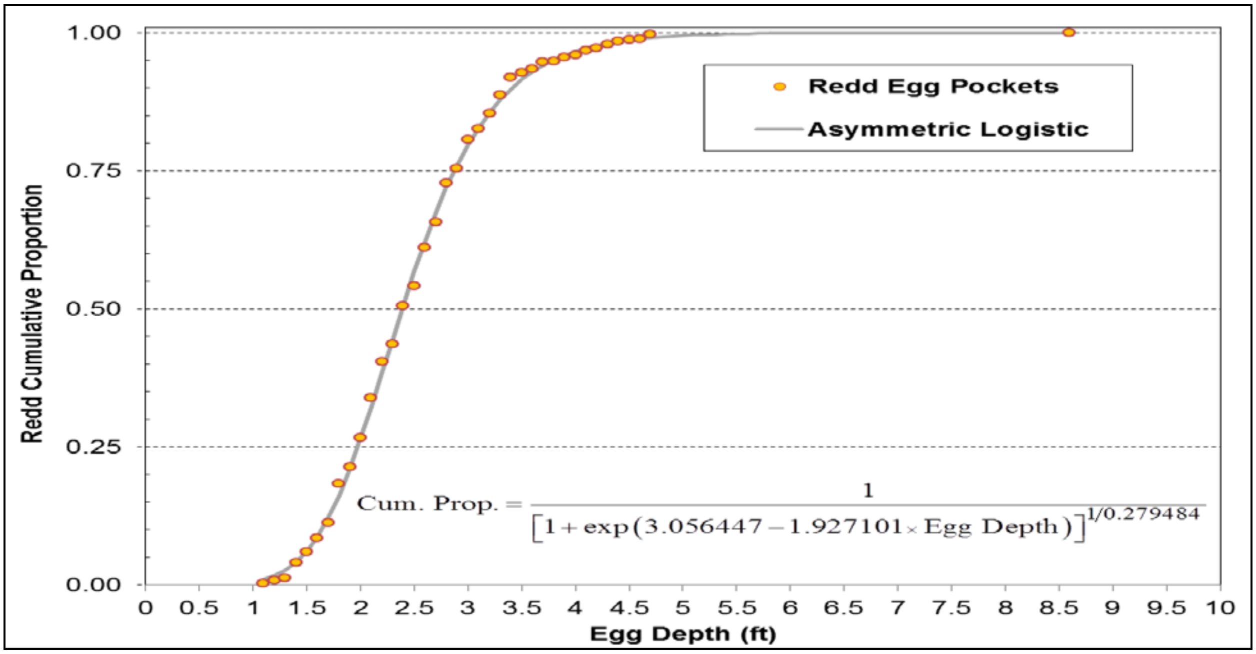

Figure 7.4-14. Cumulative proportions of egg depths derived from the 2011 weekly Chinook salmon redd surveys in the lower Yuba River, and derived asymmetric logistic curve used to assess the expected depths of the egg pockets for both spring-run and fall-run Chinook salmon spawning in the lower Yuba River.

Calculate Embryo Incubation Period for each "Redd Cohort"

Based on the date of construction for a given daily redd cohort, the estimated duration of embryo incubation for that cohort must be determined to set the period for which potential dewatering events may potentially affect a given redd. The approach to calculate the embryo incubation period for each spring-run and fall-run Chinook salmon redd cohort follows the methodology used by the RMT (2013a) to estimate the duration of spring-run and fall-run Chinook salmon embryo incubation based on water temperatures monitored in the lower Yuba River, expressed as ATUs. As reported by Raleigh et al. (1986), the time required for salmonid egg incubation varies with average water temperature. Starting on the day of a given redd's construction, daily modeled water temperatures for a given simulated year are used to calculate the number of days required to reach 1,550 (°F) ATUs, which is the reported number of ATUs necessary for a fertilized spring-run Chinook salmon egg to become an emergent fry (Armour 1991, as cited in CDFG 1998). The number of days required to reach 1,550 ATUs for each redd cohort for a given model year is then used to specify the evaluation period for identifying potential redd dewatering events for redds within a given cohort. The calculated ATUs and associated embryonic incubation periods for each spring-run Chinook salmon redd cohort utilized the Long Bar water temperature model node (i.e., model node YR NR LONGS BAR). The calculated ATUs and associated embryonic incubation periods for each fall-run Chinook salmon redd cohort utilized the Long Bar node for upstream of Daguerre Point Dam, and the below Daguerre Point Dam water temperature node (i.e., model node YR BLW DAGUERRE DAM) for downstream of Daguerre Point Dam. Using the above approach, separate incubation periods were calculated for the Environmental Baseline, Without-Project, Proposed Action and Cumulative Condition scenarios, in consideration of the different water temperature regimes associated with each scenario.

The embryo incubation period is calculated for each redd cohort for each of the 41 modeled years (WY 1970 through 2010). Daily water temperatures were simulated using YCWA's Relicensing Water Temperature Model (Technical Memorandum 2-6, *Water Temperature Models*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA).

Calculate Stage-Discharge Relationships for each Morphological Unit Type Upstream of Daguerre Point Dam

To identify changes in daily WSELs (associated with changes in simulated mean daily flows), multiple stage-discharge relationships were developed. Because Chinook salmon have been observed to spawn in particular MUs in the lower Yuba River, and because different MU types have different stage-discharge relationships, stage-discharge relationships were calculated separately for each MU type utilized for spawning by Chinook salmon (based on the redd surveys) upstream of Daguerre Point Dam (for spring-run Chinook salmon), and for upstream and downstream of Daguerre Point Dam (for fall-run Chinook salmon).

The stage-discharge relationships were calculated using the RMT's digital elevation model of the lower Yuba River and the RMT's Sedimentation and River Hydraulics Two-dimensional Model (SRH2D v2.1). The SRH2D model was developed by the RMT to simulate river hydraulics as well as predict flow velocities and directions in the river, excluding a 1.2-mi long inaccessible, narrow, bedrock canyon known as the Narrows Reach. Stage-discharge relationships were developed over the maximum range of flows that can be simulated with the SRH2D model (300 to 110,400 cfs). To develop stage-discharge relationships for flows between 0 and 300 cfs, the lowest four data points in the stage-discharge relationships were used to develop a fitted line that extends to 0 cfs. Statistical analysis was then used to evaluate the fitted stage-discharge relationships for each MU between 0 and 300 cfs. The relationship-derived fit using the last 4 data points was utilized for all MUs where the relationships had a level of significance (p) lower than 0.15 and explained more than 75 percent of the variability in the response variable (depth). In some MUs (hillside, lateral bar, medial bar, point bar, slackwater, and slow glide), the relationship did not meet these criteria, and additionally showed no consistent trend in decreasing depth with decreasing flow between the last 4 data points of the stage-discharge relationships. Therefore, for these MUs, linear interpolation was used to develop depths between 300 and 0 cfs. Additionally, due to very shallow (<.10 ft) and highly variable depths for flows below 1,300 cfs for the hillsides and lateral, medial and point bars, stage-discharge relationships for these MUs were modified to reflect linear interpolation between 1,300 cfs and 0 cfs.

The resultant stage-discharge relationships (Table 7.4-9 and Table 7.4-10) were applied to modeled daily flows in order to determine the daily stages for each applicable MU upstream or downstream of Daguerre Point Dam, as further described below.

Table 7.4-9. Look-up stage-discharge table for Chinook salmon redds in morphological units located upstream of Daguerre Point Dam. Yellow highlighted cells contain stages calculated using the procedure described in text.

Flow (cfs)	Stage or WSEL (ft.) in morphological unit type (h) upstream of Daguerre Point Dam											
	Chute	Fast glide	Hillside	Lateral bar	Medial bar	Point bar	Pool	Riffle	Riffle trans.	Run	Slack water	Slow glide
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.78	0.86	0.01	0.01	0.00	0.01	4.64	0.16	0.13	1.01	0.18	0.22
100	1.21	1.32	0.02	0.01	0.01	0.01	5.33	0.30	0.25	1.51	0.35	0.44
150	1.51	1.63	0.04	0.02	0.01	0.02	5.73	0.42	0.35	1.83	0.53	0.67
200	1.74	1.87	0.05	0.02	0.02	0.03	6.02	0.53	0.44	2.08	0.70	0.89
250	1.93	2.06	0.06	0.03	0.02	0.04	6.24	0.63	0.53	2.28	0.88	1.11
300	2.10	2.26	0.07	0.04	0.03	0.04	6.49	0.73	0.63	2.47	1.05	1.33
350	2.22	2.37	0.08	0.04	0.03	0.05	6.59	0.80	0.69	2.59	1.05	1.36
400	2.34	2.47	0.10	0.05	0.03	0.06	6.69	0.87	0.74	2.70	1.05	1.39
450	2.44	2.56	0.11	0.05	0.04	0.06	6.76	0.95	0.80	2.80	1.08	1.42
530	2.60	2.70	0.13	0.06	0.04	0.08	6.91	1.05	0.88	2.96	1.03	1.44
600	2.73	2.81	0.14	0.07	0.05	0.09	7.02	1.14	0.95	3.09	1.02	1.47
622	2.77	2.84	0.15	0.07	0.05	0.09	7.04	1.18	0.98	3.13	1.06	1.49
700	2.96	2.97	0.17	0.08	0.06	0.10	7.17	1.27	1.07	3.35	1.04	1.55
800	3.12	3.11	0.19	0.10	0.07	0.11	7.32	1.39	1.19	3.51	1.03	1.64
880	3.24	3.21	0.21	0.11	0.07	0.13	7.43	1.48	1.28	3.63	1.04	1.71
930	3.32	3.27	0.22	0.11	0.08	0.13	7.49	1.54	1.34	3.70	1.08	1.76
1,000	3.42	3.37	0.24	0.12	0.08	0.14	7.58	1.62	1.42	3.81	1.14	1.85
1,300	3.81	3.71	0.31	0.16	0.11	0.19	7.94	1.93	1.73	4.20	1.40	2.15
1,500	4.05	3.91	0.38	0.24	0.17	0.27	8.15	2.12	1.92	4.43	1.59	2.34
1,700	4.27	4.09	0.43	0.31	0.23	0.34	8.34	2.30	2.09	4.64	1.75	2.50
2,000	4.58	4.35	0.43	0.43	0.31	0.44	8.62	2.54	2.33	4.94	1.96	2.74
2,500	5.03	4.73	0.63	0.61	0.44	0.64	9.02	2.92	2.70	5.38	2.31	3.10
3,000	5.44	5.06	0.81	0.79	0.58	0.84	9.37	3.26	3.01	5.77	2.62	3.41
4,000	6.16	5.66	1.06	1.11	0.86	1.21	10.03	3.86	3.59	6.48	3.16	3.98
5,000	6.78	6.19	1.29	1.52	1.19	1.62	10.60	4.41	4.10	7.10	3.66	4.48
7,500	8.24	7.39	1.88	2.84	2.27	2.96	11.84	5.68	5.30	8.52	4.83	5.63
10,000	9.17	8.16	2.28	3.69	3.03	3.85	12.69	6.59	6.12	9.43	5.64	6.43
15,000	10.93	9.61	3.10	5.28	4.46	5.51	14.34	8.21	7.62	11.14	7.22	7.86
21,100	12.73	11.13	3.96	6.93	5.98	7.19	16.02	9.91	9.23	12.89	8.84	9.38
30,000	14.94	13.04	5.40	8.99	7.76	9.31	18.22	12.00	11.18	15.03	10.82	11.27
42,200	16.98	15.05	6.73	10.98	9.68	11.26	20.46	14.11	13.21	17.09	12.86	13.23
84,400	22.46	20.49	11.31	16.49	14.75	16.44	26.67	19.76	18.63	22.62	18.41	18.67
110,400	25.11	23.18	13.59	19.19	17.29	18.97	29.57	22.54	21.32	25.29	21.11	21.35

Table 7.4-10. Look-up stage-discharge table for Chinook salmon redds in morphological units located downstream of Daguerre Point Dam. Yellow highlighted cells contain stages calculated using the procedure described in text.

Flow (cfs)	Stage or WSEL (ft.) in morphological unit type (h) downstream of Daguerre Point Dam											
	Chute	Fast glide	Hillside	Lateral bar	Medial bar	Point bar	Pool	Riffle	Riffle trans.	Run	Slack water	Slow glide
0	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.90	1.10	NA	0.02	0.02	0.02	5.03	0.27	0.25	1.25	0.21	0.25
100	1.36	1.61	NA	0.03	0.03	0.03	5.72	0.48	0.45	1.79	0.42	0.49
150	1.68	1.95	NA	0.05	0.05	0.05	6.12	0.66	0.62	2.13	0.64	0.74
200	1.92	2.20	NA	0.06	0.07	0.07	6.41	0.80	0.77	2.39	0.85	0.99
250	2.11	2.40	NA	0.08	0.08	0.08	6.63	0.93	0.89	2.60	1.06	1.24
300	2.27	2.58	NA	0.10	0.10	0.10	6.77	1.04	1.00	2.77	1.27	1.48
350	2.40	2.71	NA	0.11	0.11	0.12	7.00	1.14	1.10	2.91	1.31	1.55
400	2.54	2.83	NA	0.13	0.13	0.14	7.12	1.25	1.19	3.04	1.37	1.62
450	2.66	2.94	NA	0.14	0.15	0.15	7.22	1.34	1.29	3.15	1.39	1.70
530	2.85	3.12	NA	0.17	0.17	0.18	7.38	1.49	1.44	3.34	1.39	1.84
600	3.00	3.26	NA	0.19	0.20	0.20	7.50	1.61	1.56	3.48	1.49	1.97
622	3.04	3.30	NA	0.20	0.20	0.21	7.53	1.65	1.60	3.52	1.54	2.01

Table 7.4-10. (continued)

Flow (cfs)	Stage or WSEL (ft.) in morphological unit type (h) downstream of Daguerre Point Dam											
	Chute	Fast glide	Hillside	Lateral bar	Medial bar	Point bar	Pool	Riffle	Riffle trans.	Run	Slack water	Slow glide
700	3.19	3.45	NA	0.22	0.23	0.24	7.67	1.78	1.73	3.68	1.63	2.15
800	3.37	3.62	NA	0.26	0.26	0.27	7.83	1.93	1.88	3.86	1.77	2.33
880	3.51	3.76	NA	0.28	0.29	0.30	7.96	2.05	2.00	3.99	1.89	2.46
930	3.59	3.84	NA	0.30	0.31	0.31	8.03	2.12	2.07	4.08	1.95	2.53
1,000	3.74	3.96	NA	0.32	0.33	0.34	8.14	2.25	2.18	4.21	2.06	2.66
1,300	4.26	4.43	NA	0.42	0.43	0.44	8.57	2.69	2.62	4.71	2.47	3.12
1,500	4.48	4.65	NA	0.52	0.52	0.50	8.90	2.90	2.81	4.93	2.53	3.35
1,700	4.74	4.89	NA	0.62	0.62	0.60	9.15	3.13	3.03	5.17	2.76	3.60
2,000	5.10	5.23	NA	0.77	0.78	0.76	9.51	3.46	3.35	5.54	3.09	3.95
2,500	5.66	5.75	NA	1.01	1.06	1.00	10.08	3.97	3.83	6.08	3.61	4.48
3,000	6.17	6.22	NA	1.21	1.34	1.21	10.60	4.43	4.26	6.57	4.26	4.96
4,000	7.11	7.08	NA	1.57	1.83	1.65	11.63	5.30	5.06	7.45	4.97	5.85
5,000	7.91	7.82	NA	1.94	2.21	2.14	12.39	6.05	5.76	8.22	5.70	6.62
7,500	9.65	9.42	NA	3.43	3.74	3.82	13.88	7.70	7.27	9.90	7.43	8.27
10,000	10.91	10.62	NA	4.59	4.93	5.04	15.02	8.92	8.41	11.13	8.44	9.49
15,000	13.15	12.77	NA	6.71	7.47	7.29	17.21	11.17	10.47	13.33	10.56	11.74
21,100	15.30	14.75	NA	8.67	10.03	9.21	19.53	13.20	12.30	15.38	12.66	13.87
30,000	18.30	17.61	NA	11.43	13.85	11.77	22.26	16.05	14.97	18.19	15.59	16.91
42,200	20.94	20.21	NA	13.99	17.30	14.11	25.40	18.64	17.33	20.80	18.16	19.72
84,400	23.00	21.72	NA	16.54	18.63	15.88	26.45	20.13	19.49	22.54	20.11	20.41
110,400	25.84	24.37	NA	19.25	21.60	18.35	29.31	22.77	22.08	25.20	22.78	23.14

Calculate Daily Change in Depth that each Redd Cohort Experiences throughout its Incubation Period

YCWA's Relicensing Water Balance/Operations Model (Operations Model) simulates Project operations on a daily time-step. Flow-dependent habitat assessments were modeled using the 41-year operational evaluation period extending from WY 1970 through 2010. For a detailed description of the model, see Technical Memorandum 2-2, *Water Balance/Operations Model*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA.

For the lower Yuba River analyses presented in this Applicant-Prepared Draft EFH Assessment, WYT classifications are in accordance with the Yuba River Index (YRI). Water year types based on the YRI are as defined in SWRCB Decision 1644. WYT designation uses DWR published Full Natural Flow for the Yuba River at Smartsville for WYs 1970 to 1999, and for WYs 2000 to 2010 uses the final determination for each year based on DWR Bulletin 120 and updates of Yuba River Unimpaired flow at Smartsville. Although WY 1977 is considered to be a conference year in YCWA's proposed conditions in Appendix E2 of the Amended FLA, it is included in the water year type summary tables as a critical year, but discussed separately under the Proposed Action and Cumulative Condition analyses.

Mean daily flows in the lower Yuba River below Deer Creek were simulated using YCWA's Relicensing Water Balance/Operations Model (Operations Model). This output node for the Operations Model was selected as most representative of the MUs located upstream of Daguerre Point Dam. The associated WSELs were calculated using the previously discussed calculated stage-discharge relationships. First, the mean daily WSEL (associated with the modeled mean daily flow) for a given MU type on the first day of a redd's incubation period (i.e., expected date of spawning) was calculated using linear interpolation. The mean daily WSELs for a given MU type for each subsequent day of a given redd cohort's calculated incubation period were then calculated using the same procedure. The daily difference in mean daily WSEL from the first day of incubation and each of the remaining days of incubation were then calculated to determine the change in depth a given redd cohort experienced throughout its incubation period.

All of the preceding methodological steps were used in the two different redd dewatering assessment approaches. Additional methodological steps unique to each approach are further described below.

7.4.2.1.5 Calculation of the Annual Redd Dewatering Index

The annual redd dewatering index (WRDY) estimates the proportion of redds constructed over the entire spring-run Chinook salmon and fall-run Chinook salmon spawning periods that are potentially dewatered at least once over their respective embryo incubation periods. In addition to the previous methods, the annual redd dewatering index approach includes the following steps and supporting information.

Calculate the Proportion of All Redds that are Potentially Dewatered at Least Once

The proportion of redds potentially dewatered during at least one day were first quantified for each spring-run Chinook salmon and fall-run Chinook salmon redd cohort (i.e., all redds that were constructed on a particular day) within a given MU type, which was calculated by comparing the maximum change in depth within each MU type throughout a redd cohort's embryo incubation period with the expected depth distribution of the redds. The proportions of redds dewatered within each MU type were then combined to calculate a total proportion of all redds constructed that may have potentially been dewatered at least once. The proportion of redds potentially dewatered was calculated twice, using the undisturbed riverbed surface as a potential dewatering threshold, and also using the estimated location of the egg pocket as an additional potential dewatering threshold.

