

29.0 CALIFORNIA CENTRAL VALLEY STEELHEAD ESU

29.1 BACKGROUND

29.1.1 Description of the ESU

The California Central Valley Steelhead (CCVS) ESU includes all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin Rivers and their tributaries, but excluding steelhead from San Francisco and San Pablo Bays and their tributaries. The ESU also includes artificially propagated steelhead stocks (and their progeny) from Coleman National Fish Hatchery (Coleman NFH) and Feather River Hatchery programs. Other anadromous hatchery steelhead stocks propagated within but not included in the ESU are the Nimbus Hatchery (Eel River) stock and the Mokelumne River Hatchery (out-of-basin composite) stock.

29.1.2 Status of the ESU

The CCVS ESU was listed as threatened on March 19, 1998 (63 FR 13347), due to the depressed numbers of naturally produced steelhead, the severe loss of habitat, the number of human-caused threats to the species including hatchery impacts, and the lack of adequate regulatory protection to conserve the ESU. Historically, steelhead were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). CCVS ESU abundance was estimated to be 40,000 fish in the 1960s but reduced to less than 10,000 by 1992, based on past spawning surveys, hatchery returns, and dam counts (McEwan and Jackson 1996). Central Valley steelhead populations show a continuing population decline, an overall low abundance, and fluctuating return rates (BRT 2003a). In the assessment of the ESU, two-thirds of the BRT members voted for the category “in danger of extinction”, and the remaining one-third voted for the “likely to become endangered” category (BRT 2003b). The BRT expressed serious concerns regarding the effects of artificial propagation on ESU productivity, spatial structure, and diversity, though they were less concerned about hatchery effects on ESU abundance.

29.2 ASSESSMENT OF HATCHERY PROGRAMS

The Central Valley Technical Recovery Team has not identified steelhead populations within the ESU. Existing wild steelhead stocks may be confined to upper Sacramento River tributaries (i.e., Antelope, Deer, and Mill creeks) and the Yuba River, and they may also reside in Big Chico and Butte creeks. Recent monitoring in the San Joaquin River watershed has detected self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers (McEwan 2001). Additionally, steelhead (and their progeny) from the artificially propagated stocks from the Coleman NFH and the Feather River Hatchery steelhead programs are considered part of the listed CCVS ESU. Anadromous hatchery programs that release out-of-ESU steelhead stocks into the CCVS ESU are operated at Nimbus Hatchery and Mokelumne River Hatchery. The following section presents a summary of the broodstock/program history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of these artificial propagation programs (Table 29.1).

Table 29.1. Artificial Propagation Programs which release steelhead within the geographical area of the C CVS ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Coleman National Fish Hatchery	integrated	yes	yearling smolt	600,000	1947
Feather River Hatchery	integrated	yes	yearling smolt	400,000	1967

Nimbus Hatchery	integrated	no	yearling smolt	430,000	1956
Mokelumne Hatchery	integrated	no	yearling smolt	100,000	1964

29.2.1 Battle Creek Population/Coleman NFH Steelhead Program

It is believed that the original steelhead population in Battle Creek was extirpated or in severe decline from loss of habitat and other human-induced impacts, including the development of hydro-electric power projects within the upper Battle Creek basin. The present population comprises native stock and upper Sacramento River steelhead collected from the Keswick Dam fish trap or the Red Bluff Diversion Dam, among other stocks that were introduced by the Coleman NFH steelhead program (SSHAG 2003). Steelhead escapement to Battle Creek has been increasing since 1995, heavily supplemented by adult returns in excess of Coleman NFH broodstock needs. The Battle Creek population has introgressed with Coleman NFH steelhead, confirmed through genetic analysis of hatchery and natural steelhead tissue samples (Nielsen *et al.* 2003). As of 1979, the Coleman NFH steelhead program has primarily depended upon hatchery returns, and integrates local, native fish as 10 percent of its broodstock. The Coleman NFH program is considered part of the C CVS ESU.

29.2.1.1 Program History. Artificial propagation of steelhead at Coleman NFH began in 1947 as an enhancement program and has since taken on a mitigation responsibility as well. The steelhead program is funded by the U.S. Bureau of Reclamation and is managed by the U.S. Fish and Wildlife Service (FWS). Since 1995, steelhead taken into Coleman NFH in excess of broodstock needs have been released above the weir to spawn naturally in upper Battle Creek, where there is a restoration project under way to restore a migration corridor and spawning/rearing habitat. FWS proposes to continue supplementation of the natural steelhead population in upper Battle Creek to expedite the establishment of a self-sustaining run within the restoration area.

29.2.1.2 Broodstock History. The Coleman NFH steelhead program was originally founded from Sacramento River stocks collected at the Keswick Dam fish trap and Red Bluff Diversion Dam. Other stocks have been utilized in the program, including those from the Nimbus, Feather River, and Mad River Hatcheries (SSHAG 2003). With few exceptions since 1979, Coleman NFH has relied upon adult returns to the hatchery for its broodstock needs. Natural, local steelhead have always been included in the program to some degree. In 1998, Coleman NFH

began 100-percent marking of their steelhead production with an adipose clip, enabling hatchery management to control the integration of natural stock. Coleman NFH now includes natural steelhead as 10 percent of the program broodstock.

