3.2.3 Aquatic Resources

3.2.3.1 Overview

Besides this introductory information, this section is divided into six subsections. Section 3.2.3.2 describes the history of fishes in the Bear River Basin. Section 3.2.3.3 identifies specific special-status aquatic species[1] that have the potential to be affected by continued Project O&M, 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 3.2.3.4 identifies specific aquatic invasive species (AIS)[2] that have the potential to be affected by continued Project O&M, 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. Section 3.2.3.5 describes relevant and reasonably available information regarding aquatic resources in areas upstream of the Project, within the Project Area, and downstream of the Project. Section 3.2.3.6 describes the known or potential Project effects on aquatic resources.

SSWD prepared this section based on its collection of existing, relevant and reasonably available information on aquatic resources. Specifically, SSWD found 100 source documents regarding aquatic resources. These sources are listed below and cited throughout this section:

- 14 papers and literature on the historic distribution of fish and influences affecting Bear River fishery.
- 37 papers and literature on special-status aquatic species.
- 37 papers and literature on AIS.
- 12 documents on the Bear River upstream of the Project, within the Project and downstream of the Project.

3.2.3.2 Historic Distribution of Fish and Influences Affecting Bear River Fisheries

3.2.3.2.1 Historic Distribution

Climatic and geologic forces are the dominant architects of Sierra Nevada ecosystems (SNEP 1997). The natural lakes and streams in the Project Vicinity were most recently formed during the Pleistocene Age from 2 million to 10 thousand years ago. During this time, glaciers periodically covered the high country of the Bear River watershed, carving out numerous cirque valleys and shallow lake basins. Glaciers scoured the uplifted granitic batholithic, which created

[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 or associated recreation and meets one or more of the following criteria: 1) listed as Sensitive by USFWS (USFWS-S); 2) listed as a Species of Concern by NMFS (NMFS-S) (NMFS 2009); 3) listed as threatened (ST) or endangered (SE) under CESA; 3) Fully Protected (FP) under California law; or 4) listed as a California Fish Species of Special Concern (CSC) (CDFW 2015a). Aquatic species listed as threatened or endangered under the ESA, or proposed for or a candidate for listing under ESA are discussed in Section 3.2.5.

[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.

the Sierra Nevada, creating the hanging valleys, steep stream gradients, and numerous barrier falls common in the watersheds. These features created upstream passage barriers and prevented fish from colonizing most high-elevation lakes and streams after the glaciers receded (CDFG 2007a).[3]

Since the massive influx of Euro-Americans began in 1850, the fish fauna and fisheries of the Sierra Nevada have changed dramatically (Moyle et al. 1995). Historically, the Sacramento–San Joaquin Drainage, which includes most of the watersheds on the west side of the Sierra Nevada, contained the richest native fish fauna with 22 taxa, including three anadromous fish – Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and Pacific lamprey (*Lampetra tridentata*) – that were an important source of food for Native Americans of the region (Moyle 1976; Lindstrom 1993; Moyle et al. 1997). Native foothill fish included anadromous and resident salmonid species (*Oncorhynchus* spp.), Pacific lamprey, Sacramento hitch (*Lavinia exilicauda*), Sacramento roach (*L. symmetricus*), hardhead (*Mylopharodon conocephalus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento speckled dace (*Rhinichthys osculus*), Sacramento sucker (*Catostomus O. occidentalis*), Sacramento perch (*Archoplites interruptus*), and sculpin (*Cottus asper* and *Cottus golosus*) (Moyle et al. 1997). Anadromous sturgeon may also have occurred. The 16-mi long segment of the lower Bear River also has previously documented populations of non-native warm water species such as black bass (*Micropterus* spp.), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*) and catfish (*Ictalurus* spp. and *Ameiurus* spp.) (SSWD 1980). Based on the biological data available, streams in the Project Vicinity may provide habitat suitable for both cold and warmwater fish species (Table 3.2.3-1).

Table 3.2.3-1. Fish native to the Bear River watershed.

Family/Species	Habitat[1]
CHINOOK SALMON (SALMONIDAE)	
Spring-run (*Oncorhynchus tshawytscha)*	Anadromous, mid-elevation, Lowlands[2]
Fall-run (*Oncorhynchus tshawytscha)*	Anadromous, foothills, lowlands[3]
LAMPREYS (PETROMYZONTIDE)	
Pacific Lamprey (*Lampetra tridentata*)	Anadromous, foothills, lowlands[3]
TROUT (SALMONIDAE)	
Resident rainbow trout (*Oncorhynchus mykiss)*	Resident, foothills, high elevation
Winter steelhead (*Oncorhynchus mykiss)*	Anadromous, lowlands, foothills[3]
MINNOWS (CYPRINIDAE)	
Sacramento hitch (*Lavinia exilicauda)*	Lowlands, foothills
Sacramento roach (*Lavinia s. symmetricus)*	Lowlands, foothills
Hardhead (*Mylopharodon conocephalus)*	Lowlands, foothills
Sacramento pikeminnow (*Ptychocheilus grandis)*	Lowlands, foothills
Sacramento speckled dace (*Rhinichthys osculus ssp)*	Lowlands, foothills

[3] In 2012, The California Department of Fish and Game (CDFG), officially changed their name to Cal Fish and Wildlife. Respectively, when referencing material from this agency, any works from the year 2011 and earlier, will remain cited as CDFG.

Table 3.2.3-1. (continued)

Family/Species	Habitat[1]
SUCKERS (CATASTOMIDAE)	
Sacramento sucker (*Catostomus O. occidentalis)*	Lowlands, foothills
Riffle sculpin (*Cottus gulosus)*	Lowlands, foothills
Prickly sculpin (*Cottus asper)*	Lowlands, foothills

Source: Modified from NID 2008.
[1] Moyle et al. 1996
[2] Extirpated in all sub-basins of the Project Vicinity. Historically, inhabited mid-elevation portions of Central Valley rivers. Lowland portions of basins were mainly used as migratory corridors. No known occurrences above historic barrier waterfall located near Camp Far West Dam.
[3] No known occurrences above historic barrier waterfall located near Camp Far West Dam.

The CVRWQCB (1998) Basin Plan lists four beneficial uses for the Bear River related to fish and aquatic resources; two existing uses and two potential uses. The two existing uses are warm freshwater habitat and cold freshwater habitat. The two potential uses are migration of aquatic organisms and spawning. The individual water quality objectives for these beneficial uses are discussed in Section 3.2.2.7.

3.2.3.2.2 Anadromous Fish

3.2.3.2.2.1 Historic Range

The Bear River has historically contained salmon, but only a fall-run (Yoshiyama et al. 2001). Adult salmon could historically ascend as far as a barrier waterfall in the immediate vicinity of Camp Far West Dam (Yoshiyama et al. 2001), approximately 16 RM upstream of the confluence with the Feather River. No waterfall currently exists in the area so it has presumably been inundated by the construction of the dam and formation of the reservoir (J. Hiskox, personal communication in Yoshiyama et al. 2001). There are no known accounts of anadromous fish upstream of the original barrier waterfall. Yoshiyama et al. (2001) estimates that less than 1 RM of salmon habitat was lost due to the creation of Camp Far West Dam.

3.2.3.2.2.2 Influences Affecting Anadromous Fish Abundance

In the Bear River, factors influencing anadromous fish abundance include flow, historic mining and water quality impacts (including mercury).

Reports issued in 1991 and 1993 by CDFG (1991) and Reynolds et al. (1993) respectively, stated that fall flows, specifically October and November, in the lower Bear River appeared to influence the Chinook salmon run size. During years of high water in October and November, Cal Fish and Wildlife reports runs as high as 300 Chinook salmon in 1984 and as low as zero in 1985 (CDFG 1991, Table 3.2.3-2). However, CDFG (1991) concludes that the monthly impaired flow pattern and quantity of water closely resembled the unimpaired flow with approximately 90 percent of the unimpaired flow released annually downstream of Camp Far West.

Table 3.2.3-2. Estimates of spawning Chinook salmon in the lower Bear River, California.[1]

Year	Number of Chinook Salmon Adult Spawners	Instantaneous Flow Range (cfs)[2]		Highest Observed Instantaneous Flow (cfs) (October & November)
		October	November	
1978	0	1.6 - 8.7	<1 - 14	14
1980	0	2.1 - 9.2	5 - 29	29
1982	<100	6.8 - 37	28 - 7,170	7,170
1983	>200[3]	37 - 55	484 - 4,360	4,360
1984	300	19 - 47	24 - 1,430	1,430
1985	0	4.4 - 33	10 - 28	28
1986	1	9.5 - 20	15 - 34	34

From: CDFG 1991
[1] Cal Fish and Wildlife Region 2, Rancho Cordova, file data for Bear River-Placer, Sutter, and Yuba counties, as cited in CDFG 1991.
[2] USGS Water Resources Data, California, Volume 4, various years, gage 11424000, Bear River near Wheatland, CA.
[3] Estimate of angler catch from Dry Creek.

Gold and other minerals mined in the vicinity of Camp Far West Reservoir are discussed in Section 3.2.1.4. With the development of hydraulic mining techniques, an estimated 254,000,000 cu yds of gravel and debris were processed from the Bear River between 1849 and 1909 (Gilbert 1917). The majority of this material eventually washed into the river causing extensive sedimentation and habitat degradation. Like much of the Central Valley, anadromous fish populations in the Bear River experienced a dramatic decline in the late 1800s as a result of mining and development.

Mercury contamination from historical gold mines represents a potential risk to aquatic resources in the Bear River. Generally, acute mercury toxicity in fish results in flaring of gill covers increased respiratory movements, loss of equilibrium, and sluggishness followed by death (Armstrong 1979). Chronic or sublethal exposures to mercury have been shown to adversely impact reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation and oxygen exchange in marine and freshwater organisms (Eisler 1987). The current data available regarding mercury in Camp Far West Reservoir and the Bear River is discussed in Section 3.2.2.10 and impaired waters (including for mercury) are discussed in Section 3.2.2.7.

3.2.3.3 Special-Status Aquatic Species

Both documented and potentially occurring special-status aquatic species in the Project Vicinity were identified based on the results of queries to the Cal Fish and Wildlife's California Natural Diversity Data Base (CNDDB) (CDFW 2015a); found on NMFS' *List of Species of Concern* (NMFS 2009); found on the California Fish and Game Commission's list of *State and Federally Listed Endangered and Threatened Animals of California* (CDFG 2009a); found on Cal Fish and Wildlife's *California Fish Species of Special* Concern (CDFW 2015c); or found on USFWS' Information, Planning, and Conservation System (IPaC) Trust Resources Report for Nevada, Placer and Yuba counties (USFWS 2015a); and review of over 100 source documents. Database queries included all USGS 1:24,000 topographic quadrangles that include the existing FERC Project Boundary and Project Vicinity. Quadrangles containing the existing FERC Project Boundary include Camp Far West and Wolf. Quadrangles immediately adjacent to the Project Boundary quadrangles include Auburn, Browns Valley, Gold Hill, Grass Valley, Lake Combie, Lincoln, Rough and Ready, Sheridan, Smartsville, and Wheatland.

Based on SSWD's review, six special-status aquatic species may occur in the Project Area or otherwise be affected by continued Project O&M. These species are:

- Fishes
  - Central Valley fall- and late-fall-run Chinook salmon Evolutionarily Significant Unit (ESU) (NMFS-S, CSC)
  - Hardhead (CSC)
  - Sacramento splittail (CSC)
  - Sacramento-San Joaquin roach (CSC)
- Amphibians
  - Foothill yellow-legged frog *(Rana boylii)* (CSC)
- Aquatic Reptiles and Turtles
  - Western (or Pacific) pond turtle *(Emys marmorata)* (CSC)

A description of each of the six special-status aquatic species, including its nearest known occurrence to Project facilities and features, is provided below.

3.2.3.3.1 Central Valley fall and late fall-run Chinook salmon ESU (NMFS-S, CSC)[4]

Four principal life history variants of Chinook salmon are recognized in the California 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 fall- and late fall-runs have been documented in the lower Bear River. Little information exists regarding the life history of Chinook salmon in the lower Bear River. Therefore, much of the information in this section is based on the life history of Chinook salmon in the lower Yuba and Feather rivers. The Bear and Yuba rivers are both tributaries to the Feather River. Therefore, it is anticipated that the life history and timing of Chinook salmon in the Bear River would be similar to that seen of the Feather and Yuba rivers.

