3.2.3 Aquatic Resources

The section discusses fish and other aquatic resources potentially affected by the Project.

3.2.3.1 Affected Environment

Section 3.2.3.1.1 identifies specific special-status aquatic species[1] that have the potential to be affected by the Project, provides a brief life history description for each special-status aquatic species, and describes the known occurrence of the special-status aquatic species in relation to Project facilities and features. Section 3.2.3.1.2 describes the history of non-special status fishes in the Yuba River Basin, focusing on the lower Yuba River and Englebright Reservoir, and other aquatic resources in the lower Yuba River. Section 3.2.3.1.3 identifies aquatic invasive species (AIS)[2] that have the potential to be affected by the Project, provides a brief life history description for each of the AIS, and describes the known occurrence of the AIS in relation to Project facilities and features.

3.2.3.1.1 Special-Status Aquatic Species

Based on review of YCWA documents (YCWA 2010, 2012a,b), CNDDB (CDFW 2020a), CWHR (CDFW 2014) and the USFWS IPaC database (USFWS 2020a), no special-status aquatic species are known to occur within the FERC Project Boundary, and nine special-status aquatic species have the potential to occur in the lower Yuba River (Table 3.2.3-1). California Central Valley spring-run Chinook salmon ESU, Central Valley steelhead ESU, and the sDPS of North American green sturgeon are not considered special-status aquatic species in this document because they are listed under ESA, and these fishes are addressed in Section 3.2.5.

Table 3.2.3-1. Special-status aquatic species with the potential to occur within the Project Vicinity and their spatial distribution.

Common Name/ (*Scientific Name*)	Status[3]	Englebright Reservoir	Lower Yuba River Reaches[1,2]			
			Narrows	Garcia Gravel Pit	Daguerre Point Dam	Simpson Lane
Chinook salmon, CV Fall/Late-Fall Run (*Oncorhynchus tshawytscha*)	NMFS-SC & SSC, PFMC-managed		X	X	X	X
Pacific lamprey (*Entosphenus [Lampetra] tridentatus*)	USFWS-SC			X	X	X

[1] For the purpose of this PAD, a special-status aquatic species is a species that has a reasonable possibility of being affected by Project O&M and meets one or more of the following criteria: 1) listed by the Sacramento, CA, USFWS as a Species of Concern (USFWS-SC); 2) on NMFS's *List of Species of Concern* (NMFS 2009b), and listed as a Species of Concern (NMFS-SC); 3) found on federal lands administered by BLM and listed as Sensitive (BLM-S) on BLM's *Animal Sensitive Species List* (BLM 2006); 4) on the CDFW Commission's list of *State and Federally Listed Endangered and Threatened Animals of California* (CDFW 2020a) and listed under CESA as a candidate for listing as endangered (SCE) or threatened (SCT), a candidate for delisting (SCD), threatened (ST) or endangered (SE); 5) Fully Protected (FP) under California law; 6) designated by CDFW as a Species of Special Concern (CDFW-SSC); and 7) a Chinook salmon managed by the Pacific Fishery Management Council (PFMC). If an aquatic species that meets one of the above criteria and is also listed as threatened or endangered under the ESA or proposed for or a candidate for listing under ESA, it is not considered "special status" in this document, but treated as an "ESA-listed species" in Section 3.2.5 of this document.

[2] For the purpose of this PAD, "aquatic invasive species" are defined as aquatic "*species that are non-native to the ecosystem under consideration, and whose introduction causes, or is likely to cause, economic or environmental harm, or harm to human health*" (National Invasive Species Council 2006). Terrestrial non-native invasive plant species are discussed in Section 3.2.4.

Table 3.2.3-1. (continued)

Common Name/ (*Scientific Name*)	Status[3]	Englebright Reservoir	Lower Yuba River Reaches[1,2]			
			Narrows	Garcia Gravel Pit	Daguerre Point Dam	Simpson Lane
river lamprey (*Lampetra ayresii*)	CDFW-SSC				X	X
California roach (*Hesperoleucus symmetricus*)	CDFW-SSC			X	X	X
Hardhead (*Mylopharodon conocephalus*)	CDFW-SSC	X		X	X	X
Chum salmon (*O. keta*)	PFMC		X	X	X	X
pink salmon (*O. gorbuscha*)	PFMC		X	X	X	X
Sacramento splittail (*Pogonichthys macrolepidotus*)	CDFW-SSC		X			
northwestern pond turtle (*Actinemys marmorata*)	CDFW-SSC	X		X		
	Subtotal	*2*	*4*	*7*	*7*	*7*
	Total	**9**				

[1] The reaches below Englebright Dam are defined as follows:
Narrows = From Englebright Dam to the downstream side of the Narrows 1 Powerhouse.
Garcia Gravel Pit = From Narrows Reach to Daguerre Point Dam.
Daguerre Point Dam = From Daguerre Point Dam to the downstream terminus of the Yuba Goldfield.
Simpson Lane = From the Yuba Goldfield to the confluence with the Feather River.

[2] SOURCE: For fishes, Tables 3.3.3.-1 and 3.3.3-21 in YCWA's Application for New License, as amended (YCWA 2014).

[3] Status Key:
NMFS-SC = Listed as a Species of Concern by NMFS.
USFWS-SC = Listed as a Species of Concern by USFWS
CDFW-SSC = Listed as a Species of Special Concern by CDFW
PFMC = Managed by the PFMC.

Central Valley fall and late fall-run Chinook salmon ESU

The Central Valley fall and late fall-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) is not listed under the ESA or CESA; however, it was identified as a NMFS-SC in 2004 due to concerns about population size and hatchery influence (NMFS 2009) and is a CDFW-SSC.

Four principal life history variants of Chinook salmon are recognized in the Central Valley and are named for the timing of their spawning runs: fall-run, late fall-run, winter-run, and spring-run. Seventeen distinct groups, or ESUs, of naturally-spawned Chinook salmon occur from southern California to the Canadian border and east to the Rocky Mountains; five of these groups occur in California (Myers et al. 1998). All variants (i.e., fall-, late fall-, winter-, and spring-runs) occur in the Project Vicinity (NMFS 2008) and the spring-, fall-, and late fall-runs have been documented in the lower Yuba River (Massa and McKibbin 2005).

Although late fall-run Chinook salmon populations occur primarily in the Sacramento River (CDFG Website 2007a as cited in RMT 2010a), incidental observations of late fall-run Chinook salmon have been reported to occur in the lower Yuba River (D. Massa, pers. comm., 2009; M. Tucker, pers. comm., 2009). Although reported, there have been only occasional episodic incidences of late fall-run Chinook salmon straying from the Sacramento River system into the lower Yuba River (USACE 2014). The remainder of this discussion refers to fall-run.

While fall-run Chinook salmon is an important commercial and recreational fish species, declines in populations of this species have resulted in harvest management restrictions. In April 2009, the PFMC adopted a closure of all commercial ocean salmon fishing through April 30, 2010, and placed restrictions on inland salmon fisheries (CDFG 2009a). Since then, and most recently during 2019, NMFS has taken several in-season management actions, including temporary closure, that have modified the commercial and recreational fishing seasons and quotas for salmon fisheries from the U.S. and Canada border to the U.S. and Mexico border (NMFS 2019).

Chinook salmon are the largest salmonids, with adults often exceeding 40 pounds, and individuals over 120 pounds have historically been reported (NMFS 2008). The generalized life history of Pacific salmon involves spawning, incubation, hatching, emergence, and rearing in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of the life-cycle (Myers et al. 1998).

Adult Chinook salmon migrate from the ocean into the freshwater streams and rivers of their birth to mate (i.e., anadromy) typically at three years of age and, following a single spawning event, they die (i.e., semelparity). Adult fall-run Central Valley Chinook salmon generally begin migrating upstream annually in June, with immigration continuing through December (Moyle 2002; NMFS 2008). Immigration generally peaks in November and, typically, greater than 90 percent of the run has entered their natal river by the end of November (Moyle et al. 2008).

The timing of adult Chinook salmon spawning activity is influenced by water temperatures. In general, when daily average water temperatures decrease to approximately 60°F, female Chinook salmon begin to construct nests (i.e., redds) into which their eggs are eventually released and simultaneously fertilized by males. Fall-run Chinook salmon require gravel and cobble areas, primarily at the heads of riffles, with water flow through the substrate for spawning. Gravel and cobble diameter sizes can range from 0.1 to 6 inches. The fall-run Chinook salmon spawning and embryo incubation period generally extends from October through March but may occur earlier if temperature conditions fall below 60°F (Moyle 2002; NMFS 2008a). In the lower Yuba River, fall-run Chinook salmon fry emergence typically occurs from late December through March (Moyle 2002). Growth rates are largely influenced by water temperature, and the optimal range of juvenile rearing temperatures is 55°F through 65°F. Young Chinook salmon will survive and grow within the range of 41°F through 66°F, but steady temperatures above 75°F are lethal (UC Davis 2009).

In the Central Valley, fall-run Chinook salmon are the most numerous of the four salmon runs and are the principal run raised in hatcheries (Moyle 2002). Historical accounts indicate that prior to construction of the original Bullards Bar Dam in the early 1920s, large numbers of Chinook salmon were present as far upstream as Downieville on the North Yuba River, but these runs were believed to be spring-run Chinook salmon (Yoshiyama et al. 2001). Upstream migration of all anadromous salmonids was further limited by construction of Englebright Dam, in 1941, downstream. Although actual numbers are not known, historical annual escapements of

Chinook salmon into the Sacramento River are estimated to have reached 600,000 spawners (Massa and McKibbin 2005; Massa 2008). Within Yuba County, the Bear, Feather, and Yuba (downstream of USACE's Englebright Dam) river watersheds support runs of Chinook salmon (DWR 2008, 2009; UC Davis 2009).

Fall-run Chinook salmon are raised at five major Central Valley hatcheries that have released more than 32 million smolts each year into California waterbodies (CDFG 2007b). While hatchery programs can increase overall returns to the fishery, Lindley et al. (2007) concluded that hatchery programs have negative effects on wild populations of Chinook salmon due to competition by hatchery fish with wild juveniles and straying of hatchery fish both within and between basins and resultant introgression of hatchery stocks with native populations.

Throughout the Central Valley, the number of Chinook salmon returning in the fall to spawn has exhibited a declining trend in recent years based on data reported in GrandTab[3].

Fall-Run Chinook Salmon in the Lower Yuba River as Summarized from YCWA's 2017 Amended Application for New License

The best summary of information regarding fall-run Chinook salmon in the lower Yuba River is YCWA's 2014 Application for New License, as amended, for the Yuba River Development Project (YCWA 2014), and in particular the Draft EFH Assessment in Volume IV of Exhibit E of the application. Provided below is a summary of information in the application, followed by a description of information related to fall-run Chinook salmon that was collected in the lower Yuba River subsequent to YCWA's filing of its Amended Application for New License, and a description of other relevant information.

The RMT (2013) developed representative temporal distributions for specific fall-run Chinook salmon lifestages through review of previously conducted studies, as well as recent and ongoing data collection activities of the RMT's Monitoring and Evaluation Program (M&E Program). The resultant lifestage-specific periodicities encompass the majority of activity for a particular lifestage and are not intended to be inclusive of every individual in the population. The lifestage-specific periodicities for fall-run Chinook salmon in the lower Yuba River are summarized in Table 3.2.3-2.

Table 3.2.3-2. Lifestage-specific periodicities for fall-run Chinook salmon in the Yuba River (shaded boxes indicate temporal utilization of the Yuba River).

Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Immigration & Staging							■	■	■	■	■	■
Spawning										■	■	■
Embryo Incubation	■	■	■							■	■	■

[3] GrandTab is a compilation of annual population estimates for Chinook salmon in the Sacramento and San Joaquin River systems. GrandTab is available for download at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=84381

Table 3.2.3-2. (continued)

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Fry Rearing	■	■	■	■	■	■	■	■																■
Juvenile Rearing		■	■	■	■	■	■	■	■	■	■	■												
Fry and Juvenile Downstream Movement	■	■	■	■	■	■	■	■	■	■	■	■												■

Unlike spring-run Chinook salmon, adult fall-run Chinook salmon do not exhibit an extended over-summer holding period. Rather, they stage for a relatively short period of time prior to spawning. Adult fall-run Chinook salmon immigration and staging has been reported to generally occur in the lower Yuba River from July through December (RMT 2013) (Figure 3.2.3-2).

Examination of preliminary data obtained from the carcass surveys does not indicate a distinct bimodal distribution of spawning activities (i.e., a distinct spring-run spawning period followed by a distinct fall-run Chinook salmon spawning period) but instead demonstrates a slow build-up of spawning activities starting in early September and transitioning into the main fall-run spawning period. The lower Yuba River fall-run Chinook salmon spawning period has been reported to extend from October through December (RMT 2013; CALFED and YCWA 2005) (Figure 3.2.3-2). Preliminary data from redd surveys, and back-calculations from carcass surveys, generally confirm this temporal distribution. During the pilot redd survey conducted from the fall of 2008 through spring of 2009, the Yuba Accord RMT (2010b) report that the majority (~63%) of fresh Chinook salmon redds constructed during November and December of 2008, potentially representing fall-run Chinook salmon, were observed upstream of Daguerre Point Dam.

Fall-run Chinook salmon embryo incubation in the lower Yuba River extends from the time of egg deposition through alevin emergence from the gravel. The fall-run Chinook salmon embryo incubation period has been reported to extend from October through March (RMT 2013; YCWA et al. 2007) (Figure 3.2.3-2). Based upon consideration of accumulated thermal units from the time of egg deposition through hatching and alevin incubation, the fall-run incubation period is considered to extend from October through March. This time period is consistent with observed trends in Chinook salmon fry captures in the rotary screw traps (RSTs) in the lower Yuba River.

Fall-run Chinook salmon juvenile rearing and outmigration (also referred to as downstream movement) in the lower Yuba River has been reported to primarily occur from December through June (CALFED and YCWA 2005; SWRI 2002). In the lower Yuba River, most fall-run Chinook salmon exhibit downstream movement as fry shortly after emergence from gravels, although some individuals rear in the river for a period up to several months and move downstream as juveniles. Thus, the fry rearing lifestage is considered to extend from mid-December through April, the juvenile rearing lifestage extends from mid-January through June, and the fry and juvenile downstream movement lifestage generally extends from mid-December through June (RMT 2013) (Figure 3.2.3-2).

Escapement surveys for Chinook salmon in the lower Yuba River occur from the Narrows Pool to USACE's Daguerre Point Dam, and from USACE's Daguerre Point Dam to the Simpson Lane Bridge. Escapement surveys suggest that approximately two-thirds of Chinook salmon spawning in the lower Yuba River occurs above USACE's Daguerre Point Dam (Jones & Stokes 2006; Massa 2006, 2007). During the escapement surveys, recoveries of Chinook salmon with coded wire tags (CWT) indicate that straying of spring-run and fall-run Chinook salmon from the Feather River hatchery occurs in the lower Yuba River. Additionally, during 2008, six Chinook salmon adults were recovered during the late-winter and early-spring portion of the escapement surveys with CWTs demonstrating that these were late fall-run fish from the Coleman National Fish Hatchery located on Battle Creek.

Annual spawning stock escapement estimates are reported in GrandTab, the Central Valley database maintained by CDFW. In the lower Yuba River, no distinction is made between phenotypic spring-run Chinook salmon and fall-run Chinook salmon in GrandTab, and all Chinook salmon returning to the lower Yuba River are reported as fall-run. As reported in GrandTab (CDFW 2020e), in the lower Yuba River, fall-run Chinook salmon spawning escapement estimates have been lower in recent years than the preceding 30-year (1989-2019) average of about 13,000 fish. Nonetheless, fall-run Chinook salmon annual spawning estimates have exhibited an increasing trend in recent years, with approximately 1,634 fish during 2017, 3,455 during 2018, and 3,446 during 2019 (CDFW 2020e).