For spring-run Chinook salmon assumed to spawn in the lower Yuba River upstream of Daguerre Point Dam from September 1 through October 15 (i.e., during 45 days of a particular year Y), the annual redd dewatering index for a single simulated year (WRDY) is expressed by the following formula when using the undisturbed riverbed surface as a potential dewatering threshold:

$$WRD_Y = \sum_{d=1}^{45} w_d \times \sum_{h=1}^{11} w_{h,d} \times \mathrm{I}_{h,d} \times \left[\Pr\left(Redd\ Depth \le \underset{i=d+1 \to ED_{d,Y}}{\mathrm{Max}} \left(WSEL_{d,h} - WSEL_{i,h} \right) \right) \Big/ \Pr\left(Redd\ Depth \le WSEL_{d,h} \right) \right]_h$$

The primary components of the formula are described below:

- The factor w_d is a temporal weighting coefficient that indicates the proportion of redds built on a particular day (d) relative to all the redds expected to be built during the 45 days of the spring-run Chinook salmon spawning period (i.e., September 1 through October 15).

- The variable $ED_{d,Y}$ indicates the duration (in number of days) of the egg incubation period for redds built on day d of year Y. The values of the variable were derived from the time series of daily water temperatures calculated by the model for each of the 41 simulated years.
- The variable $WSEL_{d,h}$ indicates the mean daily WSEL in MU type h on the date of redd construction d, and the variable $WSEL_{i,h}$ indicates the mean daily WSEL in MU type h on any day i subsequent to the date of redd construction.
- The variable $I_{h,d}$ was used to indicate whether the mean daily WSEL in MU type h on date d corresponds to a water depth equal to or greater than the lowest observed spawning depth of Chinook salmon. The field observations used to fit the cumulative Chinook salmon redd depth distributions showed redd depth minima of 0.33 ft for Chinook salmon redds. The indicator variable $I_{h,d}$ takes the value 1 if $WSEL_{d,h}$ is equal to or greater than 0.33 ft for Chinook salmon, and otherwise takes the value of 0.
- The factor $W_{h,d}$ is a spatial weighting coefficient that indicates the proportion of redds expected to be built in a particular MU h, relative to all of the redds expected to be built within all of the 11 MU types, during each day of the 45-day spring-run Chinook salmon spawning period. The value of an individual Wh,d was calculated as $w_{h,d} = \left(w_h \times \mathrm{I}_{h,d}\right) \Big/ \sum_{h=1}^{11} \left(w_h \times \mathrm{I}_{h,d}\right)$. The values of the W_h coefficients are the observed proportions of redds per MU type, considering all spring-run Chinook salmon redds observed during the 2009 and 2010 redd surveys.

When using the estimated location of the egg pocket as a potential dewatering threshold, the annual egg pocket dewatering index for a single simulated year (WRD_Y) is expressed by the formula:

$$WRD_Y = \sum_{d=1}^{45} w_d \times \sum_{h=1}^{11} w_{h,d} \times \mathrm{I}_{h,d} \times \left[\Pr\left(Egg\ Depth \leq \underset{i=d+1 \rightarrow ED_{d,Y}}{\mathrm{Max}} \left(WSEL_{d,h} - WSEL_{i,h} \right) \right) \Big/ \Pr\left(Egg\ Depth \leq WSEL_{d,h} \right) \right]_h$$

The only difference with the previous formula is that the dewatering probabilities were obtained from the cumulative Chinook salmon egg depth distribution, rather than from the cumulative redd depth distribution.

The fall-run Chinook salmon annual redd and egg pocket dewatering index formulae are essentially identical to the spring-run Chinook salmon annual redd and egg pocket dewatering index formulae, with the exception of the different number of spawning days, the use of a different number of MUs, and accounting for redds downstream of Daguerre Point Dam.

For fall-run Chinook salmon assumed to spawn in the lower Yuba River upstream and downstream of Daguerre Point Dam from October 1 through December 30 (i.e., during 72 days of a particular year Y), the annual redd dewatering index for a single simulated year (WRD_Y) is expressed by the following formula when using the undisturbed riverbed surface as a potential dewatering threshold:

$$WRD_Y = \left\{ \sum_{d=1}^{92} w_{d,\,\mathrm{U}} \times \sum_{h=1}^{12} w_{h\ \mathrm{U},d} \times \mathrm{I}_{h\ \mathrm{U},d} \times \left[\Pr\left(Redd\ Depth \le \max_{i=d+1 \to ED_{d,Y\ \mathrm{U}}} \left(WSEL_{d,h\ \mathrm{U}} - WSEL_{i,h\ \mathrm{U}} \right) \right) \Big/ \Pr\left(Redd\ Depth \le WSEL_{d,h\ \mathrm{U}} \right) \right]_h \right\} +$$

$$+ \left\{ \sum_{d=1}^{92} w_{d,\,\mathrm{D}} \times \sum_{h=1}^{12} w_{h\ \mathrm{D},d} \times \mathrm{I}_{h\ \mathrm{D},d} \times \left[\Pr\left(Redd\ Depth \le \max_{i=d+1 \to ED_{d,Y\ \mathrm{D}}} \left(WSEL_{d,h\ \mathrm{D}} - WSEL_{i,h\ \mathrm{D}} \right) \right) \Big/ \Pr\left(Redd\ Depth \le WSEL_{d,h\ \mathrm{D}} \right) \right]_h \right\}.$$

The first term in the above formula calculates the annual redd dewatering index within the reach upstream of Daguerre Point Dam, while the second term calculates the annual redd dewatering index within the reach downstream of Daguerre Point Dam.

When using the estimated location of the egg pocket as a potential dewatering threshold, the annual egg pocket dewatering index for a single simulated year of fall-run Chinook salmon spawning is expressed by the formula:

$$WED_Y = \left\{ \sum_{d=1}^{92} w_{d,\,\mathrm{U}} \times \sum_{h=1}^{12} w_{h\ \mathrm{U},d} \times \mathrm{I}_{h\ \mathrm{U},d} \times \left[\Pr\left(Egg\ Depth \le \max_{i=d+1 \to ED_{d,Y\ \mathrm{U}}} \left(WSEL_{d,h\ \mathrm{U}} - WSEL_{i,h\ \mathrm{U}} \right) \right) \Big/ \Pr\left(Egg\ Depth \le WSEL_{d,h\ \mathrm{U}} \right) \right]_h \right\} +$$

$$+ \left\{ \sum_{d=1}^{92} w_{d,\,\mathrm{D}} \times \sum_{h=1}^{12} w_{h\ \mathrm{D},d} \times \mathrm{I}_{h\ \mathrm{D},d} \times \left[\Pr\left(Egg\ Depth \le \max_{i=d+1 \to ED_{d,Y\ \mathrm{D}}} \left(WSEL_{d,h\ \mathrm{D}} - WSEL_{i,h\ \mathrm{D}} \right) \right) \Big/ \Pr\left(Egg\ Depth \le WSEL_{d,h\ \mathrm{D}} \right) \right]_h \right\}.$$

The calculations of the annual dewatering indices (WRD_Y) (using both dewatering thresholds) for spring-run Chinook salmon and fall-run Chinook salmon were repeated for each of the 41 modeled years (1970-2010), for the Environmental Baseline and Without-Project scenarios.

7.4.2.1.6 Redd Dewatering Results

Spring-run Chinook Salmon

Estimation of potential spring-run Chinook salmon redd dewatering indicates that the long-term average of the percentage of redds built within a given year that would have the potential to be dewatered with slightly less frequency under the Environmental Baseline relative to the Without-Project. Under both scenarios, the potential for redd dewatering is very low, averaging only about 0.01 percent and 0.10 percent annually, respectively. To put this into context, an estimated 1,148 and 1,465 spring-run Chinook salmon redds were constructed in the lower Yuba River during 2009 and 2010, respectively. Correspondingly, applying the 41-year average, it is estimated that essentially no spring-run Chinook salmon redd would be expected to be dewatered under the Environmental Baseline, and only about 1 spring-run Chinook salmon redd would be expected to be dewatered under the Without-Project scenario during each of these 2 years.

The percentage of redds potentially dewatered would be very small, and similar under the Environmental Baseline and Without-Project scenarios during all WYTs (Table 7.4-11). The largest difference between the Environmental Baseline and Without-Project scenarios potential spring-run Chinook salmon redd dewatering occurs during dry WYs, when the probability of redd dewatering is less under the Environmental Baseline, relative to the Without-Project scenario.

Table 7.4-11. Estimated spring-run Chinook salmon redd and egg pocket potential dewatering under the Environmental Baseline scenario relative to the Without-Project scenario.

WYT Categories	Redd Dewatering Index (%)			Egg Pocket Dewatering Index (%)		
	Environmental Baseline	Without Project	Difference	Environmental Baseline	Without Project	Difference
Long-term (All WYs)	0.01%	0.10%	-0.09%	0.00%	0.00%	0.00%
Wet	0.02%	0.14%	-0.12%	0.00%	0.00%	0.00%
Above Normal	0.01%	0.05%	-0.04%	0.00%	0.00%	0.00%
Below Normal	0.00%	0.01%	-0.01%	0.00%	0.00%	0.00%
Dry	0.00%	0.20%	-0.20%	0.00%	0.00%	0.00%
Critical	0.00%	0.04%	-0.04%	0.00%	0.00%	0.00%

The long-term and WYT averages of the percentage of egg pockets dewatered indicates that no egg pockets would be expected to be dewatered under the Environmental Baseline scenario or the Without-Project scenario.

Fall-run Chinook Salmon

Estimation of potential fall-run Chinook salmon redd dewatering indicates that the long-term average of the percentage of redds built within a given year would be dewatered less frequently under the Environmental Baseline scenario, relative to the Without-Project scenario (Table 7.4-12). Under the Environmental Baseline scenario, the estimated percent of expected redds dewatered is relatively low, averaging only about 1.32 percent annually. To put this into context, an estimated 2,079 and 1,559 fall-run Chinook salmon redds were constructed in the lower Yuba River during 2009 and 2010, respectively. Correspondingly, applying the 41-year average, it is estimated that only about 27 and 21 fall-run Chinook salmon redds would be expected to be dewatered under the Environmental Baseline scenario during 2009 and 2010, respectively. Under the Without-Project scenario, approximately 99 and 74 redds would be expected to be dewatered during 2009 and 2010, respectively.

The highest estimated percentage of redds potentially dewatered occurs during wet WYs under both the Environmental Baseline scenario (2.88%) and the Without-Project scenario (8.25 percent). Under the Environmental Baseline scenario, the percentage of redds potentially dewatered generally decreases as the WYTs become drier from wet to critical. The largest differences between the Environmental Baseline scenario and the Without-Project scenario occur during the wetter WYTs, with less estimated fall-run Chinook salmon redd dewatering occurring under the Environmental Baseline scenario.

Table 7.4-12. Estimated fall-run Chinook salmon redd and egg pocket potential dewatering under the Environmental Baseline scenario relative to the Without-Project scenario.

WYT Categories	Redd Dewatering Index (%)			Egg Pocket Dewatering Index (%)		
	Environmental Baseline	Without Project	Difference	Environmental Baseline	Without Project	Difference
Long-term (All WYs)	1.32%	4.74%	-3.42%	0.76%	2.73%	-1.97%
Wet	2.88%	8.25%	-5.37%	1.79%	5.45%	-3.66%
Above Normal	0.55%	3.45%	-2.90%	0.23%	1.54%	-1.31%
Below Normal	0.84%	2.57%	-1.73%	0.37%	1.29%	-0.92%
Dry	0.20%	2.93%	-2.73%	0.04%	1.26%	-1.22%
Critical	0.09%	2.16%	-2.07%	0.01%	0.72%	-0.71%

The highest estimated percentage of egg pockets potentially dewatered occurs during wet WYTs for both the Environmental Baseline scenario (1.79%) and the Without-Project scenario (5.45%). Under the Environmental Baseline, the percentage of egg pockets potentially dewatered generally decreases as WYTs become drier from wet to critical. Potential egg pocket dewatering is lower under the Environmental Baseline scenario than under the Without-Project for all WYTs.

Estimations of fall-run Chinook salmon redd and egg pocket dewatering under the Environmental Baseline and Without-Project scenarios are higher for fall-run Chinook salmon than for spring-run Chinook salmon. The increased potential redd dewatering for fall-run Chinook salmon is due to the high flow events (storm flows) that occur during the latter portion of their incubation period (i.e., January through March). Flows during these events exceed the combined flow capacity at the Narrows 1 and Narrows 2 facilities (4,130 cfs). The fact that uncontrolled storm flows are causing the relatively higher redd dewatering percentages for fall-run Chinook salmon is evidenced by the higher redd dewatering index under the Without-Project scenario, which represents the Environmental Baseline without Project operations.

7.4.2.1.9 Water Temperature

The upper tolerable WTI value of 58°F was developed by the RMT (2013a) to evaluate both the spawning and embryo incubation lifestages for Chinook salmon because these lifestages are closely linked temporally, and studies describing how water temperature affects embryonic survival and development based on varying water temperature treatments on holding adults often report similar results to water temperature experiments conducted on fertilized eggs. The value of 58°F was selected by RMT (2013a) because: 1) upper value of the range given for preferred water temperatures (i.e., 53°F to 58°F) for eggs and fry (NMFS 2002b); 2) constant egg incubation temperatures between 42.5°F and 57.5°F resulted in normal development (Combs and Burrows 1957); and 3) the natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work).

Evaluation of the spring-run Chinook salmon and fall-run Chinook salmon spawning and embryo incubation upper tolerable WTI value in the lower Yuba River was conducted using simulated water temperatures under existing conditions (i.e., the Environmental Baseline) and the Without-

Project scenario. In summary, monitored and modeled water temperatures are generally suitable during the spring-run and fall-run Chinook salmon spawning and embryo incubation periods, with the exception of early October of the fall-run Chinook salmon spawning and embryo incubation lifestages under existing conditions. Simulated water temperatures under existing conditions are substantially more suitable for all Chinook salmon lifestages relative to the Without-Project scenario.

7.5 Juvenile Rearing Habitat

The abundance of in-river juvenile Chinook salmon is a function of many factors, including abundance of newly emerged fry, quantity and quality of suitable habitat, abundance and composition of food, and interactions with other fish, birds and mammals (Bjornn and Reiser 1991). HAPCs associated with juvenile Chinook salmon rearing complex channels and floodplain habitats, as well as thermal refugia.

7.5.1 Complex Channels and Floodplain Habitats

In general, complex channels and floodplain habitats, including wetlands, oxbows, side channels, and steeper, more constrained channels with high levels of LWM, provide valuable habitat for all Pacific salmon species (NMFS and PFMC 2011). The density of rearing salmon is reported to be greatest in areas of high quality naturally functioning floodplain habitat and in areas with large woody material (LWM), rather than in anthropogenically modified floodplains (Brown and Hartman 1988; Montgomery et al. 1999). Complex floodplain habitats are dynamic systems that change over time, and the habitat-forming processes that create and maintain these habitats (e.g., erosion, channel avulsion, input of large wood) should be considered as integral to the habitat (NMFS and PFMC 2011).

LWM is generally considered to be an important component of these habitats, and typically occurs in the form of logjams in floodplains and larger rivers (NMFS and PFMC 2011). LWM helps to create complex channels and floodplain habitats and important spawning and rearing habitat by trapping sediment, nutrients, organic matter, creating pools, sorting gravels, providing cover and hydrologic heterogeneity, and creating important spawning and rearing areas for salmon (Abbe and Montgomery 1996; Bilby and Bisson 1998). These areas also provide pools, off-channel areas, shade, cooler temperatures, and thermal refugia during both summer and winter.

In most river systems throughout California, complex floodplain habitats have been subject to a high degree of direct anthropogenic modification. Floodplain areas have been cleared of woodland vegetation, drained, and filled to allow agricultural, residential, and urban development (Pess et al. 2002). Channelization and diking of rivers has effectively separated rivers from many off-channel habitats once available to salmonids (Reeves et al. 1998 as cited in NMFS and PFMC 2011). Clearing of large wood accumulations in rivers was commonplace to both improve navigation and facilitate transport of logs from upstream forest to mill sites downstream (Bilby and Bisson 1998).

Low-gradient, unconstrained reaches that typify where complex floodplain habitats are expressed are also highly responsive to disturbances that happen higher up in the watershed (NMFS and PFMC 2011). For example, sediments generated by land use practices are typically routed through higher gradient, transport reaches and are deposited in low-gradient reaches. This can lead to widening and shallowing of the river channel, filling in of pool habitats, and reductions in the average particle size of the substrate (Montgomery and Buffington 1998). These changes, in turn, diminish the quality of spawning and rearing habitats for salmon, as well the capacity of affected reached to produce invertebrates that salmonids depend on for food (NMFS and PFMC 2011).

Historical land use practices including logging of riparian forests and active removal of wood from the stream channel to facilitate fish passage and protect local infrastructure has fundamentally altered the structure and function of salmon habitats (NMFS and PFMC 2011). Despite improvements in forest and land management that have occurred in the last 40 to 50 years, the legacy of early practices remains apparent in diminished sources for recruitment of large wood (particularly of coniferous origin), decreased quantities of large wood in stream channels, and a shift in composition of large wood pieces from large-diameter pieces of coniferous origin to smaller diameter pieces of hardwood origin, which decompose at a much faster rate (Bilby and Bisson 1998).

Historically, neither complex floodplain habitats nor mid-gradient channels with large quantities of in-channel wood were inherently rare within forested landscapes of California, but they have become increasingly so in response to human alterations of the landscape.

7.5.2 Thermal Refugia

Thermal refugia are defined as areas where fish may escape high water temperatures, especially during hot, dry summers in California (NMFS and PFMC 2011). Thermal refugia provide important holding and rearing habitat for adults and juveniles (Goniea et al. 2006; Sutton 2007). Important thermal refugia often exist higher in hydrologic units and are most susceptible to blockage by artificial barriers (Yoshiyama et al. 1998). Reduced flows that are either anthropogenic, natural or climate-change induced also may reduce or eliminate access to refugia (Battin et al. 2007). Loss of structural elements such as large wood can also influence the formation of thermal refugia.

Thermal refugia typically include coolwater tributaries, lateral seeps, side channels, tributary junctions, deep pools, areas of groundwater upwelling and other mainstem river habitats that are cooler than surrounding waters (≥3.6°F cooler) (Torgersen et al. 1999; Ebersole et al. 2003). As such, refugia can occur at spatial scales ranging from entire tributaries (e.g., spring-fed streams), to stream reaches (e.g., alluvial reaches with high hyporheic flow), to highly localized pockets of water only a few square meters in size embedded within larger rivers (NMFS and PFMC 2011).

Studies have shown that salmon increase their use of thermal refugia (e.g., cool water tributaries) when exposed to elevated water temperatures (Sutton 2007), which can significantly reduce migration rates and suggests these areas provide crucial habitat in warm years (Goniea et al. 2006). Torgersen et al. (1999) state that the ability for coldwater fish such as salmon to persist in warmwater environments (>77°F) that experience elevated summer temperatures and seasonal low flows may be attributed to thermal refugia because even relatively minor differences in temperature are ecologically relevant for fish. In addition, climate change is expected to cause a rise in freshwater temperatures and a reduction in snowpack, which would lead to lower flows in the summer and fall (Battin et al. 2007; Mote et al. 2003; Stewart et al. 2004). These water temperature changes would likely result in a reduction in the quantity and quality of freshwater salmon habitat, making thermal refugia even more important in the future (NMFS and PFMC 2011).

The abundance of cool water habitat features can vary substantially depending upon many factors including geographic location, flow characteristics and time of year (NMFS and PFMC 2011). However, in certain areas with hot, dry summers (e.g., lower Sacramento River) it is likely that little, if any, suitable holding habitat exists for salmon to take refuge from elevated water temperatures (NMFS 2009b). Moreover, because climate change is expected to cause an increase in freshwater temperatures and prolonged summer drought periods (Battin et al. 2007; Mote et al. 2003), these habitat types can be expected to become more rare (ISAB 2007).

