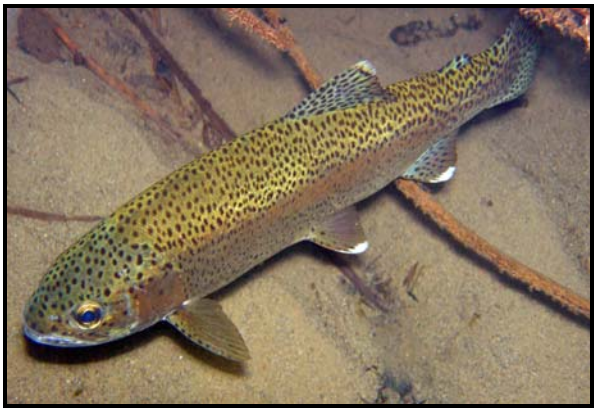
UNITED WATER CONSERVATION DISTRICT

"Conserving Water Since 1927"

Fish Passage Monitoring and Studies, Vern Freeman Diversion Facility, Santa Clara River

Annual Report

2007 Monitoring Season



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Annual Report
2007 Monitoring Season

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Cover Photos (by Steve Howard) clockwise from top left*: Sespe Creek O. mykiss, Central California Steelhead Smolt, Freeman Fish Trap, Freeman Facility tour.*

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Freeman Diversion Facility

The Freeman Diversion Facility was constructed in 1991 and is located approximately 10.7 miles upstream from the Pacific Ocean. The main purpose of the facility is to conserve groundwater resources in the Oxnard plain. The facility is comprised of a concrete dam, a denil fishway (fish ladder), a screened fishbay, a downstream migrant trap, various canals and spreading grounds. The concrete dam is a complete barrier to steelhead and Pacific lamprey upstream migration so the fish ladder was constructed in an attempt to allow unimpeded migration through the facility. The screened fishbay is located directly downstream of where flow enters the facility and its function is to keep fish out of the canals and spreading grounds and to direct fish to the downstream migrant trap or back to the river. Located at the end of the fishbay is a fish bypass pipe that can be used to direct fish back to the river when there is sufficient flow to allow for migration to the estuary.

Species Composition

The Santa Clara River is home to two native, anadromous (*lives in ocean, spawns in freshwater*) fish species, the southern steelhead trout (*Oncorhynchus mykiss*) and the Pacific lamprey (*Lampetra tridentata*). Southern steelhead are federally listed as endangered and Pacific lamprey, which currently has no federal protection are experiencing low numbers in the Santa Clara River and in many drainages on the west coast of the United States. There are two additional native fish species in the Santa Clara River, the federally-threatened tidewater goby (*Eucyclogobius newberryi*), which lives in the estuary and the threespine stickleback (*Gasterosteus aculeatus*). The threespine stickleback is comprised of two sub-species in the Santa Clara River, the partially-armored and unarmored threespine stickleback. The partially-armored stickleback, which is plentiful, exists in the Ventura County reach and the unarmored threespine stickleback exists in the Los Angeles reach of the Santa Clara River. The unarmored threespine stickleback sub-species is federally and California endangered and a California fully-protected species. The unarmored sub-species have never been observed in Ventura County. Additional fish species known to occur in the Santa Clara River include: Arroyo

chub (*Gila orcutti*), Santa Ana sucker (*Catostomus santaanae*), Owens sucker (*Catostomus fumeiventris*), Santa Ana-Owens sucker hybrids (*C. santaanae x fumeiventris*), largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), black bullhead (*Ameiurus melas*), prickly sculpin (*Cottus asper*), fathead minnow (*Pimephales promelas*), inland silverside (*Menidia beryllina*), threadfin shad (*Dorosoma petenense*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*) and mosquitofish (*Gambusia affinis*).

Environmental Setting

The Santa Clara River has the largest watershed in southern California south of Point Conception with an area of approximately 1600 square miles. Its headwaters originate on the north slope of the San Gabriel Mountains near Acton, California in Los Angeles County and the river flows approximately 116 miles from east to west to its estuary in the City of Ventura. The Santa Clara River and its tributaries have high annual flow variability, from extreme flood events to multi-year droughts.

In 2007, Ventura County experienced, depending on the location, either the driest or one of the top five driest years on record. The Santa Clara River watershed itself had the driest year on record with total rainfall equaling 5.36 inches in Santa Paula. These dry conditions typically result in either minimal or no steelhead migration mostly due to a lack of a continuous, deep migration corridor and poor water quality conditions. However, since precipitation during the 2004-2005 rain year was extremely high (40.37 inches in Santa Paula) and was normal during the 2005-2006 rain year (18.44 inches in Santa Paula), the impact of the dry conditions in 2007 on steelhead downstream migration was minimal because the groundwater basins were fairly full during the early part of the migration season maintaining a connection from spawning tributaries to the mainstem Santa Clara River. Still, during the end of the migration season the groundwater basins quickly receded and surface water loss to groundwater occurred within the lower reaches of the main spawning tributaries. Upstream migration was not feasible during 2007 because the lower Santa Clara River was dry during the entire migration season.

Steelhead migration data collected over the last decade in the Santa Ynez and Santa Clara Rivers show a strong trend toward downstream migration pulses occurring during strong-prolonged rain events. In 2007, flows in Sespe Creek, a major Santa Clara River

steelhead tributary, did not exceed 200 cfs during the migration season. Two small storms occurred between January 27 and February 27 and these two events most likely triggered the downstream steelhead migration that did occur this year. A total of 12 steelhead smolts, 2 resident rainbow trout, and 60 young of the year rainbow trout were trapped at the Freeman Diversion Fish Trap.

The remainder of this report summarizes the monitoring, study methods and study results at the United Water Conservation District (District) Vern Freeman Diversion Fish Passage Facility on the Santa Clara River for 2007.