[4] Photo source: http://www.usgs.gov/features/lewisandclark/images/Chinook_Salmon.jpg

Of the variants, the Central Valley fall-/late fall-run Chinook salmon ESU, a combination of the fall- and late fall-runs as characterized by NMFS, is included on NMFS' Species of Concern List in 2004 due to concerns about population size and hatchery influence (NMFS 2009).

Although it is an important commercial and recreational fish species, declines in populations resulted in harvest management restrictions throughout California. In April 2009, the Pacific Fishery Management Council and NMFS adopted a closure of all commercial ocean salmon fishing through April 30, 2010, and placed restrictions on inland salmon fisheries over the same time frame (CDFG 2009a). Currently the Bear River from the non-Project diversion dam to SR 65 is only subject to sport fishing regulations, which is open from the fourth Saturday in May through October 15.

The generalized life history of Pacific salmon (*Oncorhynchus* sp.) 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).

Chinook salmon is the largest salmonid, with adults often exceeding 40 pounds, and individuals over 120 pounds reported (NMFS 2008). Adult Chinook salmon migrate from the ocean into the freshwater streams and rivers of their birth to mate (i.e., anadromy) 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). In the Central Valley, 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 mean daily water temperatures decrease to approximately 60°F, female Chinook salmon begin to construct nests, which are known as 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 sizes can range from 0.1 to 6 in. 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 2008). Based on life history periodicities in the Feather and Yuba rivers, fall-run Chinook salmon fry emergence is expected to typically occur from late December through March within the Project Vicinity (Moyle 2002). Growth rates are largely influenced by water temperature, and the optimal range of juvenile rearing temperatures is 55°F-65°F. Young Chinook salmon will survive and grow within the range of 41°F-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). 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.[5] Little is known about the historical run size, but it has been reported to be highly variable from year to year depending on fall flow conditions. According to Chamberlain and Wells (1879a), the Bear River was full of salmon and the Native Americans speared them by the hundreds in the clear water; becoming scarce when the river became muddy from the hydraulic mining.

Fall-run Chinook salmon are raised at five major Central Valley hatcheries that release more than 32 million smolts each year into California water bodies (CDFG 2007b). According to Cal Fish and Wildlife records, Chinook salmon fry stocking occurred in the Bear River in 1981, 1983, 1985, 1986, and 1987. Stocking typically occurred at Patterson's Gravel Plant (RM 16). Each year roughly 100,000 Feather River or Nimbus Hatchery fall-run fry were released into the river. In 1985, 76,800 spring-run Chinook salmon were planted as well. No known plantings of Chinook fry in the lower Bear River have occurred since 1987. Recently, Chinook salmon have been released in the Feather River at the Hatchery and near Live Oak (RMIS 2015).

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.

Unlike spring-run Chinook salmon, adult fall-run Chinook salmon does 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 nearby lower Yuba River from August through November (CALFED and YCWA 2005).

Fall-run Chinook salmon embryo incubation extends from the time of egg deposition through alevin emergence from the gravel. The fall-run embryo incubation period in the lower Yuba River has been reported to extend from October through March in the neighboring lower Yuba River (YCWA et al. 2007).

In the Central Valley, fall-run Chinook salmon fry emergence generally occurs from late-December through March (Moyle 2002). Fall-run Chinook salmon juvenile rearing and outmigration 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 of up to several months and move downstream as juveniles. Thus, the fry rearing lifestage is considered to extend from December through April, and the juvenile rearing lifestage from March through June.

Importantly, the EPA has developed water temperature guidelines to assess water temperature effects on anadromous salmonids (EPA 2003). These guidelines are 7-day averages of the daily maxima (7DADM) water temperatures that the EPA claims maintains protection of anadromous salmonids. Although the EPA developed these guidelines based on the EPA's review of

[5] GrandTab is a compilation of annual population estimates for Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento and San Joaquin River systems. GrandTab is available for download at: http://www.calfish.org/IndependentDatasets/CDFGFisheriesBranch/tabid/157/Default.aspx

literature describing water temperature-related effects on various species of anadromous salmonids, the EPA did not develop species-specific guidelines. Further, the EPA (2003) does not distinguish between ESUs or DPS' of conspecific anadromous salmonids (e.g., spring-run and fall-run Chinook salmon). Table 3.2.3-3 shows the EPA guidelines for the anadromous salmonid lifestages.

Table 3.2.3-3. EPA water temperature guidelines (EPA 2003)[6] for protection of anadromous salmonids by life stage.

Salmonid Life History Phase Terminology	7-Day Average of the Daily Maxima Guideline (°C)	Protective of
Adult Migration	≤18°C	Salmon and steelhead migration
Spawning and Egg Incubation	≤13°C	Salmon and steelhead spawning, egg incubation and fry emergence
Juvenile Rearing and Emigration	≤16°C for "core" juvenile rearing;[1] ≤18°C for migration and non-core juvenile rearing	Salmon and steelhead rearing and juvenile migration
Smoltification	≤14°C	Composite criteria for salmon and steelhead smoltification[2]

[1] The EPA recommends that for areas of degraded habitat, "*core juvenile rearing*" use cover the downstream extent of low density rearing that currently occurs during the period of maximum summer temperatures (EPA 2003).

[2] The EPA establishes a guideline of ≤15°C for salmon smoltification and a guideline of ≤14°C for steelhead smoltification; but for a composite guideline for both species, the steelhead guideline of ≤14°C is applied.

The EPA recommends the above metrics because they "*describe the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day*." The EPA states that, because this metric uses daily maximum water temperatures, it can be used to protect against acute water temperature effects (EPA 2003). The EPA also states that this metric can be used to protect against sub-lethal or chronic effects, but the cumulative thermal exposure of fish over the course of a week or more needs to be considered when selecting a 7DADM value to protect against these effects EPA (2003). Based on studies of fluctuating water temperature regimes, the EPA concludes that:

> ...fluctuating temperatures increase juvenile growth rates when mean temperatures are colder than the optimal growth temperature derived from constant temperature studies, but will reduce growth when the mean temperature exceeds the optimal growth temperature. When the mean temperature is above the optimal growth temperature, the "mid-point" temperature between the mean and maximum is the "equivalent" constant temperature. This "equivalent" constant temperature then can be directly compared to laboratory studies done at constant temperatures. For example, a river with a 7DADM value of 18°C and a 15°C weekly mean temperature (i.e., diurnal variation +/- 3°C) will be roughly equivalent to a constant laboratory study temperature of 16.5°C (mid-point between 15°C and 18°C). Thus, both maximum and mean temperatures are important when determining a 7DADM value that is protective against sub-lethal/chronic effects.

Because the 7DADM water temperature guideline is reportedly about 3°C higher than the weekly mean water temperature in many rivers in the Pacific Northwest (Dunham et al. 2001 and

[6] *Id.*

Chapman 2002, both as cited in EPA 2003),[7] EPA (2003) said it first started with the constant temperatures that scientific studies indicate would be protective against chronic effects, and then added 1-2°C to develop 7DADM temperatures that would protect against chronic effects.

Chinook salmon occur in the Bear River. A more detailed discussion regarding specific observations of Chinook salmon is provided in Section 3.2.3.5.

3.2.3.3.1.1 Hardhead (CSC)[8]

Hardhead has been reported to occur in the upper Yuba River, the lower Bear, Feather, and Yuba rivers and the Honcut Creek headwaters (UC Davis 2009). The report did not provide specific population counts for the lower Bear River.

Hardhead is a large cyprinid species that can reach lengths of over 23 in., and generally occurs in large, undisturbed, low- to mid-elevation, cool- to warm-water rivers and streams (Moyle 2002). Hardhead was designated CSC by Cal Fish and Wildlife in 1995, and is listed by Cal Fish and Wildlife as a Class 3 Watch List species, meaning that it occupies much of its native range but was formerly more widespread or abundant within that range (CDFG 2009a, b). Historically, hardhead was considered a widespread and locally abundant species in California, but its specialized habitat requirements, widespread alteration of downstream habitats, and predation by smallmouth bass (*Micropterus dolomieu*) have resulted in population declines and isolation of populations (Moyle 2002).

Most reservoir populations have proved to be temporary; presumably the result of colonization of the reservoir by juvenile hardhead before introduced predators became established. Brown and Moyle (1993) observed that hardhead disappeared from the upper Kings River when the reach was invaded by bass.

Hardhead mature following their second year. Spawning migrations, which occur in the spring into smaller tributary streams, are common. The spawning season may extend into August in the foothill streams of the Sacramento and San Joaquin river basins. Spawning behavior has not been documented, but hardhead are believed to elicit mass spawning in gravel riffles (Moyle 2002). Little is known about life stage specific temperature requirements of hardhead; however, temperatures ranging from approximately 65°F to 75°F are believed to be suitable (Moyle 2002).

In 1980, Cal Fish and Wildlife reported hardhead to be present in Camp Far West Reservoir. However, in 2012, Cal Fish and Wildlife conducted boat electrofishing surveys at nine sites in the reservoir and did not report any hardhead to be present. SSWD found no records of hardhead in the Bear River.

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[7] *Id.*

[8] Photo source - http://calfish.ucdavis.edu/calfish/Hardhead.html

3.2.3.3.1.2 Sacramento Splittail (CSC) [9]

The Sacramento splittail, a minnow, was listed as threatened under the ESA on February 8, 1999, and delisted on September 22, 2003 (USFWS 2003a, b). Sacramento splittail is designated as a CSC (CDFW 2015a, b). Sacramento Splittail is a large cyprinid, growing in excess of 12 in., and is adapted to living in freshwater and estuarine habitats as well as alkaline lakes and sloughs (Moyle 2002).

Historically, Sacramento splittail inhabited sloughs, lakes, and rivers of the Central Valley with populations extending upstream to Redding in the Sacramento River, to the vicinity of 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 2003b). Currently, the species is known to migrate up the Sacramento River to Red Bluff Diversion Dam 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 2003b).

Sacramento splittail has been documented only in the lower Feather River (UC Davis 2009) and, according to Moyle, evidence of self-sustaining populations of Sacramento splittail occurring outside of these areas is weak (Moyle et al. 2004). During the preparation of this PAD, no documentation of splittail in the Bear River, either historical or current, was found.

3.2.3.3.1.3 Sacramento-San Joaquin Roach (CSC) [10]

The Sacramento-San Joaquin roach, a CSC, 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. There is little quantitative information available on the abundance of Sacramento-San Joaquin roach. Assuming this widely distributed form is indeed just one subspecies, it appears to be abundant in a large number of streams. However, it is now absent from many streams and stream reaches where it once occurred (Leidy 1984).

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; Moyle et al. 1982). Assuming that the Sacramento-San Joaquin roach is indeed a single taxon, 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 ppm) (Taylor et al. 1982). However, it is a habitat generalist, also being found in cold, well-

[9] Photo source http://swr.nmfs.noaa.gov/overview/sroffice/2Dredge_species_list.html
[10] Photo source - http://calfish.ucdavis.edu/calfish/CaliforniaRoach.htm

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) in CDFG 2008a 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.

Sacramento-San Joaquin roach have been reported to occur in the upper Yuba River, the lower Bear and Feather rivers, the Middle Fork of the Feather River, and the Honcut Creek headwaters (UC Davis 2009).

3.2.3.3.1.4 Foothill Yellow-Legged Frog (CSC) [11]

The foothill yellow-legged frog is a stream-adapted species, usually associated with shallow, flowing streams with backwater habitats and coarse cobble-sized substrates (Jennings and Hayes 1994) between about 600 to 5,000 ft elevation (Moyle 1973; Seltenrich and Pool 2002; ECORP 2005). The Project ranges in elevation from 150 ft to 320 ft. The foothill yellow-legged frog is listed as a CSC. Populations persist on some portions of previously occupied drainages (NatureServe© 2015). Foothill yellow-legged frog populations may require both mainstem and tributary habitats for long-term persistence. Streams too small to provide breeding habitat for this species may be critical as seasonal habitats (e.g., in winter and during the hottest part of the summer) (VanWagner 1996; Seltenrich and Pool 2002), and there is evidence that habitat use by young-of-the-year, sub-adult, and adult frogs differs by age-class and changes seasonally (Randall 1997). Adult migrations appear to be limited to modest movements along stream corridors (Ashton et al., 1998), but the magnitude of such movements, any seasonal component, and differences between sexes remains largely unknown. Foothill yellow-legged frog is infrequent in habitats where introduced fish and bullfrogs are present (Jennings and Hayes 1994).

