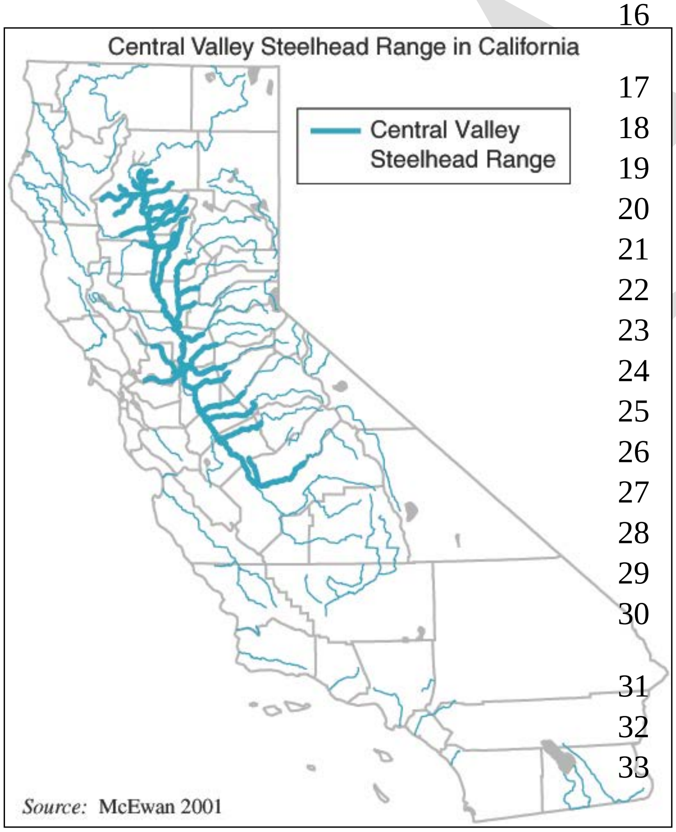
A.17 CENTRAL VALLEY STEELHEAD (*ONCORHYNCHUS MYKISS*)

illustration by Joseph Tomelleri

A.17.1 Legal and Other Status

The Central Valley steelhead Evolutionarily Significant Unit (ESU)[1] was federally listed as threatened on March 19, 1998 (NOAA 1998). This listing included, "only natural spawned populations of steelhead (and their progeny) residing below naturally and man-made impassable barriers (e.g., impassible waterfalls and dams). . . in the Sacramento and San Joaquin Rivers and their tributaries" (NOAA 1998). Steelhead in San Pablo and San Francisco Bays and their tributaries were not included in this ESU. On June 14, 2004, the National Marine Fisheries Service (NMFS) proposed that all West Coast steelhead be reclassified from ESUs to Distinct Population Segments (DPS)[2] and proposed to retain Central Valley steelhead as threatened (69 FR 33102). Threatened status of the Central Valley DPS was reaffirmed on January 5, 2006 (NOAA 2006). This decision included the Coleman National Fish Hatchery and Feather River Hatchery steelhead populations. Although previously included in the ESU, these populations were not deemed essential for conservation and were, therefore, not included in the listed steelhead population.



Critical habitat for the Central Valley steelhead was designated throughout the Central Valley on September 2, 2005 (NOAA 2005a). Critical habitat was further characterized in the Federal Register Final Rule for steelhead (NOAA 2006). Critical habitat for the species is divided into 22 hydrologic units by watersheds. Of these, two occur in Butte County and include the Marshville and Butte Creek Hydrologic Units. These units include the Feather River through Oroville and Little Chico, Butte, Little Butte, and Little Dry creeks near Paradise.

Central Valley steelhead are not listed under the California Endangered Species Act but are designated as a California

[1] An ESU is defined as a population that: 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component in the evolutionary legacy of the species" (Johnson et al. 1994).

[2] A DPS is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or distinct population segments of vertebrate species (NOAA 2011).

Species of Special Concern.