2.1 INTRODUCTION

In southern California, downstream migrant steelhead and Pacific lamprey typically migrate downstream from their natal streams to the Pacific Ocean in the spring. Data collected from 1991 to 2007 at the Freeman Diversion show that the majority of downstream migration occurs in March, April, and May. This migration can occur when flows in the Santa Clara River are rapidly receding. When this occurs, it is necessary to trap all downstream migrant steelhead and Pacific lamprey and relocate them to the estuary or other appropriate habitats based on individual life stages.

The primary objective for trapping downstream migrants is to avoid impacts to steelhead smolts, kelts and lamprey during their downstream migration to the Pacific Ocean when there is not sufficient flow in the lower river. Another important objective is to gather data regarding anadromous downstream migration in the Santa Clara River. Since there is a lack of specific knowledge regarding steelhead in southern California, these data can be used during the steelhead recovery planning process and for managers of anadromous fishes in the Santa Clara River. Additionally, trapping activities aid in monitoring fish movement and assemblages within the Santa Clara River and can potentially mitigate for stranding and predation in the lower river.

2.2 METHODS

Data is collected using standardized data sheets and includes: date and time, numbers of anadromous *O. mykiss* and *L. tridentata* trapped and relocated, fork length of *O. mykiss*, numbers of other aquatic species trapped and relocated, flow and water quality parameters, and photos are taken to document the physical condition of individual fish.

2.2.1 DOWNSTREAM MIGRANT TRAP CHECKS

Trapping is triggered when there is not sufficient flow in the lower river based on depth criteria at critical riffles. The current flow threshold for sufficient upstream and downstream migration is 160 cfs measured at critical riffles in the lower river. This threshold was developed from the results of a steelhead migration instream flow study

conducted by Thomas Payne and Associates in the lower Santa Clara River. This study evaluated surface water depths at various flows to understand what flows would be required for steelhead to migrate from the ocean to the Freeman Fish Ladder.

Downstream migrant steelhead smolts, kelts, lamprey and other fish entering the screened fishbay section within the diversion facility are prevented from entering the diversion canal by a self cleaning, 3/16-inch mesh screen which directs the fish to the downstream migrant trap. If fish trapping is not warranted because of sufficient migration flows, the downstream migrant trap will be lifted from the fishbay and all downstream migrants will enter a fish bypass pipe and exit to the river downstream of the diversion. During periods when flow between the diversion and the ocean is not contiguous and at least 160 cfs, fish are collected in the downstream migrant trap. Steelhead smolts, kelts and lamprey trapped at the facility are transported in aerated coolers by truck to the Santa Clara River Estuary. Resident rainbow trout that are not exhibiting phenotypic steelhead characteristics such as smolting are transported to either the Santa Clara River in Santa Paula or Sespe Creek at the end of Grand Avenue depending on flow conditions. Sespe Creek is the preferred relocation site for resident rainbow trout. All other native aquatic species are returned to the river upstream of the diversion. Non-native aquatic species are removed from the river.

The downstream migrant trap consists of 3/16-inch mesh metal screens. Flow enters through a weir gate with an opening that directs fish and other aquatic species into the trap from the screened fishbay. The trap is situated to keep all intercepted fish immersed in at least two feet of water.

The trap is checked daily in the morning and downstream migrants are removed from the trap with a dip net, counted and fork lengths are measured to the nearest millimeter (mm). Other trapped aquatic species are counted during each trap check.

2.3 RESULTS

2.3.1 DOWNSTREAM MIGRANT TRAP CHECKS

The downstream migrant trap was in operation from January 4 to June 15, 2007. A total of 2 resident, 14 steelhead smolt (Photo 1, Appendix B), and 60 young of the year (Photo 2, Appendix B) *O. mykiss* were trapped and relocated during the 2007 migration season. The smolt migration period occurred from March 9 to April 13. This is the first year since trapping began in 1993 where a large number of young of the year *O. mykiss* were

collected in the downstream migrant trap. The young of the year arrived from May 5 to June 13 following the completion of the smolt migration (Figure 1, Appendix A). No downstream migrant lamprey were observed or collected at the Freeman Diversion facility in 2007.

Additional fish collected in the Freeman downstream migrant trap include: partially armored threespine stickleback (N=7054), Arroyo chub (N=570), Santa Ana suckers (N=557), Owens suckers (N=439), Santa Ana/Owens sucker hybrids (N=76), fathead minnow (N=319), largemouth bass (N=8), green sunfish (N=2), brown bullhead (N=2), prickly sculpin (N=3293) and mosquitofish (N=11) (Table 1, Appendix A). The majority of the stickleback and prickly sculpin were young of the year indicating that these fish are most likely reproducing in the impound upstream of the diversion.

Amphibians and reptiles collected in the Freeman downstream migrant fish trap include: California toad (N=7), bullfrog (N=115), African clawed frog (N=5), tree frog (N=73) and Western pond turtle (N=5) (Table 1, Appendix A).

3.1 INTRODUCTION

The denil fish ladder was placed within the Vern Freeman Diversion Facility to facilitate steelhead upstream migration over the concrete diversion dam that is a complete barrier to migration. The fish ladder also facilitates lamprey upstream migration and hundreds of lamprey passed the ladder in the 1990's. Very few adult steelhead (N=5) have passed through the fish ladder since it was constructed in 1991 and studies are in the planning stages to evaluate the efficiency of the fish ladder to attract to the ladder entrance and pass steelhead and lamprey.

