Section 10

Section 10
FISHERIES AND AQUATIC RESOURCES

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FISHERIES AND AQUATIC RESOURCES

SOURCES OF DATA

All information on the biology, distribution, and abundance of fishery resources and their habitats was obtained from various studies and reports. No field surveys were conducted for this assessment. Several documents served as the primary sources of information on fishery resources. Dr. Peter Moyle's book, *Inland Fishes of California,* provided most of the biological background information on native and non-native fish life history characteristics. Information on the Sacramento River was primarily extracted from state and federal agency documents pertaining to restoration of anadromous salmonid fishery resources and ecosystem restoration. These included:

- California Department of Fish and Game's (CDFG) *Restoring Central Valley Streams: A Plan for Action*
- U.S. Fish and Wildlife Service's (USFWS) Anadromous Fish Restoration Program (AFRP);
- California Resources Agency's *Upper Sacramento River Fisheries and Riparian Habitat Management*
- The CALFED *Ecosystem Restoration Plan*

Because extensive information on fishery resources and their habitats in the Sacramento River are provided in these and other documents, and because of large-scale, ongoing state and federal programs on the Sacramento River, the main stem Sacramento River is only briefly discussed in this section of the watershed assessment.

Information on fish and associated habitats in the small intermittent streams of western Tehama County is limited. The primary documents used to provide recent information on fishery resources within these streams included several reports from California State University, Chico by Dr. Paul Maslin and his students. These reports focused on non-natal rearing of anadromous salmonids in the lower-most reaches of western Tehama County streams, but included data relevant to other native and non-native fish species in those areas. Additionally, information regarding Thomes and Elder Creeks was gleaned from CDFG files, while CALFED studies of offstream storage sites provided data for portions of Thomes and Upper Red Bank Creeks.

HISTORICAL CONTEXT

The historical abundance and distribution of Sacramento River salmon and steelhead populations within the main stem and anadromous salmonid-producing tributaries are described within numerous documents (e.g., CALFED Ecosystem Restoration Program, CDFG's Central Valley and fishery restoration plans, USFWS Anadromous Fish Restoration Program). In the CDFG Fish Bulletin No. 179, Yoshiyama et al. (2001) state:

> Chinook salmon (*Oncorhynchus tshawytscha*) formerly were highly abundant and widely distributed in virtually all the major streams of California's Central Valley drainage –

> encompassing the Sacramento River basin in the north and San Joaquin River basin in the south.
>
> In the Sacramento River basin, constituting the northern half of the Central Valley system (covering about 24,000 square miles), most Coast Range streams historically supported regular salmon runs; however, those 'westside' streams generally had streamflows limited in volume and seasonal availability due to the lesser amount of snowfall west of the valley, and their salmon runs were correspondingly limited by the duration of the rainy season.

Riparian forests near the Sacramento River have declined to just 2 to 3 percent of the original area (McGill 1979 and 1987, as cited by CALFED, 1999). Large-scale agricultural clearing and fuel harvest for riverboats from about 1850 to the turn of the century initiated this reduction. During the early to mid 1900s, reservoir and levee projects to assist with flood control resulted in additional reductions in floodplain riparian stands. Loss of riparian habitats likely affected the associated streams and the quality of their fishery habitat. At the same time, large multipurpose reservoirs and diversion dams impounded the Sacramento River. These structures stopped the upstream migration of anadromous fish into tributaries where spawning and rearing historically occurred.

HABITAT TYPES

Sacramento River

The Sacramento River is a major river of the western United States and comprises the largest and most important riverine ecosystem in California. It yields 35 percent of the state's water supply, while providing passage, spawning and rearing capabilities for all species of anadromous fish found in the Central Valley.

The Sacramento River in Tehama County provides habitat attributes to support cold and warm water fish species year round. While the upper reach above Red Bluff Diversion Dam (RBDD) flows through confined canyons, the southern reach meanders over a broad alluvial floodplain. The RBDD, located in central Tehama County, is a portion of the federal Central Valley Project (CVP). According to CALFED (1999), the CVP is one project that contributed to the alteration of the Sacramento River's natural flow regime, sediment transport capabilities, and riparian and riverine habitats. Fish habitat characteristics of the main stem Sacramento River are described in state and federal salmon and ecosystem restoration plans.

Tehama West Tributary Streams

Relatively little is known about the fishery resources of the Tehama West Watershed. However, it appears that the fisheries are affected by the "flashy" nature of their water flow. These streams often have high flows during winter storms, frequently dry out in summer in Sacramento Valley reaches, experience high summertime water temperatures prior to drying, and lack habitat heterogeneity (e.g., pools). These conditions result in an unusual situation where the streams exhibit three fishery zones. The first zone, for the larger West Tehama tributaries, is in the Coast Range canyons. Here the streams are perennial and support a variety of native and introduced fish species. Fish have the ability to access some of these headwater areas from the Sacramento River during periods of moderate stream flow.

The second stream zone for these tributaries is where they reach and cross the Sacramento Valley. In this mid-zone the streams become ephemeral and have few, if any, fish present much of the year. Then, as the streams come closer to the Sacramento River, the third zone occurs. The streams pick up irrigation runoff and hold small amounts of water all summer long. In these lowest reaches the streams become seasonally used by a variety of fish species that spend most of their life in the Sacramento River or come up from the ocean. More information about each of the major watershed streams can be found in the following discussions.

Thomes Creek

Thomes Creek drains the east side of the Coastal Range from the Yolla Bolly-Middle Eel Wilderness Area south to Anthony Peak. Much of the upper portion of the drainage is near 6,000 feet elevation. The stream flows eastward for approximately 70 miles through southern Tehama County, before entering the Sacramento River near the community of Tehama. The drainage area encompasses approximately 188 square miles and contributes a mean annual run-off of about 200,000 acre-feet (CDFG 1969). No significant dams are on the stream, although there are two seasonal diversion dams located near Paskenta and Henleyville.

The upper tributaries contain a variety of native species including rainbow trout (see species descriptions and Table 10-1). Well-known habitat features in the steep canyon portions of this drainage mentioned in this assessment include: the "Slab", close to the Willow Creek confluence, where a major road crosses the stream and has served as access to the historical survey and planting efforts; a natural anadromous fish barrier near the confluence of Horse Trough Creek (Barron, F. personal communications); Lake Hollow, a point where road access has allowed fishery surveys; and the "Gorge", a steep, rocky canyon with a partial, natural barrier to fish species at its upper end (CDFG Various) (see Figure 10-1).

Table 10-1
NATIVE FISH SPECIES IN UPPER SEGMENTS OF THOMES, ELDER, AND RED BANK CREEKS, TEHAMA COUNTY

Common Name	Scientific Name	Thomes Creek[1,2,3]	Elder Creek[1,3]	Red Bank Creek[2]
California roach	*Lavinia symmetricus*	x		x
Hardhead	*Mylopharodon conocephalus*	x		
Pacific lamprey	*Lampetra tridentata*	x		x
Rainbow trout	*Oncorhynchus mykiss*	x	x	x
Sacramento pikeminnow	*Ptychocheilus grandis*	x		x
Sacramento sucker	*Catostomus occidentalis*	x	x	x
Speckled dace	*Rhinichthys osculus*	x		

Sources:
1California Rivers Assessment; http://ice.ucdavis.edu/California_Rivers_Assessment;
2CALFED 2000;
3CDFG Various

Thomes Creek flows out of the Coast Range near Paskenta where an upper irrigation diversion dam is located. This structure is pushed up from streambed gravel and cobble each year (Barron, F., personal communications.) Downstream from this point the stream gradient is gentle and summertime flow is intermittent until fall, when the first heavy rains occur. Fish use of this section of stream varies greatly with the season.

From the stream's confluence with the Sacramento River to approximately 7 miles upstream, the habitat is suitable for juvenile Chinook rearing during December to March (Maslin et al 1995). In this reach Thomes Creek provides spawning habitat for native fish such as the Sacramento pikeminnow (*Ptychocheilus grandis*) and Sacramento sucker (*Catostomus occidentalis*). The lower reaches have been significantly altered by the construction of flood-control levees and bank protection projects and contain large amounts of sediment and gravel. (Thomes Creek is the largest commercial gravel source in Tehama County.) However, the upper watershed supports a variety of fish.

In 1982, during studies for a proposed dam, 22 species of fish were recorded within various portions of Thomes Creek (Brown et al 1983 as cited in CALFED 2000). Steelhead were reported to be the most abundant fish above the "Gorge", while Sacramento pikeminnow, Sacramento sucker, hardhead, California roach, and speckled dace were among the most common fish below that feature. (Note that the "steelhead" mentioned in this reference likely means "rainbow trout", as there is an andromous fish barrier a short distance above the "Gorge".) Fish observed near Paskenta included: bluegill and green sunfish; brown bullhead, channel and white catfish; carp, golden shiner, and goldfish; hitch; largemouth and smallmouth bass; mosquitofish; Pacific lamprey; prickly sculpin; speckled dace; threespine stickleback; and tule perch.

Elder Creek

The Elder Creek watershed drains the ridges east of the Yolla Bolly-Middle Eel Wilderness Area and contains approximately 142 square miles of area. It enters the Sacramento River near the community of Gerber.

The drainage contains mostly shale, mudstone, and fine sedimentary deposits that produce minimal amounts of gravel, in contrast to the Thomes Creek drainage. No large gravel deposits exist in the lower stream reaches where a flood-control levee system has directed and concentrated flows, resulting in increased sediment transport and degradation throughout the reach. The upstream reach (approximately 20 miles from the valley floor) flows through a rugged canyon area that supports resident fish, and possibly has limited value for steelhead (CDFG Various; CALFED 1999). The mid-reach, through the Sacramento Valley, is ephemeral and has fish only during certain times of the year. The lowest reach is used by a variety of fish that spend most of their time in the Sacramento River, as will be discussed in later portions of this section.

Red Bank Creek

Red Bank Creek is the smallest of the three main Tehama West drainages, containing approximately 117 square miles of land. Its headwaters are located in the ridges east of the Yolla Bolly-Middle Eel Wilderness Area and it flows through rugged canyons in the Coast Range. Within the canyon reaches this stream and its tributaries contain water year-round and support a variety of fish species; however, no evidence of trout stocking was found. In 1998 the stream and tributaries Dry and Grizzly Creeks were sampled at a proposed dam site (CALFED 2000). Fish captured included California roach, Pacific lamprey, Sacramento pike minnow, Sacramento sucker, bluegill, green sunfish, largemouth bass, and steelhead (juvenile).

As in the case of Thomes and Elder Creeks, Red Bank Creek has intermittent flow through the Sacramento Valley until near its confluence with the Sacramento River at Red Bluff. A variety of fish species use its lower-most portions, as will be described later in this section.

Appendix 10-2 summarizes those native fish species observed in lower reaches of the tributaries of the Sacramento River by Maslin et al. (1995-1999), Moore (1997), and Villa (1985).

DESCRIPTION OF FISH SPECIES

Native Fish Species

The California Rivers Assessment (CARA 1997) at the University of California, Davis identified 18 native fish species in the Sacramento River and other waters of Tehama County. These taxa are listed in Table 10-2. Other sources of information regarding the fish found in the watershed area include: CALFED (2000), which provides information regarding fish presence at proposed dam sites on Thomes Creek (near Paskenta) and Upper Red Bank Creek; NOAA (2006) and CDFG files (CDFG Various), which offer survey information for Upper Elder Creek and the portions of Thomes Creek between Paskenta and the "Slab" (see Figure 10-1). The biology, distribution, and abundance of these native fish species in the watershed is described below in order of taxonomic family.

Lampreys: Family Petromyzontidae

Pacific Lamprey (Lampetra tridentate)

Pacific lamprey spend most of their adult life phase in the ocean where they prey on a wide variety of fish species. Spawning migration into the river is usually between early March and June (Moyle 2002). Large numbers have been seen in the Sacramento River clinging to the Red Bluff Diversion Dam gate piers during the spring (USFWS unpublished observations). Male and female lamprey construct nests and spawn in gravelly, swift areas of the river and both sexes usually die shortly thereafter. Lamprey embryos hatch in about 19 days at 59ºF, and the resulting larvae (ammocoetes) spend a short time in the gravels before moving with the current to downstream areas of soft sand and mud where they rear for several years. Upon reaching about 6–7 inches in length, the ammocoetes transform (metamorphose) into adults, migrating downstream during high-flow events in winter and spring (Moyle 2002). Although the species is commonly found in the Sacramento River, it has also been recorded in mid-reaches of Thomes and Red Bank Creeks (CALFED 2000). Presumably, the fish could not successfully propagate in lower reaches of those streams because of intermittent flow conditions, but would move from the Sacramento River to the tributaries mid-reaches when stream flows are moderate.

During trapping operations at RBDD from July 1994 through June 2000, the U.S. Fish and Wildlife Service captured 5,199 of these fish (Appendix 10-1). It ranked as the fifth most abundant of all species captured.

River Lamprey (Lampetra ayresi)

River lamprey life history characteristics are not as well known as Pacific lamprey because the species has not been studied in California (Moyle 2002). Most observations have been made in the lower Sacramento-San Joaquin River systems. The timing of spawning migrations is not well known.

The species reproduces in a similar riverine environment as Pacific lamprey and adults die after spawning. The ammocoete metamorphosis into the adult life phase is the longest among lamprey species (9–10 months) (Moyle 2002). The population status of river lamprey is largely unknown, which may be attributable to a small population or lack of research on the species. A total of only 79 river lampreys were captured by the USFWS during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1). Presumably, the fish could not successfully propagate in lower reaches of the small streams in western Tehama County because of their flow regimes.

Table 10-2
NATIVE FISH SPECIES IN THE SACRAMENTO RIVER IN TEHAMA COUNTY AND POPULATION STATUS

Common Name	Scientific Name	Status (see below)
California roach	*Lavinia symmetricus*	4
Chinook salmon[a]	*Oncorhynchus tshawytscha*	1
Green sturgeon[b]	*Acipenser medirostris*	2
Hardhead	*Mylopharodon conocephalus*	3
Hitch	*Lavinia exilicauda*	4
Pacific lamprey	*Lampetra tridentata*	0
Prickly sculpin	*Cottus asper*	5
Rainbow trout/Steelhead[c]	*Oncorhynchus mykiss*	5/1
Riffle sculpin	*Cottus gulosus*	5
River lamprey	*Lampetra ayresi*	2
Sacramento blackfish	*Orthodon microlepidotus*	5
Sacramento pikeminnow	*Ptychocheilus grandis*	5
Sacramento splittail	*Pogonichthys macrolepidotus*	3
Sacramento sucker	*Catostomus occidentalis*	5
Speckled dace	*Rhinichthys osculus*	4
Threespine stickleback	*Gasterosteus aculeatus*	4
Tule perch	*Hysterocarpus traski*	4
Western brook lamprey	*Lampetra richardsoni*	3
White sturgeon	*Acipensar transmontanus*	5

Fish Status Ratings (defined by Dr. Peter Moyle, U.C. Davis)

Status	Meaning
0	Not specified
1	Threatened or endangered-usually formally listed but not always
2	Special concern species is in decline or has very limited distribution
3	Watch list species in decline but not yet in serious trouble. Monitoring needed
4	Species overall not in decline or in danger of extinction but has subspecies or distinctive populations that are
5	Species widespread and abundant

Notes, based upon more recent Federal actions:
[a] Spring-run has Threatened status; winter-run has Endangered status; fall and late-fall runs are candidates for listing.
[b] Proposed for Federal Threatened status in 2005.
[c] Rainbow exist in the headwaters; steelhead only exist below the Horse Trough Creek barrier of Thomes Creek. Steelhead are federally-listed.

Source: CARA 1997; NOAA 2006

Western Brook Lamprey (Lampetra richardsoni)

Western brook lamprey is a small non-predaceous species with major inland distributions in the Sacramento River drainage. Neither the adults nor larvae enter salt water. Spawning in river gravels begins when water temperatures exceed 50°F and is similar to Pacific lamprey (Moyle 2002). The CARA (1997) project identified the species in the watershed tributary streams, where perennial reaches exist; however, the species was not recorded by CALFED in proposed dam sites on Thomes Creek near Paskenta or Upper Red Bank Creek (2000).

