RESULTS OF FISH PASSAGE MONITORING AT THE VERN FREEMAN DIVERSION FACILITY, SANTA CLARA RIVER

Prepared for

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1.0 INTRODUCTION

The United Water Conservation District (UWCD) undertook the Freeman Diversion Improvement Project to improve the existing diversion work on the Santa Clara River in Ventura County, California. This action was taken at the direction of the State Water Resources Control Board (SWRCB) to combat seawater intrusion in the Oxnard Coastal Plain aquifers resulting from groundwater overdrafting to supply water for irrigation, industry, and municipal uses. The improvements, consisting primarily of a permanent concrete riverbed stabilization structure, were necessary for the UWCD to maintain its ability to divert water to groundwater recharge basins in the Oxnard Plain Forebay Basin. Historic in-river aggregate mining destabilized the Santa Clara River bed, which had lowered approximately 22 feet opposite the diversion headworks since 1928, when diversions began. Instability of the river bed also contributed to repeated failures of the previous sand dike diversion structure. The permanent concrete structure, constructed in 1990, has since halted the headcutting, stabilized the river bed both upstream and downstream of the project, and improved the ability of the UWCD to divert streamflow to groundwater recharge basins.

The project was permitted through a U.S. Army Corps of Engineers (COE) 404 Permit No. 86-116-T5. The Freeman Diversion also consists of a two-entrance denil fish ladder, fish screen, and bypass facilities as described in Special Condition A of the COE 404 permit. Special Condition B of the 404 permit focuses on the fisheries mitigation features of the project, and states:

> "B. The District shall institute a plan for evaluation of the mitigation features of the project to determine their effectiveness at accomplishing their designated purpose. This evaluation process may include studies on fish movement, flows and timing and will be conducted for a period of 5 years after the project is completed. The plan is to be developed by the District within 18 months of permit issuance and is to be approved by the CE in consultation with the involved resource agencies. The

implementation of the plan shall include the installation of some functional, mutually agreeable device for counting fish passage through the ladder."

An appropriate study plan (ENTRIX 1991) to monitor steelhead utilization of the fish ladder was developed and approved by the Department of Fish and Game, United States Fish and Wildlife Service and the COE (Agencies). The plan centered on the installation of a semi-permanent fish trap and counting device which became operational in February of 1993. Prior to the installation of the semi-permanent fish trap and counter, upstream fish migration was monitored with a temporary trap (described in ENTRIX 1991) in 1991 and 1992. A number of details pertaining to the operation of the semi-permanent fish trap and counting device required refinement after installation. As a result, an agreement was reached between the UWCD and the Agencies to view the 1993 trapping season as a preliminary year to work out the details of the operating procedures. The five year monitoring phase will begin with the 1994 water year.

This report will present qualitative observations of fish in the ladder for 1993 water year, as well as summarize the trapping data collected in 1991 and 1992. In addition, recommendations to improve the operation of the fish counting device and the fish trap are presented.

2.0 METHODS

The study design for this program is presented in ENTRIX (1991). In brief, the study was designed to monitor the upstream (adult) and downstream (juvenile) migrations of steelhead trout (*Oncorhynchus mykiss*) through the fish ladder. In 1993, a semi-permanent fish trap was installed in the fish ladder (prior to 1993, a temporary trap and fyke net were placed in the ladder during high flow events to monitor fish movement upstream of the diversion facility). Under agreement with the Agencies, the fish ladder is to be operated continuously throughout the period of flow in the Santa Clara River at the Vern Freeman Diversion Dam provided certain headwater elevation criteria are met (i.e., the headwater elevation is between 160-164 feet per the COE 404 permit). However, the ladder was closed during periods of high headwater associated with large storm events and when sand was flushed from the mouth of the diversion intake. Closing the ladder during these periods reduced the build up of sand and debris at the fish trap.

Steelhead migrating upstream through the fish ladder are funneled by a series of guide bars which directs the fish into the counting tubes. The guide bars are spaced sufficiently apart to allow lamprey (but not adult steelhead) to migrate unhindered past the trap. The counting tubes lead into the actual fish trap. The fish trap can be enabled by closing a gate which blocks upstream migration of trout through the trap. Thus, with the trap enabled (blocked), fish can be captured in the trap to verify the counts recorded through the counting tubes. The trap was designed with a low velocity holding compartment which allows fish to rest in the trap until they can be identified, measured and released to continue their upstream migration.

Fish collected in the trap (or captured in the ladder during dewatering for trap maintenance) were identified to species, measured (fork length - FL) to the nearest millimeter (mm) and photographs were taken of representative individuals. Scales samples were taken of rainbow trout for age determination and to determine if the fish were wild or of hatchery origin.