The lower Yuba River is unique, in that the Project provides substantial, dependable low water temperature refugia for holding, spawning and rearing of Chinook salmon, due to the release of large flows drawn from a large pool of cold water in New Bullards Bar Reservoir.

7.5.3 Yuba River Watershed Upstream of Englebright Dam

7.5.3.1 North Yuba River (New Bullards Bar Dam Reach)

7.5.3.1.1 Complex Channels and Floodplain Habitats

In 2012, YCWA conducted a riparian habitat study in the Project-affected reaches upstream of the Englebright Reservoir to assess the condition of riparian habitats upstream that may be affected by the Proposed Action (see Technical Memorandum 6-1, *Riparian Habitat Upstream of Englebright Reservoir*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA). Field efforts included surveys for riparian vegetation and LWM. All LWM that exceeded half of the average bankfull widths for each reach, exceeded 25 in in diameter and 25 ft in length, or showed morphologic influence (e.g., trapping sediment or altering flow patterns) were considered "key" pieces. The largest size classes of LWM (i.e., longer than 50 ft and greater than 24 in diameter) were rare or uncommon.

In general, site vegetation was limited overall due to substrate, and most vegetation was low growing and distributed amongst the boulders where a foothold was possible. Himalayan blackberry was present within most vegetation transects. Himalayan blackberry may affect the function of riparian communities because it generally does not provide significant shade for stream water and does not contribute to LWM in streams (Bennett 2006). Although Himalayan blackberry were present throughout the stream reaches, shrubs and trees of various age classes were also present, indicating that recruitment is still occurring and Himalayan blackberry has not completely displaced those species, and the function of the riparian communities does not appear to have changed, as shrubs and trees continue to provide stream shade and LWM sources. Overall, YCWA assessed the assessment area communities as healthy because there is no indication of a lack of riparian function in these areas. YCWA evaluated most stream reaches as healthy because recruits of woody vegetation and a variety of age classes were present in all stream reaches, indicating that germination is occurring under current Project operation and lateral distribution of woody species is within the expected range, with willows near the wetted edge and other hardwood species occurring farther upslope (Harris and McBride 2013).

The North Yuba River at the survey site was dominated by bedrock and large boulders, and woody species cover along vegetation transects was about 1 percent in the North Yuba River. The assessment site at the North Yuba River upstream from the confluence with the Middle Yuba River reportedly has a high potential to be affected by changes in flow patterns between With- and Without Hydrology (see Technical Memorandum 6-1, *Riparian Habitat Upstream of Englebright Reservoir*). Summary results from Technical Memorandum 6-1 with respect to North Yuba River floodplain and riparian habitat conditions are provided below.

Overall, vegetation was limited, but a variety of age classes for all observed species was present in the riparian corridor. Under current Project O&M, the riparian vegetation appears healthy and hydrologically connected within the floodplain. However, changes in discharge volume, and associated periods of continuous inundation reportedly are not infrequent and can be dramatic. Field observations indicated that the majority of the woody species were willows and were present upslope of bankfull, within floodprone. The dominant substrate at transects was bedrock and boulder; substrates with limited capability to support woody vegetation (Figure 6.0-1 in Attachment 6-1D of Technical Memorandum 6-1, *Riparian Habitat Upstream of Englebright Reservoir*). Woody species may not be present closer to the wetted edge because supporting fines may not be present, inundation of substrate conditions may be too high or continuously long, or the velocity of high flows may prevent establishment.

LWM has the potential to influence pool formation, increase shade and collect sediment and organic litter within streambeds (e.g., Lassettre and Harris 2001). Thirteen key pieces of wood were located during LWM surveys. Of these, no key pieces were located in the North Yuba River. Smaller size classes of LWM were not evenly distributed throughout the reaches surveyed, and the average volume (m3) of LWM per 100 meters in the North Yuba River was reported to be 6.7 m3 per 100 m average.

In the past, YCWA has annually gathered all LWM that accumulates in New Bullards Bar Reservoir, booms it together and burns it, with appropriate permits, every 1 to 3 years. Using data collected by Senter et. al. (2012), the volume of wood captured by New Bullards Bar Reservoir can be estimated for 2010 (125,000 yd3) and 2012 (295,000 yd3). Not all of this calculated volume of wood represents pieces that meet the criteria of LWM. The USACE has developed a Large Woody Material Management Program (LWMMP), which includes the implementation of a Pilot Study to enhance rearing conditions for spring-run Chinook and steelhead in the lower Yuba River (USACE 2012b). The USACE initiated a Pilot Study during the fall of 2013 to determine an effective method of replenishing the supply of LWM back into the lower Yuba River. The USACE Pilot Study used LWM from existing stockpiles at New Bullards Bar Reservoir for placement at selected sites along the lower Yuba River. A long-term

LWMMP for the lower Yuba River is anticipated to occur within 1 year following completion of the Pilot Study, and is subject to available funding.

7.5.3.1.2 Thermal Refugia (Water Temperatures)

During the December through June fall-run Chinook salmon juvenile rearing and downstream movement period, maximum daily average water temperatures in the North Yuba River upstream of the confluence with the Middle Yuba River equaled or exceeded the upper tolerable WTI of 65°F (18.3°C) during May 2009 and 2012, and during June 2009, 2010 and 2012.

Maximum daily average water temperatures in the North Yuba River upstream of the Middle Yuba River during the year-round spring-run Chinook salmon juvenile rearing and downstream movement period that would apply if fish were able to access areas upstream of Englebright Dam equaled or exceeded the upper tolerable WTI of 65°F during May 2009 and 2012, June 2009, 2010 and 2012, and during all sampled years in July, August and September. Additionally, minimum daily average water temperatures in the North Yuba River upstream of the Middle Yuba River during July, August and September usually exceeded 65°F.

As discussed above for Migratory Habitat (Section 7.3), the water temperature suitability evaluation conducted for this Applicant-Prepared Draft EFH Assessment utilizes lifestage-specific periodicities and WTI values specified in RMT (2013a) for fall-run and spring-run Chinook salmon, and YCWA's Relicensing Water Temperature Model to evaluate simulated daily water temperatures over the modeled period of record (WY 1970-2010). Additional detail on the species-specific lifestage periodicities and WTI values is provided in Section 6.0 of the Applicant-Prepared Draft BA.

This section evaluates water temperature suitabilities for juvenile rearing and downstream movement lifestages of spring-run and fall-run Chinook salmon for the North Yuba River, the Middle Yuba River and the Yuba River upstream of Englebright Dam.

Environmental Baseline Scenario compared to Without-Project Scenario

Tables 7.5-1 and 7.5-2 display the differences in the spring-run and fall-run Chinook salmon juvenile rearing and downstream movement lifestage-specific upper tolerable WTI value exceedance probabilities under the Environmental Baseline scenario relative to the Without-Project scenario (i.e., the probability of exceeding a WTI value under the Environmental Baseline scenario minus the probability of exceeding that WTI value under the Without-Project scenario).

Water temperature exceedance probabilities are generally similar under the Environmental Baseline and Without-Project scenarios during October through April of the juvenile rearing and downstream movement lifestages of spring-run and fall-run Chinook salmon.

Table 7.5-1. Difference in simulated upper tolerable water temperature exceedance probabilities for spring-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Spring-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Juvenile Rearing and Downstream Movement	NYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-43.6	-82.0	-100.0	-100.0	-99.8	-87.5	-53.8	-1.0	0.0	0.0	0.0	0.0	0.0
	MYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	25.2	25.5	20.3	0.0	0.0	0.0	0.0	-1.5	-4.7	-2.4	0.0	0.0	0.0	0.0	0.0
	YR BLW MYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	32.9	55.8	35.9	8.0	0.0	0.0	0.0	-5.2	-26.8	-4.1	0.0	0.0	0.0	0.0	0.0
	YR ABV COLGATE	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	16.1	51.1	60.5	32.0	4.6	0.0	0.0	0.0	0.5	-14.8	-4.2	0.0	0.0	0.0	0.0	0.0
	YR BLW COLGATE	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.7	-17.6	-56.7	-92.8	-100.0	-100.0	-100.0	-97.7	-64.9	-7.3	0.0	0.0	0.0	0.0	0.0
Yearling+ Smolt Emigration	NYR	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0
	MYR	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0
	YR BLW MYR	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.2	0.0	0.0	0.0	0.0	0.0
	YR ABV COLGATE	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3										0.7	0.0	0.0	0.0	0.0	0.0
	YR BLW COLGATE	68°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0

Table 7.5-2. Difference in simulated upper tolerable water temperature exceedance probabilities for fall-run Chinook salmon lifestages under the Environmental Baseline scenario, relative to the Without-Project scenario.

Fall-run Chinook Salmon Lifestage	Node	Upper Tolerable WTI Value	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Juvenile Rearing and Downstream Movement	NYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-43.6												0.0
	MYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	25.2	25.5	20.3												0.0
	YR BLW MYR	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	32.9	55.8	35.9												0.0
	YR ABV COLGATE	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	16.1	51.1	60.5	32.0												0.0
	YR BLW COLGATE	65°F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.7	-17.6	-56.7												0.0

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario, are generally substantially more suitable for spring-run Chinook salmon juvenile rearing and downstream movement during late June through September in the North Yuba River below New Bullards Bar Dam and during June through September in the Yuba River below New Colgate Powerhouse, in addition to during late September in the Yuba River below the Middle Yuba River and above New Colgate Powerhouse. Water temperatures are generally similar for all months evaluated for the spring-run Chinook salmon yearling smolt outmigration lifestage. Water temperatures are substantially more suitable for the fall-run Chinook salmon juvenile rearing and downstream movement lifestage during late June in the North Yuba River below New Bullards Bar Dam and during June in the Yuba River below New Colgate Powerhouse.

Water temperatures under the Environmental Baseline scenario, relative to the Without-Project scenario, are generally substantially less suitable for spring-run Chinook salmon juvenile rearing and downstream movement during late May through June in the Middle Yuba River and in the Yuba River below the Middle Yuba River, and during May through June in the Yuba River above New Colgate Powerhouse. Water temperatures are substantially less suitable for fall-run Chinook salmon juvenile rearing and downstream movement during late May through June in the Middle Yuba River and in the Yuba River below the Middle Yuba River, and during May and June in the Yuba River above New Colgate Powerhouse.

7.5.3.1.3 Prey Availability (Macroinvertebrate Community Assemblages)

In 2012, YCWA conducted an aquatic macroinvertebrates study in stream reaches upstream of Englebright Reservoir that are potentially affected by the Proposed Action. YCWA and Relicensing Participants agreed to not sample two locations that were identified in the FERC-approved study: 1) the Middle Yuba River downstream of Our House Dam; and 2) the North Yuba River downstream of New Bullards Bar Reservoir. The sites were not sampled due to poor site conditions to implement the approved protocol.

An index of biotic integrity (IBI) score of 21 was found at the site in the North Yuba River upstream of the Middle Yuba River, and a multi-metric index (MMI) score of 16 was found at the survey site in the North Yuba River upstream of the Middle Yuba River. Figure 7.5-1 shows these scores by site, including the North Yuba River and other reaches upstream of Englebright Dam.

Benthic Macroinvertebrate (BMI) communities in streams can be highly influenced by a variety of naturally occurring and human-induced factors, including annual hydrologic cycles, timing and magnitude of spring outflows, water temperatures, streambed substrate composition, channel gradient, bank erosion and sediment deposition, pollution, riparian habitat degradation, instream-mining, hydropower development and recreational activities. The presence of dams and diversions on streams can substantially affect the supply and mobility of streambed sediment by retention in storage reservoirs and alteration of the magnitude and timing of stream flows, which can significantly affect the abundance and distribution of BMI communities. Rehn (2009) found that BMI-based IBI metrics tend to be lowest immediately downstream of dams and diversions, but normally increase with distance below these structures.

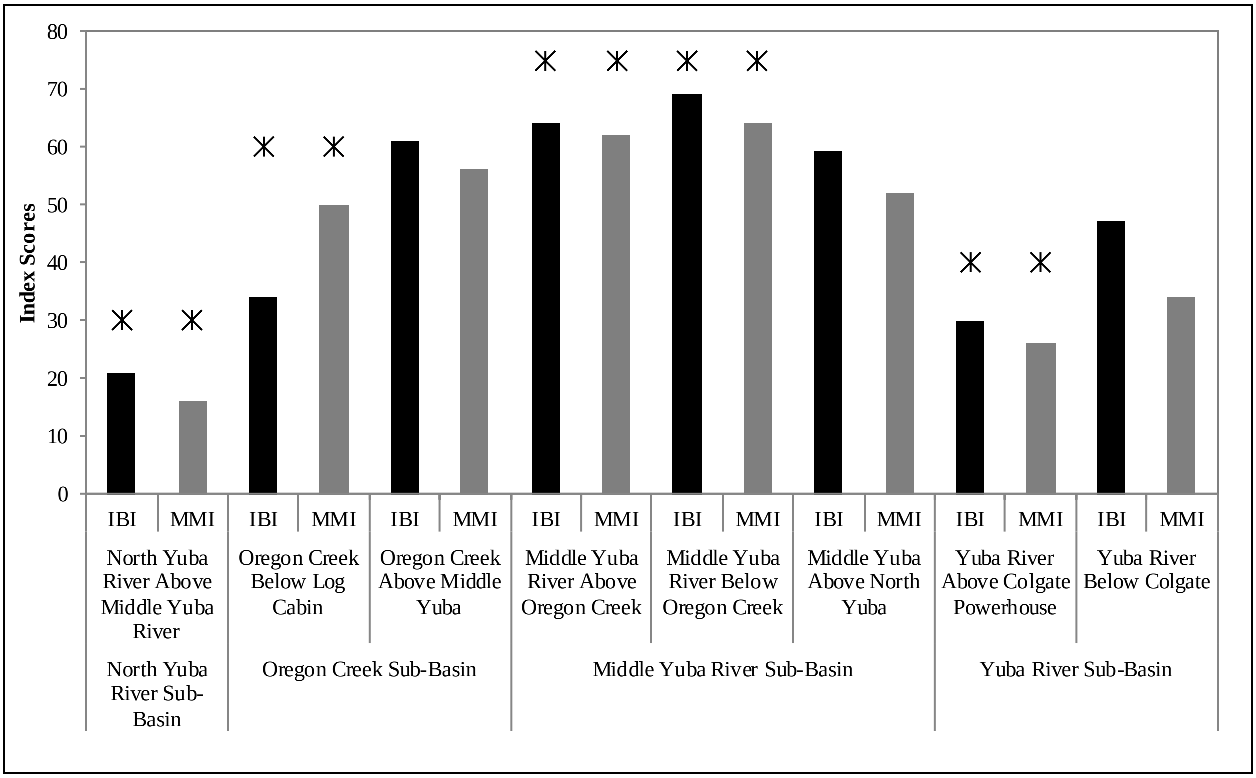

Figure 7.5-1. Overview of scores by basin, stream, and indices. Sites with starred symbols represent locations where insufficient organisms were collected to make the resultant IBI and MMI scores reliable.

Trends in BMI index site scores and potential interrelated factors leading to those scores were evaluated in Technical Memorandum 3-1, *Aquatic Macroinvertebrates Upstream of Englebright Reservoir*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA. Overall site scores from both indices found that higher quality sites (as ranked) were found further downstream, which reportedly is similar to findings by Rehn (2009). Sites below reservoirs generally show a significant difference in reduced quality. Rehn (2009) suggests that reduced quality may include lower diversity, EPT (i.e., ephemoptera, plecoptera, and trichoptera) richness, and reduced intolerant taxa and that studies showed that these issues may lessen with distance downstream. Generally, the sampling results followed these trends.

A single sample location was located in the North Yuba River Sub-basin near the confluence with the Middle Yuba River and only 2.0 mi downstream of New Bullards Bar Dam. This location had the lowest IBI and MMI scores of all the study sites. Additionally, an insufficient number of BMI were collected at the site, making the calculated IBI and MMI scores less reliable. It is likely that the low abundance of BMI and low IBI and MMI scores at this site are partially related to available habitat. Habitat at this site was dominated by pool (79%) with boulder substrates (49%). The dominance of these parameters are not ideal for high abundance and diversity of BMI populations. Another factor possibly contributing to the overall low scores was the lack of riparian vegetation. Water quality parameters were within expected ranges and did not appear to be a limiting factor to BMI.

7.5.3.2 Middle Yuba River (with Emphasis on the ~1.5 Miles of EFH Upstream from the Confluence of the Middle Yuba River and the North Yuba River)

7.5.3.2.1 Complex Channels and Floodplain Habitats

As described in Technical Memorandum 6-1, the Middle Yuba River downstream of Our House Diversion Dam was dominated by cobble, large boulders, and gravel with many pools and pocket water areas. There was no evidence of channel encroachment or bank instability. The average bankfull width in the site was 73 ft and the average flood prone width was 106 ft. In general, site vegetation was diverse in species assemblage and age class. For the site as a whole, riparian vegetation was dense enough to limit walking on banks (see Figure 3.0-1 in Attachment 6-1D of Technical Memorandum 6-1). Summary results from Technical Memorandum 6-1 with respect to Middle Yuba River floodplain and riparian habitat conditions downstream of Our House Diversion Dam are provided below.

- **Transect 2** - Observed bankfull width was about 65 ft and flood prone width was about 100 ft. Transect 2 was comprised of cobble, boulder, and gravel to valley extent on river right, and bedrock on river left. Mature woody vegetation includes red willow (20 – 75% cover) and white alder (50 – 75% cover) on river right and left. Recruits and seedlings of red willow were recorded on river right and seedlings of red willow were recorded on river left. Upslope of floodprone, the bedrock river valley walls support little vegetation with sparse poison oak and Himalayan blackberry. Within bankfull, the bedrock river valley walls support little vegetation (see Figure 3.0-2 in Attachment 6-1D of Technical Memorandum 6-1, *Riparian Habitat Upstream of Englebright Reservoir*).
- **Transect 4** - Observed bankfull width was about 60 ft and flood prone width was about 80 ft. Transect 4 was comprised of a large boulders and bedrock on river right and large boulders on river left. Mature woody vegetation included white alder (up to 60 % cover), red willow (20 – 80% cover), and black locust (up to 5% cover) on river right; and white alder (35% cover) mid-channel; and, white alder (65% cover) and red willow (5% cover) on river left. White alder recruits, as well as red willow and black locust seedlings were recorded mid-channel. White alder and red willow seedlings as well as red willow recruits were recorded on river left. Upslope of bankfull, the bedrock river valley walls support little vegetation with sparse poison oak and Himalayan blackberry. Within bankfull, the bedrock river valley walls support little vegetation.
- **Transect 7** - Observed bankfull width was about 70 ft and flood prone width was about 105 ft. Transect 7 was comprised of small boulders and large cobbles with sand on river right and left with some bedrock on river left. Mature woody vegetation includes both white alder (30 – 85% cover) and cottonwood (10% cover) on river right and white alder (100% cover) on river left. Both recruits and seedlings of white alder and seedlings of red willow were recorded on river right; no recruits and seedlings were recorded on river left. Younger-looking (smaller) woody species had greater cover within bankfull, with larger trees and shrubs farther from the wetted edge. The wetted edge of the channel

within bankfull on river left meets the steep bedrock bank and did not support vegetation. Upslope of bankfull, the bedrock river valley walls support little vegetation.

Overall, a variety of age classes for all observed species was present in the riparian corridor. Vegetation was healthy and appeared hydrologically connected within the floodplain. The dominant substrate included boulders, cobbles, and gravel, and woody species were present and supported in the area. Areas with bedrock substrate supported little to no vegetation.

The Middle Yuba near Yellowjacket Creek exhibited the greatest amount of LWM in surveyed areas, with 45 pieces counted, while the Middle Yuba River upstream of Oregon Creek (~2 mi) had the fewest with one piece of LWM.