3.2 METHODS

In years with sufficient rainfall, upstream migrant monitoring is conducted to determine if adult steelhead use and effectively navigate the fish ladder. Data is collected using standardized data sheets and includes: date and time, adult upstream migrants observed and/or relocated, numbers of fish observed, flow and water quality parameters during fish observations is measured, and photos are taken to document the physical condition of individual fish. Water quality data is taken using a Horiba multi-parameter U-20 series meter. Currently, there is no active fish trap deployed within the fish ladder to monitor upstream migration. In order to monitor steelhead upstream migration, the district installed a passive monitoring device that counts upstream migrant steelhead when they jump over a false weir and through an infrared (IR) scanning devise counter. To date, no fish have been documented jumping through the counter. The only other option for upstream migration monitoring is when the fish ladder is shutdown or when flow is reduced within the fish ladder. Monitoring during hour long shutdowns of the fish ladder only allows for intermittent observations during the migration season. It would benefit the recovery effort if some kind of active trap was installed within the fish ladder. An active trap would temporarily trap all upstream migrants so that information can be gathered regarding ladder efficiency, migration timing, fish condition, water quality at migration, etc.

The remainder of the section describes each upstream migration monitoring method in detail.

3.2.1 VIDEO OBSERVATION

Upstream migration monitoring is conducted using a false weir and infrared counter (Photo 3, Appendix B). The false weir creates a barrier within the ladder that forces upstream migrant steelhead to jump out of the water approximately six inches to get over a small "fall or cascade" to continue upstream. Consequently, the upstream migrants jump through the infrared counter that passively counts and films each fish that negotiates the weir. The weir was designed with a bar screen at the bottom of the structure to allow lamprey upstream migration past the false weir. It is unclear if lamprey will be able to pass through the bar screen. Approach velocities at the bar screen and potential monitoring alternatives will be evaluated during the next couple of years of operations

Once steelhead jump over the false weir, two video monitoring systems document upstream migration through the fish ladder as well as species identification and size. A Digital Video Recorder (DVR) is the primary device used and a Video Cassette Recorder (VCR) is used as a back-up system (Photo 4, Appendix B). Both systems receive the same image from a single camera mounted on the side of the ladder four-feet upstream of the false weir. The camera is positioned so it clearly captures images of migrant steelhead jumping over the weir structure. A twenty-five watt fluorescent light is used to illuminate the false weir at night.

The primary recording and counting system consisted of a DVR with an "event trigger" that captures a video clip of any event, which sets off a triggering device on the false weir. The DVR records events for twenty seconds before and then ten seconds after being triggered.

The IR scanner device is equipped with sensors on both sides of the false weir with multiple closely spaced invisible beams that when broken by a fish jumping through the beams, it signals the DVR to record the event.

To evaluate the efficiency of the IR scanner device, the ladder, false weir, and video monitoring systems are checked at least once a day (usually in the a.m.). Any recorded images saved on the DVR are reviewed by staff during these checks.

3.2.2 LADDER SHUTDOWNS

During shutdowns/dewatering of the ladder, a thorough examination of the entire fish

ladder is conducted to check for the presence of any fish species. The ladder is shut down for operational reasons such as high storms flows, channel flushes, and/or removal of debris from the weir. Also, the ladder will be briefly shut down opportunistically on a few occasions to check the facility and to look for steelhead and Pacific Lamprey migrants that are potentially trapped in the ladder system.

3.3 RESULTS

Flows were insufficient to allow for the operation of the upstream migrant fish ladder. This resulted in non-operational status of the fish ladder for the 2007 season.

3.3.1 SMOLT TO ADULT RETURN DATA FROM 1996-2007

Southern California steelhead experience extreme environmental conditions such that migration potential can be zero during dry years, minimal during normal years and high during wet years. Based on data collected at the Freeman Diversion downstream migrant fish trap and fish ladder, Smolt to Adult (SAR) steelhead return rates can be calculated with the error being from smolts that are not counted that go over the dam and that are not trapped during high flows and from adults not detected traversing and passing the fish ladder. SAR ratios are typically generated by the recapture of adults that were tagged with coded wire tags (CWT) or passive integrated transponder tags (PIT). The SAR ratios for the Santa Clara River are simply based on the ratio of out-migrant smolts trapped at the Freeman Diversion to upstream migrant adults detected within the Freeman Diversion Fish Ladder. The Smolt to Adults return rates for the steelhead in the Santa Clara River are based on data collected from 1996 to 2007 and range from 0 to 1.06% (Table 2).

Table 2 - Smolt-to-Adult returns of Santa Clara River steelhead at the Vern Freeman Diversion Dam 1996-2007 migration years (UWCD Data).

Smolt Migration Year	No. of Smolts	No. of Adult Returns	Smolt-Adult Return Rate (%)
1996	94	1	1.06
1997	413	0	0
1998	2	0	0

1999	5	0	0
2000	839	2	0.23
2001	119	2	1.68
2002	3	0	0
2003	41	0	0
2004	2	0	0
2005	0	0	0
2006	14	0	0
2007	12	0	0

These data are based on a comparison of a year's cohort of smolts with the adult returns from that same year. For instance, the 783 smolts from 2000 are compared with the 2 adults returning that same year. These 2 adults were most likely from the cohorts between the years of 1997 to 1999 depending on how many years these fish remained in the ocean. Since there was no mark-recapture of these fish it is impossible to generate SAR ratios using traditional methods but this exercise at least shows us that with the low numbers of out migrants, there is low potential for adult returns. There are also some holes in this data because not all smolts are trapped at the Freeman Diversion when the dam is spilling, although it is assumed that most are trapped. Also, there were a few years from 1998 to 2000 when there was no counting device in the Freeman fish ladder for upstream migrant adult steelhead so migration could have occurred and was not detected. Even with these limitations, most of the upstream and downstream migrants were most likely captured or detected during most years.