Juvenile salmonid outmigration (RST) monitoring was conducted in the lower Yuba River near Hallwood Boulevard by CDFW annually from 1999 to 2006, and by the Yuba Accord RMT from 2006 to 2009. Data from CDFW RST monitoring are available from 1999 to 2005, and a Yuba Accord RMT report (Campos and Massa 2010) has been prepared for the sampling period extending from October 1, 2007, to September 30, 2008. Analyses of CDFW RST data indicate that about 98 to 99 percent of the total numbers of juvenile Chinook salmon were captured by May 1 of each year, followed by up to about 1 percent during May and June (YCWA et al. 2007). During the 2007 to 2008 sampling period, 95 percent of all juvenile Chinook salmon were captured by June 2, 2008 (Campos and Massa 2010).

For the sampling periods extending from 2001 to 2005, CDFW identified specific runs based on sub-samples of lengths of all juvenile Chinook salmon captured in the RSTs by using the length at-time tables developed by Fisher (1992), as modified by S. Green (CDWR). Although the veracity of utilization of the length-at-time tables in the lower Yuba River has not been ascertained, the examination of run-specific determinations indicate that, in the lower Yuba River, the majority (i.e., 81.1%) of fall-run Chinook salmon move past the Hallwood Boulevard RST from December through March, with decreasing numbers captured during April (i.e., 8.9%), May (i.e., 6.6%), June (i.e., 3.2%), and July (i.e., 0.2%). Most of the fish captured from December through March were post-emergent fry (<50 mm FL), while nearly all juvenile fall-run Chinook salmon captured from May and later were larger (≥50 mm FL) (YCWA et al. 2007). As an overall characterization, juvenile fall-run Chinook salmon downstream movement extends from late December through June.

Lower Yuba River Fall-Run Chinook Salmon Information Developed After YCWA's 2017 Amended Application for New License

The content of 13 new source documents pertaining to lower Yuba River fisheries resources that have been developed after YCWA filed its Application for New License, as amended, are summarized below. Many of the documents and ongoing monitoring and evaluation activities do not specifically distinguish between spring-run and fall-run Chinook salmon, particularly regarding the juvenile rearing and emigration lifestages. Other studies have been and are being conducted specifically to address such distinctions. Therefore, for all of these reasons and for organizational efficiency and consistency, the suite of documents addressing Chinook salmon are presented in this section of this PAD. Documents pertaining specifically and only to spring-run Chinook salmon and *O. mykiss* (steelhead) are incorporated into the life history descriptions presented in Section 3.2.5 of this PAD.

- California Central Valley Chinook Population Database Report (CDFW 2020d)

  CDFW compiles annual population estimates of Chinook salmon in the Sacramento-San Joaquin River system. Chinook salmon estimates are based on counts of fish entering hatcheries and migrating past dams, carcass surveys, live fish counts, and ground and aerial redd counts. Estimates are provided by CDFW, USFWS, DWR, the RMT, and others. Figure 3.2.3-1 presents the in-river fall-run Chinook salmon annual adult escapement in the lower Yuba River from 1953-2018 (CDFW 2020d). CDFW reported information does not distinguish between spring-run and fall-run Chinook salmon, and all Chinook salmon returning to the lower Yuba River are reported as fall-run.

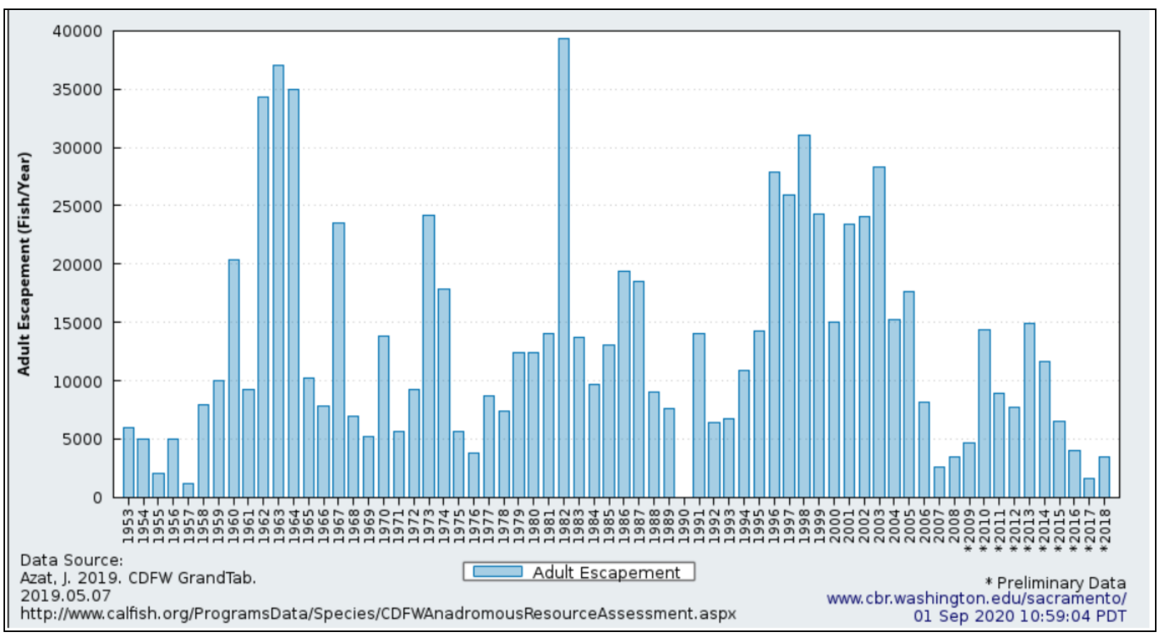

Figure 3.2.3-1. Fall-run Chinook salmon annual adult escapement in the lower Yuba River from 1953 through 2018 (CDFW 2020d).

- Juvenile Salmonid Habitat-Discharge Relationships Change as a Result of Natural Morphodynamic Processes (Moniz and Pasternack 2020, in press)

  Relationships between fluvial aquatic habitat availability and discharge are often assumed to remain static when used with hydrologic datasets to analyze changes in habitat availability over time. Despite this assumption, studies have observed significant changes in aquatic habitat availability before and after restoration projects, dam removals, and extreme flood events. However, research is lacking on how aquatic habitat changes as a result of morphodynamic processes during more natural and commonly occurring hydrologic conditions. This study compared rearing salmonid habitat availability at 19 discharges before and after a 6-8 year (2006/2008 to 2014), relatively mild hydrologic period punctuated with modest floods on the lower Yuba River. The total area of juvenile rearing habitat remained relatively consistent at discharges less than two times bankfull but decreased by up to 25% at discharges greater than two times bankfull. Significant decreases in juvenile rearing habitat area appeared to be the result of widespread erosion on floodplains, terraces, and lateral bars, even after only modest floods. These changes enhanced channel-floodplain connectivity. As a result, spatially delineated areas of lost habitat tended to increase in water depth and velocity at baseflow, bankfull, and floodplain-filling discharges, while areas of gained habitat decreased in depth and velocity. The finding that habitat-discharge relationships change as a result of natural morphodynamic processes should be considered when making long-term regulatory and management decisions.

- Machine Learning Prediction of Lower Yuba River 2017 Subaerial Sediment Facies (Diaz-Gomez and Pasternack 2020)

  Substrate grain size distribution (GSD) is an important contributor to physical habitat, but it is very difficult to map or model because it traditionally involves direct measurement methods and/or visual characterization. The intent of this study was to quantify and map the sediment facies of the lower Yuba River by developing a new remote sensing framework reliant on airborne LiDAR data and machine learning. Using 2017 Airborne LIDAR and 2018/2019 unmanned aerial vehicle (UAV) imagery collected in the field, spectral and topographic predictors were identified as a representation of substrate facies classes, and then used to “train” competing algorithms to find the relationship between facies and the predictor variables. The model was applied to all predictors to obtain a facies map of the lower Yuba River subaerial substrate area, and a substrate distribution map of the lower Yuba River at a 1.52 m pixel size was generated with a 77 percent total accuracy.

- Recovery of Coded-Wire Tags from Chinook Salmon in California’s Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2014 (PSMFC and CDFW 2019).

  Since 2007, a constant fractional marking (CFM) program has ensured that at least 25 percent of all CV hatchery fish are tagged with a microscopic (≤ 1 mm) coded-wire tag (CWT). Each CWT contains a binary or alpha-numeric code that identifies a specific release group of salmon (e.g., agency, species, run, brood year, hatchery or wild stock, release size, release date(s), release location(s), number tagged and untagged). Each salmon containing a CWT is also externally marked with a clipped adipose fin (ad-clip) to allow for easy visual identification. In 2014, approximately 63,000 CWTs were recovered and successfully read from ad-clipped Chinook salmon sampled in fall-, winter-, spring-, and late-fall-run natural area spawning surveys, at hatcheries, in the angler sport harvest, and in ocean salmon commercial and sport fisheries south of Cape Falcon (i.e., California and Oregon).

The 2014 results show that fall-run Chinook salmon escapement into the lower Yuba River was predominantly natural-origin salmon, and hatchery-origin fish were primarily net pen "FRHFn" releases. Spring- and fall-run returns to the Feather River Hatchery (FRH) (including preseason spring-run returns that died prior to release), and spawners in the Feather River were predominantly hatchery-origin while escapement to the lower Yuba River above and below Daguerre Point Dam (DPD) contained more natural-origin salmon (Figure 3.2.3-2). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall/spring-run spawners Yuba River above DPD - 49% (FRHFn)
- Fall/spring-run spawners Yuba River below DPD - 45% (FRHFn)
- Spring-run returns FRH - 100% (FRHS)
- Fall-run returns FRH - 95% (FRHFn)
- Fall/spring-run spawners Feather River - 83% (FRHFn)

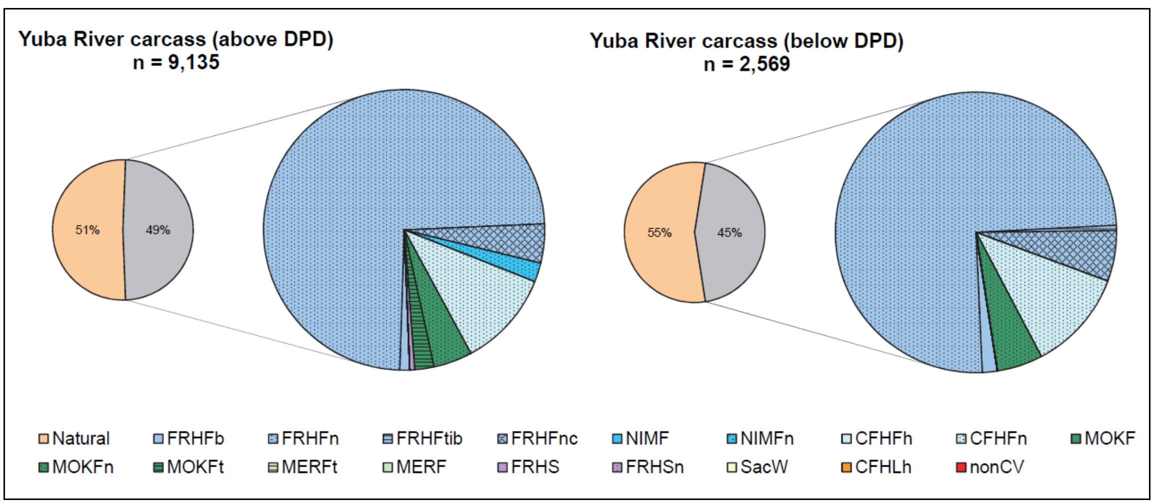

Figure 3.2.3-2. Proportion of hatchery- and natural-origin fish in the lower Yuba River during 2014 (PSMFC and CDFW 2019).

- Final Environmental Impact Statement for the Yuba River Development Project (FERC and USACE 2019)

  On January 2, 2019, FERC and the USACE issued a Final Environmental Impact Statement (EIS) for the Yuba River Development Project, which contained FERC staff's evaluations of YCWA's proposal and the alternatives for relicensing the Yuba River Development Project. The Final EIS analyzed the effects of continued Yuba River Development Project operation, and recommended conditions for any license that may be issued for the Yuba River Development Project. FERC and the USACE determined that the primary issues associated with relicensing the Yuba River Development Project are potential effects of continued project operation on geology and soils, water quality, fisheries resources, terrestrial resources, threatened and endangered species, recreation and land use, and cultural resources. The Final EIS included a discussion of the anticipated environmental effects of issuing a new license for the Yuba River Development Project under the staff alternative. The FERC and USACE staff alternative also included recommended modifications to YCWA's proposal and some additional measures that would adequately protect and enhance environmental resources affected by the project. Based on FERC's review of agency and public comments filed on the project and review of the environmental and economic effects of the proposed project and its alternatives, FERC and USACE selected the staff alternative as the preferred alternative. Many of the lower Yuba River fisheries-related issues and evaluations addressed in the Final EIS also pertain to the Narrows Project relicensing because coordinated operations between Narrows 1 and 2 powerhouses were evaluated in the Yuba River Development Project Final EIS.

- Bioverification of Microhabitat Suitability Models for Rearing Salmonids in the Lower Yuba River (Moniz and Pasternack 2019a)

  This study involved bioverification of a two-dimensional (2D) predictive model of microhabitat suitability for rearing juvenile Chinook salmon and *O. mykiss* throughout the entire lower Yuba River at a near-census scale. Water depth and velocity habitat suitability curves (HSCs) were developed for two lifestages (i.e., size classes) of each species, based on data from snorkel surveys conducted over three years at seven sites along the river. HSC cover values were modified from previous studies. Microhabitat suitability models were developed by applying the HSC functions to previously validated 2D hydrodynamic model outputs and maps of cover types.

  Microhabitat suitability models were tested for bioverification using an independent set of observational data (i.e., snorkel data not used to develop the HSC functions) and two separate statistical testing methods. Statistical bootstrapping was used to quantify the level of uncertainty associated with forage ratio values. Forage ratio values were then adjusted according to their associated level of uncertainty. For a model to be considered fully bioverified, the adjusted forage ratio values (or "forage ratio residuals") had to indicate both avoided and preferred habitat, and the ratios had to continually increase with increasing suitability values. The forage ratio residuals for models that incorporated cover, depth, and velocity indicated both avoided and preferred habitat and continually increased with increasing suitability values for all four combinations of species and lifestages. This set of models was, therefore, considered fully bioverified, and is now being used by YCWA and the University of California, Davis, to analyze the availability of preferred juvenile salmonid rearing habitat along the lower Yuba River.

- Habitat Suitability Curves for Rearing Salmonids in the Lower Yuba River (Moniz and Pasternack 2019b)

  The purpose of this study was to use newly available microhabitat utilization data, relatively recently collected from the lower Yuba River, to develop HSCs for fry and juvenile salmonid rearing as a first step toward producing microhabitat suitability models that may be hydraulically validated and bioverified. The specific objectives of this study were to: 1) summarize previous attempts at developing and testing HSCs for fry and juvenile salmonid rearing in the lower Yuba River; 2) develop a new set of HSCs using relatively recently collected microhabitat utilization data; and 3) qualitatively compare the newly developed and previously developed HSCs. Microhabitat utilization data were collected in 2012, 2014, and 2015 during snorkel surveys conducted by Pacific States Marine Fisheries Commission on behalf of the RMT. Surveys were conducted at seven 400-ft-long sites representing seven of the eight previously designated geomorphic reaches in the lower Yuba River. These data were used to develop water depth and velocity HSCs for fry and juvenile anadromous salmonids using non-parametric tolerance limits at the 90 percent confidence level. An important outcome of this study is that the development and application of a formula for counting large groups of fish observed at a single location, which successfully yielded an intermediate pattern of HSCs when compared to other methods that have been used for counting fish in large groups ((Beak Consultants, Inc. 1989; Gard 2010). The new approach offered a compromise that gives value to each observation, while preventing a few observations with relatively large schools of fish from potentially substantially shifting the distribution of observations and the resulting HSC. The newly developed curves were then qualitatively compared to previously developed HSCs (see the bioverification report described above).