Breeding tends to occur in spring or early summer and eggs are laid in areas of shallow, slow-moving waters near the shore. Timing and duration of breeding activity may vary geographically and across populations. In California, egg masses have been found between April 22 and July 6, with an average of May 3 (Ashton et al. 1998). Kupferberg (1996a, b) reports an approximate breeding period of 1 month beginning late April to late May. Rainfall during a given breeding season has the potential to delay oviposition (Kupferberg 1996a, b).

Egg masses vary in size and in the number of eggs/mass. The size of an egg mass after it has absorbed water (usually a few hours after oviposition) is 5 to 10 cm in diameter and "*resembles a cluster of grapes*" (Stebbins 1985). The number of eggs in a mass can range from 300 to 2,000

[11] Photo source: Stephen Nyman, PhD

(Zweifel 1955), with an average of about 900 eggs (Ashton et al., 1998). Eggs generally hatch within 5 to 37 days (Zweifel 1955; Ashton et al. 1998). Hatching rates are influenced by temperature, with faster developmental times in warmer waters, up to the critical thermal maximum temperature of about 26˚C (Zweifel 1955; Duellman and Trueb 1986). Tadpoles move away from their egg mass after hatching (Ashton et al. 1998) and typically metamorphose 3 to 4 months after hatching.

A search of the CNDDB for the USGS 1:24,000 quadrangles of Camp Far West, Nicolaus, Sheridan, Wheatland, and Wolf found no known occurrences of foothill yellow legged frogs (CDFW 2015). Through a search of the literature no other studies or known occurrences of FYLF in the Project Area were found.

3.2.3.3.1.5 Western Pond Turtle (WPT) (CSC) [12]

The western, or Pacific, pond turtle (WPT) occurs in a wide variety of aquatic habitats up to a 6,000 ft elevation, particularly permanent ponds, lakes, side channels, backwaters, and pools of streams, but is uncommon in high-gradient streams (Jennings and Hayes 1994). Western pond turtle has declined due to loss of habitat, introduced species, and historical over-collection (Jennings and Hayes 1994), and has been designated as CSC. Isolated occurrences of WPT in lakes and reservoirs sometimes occur from deliberate releases of pets.

Although highly aquatic, WPT often overwinters 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 ft 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 WPT away from aquatic habitats for as much as 7 months in 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 basking occurs on 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). During the terrestrial period, Reese and Welsh (1997) found that radio-tracked WPT were burrowed in leaf litter.

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 WPTs have been documented traveling long distances from perennial watercourses for both aestivation and nesting, with long-range movements to aestivation sites averaging about

[12] Photo source: http://sfbaywildlife.info/species/pacific_pond_turtle.htm

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820 ft, and nesting movements averaging about 295 ft (Rathbun et al. 2002). Introduced species of turtles (e.g., red-eared sliders [*Trachemys scripta elegans*]) are likely to compete with western pond turtle for basking sites, while bullfrogs and predatory fish species may prey on hatchling western pond turtles. Major factors cited as limiting WPT populations include loss of aquatic habitats, elevated nest and hatchling predation, reduced availability of nest habitat, and road mortality (BLM and USFWS 2009).

CDFW (2015) reports five occurrences of WPT in the Project Vicinity: 1) in Dry Creek about 2.5 mi west of Wheatland, approximately 8.5 mi from Camp Far West Dam; 2) the south end of Wood Duck Slough, 2 mi north of Nicolaus, approximately 16.7 mi from Camp Far West Dam; 3) the upper end of Best Slough, South of Beale Air Force Base, approximately 4.3 mi from Camp Far West Dam; 4) along Dry Creek, approximately 1-mi east of the junction of Spenceville Road and Waldo Road in the Spenceville Wildlife Area, approximately 4.3 mi from Camp Far West Dam; and 5) along Dry Creek, approximately 1.3 mi east of the junction of Spenceville Road and Waldo Road in the Spenceville Wildlife Area, approximately 4.4 mi from Camp Far West Dam. Through a search of the literature, no other studies or known occurrences of WPT were found.

3.2.3.4 Aquatic Invasive Species

SSWD generated a list of AIS known or with the potential to occur in the Project Area using the Nonindigenous Aquatic Species application available at the USGS website (USGS 2015a). From the generated list of relevant species, those species that did not occur within a reasonable distance of the Project Vicinity and those occurrences whose dates were past consideration were eliminated. SSWD also utilized Cal WeedMapper, a web application used as a tool for mapping invasive plant distribution, and California State Parks Division of Boating and Waterways (DBOW) databases to generate a list of invasive aquatic plant species that occur or have the potential to occur within or near the FERC Project Boundary. The discussion of aquatic invasive species below is focused on the 13 AIS identified by SSWD. These include 4 mollusks (snails and bivalves), 8 aquatic algae and plants and 1 amphibian. Table 3.2.3-4 lists the status, habitat requirements and occurrence in the Project Vicinity for each of these AIS. Each of the AIS is described below.

Table 3.2.3-4. Aquatic invasive species known or with the potential to occur in the Project Vicinity.

Common Name/ Scientific Name	Status	Habitat Requirements	Known From Project
MOLLUSKS			
Quagga mussel *Dreissena rostriformis bugensis*	C.C.R. 14 Section 671(c)(10), Restricted Species F.G.C. §§ 2301 and 2302 regulates dreissenid mussel.	Freshwater lakes, reservoirs and streams and colonize soft and hard substrates	No. Closest known occurrence is Lahontan Reservoir which is approximately 180 mi away.

Table 3.2.3-4. (continued)

Common Name/ Scientific Name	Status	Habitat Requirements	Known From Project
MOLLUSKS (continued)			
Zebra mussel *Dreissena polymorpha*	Federal Lacey Act (18 U.S.C. 42) lists zebra mussels as injurious wildlife. C.C.R. 14 Section 671(c)(10), Restricted Species F.G.C. §§ 2301 and 2302 regulates dreissenid mussel.	Freshwater lakes, reservoirs and streams and colonize any stable substrate	No. Closest known location of zebra mussels is San Justo Reservoir in California, approximately 200 mi south of the Project.
New Zealand mudsnail *Potamopyrgus antipodarum*	C.C.R. 14 Section 671(c)(10), Restricted Species	Freshwater and brackish lakes, reservoirs and streams	No. Closest known occurrence is on American River near the Reclamation's Nimbus Dam, approximately 45 mi from the Project.
Asian clam *Corbicula fluminea*	--	Freshwater lakes, reservoirs and streams, and often bury themselves in sandy, bottom sediments	Yes. In 2014, Asian clams were reported in Camp Far West reservoir at North and South Recreation Area boat launches.
PLANTS			
Curly leaf pondweed *Potamogeton crispus*	Cal-IPC 'moderate' species	Quiet waters, especially brackish, alkaline, or eutrophic waters of ponds, lakes, and streams	No. Curly leaf pondweed has been located in Nevada County, but has not been documented from Camp Far West Reservoir.
Eurasian watermilfoil *Myriophyllum spicatum*	Cal-IPC 'high' species	Surface of freshwater lakes, ponds, and slow-moving waters	No. The species has been located in Nevada, Placer and Yuba Counties, including within the area around the Project.
Hydrilla *Hydrilla verticillata*	C.C.R. 3 Section 3962(a)(1) Cal-IPC 'high' species CDFA A-rated	Freshwater lakes, ponds, and slow-moving waters	No. The closest occurrences of hydrilla to the Project are in Yuba County in 15 ponds and one canal, and in Nevada County in three ponds.
Water hyacinth *Eichhornia crassipes*	Cal-IPC 'high' species	Both natural and man-made freshwater systems (e.g., ponds, sloughs and rivers)	No. The nearest occurrences of water hyacinth are in Placer and Yuba counties.
Brazilian waterweed *Egeria densa*	Cal-IPC 'high' species	Slowly moving non-turbid shallow waters of lakes, springs, ponds, streams, and sloughs	No. There are occurrences in Yuba and Nevada counties in the area of the Project.
Parrot's feather milfoil *Myriophyllum aquaticum*	Cal-IPC 'high' species	Ponds, lakes, rivers, streams, canals, and ditches, usually in still or slow-moving water, but occasionally in faster-moving water of streams and rivers	No. There occurrences also in Nevada and Placer counties, including in the area of the Project.
Carolina fanwort *Cabomba caroliniana*	CDFA Q-rated	Mud of stagnant to slow-flowing water, including streams and smaller rivers	No. The closest occurrence to the Project is in Snodgrass Slough in Sacramento County, approximately 70 mi away.
Water primrose *Ludwigia* spp.	Cal-IPC 'high' species CDFA Q-rated	Shallow, stagnant, nutrient-rich water such as flood control channels, irrigation ditches, and holding ponds	No. The closest known occurrence of a water primrose species is in a pond in Condon Park, Grass Valley, approximately 30 mi from the Project
AMPHIBIANS			
American bullfrog *Lithobates catesbeianus*	--	Quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, and marshes	No. The closest documented occurrences of bullfrogs are approximately 30 mi upstream in the Bear River below Rollins Reservoir.

Source: Cal-IPC 2014, CDFA 2015a, USGS 2015a-d

3.2.3.4.1 Quagga Mussel[13]

Quagga mussel is a small (up to 1.6 in.) freshwater mollusk, native to the Dneiper River drainage of Ukraine and Ponto-Caspian Sea. Ballast water discharge from transoceanic liners carried mollusks to North America, and larval drift and recreational and commercial boating have facilitated their spread. Quagga mussels were first found in the U.S. in 1989 in the Great Lakes and have since moved west (USGS 2014a).

The closest current known location of quagga mussel to the Project are Lahontan Reservoir (i.e., not reported since 2011), which is approximately 180 mi away. In California, quagga mussels are in Southern California, the closest of which is approximately 500 mi south of the Project (USGS 2015a).

Quagga mussels can inhabit freshwater lakes, reservoirs and streams and colonize soft and hard substrates. The mussels can cause tremendous damage to hydro facilities and aquatic ecosystems once they invade a system. They clog water intakes and fish screens, as well as impede recreation opportunities by growing on recreation facilities (USGS 2015a).

In addition, quagga mussels consume large quantities of microscopic plants and animals, which are the basis of native communities, and thus, lead to the disturbance of the natural ecosystem, harming plants and wildlife (USFWS 2011). A single female can produce over a million eggs a year (USGS 2014a).

In North America, quagga mussel cannot survive in water with salinity over 5 parts per thousand (USGS 2014a). Currently, the best scientific data indicates that if calcium levels are low (less than 12 mg/L), introduced adult quagga mussels will not survive and veligers will not develop (Claudi and Prescott 2011). There are other water quality parameters that appear to also limit the ability of quagga mussel adults to survive and veligers to successfully develop, including pH, hardness and water temperature. Calcium carbonate solubility increases as pH decreases. In spite of adequate calcium, if the pH is low (less than 7.3 units), shells will become thin as they lose calcium to the external environment (Claudi and Prescott 2011). However, initial introduction can occur under a broader range of conditions.

Research is currently being conducted on the management of quagga mussel once it has invaded a waterbody; although there are promising leads, prevention is the only effective management strategy (USGS 2014a). Research on natural enemies, both in Europe and North America, has focused on predators, particularly birds (i.e., 36 species) and fish (i.e., 53 species that eat veligers and attached mussels). The vast majority of the organisms that are natural enemies in Europe are not present in North America. Ecologically similar species do exist; however, they have not been observed preying on dreissenids at levels that limit populations. In California, native and non-native species predators include redear sunfish, smallmouth bass, diving ducks and crayfish (Hoddle 2014).

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[13] Photo from <http://www.100thmeridian.org/Images/Mead/quagga.jpg>

Under C.C.R. 14 § 671(c)(10), quagga mussel is listed as a Restricted Species, which means it is *"unlawful to import, transport, or possess live (quagga mussels)…except under permit issued by the department."* Additionally, pursuant to this regulation, all species of *Dreissena* are termed "detrimental," which means they pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety.