A.17.2 Species Distribution and Status

A.17.2.1 Range and Status

West Coast steelhead occur in Washington, Oregon, Idaho, and throughout California as far south as San Mateo Creek in San Diego County (McEwan 2001). The Central Valley steelhead DPS was once widespread throughout the Central Valley. Historically, steelhead likely occurred from the McCloud River and other northern tributaries in the Central Valley to Tulare Lake and the Kings River in the southern San Joaquin Valley (McEwan 2001, Good et al. 2005). More than 95 percent of historical spawning habitat is currently inaccessible to steelhead, and, before major dam construction, between 1 and 2 million steelhead may have spawned in Central Valley waterways (McEwan 2001).

No reliable estimates of historical Central Valley steelhead population size currently exist. Based on monitoring below the confluence of the Sacramento and San Joaquin rivers at Chipps Island in 1997 to 1999 and calculations reported in Good et al. (2005) using generous assumptions, roughly 100,000–300,000 steelhead juveniles are produced naturally each year in the Central Valley. In the 1950s, the average estimated spawning population size above the mouth of the Feather River in the Sacramento River system was 20,540 fish (McEwan and Jackson 1996). In 1991-1992, the annual run size for the total Sacramento River system was likely less than 10,000 adult fish.

The population numbers returning to the Red Bluff Diversion Dam fish ladders have decreased substantially since 1966. In the late 1960s, roughly 20,000 fish passed through the fish ladders; in 1994, only 2,000 returned (Good et al. 2005). These statistics include hatchery fish from Coleman National Fish Hatchery.

The present distribution of Central Valley steelhead is greatly reduced from their historical range, mostly due to impassible dams that block access to spawning and rearing habitat. Naturally spawning populations that support anadromy have been found in the upper Sacramento River and tributaries, Mill, Deer, and Butte creeks, and the Feather, Yuba, Mokelumne, Calaveras, and Stanislaus rivers (McEwan 2001). Incidental captures of juvenile steelhead during Chinook salmon monitoring in the Cosumnes, Tuolumne, and Merced rivers confirm a widespread distribution of steelhead in accessible streams and rivers (Good et al. 2005).

A.17.2.2 Distribution and Status in the Plan Area

Central Valley steelhead have been observed spawning in the Plan Area in the Feather River upstream of the Thermalito Afterbay outlet to the Fish Diversion Dam (DWR 1999, NOAA 2005b); Big Chico Creek (CDFG 1993, NOAA 2005b); Butte Creek upstream of River Mile (RM) 13 to upstream of the Plan Area (USFWS 2000); Little Dry Creek throughout its length in the Plan Area (NOAA 2005); Little Chico Creek throughout its length in the Plan Area (NOAA 2005b); and Mud Creek (NOAA 2005b) (Figure A-17). Juvenile rearing occurs in all of these waterways as well as in Rock Creek and Lindo Channel. Although the California Natural Diversity Database (CNDDB 2006) has no records of Central Valley steelhead within Butte County, critical habitat has been identified by NMFS to include the Feather River, Little Chico Creek, Butte Creek, Little Butte Creek, and Little Dry Creek (NOAA 2005b).

A.17.3 Habitat Requirements and Special Considerations

Optimal habitat for steelhead throughout its range on the Pacific Coast can generally be characterized by clear, cool water with abundant instream cover, well-vegetated stream banks, relatively stable water flow, and a 50:50 pool-to-riffle ratio (Raleigh et al. 1984). Although optimal water temperatures for steelhead are considered to range from 53.8ºF to 68ºF (12ºC to 20ºC), various sources document southern steelhead as persisting in streams with water temperatures ranging from 58ºF to 80ºF (14.4ºC to 25.5ºC) during the summer and early fall months of drought years (Titus et al. 2003). The critical thermal maximum is reported to be up to 85ºF (29.4ºC) (Lee and Rinne 1980). Maximum water temperature thresholds have been established by NOAA (2009) for spawning and egg incubation at 56°F and for juvenile rearing and juvenile and adult migration at 65°F.