Minnows: Family Cyprinidae

California Roach (Lavinia symmetricus)

California roach are widely distributed throughout Central Valley streams in a variety of habitats, particularly small warm streams and including intermittent streams. The species is omnivorous and tolerant of very warm water (86–95ºF) and low oxygen levels (1–2 ppm) (Moyle 2002). Roach do not persist well in streams dominated by non-native predatory fish (e.g., largemouth bass and green sunfish) and tend to be most abundant when found by themselves or with only one or two other fish species (Moyle 2002). Spawning occurs from March through early July in stream currents over small rocks when water temperatures exceed 60.8ºF (Moyle 2002). The USFWS captured 275 of the species (less than 1 percent of the total captured) from July 1994 to June 2000 at RBDD (Appendix 10-1).

The species is widely distributed throughout western Tehama County streams. During springtime studies by Maslin et al. in 1997 and 1998, California roach were observed in lower reaches of Elder, Red Bank, Reeds, Thomes, Dibble, Jewett, McClure, and Oat Creeks. Two other studies, one during December 1980 to June 1981 (Villa 1985) and the other from January to April 1996 (Moore 1997), noted this species in these same streams. California Department of Fish and Game files report roach present in several mid-reaches of Thomes Creek, including between Paskenta and Lake Hollow; however, none were found above the partial fish barrier at Lake Hollow (CDFG Various). This species was also found in Upper Red Bank Creek during CALFED (2000) investigations.

Hardhead (Mylopharodon conocephalus)

Hardhead resemble Sacramento pikeminnow, although they are sufficiently different to be taxonomically placed in a different genus. Hardhead are widely distributed in low to mid-elevation streams in the Sacramento drainage and the river. The omnivorous species is always associated with Sacramento pikeminnow and usually with Sacramento sucker, but tend to be absent in streams with introduced species (e.g., centrarchids) (Moyle 2002). Although the species can tolerate relatively warm water temperatures (optimal 75.2–82.4ºF), it is relatively intolerant of low oxygen levels, limiting their distribution to well-oxygenated streams (Moyle 2002). Hardhead prefer clear deep pools and runs with sand-gravel-boulder substrates and slow velocities. Spawning behavior has not been documented but is believed to be similar to pikeminnow or hitch. A study performed by the USFWS at RBDD from July 1994 to June 2000 reported the capture of 1,309 hardhead (see Appendix 10-1).

Maslin et al. observed hardhead during studies in 1997 and 1998 in lower, near-river reaches of Elder, Reeds, Thomes, and McClure Creeks. Additionally, a study of the Sacramento sucker life history performed by Villa (1985) on Thomes Creek reported the presence of hardhead during the period of December 1980 to June 1981. Hardhead also have been recorded in the Coast Range portions of the Thomes Creek drainage from near Paskenta (CALFED 2000) to the "Slab" (CDFG Various) (see Figure 10-1).

Hitch (Lavinia exilicauda)

Hitch are widespread in warm, low-elevation, slow-moving river reaches and sloughs; clear, low-gradient streams; and lakes (Moyle 2002). The species has the highest temperature tolerances of native fishes in the Central Valley and prefers temperatures of 80.6–84.2°F. Hitch are open-water, omnivorous feeders commonly found with both native and non-native species, but mainly with native species in less disturbed habitats (Moyle 2002). Hitch spawn in stream riffles with fine to medium gravel at water temperatures of 57.2–64.4°F. Hatching is rapid (3–7 days); larvae become free swimming in 3–4 days, and the fry move quickly downstream. These attributes allow the species to reproduce in intermittent streams that dry up in summer (Moyle 2002). The USFWS noted the presence of small numbers of hitch during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1).

Maslin et al. found hitch in Elder and Dibble Creeks during springtime studies performed in 1997 and 1998 (Appendix 10-2), and Villa (1985) observed the species in lower Thomes Creek during the period of December 1980 to June 1981.

***Sacramento Blackfish (Orthodon microlepidotus*)**

Sacramento blackfish, a commercially important species for Asian food markets, are found in low-elevation reaches of the Sacramento River and its major tributaries. The species is abundant in highly modified, warm, turbid Central Valley waterways and in Sacramento River oxbow lakes (Moyle 2002). The species is very tolerant of warm water (71.6–82.4ºF) and can be commonly found in water exceeding 86ºF with low dissolved oxygen. Spawning is presumed to occur between April and July, at water temperatures of 53.6–75.2ºF, in shallow areas among aquatic plants (Moyle 2002). In the Sacramento River the USFWS caught only one Sacramento blackfish during trapping operations between 1994 and 2000 (Appendix 10-1). Because of the species' habitat needs, it is unlikely to be found in the small streams of western Tehama County, but would likely be found in the Sacramento River, particularly in oxbow-lake environments.

***Sacramento Pikeminnow (Ptychocheilus grandis*)**

The Sacramento pikeminnow (previously called "squawfish") is widespread in both large and small streams throughout the Sacramento River basin, including western Tehama County. The piscivorous (fish-eating) pikeminnow mainly inhabits pools and runs in clear, warm (64.4°–2.4°F), low-gradient river sections with muddy or rocky bottoms and overhanging vegetation (Moyle 2002). It is commonly found with hardhead and Sacramento suckers. Spawning occurs during the spring months at night, when they congregate in favorable spawning areas. Females release eggs near the bottom; eggs are simultaneously fertilized by one or more males and then sink to the bottom and adhere to rocks and gravel (Moyle 2002). The fish is seasonally abundant in the Sacramento River (Appendix 10-1).

California Department of Fish and Game office memos and proposed dam studies (CDFG Various; CALFED 2000) reported the species' presence throughout much of the lower and mid-portions of the Thomes Creek drainage. Their presence was also noted at the Highway 99E crossing of the stream; in the Paskenta area; and at Lake Hollow, immediately upstream from the "Gorge". The partial-fish barrier at Lake Hollow may be their upper limit in the drainage (see Figure 10-1).

The species was also recorded for Upper Red Bank Creek by CALFED (2000). It is likely that they also exist in the mid-reaches of Elder Creek; however, no records were found regarding this assertion.

Sacramento Splittail (Pogonichthys macrolepidotus)
Sacramento splittail are native to Central Valley lakes, rivers, and sloughs and are relatively long-lived (5–7 years). Early surveys found the species in the Sacramento River upstream as far as Shasta County, but presently they are only found upstream as far as Red Bluff during wet hydrological conditions. Two of the species were caught at RBDD during trapping operations from July 1994 through June 2000 (Appendix 10-1). Where found, the fish is typically in water temperatures between 41-75.2ºF (Moyle 2002). Splittail feed on bottom invertebrates and detritus. Their spawning primarily occurs in March and April and ideal spawning habitat for the species is within flooded vegetation, which also provides habitat for hatched young fish. The onset of spawning is associated with increased photoperiod and water temperatures (57.2–66.2ºF), and rising water levels. Adhesive eggs stick to vegetation and hatch in 3–7 days (Moyle 2002).
Sacramento splittail was listed by the USFWS as threatened on February 8, 1999 (64 FR 5963). On June 23, 2000, the Federal Eastern District Court of California found the USFWS final rule to be unlawful and on September 22, 2000, remanded the determination back to USFWS for a re-evaluation of the agency's decision. After a thorough review and consideration of all the best scientific and commercial information available, the USFWS removed the Sacramento splittail from the list of threatened species on September 22, 2003 (68 FR 55139). The USFWS recognized that the Sacramento splittail may be experiencing a decline in population and continues to face potential threats from habitat loss. Other threats include the effects of drought and climate change on habitat, non-native competitors and predators, and possible threats of disease and environmental contaminants. Because of these threats the agency moved the splittail to its species of concern list (USFWS 2005).

Speckled Dace (Rhinichthys osculus)
Speckled dace inhabit virtually a wide variety of habitat from slow to fast moving water and either small creeks or large rivers—as long as the water is well-oxygenated, clear, and provides ample deep cover in the form of vegetation and rocks (Moyle 2002). The species generally spawns on gravel edges of riffles in June and July but can spawn throughout summer. A total of 175 speckled dace were captured during trapping operations from July 1994 through June 2000 at RBDD (see Appendix 10-1).

Spawning in intermittent streams may be induced by high-flow events. The fish thrives in small streams in habitats characterized by shallow, rocky riffles and runs where they feed (Moyle 2002). Villa (1985) noted the presence of the species in lower Thomes Creek during the period of December 1980 through June 1981 and California Department of Fish and Game recorded them during surveys of the stream immediately below the Lake Hollow barrier (CDFG Various), about 6 air-miles west of Paskenta (see Figure 10-1). There are no records for this species in either Upper Red Bank or Elder Creeks.

Sturgeon: Family Acipenseridae

White Sturgeon (Acipensar transmontanus)

White sturgeon, valuable sport fish, spend most of their lives in the Sacramento–San Joaquin estuary or ocean, returning to the Sacramento River to spawn. White sturgeon are a long-lived species; male sturgeon reach sexual maturity at 10–12 years and females at 12 –16 years. Spawning migration in the Sacramento River occurs between late February and early June when water temperatures are

46.4–66.2°F, peaking around 57.2°F (Moyle 2002). Most spawning occurs in the Sacramento River between Knights Landing and Colusa over deep gravel riffles. Only a fraction of the adult sturgeon population spawns each year and the species returns every several years to spawn (Moyle 2002). White sturgeon have been observed immediately downstream of RBDD in the Sacramento River (USFWS unpublished observations), but no sturgeon would be expected to be found in the small western Tehama County tributaries.

***Green Sturgeon (Acipenser medirostris*)**

Green sturgeon are the most marine species of sturgeon but have been studied less than white sturgeon, probably because of a smaller population, limited spawning distribution, and lesser value as a sport and commercial species (Moyle 2002). Spawning in the Sacramento River is believed to occur from March to July, peaking from mid-April to mid-June. Spawning takes place in deep, swift water and adult fish have been observed as far upstream as Red Bluff (Moyle 2002). Only three green sturgeons were captured during trapping operations at RBDD by the USFWS between 1994 and 2000 (Appendix 10-1). Green sturgeons are not likely to exist in streams of western Tehama County because of their life-history requirements.

Suckers: Family Catostomidae

Sacramento Sucker (Catostomus occidentalis)

Adult Sacramento suckers are most abundant in cool larger streams with moderate gradient and many pools. The juveniles are often associated with smaller tributaries and slower reaches of the Sacramento River (Moyle 2002). The species is typically associated with native minnows such as pikeminnow, hardhead, and roach, but it is also common in habitats dominated by non-native species. The spawning migrations occur in tributary streams during late February and early June, with a peak in March and April, when temperatures are 53.6–64.4°F. Sacramento suckers congregate to spawn in gravel riffles and fertilized eggs adhere to gravel or settle in small backwaters (Moyle 2002). They can be long-lived and often have a non-uniform age structure and strong year classes, indicating that reproductive success is variable. Reproductive success is highest during wet years, when high flows improve access to spawning habitat and provide additional rearing habitat for larvae and small juveniles. Sacramento suckers prefer temperatures around 68-77°F but can be found in streams where temperatures may reach 84.2–86°F. If habitat conditions exist year-round, juvenile suckers may rear in the spawning stream for 2 to 3 years before moving down to the larger river with high flows (Moyle 2002).

The species is abundant in the Sacramento River (Appendix 10-1), as well as locally or seasonally in Tehama West tributaries. For example, as many as 240,000 adult suckers were estimated during a spawning run in a lower reach of Thomes Creek (Villa 1985) between December 1980 and June 1981. Moore (1997) found 25 juveniles and more than 1,000 adults in lower Blue Tent and Dibble Creeks, Maslin et al. (1997) reported the presence of the species in lower portions of Coyote, Dibble, Elder, Jewett, McClure, Oat, Red Bank, Reeds, and Thomes Creeks.

The Sacramento sucker is also known to exist in the Coast Range portions of both Elder Creek and Thomes Creek (CDFG Various). Specifically, large sucker populations were noted during a stocking trip on the North Fork of Elder Creek in 1966 (CDFG Various) and they have been sighted in the Thomes Creek drainage at Lake Hollow, immediately upstream from the "Gorge" (see Figure 10-1). The species was also recorded in Red Bank Creek (CALFED 2000)

Trout and Salmon: Family Salmonidae

Chinook Salmon (*Oncorhynchus tshawytscha*)

The Sacramento River in Tehama County supports four races or runs of Chinook salmon. These distinct runs are defined by the primary period of entry into freshwater from the ocean and begin their upstream migration: fall-run, late-fall run, winter run, and spring run. The Sacramento River in Tehama County supports each freshwater life phase for these runs (i.e., upstream migration, holding, spawning, egg incubation, fry and juvenile rearing, and juvenile downstream migration). Trapping operations at RBDD from July 1994 through June 2000, in which downstream migrant fish were captured, tallied 744,925 juvenile Chinook salmon—87 percent of the entire fish catch. Of all the Chinook, 87 percent were fall-run, two percent late-fall run, six percent winter run, and five percent spring run (see Appendix 10-1). The following description of Chinook salmon life history characteristics is extracted from Vogel and Marine (1991):

> The life span of Chinook salmon may range from 2 to 7 years. Chinook salmon will spend from 1-1/2 to 5 years feeding and roaming in the ocean before maturing and returning to their natal streams to spawn. Both life span and the timing of spawning migrations are primarily genetically controlled. All Chinook salmon die upon completion of spawning.
>
> The eggs are laid in nests, referred to as redds, excavated by the female in uncompacted gravels. Appropriate gravel beds selected by female Chinook salmon consist mainly of gravel ranging in size from one to six inches in diameter. Optimal survival of eggs and pre-emergent fry occurs when the largest fraction of the redd is composed of the smaller-sized gravels. The female will seek out gravel beds with water depths and velocities sufficient for spawning activities and egg incubation. Depths where Chinook salmon redds may be located range from shallow riffle areas (0.5 to 2 feet deep) to deep runs or glides (5 to over 20 feet deep). Spawning depth is a function of physiological requirements, available habitat, and specific preferential differences between stock of salmon, probably under genetic influence. For instance, some winter-run Chinook salmon have been observed to spawn on gravels in deeper water than the other three Sacramento River salmon runs. Preferred spawning velocities are generally in the range of 1.5 to 2.5 feet per second just above the surface of the gravel bed.
>
> As the female lays the eggs in the redd, one or more male salmon fertilize the eggs. The female subsequently buries the eggs in the redd by displacing gravels upstream of the redd onto the eggs.
>
> Eggs hatch after a variable incubation period dependent on water temperature, but is generally about 40 to 60 days. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 40ºF and 56ºF. The newly hatched larvae, or pre-emergent fry, will remain in the redd and absorb the yolk stored in their yolk-sac to grow into fry. This period of larval incubation will last approximately 2 to 4 weeks depending on water temperatures. The fry then wiggle their way out of the redds, up into the water above. The fry will seek out shallow nearshore areas with slow current and vegetative and/or boulder cover nearby where they begin to feed on insects and crustaceans drifting in the current. As they grow,

the juvenile salmon (approximately 50 to 75 mm in length) move out into deeper, swifter water for rearing, but continue to remain near boulders, fallen trees, and other such cover to reduce chances of being preyed upon and minimize energy expenditure. Juvenile salmon may emigrate downstream toward the estuary at any time from immediately after they emerge from the redd to after spending over one year in freshwater. The length of juvenile residence time in freshwater and estuaries varies between salmon runs and depends on a variety of factors including season of emergence, riverflow, turbidity, water temperature, and interactions with other species.

Figure 10-2 shows the life history characteristics for the four Chinook salmon runs at and upstream of Red Bluff. Based on available data, none of the small streams in western Tehama County support a sustained run of any of the four Sacramento River salmon runs. Sufficient cold-water instream flows are necessary to attract salmonids into Sacramento River tributaries prior to spawning activities. For intermittent streams these conditions are usually not present until late fall when runoff events begin and ambient air temperatures cool water temperatures to acceptable levels for salmon. Adult salmonids are known to stray into non-natal streams; however, salmon use of a stream is largely genetically "driven". An established run of salmonids into a stream explicitly requires that the returning spawning fish were originally hatched in the stream several years prior to their return.

On occasion, some adult salmon stray into Tehama West tributaries and spawn, if suitable conditions exist in a given year (e.g., flow, water temperature, physical spawning habitat features). For instance, there have been years when fall-run salmon have been observed in Thomes Creek and Coyote Creek, presumably attracted by suitable flows during the principal fall migration period (Table 10-3). However, due to the intermittent flow characteristics in these tributaries, the life cycle is unlikely to be completed and a run to be established, because of insufficient, sustained stream flows to support all freshwater life stages.