In addition, F.G.C. §§ 2301 and 2302 provide specific regulations on dreissenid mussels, including quagga and zebra mussels. F.G.C. § 2301 states that nobody shall: "*possess, import, ship, or transport in the state, or place, plant, or cause to be placed or planted in any water within the state, dreissenid mussels*." This law gives the director of the Cal Fish and Wildlife, or his or her designee, the right to conduct inspections of conveyances, order conveyances to be drained, impound or quarantine conveyances, and close or restrict access to conveyances to prevent the importation, shipment, or transport of dreissenid mussels. Additionally, F.G.C. § 2301 requires a public or private agency that operates a water supply to prepare and implement a plan to control or eradicate dreissenid mussels if detected in their water system. This law also requires any entity which discovers dreissenid mussels to immediately report the finding to Cal Fish and Wildlife.

Pursuant to F.G.C. § 2302, any person, or federal, state, or local agency, district, or authority that owns or manages a reservoir where recreational, boating, or fishing activities are permitted, shall: 1) assess the vulnerability of the reservoir for introduction of dreissenid mussels; and 2) develop and implement a program designed to prevent the introduction of dreissenid mussels. At a minimum, the prevention program shall include: public education, monitoring, and management of the recreational, boating, and fishing activities that are permitted.

3.2.3.4.2 Zebra Mussel[14]

Zebra mussel is a small (around 0.2-in.), freshwater mollusk, native to the Black, Caspian and Azov seas. Ballast water discharge from a single commercial cargo ship into the Great Lakes in 1988 is responsible for their introduction into the U.S. Since then, larval drift and recreational and commercial boating have facilitated their spread (USGS 2014b).

The closest current known location of zebra mussels to the Project Area is the currently-closed San Justo Reservoir in California, approximately 200 mi south of the Project (San Benito County 2013). There are no other known zebra mussel occurrences in California or Nevada (USGS 2015b).

Zebra mussel can inhabit freshwater lakes, reservoirs and streams and colonize any stable substrate. They can also settle on submerged plants and be transported with them on bait buckets, fishing gear or boats. These mussels can cause damage to hydroelectric facilities and ecosystems once they invade a system. They clog water intakes and fish screens, as well as impede recreation opportunities by growing on recreation facilities (Forest Service 2013).

[14] Photo from http://watrnews.com/2012/07/zebra-mussels-found-in-lake-ray-roberts/

Additionally, zebra mussels consume large quantities of microscopic plants and animals, which are the basis of native communities, and thus, lead to the disturbance of the natural ecosystem, harming plants and wildlife (USFWS 2011). A single female can lay 40,000 eggs in a single reproductive cycle and up to one million in a spawning season (USGS 2014b).

Zebra mussels can tolerate only very low salinity (USGS 2014b). Currently, the best scientific data indicates that if calcium levels are low (i.e., less than 12 mg/L), introduced adult zebra mussels will not survive and veligers will not develop (Claudi and Prescott 2011). There are other water quality parameters that appear to also limit the ability of zebra mussel adults to survive and veligers to successfully develop, including pH, hardness and water temperature. Calcium carbonate solubility increases as pH decreases. In spite of adequate calcium, if the pH is low (i.e., less than 7.3 units) shells will become thin as they lose calcium to the external environment (Claudi and Prescott 2011). However, initial introduction can occur under a broader range of conditions.

Extensive research is currently being conducted on the management of zebra mussel once it has invaded a waterbody and although there are promising leads; prevention is the only effective management strategy (USGS 2014b). Research on natural enemies, both in Europe and North America, has focused on predators, particularly birds (i.e., 36 species) and fish (i.e., 53 species that eat veligers and attached mussels). The vast majority of the organisms that are natural enemies in Europe are not present in North America. Ecologically similar species do exist; however, they have not been observed preying on dreissenids at levels that limit populations. In California, native and non-native species predators include redear sunfish, smallmouth bass, diving ducks and crayfish (Hoddle 2014).

The Federal Lacey Act (18 U.S.C. 42) lists zebra mussels as injurious wildlife, whose importation, possession, and shipment within the U.S. is prohibited. If found, any zebra mussels brought into the U.S. will be promptly destroyed or exported by the USFWS at the cost of the importer.

Under C.C.R. 14 § 671(c)(10), zebra mussels are listed as a Restricted Species, which means it is *"unlawful to import, transport, or possess (zebra mussels)…except under permit issued by the department."* Additionally, pursuant to this regulation, all species of *Dreissena* are termed "detrimental," which means they pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety.

In addition, F.G.C. §§ 2301 and 2302 provide specific regulations on dreissenid mussels, including quagga and zebra mussels. F.G.C. § 2301 states that nobody shall: "*possess, import, ship, or transport in the state, or place, plant, or cause to be placed or planted in any water within the state, dreissenid mussels*." This law gives the director of Cal Fish and Wildlife, or his or her designee, the right to conduct inspections of conveyances, order conveyances to be drained, impound or quarantine conveyances, and close or restrict access to conveyances to prevent the importation, shipment, or transport of dreissenid mussels. Additionally, F.G.C. § 2301 requires a public or private agency that operates a water supply to prepare and implement a plan to control or eradicate dreissenid mussels if detected in their water system. This law also requires any entity which discovers dreissenid mussels to immediately report the finding to Cal Fish and Wildlife.

Pursuant to F.G.C. § 2302, any person, or Federal, state, or local agency, district, or authority that owns or manages a reservoir where recreational, boating, or fishing activities are permitted, shall: 1) assess the vulnerability of the reservoir for introduction of dreissenid mussels; and 2) develop and implement a program designed to prevent the introduction of dreissenid mussels. At a minimum, the prevention program shall include: public education, monitoring, and management of the recreational, boating, and fishing activities that are permitted.

3.2.3.4.3 New Zealand Mudsnail[15]

New Zealand mudsnail is a small (around 4 to 6 mm), freshwater mollusk, native to the lakes and streams in New Zealand and nearby small islands. Ballast water discharge from commercial cargo ships into the Great Lakes is most likely responsible for their introduction into the U.S. Since then, recreationists and recreational and commercial boating have facilitated their spread westward (CDFW 2015d).

The closest current known location of New Zealand mudsnails to the Project is the America River near the USDOI, Bureau of Reclamation's Nimbus Dam, approximately 45 mi from the Project. The species is fairly widespread in California (USGS 2015d).

New Zealand mudsnails can inhabit freshwater and brackish lakes, reservoirs and streams. They can tolerate siltation and benefit from disturbance and high nutrient flows. These snails can compete with other grazers and cause decreases in species richness. Reduction in algal production can rapidly reduce food resources for native species. An inhibiting factor for the species is temperature, as it cannot tolerate temperatures below freezing or above 93°F (CDFW 2015d).

There are a couple of potential management strategies for New Zealand mudsnails, mostly for small waterbodies that can be isolated from the rest of a system. Methods include chemical control and draining water to allow substrate to heat and freeze. Cal Fish and Wildlife has suggested methods for decontaminating equipment and boats after using them in known infested waters (CDFW 2015f). Management in large waterbodies is difficult, and research is ongoing. Current suggestions for limiting the spread of mudsnails include mechanical removal of snails, segregating gear for use in infested or non-infested waters, freezing wading gear to kill mudsnails, and not transporting any live animals or materials between water bodies (CDFW 2015d).

Under C.C.R. 14 § 671(c)(9)(A), New Zealand mudsnails are listed as a Restricted Species, which means it is *"unlawful to import, transport, or possess live (New Zealand mudsnail)…except under permit issued by the department."* Additionally, pursuant to this regulation, New Zealand mudsnails are termed "detrimental," which means they pose a threat to native wildlife, the agricultural interests of the state, or to public health or safety.

[15] Photo from <http://www.seagrant.umn.edu/newsletter/2006/06/images/mudsnail.jpg>

3.2.3.4.4 Asian Clam[16]

Asian clam is a small (around 0.2-in.), freshwater mollusk, native to temperate and tropical southern Asia, eastern Mediterranean and the Southeast Asian islands to Australia. This species was first located in the U.S. in 1938 in the Columbia River and is believed to have been brought by Chinese immigrants as food. People have spread the species through bait buckets, aquaculture and intentional introductions for consumption (USGS 2014c).

In 2014, Asian clams were reported in Camp Far West reservoir at the NSRA and SSRA boat launches. In California, Asian clams are also known in the Sacramento and San Joaquin drainages, Santa Barbara County south to San Diego County, the Salton Sea and the San Francisco Bay (USGS 2015d).

Asian clams can inhabit freshwater lakes, reservoirs and streams, and often bury themselves in sandy, bottom sediments. These clams can foul complex power and water systems and have temporarily closed down nuclear power plants and weakened concrete structures in the U.S. An inhibiting factor for the species is temperature, as they have a low tolerance to cold temperatures, which can cause their populations to fluctuate (USGS 2014c). Nonetheless, Asian clams are well-established in Lake Tahoe, an area with winter time freezing temperatures, at depths from 5 ft to 250 ft, though the individuals are smaller than those in warmer waters (TERC 2008). The species is also sensitive to salinity, drying, low pH and siltation (USGS 2014c).

Management methods for Asian clam include mechanical (e.g., scraping colonies off substrate), bottom barriers, suction removal and chemical and temperature alteration, though some of these techniques cannot be used in many water bodies (USGS 2014c).

3.2.3.4.5 Curly Leaf Pondweed[17]

The genus *Potamogeton* contains many widespread, variable species that are difficult to tell apart (Cal-IPC 2014). All are native to California, except curly leaf pondweed, whose distinguishing characteristic is very wavy (undulate) leaves (DiTomaso et al. 2013). Native to Eurasia, Africa and Australia, curly leaf pondweed can grow up to 0.8-in. in length and be found in water as deep as 4.7 in.

Most pondweeds reproduce vegetatively from rhizomes or stem fragments. Curly leaf pondweed is unusual as it both flowers and fruits in late spring and early summer, at which time it also produces turions, a wintering bud resembling brown pinecones, that becomes detached and remains dormant at the

[16] Photo from <m.wxxi.org>
[17] Photo from http://nas.er.usgs.gov/queries/GreatLakes/SpeciesInfo.asp?NoCache=6%2F11%2F2010+12%3A45%3A18+PM&SpeciesID=1134&State=&HUCNumber=DGreatLakes/.

bottom of the water body it inhabits (Cal-IPC 2014; DiTomaso et al. 2013). Turions can survive unfavorable conditions. The plants become dormant over the summer and decay, contributing to eutrophic conditions, leaving only their fruits and turions in the waterbody. The turions germinate in late summer or fall, and the plants overwinter as small plants only a few centimeters in size. Growth then continues as the water begins warming in the spring (DiTomaso et al. 2013).

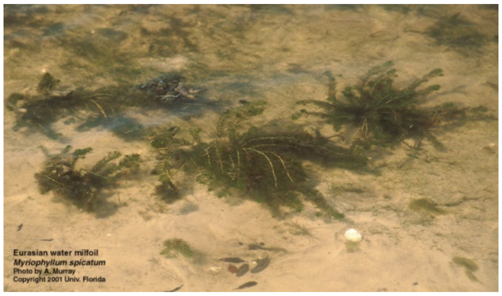
Curly leaf pondweed is widely distributed throughout California, and is found throughout the Central Valley and northern Sierra foothills. The plant's production of both seed and turions makes it resistant to disturbance such as dredging. Their small size allows them to be easily transported attached to waterfowl, boats, or fishing gear (Cal-IPC 2014). Curly leaf pondweed has been located in Nevada County, but has not been documented from Camp Far West Reservoir (Invasive.org 2014).

Laboratory and field studies have found that germination is generally controlled by temperature, light intensity, photoperiod, and anoxic conditions. It grows in the fine substrates and quiet (standing or slow moving) calcium-rich waters of lakes, reservoirs, ponds, rivers, streams, springs, small ponds and ditches and is tolerant of a wide-range of water quality conditions. It can grow in clear to turbid and polluted waters, and in alkaline or brackish waters; and it is tolerant of significant nutrient pollution. The species is shade intolerant (Cal-IPC 2014).