- Daguerre Point Dam Predation Survey Interim Report (Kowalik et al. 2019)

  In 2015, the RMT developed a study to investigate juvenile salmonid survivorship and predation of juvenile Chinook salmon at Daguerre Point Dam. Survey efforts focused on the Daguerre Point Dam complex, defined as the upstream intake and fish bypass pipe for the Hallwood-Cordua Diversion, the plunge pool immediately downstream of the dam, and the South Canal Diversion were targeted for hook-and-line predatory fish sample collections, while baited underwater video (BUV) footage was collected exclusively at the plunge pool. Surveys were effectively performed year-round, but survey periods marked by extreme flows and increased turbidity were typically excluded from data collection and analyses. The year-round sampling paradigm allowed for both the temporal consideration of transitory anadromous species and covered the emigration period of juvenile salmonids in the lower Yuba River (RMT 2013). Angling data and benthic video footage-based analyses were performed for each data collection method from either angling, and/or standardized BUV data from May 2016 through May 15, 2019. The study found that:

  - Predation rates on juvenile Chinook salmon appear to be low but may not accurately represent total predation losses at the Daguerre Point Dam complex due to an inability to extrapolate the predation rates from abundances of predator fish species to arrive at total loss estimates.

- Predation on juvenile Chinook salmon was difficult to gauge due to an inability to create abundance estimates for piscivorous fishes.
- *O. mykiss* primarily utilized benthic macroinvertebrates as food items, with strong representation in the digesta by mayflies, midges, and stoneflies.
- High predation by striped bass was observed on sculpin species and stoneflies, and Sacramento pikeminnow utilized signal crayfish as a primary food item.
- Some ontogenetic shifts in prey selection were observed by larger fishes, but prey availability coupled with thermal-metabolic considerations of predator fishes may better describe foraging patterns observed in this study.
- Water temperatures at the Daguerre Point Dam complex are suspected to be too cool for striped bass and Sacramento pikeminnow to present a risk of predation to emigrating juvenile Chinook salmon, based on reported thermal-metabolic requirements of these predator species.

- 2017 Lower Yuba River Topographic Mapping Report (Silva and Pasternack 2018)

  High winter flows during 2017 resulted in dramatic topographic changes to the lower Yuba River corridor - both in the mainstem channel and in various secondary and tertiary channels. Because the flooding occurred at the end of a severe multi-year drought, it presented a unique opportunity to examine the effects of a single intense wet season on fluvial processes and habitat after a period of drought. In 2017, YCWA sponsored another topographic mapping effort on the lower Yuba River as part of its on-going efforts to understand changes in the river over time, and to monitor associated environmental conditions. Advancements and cost reductions in remote sensing technology, such as bathymetric LiDAR, which involves a green laser that penetrates through the water column, and multibeam (MB) sonar, which scans a deeper river bottom comprehensively, allowed for efficient mapping of large spatial extents with high point resolutions (approximately 10 pts/m^2 for bathymetric LiDAR and 180 pts/m^2 for MB sonar). Airborne LIDAR data and MB sonar were collected on the lower Yuba River during August and September of 2017. A few localized single beam sonar and Real-time kinematic (RTK) Global Positioning System (GPS) surveys also were conducted later in 2017 and during the first half of 2018 to fill in a few data gaps. Several steps were undertaken to merge the different data sources together, and then carefully re-process all of the data together in a bare-earth terrain model. Overall, the 2017 topographic mapping effort resulted in the production of a high-quality, high-resolution final product that is referred to as the "2017 Digital Elevation Model (DEM)".

- Lower Yuba River Chinook Salmon Escapement Technical Memorandum (PSMFC 2018)

  This report presents results of Chinook salmon spawning escapement surveys conducted from September 10, 2018, to the week of December 31, 2018. Due to a low number of fresh fish captured downstream of Daguerre Point Dam (n = 24), and no recaptures in this area during the survey, additional population modeling techniques were explored. Statistical resampling necessary to perform confidence interval calculation for population sizes proved negligible under Cormack-Jolly-Seber (CJS) estimation methods due to the lack of recaptures, and PSMFC therefore explored additional below Daguerre Point Dam estimation techniques. PSMFC (2018) conservatively estimated the downstream abundance of adult Chinook salmon to be derived directly from the number of all carcasses (fresh and not fresh) observed downstream of Daguerre Point Dam (n = 24) and also offer an alternative estimate of n = 417 which is the difference obtained from Mark Closed model total river estimates (N = 3,466) and VAKI Riverwatcher™ upstream estimates (n = 3,049). Over 80 percent of the returning escapement in 2018 utilized the area between the Narrows pool and Daguerre Point Dam (PSMFC 2018). Of the 133 fresh carcasses examined, 56 were ad-clipped (with valid tags), and release locations for these 56 fish included the Feather River Hatchery (32 fish), the Mokelumne Hatchery (22 fish) and Nimbus Fish Hatchery (2 fish).

- Lower Yuba River Chinook Salmon Escapement Technical Memorandum (PSMFC 2017)

  This report presents results of Chinook salmon spawning escapement surveys conducted from September 18, 2017, to the week of December 25, 2017. Due to an extremely low sample size of individuals captured below Daguerre Point Dam (n = 20), the CJS model was deemed inappropriate for population expansion estimation and rather the number of individuals handled/observed downstream of Daguerre Point Dam serves as the abundance estimate for that survey area. The VAKI Riverwatcher™,[4] net count of 1,628 individuals was combined with the number of individuals observed below Daguerre Point Dam (n=20) for a total adult abundance of 1,648 Chinook salmon. Nearly 90 percent of the returning escapement in 2017 utilized the area between the Narrows Pool and Daguerre Point Dam (PSMFC 2017). Of the 73 fresh carcasses examined, 22 were ad-clipped and release locations for these 22 fish included the Coleman Hatchery (12 fish), the Feather River Hatchery (4 fish), the Mokelumne Hatchery (4 fish) and Nimbus Fish Hatchery (2 fish).

- Lower Yuba River Chinook Salmon Escapement Technical Memorandum (PSMFC 2016)

  This report presents results of Chinook salmon spawning escapement surveys conducted beginning the week of September 19, 2016, to the week of December 26, 2016. Due to the failure of the VAKI Riverwatcher™ on the North Ladder, net passage data for the

[4] On August 14, 2017, the North VAKI Riverwatcher experienced equipment failure leading to an outage which lasted until September 25th, 2017. However, the low numbers of passages upstream of DPD prior to the outage (n = 8), the low number of passages in the South Ladder during this period (n = 1), the lack of visual observation of either redds or salmon upstream of DPD or in the plunge pool, and lack of carcass recoveries support that few if any salmon passed DPD during the period the North VAKI Riverwatcher was offline and thus there is sufficient confidence that the 2017-2018 VAKI dataset represents an accurate estimate of the number of Chinook salmon migrating upstream of DPD.

entire survey period could not be calculated. The VAKI Riverwatcher™ system on the South ladder, which maintained functionality throughout the survey period, counted a net total of 1,135 individuals. To estimate Chinook salmon escapement both upstream and downstream of Daguerre Point Dam, crews employed a mark-recapture survey using the same methods in the below- Daguerre Point Dam survey (carcass survey) conducted in previous years. Due to extremely low sample size of individuals captured below Daguerre Point Dam (n = 46), data were pooled for the entire river for escapement estimations. CJS models predicted an estimated escapement abundance of 3,565 individuals for the entire lower Yuba River, including both adult and grilse. Nearly 90 percent of the returning escapement in 2016 utilized the area between the Narrows pool and Daguerre Point Dam (PSMFC 2018). Of the 436 fresh carcasses examined, 85 were ad-clipped, and release locations for these 85 fish included the Coleman National Fish Hatchery (38), the Feather River Hatchery (39 fish), the Mokelumne Hatchery (5 fish), the Merced Fish Hatchery (2 fish) and Nimbus Fish Hatchery (2 fish).

- Redd Monitoring and Mapping in the Englebright Dam Reach of the Lower Yuba River, CA – Summary Report (Stearman et al. 2017)

  This report describes the temporal and spatial use of spawning substrates by Chinook salmon and steelhead in the 1-mile long reach of the lower Yuba River downstream of Englebright Dam beginning the week of September 12, 2016 and extending to the week of December 12, 2016. A total of 97 redds was observed during the survey period, of which 41 were positively identified as Chinook salmon redds, none were positively identified as a steelhead redds, and 56 redds were of unknown species origin. Approximately 90.0 percent of redds were observed at water temperatures at or below 53.6°F, and 100 percent were observed at or below 54.7°F. Chinook salmon redds were observed at an average depth of 1.85 ± 0.19 ft, an average mean column velocity of 1.53 ± 0.19 ft/s, and an observed average nose velocity of 1.12 ± 0.16 ft/s. As with previous surveys, redds were located in many areas where suitable spawning gravels did not exist prior to USACE gravel injection (Campos et al. 2013, 2014; Stearman & Massa 2015). Interestingly, redds were observed during the 2016 survey in many new areas downstream of the injection site as well, suggesting sufficient distribution accumulation of injection gravels throughout the reach to promote expansion of spawning habitat. Similar to the 2015 season, redd abundances were low early in the season, matching concurrent observations from escapement surveys and the VAKI Riverwatcher™ systems at Daguerre Point Dam. As in previous years (Campos et al. 2013, 2014; Stearman & Massa 2015), indices for redd superimposition impacts remained below 10 percent for the entire survey, indicating that the potential for disruption and dislodgement of incubating eggs within individually constructed redds was relatively small.

<u>Other Relevant Information</u>

YCWA also found seven source documents of relevant information pertaining to anadromous salmonid habitat enhancement efforts that are either proposed, ongoing, or have been recently completed in the lower Yuba River. The majority of the projects described below are intended to improve habitat for Chinook salmon and steelhead fry and juvenile rearing in the lower Yuba River.

- Hammon Bar Riparian Enhancement Project (SYRCL 2013)

  Funded by the Anadromous Fish Restoration Program (AFRP) and others, the Hammon Bar Riparian Enhancement Project was designed to evaluate methods and demonstrate benefits of planting large cuttings of cottonwood and willow trees in the floodplain of the lower Yuba River. The project also intended to create new stands of structurally and biologically diverse riparian vegetation that would enhance fish habitat through additional shading, cover, food supply, and geomorphic and hydraulic complexity. Over 6,000 cuttings of native species (i.e., Fremont cottonwood, Gooddings black willow, red willow, and arroyo willow) were planted in about a 5-acre area of Hammon Bar. First year results for 2011 plantings suggested high survival rates for all four species planted, but survivorship was much less the following year and for cuttings planted in the fall of 2012. SYRCL (2013) reports that climatic conditions may have influenced the low survivorship for both classes of cuttings in 2013. Monitoring results from 2014-2016 indicate that cutting survivorship ranged from between 30 percent (red willow and Freemont cottonwood) up to about 60 percent (Gooddings black willow and arroyo willow) (SYRCL 2020).

- Lower Yuba River Large Woody Material Management Plan Pilot Study (USACE 2014)

  The USACE completed a pilot LWM placement project in 2013 (USACE 2012; 2014). LWM was collected from existing stockpiles at New Bullards Bar Reservoir and placed on Lower Gilt Edge Bar along the lower Yuba River. LWM was distributed into 7 root wad piles, 12 log jam piles, and 15 small debris piles. The total area covered by LWM was about 0.4 acre. The intent of the pilot study was to enhance rearing conditions for juvenile spring-run Chinook salmon and steelhead by replenishing the supply of LWM in the lower Yuba River.

- Yuba River Canyon Salmon Habitat Restoration Project (USFWS and Yuba County 2016)

  Funded by the AFRP, the Yuba River Canyon Salmon Habitat Restoration Project was one of five projects identified in a document titled "*Yuba River Canyon – Englebright Dam and Narrows Reaches of the Lower Yuba River Habitat Management and Restoration Plan*" (ESA 2015) that was prepared to support the AFRP's work in the lower Yuba River. Designed to improve about 8.5 acres of spawning habitat and juvenile rearing habitat, the project was located at the lower end of the Englebright Dam Reach, just above the confluence of Deer Creek. The AFRP's restoration approach was to excavate, grade and sort the alluvial bar and enhance existing in-river topography, while reducing the amount of armoring on the adjacent alluvial bar. Construction was completed in the fall of 2018.

- Upper Rose Bar Restoration Project (CDFW 2020c; SYRCL and ESA 2016)

In 2016, SYRCL and others completed a feasibility study and conceptual designs for a habitat restoration project at Upper Rose Bar on the lower Yuba River. The basic concept was to create an additional riffle at the upstream head of Upper Rose Bar and to increase the area of habitat with suitable water depths, velocities, and substrate sizes for anadromous salmonid spawning. On March 25, 2020, CDFW awarded $365,000 to SYRCL for planning-related activities, including completion of restoration designs and environmental compliance, preparation of permit applications, and stakeholder outreach for a future implementation project to restore spawning and rearing habitat at Upper Rose Bar.

- Hallwood Side Channel and Floodplain Restoration Project (USFWS and Yuba County 2017)

  Developed by the AFRP, SYRCL and others, the Hallwood Side Channel and Floodplain Restoration Project is intended to increase the amount of available Chinook salmon and steelhead juvenile rearing habitat in the lower Yuba River. The project has the potential to enhance up to 170 acres of seasonally-inundated riparian floodplain habitats, more than 3 miles of perennial side channels and alcoves, and more than 4 miles of seasonal side channels. The project would occur in four phases, three of which are not fully permitted and are not funded. Phase 1 of the Hallwood Project is in construction, has a local cost-share (YCWA), includes federal participation (USFWS and CVPIA funding), has conservation support (SYRCL), and all permits and approvals are in place.

  Phase 1 represents an enhancement of floodplain rearing habitat within a grading footprint of 89 acres and is comprised of about 1.7 miles of perennial side channels and 6.1 miles of seasonally inundated side-channels, alcoves, and swales. Terraforming and terrain lowering of high elevation terraces and floodplain areas will improve and create new habitat that would become inundated at flows within the operational range for the lower Yuba River (up to about 3,400 cfs from Narrows 2, with an additional 730 cfs release capacity from Narrows 1), and provide floodplain rearing habitat up to 10,000 cfs. The project will increase the extent and duration during which juvenile salmonids are able to access the floodplain over a range of flows, as well as creating and enhancing perennial and seasonal side channel habitat. Beginning in August 2019, the project (Phase 1) removed about 1.2 million cubic yards of sediment from the elevated floodplain and a section of the Middle Training Wall. Phase I is expected to be completed in 2020 or 2021.