7.5.3.2.2 Thermal Refugia (Water Temperatures)

During the December through June fall-run Chinook salmon juvenile rearing and downstream movement period (which would apply if fish were able to access areas upstream of Englebright Dam), maximum daily average water temperatures in the Middle Yuba River upstream of the confluence with the North Yuba River exceeded the upper tolerable WTI of 65°F (18.3°C) during May 2009 and 2012, and during June 2009, 2010 and 2012.

During the year-round spring-run Chinook salmon juvenile rearing and downstream movement period, maximum daily average water temperatures in the Middle Yuba River upstream of the confluence with the North Yuba River equaled or exceeded the upper tolerable WTI of 65°F during May 2009 and 2012, June 2009, 2010 and 2012, during July, August and September in all sampled years, and October 2011. Additionally, minimum daily average water temperatures in the Middle Yuba River upstream of the confluence with the North Yuba River generally exceeded 65°F during July and August from 2009 through 2012.

Simulated water temperatures in the Middle Yuba River during the juvenile rearing and downstream movement lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented under the North Yuba River in Section 7.5.3.1 above.

7.5.3.2.3 Prey Availability (Macroinvertebrate Community Assemblages)

In the Middle Yuba River, three macroinvertebrate sampling locations were identified downstream of Our House Diversion Dam. Key survey findings are summarized below.

- Riparian vegetation was similar throughout the three sampling sites, as were basic water quality parameters and other site characteristics.
- There was no apparent trend in IBI or MMI scores as distance downstream of the diversion dam increased.
- The highest IBI and MMI scores were calculated for the site located below the Oregon Creek confluence (i.e., 69 and 64, respectively). This site had the greatest amount of riffle habitat with the least amount of pool habitat and a cobble dominated substrate.

While the other 2sites in the Middle Yuba River had IBI and MMI scores above 50, there was a substantial increase in pool habitat and boulder substrate. These riffle dominated habitats, which often include a large percentage of cobble, provide more surface area and interstitial space for BMI communities to be successful and may have contributed to higher metric scores. In addition, cobble dominated substrates provide more flow refugia for BMI, especially those with limited mobility.

7.5.3.3 Yuba River Upstream of Englebright Reservoir

7.5.3.3.1 Complex Channels and Floodplain Habitats

The Yuba River downstream of New Colgate Powerhouse was dominated by gravel and boulders with some bedrock and sand, and channel habitats were predominantly pools and runs or step runs. There was no evidence of channel encroachment or bank instability. The average bankfull width in the site was 153 ft and the average flood prone width was 287 ft.

Overall, a variety of age classes for all observed species was present in the riparian corridor. Vegetation in the site was healthy and appeared hydrologically connected within the floodplain. Woody species were present in areas with substrate capable of supporting woody vegetation. The dominant substrate at transects included cobble gravel and sand with some bedrock and boulder. With the exception of the higher areas on cobble bars, woody species were present and supported to some degree on all substrates, with less cover in bedrock areas.

7.5.3.3.2 Thermal Refugia (Water Temperatures)

Of the sites monitored during the December through June fall-run Chinook salmon juvenile rearing and downstream movement period, maximum daily average water temperatures exceeded the upper tolerable WTI of 65°F (18.3°C) during May 2009 and 2012 and June 2009, 2010 and 2012 at the Yuba River downstream of the confluence of North Yuba River and Middle Yuba River, and during May 2009 and 2012 and June 2009, 2010 and 2012 at the Yuba River upstream of New Colgate Powerhouse.

During the year-round spring-run Chinook salmon juvenile rearing and downstream movement period, maximum daily average water temperatures met or exceeded the upper tolerable WTI of 65°F during most months from June through September at the two upstream sites (Yuba River downstream of the confluence of the North Yuba River and Middle Yuba River, and the Yuba River upstream of New Colgate Powerhouse). Maximum daily average water temperatures did not exceed 65°F in the Yuba River downstream of New Colgate Powerhouse and downstream of Dobbins Creek during the 2009 through 2012 monitoring period.

Simulated water temperatures in the Yuba River above Englebright Dam during the juvenile rearing and downstream movement lifestages of spring-run and fall-run Chinook salmon under the Environmental Baseline scenario, and under the Environmental Baseline scenario relative to the Without-Project scenario, were presented under the North Yuba River in Section 7.5.3.1 above.

7.5.3.3.3 Prey Availability (Macroinvertebrate Community Assemblages)

There were two macroinvertebrate sampling locations in the Yuba River, one upstream and one downstream of New Colgate Powerhouse. IBI and MMI scores were higher below New Colgate Powerhouse than those observed at the upstream location. An insufficient number of BMI were collected at the upstream site, making the calculated IBI and MMI scores less reliable. IBI and MMI scores appeared to be positively related to habitat type and substrate. The sampling location downstream of New Colgate Powerhouse was primarily composed of riffle (50%), with boulder (49%) and cobble (35%) as the most prominent substrates. Riparian vegetation was similar throughout the two sampling sites as were other general site characteristics. Water quality measurements varied due to the nature of water being released from the powerhouse. Significantly cooler water temperatures and increased dissolved oxygen were measured downstream of the powerhouse.

7.5.4 Downstream of Englebright Dam

7.5.4.1 Lower Yuba River

Historically, the Yuba River was connected to vast floodplains and included a complex network of channels, backwaters and woody material (NMFS 2009b). The legacy of hydraulic and dredger mining is still evident on the lower Yuba River where, for much of the river, dredger piles confine the river to an unnaturally narrow channel. The consequences of this unusual and artificial geomorphic condition include reduced floodplain and riparian habitat and resultant limitations in fish habitat, particularly for rearing juvenile salmonids (NMFS 2009b).

Juvenile Chinook salmon rearing habitat in the EFH Action Area includes the entire 24 mi of the lower Yuba River. In general, however, juvenile Chinook salmon have been observed throughout the lower Yuba River but with higher abundances above Daguerre Point Dam. The higher abundances above Daguerre Point Dam may be due to larger numbers of spawners, greater amounts of more-complex, high-quality cover, and lower densities of predators such as striped bass and American shad, which are restricted to areas below Daguerre Point Dam (SWRI et al. 2000).

7.5.4.1.1 Flow-Dependent Instream Habitat

As presented in Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*, WUA-discharge relationships for Chinook salmon were calculated separately for fry and juveniles, incorporating a "with cover" habitat suitability criteria (HSC), and a "without cover" HSC. The resultant habitat-discharge relationships varied highly among simulated scenarios.

Some previously conducted PHABSIM studies of large riverine systems in the Central Valley of California have not included fry or juvenile rearing lifestages because of the uncertainty or unreliability of habitat-discharge relationships. For example, in the FERC relicensing of the Oroville Facilities (FERC Project No. 2100), DWR (2005) reported that Chinook salmon (and steelhead) fry and juvenile rearing habitat-discharge relationships in the lower Feather River were ambiguous and difficult to interpret, and the results did not support a clear alternative or ideal discharge level.

Methodology

For this EFH Assessment, the Relicensing Participant's consensus HSCs and resultant WUA-discharge relationships were used in conjunction with the 41-year daily Operations Model to address Project-related flow effects on fry and juvenile rearing habitat for spring- and fall-run Chinook salmon. Calculation of spring-run and fall-run Chinook salmon fry and juvenile habitat availability was generally conducted consistent with the methodology applied in Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*, except as otherwise noted in this section.

In this Applicant-Prepared Draft EFH Assessment, two separate evaluations of fry and juvenile rearing WUA were conducted for both spring-run and fall-run Chinook salmon – an in-channel analysis, and a full-flow analysis. For the in-channel analysis, fry and juvenile rearing WUA for spring-run and fall-run Chinook salmon was evaluated for simulated flows up to 5,000 cfs, which generally represents the bankfull flow in the lower Yuba River. In Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*, substrate was representative of instream object cover because of its potential provision of localized hydraulic roughness, and was modeled up to 5,000 cfs. Hence, for this Applicant-Prepared Draft EFH Assessment, in-channel fry and juvenile rearing with cover analyses are presented for flows up to 5,000 cfs. For these analyses, results are presented as long-term average for the entire period of simulation and average by water year type, expressed as percent of maximum WUA. Habitat duration exceedance distributions also are presented as percent of maximum WUA.

For the full-flow analyses, because no field-based substrate and cover mapping was conducted in the terrestrial river corridor outside the 5,000 cfs wetted area for Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*, substrate values in overbank areas were extrapolated from available data (as described in Technical Memorandum 7-10) and used for the full-flow analysis, and cover was not included. In this Applicant-Prepared Draft EFH Assessment, spring-run and fall-run Chinook salmon fry and juvenile rearing without cover analyses are presented for the full range of flows over the hydrologic period of evaluation. Because overbank flows (greater than 5,000 cfs) are relatively infrequent, transient in nature, occur primarily as a result of storm runoff and exceed the combined release capacity at Narrows 1 and Narrows 2, using a theoretical maximum WUA associated with such flows would be inappropriate in an analysis over the entire 41-year period of evaluation. Accordingly, for these analyses, results instead are presented in terms of acres of WUA (separately for flows less than or equal to 5,000 cfs, and for flows greater than 5,000 cfs) for the long-term average and for averages by water year type.

Modeled relationships between river flow and the inundation of floodplain habitat downstream of Englebright Dam also were presented in Technical Memorandum 7-10, *Instream Flow Downstream of Englebright Dam*. Inundation area, depth of inundation, and velocities in the inundation area were modeled at flows of 4,000 cfs, 5,000 cfs, 7,500 cfs, 10,000 cfs, 15,000 cfs, 21,100 cfs, 30,000 cfs, 42,200 cfs, 84,400 cfs, and 110,400 cfs for the 8 identified geomorphic reaches. The exceptions were the 2 lowermost reaches, the Hallwood and Marysville geomorphic reaches, for which modeling was restricted to no more than 42,200 cfs. For this Applicant-Prepared Draft EFH Assessment, rather than just characterizing inundation, spring- and fall-run Chinook salmon fry and juvenile rearing habitat was estimated and evaluated over the full range of flows simulated by the daily hydrologic Operations Model for the various scenarios of comparison (full-flow analysis).

Fry and juvenile rearing analyses were conducted for the following lifestage-specific periodicities identified in RMT (2013a).

- Spring-run Chinook salmon fry rearing – Mid-November through mid-February
- Spring-run Chinook salmon juvenile rearing – Year-round
- Fall-run Chinook salmon fry rearing – Mid-December through April
- Fall-run Chinook salmon juvenile rearing – Mid-January through June

Modeled Chinook Salmon Fry and Juvenile Rearing Habitat Availability

This section evaluates spring-run and fall-run Chinook salmon fry and juvenile rearing habitat availability (WUA) under existing conditions (i.e., the Environmental Baseline scenario) using simulated hydrologic conditions, compared to hydrologic conditions under the “Without-Project” scenario. The following evaluations utilize the same methodology employed in the Applicant-Prepared Draft BA for spring-run Chinook salmon, modified to represent the timing and geographic location for fall-run Chinook salmon, as applicable.

<u>Spring-run Chinook Salmon Fry In-Channel Rearing Habitat</u>
Table 7.5-3 displays the long-term average and average by WYT spring-run Chinook salmon fry in-channel rearing habitat (percent of maximum WUA) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average fry rearing habitat availability (WUA) in the lower Yuba River is similar under the Environmental Baseline and Without-Project scenarios (long-term average of 88.6% and 89.5% of the maximum WUA, respectively). The Environmental Baseline scenario results in an essentially equivalent amount of maximum fry rearing habitat during wet WYs, 0.3 percent more during above normal WYs, 1.9 percent less during below normal WYs, 2.0 percent less during dry WYs, and 1.3 percent less during critical WYs. Neither the Environmental Baseline scenario nor the Without-Project scenario provide an average of over 90 percent of maximum fry rearing WUA during any WYT, except for during dry and critical WYTs under the Without-Project scenario, although both scenarios provide an average of 80 percent or more of maximum fry rearing in-channel WUA during all WYTs.

Table 7.5-3. Long-term and WYT average spring-run Chinook salmon fry in-channel rearing WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	88.6	88.6	88.9	87.6	88.2	89.7
Without-Project	89.5	88.6	88.6	89.5	90.2	91.0
Difference	-0.9	0.0	0.3	-1.9	-2.0	-1.3

1 As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
2 Based on the WY 1970-2010 simulation period.

Habitat durations for spring-run Chinook salmon fry in-channel rearing under the Environmental Baseline and Without-Project scenarios are presented in Figure 7.5-2. The Environmental Baseline scenario provides slightly less (about 5% of maximum WUA) amounts of fry rearing habitat availability over the upper about 40 percent of the exceedance distribution, although remaining over 90 percent maximum WUA. The Environmental Baseline scenario achieves over 80 percent of maximum fry rearing WUA over the entire exceedance distribution, whereas the Without-Project scenario provides less than 80 percent maximum WUA for the lowermost (about 3%) of the distribution.

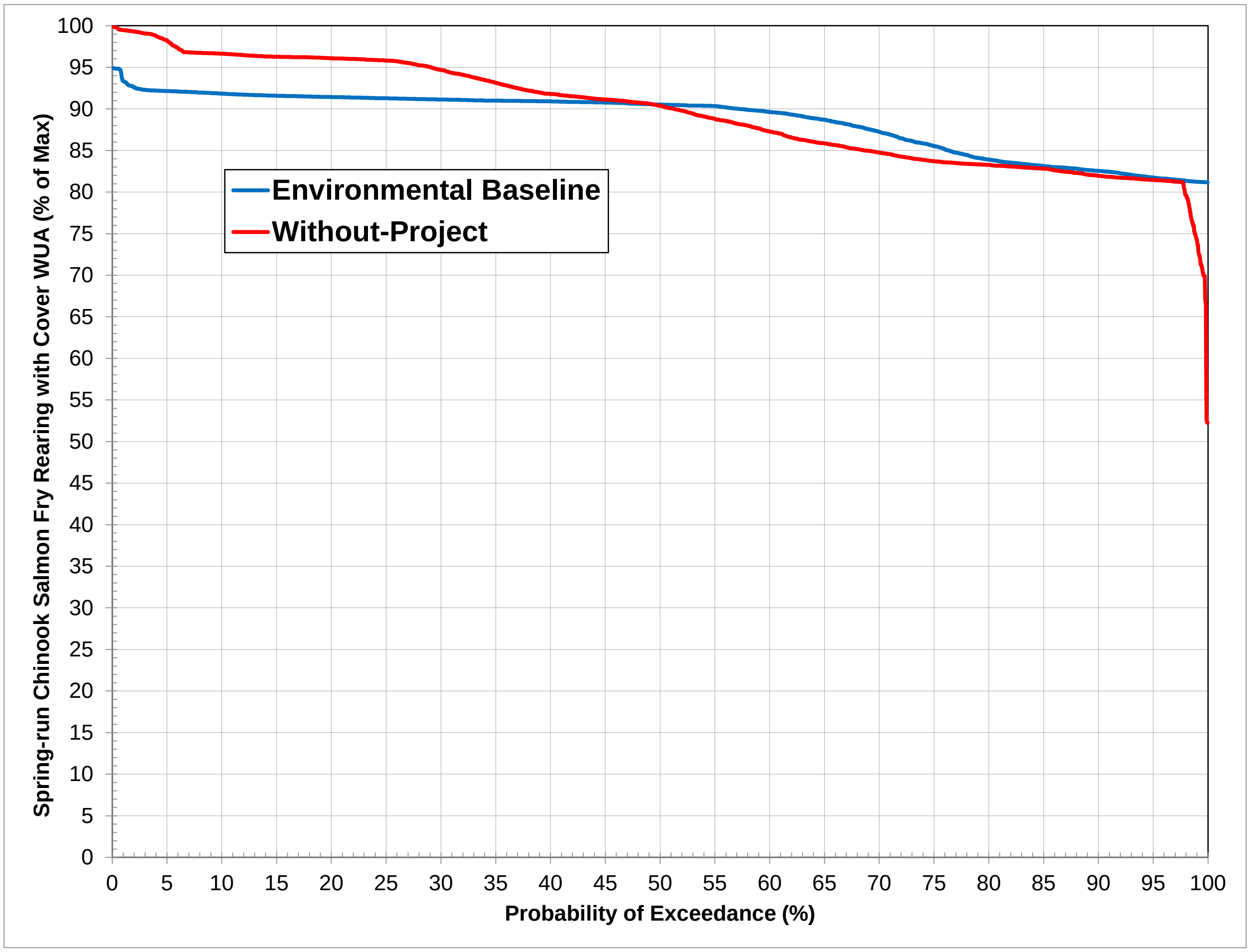

Figure 7.5-2. Spring-run Chinook salmon fry in-channel rearing habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

Spring-run Chinook Salmon Juvenile In-Channel Rearing Habitat

Table 7.5-4 displays the long-term average and average by WYT spring-run Chinook salmon juvenile in-channel rearing habitat (percent of maximum WUA) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average juvenile rearing WUA in the lower Yuba River is substantially higher under the Environmental Baseline scenario relative to the Without-Project scenario (long-term average of 96.3% versus 79.6% of maximum WUA). The Environmental Baseline scenario also results in substantially more juvenile rearing habitat during all WYTs, ranging from 13.9 percent more during wet WYs to 21.3 percent more during critical WYs. The Environmental Baseline scenario provides an average of over 90 percent of maximum juvenile in-channel rearing WUA during all WYTs, whereas the Without-Project scenario does not provide an average of over 90 percent of maximum juvenile rearing WUA during any WYT, and only provides 80 percent during wet, below normal and dry WYTs.

Table 7.5-4. Long-term and WYT average spring-run Chinook salmon juvenile in-channel rearing WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	96.3	95.5	95.7	96.4	97.5	97.1
Without-Project	79.6	81.6	79.7	80.7	80.1	75.8
Difference	16.7	13.9	16.0	15.7	17.4	21.3

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Habitat duration for spring-run Chinook salmon juvenile in-channel rearing under the Environmental Baseline and Without-Project scenarios is presented in Figure 7.5-3. The Environmental Baseline scenario provides higher amounts of juvenile rearing habitat availability over the entire exceedance distribution, and provides substantially more habitat over about the lower 40 percent of the distribution. The Environmental Baseline scenario achieves over 90 percent of maximum spawning WUA with about a 99 percent probability, while the Without-Project scenario achieves over 90 percent of maximum juvenile rearing WUA with about a 60 percent probability (and over 80% with about a 63% probability).