Smolt to Adult return rate data are readily available especially from steelhead hatcheries in the Pacific Northwest. These rates are extremely variable from river to river and from year to year. The variability from river to river could be based on hatchery production and differences in the health of these rivers as well as migration impediments. The variability from year to year could be based on variable ocean conditions that have an impact on steelhead survival as they enter the ocean. Data collected by the Oregon

Department of Fish and Wildlife are summarized in Tables 3 and 4 to compare the Santa Clara River SAR rates to SAR rates from other rivers in the Pacific Northwest. The SAR rates from data at the Three Mile Falls Dam on the Umatilla River in Oregon range from 1.418 to 5.316% with an average of 3.534 % (Table 3). The SAR rates from data at Oak Springs Hatchery and Umatilla Hatchery on the Umatilla River in Oregon range from 0.043 to 0.752% with an average of 0.380% (Table 4).

The data in Tables 3 and 4 were found at this website:

(https://nrimp.dfw.state.or.us/web%20stores/data%20libraries/files/ODFW/ODFW_356_2_MC_Section8_HydroLimitFactor.doc)

Table 3 - Smolt-to-Adult returns of Umatilla River wild summer steelhead at Three Mile Falls Dam for 1995-2002 migration years.

Smolt Migration Year	No. of Smolts	No. of Adult Returns	Smolt-Adult Return Rate (%)
1995	54361	837	1.540
1996	73361	1,040	1.418
1997	22221	1,026	4.615
1998	59182	3,146	5.316
1999	46530	2,299	4.941
2000	81759	4,045	4.948
2001	33844	1,135	3.353
2002	77016	1,649	2.141
Mean	56304	1897	3.534

Table 4 - Smolt-to-Adult return (hatchery release to Three Mile Falls Dam) of Umatilla Hatchery steelhead 1987-97 broods.

Brood Year	Rearing Location	Smolts Released	No. Adult Returns	Smolt-Adult Return Rate (%)
1987	Oak Springs Hatchery	61,306	268	0.437
1988	Oak Springs Hatchery	81,712	35	0.043
1989	Oak Springs Hatchery	89,193	628	0.704
1990	Oak Springs Hatchery	71,935	430	0.598
1991	Umatilla Hatchery	199,404	169	0.085
1992	Umatilla Hatchery	158,388	495	0.313
1993	Umatilla Hatchery	153,098	589	0.385
1994	Umatilla Hatchery	146,463	1101	0.752
1995	Umatilla Hatchery	146,703	489	0.333
1996	Umatilla Hatchery	137,287	389	0.283
1997	Umatilla Hatchery	137,485	341	0.248
Mean		125,725	449	0.380

These data are from hatcheries and not from the wild but these are real steelhead "return" data and the objective in comparing these data with the Santa Clara River data was to assess whether the ratio of downstream migrants to upstream migrants is commensurate with existing data. Unfortunately there are no other data of this kind in southern California to compare with the Santa Clara River data. Certainly river and ocean conditions in southern California are less pristine and variable than in Oregon and the SAR rates would be expected to be somewhat higher in the Pacific Northwest as compared to southern California. Based on the low number of downstream migrant steelhead (recruitment) that are emigrating to the ocean, it is expected based on existing

SAR data that low numbers of upstream migrant steelhead (escapement) would return to the Santa Clara River.

It would be beneficial to local steelhead recovery efforts in the Santa Clara River to build a steelhead conservation hatchery. This hatchery could be added to the existing California Department of Fish and Game (CDFG) Fillmore Fish Hatchery. Broodstock could be collected at the Freeman Diversion and eventually the offspring could be released as fry in Santa Paula and Sespe Creeks. The potential increase in steelhead returns could also assist in assessing site specific recovery actions and collecting data regarding impacts including migration impediments that exist within the Santa Clara River watershed. This hatchery would most likely rely on various funding mechanisms to construct and operate. There are local water agencies, special interest groups, and state and federal agencies that would most likely have an interest in funding a local steelhead conservation hatchery.

4.1 INTRODUCTION

During high flow events when the river is highly turbid (over 3000 ntu's), District operations staff "turn-out" all river flows from the facility and the fishbay section of the diversion structure can become dewatered or extremely shallow. When the water is turned out of the facility, head gates located at the lower end of the fishbay are closed to retain sufficient depth in the fishbay so that bird predation of fishes does not occur. Additional operations and maintenance activities include "flushes" where United operations staff "turn-out" all river flows from the facility either during high flow events, to flush sand through roller gates to maintain an approach channel to the Freeman Diversion intake, or to maintain the canal gates and screens.

The primary objective of fish stranding surveys is to reduce potential *O. mykiss* stranding downstream of the Freeman Diversion in the Santa Clara River when diversion operations cause river flow to rapidly diminish.

4.2 METHODS

4.2.1 FISHBAY STRANDING SURVEYS

During "turn-outs" and "flushes", the fishbay is thoroughly examined for the presence of steelhead and Pacific lamprey. Two biologists survey the fishbay as it is dewatering and seine the entire area with either 3/8 or ¼-inch mesh seines that are 4-feet deep and from 10 to 20-feet long (Photo5, Appendix B). The primary objective of these surveys during the steelhead and lamprey migration season is to capture and relocate steelhead and lamprey stranded during dewatering of the fishbay to appropriate habitats either in the estuary (smolts, kelts, silver lampreys) or the Santa Clara River (adult steelhead and lampreys) All fish are transported via aerated coolers. Non native aquatic species are removed from the river.

4.2.2 LOWER RIVER STRANDING SURVEYS

Stranding surveys conducted in the Santa Clara River below the Freeman Diversion are conducted when flow is lost following a significant reduction in releases from the facility

or when releases stop all together. Stranding surveys are also conducted following "turn-out" and "flushing" operations. These surveys are conducted by entering the non-wetted area of the floodplain via a Polaris Ranger All Terrain Vehicle and following the remnant active channel looking for fish. Stranded fish are captured either will dipnets or 1/8 inch to 1/4 inch mesh seines and placed in an aerated cooler. Upstream migrant steelhead and lamprey collected during the surveys will be relocated upstream of the Freeman Diversion Dam and downstream migrant steelhead and lamprey will be relocated to the estuary.