- Lower Yuba River Ecosystem Restoration Project Feasibility Report, Final Environmental Assessment and Chief of Engineer’s Report (USACE 2019)

  The Yuba River Ecosystem Restoration Feasibility Study was one of three USACE ecosystem restoration studies authorized by Congress in 2014. The USACE’s 2019 Recommended Plan for the Lower Yuba River Ecosystem Restoration Project involves the restoration of about 179 acres of fry and juvenile rearing habitat along the lower Yuba River. The proposed project would involve four increments of about 43 acres of aquatic habitat (e.g., side channels, backwater areas, bank scallops) and an additional 136 acres of riparian habitat that would be improved through floodplain lowering, grading and native vegetation plantings. Because the Administration has completed its study with the issuance of the Chief of Engineer's Report, the next step would be for Congress to determine whether to authorize and appropriate funds for the USACE to design and construct the project.[5]

- Lower Yuba River Long Bar Restoration Project (SYRCL 2020)

  The AFRP, SYRCL and others are in the process of developing 40 acres of floodplain habitat restoration and nearly one mile of off-channel habitat at the downstream end of Long Bar on the lower Yuba River (SYRCL 2020). During July 2020, the project proponents held a virtual community meeting[6] to discuss the status of the project, and to present information regarding the project design and monitoring.

Licensee also found two sources of anecdotal information that may be relevant to fish resources downstream of the Project. The contents of these anecdotal sources are described below.

- CNDDB

  A query of the CNDDB for special concern species within quadrangles located downstream of the Project (i.e., Browns Valley and Yuba City), did not reveal any confirmed occurrences of fish species of special concern except for the Central Valley fall-/late fall-run Chinook salmon ESU (CDFW 2020a).

- CDFG's Fish Stocking Program

  Salmon and steelhead from the Feather River Hatchery are artificially stocked in waterbodies within numerous counties located downstream of the Project Area including 10 waterbodies in Sacramento County and one in Yuba County (CDFG 2008b).

Pacific Lamprey

The Pacific lamprey (*Lampetra tridentata*) is not listed under the ESA or CESA; however, the species is identified as a USFWS-SC. A petition to list Pacific lamprey under the ESA was reviewed in 2003, with insufficient information to warrant listing (USFWS 2004).

The habitat requirements of Pacific lamprey have not been well studied in Central Valley streams. Much of the understanding of Pacific lamprey life history habitat and population traits

[5] At this time, there is no pending Water Resources Development Act bill to authorize the project, but the possibility exists that a bill could be introduced in the future.

[6] https://www.youtube.com/watch?v=1LiVASXMG1w

is based on collective observations and evaluations of Pacific lamprey elsewhere throughout its range.

The Pacific lamprey is anadromous, though some landlocked forms exist, and has two very distinct parts of its life cycle. Eggs hatch into larvae known as ammocoetes, usually within a freshwater stream. Ammocoetes (larval lamprey) burrow tail first into mud or soft substrate where they filter feed on algae and organic matter. The larval lampreys often move around the stream in their 5-7 year stay in freshwater. When the ammocoetes reach a length of around 14 to 16 cm TL, they begin a drastic change in physiology and physical appearance, assuming a silvery form with large eyes and a sucking disc. The newly morphed lampreys swim downstream to the Pacific Ocean where they take on a new predatory lifestyle in an estuarine or saltwater environment, although rarely straying far from the mouth of their home stream. Pacific lampreys attack and feed on fish, including salmon and flatfish. Their stay at sea usually lasts 3 to 4 years in Canada but may be shortened in more southern populations. Like salmon, the lamprey return to freshwater and migrate upstream to spawn and die. Most upstream movement occurs during the night under high flow conditions. Some streams have different runs of lamprey. Runs may be different in the timing of entry to freshwater or in the amount of time spent in freshwater before breeding occurs.

Adult Pacific lamprey requires clean, gravel-rich riffles in perennial streams to spawn successfully; these requirements are thought to be similar to those of salmonids. Pacific lamprey spends well over half of its total life cycle in freshwater. The adult migration into freshwater towards upstream spawning areas primarily begins between early March and late June (Moyle 2002). Nests are built on gravel substrate, with moderately swift current, water temperatures typically from 12° to 18°C, and at depths ranging from 0.1 to 1.5 m (Moyle 2002). Adults typically die after spawning. Ammocoetes rear in sand and mud substrates, gradually moving downstream over the rearing period. Ammocoetes require water temperatures that are lower than 25°C (Moyle et al. 1995). Meeuwig et al. (2004) found significant death or deformation of eggs and early stage ammocoetes in water with temperatures greater than 22°C. Following ammocoete metamorphosis, downstream migration coincides with high flow events in late-winter and early spring (Moyle 2002).

Within the lower Yuba River, the Pacific lamprey is abundant and well distributed (YCWA 2012). Snorkel and electrofishing surveys of the Yuba River downstream of Englebright Dam (RM 24) documented that juvenile lamprey occur throughout most of this reach. Juvenile Pacific lamprey was the fourth most abundant species (out of 25 species) captured during downstream migration surveys conducted at RM 7.2 from 1999 through 2010. Juvenile Pacific lamprey downstream migration occurred throughout the year with the peak of migration occurring between December and February (YCWA 2012). Although lamprey were most recently observed in the VAKI Riverwatcher fish monitoring system at Daguerre Point Dam during 2016 and 2017, lamprey in the lower Yuba River are not categorized to species. No lamprey were observed in the VAKI Riverwatcher from 2018 through February 2020.

River Lamprey

The river lamprey (*Lampetra ayresi*) (is not listed under the ESA or CESA; however, the species is identified as a CDFW-SSC. A petition to list river lamprey under the ESA was reviewed in 2003, with insufficient information to warrant listing (USFWS 2004).

The river lamprey occurs along most of the Pacific Coast, from just north of Juneau, Alaska, to San Francisco Bay in California. While its general range is widespread, detailed information on its distribution and abundance is lacking. The river lamprey is associated with large river systems such as the Fraser, Columbia, Klamath, Eel, and Sacramento rivers. Beamish (1980) and others have noted that river lamprey appears to be concentrated only in particular rivers, and only in the lower portions of these large rivers.

Little information is available on river lamprey life history. According to Moyle (2002), its life span is 6 to 7 years. Adult lampreys spawn in gravel bottomed streams, at the upstream end of riffle habitat. Both sexes construct the nests, often moving stones with their mouths. River lampreys lay 11,400 to 37,300 eggs per adult female. Adults typically die after the eggs are deposited and fertilized. After the eggs hatch, young ammocoetes drift downstream to areas of low velocity and silt or sand substrate. They remain burrowed in the stream bottom, living as filter feeders on algae and detritus for 2 to 7 years. Metamorphosis from the ammocoete to macropthalmia lifestage occurs between July and April. At this time, macropthalmia are thought to live deep in the river channel, which may explain why they are rarely observed. As adults, their oral disc develops just before they enter the ocean between May and July. During the relatively brief 3 to 4 months they are at sea in the parasitic phase, they remain close to shore, feeding primarily on smelt and herring near the surface. After the adult feeding phase, river lampreys migrate to spawning areas and cease feeding. Its degree of fidelity to its natal streams is unknown.

Riffle and side channel habitats are important for spawning and for ammocoete rearing. Because lamprey ammocoetes colonize areas and are relatively immobile in the stream substrates, good water quality is essential for rearing. Adults feed in nearshore marine and estuarine habitat.

River lampreys were consistently observed emigrating past the RST survey sites near Hallwood Boulevard (RM 7.2) in the lower Yuba River between 1999 and 2010 (YCWA 2013a). A total of 340 juvenile river lampreys were counted at the RST sites during the survey period. As discussed above, although VAKI Riverwatcher observations of lamprey in the lower Yuba River are not categorized to species, lamprey were most recently observed during 2016 and 2017. No lamprey were observed in the VAKI Riverwatcher from 2018 through February 2020.

Sacramento-San Joaquin Roach[7]

The Sacramento-San Joaquin Roach (*Lavinia symmetricus*) is not listed under the ESA or CESA; however, the species is identified as a CDFW-SSC.

The Sacramento-San Joaquin roach is part of the California roach complex, which is composed of various subspecies. The Sacramento-San Joaquin roach is found in the Sacramento and San Joaquin River drainages, except the Pit River, and in other tributaries to San Francisco Bay. The Sacramento-San Joaquin roach is generally found in small, warm intermittent streams, and is most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002). Assuming that the Sacramento-San Joaquin roach is indeed a single taxon, which is unlikely, it is abundant in a large number of streams although it is now extirpated from a number of streams and stream reaches where it once occurred (Moyle 2002). Roach are tolerant of relatively high temperatures (86°F to 95°F) and low oxygen levels (1 to 2 mg/L) (Taylor et al. 1982). However, it is a habitat generalist, also being found in cold, well-aerated clear "trout" streams (Taylor et al. 1982), in human-modified habitats (Moyle 2002; Moyle and Daniels 1982) and in the main channels of rivers.

Reproduction occurs from March through early July, depending on water temperature (Moyle 2002). Murphy (1943) states that spawning is determined by water temperature, which must be approximately 60°F for spawning to be initiated. During the spawning season, schools of fish move into shallow areas with moderate flow and gravel/rubble substrate (Moyle 2002). Females deposit adhesive eggs in the substrate interstices and the eggs are fertilized by attendant males. Typically, 250-900 eggs are produced by a female and the eggs hatch within two to three days. Fry remain in the substrate interstices until they are free-swimming.

Within Yuba County, Sacramento-San Joaquin roach have been reported to occur in the upper Yuba River Watershed, the lower Bear and Feather rivers, the Middle Fork of the Feather River, and the Honcut Creek headwaters (UC Davis 2009). In addition, Sacramento-San Joaquin roach have been documented during the RST monitoring on the lower Yuba River (Casey Campos, PSMFC, 2009 pers. comm.). More recently, there have been no observations of Sacramento-San Joaquin roach in the VAKI Riverwatcher fish monitoring system at Daguerre Point Dam from 2015 through February 2020.

[7] Photo source - http://calfish.ucdavis.edu/calfish/CaliforniaRoach.htm

Hardhead

The hardhead (*Mylopharodon conocephalus*) is not listed under the ESA or CESA; however, the species is identified as a CDFW-SSC.

Hardhead is a large (i.e., up to 60 cm standard length [SL]), long-lived (i.e., 10 years plus) minnow that is native to the Sacramento-San Joaquin River watersheds of Central California.

Historically, the hardhead was considered a widespread and locally abundant species within its range. Substantial alteration of its relatively specialized habitat requirements and predation, as well as competition from introduced black bass and other centrarchids, have resulted in population declines and isolated populations (Moyle 2002). Today, the species is still widely distributed in the Sacramento-San Joaquin drainage, as well as in the Russian River drainage, although its abundance is considered to be substantially reduced. The current range of hardhead extends from the Kern River in the south to the Pit River in the north. In the Sacramento River drainage, hardhead is present in most of the larger tributary streams as well as in the Sacramento River.

Hardhead is typically found within larger mid- and low-elevation streams where summer mean daily water temperatures exceed 20°C (Moyle and Nichols 1973; Moyle and Daniels 1982). The elevation range of hardhead is 30 to 4,750 ft (Reeves 1964). Optimal summer temperatures appear to range between 24° and 28°C (Knight 1985). Hardhead is relatively intolerant of low DO levels, especially at higher temperatures, a factor which may limit its distribution to well-oxygenated streams and the surface water of reservoirs (Cech et al. 1990). Adult hardhead generally rear in clear, deep (>1 m) pools with sand-gravel-boulder substrates and slow water velocities (<25 cm sec-1) (Moyle and Nichols 1973, Knight 1985, Moyle and Baltz 1985). Adult hardhead tend to remain in the lower portion of the water column; they rarely move into the upper water column (Knight 1985). Juvenile hardhead concentrate in shallow water close to the stream margin (Moyle and Baltz 1985). Hardhead spawning occurs during the spring (March-May), when hardhead migrate upstream to gravel riffles, often within tributary streams.

Hardhead is a bottom feeding species that forages for benthic invertebrates and aquatic plant material in quiet water. Smaller, younger hardhead (<20 cm SL) feed primarily on mayfly and caddisfly larvae, and small snails (Reeves 1964). Larger, older hardhead feed more on aquatic plants (especially filamentous algae), as well as crayfish and other large invertebrates (Moyle et al 1995). Hardhead mature following their second year.

Within Yuba County, hardhead has been reported to occur in the Yuba River upstream of Englebright Dam, the lower Bear, Feather, and Yuba rivers, and the Honcut Creek headwaters (U.C. Davis 2012). Hardhead is the only special-status fish species confirmed[8] during YCWA's fish population surveys for the Yuba River Development Project relicensing to occur upstream of Englebright Dam. YCWA's fish population studies for the YRDP relicensing also confirmed that hardhead occur in the lower Yuba River (YCWA 2013b).

Adult and juvenile hardhead have been documented in the lower Yuba River downstream of Englebright Dam during various surveys conducted since the late 1980s (Beak 1989; Kozlowski 2004; ICF/JSA 2003, 2008, 2009, 2010; RMT 2013; YCWA 2012) (Figure 3.2.3-3). Juvenile hardhead were routinely collected during juvenile salmon emigration studies on the Yuba River between 1999 and 2009 (YCWA 2012; RMT 2013). Rotary screw traps (RST) operating near RM 7.2 (1999-2009)[9] annually collected downstream migrating juvenile hardhead. Juvenile hardhead were also routinely observed between Englebright Dam and the Feather River during snorkel and electrofishing surveys conducted between 1985 and 2002. However, no hardhead were observed during RMT snorkel surveys in 2012 (RMT 2013). More recently, hardhead have been recorded annually in the VAKI Riverwatcher fish monitoring system at Daguerre Point Dam from 2015 through February 2020.

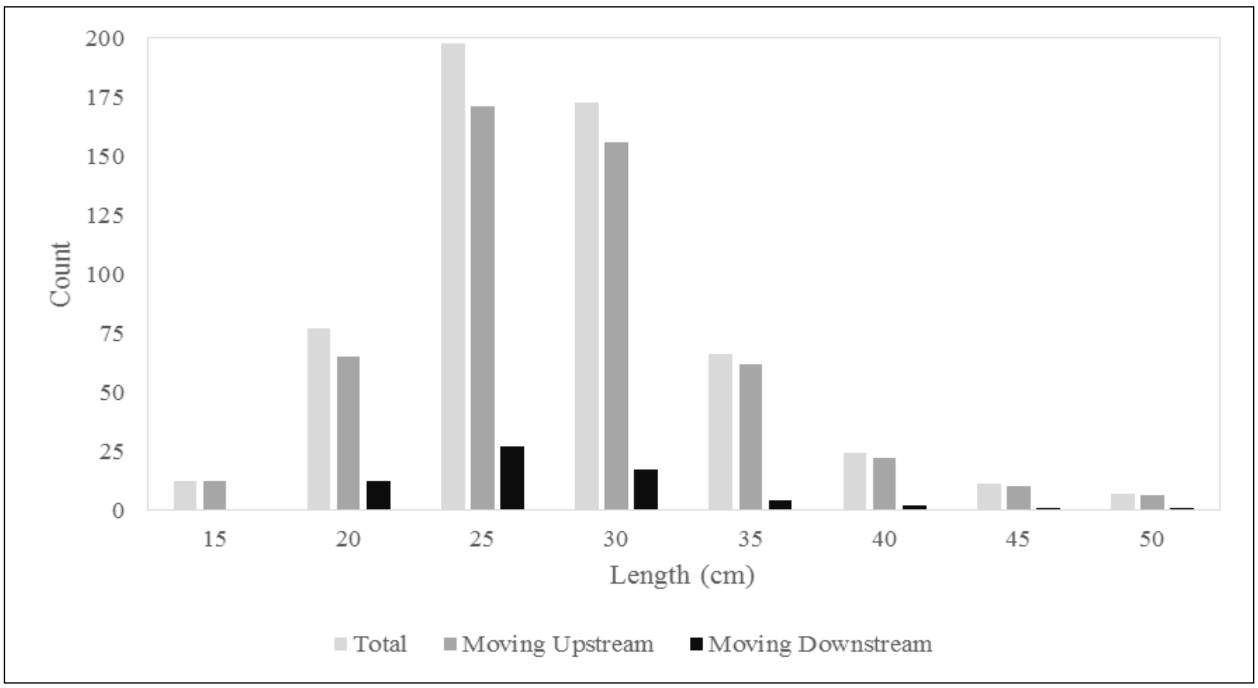

Figure 3.2.3-3. Size distribution and direction of movement of hardhead observed using a VAKI RiverwatcherTM fish monitoring system at Daguerre Point Dam fishways (RM 11.6) between January 2004 and February 2015.