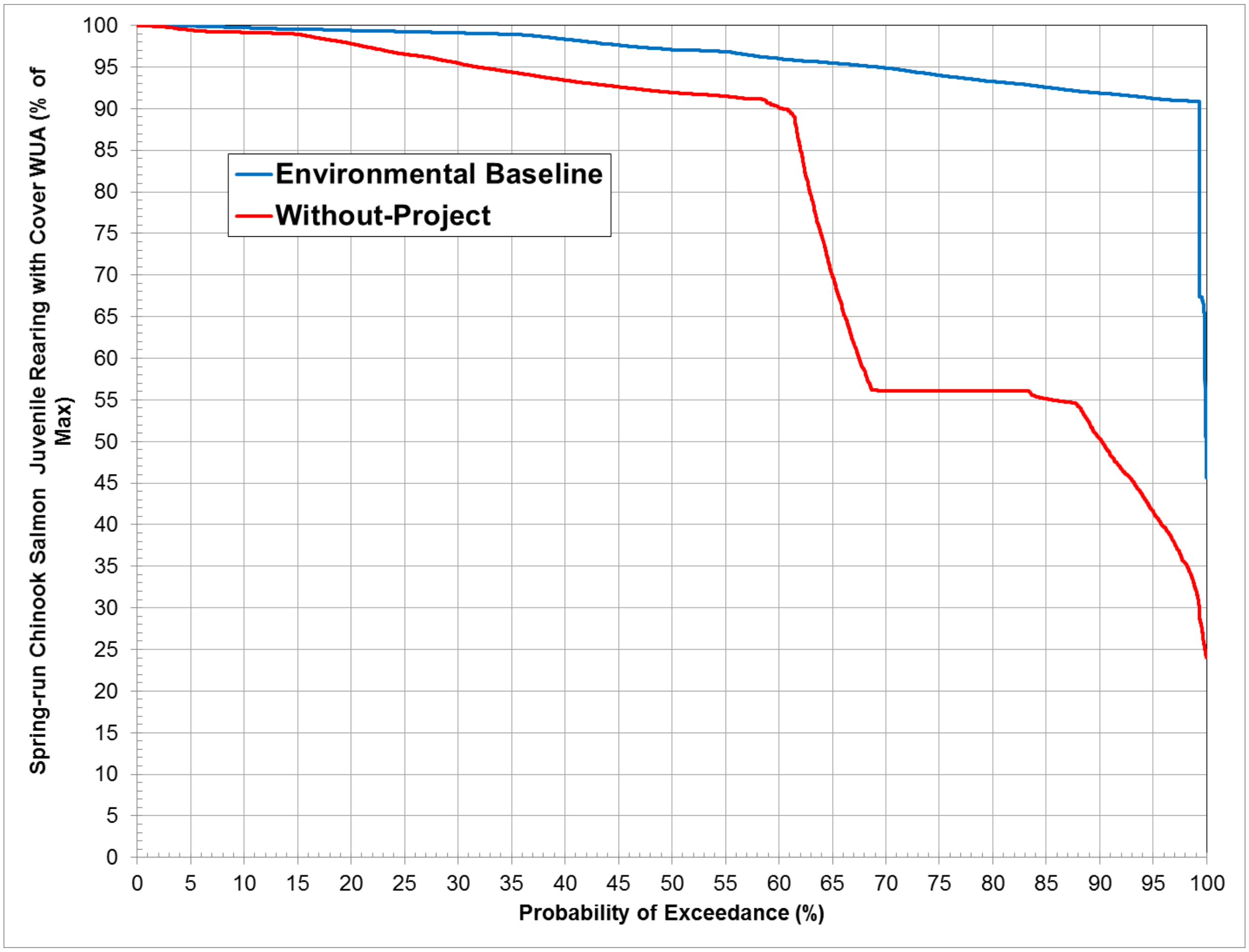

Figure 7.5-3. Spring-run Chinook salmon juvenile in-channel rearing habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

Fall-run Chinook Salmon Fry In-Channel Rearing Habitat

Table 7.5-5 displays the long-term average and average by WYT fall-run Chinook salmon fry in-channel rearing habitat (percent of maximum WUA) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average fry rearing habitat availability (WUA) in the lower Yuba River is similar under the Environmental Baseline and Without-Project scenarios (long-term average of 87.2% and 86.6% of the maximum WUA, respectively). The Environmental Baseline scenario results in 1.3 percent more maximum fry rearing habitat during wet WYs, 0.1 percent more during above normal WYs, 1.2 percent less during below normal WYs, 0.1 percent more during dry WYs, and 1.8 percent more of WUA during critical WYs. Neither the Environmental Baseline scenario nor the Without-Project scenario provides over 90 percent of maximum fry rearing WUA during any WYT, although both scenarios provide 80% or more of maximum fry rearing WUA during all WYTs.

Table 7.5-5. Long-term and WYT average fall-run Chinook salmon fry in-channel rearing WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	87.2	88.2	87.3	85.4	85.7	88.6
Without-Project	86.6	86.9	87.2	86.6	85.6	86.8
Difference	0.6	1.3	0.1	-1.2	0.1	1.8

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Habitat duration for fall-run Chinook salmon fry in-channel rearing under the Environmental Baseline and Without-Project scenarios is presented in Figure 7.5-4. The Environmental Baseline scenario provides slightly less (about 4% of maximum WUA) amounts of fry rearing habitat availability over about the upper 15 percent of the exceedance distribution, but provides slightly more (about 2-3% of maximum WUA) over the lower 80 percent of the distribution. The Environmental Baseline scenario provides substantially more habitat over about the lowest 2 percent of the distribution. The Environmental Baseline scenario achieves over 90 percent of maximum fry rearing WUA with about a 33 percent probability, while the Without-Project scenario achieves over 90 percent of maximum fry rearing WUA with about a 27 percent probability. Both scenarios provide 80 percent or more of maximum fry rearing habitat WUA over nearly the entire exceedance distributions.

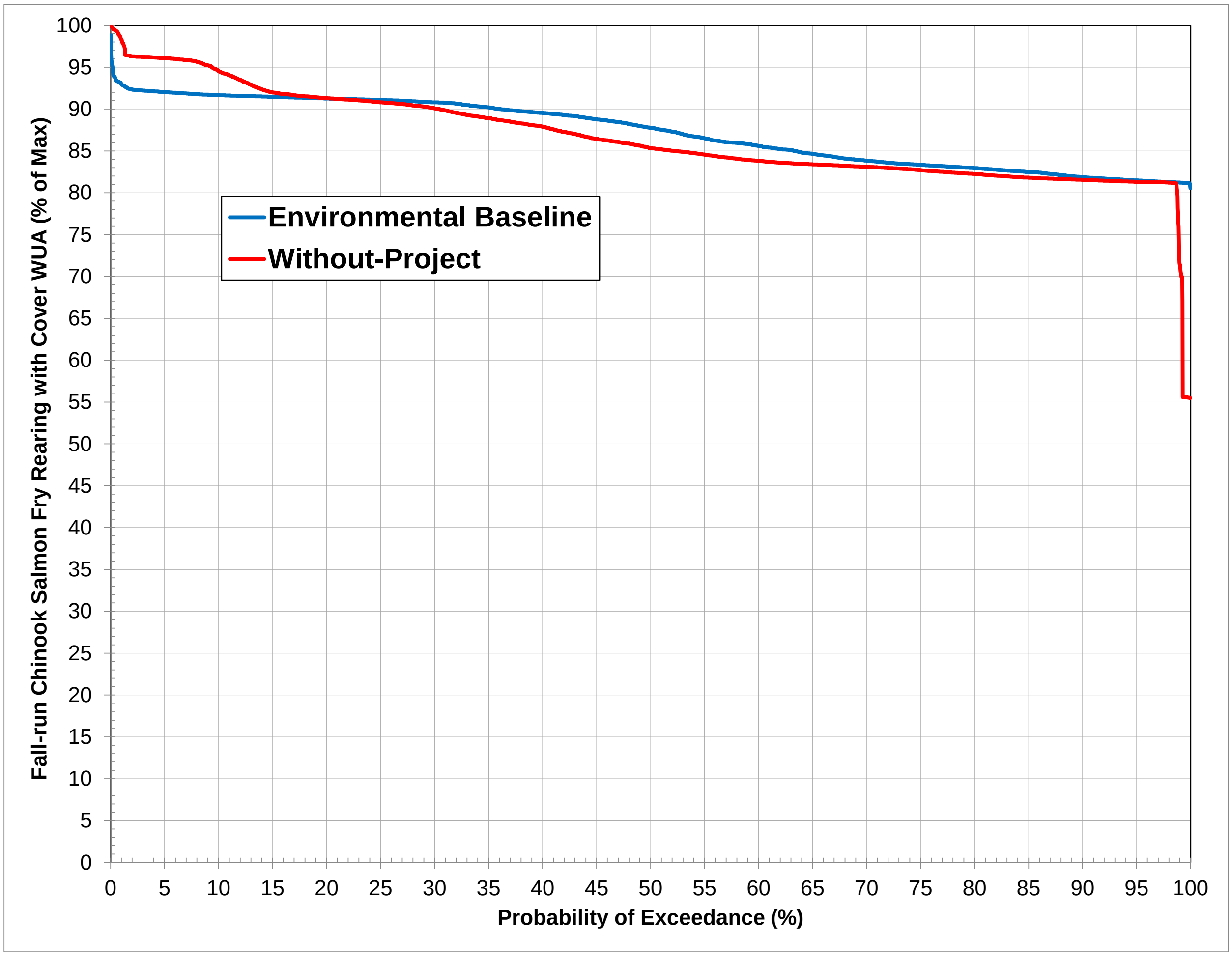

Figure 7.5-4. Fall-run Chinook salmon fry in-channel rearing habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

Fall-run Chinook Salmon Juvenile In-Channel Rearing Habitat

Table 7.5-6 displays the long-term average and average by WYT fall-run Chinook salmon juvenile in-channel rearing habitat (percent of maximum WUA) under the Environmental Baseline and Without-Project scenarios. Over the entire 41-year simulation period, long-term average juvenile rearing WUA in the lower Yuba River is similar, but slightly higher under the Environmental Baseline scenario relative to the Without-Project scenario (long-term average of 95.0% versus 93.2% of maximum WUA). The Environmental Baseline scenario also results in similar maximum juvenile rearing habitat during all WYTs, with the exception of critical WYs, when the Environmental Baseline scenario provides about 6.2 percent more maximum WUA than the Without-Project scenario. Both the Environmental Baseline and Without-Project scenarios provide over 90 percent of maximum juvenile rearing WUA during all WYTs.

Table 7.5-6. Long-term and WYT average fall-run Chinook salmon juvenile in-channel rearing WUA (percent of maximum) under the Environmental Baseline and Without-Project scenarios.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline	95.0	93.5	93.5	94.2	96.3	97.5
Without-Project	93.2	93.5	93.5	94.2	94.2	91.3
Difference	1.8	0.0	0.0	0.0	2.1	6.2

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Habitat duration for fall-run Chinook salmon juvenile in-channel rearing under the Environmental Baseline and Without-Project scenarios is presented in Figure 7.5-5. The Environmental Baseline scenario provides slightly higher amounts of juvenile rearing habitat availability over the entire exceedance distribution. The Environmental Baseline scenario achieves over 90 percent of maximum spawning WUA with a 100 percent probability, while the Without-Project scenario achieves over 90 percent of maximum juvenile rearing WUA with about a 93 percent probability.

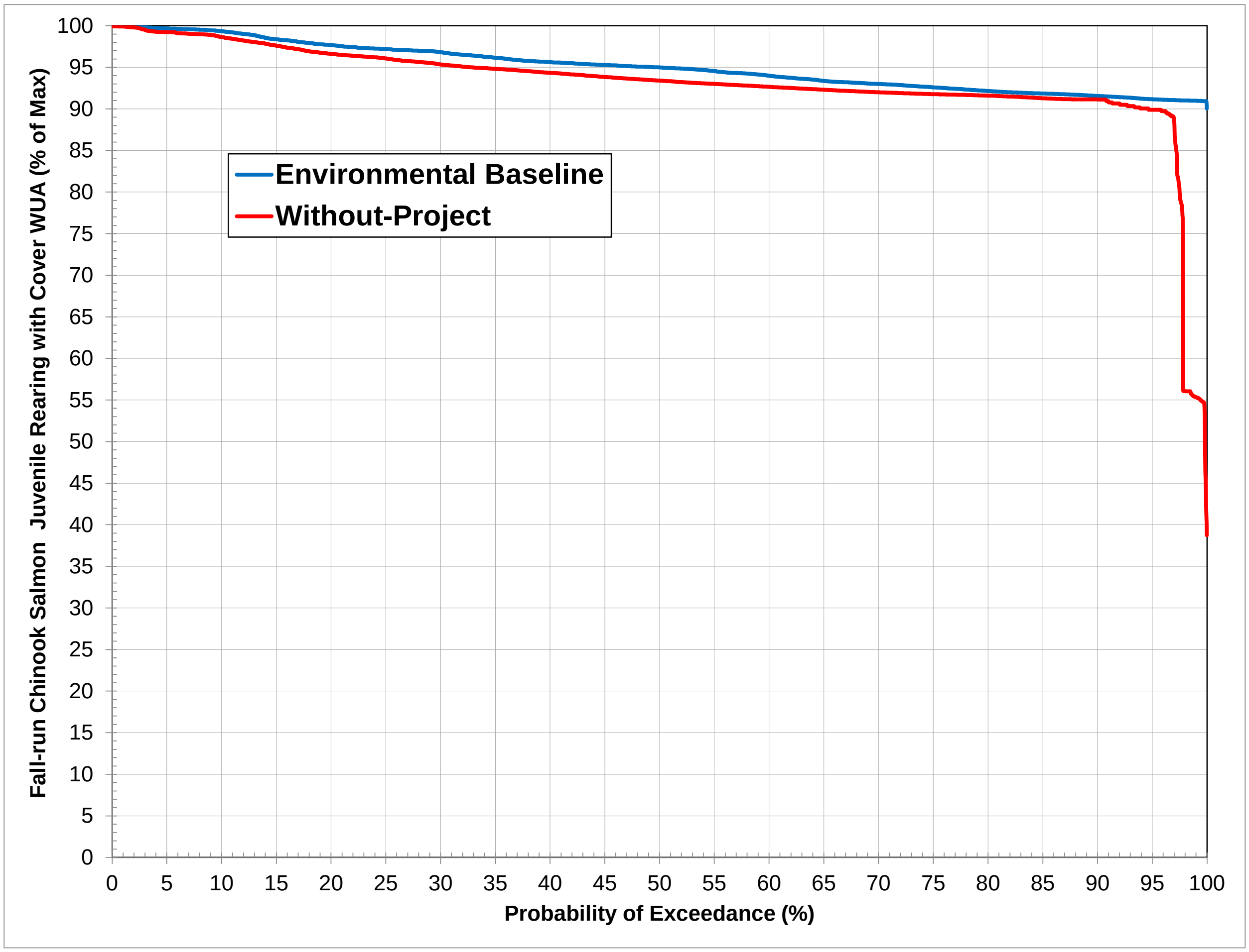

Figure 7.5-5. Fall-run Chinook salmon juvenile in-channel rearing habitat duration over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

Spring-run Chinook Salmon Fry Full-flow Rearing Habitat

Table 7.5-7 displays the full-flow analysis of the amounts (ac) of spring-run Chinook salmon fry WUA without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Results are shown for all days - for days when flows were less than or equal to 5,000 cfs and for days when flows were greater than 5,000 cfs, and the differences between the 2 scenarios over the long-term full simulation period (all years) and by water year type.

For the entire simulation period, slightly less amounts of fry rearing habitat (total WUA) are available under the Environmental Baseline compared to the Without-Project scenario. The Environmental Baseline results in 2.8, 3.1, 4.1, 4.2, and 5.4 percent less fry rearing habitat during wet, above normal, below normal, dry, and critical WYs, respectively.

Table 7.5-7. Acres of spring-run Chinook salmon fry weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation for days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs, and the differences between the two scenarios over the long-term full simulation period and by water year type.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline						
Total Days in Analysis	**3,772**	**1,380**	**552**	**644**	**460**	**736**
Days ≤ 5,000 cfs	3,317	979	506	639	458	735
Days > 5,000 cfs	455	401	46	5	2	1
Avg. WUA	**154.3**	**58.0**	**22.3**	**25.3**	**18.3**	**30.3**
WUA ≤ 5,000 cfs	131.8	38.1	20.1	25.1	18.2	30.2
WUA > 5,000 cfs	22.5	19.9	2.3	0.2	0.1	0.0
Without-Project						
Total Days in Analysis	**3,772**	**1,380**	**552**	**644**	**460**	**736**
Days ≤ 5,000 cfs	3,173	920	453	630	442	728
Days > 5,000 cfs	599	460	99	14	18	8
Avg. WUA	**160.3**	**59.7**	**23.0**	**26.4**	**19.1**	**32.0**
WUA ≤ 5,000 cfs	129.9	36.1	18.1	25.7	18.3	31.6
WUA > 5,000 cfs	30.4	23.6	4.9	0.7	0.8	0.4
Differences						
Avg. WUA	**-6.0**	**-1.7**	**-0.7**	**-1.1**	**-0.8**	**-1.7**
% change	**-3.7%**	**-2.8%**	**-3.1%**	**-4.1%**	**-4.2%**	**-5.4%**

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Figure 7.5-6 displays the full-flow analysis of the amounts (ac) of spring-run Chinook salmon fry WUA without cover under the Environmental Baseline and the Without-Project scenarios. For both scenarios, a trend was observed of the most spring-run Chinook salmon fry rearing habitat occurring during wet WYs with decreasing amounts from wet to above normal WYs, then fry habitat increasing in below normal WYs, decreasing in dry WYs, and increasing in critical WYs. For both the Environmental Baseline and Without-Project scenarios, relatively little additional fry rearing habitat is provided by days when flows were > 5,000 cfs during below normal, dry and critical WYTs.

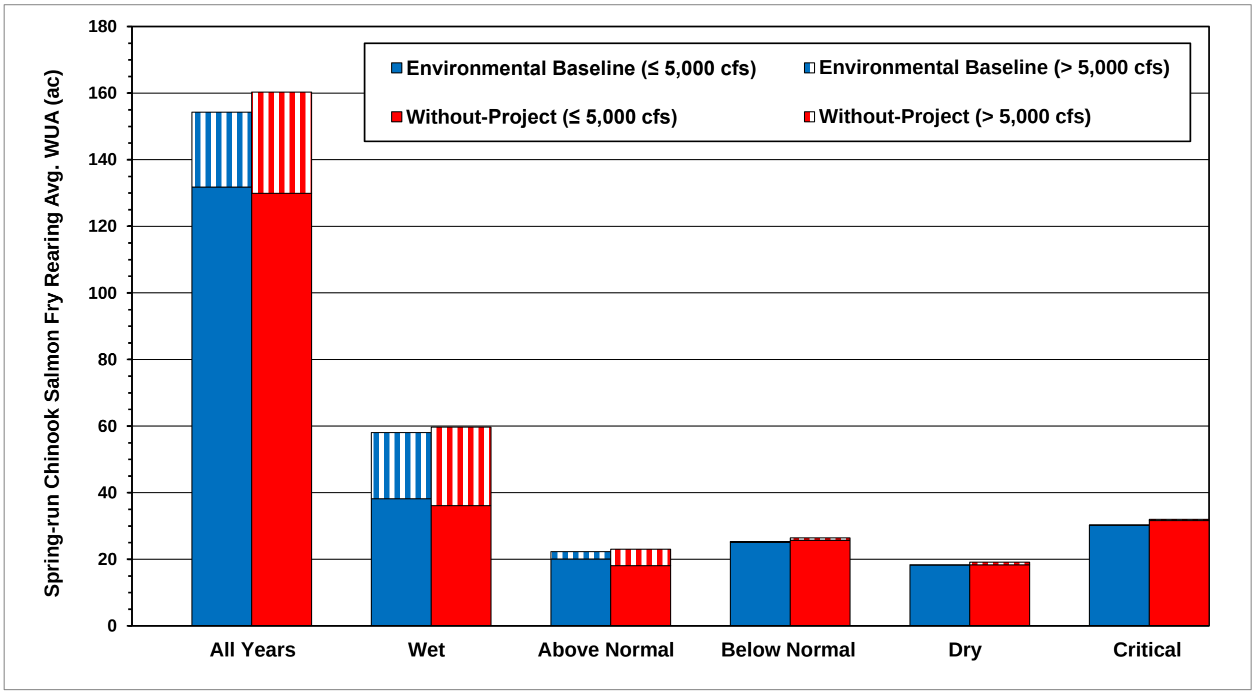

Figure 7.5-6. Comparison of the amount (acres) of spring-run Chinook salmon fry weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Shown are the amounts over the long-term full simulation period (all years) and by water year type of total habitat provided on days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs.