Effective control of curly leaf pondweed is difficult because of its vegetative reproduction. Mechanical removal can help remove stem densities, but escaped stem fragments can drift to other areas and develop into new plants. Bottom barriers can be used to cover and smother pondweed infestations. Dredging can be used to remove infestations in canals and other waterbodies. Pond drawdowns or canal detwatering may be used to suppress growth of pondweed, but plants can still resprout from rhizomes in moist, cool bottom sediments (DiTomaso et al. 2013). Triploid grass carp (*Ctenopharyngodon idella*) have also been used as a biological control mechanism, however these fish do not selectively feed on non-native plants and a permit is required by Cal Fish and Wildlife for possession and use of these fish in California. Broadcast chemical control has proved to be effective, but can damage native species (CABI 2015).

Curly leaf pondweed is rated as a "moderate" invasive plant by the California Invasive Plant Council (Cal-IPC), which means the "*species has substantial and apparent - but generally not severe - ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.6 Eurasian Watermilfoil[18]



Eurasian watermilfoil grows submerged, rooted in mud or sand, with branching stems 12 to 20 ft long that widen towards the root. Its leaves are finely divided, feather-like, 0.5 to 1.5 in. long and whorled in groups of 3 to 6 (commonly 4) around the stem. Its spike of flowers, 1.5 to 3.0 in. long, extends up from water surface, typically pink (Cal-IPC 2014; DiTomaso et al. 2013).

Watermilfoil grows rapidly in spring (March-April), creating dense mats on the surface of freshwater lakes, ponds, and slow-moving waters (Cal-IPC 2014). In the early 1990s, it was present, but uncommon, in San Francisco Bay Area's ditches and lake margins, as well as in the Sacramento-San Joaquin Delta (SFEI 2014). The University of Reno reports that in 2002, Eurasian watermilfoil covered over 160 ac of Lake Tahoe (Donaldson and Johnson 2002). Watermilfoil is now widespread throughout California, especially through the Central Valley in the Sacramento River Watershed, its tributaries, and the Delta. The species has been located in Nevada, Placer and Yuba counties, including within the area around the Project (Cal Weed Mapper 2015).

The key factor for the establishment of Eurasian watermilfoil is still water (Donaldson and Johnson 2002). Eurasian watermilfoil reproduction is primarily vegetative via rhizomes, stem fragments, and axillary buds. Some populations produce seeds, although seed reproduction appears to be insignificant (DiTomaso et al. 2013). Watermilfoil can tolerate a wide range of environmental conditions, including low light levels, high or low nutrient waters, and freezing water temperatures. In waters where temperatures do not drop below 50°F, there is little seasonal die-back (Cal-IPC 2014); high temperatures promote multiple periods of flowering and fragmentation. Eurasian watermilfoil also creates its own habitat by trapping sediment and initiating a favorable environment for further establishment. It is an opportunistic species that prefers disturbed substrates with much nutrient runoff (Cal-IPC 2014). This watermilfoil can grow on sandy, silty, or rocky substrates, but grows best in fertile, fine-textured, inorganic sediments. The plant will thrive in brackish waters with a salinity of up to 10 parts per thousand. As the plant is easily spread by vegetative fragments, transport on boating equipment plays the largest role in contaminating new water bodies. A single stem fragment hitching a ride on a boat or trailer can spread the plant from lake to lake (Donaldson and Johnson 2002).

Efforts are underway to identify insects which are native to Nevada or California that prey on the plant and help control Eurasian watermilfoil. A North American native milfoil weevil (*Euhrychiopsis lecontei*) has been identified in several studies in other states and Canada as a possible control species. Triploid grass carp may also be an effective biocontrol mechanism; however, grass carp prefer other submerged plants, including native species, to watermilfoil (DiTomaso et al. 2013). Other control techniques for this species includes mechanical removal, herbicide treatment, benthic barriers (such as mats to prevent establishment), and tillage (CABI 2015). Mechanical removal can help remove stem densities, but escaped stem fragments can

[18] Photo from http://www.sfei.org/nis/milfoil.html.

drift to other areas and develop into new plants (DiTomaso et al. 2013). The most effective technique is to prevent its spread to and establishment in new waterbodies.

Eurasian watermilfoil is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.7 Hydrilla[19]

The submerged aquatic perennial hydrilla has small spear-shaped leaves up to 1-in. long and 1 to 4 mm-wide, with toothed edges, arranged in whorls of usually 5 to 8 leaves, with many whorls along each stem. Typically, it is found in shallow (i.e., less than 11.5 ft) water, but if the water is clear enough it may be found growing to depths of 48 ft (DiTomaso et al. 2013; Cal-IPC 2014).

Hydrilla grows rapidly in spring and summer, creating dense mats in freshwater lakes, ponds, and slow-moving waters. In spring, when water temperatures exceed 60°F, hydrilla begins to grow, producing large amounts of biomass by late summer and early fall. It can tolerate some salinity and is sometimes found in upper estuaries. It grows better on mud than on sand. Growth is enhanced in water with agricultural runoff that raises nutrient levels. Dieback of above-ground portions of the plant usually occurs in late fall and winter (Cal-IPC 2014).

Hydrilla can reproduce by fragmentation of stems, rhizomes, root crowns, and by the production of tubers and turions. The plant is most likely to spread when fragments are carried into new waterbodies by recreational watercraft or water dispersal. Once established, it produces a bank of tubers and turions in the soil that may remain viable for three to five years (Cal-IPC 2014).

Hydrilla was imported into the U.S. from Asia in the late 1950s for aquarium use. In California, hydrilla was first found in Yuba County in 1976 (Cal-IPC 2014) and has since been found in 17 of California's 58 counties. The California Department of Food and Agriculture (CDFA) implements and eradication program specifically for hydrilla. The CDFA has successfully eradicated hydrilla from fourteen counties and currently conducts hydrilla eradication efforts in four counties throughout California integrating various methods of control. The CDFA surveys the Sacramento-San Joaquin Delta for hydrilla annually and has not documented its presence there. The closest occurrences of hydrilla to the Project are in Yuba County in 15 ponds and one canal, and in Nevada County in three ponds; all of these infestations are currently being eradicated by CDFA (CDFA 2013).

Manual removal of hydrilla can be used for small infestations, but herbicides are usually necessary for large infestations. Sterile triploid grass carp (*Ctenopharyngodon idella*) are approved for hydrilla control in the Imperial Irrigation District drainage system in southeastern California by permit issued by Cal Fish and Wildlife (Cal-IPC 2014).

[19] Photo from http://www.sfei.org/nis/hydrilla.html.

Hydrilla is listed by the CDFA as an A-rated noxious weed, which means "*a pest of known economic or environmental detriment and is either not known to be established in California or it is present in a limited distribution that allows for the possibility of eradication or successful containment* (and is) *subject to state enforced action involving eradication, quarantine regulation, containment, rejection, or other holding action*" (CDFA 2015a). CDFA implements an ongoing program to eradicate hydrilla from California. Yuba and Nevada counties are designated hydrilla eradication areas pursuant to C.C.R. 3 § 3962(a)(1). Cal-IPC gives hydrilla an invasive plant rating of "high," meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.8 Water Hyacinth[20]

Water hyacinth is a free-floating perennial. It has bushy, fibrous roots and is often found in large mats on the water surface measuring tens or hundreds of feet in diameter. Seedlings are most often rooted in mud along shorelines or on floating mats. Leaves are round or oval and shiny green and 3 to 8 in. across. Buoyant bulbs are present at the base of the leaf stalks an attached to a thick erect stem which can grow up to 2 ft tall (DiTomaso et al. 2013; Cal-IPC 2014). Water hyacinth flowers are pale blue, purple to whitish with six petals (Cal-IPC 2014).

Water hyacinth can be found in both natural and man-made freshwater systems (e.g., ponds, sloughs and rivers). It cannot tolerate brackish or saline water with salinity levels above 1.8 percent. Water hyacinth obtains nutrients directly from the water and can double its size every ten days in hot weather. Water hyacinth's transpiration rate is calculated to be almost eight times the evaporation rate of open water. It alters water quality beneath the mats by lowering pH, dissolved oxygen and light levels, and increasing carbon dioxide and turbidity (Cal-IPC 2014).

Vegetative reproduction occurs from late spring through fall. Water hyacinth reproduces primarily from pieces of runners, and in as little as a week, the number of individuals can double. Plant fragments can spread via a number of mechanisms, "daughter" plants break off and float downstream, or the stout leaves act like sails and float downstream en masse. Water hyacinth also reproduces by seed which can spread by water flow and clinging to the feet or feathers of birds. Seeds require warm, shallow water and high light intensity for germination. Seeds can remain viable in sediment for 15 to 20 years (Cal-IPC 2014; DiTomaso et al. 2013).

Native to Central and South America, water hyacinth was introduced into the U.S. in 1884 as an ornamental plant for water gardens. By 1904, water hyacinth had made its way into Yolo County, California. In California, water hyacinth typically is found below 660 ft elevation in the Central Valley, San Francisco Bay Area, and South Coast (Cal-IPC 2014). The Sacramento-San Joaquin Delta and several of the rivers draining into the Delta are heavily infested. The nearest occurrences of water hyacinth to the Project are in Placer and Yuba counties (Cal Weed Mapper 2015).

[20] Photo from http://www.sfei.org/nis/hyacinth.html.

At present, aquatic herbicides remain the primary tools available to control water hyacinth. Two weevils and a moth have been introduced as biological controls, but have not demonstrated much success. Most animals, except rabbits, do not readily eat the plant, possibly because its leaves are 95 percent water and have high tannin content (Cal-IPC 2014). The DBOW conducts annual treatments for water hyacinth and is the only agency in California currently authorized to use herbicides in the Delta and tributaries. In 2014, DBOW treated 2,617 ac of water hyacinth with glyphosate and 2, 4-D (DBOW 2015).

Cal-IPC gives water hyacinth a "high" invasive plant rating, meaning 'the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure' (Cal-IPC 2014).

3.2.3.4.9 Brazilian Waterweed[21]

Brazilian waterweed[22] is a fast-growing, shallow-water perennial aquatic plant that grows rooted in mud, submerged or floating, with stems up to 15 ft long and 1/8-in. thick. Its leaves are small, smooth, spear-shaped, 1 to 2.5 in. long, 0.06 to 0.12-in. wide, arranged in whorls of three to six leaves, with many whorls along stem. It displays prominent white flowers extending 1.5 in. above the water surface on long, thread-like flower tubes attached to stems (SFEI 2014; DiTomaso et al. 2013).

All populations of Brazilian waterweed in the western U.S. reproduce vegetatively by stolon and stem fragments as all plants are male and no fruit is produced. Although similar in appearance to hydrilla, Brazilian waterweed does not produce tubers or turions. Plants easily break into free-floating fragments and disperse to new areas by water flow, waterfowl, and human activities such as fishing and boating. However, only fragments with a double node can develop into new plants (DiTomaso et al. 2013).

Native to South America, Brazilian waterweed was introduced to California more than 30 years ago and now infests approximately 12,000 ac of the 50,000 surface ac of the Sacramento-San Joaquin Delta. Commonly sold as aquarium decor, it may have been introduced to the Delta when dumped by an aquarium owner (DBOW 2014). Brazilian waterweed is found throughout the California Central Valley, especially between Stockton and Butte counties, and in the Sacramento-San Joaquin Delta and tributaries. There are known occurrences in Yuba and Nevada counties but none documented within the Project Area. (Cal Weed Mapper 2015).

Brazilian waterweed prefers slowly moving non-turbid shallow waters of lakes, springs, ponds, streams, and sloughs, rarely establishing itself greater than 20 ft below the surface. Brazilian waterweed's growth is affected by nutrient status, light intensity, day length, temperature, turbidity, salinity, and rate of water flow. The plant inhabits acidic to alkaline waters and is highly susceptible to iron deficiencies and salinity. In the Delta, plants grow year-round with

[21] Photo from <http://www.sfei.org/nis/waterweed.html.
[22] Also known as "*Egeria elodea*" or "Brazilian elodea."

maximum growth occurring in the spring. Ideal temperatures range between 50°F and 80°F, but in climates with colder temperatures, Brazilian waterweed senesces in winter (SFEI 2014).