8 Sacramento-San Joaquin roach is reported to occur in the upper Yuba River Watershed; however, the source does not provide any documentation.
9 RST surveys ended in 2009.

Adult and juvenile (< 20 cm SL) hardhead have been observed moving past Daguerre Point Dam (RM 11.6) during the VAKI Riverwatcher™ stream survey[10] (Figure 3.2.3-4 YCWA 2012a). Both upstream and downstream passage was observed. Upstream passage occurred between January and October but was concentrated during the May and June spawning period (Figure 3.2.3-2). Downstream passage was observed between March and August, with the majority (63%) of downstream passage occurring during June.

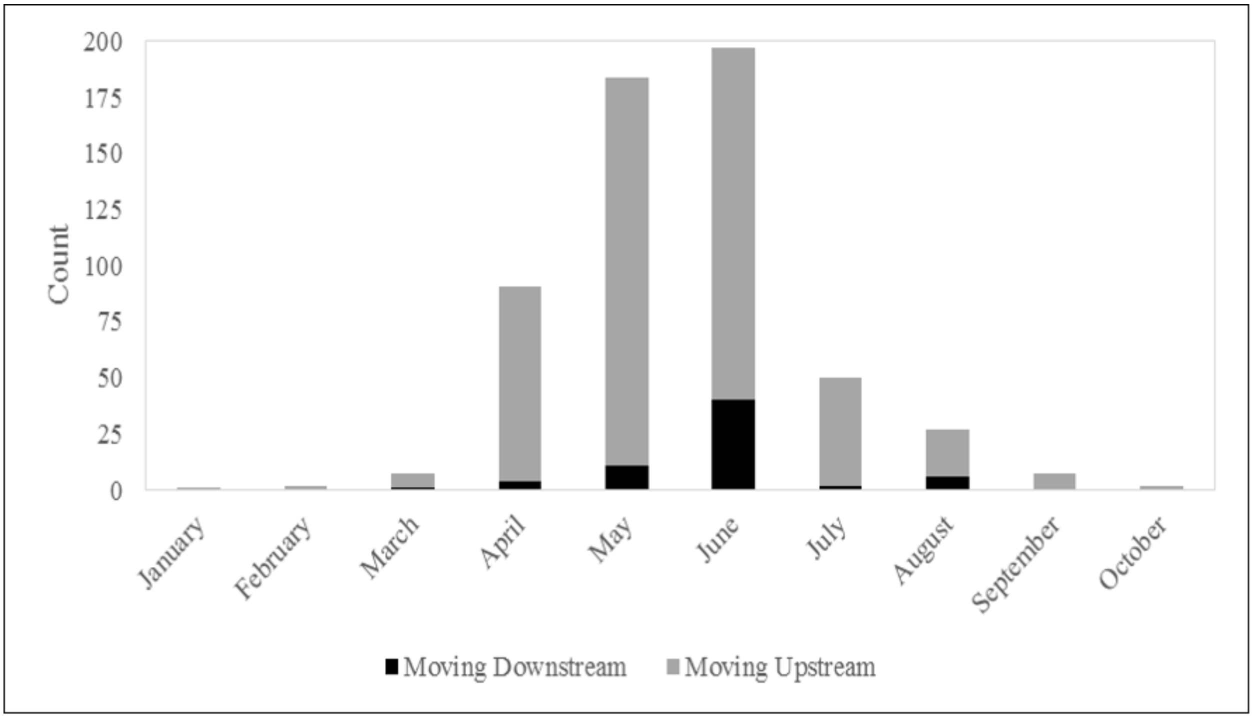

Figure 3.2.3-4. Temporal distribution and direction of movement of hardhead observed using a VAKI Riverwatcher™ fish monitoring system at Daguerre Point Dam fishways (RM 11.6) between January 2004 and February 2015.

Chum Salmon

The Chum salmon (*Oncorhynchus keta*) is not listed under the ESA or CESA; however, the species is identified as one that is managed by the PFMC.

Chum salmon has the widest natural geographical distribution of the Pacific salmons, ranging from Korea up along the Arctic coast of Russia, and from the Mackenzie River on the Canadian Arctic coast of North America southward into central California. Historically, the species was reported to occur in all streams from San Francisco to the Bering Straits, and was said to be

[10] VAKI Riverwatcher™ surveys have continued through 2017. Reportable data are only available through February 2015.

abundant in the fall, from Sacramento northward (Moyle et al. 1995). Chum salmon has an anadromous life history that is typically completed in 3-5 years. The freshwater life stage is very short as chum fry immediately swim downstream upon emergence, migrating quickly to the estuary.

In North America, there is a northern (early-run) stock that spawns from June through September and a southern (late-run) stock that spawns from August through January. In Washington, Oregon, and California, all stocks are late-run. The early-run fish generally spawn in main stems of streams, while the late-run fish spawn in smaller streams which have more favorable winter temperatures. Adults show strong homing behavior to their natal streams. They can spawn at 2-7 years of age, but primarily spawn at ages 3-5.

Presently in California, chum salmon is rarely encountered. A few adults and juveniles are regularly observed in the Klamath River (Moyle et al. 1995). Adult chum salmon have also been reported in Humboldt Bay, the Eel River (Redwood Creek, Humboldt County), the South Fork Trinity River, the Smith River drainage, and in Mill Creek (Del Norte County). The southernmost freshwater occurrence of chum salmon recorded was in the San Lorenzo River (Santa Cruz County) in the early 1900s.

In the 1880s, chum salmon was a minor portion of the salmon catch in the Sacramento River system along with pink, coho, and Chinook salmon (Moyle et al. 1995). Sixty-eight chum salmon were observed during a 10-year (1949-1958) survey of the Sacramento River. Since then, a few fish have been observed in the Sacramento drainage, including one chum in the Yuba River in the mid-1970s, five at the Feather River Hatchery over the last 25 years, and several at Nimbus Fish Hatchery on the American River up until 1990.

A single adult chum salmon was recorded passing Daguerre Point Dam in November 2008 during the VAKI Riverwatcher™ survey. Two additional chum salmon were identified in 2013, one chum salmon was identified in 2017, and two chum salmon were identified in 2018. No additional sightings were identified from available data from 2004 through February 2020. None of the previously conducted or currently ongoing juvenile monitoring studies in the Yuba River have observed chum salmon. There currently is not a sustained population of chum salmon in the lower Yuba River.

Pink Salmon

The pink (*Oncorhynchus gorbuscha*) is not listed under the ESA or CESA; however, the species is identified as one that is managed by the PFMC.

The pink salmon occur around the Pacific Rim of Asia and North America. However, the spawning distribution of pink salmon is much more restricted, extending from Puget Sound, Washington to Norton Sound, Alaska in North America and from North Korea to Anadyr Gulf, Russia (Moyle et al. 1995). Pink salmon live for 2 years. Adults move into fresh water between June and September and spawn from mid-July to late

October, depending on the geographic location. Spawning in California has only been recorded in October (Fry 1967). Most pink salmon spawn in the intertidal or lower reaches of streams and rivers. Embryos hatch after 4 to 6 months of incubation, presumably in February and March in California. The alevins emerge from the gravel in April or May, after which the fry immediately begin to migrate downstream into the estuary. Juvenile migration is rapid and fish spawned within the lower reaches of the river usually reach the estuary in one night. Once in the estuary, they form large schools and remain in the inshore areas for several months before moving out to sea.

California is the southern extent of pink salmon range and, although the species was probably never common in California, they have occurred in noticeable numbers in the past (Moyle et al. 1995). In the late 1880s, the pink salmon was reported to occur in the Sacramento River system as well as in Humboldt County waters, and pinks were included in the salmon catch sent from the northern coast to San Francisco markets (Collins 1892). During the late 1800s, pink salmon was reported to occur in the Sacramento River, usually in October. During the 1930s, commercial fishermen on the Sacramento River reportedly captured a dozen or more pink salmon in some seasons (Hallock and Fry 1967). Thirty-eight pink salmon were reportedly observed in the Sacramento River system during the period from 1949 to 1958, with fish taken near Redding, in Mill Creek, and at Nimbus Fish Hatchery on the American River (Hallock and Fry 1967). Recent occurrences of pink salmon in the Sacramento River basin have been infrequent. Several pink salmon were observed in the American River during the early 1990s. Spawning occurs on occasion in the Sacramento-San Joaquin River system. Juvenile pink salmon were identified at the state J.E. Skinner Fish Protective Facility near Tracy in 1990 (Moyle et al 1995).

In 2011 and 2013, pink salmon were observed in the lower Yuba River during the VAKI Riverwatcher™ survey at Daguerre Point Dam (Table 3.2.3-3). These were the only sightings during the 16 years of available data (2004-February 2020). Altogether, eight adults and one subadult (24 cm was considered sub-adult due to significantly smaller size) were observed migrating upstream past Daguerre Point Dam, and two adults were observed passing downstream of the dam. There is not a sustained population of pink salmon in the lower Yuba River, and the fish is not reported to occur upstream of Englebright Dam.

Table 3.2.3-3. Summary of pink salmon observed migrating past Daguerre Point Dam in the Yuba River during the VAKI Riverwatcher™ monitoring study from 2004 through 2020.

Date Observed	Length (cm)	Migrating
4/25/11	24	Upstream
8/28/11	49	Upstream
9/9/11	77	Upstream
9/16/11	86	Upstream
9/16/11	76	Downstream
9/16/11	88	Upstream
9/16/11	65	Downstream
9/16/11	72	Upstream
10/10/11	47	Upstream
9/10/13	78	Upstream
9/25/13	67	Upstream
Total	**11**	**9 = Upstream** **2 = Downstream**

Sacramento splittail

The Sacramento splittail (*Pogonichthys macrolepidotus*) is not listed under the ESA or CESA; however, the species is identified as a CDFW-SSC. The fish was federally listed as threatened on February 8, 1999 and delisted on September 22, 2003 (USFWS 2003).

Splittail are large cyprinids, growing in excess of 30 cm and are adapted to living in freshwater and estuarine habitats as well as alkaline lakes and sloughs (Moyle 2002).

Sacramento splittail is typically found in water with temperatures between 5° and 24°C. However, fish acclimated to higher temperatures (29° to 33°C) reportedly can survive rapid changes in water temperature for short periods of time (Moyle 2002). In laboratory studies conducted at the University of California at Davis, mean critical thermal minima (CT_{min}) and maxima (CT_{max}) for age-2 fish were 7° and 29°C, respectively (Young and Cech 1996). The onset of Sacramento splittail spawning reportedly is associated with increasing water temperatures of 14° to 19°C (Moyle 2002). Sacramento splittail reportedly prefers to spawn in water temperatures that range from 9° to 20°C (Caywood 1974).

Historically, splittail inhabited sloughs, lakes, and rivers of the Central Valley with populations extending upstream to Redding in the Sacramento River, to the vicinity of the Colusa-Sacramento River State Recreation Area, in Butte Creek/Sutter Bypass, to Oroville in the Feather River, to Folsom in the American River, and to Friant in the San Joaquin River (Moyle et al. 2004; USFWS 2003). The current distribution is limited by dams and other barriers. Currently, the species is known to migrate up the Sacramento River to Red Bluff and up the San Joaquin River to Salt Slough in wet years as well as into the lower reaches of the Feather and American rivers (USFWS 2003).

Splittail has been documented in the Feather River Watershed as far upstream as Oroville (Moyle et al. 2004). The University of California Fish Website (U.C. Davis 2012) lists the Yuba River downstream of Englebright Dam among the watersheds where splittail occurs, although no reference is provided for this determination, and YCWA could not find any verified observations of splittail nor was it found during YCWA's Yuba River Development Project relicensing studies.

Northwestern pond turtle

The northwestern pond turtle (*Actinemys marmorata marmorata*) (NWPT) is not listed under the ESA or CESA; however, the species is identified as a SSC.

There are two native aquatic turtles - the NWPT and the southwestern pond turtle (*Actinemys pallida*)- in California. The NWPT ranges from the San Francisco Bay all the way up to British Columbia. NWPT live in a variety of natural habitats including small mountain creeks, large rivers and oxbow lakes, and modified habitats, such as wastewater treatment oxidation ponds, irrigation ditches, urban parks, and artificially created lakes from sea level to nearly 6,700 feet (Nafis 2020a).

Although highly aquatic, NWPT often overwinter in forested habitats and eggs are laid in shallow nests in sandy or loamy soil in summer at upland sites as much as 1,200 feet from aquatic habitats (Jennings and Hayes 1994). Hatchlings do not typically emerge from the covered nests until the following spring. Reese and Welsh (1997) documented NWPT away from aquatic habitats for as much as seven months a year and suggested that terrestrial habitat use was at least in part a response to seasonal high flows. Basking sites are an important habitat element (Jennings and Hayes 1994) and substrates include rocks, logs, banks, emergent vegetation, root masses, and tree limbs (Reese undated). Terrestrial activities include basking, overwintering, nesting, and moving between ephemeral sources of water (Holland 1991). Breeding activity may occur year-round in California, but egg-laying tends to peak in June and July in colder climates, when females begin to search for suitable nesting sites upslope from water. Adult NWPTs have been documented traveling long distances from perennial watercourses for both aestivation and nesting, with long-range movements to aestivation sites averaging about 820 feet, and nesting movements averaging about 295 feet (Rathbun et al. 2002). During the terrestrial period, Reese and Welsh (1997) found that radio-tracked WPTs burrowed in leaf litter. Introduced species of turtles (e.g., red-eared sliders) may out-compete WPT for basking sites, and bullfrogs are known to consume hatchling WPTs.

The Yuba River provides potential habitat for WPT, as the species is known to live in large rivers like the Yuba River. Along the Yuba River, habitats potentially suitable for WPT include numerous mid-channel, scour pools located downstream of Timbuctoo Bend. As part of the relicensing of the YRDP, YWCA conducted NWPT surveys, including just below Englebright Dam. The species was observed at Englebright Lake during YCWA's surveys. Figure 3.2.3-5 shows the location of the field reconnaissance sighting, as well as known NWPT occurrences along or near the Yuba River up to Daguerre Point Dam.