In fresh water, steelhead use freshwater habitat for spawning, rearing, and migration (NOAA 2000). Essential features of steelhead habitat include adequate substrate, water quality and quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. In general, appropriate stream flow, water temperature, and water chemistry (e.g., high dissolved oxygen and low turbidity) are necessary for adult migration to spawning areas and juvenile migration to the ocean. Suitable water depth, velocity, and substrate composition are the primary requirements for spawning, although water temperature and turbidity are also important. Dissolved oxygen, pH, and water temperature all affect survival of incubating embryos. Fine sediment particles (sand and smaller) can settle into the spaces between larger substrate particles (such as gravel and cobbles) in the redd, which reduces water flow and dissolved oxygen concentrations.

For juvenile steelhead, living space (defined by water depth and velocity), shelter from predators and adverse environmental conditions, a food supply, and suitable water quality and quantity are necessary for survival and development while in fresh water. Young-of-the-year steelhead use shallow water and constituent habitats whereas larger, older juveniles use deeper water for ontogeny and survival (A. Spina, unpublished data). All age classes, however, may seek cover and cool water in pools during the summer (Nielsen et al. 1994), especially when flow, and consequently space, decline during the summer and fall (Kraft 1972).

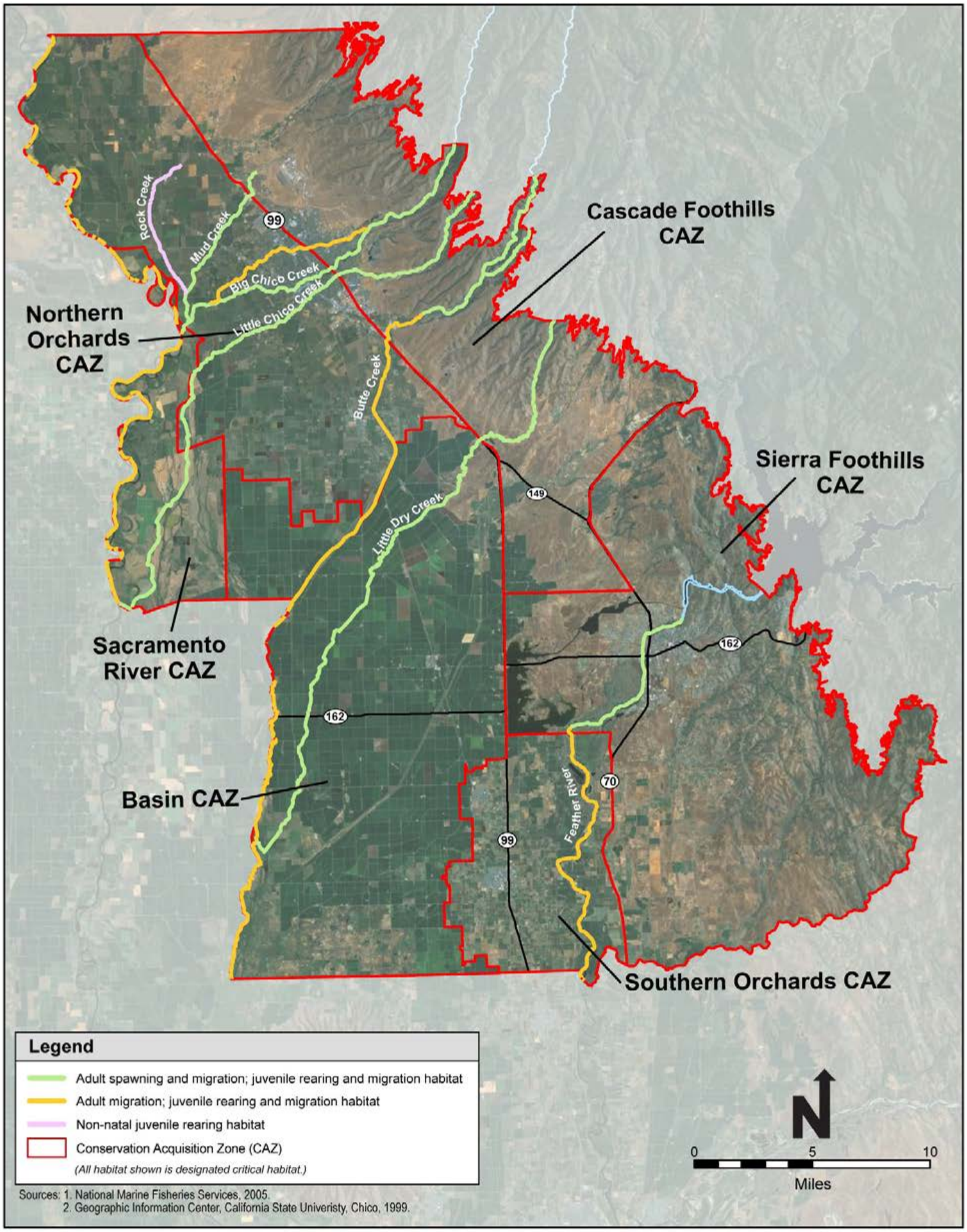


Figure A-17. Central Valley Steelhead Modeled Habitat

The five primary constituent elements of freshwater critical habitat for steelhead include the following:

- Freshwater spawning sites (i.e., providing suitable water temperatures and instream flows for successful spawning in the upstream reaches of the tributary rivers);
- Freshwater rearing sites (i.e., providing suitable water quality for juvenile rearing, instream flows to support physical habitat, connectivity with floodplains, tidal habitat, channel margin habitat, and other juvenile rearing areas, and providing suitable food resources for juvenile rearing);
- Freshwater migration corridors (i.e., reducing and avoiding passage barriers and impediments, providing suitable water quality and instream flows to support access and connectivity for migration within the tributary rivers, seasonally inundated floodplains and tidal habitats, and migration pathways through the Delta); and