Mechanical control and herbicides are effective methods of control. However, Brazilian waterweed can propagate from small sections of stem, so repeated treatments are often necessary for full control (Cal-IPC 2014). Triploid grass carp may be a good option for control, as Brazilian waterweed is one of its most preferred diets, although a permit is required from Cal Fish and Wildlife for possession and use of this species. DBOW conducts annual treatments for Brazilian waterweed and is the only agency in California authorized to use herbicides in the Delta and its tributaries. In 2014, DBOW conducted herbicide treatments from June through September, including in the Sacramento area (DBOW 2014).

Brazilian waterweed is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.10 Parrot's Feather Milfoil[23]

Parrot's feather milfoil is a stout aquatic perennial that forms dense mats of intertwined brownish rhizomes in water (Cal-IPC 2014). Stems are mostly submerged and can grow up to 16 ft in length. Submersed leaves are arranged in whorls of three to six per node; emergent leaves are similar in appearance but are slightly thicker. Additionally, emerged leaves are light gray-green and resemble a bottlebrush. The bottlebrush appearance results from the fact that the leaves appear in whorls of four to six at each node and each leaf is feather-like, the blade divided into twenty-four to thirty-six thread-like segments. Unlike other milfoils (*Myriophyllum* spp.), parrot's feather stems may grow as much as 8 in. above the water surface (DiTomaso et al. 2013).

Parrot's feather milfoil occurs in ponds, lakes, rivers, streams, canals, and ditches, usually in still or slow-moving water, but occasionally in faster-moving water of streams and rivers. It tolerates soft to very hard water and a pH range of 5.5 to 9.0. It does not tolerate brackish water and requires high light conditions (Cal-IPC 2014). In north and central California, it is wide spread through the Central Valley and North Coast, especially in Mendocino, Butte, Yuba, and Sutter counties, with occurrences also in Nevada and Placer counties. There are no documented occurrences within the Project Area. (Cal Weed Mapper 2015).

Introduced from South America as an aquarium plant and pond ornamental in the late 1800s to early 1900s, parrot's feather milfoil grows best in tropical regions and can survive freezing by becoming dormant. In California, parrot's feather milfoil grows most rapidly from March until September. In spring, shoots begin to grow rapidly from overwintering rhizomes as water temperature increases. Underwater leaves tend to senesce as the season advances. Plants usually flower in the spring, but may also flower in the fall (Cal-IPC 2014).

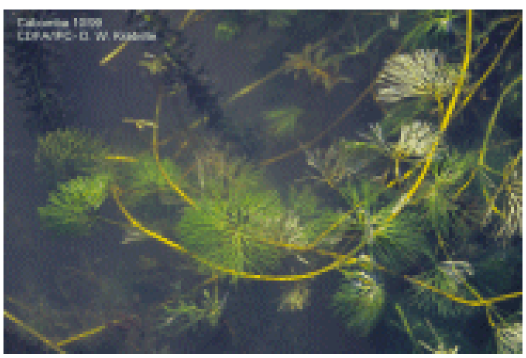
[23] Photo from http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua003.html.

With its tough rhizomes, parrot's feather milfoil can be transported long distances on boat trailers. Any rhizome or stem sections with at least one node, even as small as 0.2-in. long, can root and establish new plants. Rhizomes stored under moist conditions in a refrigerator survived for one year. Once rooted, these new plants produce rhizomes that spread through sediments and stems that grow until they reach the water surface (Cal-IPC 2014). Most plants in its introduced range are female, thus only populations within its native range develop seed (DiTomaso et al. 2013).

Biological, mechanical, and chemical controls have all been attempted by researchers. Of the available methods, chemical control seems to hold the most promise for control of this milfoil. Biological control is largely ineffective, with many typical aquatic herbivores finding the plant unpalatable. Mechanical control is difficult because of the species' ability to regenerate from a small fragment of the original plant and its rapid growth rate, requiring many repeated treatments to control an infestation. There are several chemical treatments that have shown promise, but many do not specifically target milfoil and may damage native aquatic species as well (Invasive Species Compendium 2014).

Parrot's feather milfoil is given a "high" invasive plant rating by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.11 Carolina Fanwort[24]



Carolina fanwort or fanwort is a submersed, sometimes floating, but often rooted, freshwater perennial plant. Its shoots are grass green to olive green or sometimes reddish brown. The leaves are of two types: submersed and floating. The submersed leaves are finely divided and arranged in pairs on the stem. The floating leaves, when present, are linear and inconspicuous, with an alternate arrangement. They are less than 0.5-in. long and narrow (i.e., less than 0.25-in.) (DiTomaso 2010). Flowers are on stalks rising from the tips of stems and are white to pink to purplish and about 0.5-in. across (DiTomaso et al. 2013)

Fanwort grows rooted in the mud of stagnant-to slow flowing water, including streams and smaller rivers. The plants flower from May to September. Although seeds are produced, there is little known about seed viability or soil longevity. Like most aquatic plants, fanwort reproduces vegetatively from small fragments. In the late summer, fanwort stems become brittle, which causes the plant to break apart, facilitating its distribution and invasion of new waterbodies (DiTomaso 2010).

In California, there have been sightings of fanwort in Contra Costa, Sacramento, and San Joaquin counties, and it is present in the Sacramento-San Joaquin Delta. The closest occurrence

[24] Photo from http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua003.html.

to the Project is in Snodgrass Slough in Sacramento County, approximately 70 mi away. The species is native to the eastern U.S., but has spread beyond its range both in North America and on other continents (CalFlora 2015).

Mechanical control can contribute to the spread of fanwort since it easily fragments, however a venture dredge, which acts like a giant vacuum cleaner, can minimize fragmentation and extract the rootball. Draining a waterbody can provide temporary control of fanwort; growth can be suppressed if areas are dewatered in high temperatures and allowed to dry or dewatered during hard freezes. Potential biological control agents have been identified and are currently being investigated in the laboratory in Argentina, but no successful field releases have been made. Some of the same herbicides used to control Brazilian waterweed and water hyacinth can be used to control fanwort (DiTomaso et al. 2013).

Carolina fanwort is listed by the CDFA as a Q-rated noxious weed, which means "*an organism or disorder suspected to be of economic or environmental detriment, but whose status is uncertain because of incomplete identification or inadequate information*" (CDFA 2015a).

3.2.3.4.12 Water Primrose[25]

Several native and non-native water primrose species are found in California. Native species include floating water primrose (*Ludwigia peploides* spp. *peploides*). Non-native species include Uruguay water-primrose (*L. hexapetala*) and creeping water primrose (*L. peploides* ssp. *montevidensis*), among others. Water primrose is part of the aquatic plant Subfamily Ludwigioideae (Family Onagraceae), of which most species are native to South America. Water primroses are floating to emergent perennials with stems up to 10 ft long. Flowers have five petals and are bright yellow (DiTomaso et al. 2013). Stems form dense mats in waterways, reaching above and below the water surface (Cal-IPC 2014).

Water primrose is found throughout the central and northern Central Valley, especially in Sacramento, Yuba, and Sutter counties and the Sacramento-San Joaquin Delta. The closest known occurrence of a water primrose species to the Project is in a pond in Condon Park, Grass Valley, approximately 30 mi away (Cal Flora 2015).

Water primrose reproduces vegetatively (roots, rhizomes, and plant fragments) and by seed, although seedlings are rarely encountered (DiTomaso et al. 2013). Water primrose establishes in areas with disturbed hydrology, high nutrient loading and flooding. The species favors areas of shallow, stagnant, nutrient-rich water such as flood control channels, irrigation ditches, and holding ponds. It is a freshwater aquatic vascular plant that is able to persist in both wet and dry transitional zones, such as lakes, ponds, reservoirs, rivers, stream, canals, bogs, marshes, riparian and bottomland habitats (Cal-IPC 2014).

[25] Photo from http://www.cal-ipc.org/ip/management/plant_profiles/Ludwigia_hexapetala.php.

Water primrose's main mode of dispersal is by flowing water when floating mats or shoots break off, however water primrose fragments can catch onto boats and other watercraft which spreads plants to new areas. The species has also been documented to be consumed and possibly transported by ducks and other waterfowl. It is a common ornamental plant and believed to be widely-spread by humans. Since it thrives in nutrient-rich waters, its spread may be facilitated by nursery cultivation/commercial use and animals (Cal-IPC 2014).

Water primrose species winged water-primrose (*L. decurrens*), *L. hexapetala*, and Peruvian water-primrose (*L. peruviana*) are listed by the CDFA as Q-rated noxious weed species (CDFA 2015a). Water primrose is rated as a "high" level invasive by the Cal-IPC, meaning "*the species has severe ecological impacts on physical processes, plant and animal communities, and vegetation structure*" (Cal-IPC 2014).

3.2.3.4.13 American Bullfrog[26]

The American bullfrog is a large frog with an average snout to vent length ranging between 3.5 and 8 in. Its color varies, with most individuals being light green to dark olive green, with dark spots and blotches. Adult bullfrogs are opportunistic feeders taking insects, worms, crustaceans, birds, bats, rodents, lizards, snakes, turtles, newts, and other frogs and tadpoles (Nafis 2013; CDFW 2014a).

Bullfrogs occur near permanent or semi-permanent water throughout California, including the quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, and marshes. The closest documented occurrences of American bullfrogs are approximately 30 mi upstream in the Bear River below Rollins Reservoir and at the Colusa National Wildlife Refuge, which is approximately 60 mi away from the Project (NID and PG&E 2011; USGS 2015e).

In California, breeding and egg-laying occur from March to July (CDFW 2014b). Reproduction begins when the air temperature reaches a certain level (measured at one location in Kansas at 70°F [Nafis 2013]). Females deposit 10,000 to 20,000 eggs in disk-shaped masses about 1 egg thick and 1 ft to 5 ft in diameter. Eggs are deposited among aquatic plants or brush growing on the bottom. In some localities, they may produce more than one clutch per season. Tadpoles use shallow waters near shore while completing development, which can take up to 6 months. Individuals in many populations overwinter as tadpoles and transform during their second year.

As demonstrated by their diet and high tadpole survival rates, bullfrogs are adaptable. In addition, they are not as sensitive to temperature and pollution as California's native frogs. Bullfrogs are found at elevation ranges from sea level to 6000 ft (Zeiner et al. 1988). In desert regions, they occur along the Mojave and Colorado rivers and in areas where irrigation creates suitable habitat. Bullfrogs can travel great distances, especially during wet periods (CDFW 2014b).

[26] Photo from http://www.californiaherps.com/frogs/pages/l.catesbeianus.html.

Native to central and eastern North America, bullfrogs were introduced to California and the West for their meat (legs), as biological controls for insects, and accidentally during fish stocking. Most fish appear to be averse to eating bullfrog tadpoles because of their undesirable taste and, other than people, the adult bullfrog has few predators. Nevertheless, bullfrog tadpoles, and some adults, are preyed upon by aquatic insects, fish, garter snakes, wading birds, and probably a few nocturnal mammals (CDFW 2014a, b).

As a result of their feeding behaviors and adaptability to natural and manmade aquatic environments, all lifestages of bullfrogs prey upon and are able to out-compete native frogs and other aquatic species. Additionally, bullfrogs are a known carrier of chytrid fungus, which causes the potentially fatal skin disease in frogs called chytridiomycosis. Chytridomycosis is believed to be a leading cause of the decline of native amphibian populations all over the world and responsible for the extinction of over 100 species since the 1970s (CDFW 2014a).

Management methods for American bullfrogs are limited to localized populations, as eradicating bullfrogs from large waterbodies is currently infeasible. Currently, there are only a few methods for managing bullfrogs, including chemical control, bullfrog-specific traps and hunting. Prevention remains the best means of management (Snow and Witmer 2010).

3.2.3.5 Aquatic Resources of the Bear River Area

Further information regarding aquatic resources of the Bear River found by SSWD is provided in the sections below for areas upstream, within, and downstream of the Project Area. Information regarding mercury in fish, including any fish ingestion advisories is discussed in Section 3.2.2.9.

3.2.3.5.1 Upstream of the Project

This section presents relevant and reasonably available information regarding aquatic resources located upstream of Camp Far West Reservoir to the base of Combie Dam on the Bear River and any tributaries to Camp Far West Reservoir. SSWD found information on fish and benthic macroinvertebrates only.