Spring-run Chinook Salmon Juvenile Full-flow Rearing Habitat

Table 7.5-8 displays the full-flow analysis of the amounts (ac) of spring-run Chinook salmon juvenile WUA without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. For the entire simulation period, substantially more (15.3%) amounts of juvenile rearing habitat (total WUA) are available under the Environmental Baseline compared to the Without-Project scenario. Relative to the Without-Project scenario, the Environmental Baseline results in increasing percentages of juvenile rearing habitat as WYTs progress from wet to critical. The Environmental Baseline provides 8.1, 12.8, 16.1, 22.2, and 27.8 percent more juvenile rearing habitat during wet, above normal, below normal, dry and critical WYs, respectively.

Table 7.5-8. Acres of spring-run Chinook salmon juvenile weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation for days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs, and the differences between the two scenarios over the long-term full simulation period and by water year type.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline						
Total Days in Analysis	**14,974**	**5,477**	**2,191**	**2,557**	**1,826**	**2,923**
Days ≤ 5,000 cfs	13,411	4,198	2,003	2,468	1,823	2,919
Days > 5,000 cfs	1,563	1,279	188	89	3	4
Avg. WUA	**253.3**	**92.4**	**35.9**	**42.6**	**31.4**	**50.9**
WUA ≤ 5,000 cfs	223.7	67.8	32.6	41.1	31.4	50.8
WUA > 5,000 cfs	29.6	24.6	3.3	1.5	0.0	0.1
Without-Project						
Total Days in Analysis	**14,974**	**5,477**	**2,191**	**2,557**	**1,826**	**2,923**
Days ≤ 5,000 cfs	12,756	3,945	1,772	2,349	1,791	2,899
Days > 5,000 cfs	2,218	1,532	419	208	35	24
Avg. WUA	**219.6**	**85.4**	**31.8**	**36.7**	**25.7**	**39.8**
WUA ≤ 5,000 cfs	177.6	55.6	24.4	33.0	25.1	39.4
WUA > 5,000 cfs	42.0	29.8	7.4	3.7	0.6	0.4
Differences						
Avg. WUA	**33.7**	**7.0**	**4.1**	**5.9**	**5.7**	**11.1**
% change	**15.3%**	**8.1%**	**12.8%**	**16.1%**	**22.2%**	**27.8%**

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Figure 7.5-7 displays the full-flow analysis of the amounts (ac) of spring-run Chinook salmon juvenile WUA without cover under the Environmental Baseline and the Without-Project scenarios. For both scenarios, decreasing amounts of total habitat were provided from wet to above normal WYs and dry WYs, and increasing amounts were provided for below normal and critical WYs. For both the Environmental Baseline and Without-Project scenarios, relatively little additional juvenile rearing habitat is provided by days when flows were > 5,000 cfs for below normal, dry and critical WYTs.

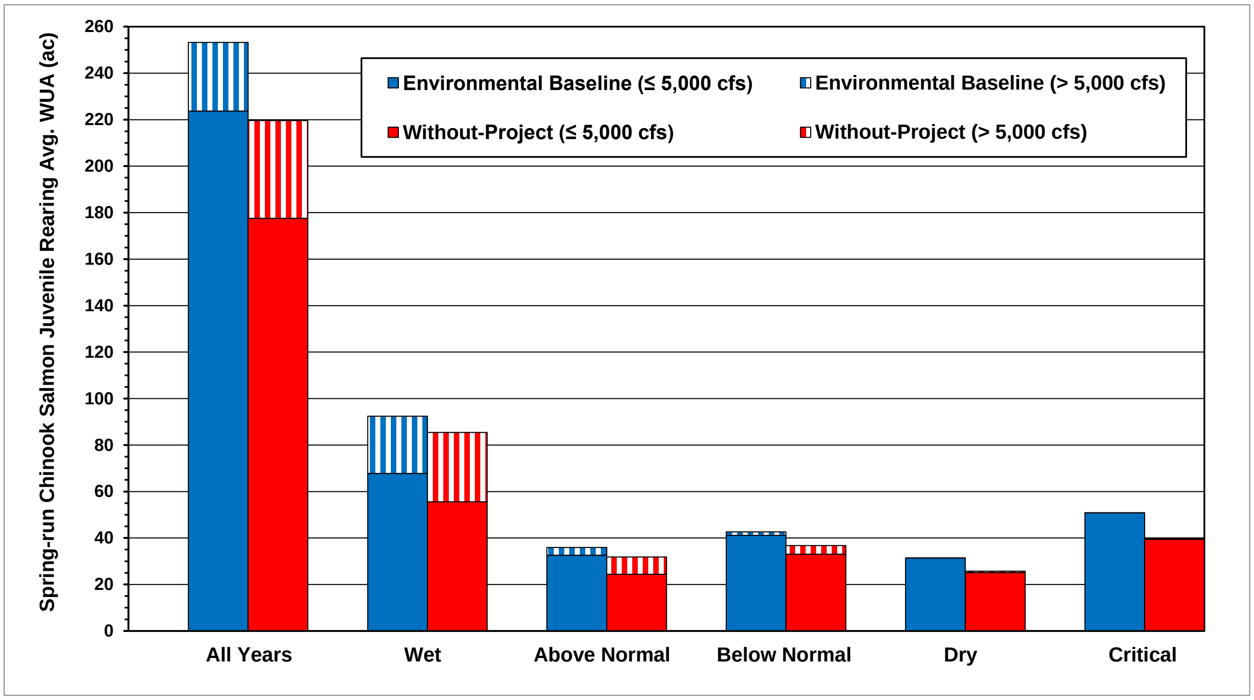

Figure 7.5-7. Comparison of the amount (acres) of spring-run Chinook salmon juvenile weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Shown are the amounts over the long-term full simulation period (all years) and by water year type of total habitat provided on days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs.

Fall-run Chinook Salmon Fry Full-flow Rearing Habitat

Table 7.5-9 displays the full-flow analysis of the amounts (ac) of fall-run Chinook salmon fry WUA without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Results are shown for all days; for days when flows were less than or equal to 5,000 cfs and for days when flows were greater than 5,000 cfs, and the differences between the two scenarios over the long-term full simulation period (all years) and by water year type.

For the entire simulation period, slightly less amounts of fry rearing habitat (total WUA) are available under the Environmental Baseline compared to the Without-Project scenario. The Environmental Baseline results in 1.1, 3.8, and 3.2 percent less fry rearing habitat during wet, above normal and below normal WYs, and 0.6 and 1.7 percent more fry rearing habitat during dry and critical WYs, respectively.

Table 7.5-9. Acres of fall-run Chinook salmon fry weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation for days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs, and the differences between the two scenarios over the long-term full simulation period and by water year type.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline						
Total Days in Analysis	**5,586**	**2,043**	**817**	**954**	**681**	**1,091**
Days ≤ 5,000 cfs	4,493	1,154	686	888	678	1,087
Days > 5,000 cfs	1,093	889	131	66	3	4
Avg. WUA	**152.0**	**59.1**	**21.5**	**24.3**	**17.4**	**29.7**
WUA ≤ 5,000 cfs	116.1	29.5	17.4	22.3	17.3	29.6
WUA > 5,000 cfs	35.9	29.6	4.1	2.0	0.1	0.1
Without-Project						
Total Days in Analysis	**5,586**	**2,043**	**817**	**954**	**681**	**1,091**
Days ≤ 5,000 cfs	4,128	1,052	546	813	649	1,068
Days > 5,000 cfs	1,458	991	271	141	32	23
Avg. WUA	**153.7**	**59.8**	**22.4**	**25.1**	**17.3**	**29.2**
WUA ≤ 5,000 cfs	105.7	26.4	13.8	20.7	16.3	28.5
WUA > 5,000 cfs	48.0	33.3	8.6	4.4	1.0	0.7
Differences						
Avg. WUA	**-1.7**	**-0.6**	**-0.9**	**-0.8**	**0.1**	**0.5**
% change	**-1.1%**	**-1.1%**	**-3.8%**	**-3.2%**	**0.6%**	**1.7%**

[1] As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
[2] Based on the WY 1970-2010 simulation period.

Figure 7.5-8 displays the full-flow analysis of the amounts (ac) of fall-run Chinook salmon fry WUA without cover under the Environmental Baseline and the Without-Project scenarios. For both scenarios, a trend was observed of the most fall-run Chinook salmon fry habitat occurring during wet WYs, with decreasing amounts from wet to above normal WYs, generally similar amounts during below normal WYs, then fry habitat decreasing for dry WYs and increasing for critical WYs. For both the Environmental Baseline and Without-Project scenarios, relatively little additional fry rearing habitat is provided by days when flows were > 5,000 cfs for dry and critical WYTs.

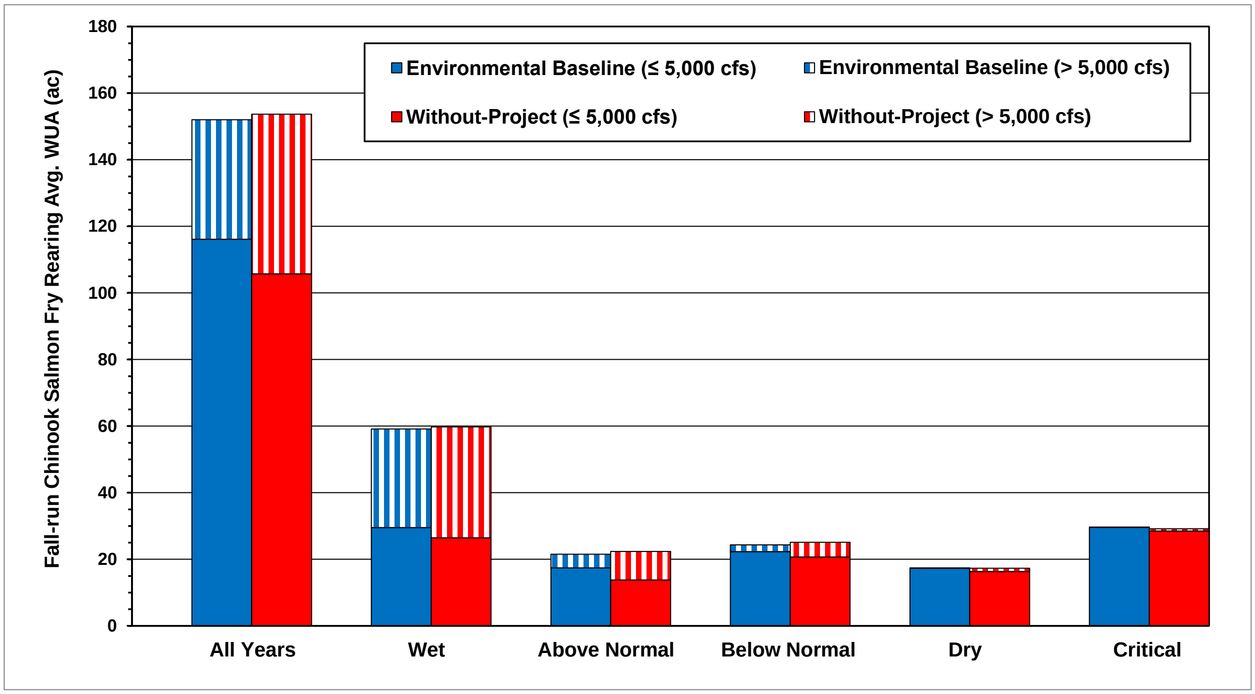

Figure 7.5-8. Comparison of the amount (acres) of fall-run Chinook salmon fry weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Shown are the amounts over the long-term full simulation period (all years) and by water year type of total habitat provided on days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs.

Fall-run Chinook Salmon Juvenile Full-flow Rearing Habitat

Table 7.5-10 displays the full-flow analysis of the amounts (ac) of fall-run Chinook salmon juvenile WUA without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. For the entire simulation period, slightly more (0.2%) amounts of juvenile rearing habitat (total WUA) are available under the Environmental Baseline compared to the Without-Project scenario. Relative to the Without-Project scenario, the Environmental Baseline results in decreasing percentages of juvenile rearing habitat during wet, above normal and below normal WYs. The Environmental Baseline provides 4.1 and 8.1 percent more juvenile rearing habitat during dry and critical WYs, respectively.

Table 7.5-10. Acres of fall-run Chinook salmon juvenile weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation for days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs, and the differences between the two scenarios over the long-term full simulation period and by water year type.

Scenario	Long-term Full Simulation Period[2]	WYTs[1]				
		Wet	Above Normal	Below Normal	Dry	Critical
Environmental Baseline						
Total Days in Analysis	**6,816**	**2,493**	**997**	**1,164**	**831**	**1,331**
Days ≤ 5,000 cfs	5,474	1,420	821	1,078	828	1,327
Days > 5,000 cfs	1,342	1,073	176	86	3	4
Avg. WUA	**246.4**	**91.5**	**33.8**	**40.2**	**30.3**	**50.7**
WUA ≤ 5,000 cfs	191.2	46.5	27.0	36.9	30.2	50.5
WUA > 5,000 cfs	55.2	45.0	6.8	3.3	0.1	0.2
Without-Project						
Total Days in Analysis	**6,816**	**2,493**	**997**	**1,164**	**831**	**1,331**
Days ≤ 5,000 cfs	4,925	1,230	618	963	805	1,309
Days > 5,000 cfs	1,891	1,263	379	201	26	22
Avg. WUA	**246.0**	**94.1**	**35.1**	**40.9**	**29.1**	**46.8**
WUA ≤ 5,000 cfs	168.4	40.7	20.4	33.1	28.1	46.0
WUA > 5,000 cfs	77.7	53.3	14.6	7.8	1.0	0.9
Differences						
Avg. WUA	**0.4**	**-2.6**	**-1.3**	**-0.7**	**1.2**	**3.8**
% change	**0.2%**	**-2.8%**	**-3.6%**	**-1.8%**	**4.1%**	**8.1%**

1 As defined by the Yuba River Index (YRI) WY Hydrologic Classification.
2 Based on the WY 1970-2010 simulation period.

Figure 7.5-9 displays the full-flow analysis of the amounts (ac) of fall-run Chinook salmon juvenile WUA without cover under the Environmental Baseline and the Without-Project scenarios. For both scenarios, decreasing amounts of total habitat were provided from wet to above normal WYs, following by slightly increasing amounts during below normal WYs, decreasing amounts during dry WYs, then increasing amounts were provided for critical WYs. For both the Environmental Baseline and Without-Project scenarios, relatively little additional juvenile rearing habitat is provided by days when flows were > 5,000 cfs for dry and critical WYTs.

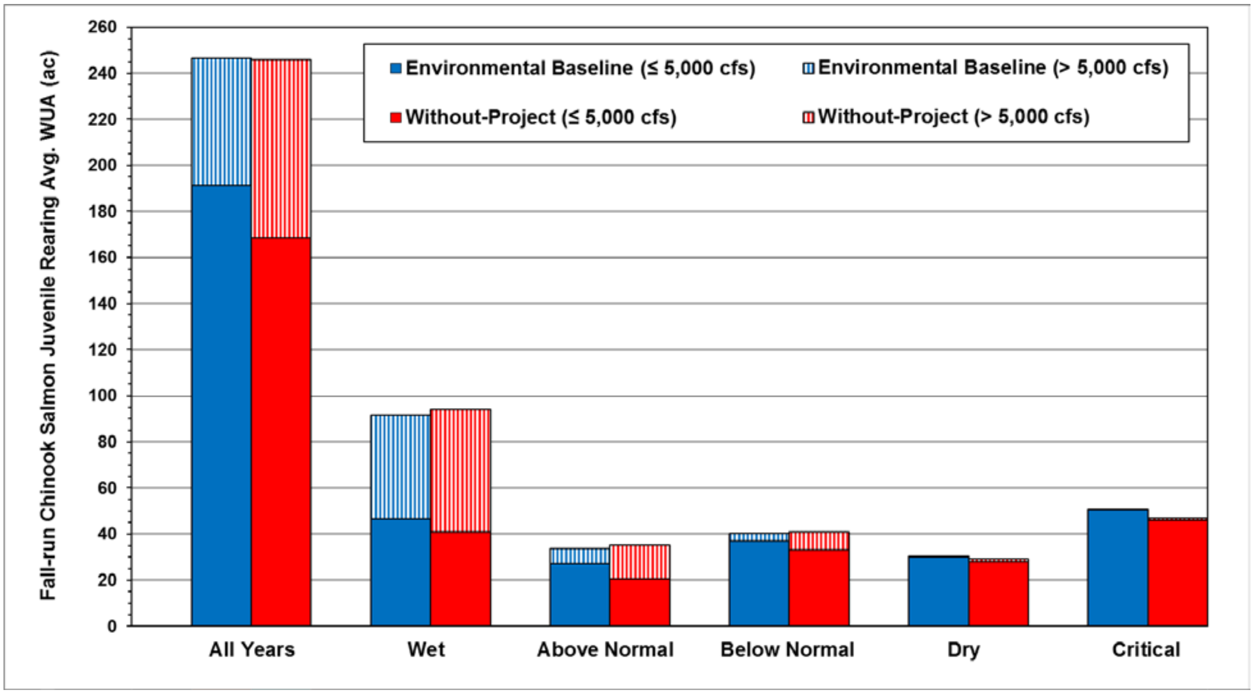

Figure 7.5-9. Comparison of the amount (acres) of fall-run Chinook salmon juvenile weighted usable area (WUA) without cover under the Environmental Baseline and the Without-Project scenarios over the 41-year period of evaluation. Shown are the amounts over the long-term full simulation period (all years) and by water year type of total habitat provided on days when flows were ≤ 5,000 cfs and for days when flows were > 5,000 cfs.

7.5.4.1.2 Complex Channels and Floodplain Habitats

The following discussions related to existing physical habitat conditions pertaining to juvenile Chinook salmon in the lower Yuba River is summarized from Section 5.0 of the Applicant-Prepared Draft BA prepared for the Proposed Action.

The physical structure of rivers plays a significant role in determining the suitability of aquatic habitats for juvenile salmonids, as well as for other organisms upon which salmonids depend for food. These structural elements are created through complex interactions among natural geomorphic features, the power of flowing water, sediment delivery and movement, and riparian vegetation, which provides bank stability and inputs of large woody debris (Spence et al. 1996). The geomorphic conditions caused by hydraulic and dredge mining since the mid-1800s, and the construction of Englebright Dam, which affects the transport of nutrients, fine and coarse sediments and, to a lesser degree, woody material from upstream sources to the lower river, continue to limit habitat complexity and diversity in the lower Yuba River.

LWM creates both micro- and macro-habitat heterogeneity by forming pools, back eddies and side channels and by creating channel sinuosity and hydraulic complexity. This habitat complexity provides juvenile salmonids numerous refugia from predators and water velocity, and provides efficient locations from which to feed. LWM also functions to retain coarse sediments and organic matter in addition to providing substrate for numerous aquatic invertebrates (Spence et al. 1996).

In the lower Yuba River, mature riparian vegetation is scattered intermittently, leaving much of the banks devoid of LWM and unshaded – affecting components that are essential to the health and survival of the freshwater lifestages of salmonids (NMFS 2002a). Although the ability of the lower Yuba River to support riparian vegetation has been substantially reduced by the historic impacts from mining activities, the dynamic nature of the river channel results in periodic creation of high-value shaded riverine aquatic (SRA) cover for fish and wildlife (Beak Consultants, Inc. 1989).

Other important components of habitat structure at the micro-scale include large boulders, coarse substrate, undercut banks and overhanging vegetation. These habitat elements offer juvenile salmonids concealment from predators, shelter from fast current, feeding stations and nutrient inputs. At the macro-scale, streams and rivers with high channel sinuosity, multiple channels and sloughs, beaver impoundments or backwaters typically provide high-quality rearing and refugia habitats (Spence et al. 1996). The lower Yuba River can be generally characterized as lacking an abundance of such features.