4.2.3 MAINSTEM STEELHEAD SURVEYS (FREEMAN TO SESPE CREEK)

The objective of this survey is to evaluate the efficiency of steelhead smolt and kelt migration in the mainstem Santa Clara River from the confluence of Sespe Creek and the Santa Clara River to the Freeman Diversion. This survey is conducted by walking from the crest of the Freeman Diversion Dam to Sespe Creek and seining as many holding habitats (pools) as possible. A 10 foot long x 4 foot high x 1/8th inch mesh seine was used during the survey. These surveys were conducted on May 22 and 24 and June 7 and 21, 2007.

4.3 RESULTS

4.3.1 FISHBAY STRANDING SURVEYS

A total of 8 turn-outs or flushes occurred during the 2007 water year. One resident *O. mykiss* (one of the two described in section 2.3.1) was collected and relocated during fish stranding surveys within the fishbay. No *O. mykiss* mortalities were observed or occurred during fish stranding surveys in 2007.

4.3.2 LOWER RIVER STRANDING SURVEYS

Visual surveys were conducted following turn-outs. No *O. mykiss* were observed or collected in the lower river during fish stranding surveys.

4.3.3 MAINSTEM STEELHEAD SURVEYS (FREEMAN TO SESPE CREEK)

No *O. mykiss* were collected or observed during multiple seining attempts from the Freeman Diversion to Sespe Creek. No aquatic species not already known to occur in the Santa Clara River were collected or observed during the surveys.

5.1 INTRODUCTION

Water quality monitoring for 2007 was conducted to monitor water quality conditions that steelhead and lamprey are exposed to in various areas within the watershed. Water temperature monitoring was conducted in various locations in the watershed and water quality measurements were focused primarily in the estuary for 2007. This monitoring will be expanded in 2008.

5.2 METHODS

Water quality monitoring for 2007 included water temperature measurements using Onset Hobo temperature loggers at various sites within the Santa Clara River watershed and in-situ water quality measurements were taken in the Santa Clara River Estuary using a Horiba U-22 multi-parameter water quality meter when steelhead smolts were relocated to the Estuary. The majority of the temperature loggers were placed at mid-depth and programmed to take measurements every hour. Insitu water quality measurements were taken when steelhead smolts were relocated to the Santa Clara River Estuary. The water quality meter was not in good working order during 2007 so the data collected is not presented in this report. The meter will be calibrated and in good working order for the 2008 steelhead migration season.

5.3 RESULTS

Water temperature monitoring occurred at seven sites. These sites include:

- Santa Clara River Estuary (1 logger)
- Santa Clara River Freeman Diversion (2 loggers)
- Santa Clara River 12th Street Bridge (1 logger)

Graphs depicting these data at the three sites are in Appendix A as Figures 2-5.

5.3.1 SANTA CLARA RIVER ESTUARY

The Santa Clara River Estuary temperature monitoring site was located near the north bank approximately 500 feet downstream of the Harbor Boulevard Bridge (Photo 6, Appendix B). The logger was placed at a depth and location so that when the sandbar

breeches, the logger will be out of water (Figure 2)

Location Information:

Date Deployed: 4/26/07 at 13:50
Date Uploaded: 12/27/07 at 14:36
Waypoint: N 34º 14.115' W 119º 15.540' (NAD 83)
Maximum Depth at Deployment: 4 ft.
Logger Depth: ~ 0.5 feet from bottom.

The Santa Clara River Estuary was closed to the ocean from approximately April 26, 2007 to December 19, 2007. The sandbar breached on December 19, 2007 following a storm event and the data indicates this with a wider diurnal variation in temperature since the logger is logging air temperature. The analysis of these data includes dates from April 26 to December 18, 2007 when the logger was submerged under water.

Water Temperature Statistics:

Table 5. Water temperature statistics at the Santa Clara River Estuary

Statistics	Date	Time	Temperature ºC
Maximum	9/3/2007	18:00	27.21
Minimum	12/13/2007	12:00	11.39
	Mean		20.41

5.3.2 SANTA CLARA RIVER FREEMAN DIVERSION

The Santa Clara River Freeman Diversion temperature monitoring site was located within the screened fishbay. The screened fishbay is a concrete channel where steelhead smolts enter the diversion and migrate to the downstream migrant trap (Photo 7, Appendix B).

Location Information:

Date Deployed: 3/28/07 at 13:50 and 6/20/07 at 12:00
Date Uploaded: 4/15/07 at 14:04 and 10/12/07 at 09:00
Waypoint: N 34º 17.904', W 119º 06.527' (NAD 83)
Maximum Depth at Deployment: 3 ft.
Logger Depth: 0.5 feet from bottom.

Water Temperature Statistics: 3/28/07 to 4/15/07 (Measured every minute)

Table 6. Water temperature statistics at the Santa Clara River (Freeman Diversion) 3/28/07 to 4/15/07

Statistics	Date	Time	Temperature ºC
Maximum	4/10/2007	16:35	25.91
Minimum	4/13/2007	05:32	8.32
	Mean		16.89

Water Temperature Statistics: 6/20/07 to 10/12/07

Table 7. Water temperature statistics at the Santa Clara River (Freeman Diversion) 6/20/07 to 10/12/07

Statistics	Date	Time	Temperature ºC
Maximum	9/6/2007	11:00	32.36
Minimum	10/9/2007	09:00	13.93
	Mean		21.51

5.3.3 SANTA CLARA RIVER 12TH STREET BRIDGE

The Santa Clara River 12th Street Bridge temperature monitoring site was located just downstream of the bridge near the south bank (Photo 8, Appendix B). The logger was attached to a fence post within an eddy downstream of a mid-channel bar. The logger remained submerged in the water column until approximately 4/15/07 when the sandy bed load inundated the logger.