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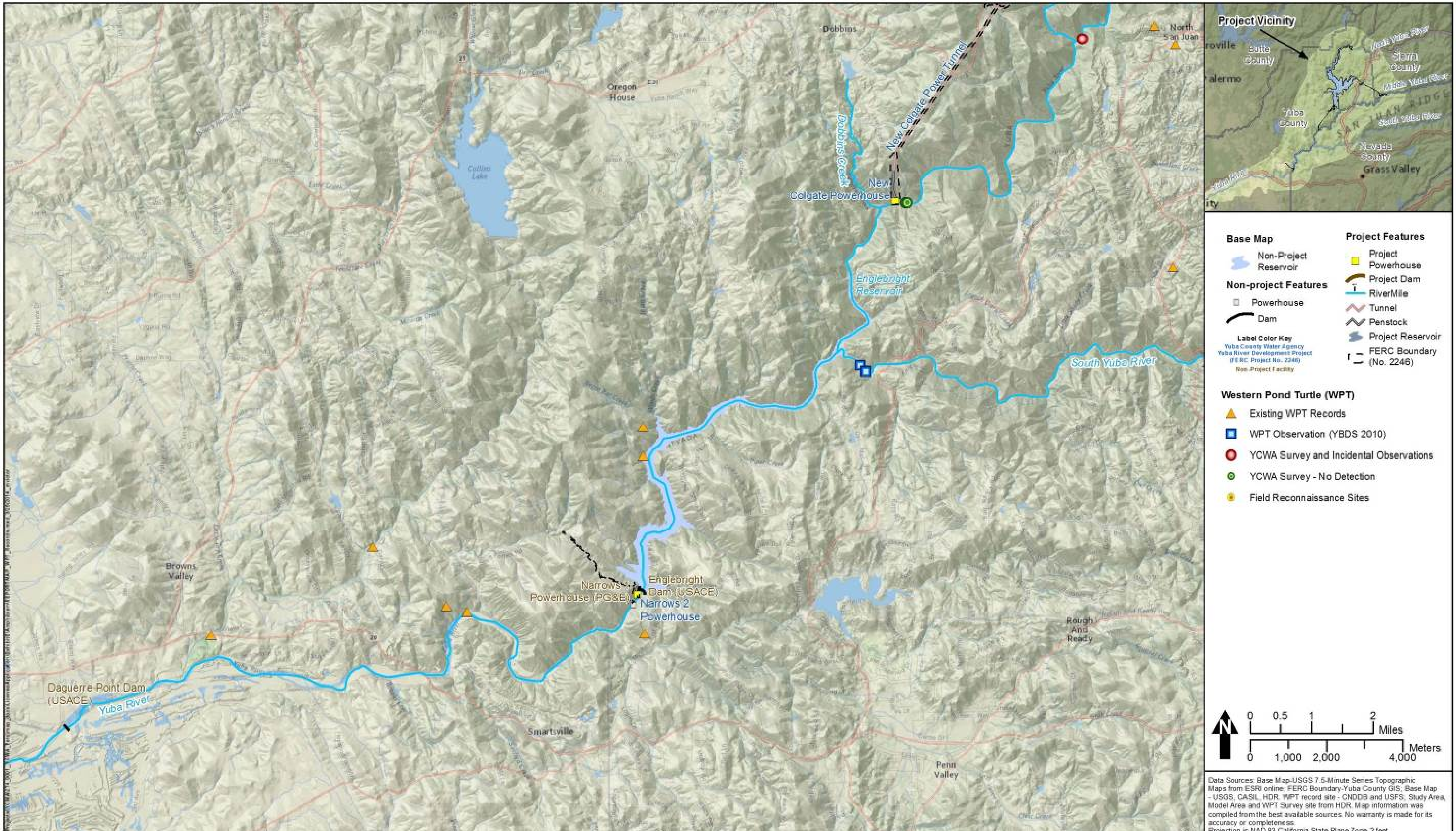

Figure 3.2.3-5. Locations of WPT field reconnaissance and survey detections, incidental observations, and existing records.

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3.2.3.1.2 Fishes and Aquatic Resources

Fishes in the Watershed

Lower Yuba River

The most recent summary of information regarding fishes in the lower Yuba River is YCWA's 2017 Application for New License, as amended, for the Yuba River Development Project (YCWA 2017). Provided below is a summary of information in the application from pages 3.3.3-37 through 3.3.3-52 of the Amended Application.

YCWA found reliable, documented occurrences of 41 fish species and anecdotal unverified reports of three species, for a total of 44 fish species in the lower Yuba River. Twenty-one species (48% of the total fish species), nine of which are anadromous, are native to California. Twenty-three species (52% of the total fish species), two of which are anadromous, were introduced to California waters. None of the fish species documented in the area are catadromous, and none are reported as endemic to the Yuba River basin. Relative abundance, temporal and spatial distribution, and habitat utilization of the reported fish species were derived primarily from two studies conducted between 1986 and 2001 (Beak 1991, Kozlowski 2001), and several studies by the RMT (RMT 2013). Table 3.2.3-4 lists the fish species and their distribution in the lower Yuba River.

Table 3.2.3-4. Fish species distribution in the Yuba River downstream of Englebright Dam.

Common Name	Scientific Name	Reach[1,2,3]			
		Narrows	Garcia Gravel Pit	Daguerre Point Dam	Simpson Lane
NATIVE RESIDENT SPECIES					
California roach	*Hesperoleucus symmetricus*				
Hardhead	*Mylopharodon conocephalus*				
Hitch	*Lavinia exilicauda*				
Prickly sculpin	*Cottus asper*				
Riffle sculpin	*Cottus gulosus*				
Sacramento blackfish	*Orthodon microlepidotus*				
Sacramento pikeminnow	*Ptychocheilus grandis*				
Sacramento splittail	*Pogonichthys macrolepidotus*				
Sacramento sucker	*Catostomus occidentalis*				
Speckled dace	*Rhinichthys osculus*				
Rainbow trout	*Oncorhynchus mykiss*				
Tule perch	*Hysterocarpus traskii*				
NATIVE ANADROMOUS SPECIES					
Fall-run Chinook salmon	*Oncorhynchus tshawytscha*				
Spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*				
Chum salmon	*Oncorhynchus keta*				
Pink salmon	*Oncorhynchus gorbuscha*				
Steelhead trout	*Oncorhynchus mykiss*				
Pacific lamprey	*Entosphenus tridentatus*				
River lamprey	*Lampetra ayresii*				
Green sturgeon	*Acipenser medirostris*				
White sturgeon	*Acipenser transmontanus*				
INTRODUCED RESIDENT SPECIES					
Black bullhead	*Ameiurus melas*				
Black crappie	*Pomoxis nigromaculatus*				
Bluegill	*Lepomis macrochirus*				

Table 3.2.3-4. (continued)

Common Name	Scientific Name	Reach[1,2,3]			
		Narrows	Garcia Gravel Pit	Daguerre Point Dam	Simpson Lane
INTRODUCED RESIDENT SPECIES					
Brown bullhead	*Ameiurus nebulosus*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Brown trout	*Salmo trutta*		RST data	RST data	
Carp	*Cyprinus carpio*		RST data	RST data	VAKI Riverwatcher™ data
Channel catfish	*Ictalurus punctatus*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Fathead minnow	*Pimephales promelas*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Golden shiner	*Notemigonus crysoleucas*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Green sunfish	*Lepomis cyanellus*	Direct observation	Direct observation	VAKI Riverwatcher™ data	Direct observation
Inland silverside	*Menidia beryllina*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Largemouth bass	*Micropterus salmoides*		RST data	RST data	VAKI Riverwatcher™ data
Redear Sunfish	*Lepomis microlophus*			Direct observation	VAKI Riverwatcher™ data
Smallmouth bass	*Micropterus dolomieu*		Direct observation	Direct observation	Direct observation
Threadfin shad	*Dorosoma petenense*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Wagasaki	*Hypomesus nipponensis*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Warmouth	*Lepomis gulosus*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
White catfish	*Ameiurus catus*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
White crappie	*Pomoxis annularus*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Bigscale logperch	*Percina macrolepida*			VAKI Riverwatcher™ data	VAKI Riverwatcher™ data
Mosquitofish	*Gambusia affinis*				Direct observation
INTRODUCED ANADROMOUS SPECIES					
American shad	*Alosa sapidissima*		VAKI Riverwatcher™ data	VAKI Riverwatcher™ data	Direct observation
Striped bass	*Morone saxatilis*		VAKI Riverwatcher™ data	VAKI Riverwatcher™ data	Direct observation

1 The reaches below Englebright Dam are defined as follows:
Narrows = From Englebright Dam to the downstream side of the Narrows 1 Powerhouse.
Garcia Gravel Pit = From Narrows Reach to Daguerre Point Dam.
Daguerre Point Dam = From Daguerre Point Dam to the downstream terminus of the Yuba Goldfield.
Simpson Lane = From the Yuba Goldfield to the confluence with the Feather River.

2 SOURCE: Table 3.3.3.-21 in YCWA's Application for New License, as amended (YCWA 2017).

3 Key:
Based on direct observation
Based only on VAKI Riverwatcher™ data
Based only on rotary screw trap (RST) data

Abundance of non-anadromous fishes in the lower Yuba River is best illustrated by the combined results of the RST surveys for 2007 through 2009 (Figure 3.2.3-6). These results show the most abundant non-anadromous fish species was threadfin shad, an introduced species, followed by sculpin, pikeminnow, largemouth bass, and Sacramento sucker.

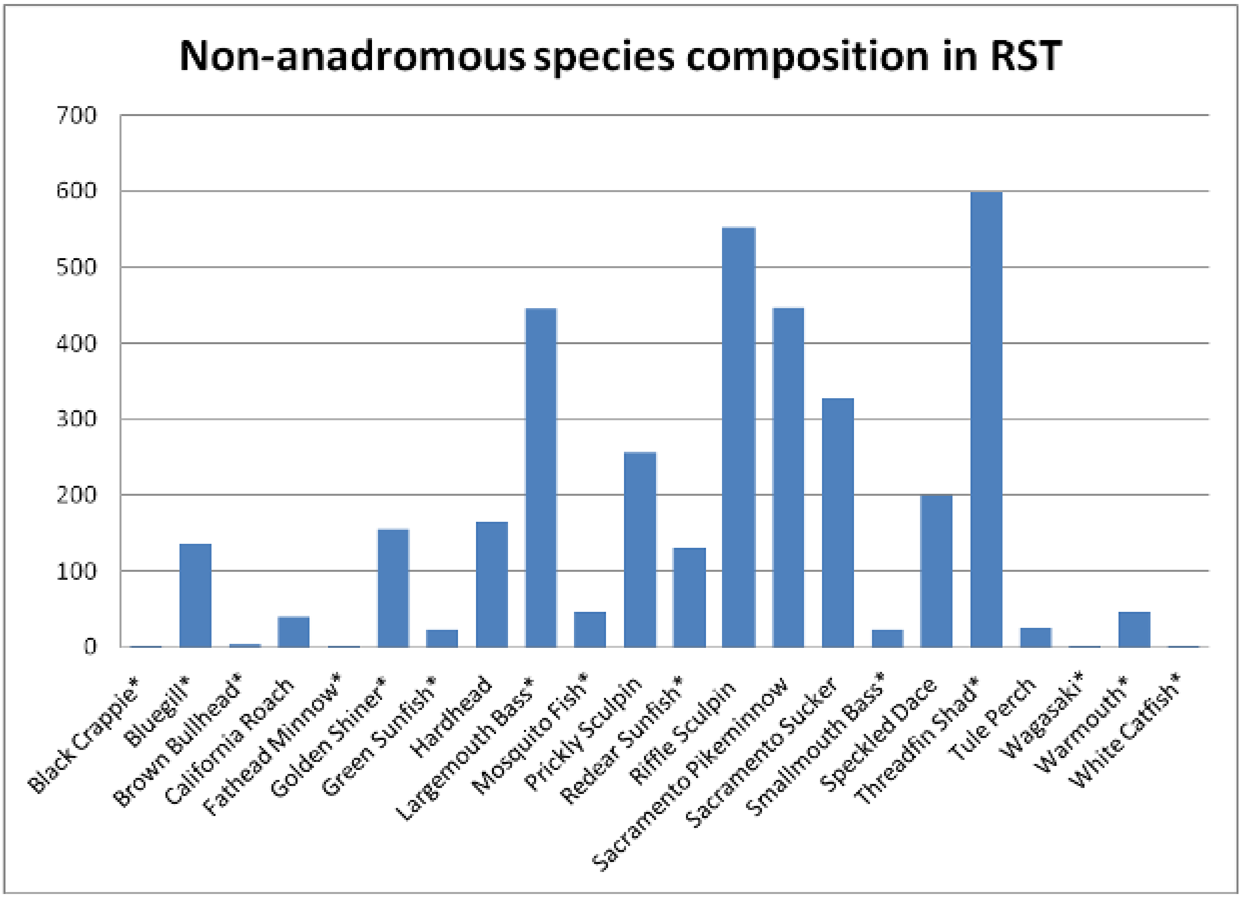

Figure 3.2.3-6. Non-anadromous species composition collected by RSTs in the Yuba River downstream of Englebright Dam during the 2007-2008 and 2008-2009 RMT surveys. (Asterisk indicates introduced species).

Englebright Reservoir

Englebright Reservoir was extensively stocked from 1950 through 2016 (YCWA 2017). Rainbow trout was the most commonly planted fish species over this period representing approximately 756,000 fish planted from 1965 through 2007 (Figure 3.2.3-7) (CDFG 2008a). Other species with sporadic or isolated plantings included brown trout, black crappie, brook trout, kokanee, lake trout, and white crappie. Since 2000, rainbow trout and brown trout have been the only species planted in Englebright Reservoir. Table 3.2.3-5 provides stocking numbers by species, where information was available, from 1965 through 2016.

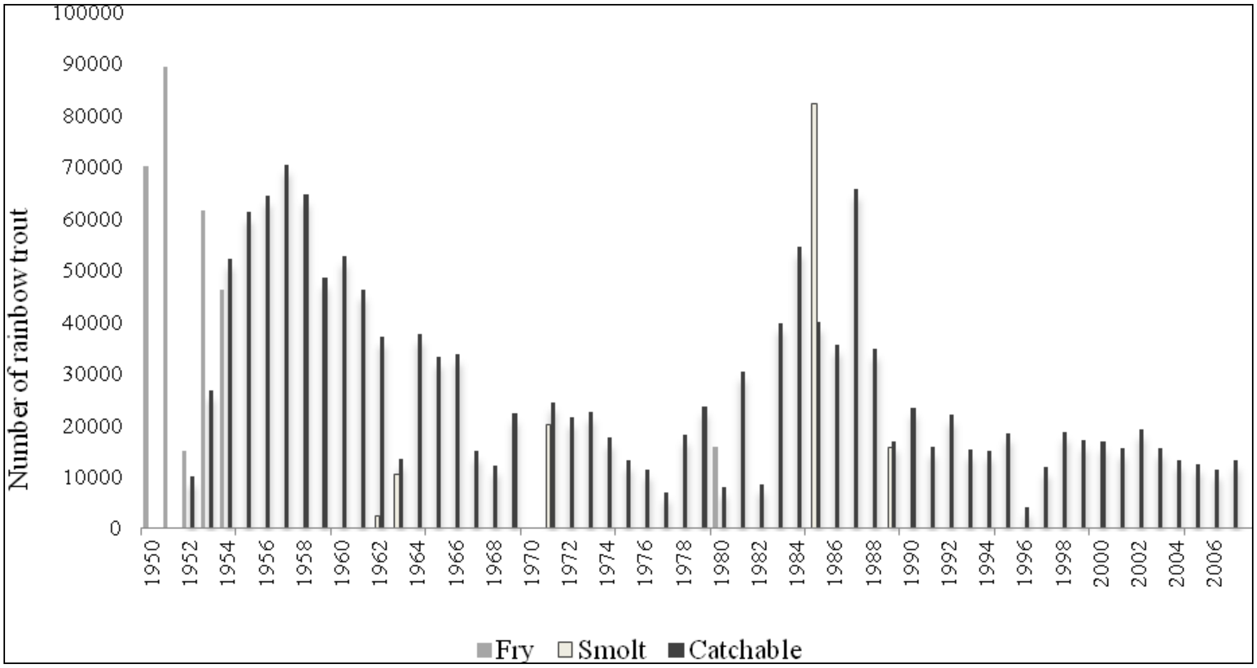

Figure 3.2.3-7. Historical CDFW rainbow trout planting at Englebright Reservoir.

Table 3.2.3-5. Known stocked fish species in Englebright Reservoir from 1965 through 2016 in order of abundance.