29.2.1.3 Similarity of Hatchery-origin to Natural-origin Fish. Coleman NFH steelhead are genetically grouped first with their founding population in the upper Sacramento River mainstem. Then they are linked with the natural Battle Creek steelhead, suggesting some structural integrity to the natural population despite hatchery influence (Nielsen *et al.* 2003). There is also a slight genetic distinction and greater productivity in late-returning steelhead as compared to the early returns of both hatchery and in-stream steelhead, attributed to the non-incorporation of natural fish at the tail run of the hatchery spawning period. Hatchery fish exhibit the steelhead run timing for the Battle Creek population (USFWS 2001).

29.2.1.4 Program Design. The goals for the Coleman NFH steelhead program include the production of 600,000 yearling smolts at 4 fish/lb. for annual January release into the mainstem Sacramento River. The program was designed for providing harvest opportunities in the upper Sacramento River basin; there is no fishing allowed in lower Battle Creek. Current production goals do not include steelhead conservation, but hatchery management desires to continue steelhead supplementation of upper Battle Creek. Broodstock are randomly collected for spawning from adult returns entering the hatchery. There are no established mitigation goals for the Coleman NFH steelhead program, and production goals have evolved throughout the history of the program. Natural fish are incorporated as 10 percent of the program broodstock. All steelhead are air-spawned, and natural broodstock are released downstream from the hatchery after spawning. Hatchery steelhead in excess of hatchery broodstock needs are culled. As of 1998, all Coleman NFH steelhead are externally marked by an adipose clip.

29.2.1.5 Program Performance. The Coleman NFH steelhead program is being evaluated within an ESA Section 7 consultation. The hatchery has undergone an evaluation of its operations within a public process, and workshops continue to involve the public in hatchery management decisions regarding the hatchery steelhead and other programs. The steelhead program has been successful in meeting its production goals and providing for a recreational freshwater fishery in the Sacramento River. The program stock has been managed to retain its genetic relationship to the local and regional steelhead populations. It is not known if hatchery steelhead exhibit high rates of straying, as the coded wire tagging of hatchery stock has been discontinued. Program fish are not usually supplied for out-of-basin research studies, but they have been used to stock reservoirs for cold-water fisheries where there is a possibility of escape into non-natal anadromous waters.

Fish monitoring on Battle Creek is conducted at the Coleman NFH barrier dam by video monitoring and trapping, adult distribution snorkel surveys, and juvenile trapping via rotary screw trap. Data is collected on (1) adult numbers; (2) run-timing of adult migration; (3) age, size, and gender of adults; (4) spawn timing; (5) location of spawning; (6) weight and condition of juveniles; (7) timing of juvenile emigration; (8) size of emigrating salmonids; (9) number of juveniles produced; and (10) potential limiting factors at various life stages. All fish released into upper Battle Creek from Coleman NFH are first passed through a tunnel-type detector to identify CWT fish. Tagged fish are euthanized for CWT recovery data.

Continued operation of the steelhead program is certain. As currently operated, program fish are overwhelming the natural population and hindering the natural selection process of the natural integrated stock. It is estimated that greater than 90 percent of the Battle Creek population is made up of Coleman NFH steelhead (USFWS 2001).

29.2.1.6 VSP Effects

Abundance - The Coleman NFH steelhead program contributes to natural abundance, and current estimates are that the natural population, founded with Coleman NFH steelhead stocks, consists almost entirely of generations of hatchery fish (USFWS 2001). Despite the steep decline of natural steelhead populations in the Central Valley, total steelhead escapement to Battle Creek often surpasses the total of remaining populations in the ESU (SSHAG 2003).

Productivity - Productivity of the hatchery steelhead relative to the natural steelhead in Battle Creek is not known. However, there is evidence that productivity of the late-returning natural steelhead is greater and may be related to a decreased hatchery influence. A study is currently under way that will compare the reproductive success of natural and hatchery steelhead in upper Battle Creek and provide data on hatchery contribution to natural productivity (D. Campton, USFWS, *pers. comm.*).

Spatial Structure - Program fish are well distributed in the six miles of lower Battle Creek, from the confluence of the Sacramento River to the Coleman NFH barrier weir. The carrying capacity of lower Battle Creek is not known, but it is likely to be exceeded in high escapement years. It is possible that program fish may fall back into the mainstem Sacramento River and spawn in the upper basin in those years.

Diversity - The Coleman NFH program incorporates natural steelhead into its broodstock and has recently doubled its broodstock numbers for the purpose of maximizing the genetic diversity of the hatchery stock. However, high numbers of the hatchery stock are overwhelming the local population and possibly genetically influencing upper Sacramento River basin stocks, which could lead to homogenization of the ESU.