Location Information:

Date Deployed: 6/11/07 at 16:00
Date Uploaded: 7/5/07 at 20:00
Waypoint: N 34º 20.871' W 119º 03.122' (NAD 83)
Maximum Depth at Deployment: 2.5 ft.
Logger Depth: ~ .5 feet from bottom.

Water Temperature Statistics:

Table 8. Water temperature statistics at the Santa Clara River (12th Street Bridge)

Statistics	Date	Time	Temperature ºC
Maximum	6/22/2007	15:00	27.41
Minimum	6/12/2007	06:00	15.53
	Mean		21.05

5.4 DISCUSSION

The maximum water temperatures at each site extend above what many believe to be the lethal temperature limit of >25ºC for salmonids. The maximum water temperature of 32.36ºC at the Freeman Diversion most likely occurred when the water was turned out of the diversion and the logger was exposed to the air. The remaining extreme water temperatures are not uncommon in southern California. Both forms of *O. mykiss* have adapted to a wide variation in water temperatures by seeking out thermal refugia when available. Other responses to upper thermal extremes include increase feeding when food

is available to offset the cost of an elevated metabolic rate. In drainages where thermal refugia and low food production occurs, thermal stress alone can cause mortalities.

Next year, additional temperature monitoring sites will be located throughout the watershed. Once we acquire enough temperature loggers, we will conduct temperature monitoring at reference pools that contain thermal regugia.

6.1 INTRODUCTION

Surveys to remove or reduce densities of exotic aquatic species in the discharge pool below the 12th Street diversion were conducted in June and July, 2007. These surveys were conducted based on direct observations of large numbers of largemouth bass, green sunfish and bullfrogs in this area and because this is a relocation site for resident *O. mykiss* collected at the Freeman Diversion Fish Trap.

Exotic fishes comprise the majority of the fish assemblages within most of the Santa Clara River and the lower reaches of its tributaries especially in Ventura County. Surveys conducted by ENTRIX, Inc. by Camm Swift and Steve Howard have documented the presence of these exotic fishes and their high abundance. These species compete for food, space (spawning and rearing), introduce parasites, dilute the gene pool and predate on native fishes. There effect on native fishes can be a leading factor within a web of impacts related to the decline of native fish populations in urban rivers and streams including the Santa Clara River. Steve Howard and Sara Gray conducted these surveys on June 13, 20, 25 and July 5, 2007.

Exotic aquatic species are also removed during downstream migrant trapping activities at the Freeman Diversion (Table 10).

6.2 METHODS

Exotic species surveys were conducted by blocknetting a section of the 12th Street Diversion effluent pool to enclose all aquatic species in a small area. Following placement of blocknets, two biologists seined the enclosure with a 30-foot long x 4-foot deep x 1/8th-inch mesh beach seine (Photos 9-12, Appendix B). All exotic species collected were placed in 5 gallon buckets and all native species were immediately placed back into the Santa Clara River adjacent to the pool. All exotic species were sacrificed following the completion of the survey.

6.3 RESULTS

6.3.1 6/13/2007 SURVEY

Exotic Species Removal Survey: At 11:00AM United Water Fisheries Biologists, Steve Howard and Sara Gray, seined the discharge pool along Santa Clara River at 12th Street bridge. The purpose of this survey was to remove non-native aquatic species that threaten native fishes. A 30-foot long, 4-foot deep x 1/4-inch mesh beach seine was used to sweep the pool using a beach seine technique. Two seine hauls resulted in the removal of: 1 largemouth bass (LB), 4 prickly sculpin (PS), 41 green sunfish (GS), 25 mosquitofish (MF), and 20 bullfrog tadpoles (BF). Dissections were performed and stomach contents analyzed of one LB (150 mm) and two GS (125 mm). One MF was found in the mouth of the LB. Stomachs were empty on all three fish. Observations of the pool after seining revealed several non-native fish remaining in the pool. This was because of watercress that has inundated most of the pool area. Some of the watercress was removed and more will be removed at a later date. These remaining fish will be removed at a later date.

6.3.2 6/20/2007 SURVEY

Exotic Species Removal Survey: Three seine hauls utilizing previous equipment and techniques (plus an additional block net seine) yielded the results in Table 9. Dissections were performed on two GS (100 and 125 mm). Both stomachs were empty. The female GS was gravid and the male GS was sexually mature. The egg skein in the GS female was ripe and the eggs were dropping into the cavity. More watercress was removed during this survey although some still remained near the outfall of the 12th Street Diversion Dam.

One young of the year (YOY) trout was captured and immediately released back into the discharge pool. It appeared to be healthy and in good shape.

6.3.3 6/25/2007 SURVEY

Exotic Species Removal Survey: Three seine hauls utilizing previous equipment and techniques yielded the results in Table 9. Dissections were performed on two GS (100 and 125 mm). Both stomachs were empty. The female GS was gravid and the male GS was sexually mature.

6.3.4 7/5/2007 SURVEY

Exotic Species Removal: Four seine hauls utilizing previous equipment and techniques yielded the results in Table 9. Dissections were performed and stomach contents analyzed of one LB (255 mm) and one GS (125 mm). Both stomachs were empty. LB and GS were both sexually mature males.

Two Inland Silversides (IS) were captured and sacrificed. This was the first time finding this species in the discharge pool. They may have been flushed into the pool from the 12th Street diversion that is located directly upstream.

This was the final exotic species removal survey at the 12th Street Bridge discharge pool for the 2007 season.