3.2.3.5.1.1 Fish

Yardas and Eberhart (2005) identified flow-related improvement needs and opportunities along with identifying key challenges in the reach between Camp Far West Reservoir and Lake Combie. They concluded that contemporary conditions in this section of the Bear River are such that ecological justifications for improved flows are limited, especially when compared to the lower Bear River or the various foothill streams that continue to support anadromous fish. The authors state that colder water temperatures due to improved summer/fall flows may help to reduce the potential for mercury methylation in this reach and Camp Far West Reservoir, but could also lead to potential conflicts with non-native fisheries. Yardas and Eberhart also noted that any change to flows would require the development of multiple agreements and understandings with various agencies, companies, districts, and private water rights holders.

In addition, Yardas and Eberhart (2005) cite John Hiscox (Cal Fish and Wildlife biologist, retired) who states that the reach between Lake Combie and Camp Far West Reservoir is now reputed to be a renowned area for bass fishing. He surmises during high flow events, game fish likely wash into the river from stocked ponds on private property. Mr. Hiscox states this reach is predominantly located in a deep canyon such that improved flows would likely provide few riparian benefits, and that the reach is predominantly private land holdings and provides few opportunities for public access. Mr. Hiscox speculated that flow improvements below Combie Dam may result in both operational and structural improvement needs.

The North Central Region (NCR) (CDFW 2012a) conducted fish community surveys in October 2011 including two locations in the Bear River: 1) upstream of Camp Far West Reservoir (BR 1); and 2) downstream of Lake Combie (BR 2). The fish community surveys focused on collecting reconnaissance level fish community data utilizing single or multiple pass depletion electrofishing methods. Data relative to species composition, temporal and spatial distribution, and presence or absence of species were collected.

At the sampling location upstream of Camp Far West Reservoir (BR1), a total of 54 fish representing four species were collected during the survey. Smallmouth bass comprised 48.1 percent (n = 26) of the total fish sampled. Sacramento sucker followed with 38.9 percent (n = 21) of the total catch. Sacramento pikeminnow was next with 9.3 percent (n = 5) and rainbow trout (n = 2) was last with 3.7 percent of the total fish collected. Only six smallmouth bass were collected at the sampling location downstream of Lake Combie Dam (BR2).

At the request of NID, ECORP Consulting, Inc. (ECORP) (ECORP 2014) conducted reach assessments within a ±5.5 mi section of the Bear River from Lake Combie to Wolf Creek to define and understand the aquatic and sediment resources. A total of 50 smallmouth bass and two spotted bass (*Micropterus punctulatus*) were observed in mid-channel pool and flatwater habitats. Most (78%) of the smallmouth bass were young-of-year and the two spotted bass were in the 1+ age class.

ECORP also completed a two-dimensional habitat model of the reach using the River 2D software program. The River 2D habitat modeling results were:

- Weighted Useable Area (WUA) curves were produced for the Laursen Reach of the Bear River (approximately 3 RM downstream of Lake Combie)
- The curves were only slightly responsive to flow, primarily from 5 to 10 cfs for all life stages and species except for trout fry.
- The upper WUA asymptote for juvenile Sacramento pikeminnow, juvenile Sacramento sucker, and juvenile hardhead was approximately 12 cfs.
- WUA for adults of these three species, adult trout, and juvenile trout increased very slightly with increased discharge.
- WUA for trout fry decreased with increased discharge over 8 cfs.
- Spawning habitat for spawning trout was generally absent.
- WUA curves indicate relatively good habitat conditions for trout species for all life stages, with the exception of spawning trout. Habitat appears to be best suited for adult and juvenile cyprinids and juvenile Sacramento sucker.

Additional information from the ECORP report can be found in Section 3.2.1.8.1 (geomorphology and habitat mapping) and Section 3.2.3.5.1.2 (benthic macroinvertebrates).

3.2.3.5.1.2 Benthic Macroinvertebrates

As part of ECORP's (2014) study, benthic macroinvertebrate (BMI) samples were collected and identified. In general, Ephemeroptera (EPT) taxa (mayflies, stoneflies, caddisflies), which are important prey items for fish, were present in relatively low quantity. There was also a greater abundance of tolerant species (e.g. blackflies) than intolerant species (e.g. midges), indicating the Bear River is a warm-water system with more environmental stressors. When compared with other area rivers (South Fork American River, North Fork Mokelumne River, and Middle Fork Yuba River), the Bear River had the lowest species diversity (i.e. taxa richness) and the lowest quantity of EPT taxa.

In 2013, one sample collection was conducted in the Bear River upstream of Camp Far West Reservoir, near Little Wolf Creek (RM 24.0), as part of the SWAMP Statewide Perennial Streams Assessment (SWRCB 2013). While the data provided did not include any BMI metric calculations, the 14 orders and 30 families identified during sampling suggest a diverse assemblage of BMIs. However, only seven of the 30 families found were from the EPT taxa suggesting a more stressed warm-water system.

Table 3.2.3-5. Orders and families of aquatic macroinvertebrates (all insects) that were found at one location in the Bear River (upstream of the Project).

Order	**Amphipoda**	**Basommatophora**	**Coleoptera**	**Odonata**	**Trombidiformes**	**Hemiptera**
Family	Hyalellidae	Planorbidae	Elmidae	Coenagrionidae	Hygrobatidae	Naucoridae
	Crangonyctidae	Physidae	Psephenidae		Torrenticolidae	
Order	**Ephemeroptera**	**Veneroida**	**Rhynchobdellida**	**Lepidoptera**	**Megaloptera**	**Hoplonemertea**
Family	Caenidae	Corbiculidae	Glossiphoniidae	Pyralidae	Corydalidae	Tetrastemmatidae
	Baetidae					
	Leptohyphidae					
Family	Ceratopogonidae	Helicopsychidae				
	Chironomidae	Hydroptilidae				
	Ceratopogonidae	Hydropsychidae				
	Simuliidae	Philopotamidae				
	Empididae	Leptoceridae				

Source: SWRCB 2013.

3.2.3.5.2 Within the Project

This section presents relevant and reasonably available information regarding aquatic resources located within the Project Area. SSWD found data for Camp Far West Reservoir but no information for the Bear River between the reservoir and the non-project SSWD diversion dam.

3.2.3.5.2.1 Fish

Since Camp Far West Reservoir's enlargement in 1963, stocking of warmwater game fish species has occurred. Largemouth bass (*Micropterus salmoides*), smallmouth bass, redear sunfish, white crappie (*Pomoxis annularis*), and channel catfish (*Ictalurus punctatus*) were the first species stocked in the reservoir. In 1965, Cal Fish and Wildlife decided to create a striped bass (*Morone saxatilis*) sport fishery in Camp Far West Reservoir. Stocking records and memorandums between Cal Fish and Wildlife employees indicated that the striped bass fishery never took hold in the reservoir. In the late 1960s, stocking of striped bass ceased and efforts shifted to focus on improving the smallmouth bass fishery. Available, though limited, fish survey and stocking records from 1964 through 1985, with some missing years, were obtained from Cal Fish and Wildlife (CDFW unpublished data). Table 3.2.3-6 summarizes available stocking records in Camp Far West Reservoir.

Table 3.2.3-6. Camp Far West Reservoir stocking records summary from 1964 to 1985.

Year	Species	Lifestage	Quantity
1964	Largemouth bass	n/a	60,734
	Smallmouth bass	n/a	8,098
	Redear sunfish	n/a	12,000
	White crappie	n/a	249
	Channel catfish	n/a	10,000
1966	Smallmouth bass	Fry	18,500
	Striped bass	n/a	18,707
1967	Smallmouth bass	Fry, Fingerlings	24,000
	Striped bass	n/a	23,835
1973	Smallmouth bass	Fry	1,500,000
1976	Smallmouth bass	Yearlings	5,050
1978	Smallmouth bass	Yearlings	5,050
1979	Smallmouth bass	n/a	430
	Channel catfish	n/a	4,030
1980	Smallmouth bass	n/a	4,300
1985	Spotted bass	Adults	40

Source: CDFW unpublished data.

In addition to the species listed in Table 3.2.3-6, Cal Fish and Wildlife records indicated that White catfish (*Ameiurus catus*) and Threadfin shad (*Dorosoma petenense*) were stocked at some point prior to 1980, but no additional details were available (CDFW unpublished data). Internal memorandums between Cal Fish and Wildlife staff in the 1970s and 1980s also indicated the presence of eleven additional species in Camp Far West Reservoir, not stocked by Cal Fish and Wildlife, including:

- Bluegill (*Lepomis macrochirus*)
- Green sunfish (*L. cyanellus*)
- Sacramento perch (*Archoplites interruptus)*
- Brown bullhead (*Ameiurus nudbulosus*)
- Black bullhead (*A. melas*)
- Common Carp (*Cyprinus carpio*)
- Hitch (*Lavinia exilicauda*)
- Hardhead (*Mylopharodon conocephalus*)
- Sacramento sucker (*Catostomus occidentalis*)

- American shad (*Alosa sapidissima*)
- Sacramento pikeminnow (*Ptychocheilus grandis*)

More recently, in April 2012, Cal Fish and Wildlife (CDFW 2012b) conducted boat electrofishing surveys at nine sites in Camp Far West Reservoir. The total numbers of individuals for each species are summarized below (Table 3.2.3-7) but no other information was available.

Table 3.2.3-7. Cal Fish and Wildlife 2012 Camp Far West Reservoir boat electrofishing summary of capture.

Species	Total Count
Spotted Bass (*Micropterus punctulatus*)	446
Bluegill (*Lepomis macrochirus*)	65
Sacramento sucker (*Catostomus occidentalis*)	51
White catfish (*Ameiurus catus*)	20
Channel catfish (*Ictalurus punctatus*)	13
Inland silverside (*Menidia beryllina*)	10
Green sunfish (*L. cyanellus*)	8
Largemouth Bass (*Micropterus salmoides*)	8
Common Carp (*Cyprinus carpio*)	7
Smallmouth Bass (*Micropterus dolomieu*)	6
Redear sunfish (*L. microlophus*)	5
Threadfin shad (*Dorosoma petenense*)	4
Goldfish (*Carassius auratus*)	3
Black crappie (*Pomoxis nigromaculatus*)	2
Sacramento perch (*Archoplites interruptus)*	1
Brown trout (*Salmo trutta*)	1

Source: CDFW 2012b

Additional information regarding fish in Camp Far West Reservoir and mercury related information can be found in Section 3.2.2.10.1.

3.2.3.5.3 Lower Bear River

This section presents relevant and reasonably available information regarding aquatic resources located in the lower Bear River including fish and benthic macroinvertebrates.

Monohan (2007) completed a data gaps analysis for the FERC relicensings on the Yuba and Bear rivers. The purpose of the gaps analysis was to identify, collect, organize and analyze available literature and data relevant to the FERC relicensings on the Yuba and Bear rivers. The references included in the library are primarily scientific documents of the research that has occurred in the Yuba and Bear river watersheds. In general the findings of the gap analysis demonstrated a lack of current data related to fisheries and aquatic resources in the lower Bear River.

3.2.3.5.3.1 Fish

<u>Fish Composition</u>

Sporadic salmon surveys on the Bear River were documented from 1982 to 1986 by Cal Fish and

Wildlife (CDFW unpublished data). Salmon numbers and redd observations depended on flows and water temperature. Salmon surveys by Cal Fish and Wildlife employees indicated the presences of roughly 100 adult salmon and steelhead strays in the Bear River in 1982. Salmon surveys were conducted from the non-Project diversion dam to Highway 70, occurred on November 16 and November 19, 1984. On November 16, 1984, Cal Fish and Wildlife employees reported seven salmon (4 males and 3 females) were on redds and one additional unattended redd from the diversion dam to Patterson's Sand and Gravel plant (~RM 15). Also, On November 16, 1984, Cal Fish and Wildlife employees canoed from SR 65 to Hudson Road and found five fresh carcasses (2 male, 2 female and 1 jack), 1 skeleton, 6 live fish and 15 redds. On November 19, 1984, Cal Fish and Wildlife employees canoed from Hudson Road to Highway 70. From Hudson Road to Pleasant Grove Road, Cal Fish and Wildlife reported finding 1 male carcass, 1 live female, and 35 redds. From Pleasant Grove Road to Highway 70, Cal Fish and Wildlife observed 3 skeletons (2 male and 1 female), 1 pair of salmon spawning and 6 unattended redds. Cal Fish and Wildlife employees conducted salmon redd surveys in December of 1986 and observed only one male carcass.