Fish Species	Year(s) Planted	Estimated Yearly Mean
DATA PERIOD 1965-2012		
Rainbow trout (various origin)	1965 – 2007, 2011 & 2012	--
Kokanee	1965, 1966 & 1977	76,107
Brown trout	1965, 1969, 1973, 1981, 1983, 1984, 1986, 1997, 2006, 2007 & 2008	3,459
Eagle Lake rainbow trout	1999	4,000
Lake trout	1965 & 1966	3,487
Brook trout	1986	990
Black crappie	1984	80
White crappie	1984	45
DATA PERIOD 2013-2016		
Rainbow trout (various origin)	2013-2016	10,634
Brown trout	2015	25,000

Source: CDFG 2008a; J. Rowan, pers. comm., 2012 and 2017.

Stocking by CDFW ceased for a period after 2007, pending a pre-stocking evaluation (CDFG 2008a), but resumed in 2011, with the planting of 16,400 triploid (sterile) rainbow trout. Skippers Cove Marina (N. Rogers, CEO, pers. comm., 2012) received approval to raise triploid rainbow trout in net pens on Englebright Reservoir on October 10, 2011. They raised approximately 600 fish in four pens, of which 15 were tagged. Fish started in net pens at 2 pounds and were raised to between 4 to 6 pounds prior to release. The first triploid rainbow trout plant occurred in spring 2012. Five of the 15 tags were returned, providing some insight into fishing success. Additional stocking events occurred from 2013-2016. More recently, up to

5,000 triploid trout were stocked in net pens and the reservoir (2,500 1/2 lb. fish) during 2018. Similar fish stocking activities occurred during 2019 and 2020 (CDFW 2020b).

Other species have been planted with less regularity than rainbow trout (Table 3.2.3-6). Brown trout have been stocked periodically since 1965, with about 38,000 planted through 2008. Other species have been planted only one to three times each since 1965, with no species other than rainbow trout or brown trout planted since 1999.

Table 3.2.3-6. Infrequently or irregularly stocked fish species in Englebright Reservoir (from CDFG 2008a).

Fish Species	Year(s) Planted	Estimated Yearly Mean
DATA PERIOD 1965-2012		
Rainbow trout (various origin)	1965 – 2007, 2011 & 2012	--
Kokanee	1965, 1966 & 1977	76,107
Brown trout	1965, 1969, 1973, 1981, 1983, 1984, 1986, 1997, 2006, 2007 & 2008	3,459
Eagle Lake rainbow trout	1999	4,000
Lake trout	1965 & 1966	3,487
Brook trout	1986	990
Black crappie	1984	80
White crappie	1984	45
DATA PERIOD 2013-2016		
Rainbow trout (various origin)	2013-2016	10,634
Brown trout	2015	25,000

Source: CDFG 2008a; J. Rowan, pers. comm., 2012 and 2017.

YCWA conducted fish population sampling at Englebright Reservoir in 2012 to supplement and update known historical fisheries information. Sampling included gill netting at four sites and boat electrofishing at five sites, performed once in June 2012. YCWA's study documented 11 fish species. Sacramento sucker (n=114, 31.5%) and spotted bass (n=96, 26.5%) were the more common species collected, followed by hardhead (n=49, 13.5%), rainbow trout (n=30, 8.3%), bluegill (n=27, 7.5%), and Sacramento pikeminnow (n=25, 6.9%) (Table 3.2.3-7). Sacramento sucker, Sacramento pikeminnow, hardhead, spotted bass, and rainbow trout catches included individuals from an exceptionally wide range of size classes. No species accounted for the majority of biomass (over 50% of total weight); however, biomass of Sacramento sucker was more than double that of any other species. Mean relative condition factor of all species was at least 1.0 (YCWA 2017).

The length-frequency distribution of hardhead displayed a wide range of ages present in the reservoir, including age-0 and adult fish, indicating the occurrence of natural reproduction. Hardhead are commonly found in low to mid-elevation sections of rivers, in warm, low-gradient margin habitat (Moyle 2002). This hardhead population likely was present in the river when the dam was constructed and has successfully persisted in similar lacustrine habitat.

Table 3.2.3-7. Summary of relative abundance, length, and weight of all fish species collected in Englebright Reservoir during June 2012 in order of abundance.

Species		N	Percentage of Total (%)	Length (mm)			Weight (g)			Mean Relative Condition[1]
Common Name	Scientific Name			Min	Max	Mean	Min	Max	Mean	
Sacramento sucker	*Catostomus occidentalis*	114	31.5	48	525	289	1.1	1,650	543.5	1.03
Spotted bass	*Micropterus punctulatus*	96	26.5	45	410	219	1.0	1,212	224.9	1.04
Hardhead	*Mylopharodon conocephalus*	49	13.5	65	486	234	2.7	1,650	368.3	1.00
Rainbow trout	*Oncorhynchus mykiss*	30	8.3	50	345	224	1.0	400	171.4	1.01
Bluegill	*Lepomis macrochirus*	27	7.5	45	154	103	1.2	107	34.2	1.01
Sacramento pikeminnow	*Ptychocheilus grandis*	25	6.9	57	620	238	1.8	2,850	338.0	1.01
Common carp	*Cyprinus carpio*	7	1.9	470	695	582	1,775	6,500	3,489.3	1.02
Brown trout	*Salmo trutta*	6	1.7	176	440	305	67.6	821	395.3	1.01
Smallmouth bass	*Micropterus dolomieu*	5	1.4	55	183	99	2.9	94	28.2	1.01
Green sunfish	*Lepomis cyanellus*	2	0.6	95	100	98	19.1	20	19.6	--
Redear sunfish	*L. microlophus*	1	0.3	161	161	161	86.9	87	86.9	--
Total	**11**	**362**	--	--	--	--	--	--	--	--

Key: N = number g = grams mm = millimeters
[1] Species with poor fit regressions did not have a reportable condition factor.

Although gillnetting and electrofishing have different selectivity, Sacramento sucker, spotted bass, and hardhead were the most common species caught by both gear types in Englebright Reservoir.

Although total catch did not vary greatly among sites, catch of individual species did. Most notably, no spotted bass were collected by electrofishing at Site 5 (the site farthest upstream), but more rainbow trout were collected there than at any other site. This is also the only electrofishing site where brown trout were found. This was the only site with both flowing and still water, with extensive shallow areas, and at which substrates were primarily sand and gravel.

The lowest gillnet catch was at Site 1, located nearest to the Englebright Dam intakes. The depth of the intakes from the water surface ranged from 56.8 to 71.6 ft from January through early July 2012, and field technicians were able to set gillnets at these depths to characterize fish presence. Catch in deep water nets approximately 580 feet from the Narrows 2 intake, included two rainbow trout and one brown trout. All other fish were found near the surface, which was the general trend throughout the reservoir (FERC and USACE 2019).

For the Yuba River Development Project relicensing, FERC and USACE (2019) stated that, although Englebright Dam is not part of the Yuba River Development Project, controlled flow releases from Englebright Reservoir into the lower Yuba River are made via the Yuba River Development Project's Narrows 2 Powerhouse. Because the penstocks to the Narrows 1 Powerhouse and to YCWA's Narrows 2 Development are the only outlets from Englebright Dam, they are the only means of discharging water downstream, except for annual spills over the top of the dam, and together these discharges and spills provide the only downstream fish passage routes. FERC and USACE (2019) recognized that some fish entrainment likely occurs at powerhouse intakes in Englebright Reservoir. In addition, they recognized that fish entrained through powerhouses may be subject to injury during turbine passage, and fish entrained into diversion tunnels may affect the species composition and recruitment of fish to the reaches downstream of the diversion facilities (FERC and USACE 2019). YCWA performed gillnetting in Englebright Reservoir in June 2012. Catch in deep water nets approximately 580 feet from the Narrows 2 Powerhouse intake, included two rainbow trout and one brown trout. All other fish were found near the surface, which was the general trend throughout the reservoir (FERC and USACE 2019). In consideration of the low number of fish found to occur in deep water, and the design of the turbine in the Narrows 2 Powerhouse, FERC and USACE (2019) concluded that the effect of operating the Narrows 2 Powerhouse on reservoir fishes was minimal.

Because FERC and USACE (2019) recognized that the Yuba River Development Project facilities present conditions that may be hazardous for fish, it is reasonable to assume that the same potential exists at the Narrows 1 facilities. Therefore, for the Narrows 1 relicensing, this PAD includes an assessment of potential fish entrainment at the Narrows 1 intake structure.

YCWA conducted studies during 2012 to evaluate the status and distribution of fisheries resources in Englebright Reservoir[11] and the potential for entrainment of fish into the Narrows 2 Intake Tunnel.[12] These studies and data represent the most current available information for evaluating the potential for entrainment of fish into the Narrows 1 Intake Tunnel. The highest elevation extent for both Narrows 2 Intake Structure and Narrows 1 Intake Structure is 460 ft. The operational range of Englebright Reservoir is the elevation range of 516 through 527 ft. Therefore, the upper extent of intake elevations for both Narrows 2 and Narrows 1 occurs at a depth range of 56 to 67 ft. During YWA's 2012 study of fish populations in Englebright Reservoir, only three adult fish (two rainbow trout and one brown trout) were captured in gillnets sampling near Englebright Dam and deployed at depths similar to the depth range of the upper extent of Narrows 1 and Narrows 2 intake elevations. The majority of fish captured in gillnets during the 2011 study were captured in shallow and near-shore samples. In consideration of the low number of fish found to occur in deep water, and the design of the turbine[13] in the Narrows 2 Powerhouse, FERC and USACE (2019) concluded that the effect of operating the Narrows 2 Powerhouse on reservoir fishes was minimal. Given that the upper extent of intake elevations for both Narrows 2 and Narrows 1 intakes occur at the same range of depths, it is reasonable to expect that the effect of any potential entrainment at Narrows 1 Intake Structure on Englebright Reservoir fish populations would also be minimal.

Englebright Reservoir may fluctuate from day to day, but annual and monthly water surface elevation changes are less than 15 ft and 5 ft, respectively. Water temperature profile data taken semi-monthly from 1990 to February 2020 to a depth of 100 feet consistently show Englebrigth Reservoir has warm monomictic characteristics of mixing freely in winter and stratifying vertically in summer. Temperature generally remains warmer than 6ºC during the winter, which prevents ice from forming on the reservoir. The temperature is relatively uniform throughout the water column (isothermal) from late winter to early spring, when surface waters start warming at a faster rate than deep water. Thermal stratification continues to become stronger, and a

[11] See YCWA (2012) Technical Memorandum 3-7, Reservoir Fish Populations, prepared for the Yuba River Development Project, FERC Project No. 2246, and available at: http://www.ycwa-relicensing.com/Technical%20Memoranda/Forms/AllItems.aspx.

[12] See YCWA (2013x) Technical Memorandum 3-11, Entrainment, prepared for the Yuba River Development Project, FERC Project No. 2246, and available at: http://www.ycwa-relicensing.com/Technical%20Memoranda/Forms/AllItems.aspx.

[13] The Narrows 2 Powerhouse has a Francis turbine, which due to its design, has a higher survival rate (Cada, 2001).

thermocline generally develops at a depth of 10 to 30 feet. Thermal stratification is usually strongest in late summer to early fall, and the reservoir turns over in winter (FERC and USACE 2019). At an elevation of 460 feet, the Narrows 1 intake is typically located within the thermocline when the reservoir is stratified. From 1990 through 2020, water temperature profile data indicate that water temperatures at the Narrows 1 intake elevation in Englebright Reservoir typically remained at or below 54°F throughout the warmest months of the year (generally May to October) and at or below 50°F during the coolest months of the year (generally December through March) (Figure 3.2.3-8).

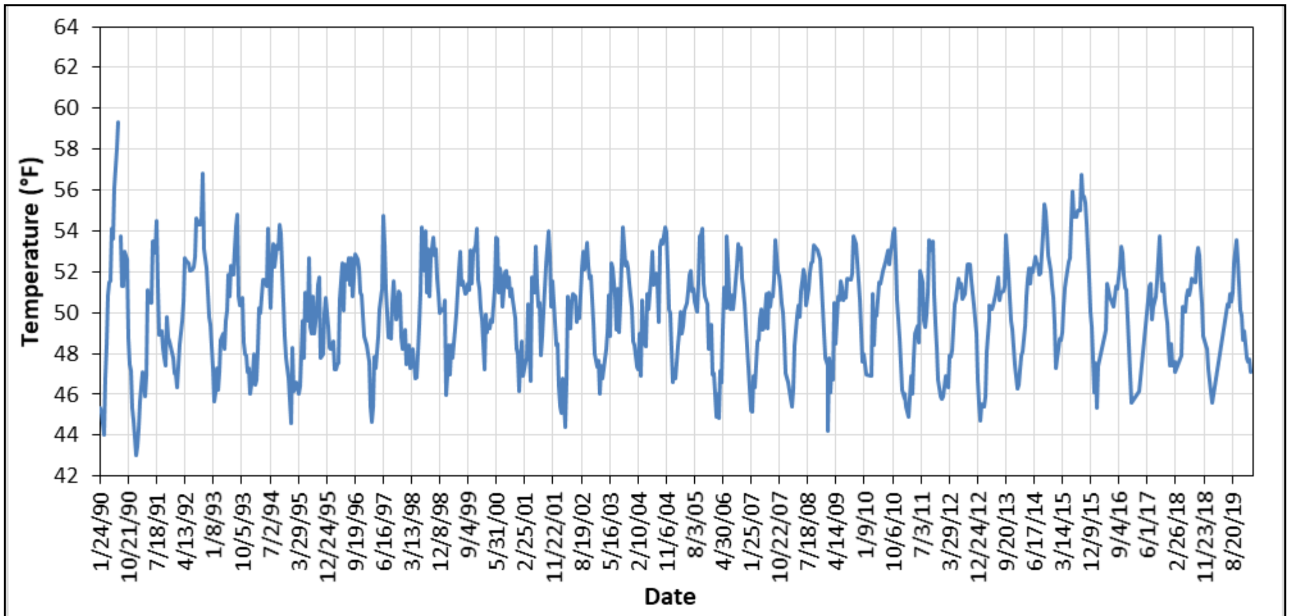

Figure 3.2.3-8. Semi-monthly water temperature vertical profile monitoring data from 1990 through February 2020 at the Narrows 1 intake elevation in Englebright Reservoir.

Benthic Macroinvertebrates

In 2012, YCWA conducted surveys at six sites on the lower Yuba River between Englebright Dam and the confluence with the Feather River. An estimated 183,682 organisms were collected from the 6 sample sites. A randomly sorted subset of 3,665 invertebrates was used to derive BMI metrics. Six aquatic insect orders were represented: Diptera (50 taxa), Ephemeroptera (11), Trichoptera (6), Plecoptera (3), Coleoptera (3), and Hemiptera (1). In addition, aquatic crustaceans, arachnids, annelids, gastropods, nemerteans, and turbellarians were identified. In general, the BMI communities at all sites were dominated by midges (Chironomidae), worms (Oligochaeta), mayflies (Baetidae), and caddisflies (Hydropsychidae). No clear upstream to downstream trend in total estimated abundance and taxa richness was observed, although abundance was highest at sites 1 and 2 (RMs 7 and 11) and lowest at the most upstream location, site 6 (RM 23). While no clear upstream to downstream trend in tolerance was observed, the number of intolerant taxa was highest at the farthest downstream site. Dominant functional feeding groups in the BMI communities in all sites were collector-gatherers and collector-filterers (range of 83 to 91%). Site conditions overall were good, and no site showed substantial degradation or disturbance based on BMI metrics. The quality of each site was generally a factor of substrate, channel size, and morphology. Overall, site 6, the site downstream of Englebright Dam, reflected the greatest degree of disturbance relative to the other sites, while site 2, the site downstream of Daguerre Point Dam, showed the best overall reported matrix scores. There was no upstream to downstream decrease in site condition (FERC and USACE 2019).