29.2.2 Feather River Population

The Feather River steelhead population is limited by a paucity of steelhead habitat in the lower basin, where it is relegated by the existence of Oroville Dam. There are few refugia that offer appropriately-sized gravel and holding pools for steelhead (DWR 2003). The natural steelhead population may also be repeatedly harassed in a local fishery with a catch-and-release strategy for unclipped *O. mykiss*. A first-time steelhead redd survey was conducted in the Feather River in the 2003-2004 spawning season. Based on 75 confirmed steelhead redds in the uppermost reach below the dam, the population of naturally-spawning steelhead was estimated to be 163 fish. The contribution of hatchery fish to the naturally spawning population is not known, but as corresponding steelhead escapement to the hatchery was estimated to number 2,999 fish, it is likely that the majority of in-stream spawners were of hatchery-origin. The Feather River Hatchery (FRH) steelhead program collects its broodstock from adult returns to the hatchery and

incorporates local, native fish into its broodstock. The FRH program is considered part of the CCVS ESU.

29.2.2.1 Broodstock History. Artificial propagation at FRH began in 1960 as mitigation for the loss of steelhead habitat above Oroville Dam. The program is funded by the California Department of Water Resources (DWR) and is managed by CDFG staff. The goals of the FRH program do not include steelhead conservation or restoration. The FRH stock was originally founded with Feather River stock, but there have been previous transfers of Nimbus Hatchery stocks (Eel River and summer-run Skamania), which may have caused the hatchery population to introgress with the out-of-basin stocks (SSHAG 2003). The hatchery population is 100-percent adipose clipped and distinguished from natural steelhead in the system. Unclipped steelhead entering the hatchery during spawning season may be used as program broodstock; however, their numbers are few (A. Kastner, CDFG, *pers. comm.*).

29.2.2.2 Similarity of Hatchery-origin to Natural-origin Fish. Genetic analysis has determined that the FRH stock is tightly joined with the Feather River stock and further genetically linked with the Battle Creek population and the upper Sacramento River-Coleman group. Broodstock are collected throughout steelhead run-timing in the Feather River, and natural steelhead are opportunistically incorporated into the hatchery program.

29.2.2.3 Program Design. The FRH steelhead program provides recreational fishing opportunities in the Feather River and the mainstem Sacramento River. The program goals for the FRH steelhead program are the production of 450,000 yearling smolts for annual release in January-February at 4 fish /lb. As of 1998, FRH steelhead production is 100-percent adipose clipped, distinguishing it from the natural population. Natural steelhead may be incorporated into the broodstock program; however, the high numbers of hatchery fish in the basin combined with low natural production limit the number of unclipped steelhead entering the hatchery.

In addition, the FRH may produce up to 250,000 steelhead eggs for transfer to the Mokelumne River Hatchery (MRH) if the MRH cannot take enough steelhead eggs to reach its production goals.

29.2.2.4 Program Performance. From 1969 to 2003, annual steelhead adult returns to the hatchery averaged 1,019 fish. This number had doubled in average steelhead returns between 2000 and 2003 (B. Cavello, DWR, *pers. comm.*) In-river release reinforces homing behavior in FRH steelhead, so program fish are not likely to stray to an appreciable extent, although a myriad of water diversions in the Central Valley may confuse a migrating adult. Based on the initial steelhead redd survey conducted in 2003, some hatchery fish are spawning in Feather River channels. The current FERC relicensing of the hydroelectric project includes the operation of the FRH, and a number of studies have been initiated to gather information and establish a data baseline for fish populations in the Feather River.

29.2.2.5 VSP Effects

Abundance - The FRH steelhead contribute to population abundance, and they are believed to make up the majority of fish in the Feather River population due to limited opportunity for natural spawning and high hatchery production.

Productivity - Productivity of the hatchery steelhead relative to the natural steelhead in the Feather River is not known. An initial steelhead redd count survey was conducted in the Feather River in 2003, but no data were collected on hatchery contribution. Future surveys will incorporate this information for the evaluation of hatchery program effects on the natural population.

Spatial Structure - Program fish are spatially distributed in the upper reaches of the Feather River basin below Oroville Dam. Steelhead habitat is limited in the river and directs the spatial structure of the in-river population. High numbers of adult steelhead returns to the Feather River consequently result in greater competition for limited habitat, superimposed redds, and less natural production, rather than an increase in the natural population.

Diversity - The FRH program incorporates natural steelhead into its broodstock; however, numbers of natural steelhead that voluntarily enter the hatchery are very low (average <5/yr.) but vary from year to year.

29.2.3 Non-ESU Hatchery Production

The Nimbus Hatchery annually produces for annual in-river release up to 430,000 steelhead yearling smolts, derived from out-of-basin Eel River stock. The Mokelumne River Hatchery (MRH) may produce and release up to 100,000 steelhead yearling smolts into the Sacramento-San Joaquin Basin Delta. The MRH steelhead program is unsustainable due to low adult returns to the facility and must be supplemented with out-of-basin FRH stock. Both programs release their juvenile steelhead in January and may impact listed steelhead populations outmigrating from the Central Valley at the same time. Adult returns may also thwart recovery efforts by straying into non-natal streams and competing for resources with native fish, superimposing established steelhead redds, hybridizing with local populations, and/or introducing disease.

29.3 CONCLUSIONS

29.4 LITERATURE CITED

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