7.5.4.1.3 Riparian Habitat and Instream Cover

Riparian Vegetation

SRA cover generally occurs in the lower Yuba River as scattered, short strips of low-growing woody species (e.g., Salix sp.) adjacent to the shoreline. Beak Consultants, Inc. (1989) reported that the most extensive and continuous segments of SRA cover occur along bars where [then] recent channel migrations or avulsions had cut new channels through relatively large, dense stands of riparian vegetation. SRA cover consists of instream object cover and overhanging cover. Instream object cover provides structure, which promotes hydraulic complexity, diversity and microhabitats for juvenile salmonids, as well as escape cover from predators. The extent and quality of suitable rearing habitat and cover, including SRA, generally has a strong effect on juvenile salmonid production in rivers (Healey 1991 as cited in CALFED and YCWA 2005).

Since completion of New Bullards Bar Reservoir, the riparian community (in the lower Yuba River) has expanded under summer and fall streamflow conditions that have generally been higher than those that previously occurred (SWRCB 2003). However, the riparian habitat is not pristine. NMFS (2005) reports:

The deposition of hydraulic mining debris, subsequent dredge mining, and loss/confinement of the active river corridor and floodplain of the lower Yuba River which started in the mid-1800's and continues to a lesser extent today, has eliminated much of the riparian vegetation along the lower Yuba River. In addition, the large quantities of cobble and gravel that remained generally provided poor conditions for re-establishment and growth of riparian vegetation. Construction of Englebright Dam also inhibited regeneration of riparian vegetation by preventing the transport of any new fine sediment, woody debris, and nutrients from upstream sources to the lower river. Subsequently, mature riparian vegetation is sparse and intermittent along the lower Yuba River, leaving much of the bank areas unshaded and lacking in large woody debris. This loss of riparian cover has greatly diminished the value of the habitat in this area.

Where hydrologic conditions are supportive, riparian and wetland vegetative communities are found adjacent to the lower Yuba River and on the river sides of retaining levees. These communities are dynamic and have changed over the years as the river meanders. The plant communities along the river are a combination of remnant Central Valley riparian forests, foothill oak/pine woodlands, agricultural grasslands, and orchards (Beak Consultants, Inc. 1989).

According to CALFED and YCWA (2005), the lower Yuba River, especially in the vicinity of Daguerre Point Dam and the Yuba Goldfields, is largely devoid of sufficient riparian vegetation to derive the benefits (to anadromous salmonids) discussed above (Figure 7.5-10).

In 2012, YCWA conducted a riparian habitat study in the Yuba River from Englebright Dam to the confluence with the Feather River (see Technical Memorandum 6-2, *Riparian Habitat Downstream of Englebright Dam*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA). Field efforts included descriptive observations of woody and riparian vegetation, cottonwood inventory and coring, and a large woody material (LWM) survey. The study was performed by establishing eight LWM study sites and seven riparian habitat study sites. One LWM study site was established within each of eight distinct reaches (i.e., Marysville, Hallwood, Daguerre Point Dam, Dry Creek, Parks Bar, Timbuctoo Bend, Narrows, and Englebright Dam). Riparian habitat sites were established in the same locations as the LWM study sites, with the exception of the Marysville study site. Riparian information regarding the Marysville Reach was developed, but no analysis was performed because of backwater effects of the Feather River.

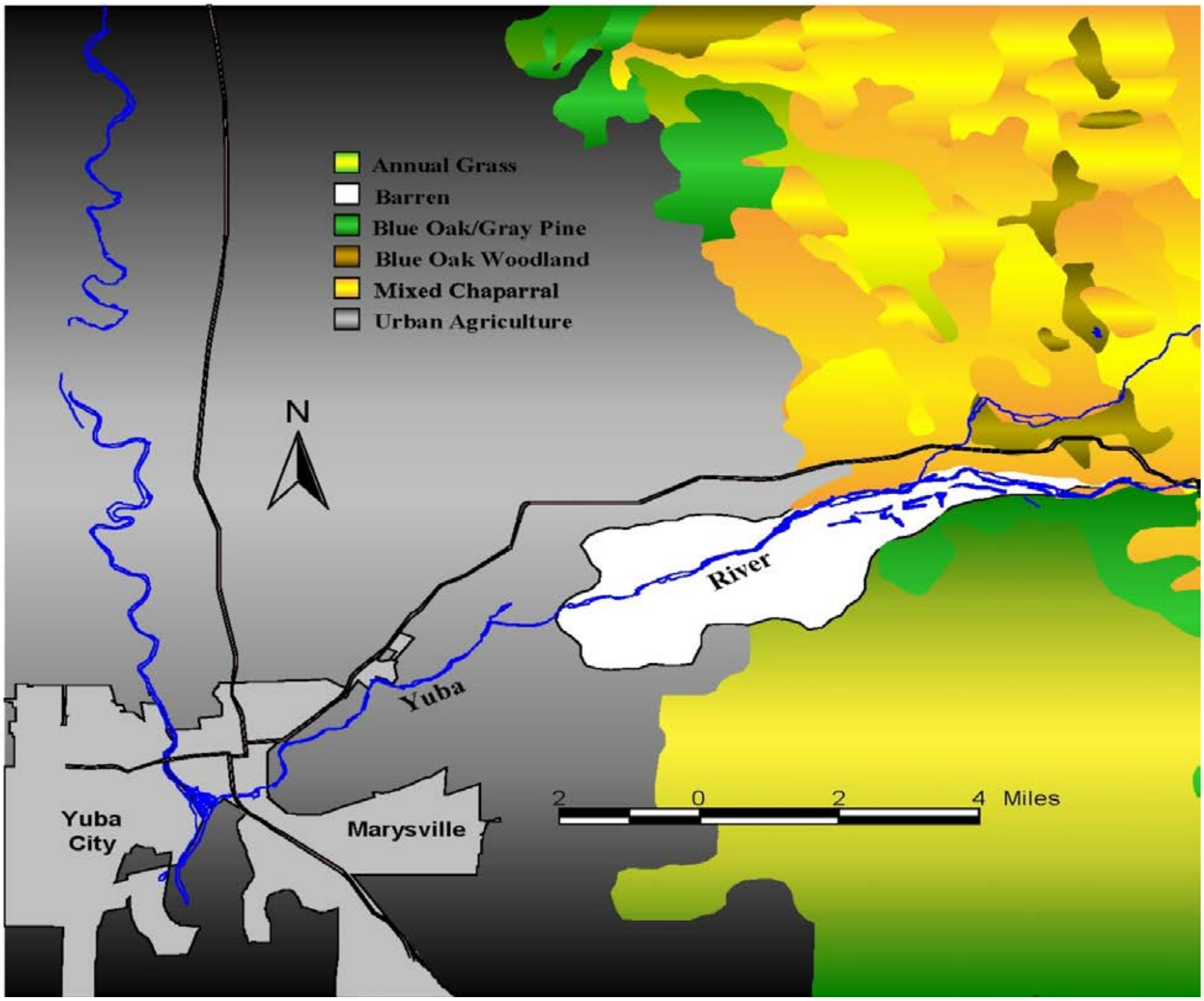

Figure 7.5-10. Vegetation communities in the lower Yuba River vicinity.
Source: CALFED and YCWA 2005

YCWA found that cottonwoods are one of the most abundant woody species in the lower Yuba River, and the most likely source of locally-derived large instream woody material due to rapid growth rates and size of individual stems commonly exceeding 2 ft in diameter and 50 ft in length. Cottonwoods exist in all lifestages including as mature trees, recruits, or saplings, and as seedlings. Cottonwoods are more abundant in downstream areas of the study area relative to upstream. Cottonwoods are distributed laterally across the valley floor. Of the estimated 18,540 cottonwood individuals/stands, 12 percent are within the bankfull channel (flows of 5,000 cfs or less), and 39 percent are within the floodway inundation zone (flows between 5,000 and 21,100 cfs). However, recruitment patterns of cottonwood have not been analyzed with respect to time or with any more detail regarding channel location (see Technical Memorandum 6-2, *Riparian Habitat Downstream of Englebright Dam*).

A total of 97 cottonwood trees were cored to estimate age. Age estimates ranged from 11 to 87 years. The cottonwood tree age analysis resulted in age estimates that place the year of establishment for trees in a range of years from ±7 to 16 years, which is too wide to allow for linking the establishment of trees to any year's specific hydrologic conditions (YCWA 2013).

Instream Woody Material

Instream woody material provides escape cover and relief from high current velocities for juvenile salmonids and other fishes. LWM also contributes to the contribution of invertebrate food sources, and micro-habitat complexity for juvenile salmonids (NMFS 2007). Snorkeling observations in the lower Yuba River have indicated that juvenile Chinook salmon had a strong preference for near-shore habitats with instream woody material (Jones & Stokes 1992).

There is currently a lack of consensus regarding the amount of instream woody material occurring in the lower Yuba River (USACE 2012b). It has been suggested (CALFED and YCWA 2005) that the presence of Englebright Dam has resulted in decreased recruitment of LWM to the lower Yuba River, although no surveys or studies were cited to support these statements. Some woody material may not reach the lower Yuba River due to collecting on the shoreline and sinking in Englebright Reservoir (USACE 2012b). However, Englebright Dam does not functionally block woody material from reaching the lower Yuba River because there is no woody material removal program implemented for Englebright Reservoir, and accumulated woody material therefore spills over the dam during uncontrolled flood events (R. Olsen, USACE, pers. comm. 2011, as cited in USACE 2012b).

About 8.7-mi of the lower Yuba River downstream of Englebright Dam, distributed among study sites per reach, were surveyed and evaluated for pieces of wood (YCWA 2013). The number of pieces of wood was relatively similar above and below Daguerre Point Dam (i.e., about 5,100 and 5,750 pieces, respectively). Woody material was generally found in bands of willow (Salix sp.) shrubs near the wetted edge, dispersed across open cobble bars, and stranded above normal high-flow indicators. Most of the woody material was diffuse and located on floodplains and high floodplains, with only about a quarter of the material in heavy concentrations (YCWA 2013).

Most (77-96%) pieces of wood found in each reach were smaller than 25 ft in length and smaller than 24 in in diameter, which is the definition of LWM used in Technical Memorandum 6-2, *Riparian Habitat Downstream of Englebright Dam*. These pieces would be typically floated by flood flows and trapped within willows and alders above the 21,100 cfs line, which is defined as the flow delineating the floodway boundary (YCWA 2013).

Instream woody material was not evenly distributed throughout the reaches. For the smaller size classes (i.e., shorter than 50 ft, less than 24 in in diameter), the greatest abundance of pieces was found in the Hallwood or Daguerre Point Dam reaches, with lower abundances above and below these reaches (YCWA 2013).

The largest size classes of LWM (i.e., longer than 50 ft and greater than 24 in in diameter) were rare or uncommon (i.e., fewer than 20 pieces total) with no discernible distribution. Pieces of this larger size class were counted as "key pieces", as were any pieces exceeding 25 in in diameter and 25 ft in length and showing any morphological influence (e.g., trapping sediment or altering flow patterns). A total of 15 key pieces of LWM were found in all study sites, including 6 in the Marysville study site. Few of the key pieces were found in the active channel or exhibiting channel forming processes (YCWA 2013).

7.5.4.1.4 Natural River Morphology and Function

According to NMFS (2014b), attenuated peak flows and controlled flow regimes have altered the lower Yuba River's geomorphology and have affected the natural meandering of the river downstream of Englebright Dam. However, alteration of river morphology and function has been very substantively affected by hydraulic mining legacy and confinement of the river channel from dredger tailings and gravel berm deposits.

As reported by RMT (2013a), preliminary evaluation of available data collected to date related to Yuba River fluvial geomorphology indicates that the Yuba River downstream of Englebright Dam has complex river morphological characteristics. Evaluation of the MUs in the Yuba River as part of the spatial structure analyses indicates that, in general, the sequence and organization of MUs is non-random, indicating that the channel has been self-sustaining of sufficient duration to establish an ordered spatial structure (RMT 2013a).

The Yuba River downstream of Englebright Dam exhibits lateral variability in its form-process associations (RMT 2013a). In the Yuba River, MU organization highlights the complexity of the channel geomorphology, as well as the complex and diverse suite of MUs. The complexity in the landforms creates diversity in the flow hydraulics which, in turn, contributes to a diversity of habitat types available for all riverine lifestages of anadromous salmonids, including juvenile rearing and downstream movement, in the Yuba River downstream of Englebright Dam (RMT 2013a).

7.5.4.1.5 Floodplain Habitat

NMFS (2014b) listed the loss of floodplain habitat in the lower Yuba River as one of the key stressors affecting anadromous salmonids (including spring-run Chinook salmon). NMFS (2009b) stated:

> Historically, the Yuba River was connected to vast floodplains and included a complex network of channels, backwaters and woody material. The legacy of hydraulic and dredger mining is still evident on the lower Yuba River where, for much of the river, dredger piles confine the river to an unnaturally narrow channel. The consequences of this unusual and artificial geomorphic condition include reduced floodplain and riparian habitat and resultant limitations in fish habitat, particularly for rearing juvenile salmonids.

NMFS (2014b) further stated that in the lower Yuba River, controlled flows and decreases in peak flows has reduced the frequency of floodplain inundation resulting in a separation of the river channel from its natural floodplain. Within the Yuba Goldfields area (RM 8–14), confinement of the river by massive deposits of cobble and gravel derived from hydraulic and dredge mining activities resulted in a relatively simple river corridor dominated by a single main channel and large cobble-dominated bars, with little riparian and floodplain habitat (DWR and PG&E 2010).

Loss of off-channel habitats such as floodplains, riparian, and wetland habitats has substantially reduced the productive capacity of the Central Valley for many native fish and wildlife species, and evidence is growing that such habitats were once of major importance for the growth and survival of juvenile salmon (Moyle 2002). Observations on the lower Yuba River indicate that remnant side channels and associated riparian vegetation play a similar role by providing flood refugia, protection from predators, and abundant food for young salmonids and other native fishes. These habitats also promote extended rearing and expression of the stream-type rearing characteristic of spring-run Chinook salmon (DWR and PG&E 2010).

As reported by RMT (2013a), despite some flow regulation, the channel and floodplain in the lower Yuba River are highly connected, with floods spilling out onto the floodplain more frequently than commonly occurs for unregulated semiarid rivers. Although some locations exhibit overbank flow below 5,000 cfs while others require somewhat more than that, 5,000 cfs generally represents bankfull flow in the lower Yuba River. In any given year, there is an 82 percent chance the river will spill out of its bankfull channel and a 40 percent chance that the floodway will be fully inundated. These results demonstrate that floodplain inundation occurs with a relatively high frequency in the lower Yuba River compared to other Central Valley streams which, in turn, contributes to a diversity in habitats available for anadromous salmonids (RMT 2013a).

RMT (2013a) conducted a flood-frequency analysis of the annual peak discharges recorded at the USGS stream gage near Marysville (11421000) that showed average annual return periods of 1.25 years and 2.5 years for the bankfull and flood discharges, respectively. Bankfull flows for similar rivers are generally assumed to occur with return periods of 1.5-2 years. The fact that the lower Yuba River is less than this implies that the channel is naturally undersized relative to generalized expectations and flows spill into the floodplain at a more frequent rate (RMT 2013a).

7.5.4.1.6 Fry and Juvenile Salmonid Stranding

Juvenile salmonids and other aquatic organisms can become stranded on gravel bars or isolated in off-channel habitats (e.g., side channels, backwaters) as a result of flow fluctuations in rivers. Bar stranding or 'beaching' is the type of stranding that occurs on low-gradient bars in which fish are exposed to the air or isolated in tiny pockets of standing water that may be present between larger particles or below the substrate on the bar surface. Off-channel stranding or 'isolation' is the type of stranding that occurs in backwaters, secondary channels, and other floodplain habitats that become disconnected from the main river by receding flows.

Juvenile salmonids are more vulnerable to stranding than adults. Salmonid fry that have just absorbed their yolk sacs and have recently emerged from the gravel are by far the most vulnerable, because they are poor swimmers and settle along shallow margins of rivers (Phinney 1974, Woodin 1984, as cited in WDF 1992). Vulnerability to stranding reportedly drops substantially for Chinook salmon once they reach a size of 50 to 60 mm in length (WDF 1992).

Larger juveniles are more likely to inhabit pools, glides, overhanging banks, and mid-channel substrates, where they are less vulnerable to stranding (WDF 1992). While stranding has been widely documented in regulated rivers, stranding mortality is difficult or impossible to accurately estimate (WDF 1992).

Fry and Juvenile Stranding Surveys

Field observations in the lower Yuba River indicate that Chinook salmon are most susceptible to bar stranding during the post-emergent fry stage (30-40 mm in length). Newly emerged fry appear to be particularly vulnerable to bar stranding because of their preference for shallow, low-velocity stream margins and use of cobble substrate as cover.

No relationship was observed between ramping rates in the lower Yuba River and the incidence of fry stranding on low gradient bars within the observed range of ramping rates (flow reductions of 100 to 200 cfs per hour at Narrows 2 Powerhouse) (B. Mitchell, ICF/JSA, pers. comm. 2012). These ramping rates corresponded to changes in stage of 0.4 to 1 in per hour at the study sites, which is well within the rates of stage change considered to be protective. A rate of 1 in per hour is generally within the range of natural rates of stage reductions in unregulated rivers (Olson and Metzgar 1987, as cited in YCWA 2003), and Higgins and Bradford (1996, as cited in Sommer et al. 2005) state that maximum recommended stage reduction levels for gravel bars of regulated rivers are typically 2.5–5 cm (1-2 in) per hour (Sommer et al. 2005). Nevertheless, some stranding of post-emergent Chinook salmon fry has been observed even at half this rate, suggesting that young fry have limited ability to detect or respond to receding water levels, regardless of the ramping rate. Similarly, surveys conducted by YCWA indicate that the small size and strong association of young fry with substrates limit their ability to detect or respond to receding water levels, regardless of ramping rate. This finding is supported by Woodin (1984, as cited in WDF 1992), who determined that any daytime ramping stranded Chinook salmon fry in Washington’s Skagit River, and by Beck Associates (1989, as cited in WDF 1992), who found no correlation between ramping rate and steelhead fry stranding during the summer in the Skagit River (WDF 1992).

Based on the densities and sizes of juvenile salmon observed in the lower Yuba River study sites, all or most of the fish visible to divers in shallow, nearshore areas were able to avoid stranding during day and nighttime flow reductions. These fish were generally greater than 40 mm in length and were observed maintaining position and actively feeding above the substrate. Field observations indicate that the potential for bar stranding of juvenile salmon decreases through the spring as the salmon’s body sizes increase.

The relatively low susceptibility of juvenile salmonids to stranding in the lower Yuba River is consistent with juvenile salmonid stranding studies in the Yolo Bypass and elsewhere. Sommer et al. (2005) found that juvenile-sized Chinook salmon did not appear to be particularly prone to stranding mortality as floodwaters receded in the Yolo Bypass. RST catch data in Yolo Bypass also did not indicate that stranding had a major influence on patterns of juvenile emigration (Sommer et al. 2005). As reported by Sommer et al. (2005), Higgins and Bradford (1996, as cited in Sommer et al. 2005) and Bradford (1997, as cited in Sommer et al. 2005), juvenile salmonids are relatively mobile and most juveniles avoided being stranded during moderate rates of stage change.

As with bar stranding, the potential for off-channel stranding (isolation) is highest for Chinook salmon fry following uncontrolled peak runoff or spills in winter and early spring (December-March). Field surveys conducted by YCWA of potential off-channel stranding sites in the lower Yuba River before and after lower Yuba River flow reductions in early April 2007, early June 2008, and late June 2010 indicate that off-channel stranding is a site-specific phenomenon that depends on the complex interaction of hydrology, site conditions (stage-discharge relationships and channel and bar morphology), and species life history, habitat use, and behavior. Consequently, the potential for off-channel stranding for a given flow reduction varies by site, reach, and season.