Table 9. Results of Exotic Species Removal at the 12th Street Diversion

Date	LB	PS	GS	MF	BF	FM	IS
6/13/2007	1	4	41	25	20	0	0
6/20/2007	10	5	45	15	22	4	0
6/25/2007	14	4	57	10	5	5	0
7/5/2007	6	14	26	15	0	14	2
Total	**31**	**27**	**169**	**65**	**47**	**23**	**2**

LB = largemouth bass, PS = prickly sculpin, GS = green sunfish, MF = mosquitofish, BF = bullfrog larvae, FM = fathead minnow, IS = inland silverside

Table 10. Results of Exotic Species Removal at the Freeman Diversion Downstream Migrant Fish Trap for 2007.

OS	SSxOS	FM	LB	GS	BB	PS	MF	BF	CF
439	76	319	8	2	4	3293	11	11	11

OS = Owens sucker, SSxOS = Santa Ana sucker/Owens sucker hybrids, FM = fathead minnow, LB = largemouth bass, GS = green sunfish, BB = brown bullhead, PS = prickly sculpin, MF = mosquitofish, BF = bullfrog, CF = African clawed frog

6.4 DISCUSSION

Although it can be difficult to eradicate exotic species that have been introduced and

established, it is important to reduce their numbers by maintaining a comprehensive exotic removal-reduction program. With a program in place, it can create a framework for conducting surveys in the most efficient method possible and during times when environmental conditions are conducive for the greatest results such as following large storm events. United Water Conservation District will continue to conduct these surveys at "high impact" locations such as near 12th Street Bridge and within the Freeman Diversion. Also, the District would like to work with other interested groups within the watershed to complete an exotic removal-reduction program for the Santa Clara River watershed that can be implemented by local and state agencies as well as private and public.

APPENDIX A

TABLE 1, FIGURES 1-5

Table 1. 2007 Freeman Diversion Downstream Migrant Fish Trap Results

Fish Species: ST = Steelhead Adul**t, RS** = Smolt**, RT** = Resident Rainbow**, YOY** = Young of the Year *O. mykiss* **, PL (Adult)** = Lamprey Adult**, PL (Am)** = Lamprey Ammocoete**, TS** = Stickleback**, AC** = Arroyo Chub**, SS** = Santa Ana Sucker**, OS** = Owens Sucker**, SSxOS** = Sucker Hybid**, FM** = Fathead Minnow**, LB** = Largemouth Bass**, GS** = Green Sunfish**, BB**= Brown Bullhead**, BC** = Black Bullhead**, PS** = Prickly Sculpin**, MF** = Mosquitofish

Amphibian/Reptile Species: CT = California Toad, **AT** = Arroyo Toad, **SFT** = Spadefoot Toad, **BF** = Bullfrog, **CRLF** = Red-legged Frog, **PT** = Pond Turtle, **CF** = African Clawd Frog, **TF** = Tree Frog

	Native Fishes							Non-native Fishes										
	ST	RS	RT	YOY	PL (Adult)	PL (Am)	TS	AC	SS	OS	SS x OS	FM	LB	GS	BB	BC	PS	MF
Total	0	12	2	60	0	0	7054	570	557	439	76	319	8	2	4	0	3293	11

	Amphibians and Reptiles							
	CT	AT	SFT	CRLF	BF	CF	TF	PT
Total	7	0	0	0	115	5	73	5

Biologists: Steve Howard (Principal Biologist), Sara Gray, Mike Gibson, Dan Anthon, Dave Curci, Geoff Mosdale

Figure 1 - Downstream migrant trap and Sespe Creek flow data for the 2007 steelhead migration season