- Estuarine areas (i.e., providing unobstructed migration and rearing opportunities, suitable water quality with salinity conditions that support juvenile and adult physiological transitions between freshwater and saltwater, and providing food resources to support juvenile growth and survival) (NOAA 2005a, 2006).

A.17.4 Life History

Steelhead are the anadromous form of rainbow trout, migrating from the Pacific Ocean to upstream rivers and streams to spawning grounds. Adult steelhead enter creeks in the winter (September to March), usually after the first substantial rainfall, and move upstream to suitable spawning areas. Spawning can occur in winter to spring (January through March, or April in some years), generally in riffle areas or the tails of pools. Suitable spawning gravels generally are 0.5 to 3 inches in diameter, are not heavily compacted, and have low amounts of sand or silt in them; however, steelhead can successfully spawn in gravels not meeting these characteristics. Females dig a nest, or redd, in the gravel and deposit their eggs, the males fertilize the eggs, and the female covers the nest with gravel.

After eggs hatch (3.5 to 5 weeks), fry emerge from the gravel in 2 to 6 weeks in late May to early June, and disperse throughout the creek, typically occupying shallow areas along stream margins. Juvenile steelhead often move to deeper water as they grow and will remain in freshwater for an average of 2 years before migrating to the ocean (NOAA 1997). Downstream movement of kelts[3] generally occurs from January through April. Downstream juvenile migration usually occurs from October to May. Photoperiod, stream flow, and temperature appear to influence emigration timing (Shapovalov and Taft 1954, Bjornn and Reiser 1991, Holubetz and Leth 1997). Juvenile steelhead may spend several weeks in the coastal lagoon or estuary of a stream before entering the ocean. They reside in the ocean for 2 to 3 years before returning to their natal stream to spawn (NOAA 1997), although in wet years steelhead may

[3] "Kelt" is the name given to adult salmon and steelhead after they have spawned.

return to spawn after only one year in the ocean (Moyle et at. 1995). Adults can spawn more than once, although most do not spawn more than twice (NOAA 1997).