3.0 RESULTS

3.1 RESULTS OF 1991 FISH TRAPPING

The Santa Clara River did not open to the ocean until March of 1991. The lower reach of the Santa Clara River naturally dries up during the late spring or early summer. Steelhead are prevented from migrating upstream or downstream until sufficient rainfall in the basin provides adequate streamflow to allow for passage to and from their spawning and rearing habitat. Once significant rains opened the lagoon to the ocean, a temporary trap was placed in the fish ladder and operated from March 26 to April 2 (Table 3-1). No steelhead were captured or observed during the 1991 survey. Lamprey were first observed in the fish ladder for the first time on the morning of March 28, and collected in the trap on the morning of March 29. During the next four days, a total of 74 adult lamprey were captured in or just below the trap. The daily number of lamprey caught ranged from 9 to 34 during this four day period. No lamprey were observed in the trap or ladder on the morning of April 2, just prior to the trap being removed.

3.2 RESULTS OF 1992 FISH TRAPPING

The temporary trap used in 1991 was fished from December 31 through January 2, 1993. No fish or lamprey were captured or observed in the fish ladder during this period.

3.3 RESULTS OF 1993 FISH TRAPPING

The fish ladder was surveyed for the first time on February 17, and monitored almost continuously through May 17 (Table 3-2). The fish ladder was operational during this time period except during periods of high sediment movement, generally associated with large storm events. The fish trap was enabled for two days (March 26 and 27) during the 1993 monitoring period, and no fish were captured in the trap.

Table 3-1. Results of fish trapping at the Vern Freeman Diversion Fish Ladder, Santa Clara River, March 26 Through April 2, 1991.

Date Surveyed	Species	Number
March 26[1]	Lamprey	0
March 27	Lamprey	0
March 28	Lamprey	0
March 29	Lamprey	9
March 30	Lamprey	16
March 31	Lamprey	34
April 1	Lamprey	15
April 2[2]	Lamprey	0
Season Total	**Lamprey**	74

[1]Trap enabled at 1700 hours

[2]Trap disabled at 1000 hours

Table 3-2. Fish ladder operating status during the 1993 monitoring period.

Time Period	Status	Comments
February 17	Closed	Trap installation
February 18-29	Open	
March 1-5	Closed	High sediment transport
March 6-26	Open	
March 27-28	Closed	High sediment transport
March 29-May	Open	

No adult or juvenile steelhead trout were observed in or around the diversion facility during the 1993 monitoring period with the exception of one 248 mm FL hatchery rainbow trout collected in the fish ladder. The trout was believed to be of hatchery origin based on the heavily eroded nature of all of its fins and analysis of the scales. Most of the scales had been absorbed; those that had not been absorbed showed even growth throughout the life of the fish, indicative of having been raised in a constant environment (i.e., a hatchery).

Adult lamprey were observed in the fish ladder from February 17 (the first survey) through May 7 (Table 3-3). The fish trap was designed to allow lamprey to migrate upstream through the ladder without being trapped, therefore the size of the spawning lamprey population could not be estimated. Approximately 465 adult lamprey were observed in the ladder. However, it is not known how many, if any, of the lamprey were counted on more than one day (i.e., it is possible that some of the lamprey may have taken more than one day to negotiate the fish ladder). It is also unknown how many, if any, lamprey took less than one day to move through the fish ladder and avoided being counted.

The daily number of lamprey observed in the fish ladder ranged from 0 to approximately 30, excluding February 17 when the upstream gate had been closed for several days prior to this observation to facilitate the installation of the fish trap (80 lamprey were collected in the fish ladder and transported upstream of the diversion facility to continue their migration run). The daily number of lamprey observed in the fish ladder remained fairly constant between at least March 7 through March 26. Lamprey were observed in the ladder through May 7.

Two additional species were collected in the fish ladder, Santa Ana suckers (*Catostomus santaanae*) and threadfin shad (*Dorosoma petenense*) (Table 3-3). Santa Ana suckers are not thought to be native to the Santa Clara River, but may have been introduced from either the Los Angeles, San Gabriel, or the Santa Ana rivers (Moyle 1976). Threadfin shad were collected in the fish ladder or observed in the diversion by-pass facility sporadically between March 26 and May 17. Threadfin shad are not native to California, but have been stocked in a number of reservoirs throughout the state, including Castaic Reservoir in the Santa Clara River Drainage. Shad were most likely introduced into the Santa Clara River as a result of the basin reservoirs over-topping their dams, and spilling into the river.

Table 3-3. Fish observations in the Vern Freeman Diversion Fish Ladder during routine maintenance operations, Santa Clara River, February 17 through May 17, 1993.