In 2003, the Bear River Coordinated Resources Management Plan Group developed a "disturbance inventory" for the Bear River (Shilling and Girvetz 2003). The report identified native fishes known to occur in the watershed based on both published and personal communications with Moyle. In addition, the report assigned a "status" to each species (Table 3.2.3-8). The report also noted that while no occurrences of Chinook salmon were reported during their CNDDB search, both the authors and Cal Fish and Wildlife staff have observed fish on the lower Bear River.

Table 3.2.3-8. Native fish potentially occurring in the Bear River watershed.

Species	Status[1]
Black crappie (*Pomoxis nigromaculatus)*	Stable
Chinook salmon (*Oncorynchus tshawytscha)*	Declining, special concern
Hardhead (*Mylopharodon conocephalus)*	Special concern
Pacific Lamprey (*Entosphenus tridentatus)*	Declining
California Roach (*Hesperoleucus symmetricus)*	Stable
Riffle Sculpin (*Cottus gulosus)*	Stable
Native trout *(Oncorynchus mykiss* ssp.*)*	Stable
Speckled dace (*Rhinichthys osculus* ssp.*)*	Stable
Sacramento squawfish (*Ptychocheilus grandis)*	Stable or expanding
Sacramento sucker (*Catostomus O. occidentalis)*	Stable or expanding

Source: Shilling and Girvetz 2003.
[1] As reported in Moyle et al. 1996

SSWD (2015 unpublished data) qualitatively sampled the fish community in the lower Bear River by snorkel on June 10, 2015 at two locations: near the SR 65 Bridge and below the diversion dam. One snorkeler searched for fish, in an upstream direction, in a zig-zag pattern to cover all available habitat niches. Surveys near the SR 65 Bridge began at the top of a large pool immediately upstream of the bridge. The weather was cloudy with air and water temperatures of 28°C and 22.2°C, respectively. The maximum visibility underwater was approximately 6 ft. A total of five species were observed, including smallmouth and largemouth bass, mosquitofish, Sacramento sucker, and one unidentified sunfish. Young of the year were only observed for black bass.

Ten habitat units were snorkeled immediately downstream of the non-Project diversion dam. The only fish observed was a Sacramento sucker, which was observed in the pool directly downstream of the diversion dam. This was likely due to the limited visibility of approximately 4 ft. Visibility was limited primarily by a high degree of suspended organic material in the water.

While conducting surveys, three potential redds were encountered at the head of a riffle, approximately 1 mi downstream of the SSWD diversion dam. The potential redds measured approximately 1 square meter and the depression was estimated to be 1 ft deep. The gravels were not free of periphyton/algae, however the gravels were of appropriate size (i.e., 2 to 3 in. diameter) and sorted downstream in a configuration typical of a salmon redd. Redds were sighted approximately 7 to 9 months after the expected Chinook salmon spawning season and were, therefore difficult to identify with a high level certainty.

Fish Habitat

In response to SSWD seeking more water rights for non-Project diversions in the Bear River, Cal Fish and Wildlife focused on the development of potential measures to restore habitat including flow regimes to increase Chinook salmon and steelhead populations (CDFG 1991). The report found that fall flows in the lower Bear River are not usually high enough to attract salmon to migrate up and spawn. During years where the October and November flows are high, Cal Fish and Wildlife estimated adult spawning runs as high as 300 fish (Table 3.2.3-2). Based on the evaluation of Chinook salmon life stage periodicities and analysis of WUA/streamflow indices, Cal Fish and Wildlife developed a set of instream flow recommendations using the Physical Habitat Simulation methodology (PHABSIM). Cal Fish and Wildlife recommended the following flows in the lower Bear River (measured at the Wheatland gage, station number 11424000) to optimize fall-run Chinook salmon habitat:

- 100 cfs from October 1 to 14 to provide ample depth and attraction for upstream adult migration and early spawning of fall-run Chinook salmon;
- 250 cfs from October 15 to December 31 to provide maximum spawning habitat for fall-run Chinook salmon, when the majority of spawning occurs;
- 190 cfs from January through March to prevent dewatering of fall-run Chinook salmon salmon redds, alevins, and/or stranding of fry;
- 100 cfs from April through June to provide maximum fall-run Chinook salmon juvenile salmon rearing habitat and facilitate their downstream movement; and
- 10 cfs from July through September for fall-run Chinook salmon juveniles' migration to the ocean by June.

Using multiple sources of information, Cal Fish and Wildlife gave ranges of preferred water temperatures for each life stage of fall-run Chinook salmon: upstream migration was 44.1° to 57.5°F (Bell 1986, Rich 1987); spawning was 41.0° to 57.0°F (Reiser and Bjornn 1979, Rich 1987 and Chambers 1956); egg incubation through fry emergence was 41.0° to 57.9°F (Reiser and Bjornn 1979 and Rich 1987); fry rearing was 44.6° to 57.2°F (Raleigh et al. 1986 and Rich 1987); and juvenile rearing was 45.1° to 58.3°F (Reiser and Bjornn 1979 and Rich 1987). Cal Fish and Wildlife stated that warm water temperatures near the confluence of the lower Bear and Feather rivers during September and October could delay upstream migration into the Bear River. Cal Fish and Wildlife asserted that the likelihood of a delay increases as temperatures rise above about 57.5°F. The report concluded that the preferred temperature range for spawning (41.0° to 57.0°F) was exceeded at Wheatland until early November, thereby shortening the period for spawning that is normally October through January. Cal Fish and Wildlife also concluded that during the incubation period of October through February, water temperatures generally exceed the optimum only during October and that the temperature range for juvenile rearing (45.1° to 58.3°F) is exceeded during the entire rearing period of April through June.

Cal Fish and Wildlife noted that its recommended flows may provide habitat and water temperatures favorable to fall-run Chinook salmon, but would likely not meet the requirements for steelhead.

Cal Fish and Wildlife also acknowledged that water diversions and operations upstream of Camp Far West may limit the ability to deliver the recommended flows and subsequent improvements to habitat and water temperature. Recommendations for future studies included increased upstream analysis, steelhead specific studies and consideration of dry year criteria.

Jones & Stokes (2005) stated that the Bear River historically experienced high winter flows and low summer flows, but today flow timing and volume is highly regulated by storage reservoir releases and diversions. The exportation of water diverted from the Bear River watershed is made through the conveyance facilities of NID and PG&E. The flow is diverted for irrigation, power generation, and domestic supply uses in the Auburn area. The report stated that upstream diversions from the Bear River basin have depleted the streamflow downstream of the non-Project diversion dam. Jones and Stokes stated that minimum flow releases are 25 cfs in the spring and 10 cfs during the rest of the year and that flows in the Bear River below the diversion dam range between zero and 40 cfs from June to December. This report found that current winter flows during wet years are similar to unimpeded flows, averaging 2,500 to 5,200 cfs and that summer flows are currently 30 to 50 percent less than the unimpaired flows.

Jones & Stokes found that habitat for Chinook salmon and steelhead below Camp Far West Dam is limited by inadequate streamflow and the high incidence of fine sediment, which is partially attributable to the relatively low gradient and reduced streamflow. Jones & Stokes stated that during heavy rain events, flow spills from Camp Far West Dam, and Chinook salmon and steelhead may migrate and spawn in the lower Bear River.

Beginning in July, water temperatures in the lower Bear River were found to be above the suitable level for steelhead rearing and that the ideal level had already been exceeded in mid-June. In the upper reach, water temperatures were found to exceed the ideal range in late June, but were within the suitable level for steelhead through July. Jones and Stokes did not provide thresholds for suitable temperatures, however, based on figures, average daily temperatures in July ranged from approximately 70° to 80°F.

Jones & Stokes assessed aerial photographs of the upper 4 mi of the lower Bear River starting from SSWD's non-Project diversion dam and moving downstream. Aerial photographs indicated relatively poor riparian shade and that about half of the reach had no shade while the remaining stream had moderate shade. The low level of shade is characteristic of the lower reaches as well. The poor shade conditions likely result in relatively quick warming of flow released from Camp Far West Reservoir.

Jones & Stokes did not perform spawning gravel surveys, but cursory surveys indicated a lack of spawning habitat. The cursory surveys found that substantial fine sediments were present, indicating unlikely spawning success. Jones & Stokes stated that the Bear River also receives agricultural runoff that may adversely affect water quality through input of contaminants and additional warming of the streamflow. Although Chinook salmon and steelhead may occur in the Bear River, this report stated that the level of fecundity among adults and the survival of subsequent life stages are expected to be minimal, given the apparent absence of spawning habitat. Jones and Stokes concluded that self-sustaining populations are likely absent in the Bear River.

SSWD (2015 unpublished data) conducted habitat mapping and channel characterization in the lower Bear River in June 2015 including assessing habitat types, dominant substrate and spawning gravel. A detail discussion of the findings is presented in Section 3.2.1.8.3 of the PAD.

3.2.3.5.3.2 Benthic Macroinvertebrates

Only one source of information was found regarding benthic macroinvertebrates downstream of the project Area. In 2011 and 2013, SWRCB staff conducted studies in the lower Bear River as part of the SWAMP Statewide Perennial Streams Assessment. One of the studies was conducted about 0.3-mi upstream of the Pleasant Grove Bridge (RM 7.2) and the other about 0.5-mi upstream of the Highway 70 Bridge (RM 4.0) (SWRCB 2011, SWRCB 2013). While the data provided did not include any BMI metric calculations, the 14 orders and 24 families identified during sampling suggest a diverse assemblage of benthic macroinvertebrates. However, only seven of the 24 families (25%) were from EPT taxa which suggest a warm water, altered environment (Table 3.2.3-9).

Table 3.2.3-9. Orders and families of aquatic macroinvertebrates (all insects) that were found at two locations in the lower Bear River (downstream of the Project).

Order	**Amphipoda**	**Arhynchobdellida**	**Hydroida**	**Coleoptera**	**Plecoptera**	**Hoplonemertea**
Family	Gammaridae	Erpobdellidae	Hydridae	Elmidae	Perlodidae	Tetrastemmatidae
Order	**Trombidiformes**	**Veneroida**	**Basommatophora**	**Ephemeroptera**	**Trichoptera**	**Diptera**
Family	Sperchontidae	Corbiculidae	Lymnaeidae	Baetidae	Leptoceridae	Chironomidae
	Hygrobatidae	Sphaeriidae	Planorbidae	Leptohyphidae	Hydropsychidae	Simuliidae
			Ancylidae	Caenidae	Philopotamidae	
Order	**Hemiptera**	**Odonata**				
Family	Naucoridae	Libellulidae				
		Coenagrionidae				

Source: SWRCB 2011 and SWRCB 2013.

3.2.3.6 Known or Potential Project Effects

Provided below is a list of known or potential Project effects on aquatic resources. The list was developed based on responses to SSWD's PAD Information Questionnaire and SSWD's current understanding of the issues.

- From Responses to SSWD's PAD Information Questionnaire:
  - Effects of Project O&M on water quantity and quality, including temperature, in the reservoir, and effects to instream flow and water quality downstream of the Bear River that may adversely affect aquatic resources as follows: BMI diversity; amphibians and their habitat; WPT and their habitat; diversity, quantity and composition of fish species; anadromous fish migration, spawning and juvenile rearing; non-anadromous stream fish spawning and habitat; reservoir fish spawning and habitat; stranding of fish; and dewatering of fish spawning sites (identified by Cal Fish and Wildlife)
  - Effects of Project O&M on flow regime below dams. Specific O&M measures are instream flow releases, fluctuations and ramping rates; project facilities; reservoir operation; and sediment management may effect healthy riverine aquatic populations and their habitat. Instream flow releases or project facilities may effect fisheries in the lower portion of the Bear River (identified by FWN)
- From SSWD:
  - Effects of Project O&M and Project recreation may introduce and/or spread aquatic invasive species.

3.2.3.7 List of Attachments

There are no attachments to this section.