Benefits of Off-Channel Rearing Areas

While floodplain and off-channel habitats are sources of stranding mortality, studies have documented that there also are significant growth and potential survival benefits associated with floodplain and off-channel habitats that are used by Chinook salmon in the Central Valley (Limm and Marchetti 2009; Jeffres et al. 2008; Sommer et al. 2001, 2005). Consequently, floodplain and other off-channel habitats had important refuge and rearing functions for native fishes, and likely contributed substantially to the productive capacity and life history diversity of Chinook salmon and other fish species in the Sacramento River system before large-scale channel modifications, levee construction, and agricultural conversion of floodplains (Lindley et al. 2009; Yoshiyama et al. 1998). Sommer et al. (2005) found that stranding losses in floodplain habitats of the Yolo Bypass might cause excessive mortality in some years, but the risks may be offset by increased rearing habitat and food resources in other years (Sommer et al. 2005).

Sommer et al. (2005) found that the majority of fish on the Yolo Bypass left with the receding floodwaters. During each survey year, Sommer et al. (2005) observed obvious peaks in RST catch associated with flow events, and additional prominent peaks associated with drainage. In other words, some individuals emigrated from the floodplain in direct association with flow, while others remained as long as possible to rear on the floodplain. In a review of the fish ecology in floodplain rivers, Welcomme (1979, as cited in Sommer et al. 2005) noted that the majority of fish emigrate from floodplain habitat during drainage.

Field observations in the lower Yuba River indicate that the occurrence of off-channel isolation is relatively insensitive to flow ramping rates and is largely a function of the magnitudes of winter and spring flows (which determine the accessibility of fry to off-channel areas), site conditions (particularly channel and floodplain morphology), and seasonal abundance, habitat use, and emigration timing of juvenile salmon (and steelhead). The fates of juvenile salmonids in isolated off-channel sites can also vary depending on the suitability of habitat conditions in these sites through the summer and fall.

WDF (1992) reported that many isolated juveniles may die from predation, temperature shock, and oxygen depletion, and that the juveniles that survived being stranded in off-channel habitats may have been in relatively poorer conditions. However, long-term monitoring of off-channel sites in the lower Yuba River during summer and fall 2008 confirmed that some of these sites can support juvenile salmonids for long periods of time and provide favorable rearing conditions based on observed growth and survival (B. Mitchell, ICF/JSA, pers. comm. 2012). Following high winter flows, fish stranding surveys indicate that the quality of off-channel habitat varies as a function of water depth, cover availability, water quality, and the presence or absence of predators. Long-term monitoring of several disconnected groundwater-fed channels in 2008 confirmed that some sites can support high densities and growth of juvenile salmon and other native fish species through the spring and summer. Habitat conditions that appear to be important for extended off-channel rearing are the presence of groundwater flow, sufficient water depths, riparian and aquatic vegetation, and the absence of large predatory fish (e.g., pikeminnow).

Effects of Project Operations under the Environmental Baseline

Maximum authorized limits on controlled flow fluctuations and ramping rates are specified in RD-1644 and YCWA's existing FERC license. (RD-1644, pp. 178-179, term 3; YCWA's FERC license, art. 33(c), fn. B.) These limitations on the controlled operations of the Narrows 2 Powerhouse are intended to protect anadromous salmonids, including Chinook salmon. RD-1644 specifies a maximum rate of change or ramping rate of 500 cfs per hour in the lower Yuba River (RD-1644, p. 178, term 3.a.) YCWA's standard operations objective at Narrows 2 has been to reduce flows at a target ramping rate of 100 cfs per hour during normal operations, and at a target ramping rate of 200 cfs per hour when passing storm flows, whenever feasible. The ramping rate changes (i.e., 100 to 200 cfs per hour) associated with YCWA's operations are similar to ramping rates specified for other Central Valley rivers, which generally correspond to recommendations described in WDF (1992) that suggest reductions in river stage of 1-2 in per hour are protective.

Controlled flow reductions due to Project operations in the fall are completed by early September, and flows then are maintained at relatively stable levels through the fall to provide stable spawning flows for spring-run and fall-run Chinook salmon and to protect redds from dewatering. These Project operations also act to minimize stranding of Chinook salmon fry, which begin to emerge from their redds during November. Thereafter, lower Yuba River flows during the winter and spring often are uncontrolled, and stranding of Chinook salmon (and steelhead) fry can occur naturally during periods of uncontrolled runoff and spills, either through uncontrolled flow fluctuations or as runoff subsides and flows drop to controllable levels.

Following the winter period of uncontrolled flows, river flows typically decline to levels that are considered controlled and subject to the RD-1644 ramping rate criteria as early as March, but in the wetter years controlled flow reductions typically do not begin to occur until later in the spring or summer.

The results of stranding surveys in the lower Yuba River show that these ramping rates are protective of juvenile salmonids once they grow beyond the sensitive early fry stage. As described above, there is no known relationship between salmonid fry stranding and ramping rates. Therefore, this Applicant-Prepared Draft EFH Assessment focuses on the potential for isolation of juvenile salmonids in off-channel areas, which is further discussed below.

Fry and Juvenile Isolation– Methodology

In this Applicant-Prepared Draft EFH Assessment, evaluation of the Environmental Baseline examines the potential for impact on spring-run and fall-run Chinook salmon juvenile isolation associated with modeled daily flows in the lower Yuba River under the Environmental Baseline, compared to the Without-Project scenario. The methodologies employed in this section are fully described in the Section 6.5.4 of the Applicant-Prepared Draft BA for spring-run Chinook salmon.

Fry and Juvenile Isolation – Results

Figure 7.5-11 displays the annual average numbers of off-channel areas (as percentages of the total number of off-channel areas) that experience n isolation events in the entire lower Yuba River under the Environmental Baseline and Without-Project scenarios separately for all WYs combined, and for wet, above normal, below normal, dry and critical WYs. The results for all WYs combined (i.e., long-term average) and for averages by WYT indicate that there are relatively less frequent isolation events under the Environmental Baseline scenario relative to the Without-Project scenario. For all WYs combined, a higher percentage of all identified off-channel areas in the lower Yuba River do not experience an isolation event under the Environmental Baseline (39.0%) compared to the Without-Project scenario (27.8%). Similar average percentages of all off-channel areas in the lower Yuba River experience 1 or 3 isolation events (about 10 and 13%, respectively) under both the Environmental Baseline and Without-Project scenarios. The Environmental Baseline results in about 14 percent of all off-channel areas experiencing 2 isolation events compared to about 10 percent under the Without-Project scenario. However, the Environmental Baseline results in lower percentages of all off-channel areas experiencing 4 or more isolation events, compared to the Without-Project scenario.

Variable patterns in the percentage of off-channel areas experiencing a given number of isolation events are observed for the individual WYTs. The Environmental Baseline typically results in a lower percentage of all off-channel areas experiencing 4 or more isolation events relative to the Without-Project scenario. The overall percentage of all off-channel areas experiencing multiple isolation events generally decreases from wetter to drier WYTs under both the Environmental Baseline and Without-Project scenarios.

It should be noted that these results are only an indicator of the potential for hydrologic disconnection and off-channel stranding of juvenile Chinook salmon. As previously discussed, some off-channel areas may pose hazards to juveniles, while other off-channel areas may benefit juvenile growth and long-term survival, depending on many factors.

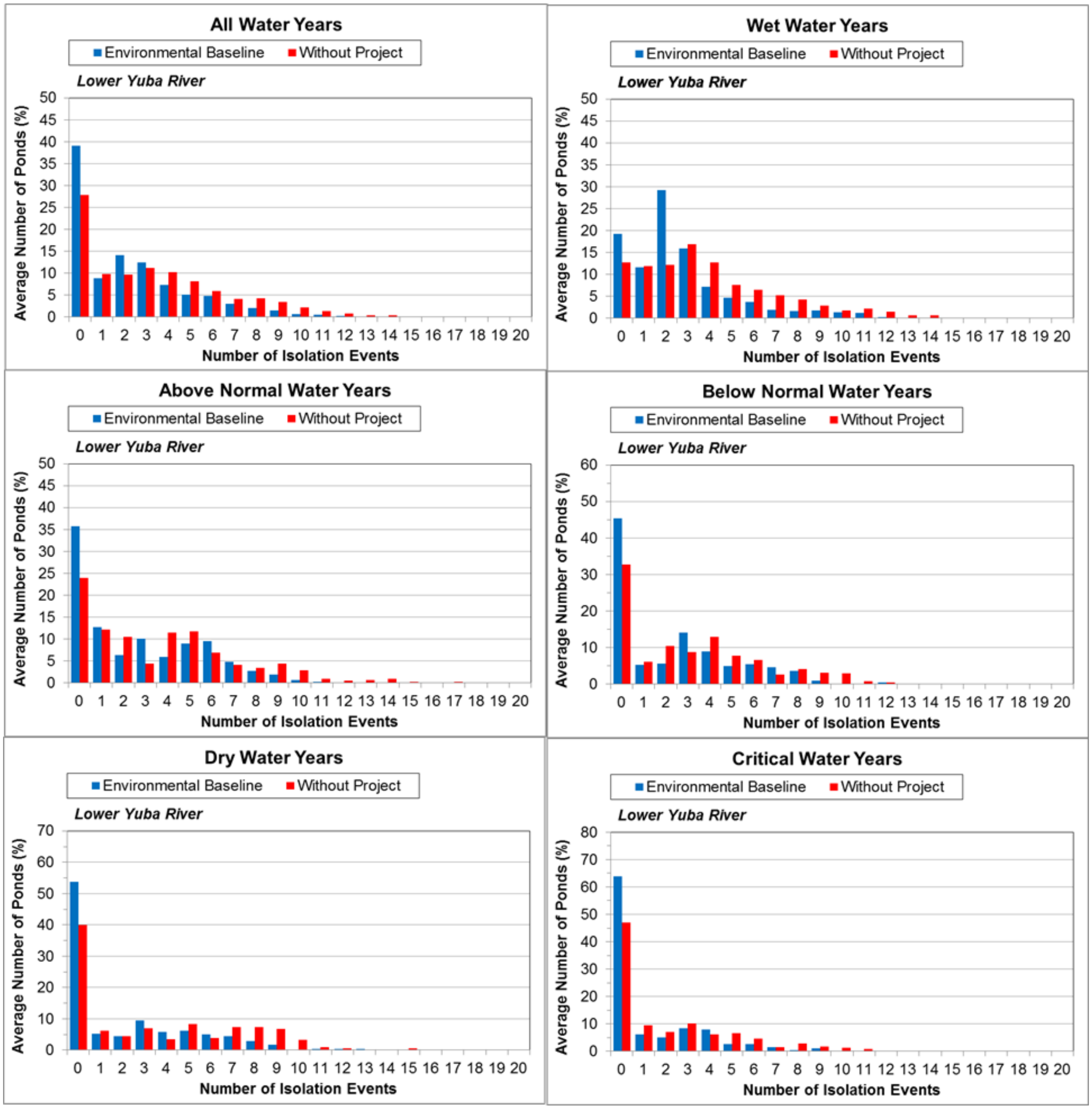

Figure 7.5-11. Average percent of all off-channel areas in the lower Yuba River experiencing the specified number of isolation events over the 41-year hydrologic period for the Environmental Baseline and Without-Project scenarios.

7.5.4.1.7 Thermal Refugia

The upper tolerable WTI value of 65°F was developed by RMT (2013a) to apply to both the spring-run and fall-run Chinook salmon juvenile rearing and downstream movement lifestages. The value of 65°F was selected by the RMT because, in addition to being specifically referenced in the literature, it represented an intermediate value between 64°F and 66.2°F, values which also are often referenced in the literature. Justification for the 65°F WTI value includes: 1) preferred for growth and development of fry and juvenile Chinook salmon in the Feather River; 2) disease outbreaks and mortalities increase at water temperatures above 65°F; 3) optimum temperature for growth appears to occur at about 66.2°F; 4) optimal range for Chinook salmon survival and growth from 53°F to 64°F; and 5) survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F.

Evaluation of the spring-run Chinook salmon and fall-run Chinook salmon juvenile rearing and downstream movement upper tolerable WTI value in the lower Yuba River was conducted using simulated water temperatures under existing conditions (i.e., the Environmental Baseline) and the Without-Project scenario. In summary, modeled water temperatures are generally suitable during the spring-run and fall-run Chinook salmon juvenile rearing and downstream movement periods, with the exception of July through mid-September of the spring-run Chinook salmon juvenile rearing and downstream movement lifestage at the Marysville location under existing conditions. However, as previously mentioned, over the October 2006 to mid-2016 monitoring period, measured water temperatures at Marysville rarely exceeded 65°F, with the exception of two days during 2013, 23 days during 2014, and during approximately June through September of 2015 (after a multi-year drought). As previously discussed, juvenile Chinook salmon are not expected to spend extended periods of time at downstream locations (e.g., Marysville) because juvenile Chinook salmon primarily rear where water temperatures are suitable in more upstream reaches of the lower Yuba River (RMT 2013a). Simulated water temperatures under the existing condition are substantially more suitable than those under the Without-Project scenario for the spring-run and fall-run Chinook salmon juvenile rearing and downstream movement lifestages.

7.5.4.1.8 Prey Availability (Macroinvertebrate Community Assemblages)

YCWA (2013) conducted BMI surveys in the lower Yuba River downstream of Englebright Dam. The surveys were completed in late July of 2012. The study took place at six sites in representative locations between Englebright Dam and the Feather River Confluence. Due to the unwadeable conditions present in the study area, methods utilized in the collection of BMI and sampling of habitat parameters in this study were derived from two protocols suitable for large unwadeable rivers – the United States Environmental Protection Agency’s Environmental Monitoring and Assessment Program, and the Large River Bioassessment Protocol.

Physical habitat varied among the sites, with substrate size decreasing and the amount of riffle habitat increasing from upstream to downstream. An estimated 183,682 invertebrates were collected from the 6 sample sites. A subset of 3,665 invertebrates was randomly sorted from the whole samples representing 6 aquatic insect orders. BMIs from the families Chironomidae and Baetidae were among the most commonly observed. In addition, aquatic crustaceans, arachnids, annelids, gastropods, mollusks, nemerteans, and turbellarians also were identified. Eighteen common BMI metrics were calculated for each site. Although metric values were not consistently related to distance downstream of a dam or reservoir, some BMI metrics were correlated with physical habitat characteristics, such as streambed substrate and habitat composition.

The quality of each site was generally a factor of substrate, channel size and morphology. Overall, the sampling site located in the Englebright Dam Reach below the Narrows 2 powerhouse (RM 23) showed the greatest degree of impairment relative to the other sites, possibly due to very little gravel and stagnant water on the margins of the river, as boulders are a less productive substrate type relative to cobble and gravel. The sampling site located in the Hallwood Reach below Daguerre Point Dam showed the best overall reported BMI metric scores. The relatively high abundance at this site was likely due to the sample plots being dominated by gravel and cobble, which have a large amount of surface area and interstitial spaces available to support higher densities of BMIs.

7.5.4.1.9 Predation

Predation can occur in three forms: 1) natural; 2) predation resulting from a relative increase in predator habitat and opportunity near major structures and diversions; and 3) predation resulting from minimal escape cover and habitat complexity for prey species (CALFED and YCWA 2005). For the purpose of stressor identification in this Applicant-Prepared Draft EFH Assessment, predation includes the predation associated with increases in predator habitat and predation opportunities for piscivorous species created by major structures and diversions, and predation resulting from limited amounts of prey escape cover in the lower Yuba River.

The extent of predation on juvenile Chinook salmon in the lower Yuba River is not well documented (NMFS 2009b). Although predation is a natural component of salmonid ecology, the rate of predation of salmonids in the lower Yuba River has potentially increased through the introduction of non-native predatory species such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*) and American shad (*Alosa sapidissima*) and through the alteration of natural flow regimes and the development of structures that attract predators (NMFS 2009b).

Predatory fish are known to congregate around structures in the water including dams, diversions and bridges, where their foraging efficiency is improved by shadows, turbulence and boundary edges (CDFG 1998). Thus, juvenile salmonids can also be adversely affected by Daguerre Point Dam on their downstream migration. Daguerre Point Dam creates a large plunge pool at its base, which provides ambush habitat for predatory fish in an area where emigrating juvenile salmonids may be disoriented after plunging over the face of the dam into the deep pool below (NMFS 2002a). The introduced predatory striped bass and American shad have been observed in this pool (CALFED and YCWA 2005). In addition to introduced predatory species, several native fish species also prey on juvenile salmonids in the lower Yuba River, including Sacramento pikeminnow, hardhead and large juvenile and adult rainbow trout/steelhead (CALFED and YCWA 2005). It has been suggested that the rate of predation of juvenile salmonids passing over dams in general, and Daguerre Point Dam in particular, may be unnaturally high (NMFS 2007), although specific studies addressing this suggestion have not been conducted.

In addition to the suggestion of increased rates of predation resulting from disorientation of juveniles passing over Daguerre Point Dam into the downstream plunge pool, it also has been suggested that unnaturally high predation rates may also occur in the diversion channel associated with the South Yuba/Brophy diversion (NMFS 2007). Other structure-related predation issues include the potential for increased rates of predation of juvenile salmonids: 1) in the entryway of the Hallwood-Cordua diversion canal upstream of the fish screen; and 2) at the point of return of fish from the bypass pipe of the Hallwood-Cordua diversion canal into the lower Yuba River. These structures are not part of the Project, and the Technical Memorandum 7-13, *Effects on Fish Facilities*, which can be found on FERC's eLibrary as referenced by the FERC accession number provided in Table E6-2 of Appendix E6, of YCWA's Amended FLA, documented that existing project flows do not affect the operation of these structures.

Although areas of EFH downstream of the lower Yuba River are not anticipated to be affected by the Proposed Action, the waterways (i.e., Feather and Sacramento rivers, Delta) discussed below are included for completeness in characterizing Pacific Coast salmon EFH.

7.5.4.2 Feather River

The Yuba River flows into the Feather River near the City of Marysville, 39 river miles (RM) downstream of the City of Oroville (NMFS 2009b). Most juvenile Chinook salmon emigrate from the lower Feather River within a few days of emergence, and 95 percent of the juvenile Chinook have typically emigrated from the Oroville Facilities project area by the end of May (DWR 2007). EFH in the reach of the Feather River extending from the confluence of the Yuba River downstream to the confluence of the Sacramento River is primarily used as a migration corridor by juvenile Chinook salmon. Although lower Yuba River juvenile Chinook salmon may utilize EFH in the Feather River during rearing and downstream movement, the Proposed Action does not have the potential to substantially affect EFH in the lower Feather River.

7.5.4.3 Sacramento River

Approximately 67 mi downstream of the City of Oroville, the Feather River flows into the Sacramento River near the town of Verona (DWR 2007, as cited in NMFS 2009b). The Feather River is considered to be a major tributary to the Sacramento River and provides about 25 percent of the flow[4] in the Sacramento River (DWR 2007, as cited in NMFS 2009b). EFH in the reach of the lower Sacramento River extending from the confluence of the lower Feather River downstream to the Delta is primarily used as a migration corridor by juvenile Chinook salmon. Although lower Yuba River juvenile Chinook salmon may utilize EFH in the lower Sacramento River during rearing and downstream movement, the Proposed Action will not affect EFH in the lower Sacramento River.

7.5.4.4 Sacramento-San Joaquin Delta

Estuaries are important rearing and foraging habitat for juvenile Chinook salmon (NMFS and PFMC 2011). Ehinger et al. (2007) found that certain types of delta habitat, distributary channels and wetlands in particular, may have a major role in juvenile Chinook salmon productivity in the Skagit River. Although lower Yuba River juvenile Chinook salmon would utilize EFH in the Delta during rearing and downstream movement, the Proposed Action will not affect EFH (e.g., sensitive habitats such as salt marsh and tidal wetlands, primary productivity) in the Delta.

[4] As measured at Oroville Dam.