A.17.5 Threats

Steelhead populations have been most significantly impacted by the construction of dams that block access to headwaters of the main stem Sacramento and San Joaquin rivers and all the major tributaries (McEwan and Jackson 1996). The construction of barrier dams along the migratory streams has blocked steelhead passage to many natal tributaries, resulting in the loss of spawning and holding habitat. Compared to historical extent, the spawning and rearing habitat accessible to steelhead has been substantially reduced. Dam-regulated low flow periods and alterations in river flows are other limiting factors for steelhead migration and reproduction. During low flows, fish are unable to reach natal spawning habitat or become disconnected and isolated from flowing water. In dry years, some individuals may be blocked from their streams and forced to remain in main rivers where breeding habitat is marginal.

Within Butte County, a major threat to steelhead is the construction of Pacific Gas and Electric's Butte Creek and Centerville head dams in upper Butte Creek, which has eliminated access to the headwaters of the Butte Meadows basin (Brown 1992 cited in McEwan and Jackson 1996). The range of steelhead for spawning is restricted to lower Butte Creek and tributaries. Ten diversion dams are located on lower Butte Creek. These dams have fish ladders, but are known to impede salmon and steelhead migration (McEwan and Jackson 1996). These diversions result in less than adequate flows and blocked passage for steelhead. Mill and Deer creeks and other minor Sacramento River tributaries with passable dams hold the last adequate spawning and rearing habitat available to steelhead in the Central Valley (McEwan and Jackson 1996).

Elevated water temperatures are the result of inadequate carryover storage in Shasta and other reservoirs and warm agricultural runoff (McEwan and Jackson 1996). Steelhead require cool water temperatures, and increases in water temperatures negatively impact the rate of survival. Land use activities associated with logging, road construction, urban development, mining, livestock grazing, agriculture, and recreation are causing a decline in quantity and quality of fish habitat by changing streambank and channel morphology, altering water temperatures, degrading water quality, and blocking access to spawning areas (McEwan and Jackson 1996).

Artificial propagation of steelhead at multiple Central Valley hatcheries presents threats to the wild steelhead population (NOAA 2009b). A major concern is genetic introgression by hatchery origin fish that spawn naturally and interbreed with wild fish (McEwan and Jackson 1996). Genetic introgression is thought to introduce maladaptive traits to wild stocks that can reduce their survival and fitness (Araki et al. 2007).

A.17.6 Relevant Conservation Efforts

Several efforts have been established by DFG to conserve and restore steelhead throughout California, including 100 percent marking of hatchery-produced steelhead, zero bag limit for unmarked steelhead, gear restrictions, harvest closures, and size limits.

Biological opinions for State Water Project (SWP) and Central Valley Project (CVP) operations (e.g., NMFS 2009a) and other federal projects involving irrigation, water diversion, and fish passage have improved or minimized adverse impacts on steelhead in the Central Valley. In 1992, an amendment to the authority of the CVP through the Central Valley Project Improvement Act (CVPIA) was enacted to give protection of fish and wildlife equal priority with other Central Valley Project objectives. From this Act arose several programs that have benefited listed salmonids. The USFWS's Anadromous Fish Restoration Program is engaged in monitoring, education, and restoration projects designed to contribute toward doubling the natural populations of select anadromous fish species residing in the Central Valley, including steelhead. Restoration projects funded through the program include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment.

The CALFED Ecosystem Restoration Program (ERP) has conducted restoration actions that include installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. A major CALFED ERP action currently underway is the Battle Creek Salmon and Steelhead Restoration Project. This project will restore 77 kilometers (km) (48 miles) of habitat in Battle Creek to support steelhead and Chinook salmon spawning and juvenile rearing at a cost of more than $90 million. The project includes removal of five small hydropower diversion dams, construction of new fish screens and ladders on another three dams, and construction of several hydropower facility modifications to ensure continued hydropower operations. This restoration effort is believed to be the largest cold water restoration project to date in North America.

Oroville Dam Federal Energy Regulatory Commission (FERC) relicensing efforts on the Feather River have considered instream flows and temperature management for steelhead spawning and juvenile rearing downstream of the dam.