Table 10-3 provides a summary of spawning Chinook salmon population estimates between 1952 to 2003 in Tehama West streams, when surveys occurred and the results were reported in the CDFG database, Grandtab. Grandtab is a compilation of data from annual reports from streams throughout the Central Valley. The counts include hatchery as well as naturally spawning fish. Of all the western Tehama County streams in this assessment area, Thomes Creek has the highest potential of supporting a fall Chinook salmon run because of the size of the watershed and more-protracted runoff than the other tributaries. Chinook salmon observed in Coyote Creek in the 1970s were likely attributable to operation of the Tehama-Colusa Fish Facilities salmon spawning channels, which required releases of water from the Tehama-Colusa Canal into Coyote Creek (a concept “mothballed” in the late 1980s).

California Department of Fish and Game files (CDFG Various) give anecdotal information regarding Chinook salmon usage of Thomes Creek. In one memo, spring-run Chinook were reported in the stream in 1946 and 1961; however, the location of the observations was not noted. Also, in 1958 a rancher observed 30–40 spring-run salmon near Henleyville.

Thomes Creek has been evaluated in recent years with regards to its upper reach accessibility to anadromous fish. In May 2004 the California Department of Fish and Game determined that an impassible barrier to Chinook salmon and steelhead exists at the point immediately above the confluence of the stream with Horse Trough Creek (Barron, F. Personal communications; CDFG

Various). This point is approximately 9 miles upstream from Paskenta and at an elevation of approximately 1,500 feet, (see Figure 10-1).

Table 10-3 FALL-RUN CHINOOK SALMON SPAWNER POPULATIONS FROM SURVEYS CONDUCTED IN THE CENTRAL VALLEY FROM 1952–2003		
Year	**Thomes Creek**	**Coyote Creek**
1957	25	
1974	60	100
1975	170	160
1976		160
1977		200
1980	151	
1981	167	
Source: CDFG GRANDTAB 2004 Note that missing years indicate no exist.ing data		

The phenomenon of "non-natal rearing" of fry and juvenile salmon occurs in the lower-most reaches of many western Tehama County streams. Non-natal juvenile salmon rearing was first described for some tributaries to the lower Fraser River in British Columbia (Murray and Rosenau 1989) and Vogel (1993) first reported non-natal rearing of juvenile Chinook salmon in intermittent streams of the Central Valley. Non-natal rearing occurs when fry and juvenile salmonids, originally hatched and reared in the Sacramento River, migrate into the lower reaches of some small intermittent streams to rear as long as suitable seasonal habitats are present (primarily controlled by flow and water temperature) (Vogel 1993). Maslin et al (1997) researched rearing Sacramento River juvenile Chinook salmon in several small, intermittent streams from Keswick Dam to Chico. Table 10-4 lists those tributaries in the assessment area that Maslin et al. (1997) suggested have potential for non-natal Chinook rearing.

Table 10-4 TEHAMA WEST STREAMS WITH POTENTIAL FOR NON-NATAL CHINOOK REARING (EXTRACTED FROM MASLIN ET AL., 1997)				
Creek	**River Mile at (Sacramento River) Mouth**	**Gradient (lowest 0.3 mi.)**	**Drainage (sq. mi.)**	**Maximum Distance Upstream 1997 (mi.) ****
Jewett	215	0.14%	52	.
Thomes	225	0.27%	300	14
McClure	226.5	0.22%	33.7	3.1
Elder	230	0.15%	140	6.5
Coyote	233	0.17%	30	2
Oat	233	0.17%	65.5	3
Red Bank	243	0.48%	115	4.5
Reeds	244.8	0.47%	74.4	1
Dibble	246	0.54%	28.2	.
Blue Tent	247.7	0.68%	18.1	.
** Estimated maximum distance juvenile Chinook salmon moved upstream for rearing				

The USFWS (1995) listed several Sacramento River western tributaries as potentially providing only rearing habitat for salmonids (Sacramento River Mile in parentheses): Oat Creek (RM 233), Coyote Creek (RM 233), Reeds Creek (RM 245), Blue Tent Creek (RM 248), Dibble Creek (RM 246), Burch Creek (RM 208), Jewett Creek (RM 215), and Red Bank Creek (RM 243).

Field studies by Maslin et al. (1994, 1995, 1996, 1997, 1998, and 1999) and Moore (1997) confirmed that juvenile salmon exist in some western Tehama County tributaries and estimated their numbers (Table 10-5). Although juvenile salmon were observed in each year of the studies, data for every year are not included in this table. For example in 1995, Maslin et al. (1995) reported seeing juvenile salmon in all of the tributaries sampled, but did not include the tabulated data.

Table 10-5
OBSERVATIONS AND POPULATION ESTIMATES OF JUVENILE SALMON DURING WINTER- SPRING-TIME ON INTERMITTENT WESTERN TEHAMA COUNTY STREAMS

Year	Creek	Number Observed	Population Estimate
	Elder	624	
1994	Thomes	202	
	Blue Tent	1682	
	Dibble	311	
1996	Reeds	14	
	Blue Tent	159	~966
	Elder		4000
	Red Bank	73	
	Oat	29	
	McClure	185	
	Coyote	26	
	Reeds	168	
1997	Thomes	156	
	Blue Tent	10	1125[1]
	Coyote		400[4]
	Dibble	84	500[1]
	Elder	8	3600[3]
	Jewett	60	2875[1]
	McClure	163	8500[1]
	Oat		900[4]
	Reeds	6	400[1]
	Thomes		16250[4]
1998	Red Bank	25	
	McClure	125	
	Blue Tent	426	
	Dibble	180	
	Red Bank	131	
	Reeds	21	
1999	Elder	58	

Footnotes from Maslin et al., 1998
[1] based on several good estimates of density
[2] based on several minimal estimates of density
[3] based on a density estimate at one site and the approximation that density typically decreases by 1 fish/meter over 5 km [refer to Figure 13 in Maslin et al., 1998 (p. 21)]
[4] based on data from previous years and comparison with similar streams
Source: Maslin et al (Various) and Moore (1997)
Note: Blank entries are "Not Reported" in the original report.

Rainbow Trout/Steelhead (Oncorhynchus mykiss)

Rainbow trout and steelhead are a popular sport fish in California. Steelhead are an ocean-run (anadromous) form of rainbow trout but both are considered the same species. Spawning migrations of steelhead generally occur in the Sacramento River from July to mid-March, with the peak passage past Red Bluff during late September and early October. Spawning occurs from late December through April (Hallock 1989). Females dig redds and lay eggs in gravel, usually at the end of a pool or in a riffle, at water depths of 4 to 6 inches and water velocities ranging from 0.7 and 6.0 feet per second (Moyle 2002). Females lay 200 to 12,000 eggs that hatch in 3 to 4 weeks, and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Juvenile steelhead rear in freshwater for 1 or 2 years prior to migrating to the ocean. Downstream migration occurs anytime from a period beginning in the fall with the first heavy runoff until early spring. Studies conducted during the 1950s found that returning Upper Sacramento River steelhead consisted of 17 percent two-year old fish, 41 percent 3-year old fish, 33 percent 4-year old fish, 6 percent 5-year old fish, and 2 percent 6-year old fish (Hallock 1989).

On the Sacramento River the USFWS performed trapping operations from July 1994 to June 2000 at RBDD and captured 3,592 juvenile rainbow trout/steelhead (less than 1 percent of the total catch). The origin of these fish could be: wild rainbow trout, wild steelhead, or hatchery steelhead from Coleman National Fish Hatchery.

Sustained populations of rainbow trout occur in upper Thomes and Elder Creeks (CARA; CALFED 2000; and CDFG Various). Thomes Creek is claimed to have over 25 miles of stream supporting the species, and an additional 22 miles of tributaries (USFS 1997). California Department of Fish and Game planting records for Elder Creek show a long period of rainbow trout releases. The South Fork received fish from 1946 through 1957; the South Fork of the South Fork in 1958 through 1966; and the North Fork from 1946 through 1967. A CDFG memo from 1966 suggested that yearly plantings in Elder Creek be halted due to the difficult and time-consuming nature of the work and that the stream be allowed to revert to a wild fishery. The suggestion was approved by the department head. Fish surveys in various sections of Thomes Creek, from the 1940s onward, showed rainbow trout in nearly all reaches above the "Gorge", approximately 7 miles west of Paskenta; however, their presence below this point is possible. Planting records for Thomas Creek showed regular releases of rainbow trout from 1946 through 1972 in upper reaches of the stream (CDFG Various).

Observations of juvenile "steelhead" along the Upper Red Bank Creek (CALFED 2000) suggest that either a small number of Sacramento River rainbow trout or steelhead negotiate at least 15 air-miles up this stream to spawn, at least on occasion. Villa (1985) found rainbow trout in lower reaches of Thomes Creek and Moore (1997) observed two juvenile rainbow trout in lower reaches of Blue Tent and Dibble Creeks. Additionally, Maslin et al. (1997 and 1998) noted the species in the Elder, Oat, Thomes, Blue Tent, Dibble, and McClure Creeks. These occurrences were likely attributable to either non-natal fish moving in from the Sacramento River and rearing during the winter; spawning fish coming into the streams from the Sacramento River; or fry produced from fish that spawned in the streams. The longitudinal distribution of trout in the smaller western Tehama County streams is seasonally limited by the availability of adequate amounts of cool water.

Sculpins: Family Cottidae

Prickly Sculpin (Cottus asper)
Prickly sculpin are widespread and abundant and live in a wide variety of freshwater, brackish, and marine environments. In streams, the fish can live in a range of habitats from small, clear, and cold waters to large, turbid, and warm rivers. In those environments prickly sculpin commonly utilize cover (e.g., rocks, woody debris, overhanging vegetation) and primarily feed on large benthic invertebrates (Moyle 2002). The fish can tolerate very warm water (82.4–86°F), but are not found in polluted waters. Prickly sculpin lay eggs during March and April in flowing water in a nest among loose rocks (Moyle 2002). Young fish exhibit a downstream movement with currents where the fish rear in lower reaches until they grow to a length of 0.5 to 0.7 inches and exhibit upstream migration. Although the species adapts to altered environments, small barriers on streams can adversely impact their life cycle (Moyle 2002). Prickly sculpin are found in the Sacramento River (Appendix 10-1); Villa (1985) noted their presence in lower Thomes Creek and Moore (1997) found three adult prickly sculpin in her study of lower Blue Tent and Dibble Creeks. Furthermore, Maslin et al. (1997 and 1998) encountered the species in lower Red Bank, Reeds, Thomes, Blue Tent, Jewett, and McClure Creeks. The species has not been recorded in Coast Range segments of Tehama West streams.

Riffle Sculpin (Cottus gulosus)
Riffle sculpin are generally found in cooler waters compared to prickly sculpin and are most abundant in streams that don't exceed 77 to 79ºF. for extended periods. The fish are most commonly found in permanent, cold headwater streams with swift water and gravelly, rocky substrates, similar to rainbow trout environments (Moyle 2002). As a result of their narrow range of habitats, the species has a more restricted and fragmented distributional range than prickly sculpin, but is, nevertheless, considered widespread and abundant (Moyle 2002). Riffle sculpin are found in the Sacramento River (Appendix 10-1) and possibly in the upper tributaries; however, there were no documents found that support their presence in Tehama West streams.

Sunfishes and Basses: Family Centrarchidae

Sacramento Perch (Archoplites interruptus)
Sacramento perch, which are the only centrarchid that occurs naturally west of the Rocky Mountains, are native to the Sacramento-San Joaquin river system (Moyle 2002). They originally inhabited slow moving, fairly clear rivers and lakes with abundant aquatic vegetation and submerged objects necessary for immature fish, but they have been able to adapt to turbid water conditions and lack of aquatic plants (Moyle 2002). Adult Sacramento perch are piscivorous and appear to prey selectively on cyprinids (Moyle 2002). Male Sacramento perch defend small territories with vegetation, rocks, and debris to which a female adheres her eggs (Calhoun 1966, as cited by Moyle 2002).

Stickleback: Family Gasterosteidae

Threespine Stickleback (Gasterosteus aculeatus)
Threespine stickleback live in shallow, weedy pool and backwater habitats or among emergent vegetation at stream margins over gravel, sand, and mud substrates. The species can complete their entire life cycle in fresh or salt water, or migrate between those environments and usually complete their life cycle in one year (Moyle 2002). Threespine stickleback are generally not found in turbid

water because the fish are sight feeders. The species spawns in April through July with increasing daylight and warming water. Stickleback reproduce in sand, utilizing small pieces of algae and aquatic plants pasted together to form a nest. Eggs hatch in 6-8 days at 63 to 68°F and fry remain in the nest for several days (Moyle 2002). Both young and adult fish generally shoal and rear with similarly-sized fish. Populations of threespine stickleback tend to disappear from highly altered or polluted streams or with introductions of predatory fishes (Moyle 2002). Threespine stickleback are common in the Sacramento River (Appendix 10-1) and were found in the lower reaches of several western tributaries by Maslin et al. (1997 and 1998), including: Coyote, McClure, Red Bank, and Thomes Creeks.

Surfperches: Family Embiotocidae

***Tule Perch* (*Hysterocarpus traski*)**

Tule perch are found in a wide variety of habitats. In riverine environments, the fish are found with complex cover (e.g., emergent plants, overhanging riparian plants, fallen trees, undercut banks), riprap, and deep pools (Moyle 2002). The species are strongly associated with permanent flows and well-developed riparian habitat. Tule perch need cool, well-oxygenated water and generally prefer water temperatures below 71.6°F and are rarely found at water temperatures more than 77°F. The viviparous (live-bearing) reproductive cycle begins with mating from July through September; intromission of the male's sperm with fertilization of the eggs occurring months later in the winter; and young being born in May or June (Moyle 2002). When found in streams, Tule perch are primarily associated with other native fish species and their absence from areas dominated by non-native taxa is probably caused by poor water quality in those habitats (e.g., high water temperatures, low dissolved oxygen, and low clarity) (Moyle 2002). The species is commonly found in the Sacramento River (Appendix 10-1) but its occurrence may be limited in the western Tehama County streams because of unsuitable habitats. However, the species may be more widespread than suspected, as Villa (1985) observed the species on lower Thomes Creek during the period December 1980 to June 1981, and it has been found in the South Fork of Cottonwood Creek, immediately north of the Red Bank Creek drainage (CALFED 2000).

Non-Native Fish Species

The following sub-section describes the biology, distribution, and abundance of non-native fish species. Refer to Appendix 10-3 for a summarization of non-native species observed in western Tehama County tributaries to the Sacramento River.

Herring: Family Clupeidae

***American Shad (Alosa sapidissima*)**

American shad from New York were introduced into the Sacramento River between 1871 and 1881 and are presently abundant (Moyle 2002). The species is a popular sport fish and has spawning runs up to Red Bluff, where they are blocked by the RBDD. The fish do not migrate from the ocean to freshwater until March and May, when water temperatures exceed 57.2ºF. Peak spawning runs and spawning activity occur when temperatures are between 62.6 and 75.2ºF (Moyle 2002). Spawning occurs in the water column of Sacramento River and large tributary channels over a variety of substrates, usually sand and gravel. The slightly negatively buoyant eggs drift downstream with embryos hatching in about a week at 62.6ºF (Moyle 2002). Young fish usually spend the first several months in freshwater before their transition to salt water (Moyle 2002). Because of its habitat requirements the species would not be expected to be found in the Tehama West streams.

***Threadfin Shad (Dorosoma petenense*)**

Threadfin shad were introduced from Tennessee to southern California in 1953 as a forage potential species by game fish in reservoirs. Subsequently, it was planted by CDFG throughout California, including the Central Valley in 1959, and have become established in that region (Moyle 2002). The species are planktivores (plankton-feeders) and inhabit open water of lake environments and river backwaters. The fish cannot tolerate cold water (below 46.4ºF) and does best in water temperatures exceeding 72ºF (Moyle 2002). Threadfin shad usually live only to 2 years of age and spawning occurs from April through August and peaks in June to July when temperatures exceed 68ºF. Adhesive eggs attach to floating or partially submerged objects and hatch in 3–6 days. The effect of this species' introduction on native fishes in the Central Valley is unknown (Moyle 2002). Threadfin shad have not been recorded in western Tehama County streams and would not be expected.