Month	No. of days surveyed	Species observed	Number
February	3	Steelhead trout	0
		Hatchery rainbow trout	0
		Lamprey	88
		Ammocetes	0
		Santa Ana sucker	0
		Threadfin Shad	0
March	22	Steelhead trout	0
		Hatchery rainbow trout	0
		Lamprey	318
		Ammocetes	0
		Santa Ana sucker	1
		Threadfin Shad	5
April	15	Steelhead trout	0
		Hatchery rainbow trout	1
		Lamprey	48
		Ammocetes	1
		Santa Ana sucker	1
		Threadfin Shad	10
May	7	Steelhead trout	0
		Hatchery rainbow trout	0
		Lamprey	11
		Ammocetes	0
		Santa Ana sucker	0
		Threadfin Shad	70-90[1]
Season total	**47**	**Steelhead trout**	**0**
		Hatchery rainbow trout	**1**
		Lamprey	**465**
		Ammocetes	**1**
		Santa Ana sucker	**2**
		Threadfin Shad	**85-105**

[1] visually estimated

Although steelhead trout have not been documented in the fish ladder during the past three years, the fish traps were not enabled continuously throughout the period of flow, and the run could have been missed. The presence of adult lamprey migrating upstream in 1991 and 1993 suggest that a steelhead population could still inhabit the Santa Clara basin streams. The adult lamprey spends from one to two years in the ocean before returning to spawn (Moyle 1976), which is similar to the southern steelhead trout (Smith 1985, Withler 1966). Thus, it is probable that steelhead would have had the opportunity migrate to and from the ocean to complete their lifecycle during the recent period of drought.

Adult lamprey were observed negotiating the fish ladder during the 1991 and 1993 sampling seasons. Ammocetes (juvenile lamprey) were also observed in the fish ladder and fish bypass in 1993. Although the size of the lamprey run is unknown, they are attracted to, and able to negotiate, the fish ladder around the diversion facility.

The three years of data collected suggest that adult lamprey are flexible in the timing of their spawning migration, entering the river in late March in 1991, and prior to mid-February in 1993. Flexibility in the timing of the spawning run has also been observed in steelhead inhabiting southern California streams. Streamflow in most southern California streams is highly variable in terms of the timing and in the length of time that the river flows to the ocean. This adaptation (in the timing of the spawning migration) allows anadromous fish to take advantage of the often short windows of opportunity to enter southern California rivers and spawn.

4.1 TRAP CALIBRATION

The counting tube calibration test indicated that the sensitivity of the system was insufficient to detect the movement of a 300 mm rainbow trout through the tubes when both tubes were connected to a single counter. The counter sensitivity was sufficient to detect the passage of two trout pulled through the tube simultaneously. After

conversations with a representative of the manufacturer (Smith-Root Inc.), it was recommended that each tube be connected to its own counter. UWCD has subsequently ordered a second counter to be installed. We recommend that the fish detection system (counting tubes) be re-tested after the installation of the second counter.

Although the trapping facility was designed to allow lamprey to by-pass the trap, one lamprey was passed through the counting tube in the same manner as the rainbow trout. A goal of the trap calibration was to select a sensitivity setting that will allow the counter to record the passage of a steelhead trout, but not sufficient to record the passage of a lamprey, should one migrate through one of the tubes. Although the lamprey pulled through the counting tube was not recorded, due to the low sensitivity of the counting tube, we recommend that lamprey be re-tested after the tube has been re-calibrated.

4.2 Recommendation to Improve Trap Operations

When the fish ladder is dewatered, and the water level drains below the level of the counting tubes, the fish counter registered "counts," resulting in false readings. Flow through the fish ladder is stopped for short periods of time as often as four times per day during high flow events for routine maintenance. We recorded as many as 2,861 counts in an upstream direction and 1,832 counts in the downstream direction in a single day due to dewatering of the fish ladder. We recommend that the counter be turned off before the fish ladder is dewatered for any reason, and the counter turn back on only after the ladder has been fully re-watered. The counters should be checked, and any "counts" should be recorded prior to dewatering the fish ladder. After the fish ladder has been fully rewatered, the counters should be reset to zero.

We also recommended that the upper and lower gates be operated such that approximately 40 cfs flows through the ladder, and such that the head differential between the ladder and the river remains at least 1.5 feet. The head differential provides the attraction flow necessary to direct fish into the ladder.

Finally, during periods of high sediment transport, sediment in and around the fish trap should be removed daily.

5.0
LITERATURE CITED

ENTRIX Inc., 1991. Vern Freeman Diversion Project fishery mitigation monitoring study plan to address 404 permit special condition B. Prepared for the United Water Conservation District. 15 pp.

Moyle, P.B. 1976. Inland fishes of California. University of California Press, Berkeley. 405 pp.

Smith, J.J. 1986. Southern Steelhead. In Abstracts of papers presented at the natural (and unnatural) history of California Trout Symposium. ed. D.P. Lee. Symposium presented by the California/Nevada Chapter of the American fisheries Society, 24 January, 1985, Monterey, California.

Withler, I.L. 1966. Variability in life history characteristics of steelhead trout, *Salmo gairdneri*, along the Pacific coast. Journal of the Fisheries Research Board of Canada 23(3):365-393.