The Fish Passage Improvement Project at the Red Bluff Diversion Dam is building a pumping facility to provide reliable water supply for high-valued crops in Tehama, Glenn, Colusa, and northern Yolo counties while providing year-round unimpeded fish passage. Gate closures at the dam have historically interrupted the passage of steelhead and other migratory species.

The Bay Delta Conservation Plan is under development to contribute to the recovery of Central Valley steelhead and other fish species. Proposed conservation measures under the plan that would benefit steelhead include restoration of up to 65,000 acres of tidal wetland, 10,000 acres of floodplain, and 10 linear miles of channel margin habitat; reductions in predation;

improvements in dissolved oxygen levels in the Stockton Deep Water Ship Channel; reductions in illegal harvest; improvements in fisheries in the Yolo Bypass; and contributions to hatchery and genetic management plans at Central Valley hatcheries.

Mitigation under the Delta Fish Agreement has increased the number of wardens enforcing harvest regulations for steelhead and other fish in the Bay-Delta and upstream tributaries by creating the Delta Bay Enhanced Enforcement Program (DBEEP). Initiated in 1994, DBEEP currently consists of nine wardens and a supervisor.

Many smaller tributaries to the Sacramento and San Joaquin rivers have local watershed conservancies with master plans to contribute to conservation and recovery of steelhead and other salmonids.

A.17.7 Species Habitat Suitability Model

Steelhead migration, spawning, and rearing habitats are defined as migration, spawning, and rearing habitats delineated by NMFS (2005b) and GIC (1999) (Figure A-17).

Spawning Habitat. Spawning habitat of Central Valley steelhead exists in multiple waterways throughout the Plan Area. Spawning occurs in the Plan Area throughout Mud Creek, Little Chico Creek, Big Chico Creek, and Little Dry Creek, in Butte Creek upstream of River Mile (RM) 13 to outside the Plan Area, and in the Feather River upstream of the Thermalito Afterbay Outlet to the Fish Diversion Dam.

Adult Migration Habitat. Adult migration habitat occurs in and downstream of all spawning habitat locations in the Plan Area.

Juvenile Rearing and Migration Habitat. Juvenile rearing and migration habitat occurs throughout adult spawning and migration habitat. Some nonnatal juvenile steelhead rearing has also been observed in Rock Creek, a tributary to Big Chico Creek.

Assumptions. Data from NMFS were used for this model because NMFS is the federal agency responsible for managing steelhead and, as such, is considered to be the authority on the distribution of the species and its habitat. Data gaps in the NMFS (2005) GIS database were augmented with information from Chico State University's Geographic Information Center (1999).

A.17.8 Recovery Plan Goals

The Public Draft Recovery Plan for Central Valley salmonids, including steelhead, was released by NMFS on October 19, 2009. Although not final, the overarching goal in the public draft is the removal of, among other listed salmonids, the Central Valley steelhead DPS from the Federal List of Endangered and Threatened Wildlife (NMFS 2009a). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations within each historical diversity group, as well as other measurable biological criteria.

A.17.9 References

Literature Cited

Araki, H., B. Cooper, and M. S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318:100-103.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. Pp. 83-138 in Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats, edited by W. R. Meehan. American Fisheries Society Special Publication 19.

DFG (California Department of Fish and Game). 1993. Restoring Central Valley Streams: A Plan for Action.

DWR (California Department of Water Resources). 1999. Feather River study, Chinook salmon emigration survey, December 1997–June 1998.

CNDDB (California Natural Diversity Database). 2006. Sacramento: California Department of Fish and Game.

GIC (Geographic Information Center). 1999. California State University, Chico.

Good, T. P., R. S. Waples, and P. Adams, eds. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66.

Johnson, O. W., R. S. Waples, T. C. Wainwright, K. G. Neely, F. W. Waknitz, and L. T. Parker. 1994. Status Review for Oregon’s Umpqua River Sea-Run Cutthroat Trout. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-VWFSC-15.