Minnows: Family Cyprinidae

***Carp (Cyprinus carpio*)**

Carp were brought to California in 1872 (Dill and Cordone 1997, as cited by Moyle, 2002). Carp are most common in low-elevation reservoirs with warm turbid water where they bottom feed on insect larvae, mollusks, algae, and vegetation (Moyle 2002); however, they are often found in slow-moving streams. Females will oviposit 50,000 to 200,000 eggs (~500 at a time) per season, which adhere to vegetation and bottom debris. Fry will remain under cover of vegetation until they reach 3 to 4 inches in length (Moyle, 2002). In California waters, carp have been held responsible for both the decline of native fish populations and the destruction of waterfowl habitat (Moyle 2002). On the Sacramento River at RBDD, 31 carp were captured by the USFWS during trapping operations performed from July 1994 to June 2000 (Appendix 10-1). The species was encountered during a study of lower Thomes Creek by Villa (1985) and above Paskenta at Lake Hollow (CDFG Various). California Department of Fish and Game suggested that the Lake Hollow partial-fish stream barrier blocked carp passage, as they were noted below but not above the feature (CDFG Various) (see Figure 10-1).

***Fathead Minnow (Pimephales promelas*)**

Fathead minnow is a species native to the eastern and midwestern United States and was introduced to California as a bait fish in the early 1950s. The California Department of Fish and Game subsequently spread the species for forage and these fish are now established throughout the Central Valley (Moyle 2002). Fathead minnow populations are most successful in pools of small, muddy streams and ponds, where other species are scarce, and can often be found in intermittent streams they prefer temperatures of 71.6 to 73.4ºF. These minnows are bottom browsers feeding on algae, invertebrates, and organic matter (Moyle 2002). Fathead minnows mature rapidly and can spawn during their first summer. The species can spawn repeatedly throughout the summer when temperatures exceed 59ºF. Adhesive eggs are laid under submerged objects, hatching in 4-6 days at temperatures about 77ºF. Fathead minnows may adversely impact California roach, a native species, in intermittent streams (Moyle 2002). This species has not been documented in Tehama West streams.

***Golden Shiner (Notemigonus chrysoleucas*)**

Introduced in 1891 (Dill and Cordone 1997, as cited by Moyle 2002), golden shiner have been widely used as a forage and baitfish and, as such, have become widely established particularly in reservoirs. Females lay eggs on submerged vegetation where a male fertilizes them. Fry form schools and feed on rotifers and diatoms, while larger fish feed on crustaceans (i.e., cladocerans, copepods) and other large zooplankton (i.e., protozoans, rotifers) (Moyle 2002). Little is known about the impact golden shiner have had on native fish (Moyle 2002), but the fish may compete with some species utilizing the same forage organisms.

The USFWS trapping operations on the Sacramento River at RBDD from 1994 to 2000 captured 541 golden shiners during that period (Appendix 10-1). In the western tributaries Moore (1997) observed four juvenile and eight adult golden shiners in 1996 on Blue Tent and Dibble Creeks, while Maslin et al. (1997 and 1998) encountered the species in Jewett, McClure, Reeds, Oat, Red Bank, and Thomes Creeks.

***Goldfish (Carassius auratus*)**

Goldfish are native to Eastern Europe and China and were introduced into California in the 1860s (Moyle, 2002). Since then, bait fishermen and aquarists have spread the fish (Moyle 2002). The species can become established in very warm water (80.6 to 98.6ºF) and in highly disturbed, polluted habitats possessing other non-native fish species, but rarely become established in streams. Goldfish can be found in warm water sloughs with dense aquatic vegetation and are omnivores, but feed primarily on algae. Goldfish first spawn in April or May, laying highly adhesive eggs over vegetation and submerged objects (Moyle 2002). Eggs hatch in about a week and young fish seek cover among vegetation. Although the species is widely distributed in California, their populations are usually small and their ecological role is not well understood (Moyle 2002). They have not been found in the Tehama West Watersheds.

Bullheads and Catfishes: Family Ictaluridae

***Black Bullhead (Ameiurus melas*)**

Introduced as a gamefish in the 1930s (Dill and Cordone 1997, as cited by Moyle 2002), black bullhead are native to the eastern United States. They prefer slow moving, warm, turbid waters with muddy bottoms (Moyle 2002). Black bullheads are omnivorous and feed on aquatic insects, crustaceans, mollusks, algae, dead fish, and an occasional live fish. Females construct nests as shallow depressions in the substrate where 1,000 to 7,000 eggs are deposited. After hatching, a parent guards the young until they reach approximately 1 inch in length (Moyle 2002). Their distribution in California appears to be expanding as a result of plantings and self-dispersal, but it is uncertain what impact black bullheads have on native taxa (Moyle 2002). On the Sacramento River at RBDD, 17 black bullhead were captured by the USFWS during their 6-year-long trapping operations (Appendix 10-1).

***Brown Bullhead (Ameiurus nebulosus*)**

Brown bullhead are native to areas east of the Great Plains and were first introduced in California in 1874 as a game and food fish (Dill and Cordone 1997, as cited by Moyle 2002). In 1890 the California Fish Commission reported that brown bullhead had been planted in every county in California (Moyle 2002). Brown bullheads are omnivorous and feed on aquatic insects, crustaceans, mollusks, algae, dead fish, and an occasional live fish. Females construct nests as a shallow depression in sand or gravel near aquatic vegetation and oviposit 2,000 to 14,000 eggs. Both parents guard the egg clutch and young until the young reach a length of approximately two inches (Moyle 2002). Although the aquaculture industry produces small numbers to stock ponds for fee fishing, their range appears to be static (Moyle 2002). It is not known what impact brown bullhead have on native fishes (Moyle 2002). Brown bullheads were occasionally caught by USFWS during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1). They have also been observed in near-river reaches of Jewett Creek during a study performed in 1998 (Maslin et al 1998); in the 1960s in Elder Creek, from Interstate 5 downstream (Borchard, R., Personal communications); and in Thomes Creek west of Paskenta and below Lake Hollow (CDFG Various).

Channel Catfish (*Ictalurus punctatus*)

Channel catfish are endemic to the Mississippi-Missouri River system, but were widely introduced in California in the late 1800s and early 1900s (Dill and Cordone 1997, as cited by Moyle 2002). Adult channel catfish move into river channels at night to feed on crustaceans and fish, while juveniles spend most of their time in riffles (Moyle 2002). Channel catfish have a cavern-nesting behavior, and use old muskrat burrows, undercut banks, log jams, or human objects (e.g., barrels) to oviposit 2,000 to 70,000 eggs. The male usually aerates and guards the egg clutch and young until the young are approximately 7 days old (Moyle 2002). It is uncertain what impact channel catfish have had on native fishes, amphibians, and crustaceans, but Moyle (2002) speculates that it has not been positive based on their feeding habits. From July 1994 to June 2000, 44 channel catfish were caught by the USFWS during the RBDD trapping operations (Appendix 10-1).

White Catfish (*Ameiurus catus*)

White catfish were transplanted from the east coast to the Central Valley in 1874 where the fish spread rapidly and have become a popular sport fish (Moyle 2002). The species is a carnivorous bottom feeder and increasingly preys on other fish as individual's size increase. White catfish prefer slow current areas and avoid deep, swift channels preferred by channel catfish and can be very successful in reservoirs and farm ponds (Moyle 2002). The fish mature at 3–4 years of age. Spawning generally occurs in June and July when temperatures exceed 69.8ºF. Reproductive behavior is similar to bullheads (Moyle 2002). White catfish was the most abundant catfish species observed during USFWS trapping operations at RBDD (1,059 fish) (Appendix 10-1).

Trout, Salmon, Char, and Whitefish: Family Salmonidae

Brown Trout (*Salmo trutta*)

Brown trout were first introduced from Europe into California in 1893 (Dill and Cordone 1997, as cited by Moyle 2002). Their distribution through the state is widespread but spotty, which may reflect hatchery-planting practices. They inhabit lakes and clear, cool (53.6 to 68°F), well-shaded water with deep pools or runs, often with aquatic plants. Brown trout have shown to be extremely adaptable to changing conditions. After 400 years of selection pressure from anglers, they are able to maintain relatively high populations even in the presence of high angling pressure. Females select gravel bottoms to build redds where they will lay 200 to 21,000 eggs (Moyle 2002). On the Sacramento River at RBDD, a single brown trout was captured by the USFWS during trapping operations (Appendix 10-1).

In a 1946 CDFG file memo (CDFG Various) brown trout were estimated to represent approximately ten percent of the trout population near Thomes Creek's confluence with Willow Creek, near the "Slab" (see Figure 10-1). Even though no CDFG planting records of brown trout were found, this species obviously was released in the upper Thomes Creek drainage and possibly Elder Creek over a half-century ago. Because recent memos do not refer to the presence of brown trout in assessment area streams, they have possibly died out.

***Kokanee/Sockeye Salmon (Oncorhynchus nerka*)**

Kokanee are a non-anadromous form of sockeye salmon with similar life cycles, except kokanee mature in lakes instead of the ocean. Sockeye only rarely occur in California as strays mixed with other salmon runs, but have similar life cycles. Kokanee/sockeye salmon found in the Sacramento River are probably either non-spawning strays or emigrating kokanee (Moyle 2002). A total of 16 of this species were captured at RBDD by the USFWS from 1994 through 2000 (Appendix 10-1). Because of its rare occurrence in the Sacramento River and cold-water habitat requirements, the species is not expected to be found in western Tehama County streams.

Live Bearers: Family Poeciliidae

***Western Mosquitofish (Gambusia affinis*)**

In 1922 western mosquitofish were brought into California from central North America in efforts to control mosquitoes (Dill and Cordone 1997, as cited by Moyle 2002). Mosquitofish feed on the most abundant food present, ranging from mosquito larvae, to algae, to zooplankton (Moyle 2002). Mosquitofish exhibit internal fertilization and females give birth to live young in shallow water with aquatic vegetation (Moyle 2002). They have been recorded to negatively impact native invertebrates and the eggs of amphibians (i.e., California newt (*Taricha torosa*) and Pacific treefrog (*Hyla regilla*) in California (Moyle 2002)). In Jewett, McClure, and Oat Creeks, Maslin et al. encountered the species in reaches close to the Sacramento River during studies performed in 1997 and 1998. In 1945 the California Department of Fish and Game captured one sub-adult at the Highway 99E crossing of Thomes Creek, and in 1980 others were captured near the "Slab" (CDFG Various) (see Figure 10-1).

Striped Basses: Family Moronidae

***Striped Bass (Morone saxatilis*)**

In order to maintain a viable population, striped bass require large cool rivers to spawn, a large water body with large populations of prey fish for adults, and large estuaries with an abundance of invertebrates for juveniles (Moyle 2002). On the West Coast only the San Francisco Bay provides all three conditions for striped bass and fish from this population migrate up the Sacramento River as far as the Red Bluff Diversion Dam (Moyle 2002). Appendix 10-1 shows that only three striped bass captured at trapping operations performed at RBDD. This species was introduced as a gamefish in 1879 (Dill and Cordone 1997, as cited by Moyle 2002). They are native to east and south coast rivers and estuaries of North America, the Atlantic Ocean, and the Gulf of Mexico. Striped bass have not been recorded in Tehama West drainages.

Sunfishes and Basses: Family Centrarchidae

***Black Crappie (Pomoxis nigromaculatus*) and White Crappie (*Pomoxis annularis*)**

Black and white crappie were probably introduced from the Midwest into southern California about 1908, with subsequent introductions into the Central Valley in the period from 1916 to 1919 and are now abundant (Moyle 2002). The two species are popular game fish and are most commonly found in large, warm water lakes and reservoirs, preferring temperatures between 80.6 and 84.2ºF. The fish generally feed on planktonic cructaceans. Spawning occurs in shallow water in constructed depressions in mud or gravel substrate or in beds of aquatic vegetation during March or April when water temperatures exceed 57.2º F, and peak between 64.4 and 68º F. The effects of these species on native fishes is unknown but is believed to be minimal because the fish primarily inhabit reservoirs and other disturbed aquatic habitats (Moyle 2002). Because of its preferred lacustrine habitats, these species are not expected to be found in western Tehama County streams.

***Bluegill (Lepomis macrochirus*)**

Introduced for sport fishing in 1908 (Dill and Cordone 1997, as cited by Moyle 2002), bluegill are common in warm-water reservoirs and warm, slow streams over much of California. Bluegills are highly prolific and, in combination with their broad feeding habits, they may have seriously impacted native fish populations (Moyle 2002). Males form a nesting colony, constructing and defending their own nests made in gravel, sand, dead leaves, sticks, or mud (Calhoun 1966, as cited by Moyle 2002). Females lay 2,000 to 50,000 eggs, which they deposit over many nests; a nest generally holds 2,000 to 18,000 eggs, but may hold as many as 62,000 (Moyle 2002).

Bluegills were the most abundantly captured non-native fish species at the RBDD between 1994 and 2000 (Appendix 10-1). In the western tributaries one juvenile bluegill was observed by Moore (1997) during a 1996 study of Blue Tent and Dibble Creeks, while Maslin et al. (1997 and 1998) found the species in Jewett, McClure, Oat, and Red Bank Creeks. Additionally, the species was observed during a study performed by Villa (1985) on lower Thomes Creek.

***Redear Sunfish (Lepomis microlophus*)**

Redear sunfish were introduced in the early 1950s (Dill and Cordone 1997, as cited by Moyle 2002), well after the establishment of most other exotic fishes in California. Redear sunfish have not been associated with the demise of native fishes due in part to their relatively recent introduction, but also because of their predominately invertebrate diet (e.g., snails, immature insects, and crustaceans) (Moyle 2002). Males construct a nest in a nesting colony in sand, gravel, or mud (Calhoun 1966, as cited by Moyle 2002). Females lay between 9,000 and 80,000 eggs (Moyle 2002). On the Sacramento River at RBDD, 48 redear sunfish were captured by the USFWS during trapping operations between 1994 and 2000 (Appendix 10-1).

***Green Sunfish (Lepomis cyanellus*)**

Green sunfish were introduced by mistake in 1891 or 1908 (Dill and Cordone 1997, as cited by Moyle 2002). Green sunfish are opportunistic feeders that prey on insects, crustaceans, and small fish. This habit has probably been an important factor in the decline of the California roach in central California (Moyle 2002). They are equally at home in small, shallow ponds and slow moving streams. Males construct nests on gravel or sandy bottoms, at locations that provide maximum exposure to full sunlight (Calhoun 1966, as cited by Moyle 2002). Females may spawn with several males and deposit 2,000 to 10,000 eggs, depending on their size (Moyle 2002). At RBDD on the Sacramento River, 51 green sunfish were captured from 1994 to 2000 (Appendix 10-1). Villa (1985) found green sunfish in lower Thomes Creek and Maslin et al. (1997 and 1998) found them in near-river reaches of Elder, Jewett, McClure, and Red Bank Creeks.

Largemouth Bass (Micropterus salmoides)

Introduced as a game fish in 1891 or 1895 (Dill and Cordone 1997, as cited by Moyle 2002), largemouth bass have become widespread in California. As a highly prized warm-water gamefish, largemouth bass have been widely planted and are under regulatory restrictions by the CDFG to maintain strong populations for anglers (Moyle 2002). This taxa, while preferring shallow ponds and lakes, also is found in warm, slow-moving streams.

Males create nests near submerged objects or vegetation as depressions in sand, gravel, or debris bottoms in which females will oviposit 2,000 to 94,000 or more eggs (Calhoun 1966, as cited by Moyle 2002). Males guard the eggs and fry for 2 to 4 weeks (Moyle 2002). On the Sacramento River at RBDD, the USFWS captured 185 largemouth bass while performing trapping operations from 1994 to 2000 (Appendix 10-1). In 1996, juvenile largemouth bass were observed by Moore (1997) in a study of lower reaches of Blue Tent and Dibble Creeks and, in 1998, Maslin et al saw largemouth bass in lower McClure Creek. Additionally, the species was found in lower Thomes Creek by Villa (1985).