Benthic macroinvertebrate and drift sample collection and monitoring was to be conducted for the Yuba River Canyon Salmon Habitat Restoration Project that was completed during the fall of 2018. The project is located about 0.5 mile downstream of the Narrows 1 Powerhouse near the confluence of the Yuba River and Deer Creek. Benthic macroinvertebrates were to have been sampled at three to five separate locations within the project site and at two control locations (one near-shore and one off-shore location). Benthic macroinvertebrate monitoring was to involve measuring and contrasting the biomass, density, and taxonomic composition of macroinvertebrates collected in the benthos and drift pre- and post-project implementation (Cramer Fish Sciences 2018). YCWA does not have a copy of the monitoring results and is not aware of what the monitoring results show.

Amphibians

This section provides an overview of amphibian species that are likely to occur in the Project Boundary, as well as upstream in Englebright Reservoir and downstream in the lower Yuba River.

Three species of amphibians are known to occur or occurred historically in the lower Yuba River (Table 3.2.3-8). Two species are aquatic during at least some portion of their life cycle, associated with still or slow-flowing water, including parts of streams, ponds, and other lentic habitats. California slender salamander (*Batrachoseps attenuatus*) is a widespread and common species associated with forests, oak woodlands, and chaparral, where they are usually only encountered by active searching under rocks, logs, bark slabs, leaf litter, or other ground-cover objects. It does not have a free-living larval stage.

Table 3.2.3-8. Amphibian species reported from the Project vicinity.

Common Name/ Scientific Name	Status	(1) General Distribution and (2) Observations
California slender salamander *Batrachoseps attenuatus*	None	(1) Widespread and common species that is terrestrial in all life stages; occurring mostly in forested foothills and chaparral, occasionally to 3,000 ft (Nafis 2020b). (2) Collected just downstream from the Englebright Reservoir in 1999 (MVZ 2020a).
Sierran treefrog (chorus frog) *Pseudacris sierra*[1]	None	(1) Widespread and common species that occurs over a wide range of elevations; and breeds in ponds, lake and reservoir edges, ditches, and slow-moving or still sections of streams (Nafis 2020c). (2) Collected downstream of Englebright Reservoir (MVZ 2020b) and observed multiple times along the Lower Yuba River (iNaturalist 2020).

Table 3.2.3-8. (continued)

Common Name/ Scientific Name	Status	(1) General Distribution and (2) Observations
Western toad *Anaxyrus boreas halophilus*[2]	None	(1) Widespread species that is terrestrial after metamorphosis and breeds in ponds, lake and reservoir edges, and slow-moving or still sections of streams across a wide range of elevations (Nafis 2020d). (2) Within range, though no specific occurrences noted below Englebright. One occurrence near Englebright (MVZ 2020c).

CSC = California Species of Special Concern, FT = Federal Threatened
[1] Previously classified as *Hyla regilla* (Pacific treefrog) (see Recuero et al. 2006a, 2006b). Retention of the common name "treefrog" reflects longstanding, popular usage.
[2] Previously classified as *Bufo boreas* (see Frost et al. 2006).
[3] Previously classified as *Rana aurora draytonii* (see Frost et al. 2006).
[4] Previously classified as *Rana catesbeiana* (see Frost et al. 2006).

Aquatic Reptiles and Turtles in the Watershed

Only one native, freshwater turtle species, NWPT, is known from the watershed and is discussed above. Introduced species of turtles in California include painted turtle (*Chrysemys picta*) and red-eared slider (*Trachemys scripta elegans*), although there are no known reports of these species in the Lower Yuba River (USGS 2020). There are no known aquatic reptiles in the Lower Yuba River.

Algae

Algae blooms can be associated with human disturbance, particularly downstream of dams and other flow-regulated water.

During the summer months, heavy blooms of the green alga genus *Cladophora* can occur in unspecified sections of Deer Creek, a non-Project-affected stream that is tributary to the lower Yuba River below USACE's Englebright Dam (Cohen et al. 2001; Shilling, pers. comm. 2003). The occurrence of the microscopic algae *Didymosphenia geminata* (commonly known as "didymo"), which has been reported to occur in the lower Yuba River is discussed below.

Riparian Vegetation

Riparian habitats support the greatest diversity of wildlife species of any habitat in California, including for many species of fish within channel edge habitats (CALFED 2000). Although fish species do not directly rely on riparian habitat, they are directly and indirectly supported by the habitat and food sources provided by the highly productive riparian ecosystem. Furthermore, riparian forest canopy on the banks of rivers can stabilize channels, provide structure for submerged aquatic habitat, contribute shade, overhead canopy, and instream cover for fish, and reduce water temperatures (CALFED 2000). It is believed that historically the banks of the lower Yuba River and its adjacent natural levees once were covered by riparian forest of considerable width (YCWA 2017).

For the Yuba River Development Project relicensing, YCWA investigated and compiled available information regarding riparian vegetation that occurred historically. Extensive hydraulic mining in the late 1800s resulted in the massive influx of mining sediments that profoundly changed the physical character of the lower Yuba River (Moir and Pasternack 2008), and eliminated much of the riparian vegetation corridor either by burying it, by retarding its regeneration, or by its use as raw material for constructing brush dams to contain sediment along the lower Yuba River (NMFS 2005). Although the levees constructed as gravel berms by dredge miners were the principal factor in creating current riparian conditions, the functionality of the existing floodplain within the constrained lower Yuba River corridor was also limited by disconnection of the channel and floodplain (due to high topographic relief) and a lack of fine substrate for riparian establishment (YCWA 2017). In addition, during the early 1990s, riparian vegetation in the lower flood channel downstream of the Yuba Goldfields was regularly removed by DWR as part of an ongoing flood flow maintenance program (CDFG 1991).

As described in YCWA (2017), review of aerial photographs taken over time has provided qualitative views and representation of changes that have occurred in the lower Yuba River channel over the past. A comprehensive catalog of aerial photos spanning the time period of 1936 through 2010 was compiled by L. Allan James for the RMT from sources including the USGS, USACE, DWR and the California State Archives. YCWA (2013d) used these photographs to evaluate historical channel and riparian changes in the lower Yuba River at six study sites (i.e., Marysville, Hallwood, Daguerre Point Dam, Dry Creek, Parks Bar, and Timbuctoo Bend). The photo sets utilized in the analysis were reasonably comparable, spanned the period from prior to the construction of Englebright Dam through the construction of the Yuba River Development Project facilities, and extend to the modern day. Additionally, the selected photo sets spanned several very large channel-changing flood events.[14]

While pre-Yuba River Development Project activities such as hydraulic mining, construction of sediment-control dams, and construction of levees drastically altered the geomorphology of the stream channel, the riparian vegetation generally has been resilient and variable through time. Cumulative changes in riparian vegetation cover in the Englebright Dam and Narrows study sites exhibited some decrease over time, although slight decreases were detected in the Narrows study site. For the remaining study sites, the cumulative change in riparian vegetation cover increased over time, although slight increases were observed in the Englebright Dam, Narrows and Marysville study sites. By contrast, dramatic increases in riparian vegetation cover were observed in the Dry Creek and Parks Bar study sites. The Dry Creek, Daguerre Point Dam and Hallwood sites had the greatest vegetated area, and they were the most dynamic, exhibiting a decrease in vegetative cover through 1970, at which time the Yuba River Development Project facilities were constructed, and then increases in vegetative cover through 2010. Overall, aerial imagery analyses demonstrate that since construction and operation of the Yuba River Development Project, some areas of the lower Yuba River have exhibited generally consistent positive trends in the amount of riparian vegetation cover, while other areas have shown dramatic increases in riparian vegetation (YCWA 2017).

[14] For additional details, see YCWA's (2013d) Technical Memorandum 6-2 and YCWA's (2017) Applicant-Prepared Draft BA, pp. BA6-11 to BA6-19.

For the Yuba River Development Project relicensing, YCWA also conducted a riparian habitat study in the Yuba River from Englebright Dam to the confluence with the Feather River.[15] Field efforts included descriptive observations of woody and riparian vegetation, cottonwood inventory and coring, and a large woody material (LWM) survey (see YCWA 2013d). Existing LiDAR also was used to produce a map of lower Yuba River riparian vegetation stands, by type, which was subject to field validation and used in YCWA's riparian study.

Based on field observations, all reaches supported woody species in various lifestages – mature trees, recruits, and seedlings. Where individuals or groups of trees were less vigorous, beaver (*Castor canadensis*) activity was the main cause, although some trees in the Marysville Reach appeared to be damaged by human camping. The structure and composition of riparian vegetation was largely associated with four landforms. Cobble-dominated banks primarily supported bands of willow shrubs with scattered hardwood trees. Areas with saturated soils or sands supported the most complex riparian areas and tended to be associated with backwater ponds. Scarps and levees supported lines of mature cottonwood and other hardwood species, typically with a simple understory of Himalayan blackberry or blue elderberry shrubs. Bedrock dominated reaches had limited riparian complexity and supported mostly willow shrubs and cottonwoods (YCWA 2017; YCWA 2013d).

Based on analysis of mapping data, the majority of the woody species present in the lower Yuba River valley include, in order of most to least number of individuals: various willow species (*Salix sp*. and *Cephalanthus occidentalis*); Fremont cottonwood (*Populus fremontii*) (i.e., cottonwoods); blue elderberry (*Sambucus nigra ssp. caerulea*); black walnut (*Juglans hindsii*); Western sycamore (*Platanus racemosa*); Oregon ash (*Fraxinus latifolia*); white alder (*Alnus rhombifolia*); tree of heaven (*Ailanthus altissima*); and grey pine (*Pinus sabiniana*). Willow species could not be differentiated by species using remote sensing information. Willow on the lower Yuba River are dominated by dusky sandbar willow (*Salix melanopsis*) and narrow leaf willow (*Salix exigua*), and relative dominance of the two species shifts respectively in the downstream direction (WSI 2010). Other species occurring are arroyo willow (*Salix lasiolepsis*), Goodings willow (*Salix goodingii*) and red willow (*Salix laevigata*).

YCWA (2013d) assessed the riparian communities in the Yuba River downstream of the Englebright Dam as healthy and recovering from historical disturbance. Although the riparian vegetation is healthy with plants having high vigor and present in all age classes, the vegetation communities tend to be simplistic in structure. Riparian communities are seral, establishing first with simplistic herb and shrub layers, then canopies of hardwood trees, and becoming more complex over time. Indicative of early seral stages, the assessed riparian communities tended to be simplistic in both lateral and horizontal stratification, with limited pockets of diverse and well-stratified riparian forests (YCWA 2013d). Areas dominated by cottonwood trees with only herbaceous understories (e.g., those found on levees), are likely a sign of interrupted riparian development, and maintenance of the levees may have prevented the natural stages of the riparian community to develop (YCWA 2017). The longitudinal distribution of riparian species

[15] For additional details regarding riparian vegetation and LWM, refer to pages BA6-75 through BA6-82 of YCWA's (2017) Applicant-Prepared Draft BA.

in the lower Yuba River downstream of Englebright Dam shows a trend of limited vegetation in the confined, bedrock areas, with increased vegetation in the less-confined, alluvial areas downstream. The increase in hardwood diversity and cover downstream of Daguerre Point Dam may be associated with sediment, as reaches above Daguerre Point Dam have greater scour, while the downstream reaches have more deposition (YCWA 2012a).

3.2.3.1.3 Aquatic Invasive Species

YCWA reviewed USGS's list of AIS, including reported geographical locations (USGS 2020), and found no reported occurrences of AIS in Englebright Reservoir or within the FERC Project Boundary. Three AIS, two mollusks and one plant, are reported to occur in the lower Yuba River within 5 miles downstream of the Project.

Table 3.2.3-9 provides for each of the three AIS its status, habitat requirements and potential for occurrence within the Project Boundary.

Table 3.2.3-9. Aquatic Invasive Species Known to Occur or with the Potential to Occur in the Project Vicinity.

Common Name/ (*Scientific Name*)	**Status or Listing: (1) CCR, (2) Cal-IPC**	**Habitat Requirements**	**Potential for Occurrence within the Project Boundary**
Asian clam (*Corbicula fluminea*)	--	Freshwater lakes, reservoirs, and streams, especially with sandy, bottom sediments (Foster et al 2020)	Suitable habitat in Yuba River below Narrows 1 Powerhouse within the Project Boundary.
New Zealand mudsnail (*Potamopyrgus antipodarum*)	(1) 14 CCR § 671(c)(9), Restricted Species	Freshwater and brackish lakes, streams, and reservoirs with silt or organic substrate (Benson et al 2020)	Suitable habitat in Yuba River below Narrows 1 Powerhouse within the Project Boundary.
hyssop loosestrife *(Lythrum hyssopifolia*)	(2) Moderate	Seasonal wetlands, ditches, and cultivated fields, especially rice fields (Cal-IPC 2020)	No known suitable habitat within the Project Boundary.

Key:
-- = None
§ = Section
Cal-IPC = California Invasive Plant Council
CCR = California Code of Regulations

As described in FERC and USACE (2019), there have been documented occurrences of AIS within the lower Yuba River Watershed.

There were Asian clam located at the boat launch on the Yuba River at Sycamore Ranch in 2016 (USGS 2020). The species is a small, invasive freshwater mollusk, native to temperate and tropical southern Asia, eastern Pacific islands, and the eastern Mediterranean. This species was first located in the United States in 1938, possibly brought by Chinese immigrants as food and later spread through bait buckets, aquaculture, and intentional introductions for consumption. Asian clams can cause fouling and weaken underwater concrete structures (USGS 2020).

CDFW biologists discovered New Zealand mudsnails in the lower Yuba River above and below the Highway 20 Bridge (CDFW 2016). The Highway 20 Bridge crosses the lower Yuba River approximately 6 miles downstream of Englebright Dam near the town of Smartsville. New Zealand mudsnails are known to reproduce quickly with large numbers of offspring; a single female is capable of producing 2.7 billion offspring within four years (CDFW 2017). If New Zealand mudsnails became established in the Yuba River Watershed, they would pose similar threats as other aquatic invasive species in other areas, including clogging facility pipes and out-competing other aquatic macroinvertebrates for food, thereby disrupting ecosystem balances across the food web.

Hyssop loosestrife was located just downstream of Timbuctoo Bend on the Yuba River in 2011 (USGS 2020). This plant is normally a wetland invader and comes from Europe. This plant can self-pollinate and produce up to 75,000 seeds that disperse via water, wildlife, and human activities (IPC 2005).

Although not known within 5 miles of the Project Boundary, one invasive algae, didymo, has the potential to occur in the lower Yuba River, although it was not observed by YCWA during Yuba River Development Project YRDP relicensing field studies. Didymo is a freshwater diatom which occurs attached to rocks or other surfaces, and the extracellular branching stalks form large mats, resistant to decay. To the observer, these mats appear as fiberglass insulation, tissue paper, brown shag carpet, or sheep skins covering the streambed (Spaulding and Elwell 2007). Originally found in the low nutrient cold waters of the far northern hemisphere and common to Scotland, Sweden, Finland, and China’s Kanchou region, *D. geminata* has now expanded its geographic range to include North America, Europe, and New Zealand (Spaulding and Elwell 2007), where it is considered a nuisance or invasive species. The first documented presence of *D. geminata* in California was from the mid-1990s on the South Fork American River, which is located south of the Yuba River (Spaulding and Elwell 2007). In the upper Yuba River Watershed, observations of *D. geminata* were common in the Middle and South Yuba rivers during previous relicensing studies conducted by PG&E and NID. In the lower Yuba River, YCWA field staff have not reported any observations of *D. geminata*, but YCWA is aware of reports of *D. geminata* in the lower Yuba River downstream of Englebright Dam.