Holubetz, T. B., and B. D. Leth. 1997. Evaluation and Monitoring of Wild/Natural Steelhead Trout Production. Annual Progress Report: January 1, 1995-December 31, 1995. Prepared for U. S. Department of Energy, Bonneville Power Administration, Portland, OR.

Kraft, M. E. 1972. Effects of Controlled Flow Reduction on a Trout Stream. Journal of the Fisheries Research Board of Canada 29:1405-1411.

Lee, R. M., and J. N. Rinne. 1980. Critical thermal maxima of five trout species in the Southwestern United States. Transactions of the American Fisheries Society 109:632-635.

McEwan, D. R. 2001. Central Valley Steelhead. Pp. 1–43 in Fish Bulletin 179: Contributions to the Biology of Central Valley Salmonids, Vol. 1, edited by R. L. Brown. California Department of Fish and Game, Sacramento.

McEwan, D. and T. A. Jackson. 1996. Steelhead Restoration and Management Plan for California. Inland Fisheries Division, California Department of Fish and Game.

Moore, T. L. 2001. Steelhead Survey Report for Antelope, Deer, Beegum and Mill Creeks, 2001. Sacramento River Salmon and Steelhead Assessment Program, California Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish Species of Special Concern in California, 2nd ed. Prepared for California Department of Fish and Game, Rancho Cordova. Contract No. 2128IF.

NOAA (National Oceanic and Atmospheric Administration). 1997. Endangered and Threatened Species: Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead. Final Rule. Federal Register 62(159):43937-43954.

NOAA (National Oceanic and Atmospheric Administration). 1998. Endangered and Threatened Species; Threatened Status for Two ESUs of Steelhead in Washington, Oregon, and California; Final Rule. Federal Register 63(53):13347-13371. March 19.

NOAA (National Oceanic and Atmospheric Administration). 2000. Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California. Federal Register 65(32):7764-7787.

NOAA (National Oceanic and Atmospheric Administration). 2005a. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. Federal Register 70(170):52488-52585. September 2.

NOAA (National Oceanic and Atmospheric Administration). 2005b. http://swr.nmfs.noaa.gov/salmon/layers/finalgis.htm.

NOAA (National Oceanic and Atmospheric Administration). 2006. Endangered and Threatened Species; Final Listing Determinations for 10 Distinct Populations Segments of West Coast Steelhead; Final Rule. Federal Register 71(3):834-862. January 5.

NOAA (National Oceanic and Atmospheric Administration). 2009a. Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project and State Water Project. June 4, 2009. http://swr.nmfs.noaa.gov/ocap.htm

NOAA (National Oceanic and Atmospheric Administration). 2009b. Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead. Sacramento Protected Resources Division. October 2009.

NOAA (National Oceanic and Atmospheric Administration). 2011. NOAA Fisheries, Office of Protected Resources Glossary. Accessed March 29, 2011 from http://www.nmfs.noaa.gov/pr/glossary.htm.

Nielsen, J. L., T. E. Lisle, and V. Ozaki. 1994. Thermally Stratified Pools and Their Use by Steelhead in Northern California Streams. Transactions of the American Fisheries Society 123:613-626.

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat Suitability Information: Rainbow Trout. Department of Interior, U.S. Fish and Wildlife Service, Washington, D.C. FWS/OBS-82/10.60.

Shapovalov, L., and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (*Salmo gairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with Special Reference to Waddell Creek, California, and Recommendations Regarding their Management. Fish Bulletin 98. California Department of Fish and Game.

Spina, A. No date. Unpublished information provided by NOAA Fisheries to SAIC.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of the freshwater fishes of Southern California. Bulletin of the Southern California Academy of Sciences 92(3):101-167.

Titus, R. G., D. C. Erman, and W. M. Snider. In preparation. History and Status of Steelhead in California Coastal Drainages South of San Francisco Bay.

USFWS (U.S. Fish and Wildlife Service). 2000. Anadromous fish restoration actions in the Butte Creek Watershed. Programmatic environmental assessment. Accessed May 2007 from http://www.delta.dfg.ca.gov/afrp/documents/Buttepea.pdf.

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