Smallmouth Bass (Micropterus dolomieu)

Smallmouth bass are native to the upper Mississippi and the Great Lakes watershed, but were introduced as a gamefish in California in 1874 (Dill and Cordone 1997, as cited by Moyle 2002). Summer water temperature, which needs to range between 68 to 80.6°F, is an important factor in the establishment of smallmouth bass populations (Calhoun 1966, as cited by Moyle 2002), and most smallmouth bass populations occur in waters that have an extended summer water temperature period of 69.8 to 71.6°F (Moyle 2002). Other habitat preferences are clear water with a moderate gradient, an intricate system of cobbles, pools, and runs, and overhanging riparian vegetation (Calhoun 1966, as cited by Moyle 2002). Crayfish appear to be an important prey item, and smallmouth bass may play a roll in controlling exotic crayfish populations (Moyle 2002). Smallmouth bass also prey on other crustaceans, insects, amphibians, and small mammals. Females oviposit 2,000 to 21,000 eggs in the nest, built by the males on gravel or sand bottoms near aquatic vegetation (Calhoun 1966, as cited by Moyle 2002). Males will defend the nest and young for 1 to 4 weeks (Moyle 2002).

Smallmouth bass, though found in some nearby reservoirs, appear to prefer low to moderate gradient streams with boulders or rock ledges. The impact smallmouth bass have on native fish populations is uncertain, but they may have caused local extinction of native frogs and other amphibians (Moyle 2002). The USFWS captured 33 individuals of this species on the Sacramento River at RBDD (Appendix 10-1). This taxa has not been previously reported in Tehama West streams, but given the correct combination of spring-time runoff and its presence in the Sacramento River, it could be present in near-river reaches.

Spotted Bass (Micropterus punctulatus)

Spotted bass are native to the central and lower Mississippi basin, but were introduced as a gamefish into California in 1933 (Moyle 2002) or 1936 (Dill and Cordone 1997, as cited by Moyle 2002). The species is very common in upstream reservoirs, including Shasta and Whiskeytown Lakes, but they also inhabit low-gradient, clear, warm river sections where they hold up in pools, while avoiding riffles and runs (Calhoun 1966, as cited by Moyle 2002). Males construct nests in gravel or among cobbles and boulders and defend the eggs (2,000 to 14,000 per female) and young for 1 to 4 weeks (Moyle 2002). On the Sacramento River the USFWS captured 188 spotted bass in their trapping operation at RBDD from 1994 to 2000, which represented less than 1 percent of the total catch (Appendix 10-1).

THREATENED AND ENDANGERED SPECIES

Table 10-6 provides the current status of threatened or endangered fish species in the assessment area.

Table 10-6
FEDERAL OR STATE LISTED SPECIES IN THE TEHAMA WEST ASSESSMENT AREA

Common Name	Scientific Name	Status Federal / State	Date Federally Listed
Steelhead	*Oncorhynchus mykiss*	Federal = Threatened State = Not Listed	March 19, 1998 (63 FR 13347)
Winter-run Chinook salmon	*Oncorhynchus tshawytscha*	Federal = Endangered State = Endangered	January 4,1994 (59 FR 440)
Spring-run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal = Threatened State = Threatened	September 16, 1999 (64 FR 50394)
Fall and Late-Fall Chinook Salmon	*Oncorhynchus tshawytscha*	Federal Species of Concern; Candidates for Listing	

Central Valley steelhead were listed as a threatened species in 1998 (63 FR 13347; March 19, 1998). This species includes all naturally spawned populations of *O. mykiss* in the Sacramento and San Joaquin Rivers and their tributaries, but excludes *O. mykiss* from San Francisco and San Pablo Bays and their tributaries. Based on an updated status review and an assessment of hatchery populations located within the range of the Evolutionary Significant Unit (ESU), NMFS recently proposed that steelhead remain listed as a threatened species (69 FR 33102; June 14, 2004). In addition NMFS proposed that resident *O. mykiss* occurring with anadromous populations below impassable barriers (both natural and man made) and two artificially propagated populations (Coleman National Fish Hatchery on Battle Creek and Feather River Hatchery on the Feather River) also be included (69 FR 71880).

The National Marine Fisheries Service (NMFS) originally listed winter-run Chinook as threatened under emergency provisions of the Endangered Species Act (ESA) on August 4, 1989 (54 FR 32085), and formally listed the species on November 5, 1990 (55 FR 46515). The State of California listed winter-run Chinook as endangered in 1989 under the California State Endangered Species Act. On January 4, 1994, NMFS reclassified the winter-run Chinook as an endangered species (59 FR 442).

Spring-run Chinook was listed as a threatened species in 1999 (64 FR 50394). The listed species includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries. The agency recently conducted a review to update the winter-run Chinook's status, taking into account new information and considering the net contribution of artificial propagation efforts. NMFS has recently proposed that the Central Valley spring-run Chinook remain listed as a threatened species (69 FR 33102; June 14, 2004) (69 FR 71880).

On April 6, 2005, National Oceanic and Atmospheric Administration (NOAA) Fisheries proposed listing green sturgeon as a threatened species (70 FR 17386). The proposed listing is based on: "new information showing that the majority of spawning adults are concentrated into one spawning river (i.e., Sacramento River), thus increasing the risk of extirpation due to catastrophic events; threats that have remained severe since the last status review and have not been adequately addressed by conservation measures currently in place; fishery independent data exhibiting a negative trend in juvenile green sturgeon abundance; and new information showing evidence of lost spawning habitat in the upper Sacramento and Feather Rivers." (70 FR 17386)

CRITICAL FISHERIES AND AQUATIC HABITAT

In determining what areas are critical habitat for federally listed species, regulations (50 CFR 424.12(b)) require that federal agencies must, "consider those physical or biological features that are essential to the conservation of a given species including space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of a species." The regulations further direct us to, "focus on the principal biological or physical constituent elements that are essential to the conservation of the species" and specify that the, "known primary constituent elements (PCE) shall be listed with the critical habitat description" (69 FR 71880).

These PCEs include sites essential to support one or more life stages of the listed species (sites for spawning, rearing, migration and foraging). These sites in turn contain physical or biological features essential to the conservation of the listed species (for example, spawning gravels, water quality and quantity, side channels, forage species). Specific types of sites and the features associated with them during the species' freshwater life stage (estuarine and marine features are also included, but not listed here) include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development

- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks

- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival (69 FR 71880)

On June 16, 1993 NMFS designated critical habitat for the winter-run Chinook from Keswick Dam to the Golden Gate Bridge (58 FR 33212), which includes the entire Sacramento River in Tehama County. The essential features of the critical habitat include (1) the river water, (2) the river bottom including those areas used as spawning substrate, (3) the adjacent riparian zone used for rearing, and (4) the estuarine water column and essential foraging habitat and food resources of the Delta and Bay, used for juvenile emigration and adult up-migration (NMFS 2005).

In September, 2005 critical habitat was designated for spring-run Chinook salmon and steelhead in northern California. Designated critical habitat for Chinook salmon includes the Sacramento River, Thomes Creek upstream to slightly west of Paskenta, and the lower-most reaches of most western Tehama County streams (see Figure 10-3 and Table 10-7). The designated habitat for the Central Valley steelhead ESU is essentially the same as for the spring-run Chinook (NOAA 2005; see Figure 10-4 and Table 10-8).

In past designations of critical habitat for anadromous salmonids, the extent of the riparian zone considered critical habitat was vague. As a result, NMFS, in the December 10, 2004 federal register notice, has designated the lateral extent of critical habitat as "the width of the stream channel defined by the ordinary high-water line as defined by the U.S. Army Corps of Engineers (Corps) in 33 CFR 329.11. In areas for which the ordinary high-water line has not been defined pursuant 33 CFR 329.11, the width of the stream channel shall be defined by its bankfull elevation."

Table 10-7
TEHAMA WEST TRIBUTARIES TO THE SACRAMENTO RIVER PROPOSED AS CRITICAL HABITAT FOR SPRING-RUN CHINOOK SALMON

Stream Name	Upstream Endpoint of Critical Habitat Designation (Decimal Degrees, WGS84 datum)	
	Latitude (North)	Longitude (West)
Sacramento River	39.6998	-121.9419
Blue Tent Creek	40.2284	-122.2551
Burch Creek	39.8526	-122.1502
Coyote Creek	40.0929	-122.1621
Dibble Creek	40.2003	-122.2420
Elder Creek	40.0526	-122.1717
Jewett Creek	39.8913	-122.1005
McClure Creek	40.0074	-122.1729
Oat Creek	40.1873	-122.1350
Red Bank Creek	40.1391	-122.2157
Reeds Creek	40.1687	-122.2377
Rice Creek	39.8495	-122.1626
Thomes Creek	39.8822	-122.5527
Unnamed Tributary to Burch Creek	39.8532	-122.1627

Note: The area begins at the Sacramento River and ends upstream at the listed locations.
Source: 69 FR 71880

Table 10-8 TEHAMA WEST TRIBUTARIES TO THE SACRAMENTO RIVER THAT ARE PROPOSED AS CRITICAL HABITAT FOR STEELHEAD		
	Upstream Endpoint of Critical Habitat Designation (Decimal Degrees, WGS84 datum)	
Stream Name	**Latitude (North)**	**Longitude (West)**
Sacramento River	39.6998	-121.9419
Blue Tent Creek	40.2284	-122.2551
Burch Creek	39.8526	-122.1502
Dibble Creek	40.2003	-122.2420
Elder Creek	40.0526	-122.1717
McClure Creek	40.0074	-122.1729
Oat Creek	40.1873	-122.1350
Red Bank Creek	40.1391	-122.2157
Rice Creek	39.8495	-122.1626
Thomes Creek	39.8822	-122.5527
Note: The area begins at the Sacramento River and ends upstream at the listed locations. Source: 69 FR 71880		

SPECIES OF SPECIAL CONCERN

Table 10-9 lists state and federal species of special concern in the Sacramento River within Tehama County. These species receive no legal protection and the use of the term does not imply that they will eventually be proposed for listing. These species have been designated by either the USFWS and NMFS or CDFG as having problems in only parts of their ranges. 'Species of concern" is an informal term used by some but not all USFWS offices and refers to those species that they believe might be declining or may be in need of concentrated conservation actions to prevent decline. The CDFG describes "species of special concern" as those that have declined in abundance over recent years with low, scattered, or highly localized populations in need of active management to prevent them from becoming threatened or endangered.

Table 10-9 FEDERAL AND STATE SPECIES OF CONCERN		
Common Name	**Scientific Name**	**Federal / State**
Fall and Late-Fall Chinook salmon	*Oncorhynchus tshawytscha*	Yes / No
River lamprey	*Lampetra ayresi*	Yes / Yes
Pacific lamprey	*Lampetra tridentate*	Yes / No
Sacramento splittail	*Pogomichthys macrolepidotus*	No / Yes
Sacramento perch	*Archoplites interruptus*	Yes / No

POTENTIAL ADVERSE CONDITIONS

Water Quality

Most of the focus concerning potential water quality impacts on fishery resources in Tehama County has related to main stem Sacramento River issues. Remediation of heavy metal contamination from acid mine drainage at Iron Mountain Mine (an EPA Superfund site) near Redding has been the most prominent water quality factor affecting upper Sacramento River fish populations. However, those past impacts were localized upstream of Tehama County because of dilution effects caused by tributary accretions between Redding and Tehama County. The California Department of Water Resource's literature review of Sacramento River water quality found several general trends in some water quality parameters in the Sacramento River: electrical conductivity, suspended sediments, dissolved solids, turbidity, color, and nutrient concentrations all increase in a downstream progression (DWR 1986). The USFWS (1995) stated that, although largely unquantified, water quality impacts on fish populations in the Sacramento River and its tributaries include effects related to high levels of suspended sediments and elevated levels of nutrients, herbicides, and pesticides from agricultural drainage.

In 1991 the U.S. Geological Survey (USGS) initiated the National Water-Quality Assessment Program (NWQA). From 1995 until April 1998 water quality data were collected and analyzed in 55 streams in the Sacramento River Basin, including Thomes and Elder Creeks.

The USGS performed an Occurrence Survey in 1995 that led to the Spatial Distribution Survey in 1997. In 1997 water quality samples were taken in depositional zones of the Sacramento River and select tributaries for a Spatial Distribution Metals Survey. The results of the 1997 survey have been included in this document because of data collected for Elder and Thomes Creeks. A description of the study design follows (USGS 2000):

> Two types of surveys are completed in NWQA investigations to obtain information on the occurrence and distribution of hydrophobic organic contaminants and trace metals and other elements in streambed sediment and tissues of aquatic organisms. The Occurrence Survey is designed to provide information throughout the study unit. Sites are chosen on the major rivers and on smaller streams which may be important because of land uses (transport of pesticides or other organic contaminants, or metals) or because of distinctive geological features (geological deposits of specific trace metals, for example). Interpretation of data from the Occurrence Survey leads to the design of a Spatial Distribution Survey. A Spatial Distribution Survey is designed to provide more information on the distribution of specific contaminants within a study unit. The Spatial Distribution Survey for the Sacramento River Basin study was focused on trace elements, specifically mercury.

Data from collection sites found in the western Tehama County assessment area are presented in Table 10-10 and depict the presence of trace metals found in streambed sediment (USGS 2000). The results, for most metals, show that Thomes, Elder, and the Upper Sacramento River have similar sediment concentrations. For instance, lead varies from 10–14 mg/g, mercury from 0.04–0.1 mg/g, and arsenic from 5.1–11.0 mg/g. The element with the most graphic disparity between streams is inorganic carbon. Thomes Creek sediments have 41 times the inorganic carbon levels as the Sacramento River and Elder Creek has 15 times the river's concentrations. It is not clear what may be responsible for these differences. These data may be used in the future to compare changes or trends over time. (It is important to keep in mind that the sample data set used in Table 10-10 is very small and that any conclusions based upon the data shown should be made very cautiously.)

Table 10-10
RESULTS OF A SPATIAL DISTRIBUTION SURVEY PERTAINING TO METALS AND OTHER ELEMENTS IN STREAMBED SEDIMENT

Metal or Other Element	Sacramento River above Bend Bridge near Red Bluff, CA 10/22/97 at 11:00 hrs	Sacramento River at Woodson Bridge, CA 10/16/97 at 13:00 hrs	Thomes Creek at Flournoy, CA 7/21/97 at 18:30 hrs	Elder Creek below Government Gulch near Tehama, CA 7/21/97 at 17:00 hrs
Aluminum (%)	8.1	7.7	7.5	7.8
Antimony (mg/g)	1.3	1	0.9	0.8
Arsenic (mg/g)	11	9.3	7.9	5.1
Barium (mg/g)	560	490	530	510
Beryllium (mg/g)	<1	<1	<1	<1
Bismuth (mg/g)	<10	<10	<10	<10
Cadmium (mg/g)	1	0.7	0.1	0.1
Calcium (%)	1.7	1.7	2.2	1.6
Inorganic carbon (%)	0.01	0.01	0.41	0.15
Organic carbon (%)	1.65	1.21	1.18	1.02
Organic plus inorganic carbon (%)	1.66	1.22	1.59	1.17
Cerium (mg/g)	35	34	43	37
Cobalt (mg/g)	27	24	25	32
Chromium (mg/g)	180	180	230	310
Copper (mg/g)	82	70	61	68
Europium (mg/g)	<2	<2	<2	<2
Gallium (mg/g)	17	17	17	20
Gold (mg/g)	<8	<8	<8	<8
Holmium (mg/g)	<4	<4	<4	<4
Iron (%)	5.1	4.6	4.6	5.6
Lanthanum (mg/g)	19	18	21	18
Lead (mg/g)	14	10	10	10
Lithium (mg/g)	28	31	52	48
Magnesium (%)	1.7	1.8	2	2.9
Manganese (mg/g)	780	720	700	850
Mercury (mg/g)	0.08	0.1	0.09	0.04
Molybdenum (mg/g)	<2	<2	<2	<2
Neodymium (mg/g)	23	22	27	24
Nickel (mg/g)	130	120	100	200
Niobium (mg/g)	7	6	5	<4
Phosphorus (%)	0.11	0.1	0.16	0.07
Potassium (%)	0.95	0.97	1.3	1.2
Scandium (mg/g)	22	21	18	23
Selenium (mg/g)	0.5	0.4	0.6	0.2
Silver (mg/g)	0.2	0.2	0.2	0.1
Sodium (%)	1.4	1.6	1.8	1.4
Strontium (mg/g)	210	180	140	110
Sulfur (mg/g)	0.07	0.06	0.1	<.05
Tantalum (mg/g)	<40	<40	<40	<40

Table 10-10 RESULTS OF A SPATIAL DISTRIBUTION SURVEY PERTAINING TO METALS AND OTHER ELEMENTS IN STREAMBED SEDIMENT				
Metal or Other Element	**Sacramento River above Bend Bridge near Red Bluff, CA 10/22/97 at 11:00 hrs**	**Sacramento River at Woodson Bridge, CA 10/16/97 at 13:00 hrs**	**Thomes Creek at Flournoy, CA 7/21/97 at 18:30 hrs**	**Elder Creek below Government Gulch near Tehama, CA 7/21/97 at 17:00 hrs**
Thorium (mg/g)	8	4	4	7
Tin (mg/g)	<5	<5	<5	<5
Titanium (%)	0.52	0.49	0.41	0.54
Uranium (mg/g)	2.2	1.9	2	1.6
Vanadium (mg/g)	190	170	160	190
Ytterbium (mg/g)	3	2	2	3
Yttrium (mg/g)	24	22	24	23
Zinc (mg/g)	230	180	100	110
Source: USGS 2000				

Entrainment

There are over 300 diversions on the Sacramento River between the cities of Redding and Sacramento. Unknown numbers of vulnerable juvenile fish are entrained (stranded) in large diversions that do not have screens. California Fish and Game Code Sections 5980-5993, 6020-6028, and 6100 provide the authority to require fish screens and bypass flows at water diversions according to specified criteria (SRA 1989).

Within the assessment area the Red Bluff Diversion Dam (RBDD) provides agricultural water to the Tehama-Colusa Canal (TCC) and Corning Canal along with wildlife refuge water. During the principal non-irrigation season of mid-September to mid-May, the RBDD gates are raised, providing unimpeded upstream and downstream fish passage at the dam. From mid-May to mid-September, the dam gates are lowered to provide gravity flow of Sacramento River water into the Tehama-Colusa Canal and to the Corning Canal pumping plant. Sacramento River fish are protected from entrainment into these two irrigation canals by angled, rotary drum screens completed in 1990 (Vogel et al 1990). Prior to construction of those fish screens, large numbers of fish were entrained into the canals (Vogel and Smith 1988). The Red Bluff Research Pumping Plant (RPP) was constructed adjacent to RBDD in an effort to minimize the detrimental impacts of water diversions on anadromous salmonids during periods when irrigation water is pumped from the river between mid-September and mid-May. The RPP's ability to deliver water to the TCC without entraining fish has allowed the USBR to modify its operation of RBDD to protect upper Sacramento River fish populations. The pumps are operated annually from March through mid-May and mid-September through October (BOR 2005).

Diversions and fish passage barriers on tributary streams have been identified as being major issues affecting salmonids (DWR 2003). Small dams on streams can prevent passage if streamflow is not adequate or if the downstream face of the dam is too long or shallow for fish to negotiate. In addition, instream gravel pits and associated ponds have been known to provide habitat for salmonid fry predators, warm to lethal temperatures, and trap or strand fish when stream flows decline. Finally, roads crossings and infrastructure features frequently block fish migration. The effects of diversions, gravel mining, and obstructions on fish have not been quantified, but the USFWS's Anadromous Fish Restoration Program has an ongoing program to prioritize and screen Central Valley diversions to protect fish. No information on unscreened diversions in the western Tehama County streams was found for this assessment.

Water Temperature

Water temperature in rivers and streams has a large effect on the distribution of native and non-native fish assemblages. Water temperature is strongly influenced by ambient air temperature. CALFED (1999) defined several important environmental functions that stream temperatures influence including:

- algae blooms
- aquatic invertebrate reproduction and growth
- fish migration, spawning, development and growth
- metabolism and behavioral cues of aquatic organisms
- amount of dissolved oxygen available in the water body
- rates of organic material decay and nutrient recycling in aquatic habitats

The California Department of Water Resources has been measuring water temperature in the Sacramento River since 1987 and has four stations in the assessment area. Water temperature data can be accessed through the California Data Exchange Center (CDEC 2005). The Shasta Dam Temperature Control Device was completed in 1997 in order to mitigate declines of winter-run Chinook salmon populations in the main stem Sacramento River to areas as far downstream as Red Bluff. This device allows water to be drawn from the lower, cooler levels of Shasta Lake when necessary, without loss of revenue from power generation.

Most of the tributaries in the assessment area are intermittent; consequently, the effects of water temperatures in those streams are only seasonally relevant to fish. Some species that may exist (e.g., juvenile Catostomids, Cyprinids, and Centrarchids) may be able to tolerate high summertime water temperatures in the Sacramento Valley reaches of these streams and could persist in pools over summer until conditions naturally cool in the fall. Alternatively, the headwaters of some watersheds (e.g., Thomes and Elder Creeks) provide sufficiently cool water to maintain those species with lower temperature requirements over summer. The longitudinal seasonal water temperature gradient in western Tehama County streams would partially define the potential distribution of native and non-native fish species in the watersheds. However, the seasonal temperature regime is presently unknown due to a lack of data.

Maslin et al (1995) provided water temperature data for the lower reaches of some western Tehama County tributaries and discussed the importance of temperature fluctuations as it pertains to fish growth. He cites Spigarelli et al. (1982) study of brown trout growth in three different temperature regimes, showing that the best weight gain and average food consumption by individual fish was from those reared in the 48 to 64°F temperature cycle. In Maslin, *et al's* study (1995), diel temperature fluctuations in Dibble and Red Bank Creeks, during periods when non-natal rearing salmonids were present, averaged about 13° F while temperature ranges in the Sacramento River averaged about 4°F. It is possible that non-natal rearing may increase salmonid fry growth rates and may be one of the adaptive reasons that this behavior exists.

Physical Barriers

The Red Bluff Diversion Dam is the only partial barrier for fish on the Sacramento River in Tehama County. When the dam gates are lowered from mid-May to mid-September, upstream fish passage is provided by fish ladders on the east and west sides and middle portion (Gate 6) of the dam. Some fish species (e.g., sturgeon, shad) do not utilize the fish ladders during that period and are blocked during a portion of their upstream migration period.

Inventories of man-caused physical barriers for fish in the west-side tributaries have been conducted and the California Department of Water Resources (DWR 2003) has identified three priority projects on Thomes Creek. These include: un-named gravel mines, the Henleyville Diversion Dam, and the Paskenta Diversion Dam. A data query in CalFish (2005) listed Sunflower Dam, on a tributary to Red Bank Creek, as a fish barrier.

In recent years, streambed degradation downstream of the TCC siphon crossing has caused a partial barrier to salmon migration that may attempt to spawn in Thomes Creek. The erosion is caused by downstream gravel mining that is removing gravel faster than can be naturally replaced. In addition, flood control levees and bank protection projects have significantly altered the lower reach of Thomes Creek. In addition, the Corning Canal siphon crosses Elder Creek just west of Interstate 5, approximately 4 miles from its mouth, and creates a barrier to migrating Chinook salmon attempting to spawn in that tributary during low to moderate flow conditions. The blocking of adult fall-run Chinook salmon by the Corning Canal siphon has been observed on several occasions since 1970 (USFWS 1995).

Anthropogenic barriers such as high-gradient rapids created by placement of large boulders around bridge foundations are found at Red Bank Creek at the railroad bridge by Highway 99W and Dibble Creek at the I-5 bridge. Such obstructions are not complete barriers because juvenile Chinook have been observed upstream from most of them (Maslin et al 1997). Additional partial or full barriers to instream movements of non-salmonid fish species may exist in some of the tributaries but have not been surveyed or inventoried.

Field collaboration between the CDFG and Crane Mills has identified an anadromous fish barrier on Thomes Creek, approximately 10 miles upstream from Paskenta (Barron, F., personal communications; see Figure 10-1). It is not known if natural barriers in the assessment area's other streams have been identified.

Spawning Areas and Sediment

Sediment in rivers and streams can have deleterious effects on fish, depending on the nature of the sediment (e.g., particle size), timing of deposition and stream transfer, and magnitude of discharge. Sediment discharge varies from year to year in all streams and is based on numerous factors including main stem and tributary streamflow, land use, floods, landslides, localized erosion, and other factors.

An interesting aspect of sediment discharge is that large storms that occur less than 5 percent of the time typically move 90 percent of the annual sediment yield. As a more extreme example, very high flow events such as the December 1964 flood, moved as much sediment in a day as would usually be moved in the Tehama West streams in a decade.

In 1982 the California Department of Water Resources (DWR) completed a 2-year study to identify causes responsible for the high sediment yield in Thomes Creek. They found that Thomes Creek was one of the fastest eroding watersheds draining into the Sacramento Valley. The high yield is directly related to unstable geologic terrain, including landsliding, erodible soils, and high relief. Although the annual yield of suspended sediment and bedload decreased significantly since the mid-1960s, the yield is still from 3-10 times higher than other westside tributaries (DWR 1982). Land use changes are factors that may cause landslides and accelerate erosion (DWR 1982); however, there is no strong evidence that this has occurred within the Tehama West drainage.

Large amounts of sediment and gravel (mostly deposited during the 1964 flood) remain in the lower reaches of Thomes Creek. At least three year-round and several seasonal gravel mining operations utilize the tributary and the extraction of gravel has impaired the upstream migration of adult salmon. Although the most stable spawning areas are above the gravel extraction reach, numerous braided channels and pits trap salmon, particularly during the rapid flow fluctuations. In addition, there is limited and heavily silted spawning habitat in lower Elder Creek (USFWS 1995).

Several flood control and water development projects have dramatically changed the natural flow regime and sediment-moving characteristics of the Sacramento River (SRA 1989). After the construction of Shasta and Keswick Dams, the natural gravel recruitment and transport in the main river channel ceased for areas immediately downstream of the dams. When high flows are released from the dams, gravel moves downstream faster than it is replaced from small tributaries below Keswick Dam. This leaves mainly large rock or bedrock in the river channel, making it unsuitable for spawning. Presently, 85 percent of the spawning gravel coming into the river between Redding and Red Bluff comes from the tributaries, primarily Cottonwood Creek (SRA 1989).

Some land uses and changes in traditional land use are factors that may cause landslides and accelerate erosion (DWR 1982). However, for the Tehama West drainages, there were no data found that show an increase in sediment discharge attributable to these factors.

Loss of Riparian Habitat

Riparian habitat provides vegetative canopy for shading and cooling stream flows; a source of food from terrestrial insects; protective cover from terrestrial predators such as birds; and wood debris pieces and jams that can provide protective cover from predators and instream rearing habitat. The stream environment is greatly influenced by the riparian plant community. Stream depth, current velocity, composition of substrate, shade, temperature, nutrient load, bank stability and other important factors can dramatically change when the riparian community is altered (SRA 1989). Loss of riparian habitat can decrease the abundance of native fishes and increase the abundance of non-native fish species.

About 150 years ago the Sacramento River was lined by up to 500,000 acres of riparian forest, with vegetation spreading up to 4–5 miles wide in the riparian corridor (SRA 1989). Development of agricultural and urban areas gradually reduced the riparian vegetation. Presently, less than 5 percent remains of the original acreage. Additionally, less than one-half of the original vegetation benefiting anadromous and resident fisheries production remains on the river's edge (SRA 1989).

Below the RBDD the river is generally unleveed and holds significant and substantial remnants of the Sacramento Valley's riparian forest. A long history of erosion, deposition, and channel migration is evident on the floodplain. During recent times this stretch of the river has meandered in deep alluvial soils. Above RBDD the river is also generally unleveed and can be considered stable. This reach is determined to be a geologically stable corridor containing Iron Canyon and generally non-erodible riverbanks throughout (SRA 1989).

Maslin et al. (1997) reported that destabilizing activities such as mining, construction, logging, or improper grazing can result in mass movement of rock debris. In the lower reaches of the Tehama West streams, deposits are deposited, creating high gravel bars. Plants have difficulty colonizing these bars and lateral scouring occurs, which widens the channel and disrupts riparian vegetation. This process results in extremely high width to depth ratio and leaves riparian habitats in poor condition (Maslin et al 1997). Attempts to mechanically shape the Tehama West tributaries have compounded this problem. According to Maslin et al. (1997), channelization has been responsible for habitat degradation on Thomes, Red Bank, Reeds, Dibble, and Blue Tent Creeks.

Elder Creek was singled out as a special case by Maslin et al. (1997). Although this stream also has mass movement of sediment (a similar characteristic of west side tributaries), levees artificially confine the channel and prevent lateral scour. The almost uniform channel shape and gradient creates a very unstable stream-bed which differs from the pool and riffle condition of most streams. Riparian vegetation is slowly returning to the artificial banks, but recruitment of large woody debris that could provide hiding cover or help scour pools is lacking (Maslin et al 1997).

Predation

Predation occurs naturally within all river and stream ecosystems. Native fish species have evolved and persisted in the presence of naturally occurring predation pressures. Natural defense mechanisms used by fishes include, among others: fish shoaling (schooling); segregation into different instream habitat types (e.g., shallow versus deep water, swift versus slow water); utilization of instream and overhead cover; etc. However, unnatural levels of predation may occur when the stream ecosystem is altered by changing habitat conditions for native fish or through the introduction of non-native fish species.

High levels of predation typically occur in the Sacramento River near instream structures such as RBDD, supporting structures for diversion pumps, and bridge piers and pilings (CALFED 1999). These forms of predation may be considered "un-natural" because prior to water management efforts, such structures and stream characteristics did not exist. For example, one specific finding from extensive research conducted at RBDD was that predation was the primary cause of downstream-migrant salmon mortality at the dam (SRA 1989; Vogel et al 1990). Sacramento pikeminnow, striped bass, and American shad were documented to prey on juvenile salmonids (USFWS unpublished data and Hall 1977, as cited by USFWS 1989). Downstream migrating juvenile fish pass under the dam gates and become disoriented and are consumed by predatory fish that accumulate below the dam.

The level of predation in west-side tributaries and its significance to native fish species is unknown; however, the presence of non-native, predatory fish such as bass and other centrarchids is undoubtedly detrimental to native fishes. Anthopogenic alterations of stream habitats that favor increases in non-native fishes are generally considered detrimental to native fish assemblages (Moyle 2002). In most years, the fish in Tehama West tributaries appear to depart to the Sacramento River prior to becoming trapped or being eliminated by predation. However, during dry years the situation may be different. In those years, stream flow in the streams may be reduced to such a level before juvenile salmonids reach smolting size and would naturally emigrate. Thus, they become trapped in pools and can be highly vulnerable to avian predators. This was observed in streams such as McClure, Blue Tent and Dibble Creeks (Maslin et al 1997).

AQUACULTURE

The CDFG reported in April 2005 that there is one registered aquaculturist in the assessment area. Westover Fisheries operates a catfish farm next to the USFWS's abandoned Chinook salmon spawning channel near Coyote Creek. The facility uses well water and rears channel catfish and common carp for commercial sale. However, CDFG states that the list may not be complete because some registered facilities were not listed at the owners' request.

PLANTING HISTORY

Coleman National Fish Hatchery in Anderson, California has conducted salmon and steelhead plantings on the Sacramento River in Tehama County for decades. A summary of Chinook salmon and steelhead plantings in areas of the Sacramento River encompassing the assessment area are located in Appendix 10-4, respectively.

California Department of Fish and Game (CDFG Various) records from 1946 to 1972 document catchable rainbow trout stocking for several locations on Upper Thomes Creek. In addition, there are CDFG records for rainbow trout stockings in the South Fork of Elder Creek from 1946 through 1957; the South Fork of the South Fork in 1958 to 1966; and the North Fork from 1946 through 1967. Stockings in the Elder Creek drainage likely stopped after 1967 internal discussions by the CDFG and it now exists as a wild trout fishery. The same is probably true of the upper Thomes Creek drainage; however, no evidence of the decision to halt stockings for this drainage were found in CDFG files.

CHANGE OVER TIME

Moyle (2002) describes how land and water development have altered stream ecosystems and stream fish faunas over time. Effects on the stream environment are often gradual and subtle and may not be attributable to a single cause. Causes are usually a result of long-term, multiple changes in entire watersheds: e.g., livestock grazing, logging, road building, off-road vehicle use, urban development, dams and diversions (Moyle 2002). Specific data related to western Tehama County stream habitat changes over time were not obtained for this assessment. The focus of state and federal agencies has been on the main stem Sacramento River and its salmon-producing tributaries (e.g., CALFED Ecosystem Restoration Plan).

DATA GAPS

There are data gaps concerning fishery resources and their associated habitats in western Tehama County streams. There have been limited fish surveys conducted by CDFG in Thomes Creek; studies of proposed dam locations near Paskenta and Upper Red Bank Creek; and research on non-natal anadromous salmonid rearing in the lower-most reaches of some western Tehama County tributaries by California State University, Chico during the mid to late 1990s. The relevance of the non-natal rearing phenomenon to Sacramento River salmon populations is not known (Vogel 1993). In addition, the spatial and seasonal distribution and abundance of native and non-native fish species and their habitats are largely unknown in these watersheds. Reach-specific, seasonal hydrologic, thermal, and physical habitat characteristics would largely define the distribution of native and non-native fish species, but are presently unknown. Finally, the effects of water diversions and distribution of fish screens are information that should be learned.

Ongoing state and federal agency fishery and ecosystem restoration programs previously discussed are addressing data gaps on main stem Sacramento River fishery resources and habitats, as well as those of other larger tributaries.

CONCLUSIONS AND RECOMMENDATIONS

The fishery resources of the Tehama West drainages are defined by the presence of the Sacramento River and its fisheries and the physical characteristics of streams that flow off the eastern slope of the Coast Range. The Sacramento River has a varied fish fauna including some taxa that stay in the stream year-round and others that travel to the ocean for a portion of their life. Over time, the natural diversity has been modified by the accidental and intentional introduction of many non-native fish species. Many native species, particularly the anadromous fishes, have been seriously affected by physical changes to the Sacramento River and its tributaries, as well as changes to ocean conditions. For instance, several runs of Chinook salmon, steelhead, and possibly several lamprey and sturgeon species have all been negatively affected by these human-caused changes.

The physical characteristics of the Tehama West drainages also play an integral role in the fisheries. Their streamflow tend to rise quickly following wet-season storms; drop equally promptly following storms; and carry very large quantities of sediment. This leads to conditions where individual streams may appear like a river during major storms and be dry or nearly dry during mid-summer. The snowpack in the headwaters of these drainages is generally less than that for most Sierra Nevadan streams, resulting in relatively light seasonal warm-season run-off. It also results in an interesting situation where the upper Coast Range stream reaches may be perennial with resident fish populations, the mid-reach sections of these streams may be dry in mid-summer, and lowest reaches (close to the Sacramento River) may have small amounts of water from irrigation run-off and support a number of fish species that seasonally enter the tributaries from the Sacramento River.

Human activities, including channelization, water diversions, and gravel mining have altered the streams in many ways and have led to a reduction in riparian habitats, reduced summertime flow, and created warmer summertime temperatures. There is no known evidence to suggest that the Tehama West drainages were ever significant anadromous fish streams. However, the changes created by human activity have likely reduced salmonid usage and possibly that of other native fishes, and changed the makeup of the fishery fauna. It is possible that improvement of watershed conditions and stream habitats could increase late spring and early summer flows in the lower reaches of the area's streams—thereby improving anadromous fisheries attributes, such as non-natal salmonid rearing.

Given the characteristics of the Tehama West drainages and their limited historical fishery values, it is likely that any efforts toward salmonid habitat restoration will be considerably lower in priority than for many other streams in the Sacramento River drainage. Regardless, NOAA Fisheries has stated that the lower reaches of the Tehama West drainages are critical habitat for Chinook salmon and steelhead and efforts should be placed in improving the stream's habitat potential.

Recommendations for habitat improvements and studies to close important data gaps follow.

Riparian Habitat Inventory and Restoration

Tehama West riparian habitats have been tremendously altered during the past century and a half. These habitats are extremely valuable for wildlife but also play important stream stabilization, water quality, and fishery habitat roles. The location of existing riparian habitats is not well known but would be the first step in planning future restoration projects. Following the identification of existing riparian stands and their attributes, steps could be taken to protect the most important ones and then to re-connect scattered habitats. The result would be a landscape planning tool that, when implemented, would improve fisheries, wildlife, and water quality.

Salmonid Spawning Surveys

Spawning surveys of the major Tehama West tributaries have been sporadic and have not given insight into the specific conditions during which spawning occurs. Yearly surveys should give insight into the timing and location of salmonid spawning and whether opportunities exist to expand either factor through enhancement projects.

Special Status Species Inventories

Several species considered to be special status (Table 10-9) have the potential of existing in Tehama West drainages. Based upon past history, it is very possible that these species may become major issues in the future. Because of this and the lack of information regarding most of these species in Tehama County, it would be proactive to conduct focused surveys for these species. The results would add to the available information regarding their status and distribution and help with future regulatory decisions. Based upon the results of the inventories, correlation may be found with land management strategies, which might give insight into ways to enhance special status species populations.

Investigations of Non-Natal Rearing

The importance of non-natal fish rearing in Tehama West drainages, relative to other forms of rearing, is not well understood. The use of small Sacramento River tributary streams by fish hatched from distant locations has been well documented, which may suggest that non-natal rearing is an important factor in the drainage's anadromous fishery. A better understanding of these tributaries' roles and potential ways to enhance this role may be of benefit to Chinook salmon and steelhead populations.

At the same time, an evaluation of predaceous fish relationships with non-natal salmonid fry would be important. It is possible that current tributary conditions encourage non-natal fry to enter the mouths of the Tehama West drainages to their doom. It is also possible that the salmonid fry and predatory fish biology is such that predation is minor. Once a better understanding of predator and prey relationships exists in the lower stream reaches, as well as the role of non-natal rearing, managers can determine if enhancement projects would be of value for the fishery resource.

Water Quantity

An analysis of water quantity in the watershed should be conducted. Quantifying how much water is being diverted and how much groundwater is being pumped from the watershed's creeks would enable fisheries' biologists to better assess their impacts on populations of anadromous fish that spawn in the watershed.

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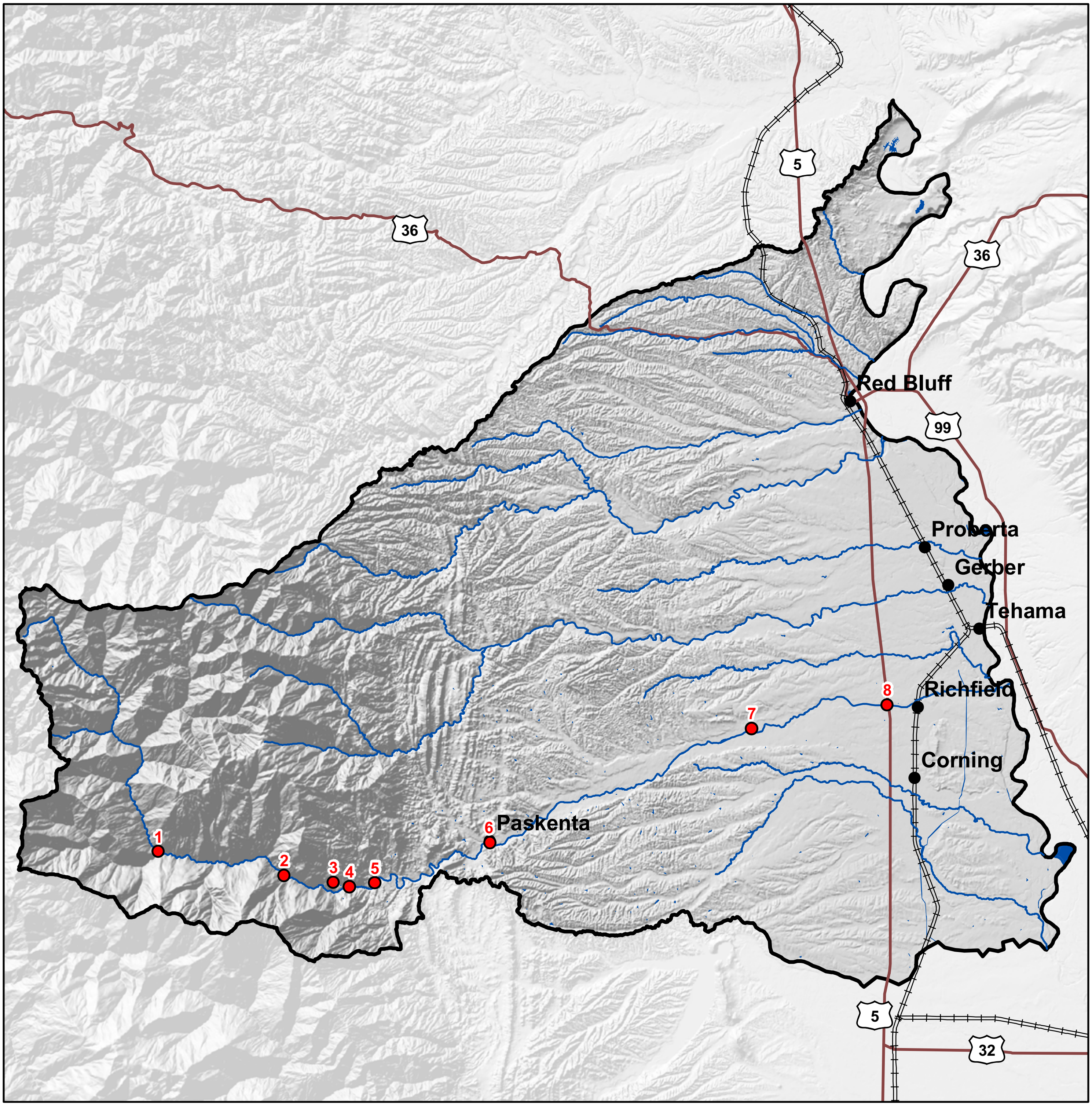

Note: "The Slab" is 15 air miles from Paskenta; Lake Hollow is considered to be a barrier to some non-salmonid fish species

Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- Water Body
- Important Fishery Location

Key

1 "The Slab"
2 Anadromous Barrier
3 Lake Hollow
4 "The Gorge"
5 Hatch Flat
6 Paskenta
7 Henleyville
8 Interstate 5

N W E S

0 2.5 5 10 Miles

VESTRA

FIGURE 10-1
STREAMS AND GEOGRAPHICAL FEATURES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

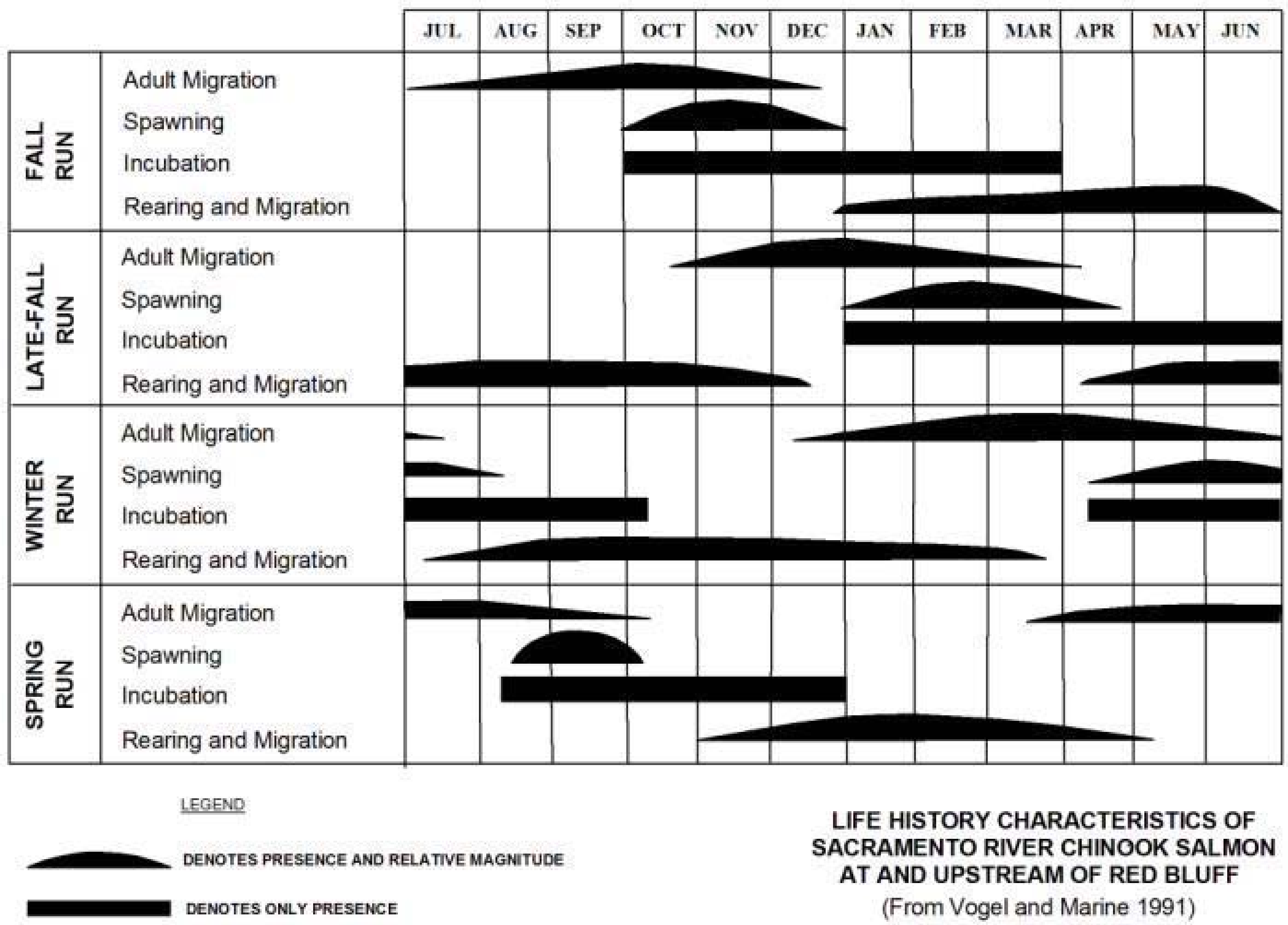

FIGURE 10-2
LIFE HISTORY CHARACTERISTICS OF SACRAMENTO RIVER CHINOOK SALMON AT AND UPSTREAM OF RED BLUFF
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: VOGEL AND MARINE 1991

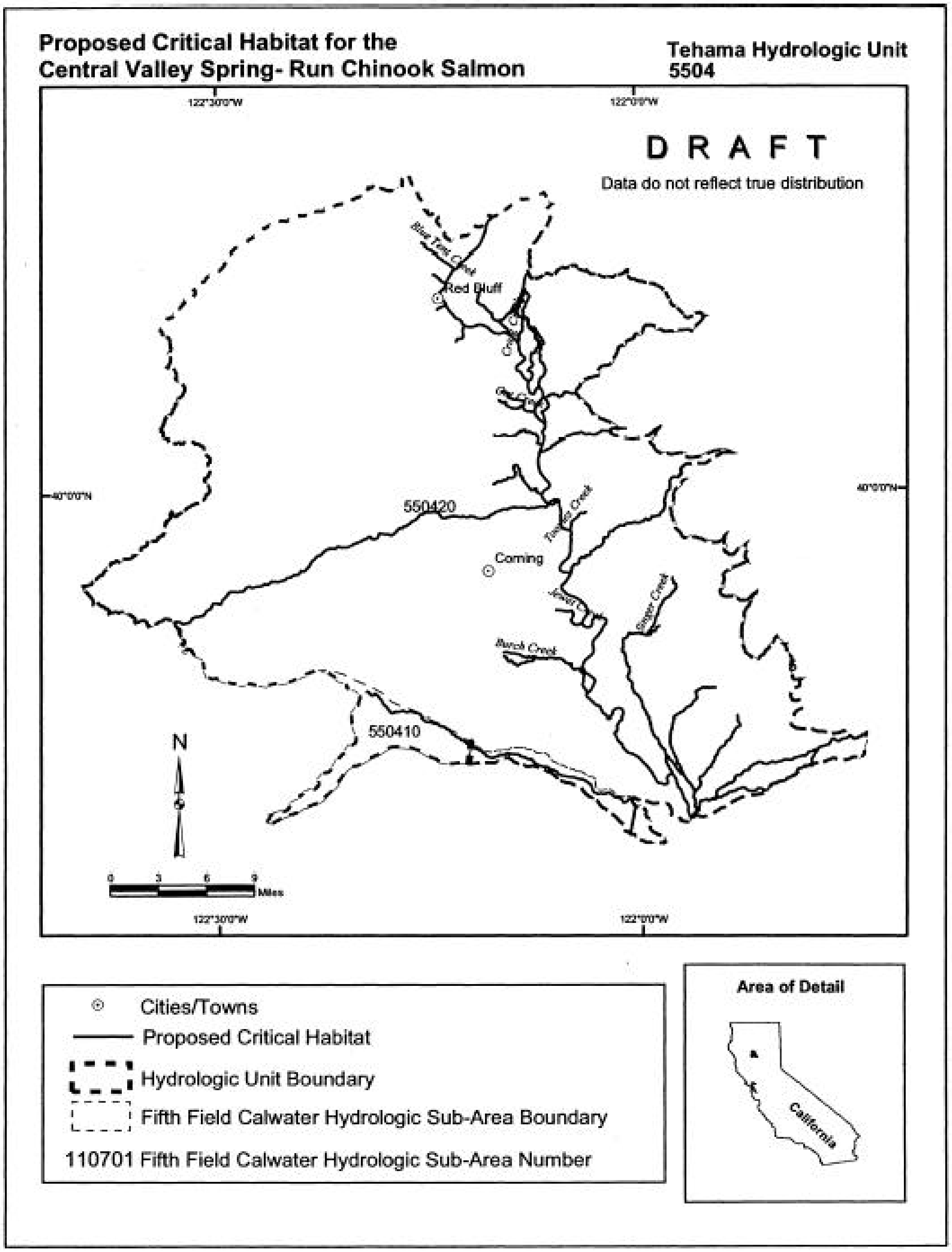

FIGURE 10-3
PROPOSED CRITICAL HABITAT FOR SPRING-RUN CHINOOK SALMON IN WESTERN TEHAMA COUNTY
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: FROM 69 FR 71880

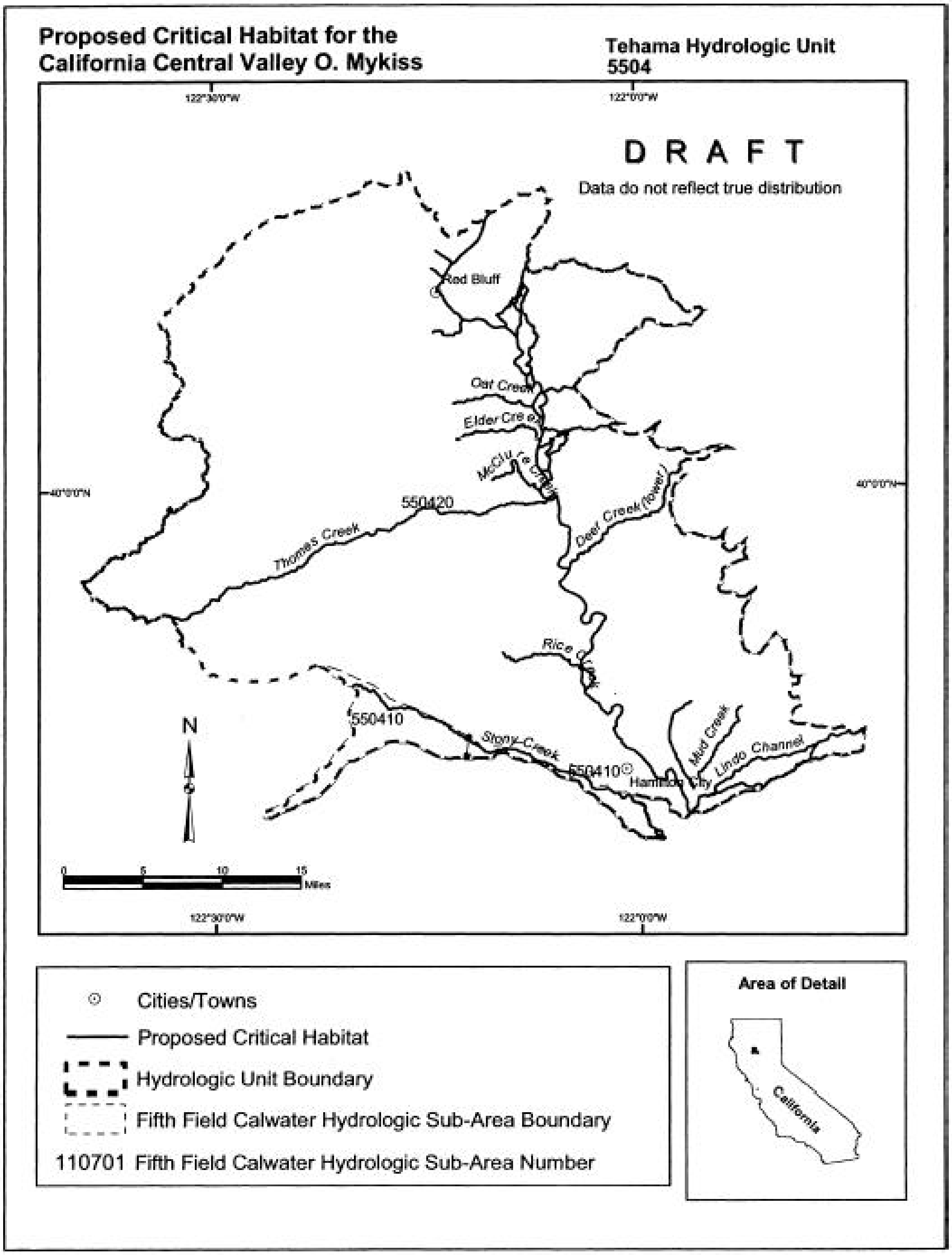

FIGURE 10-4
PROPOSED CRITICAL HABITAT FOR STEELHEAD IN WESTERN TEHAMA COUNTY
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: FROM 69 FR 71880

Appendix 10-1

FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS

Appendix 10-1
FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS AT RED BLUFF DIVERSION DAM, SACRAMENTO RIVER, CALIFORNIA, FROM JULY 1994 THROUGH JUNE 2000

Common Name	Scientific Name	Number Captured	Percent	Species Classification
Chinook salmon	*Oncorhynchus tshawytscha*	744,925	87	native
Fall run		649,693	76	native
Winter run		48,408	6	native
Spring run		33,604	4	native
Late-fall run		13,220	2	native
Sacramento pikeminnow	*Ptychocheilus grandis*	33,951	4	native
Sacramento sucker	*Catostomus occidentalis*	33,242	4	native
prickly sculpin	*Cottus asper*	10,523	1	native
Pacific lamprey	*Lampetra tridentate*	5,199	*	native
lampetra fry	*Lampetra spp.*[1]	4,104	*	native
cypriniformes fry	Cypriniformes[2]	3,798	*	native
rainbow trout/steelhead	*Oncorhynchus mykiss*	3,592	*	native
sturgeon fry	*Acipenser spp.*[3]	2,605	*	native
riffle sculpin	*Cottus gulosus*	2,087	*	native
bluegill	*Lepomis macrochirus*	2,013	*	non-native
hardhead	*Mylopharodon conocephalus*	1,309	*	native
cottus fry	*Cottus spp.*[4]	1,263	*	native
threadfin shad	*Dorosoma petenense*	1,260	*	non-native
white catfish	*Ictalurus catus*	1,059	*	non-native
golden shiner	*Notemigonus crysoleucas*	541	*	non-native
threespine stickleback	*Gasterosteus aculeatus*	326	*	native
California roach	*Lavinia symmetricus*	275	*	native
spotted bass	*Micropterus punctulatus*	188	*	non-native
largemouth bass	*Micropterus salmoides*	185	*	non-native
speckled dace	*Rhinichthys osculus*	175	*	native
centrarchidae fry	Centrarchidae[5]	87	*	non-native
river lamprey	*Lampetra ayresi*	79	*	native
tule perch	*Hysterocarpus traski*	77	*	native
green sunfish	*Lepomis cyanellus*	51	*	non-native
redear sunfish	*Lepomis microlophus*	48	*	non-native
channel catfish	*Ictalurus punctatus*	44	*	non-native
black crappie	*Pomoxis nigromaculatus*	41	*	non-native
hitch	*Lavinia exilicauda*	41	*	native
smallmouth bass	*Micropterus dolonieui*	33	*	non-native
carp	*Cyprinus carpio*	31	*	non-native
black bullhead	*Ictalurus melas*	17	*	non-native
kokanee/sockeye	*Oncorhynchus nerka*	16	*	non-native
white crappie	*Pomoxis annularis*	16	*	non-native
brown bullhead	*Ictalurus nebulosus*	8	*	non-native
American shad	*Alosa sapidissma*	4	*	non-native
green sturgeon	*Acipenser medirostris*	3	*	native
striped bass	*Morone saxatilis*	3	*	non-native
fathead minnow	*Pimephales promelas*	2	*	non-native

Appendix 10-1
FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS AT RED BLUFF DIVERSION DAM, SACRAMENTO RIVER, CALIFORNIA, FROM JULY 1994 THROUGH JUNE 2000

Common Name	Scientific Name	Number Captured	Percent	Species Classification
goldfish	*Carassius auratus*	2	*	non-native
Sacramento splittail	*Pogonichthys macrolepidotus*	2	*	native
brown trout	*Salmo trutta*	1	*	non-native
Sacramento blackfish	*Orthodon microlepidotus*	1	*	native
Total		853,227		

* Less than 1% of total fish captured by rotary-screw traps
[1] Fry were grouped to genus (*Lampetra tridentate*, *Lampetra ayresi*, or *Lampetra pacifica*).
[2] Fry were grouped to order (likely *Ptychocheilus grandis*, *Mylopharodon conocephalus*, *or Catostomus occidentalis*).
[3] Fry were grouped to genus (likely *Acipenser medirostris*).
[4] Fry were grouped to genus (*Cottus asper* or *Cottus gulosus*).
[5] Fry were grouped to order (*Micropterus spp*. Or *Lepomis spp*.).
Source: USFWS 2002

Appendix 10-2

NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES

Appendix 10-2
NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES,

Species	Tributary										
	Blue Tent Creek	Brickyard Creek	Coyote Creek	Dibble Creek	Elder Creek	Jewett Creek	McClure Creek	Oat Creek	Red Bank Creek	Reeds Creek	Thomes Creek
California roach	x			x	x			x	x	x	x
Chinook salmon	x	x	x	x	x	x	x	x	x	x	x
Fathead minnow			x								
Hardhead					x		x			x	x
Hitch				x	x						x
Pacific lamprey									x		x
Prickly sculpin	x					x	x		x	x	x
Rainbow trout / steelhead	x			x	x		x	x	x		x
Sacramento sucker	x		x	x	x	x	x	x	x	x	x
Sacramento pikeminnow	x		x	x	x		x	x	x	x	x
Speckled dace											x
Threespined stickleback			x				x		x		x
Tule perch											x
Source: Maslin et al. (1995 – 1999), Moore (1997), Villa (1985); CALFED (2000); and CDFG (Various)											

Appendix 10-3

NON-NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTIARIES

Appendix 10-3 NON-NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES,										
	Tributary									
Species	**Blue Tent Creek**	**Coyote Creek**	**Dibble Creek**	**Elder Creek**	**Jewett Creek**	**McClure Creek**	**Oat Creek**	**Red Bank Creek**	**Reeds Creek**	**Thomes Creek**
Bluegill	x		x		x	x		x		x
Brown bullhead				x	x					x
White catfish										x
Carp										x
Golden shiner	x		x		x	x	x	x		x
Goldfish										x
Green sunfish				x	x	x		x		x
Smallmouth bass										x
Largemouth bass	x		x			x				x
Mosquitofish					x	x	x			x
Source: Maslin et al. (1995 – 1999), Moore (1997), and Villa (1985); Borchard (2005)										

Appendix 10-4

COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER

Appendix 10-4 COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER FROM 1941 THROUGH JANUARY 2000			
Date	Race	Number Released	Release Location on Sacramento River
8/11/1965	Fall	65,000	Red Bluff
9/10/1965	Fall	36,000	Red Bluff
10/4-21/1965	Fall	1,183,900	Jelly's Ferry Area
11/2-30/1965	Fall	3,083,600	Jelly's Ferry Area
7/20-29/1965	Fall	570,800	Jelly's Ferry Area
8/1/1966	Fall	56,000	Red Bluff
8/8-25/1966	Fall	746,900	Jelly's Ferry Area
9/1/1966	Fall	47,500	Red Bluff
9/6-19/1966	Fall	871,100	Jelly's Ferry Area
2/9/1965	Winter	4,300	Jelly's Ferry Area
7/5/1969	Fall	2,500	Red Bluff
6/3/1975	Fall	457,250	RBDD
5/14-28/1976	Fall	433,090	Lake Red Bluff
5/14-28/1976	Fall	403,232	Above RBDD
5/14-28/1976	Fall	401,018	Below RBDD
6/1/1976	Fall	124,230	Above RBDD
6/1/1976	Fall	38,270	Below RBDD
6/1/1976	Fall	49,770	Lake Red Bluff
5/6-24/1977	Fall	932,312	Red Bluff
11/3-7/1977	Fall	302,373	Red Bluff
12/14/1977	Fall	200,124	Red Bluff
12/14-19/1977	Fall	115,318	Red Bluff
1/8-9/1978	Fall	225,680	Red Bluff
9/4-7/1979	Fall	522,575	Red Bluff
2/11/1980	Late-Fall	50,200	Red Bluff
2/29/1980	Fall	54,410	Red Bluff
3/12/1980	Fall	51,284	Red Bluff
2/5/1981	Late-Fall	51,200	Red Bluff
2/6-27/1981	Fall	11,186	Red Bluff
5/18/1981	Fall	101,477	Red Bluff
1/27/1982	Late-Fall	51,757	Red Bluff
2/5-25/1982	Fall	101,421	Red Bluff
5/5/1982	Fall	99,240	Red Bluff
5/24-27/1983	Fall	1,173,350	Red Bluff
6/1-9/1983	Fall	1,258,400	Red Bluff
11/17-21/1983	Late-Fall	287,475	Red Bluff
1/17-19/1984	Late-Fall	651,083	Red Bluff
3/1-23/1984	Fall	102,740	Red Bluff
4/26/1984	Fall	300,000	Red Bluff
5/3/1984	Fall	564,450	Red Bluff
5/9-17/1984	Fall	3,199,490	Red Bluff
11/20/1984	Late-Fall	154,575	Red Bluff
1/10/1985	Late-Fall	65,380	Red Bluff
2/14/1985	Fall	56,500	Red Bluff
3/14/1985	Fall	53,600	Red Bluff
4/18-22/1985	Fall	2,007,000	Red Bluff
5/14-15/1985	Fall	2,482,237	Red Bluff
12/9/1985	Late-Fall	103,704	Red Bluff
3/19/1986	Fall	1,583,676	Red Bluff

Appendix 10-4
COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER FROM 1941 THROUGH JANUARY 2000

Date	Race	Number Released	Release Location on Sacramento River
4/14/1986	Fall	608,140	Red Bluff
5/9-13/1986	Fall	3,419,026	Red Bluff
11/4/1986	Late-Fall	317,988	Red Bluff
3/13/1987	Fall	54,280	Red Bluff
5/3-13/1987	Fall	269,365	Red Bluff
2/22/1988	Fall	54,247	Red Bluff
4/1-15/1988	Fall	725,187	Red Bluff
5/9-13,1988	Fall	4,573,025	Red Bluff
2/3-24/1989	Fall	5,678,534	Red Bluff
3/23/1989	Fall	684,193	Red Bluff
5/9-10/1989	Fall	5,537,520	Red Bluff
5/12/1990	Fall	52,212	Red Bluff
2/28/1991	Fall	307,819	Bend Bridge
3/1-25/1991	Fall	4,518,601	Red Bluff
5/1/1991	Fall	64,700	Red Bluff
2/13-28/1992	Fall	4,761,200	Red Bluff
3/3-19/1992	Fall	6,318,720	Red Bluff
4/15/1992	Fall	54,556	Red Bluff
3/10/1993	Fall	123,743	Red Bluff
2/7-16/1994	Fall	2,226,597	Red Bluff
3/1-10/1994	Fall	2,287,347	Red Bluff
2/13-23/1995	Fall	1,482,415	Red Bluff
3/10/1995	Fall	101,331	Red Bluff
1/29/1996	Fall	1,319,814	Red Bluff
2/8-28/1996	Fall	5,222,300	Red Bluff
3/5-15/1996	Fall	1,001,507	Red Bluff
2/20-27/1997	Fall	3,097,705	Bow River Boat Ramp
3/4-12/1997	Fall	2,915,824	Bow River Boat Ramp
2/4-26/1998	Fall	8,203,920	Below RBDD
1/29/1999	Fall	384,882	Bow River Boat Ramp
1/29/1999	Fall	370,191	Woodson Bridge

Note: Plantings in the assessment area began in 1965.
Source: USFWS, 2001