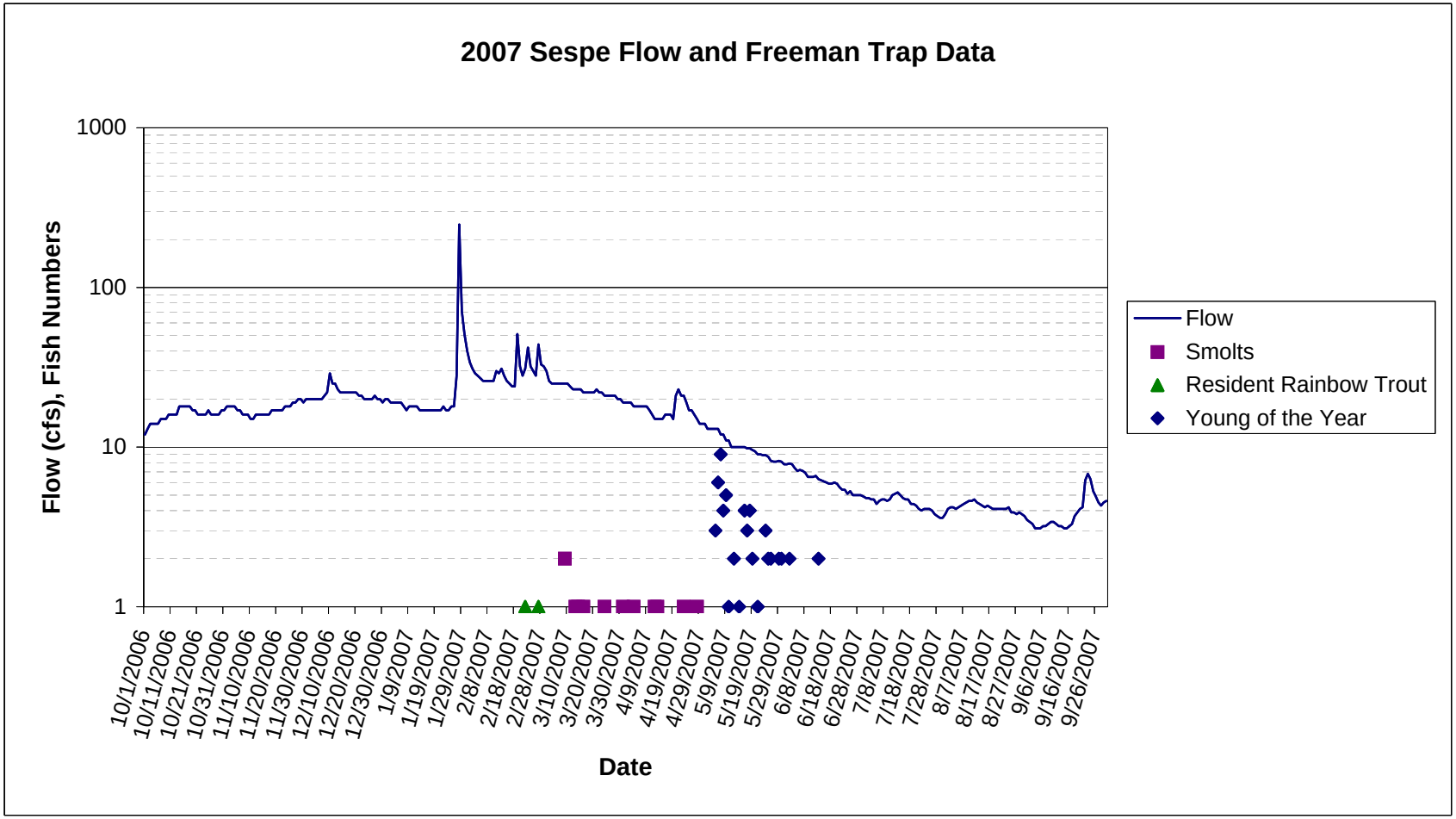


Figure 2. Santa Clara River Estuary water temperature data

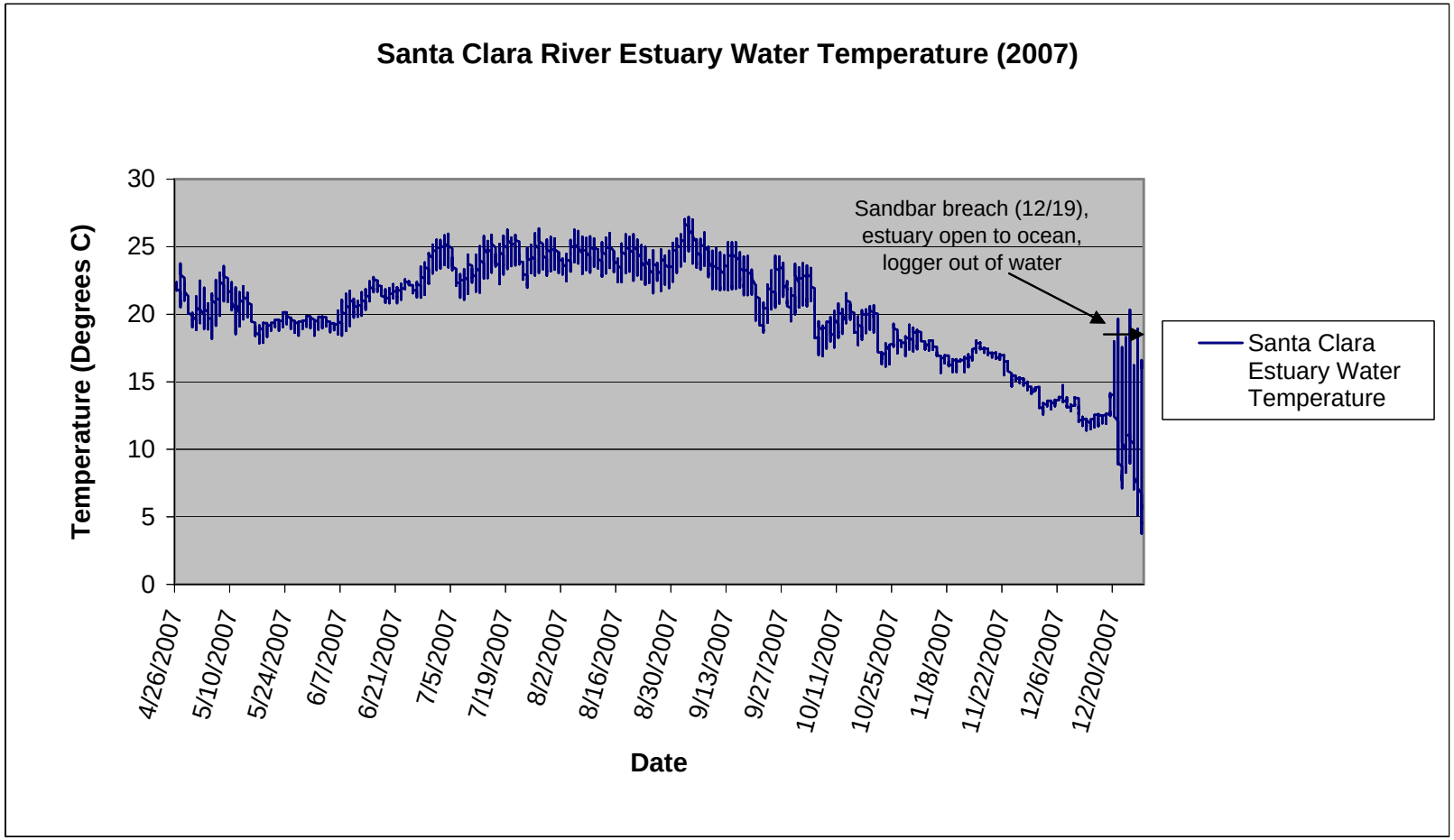


Figure 3 - Santa Clara River water temperature data (Freeman Diversion) 3/28/07 to 4/15/07

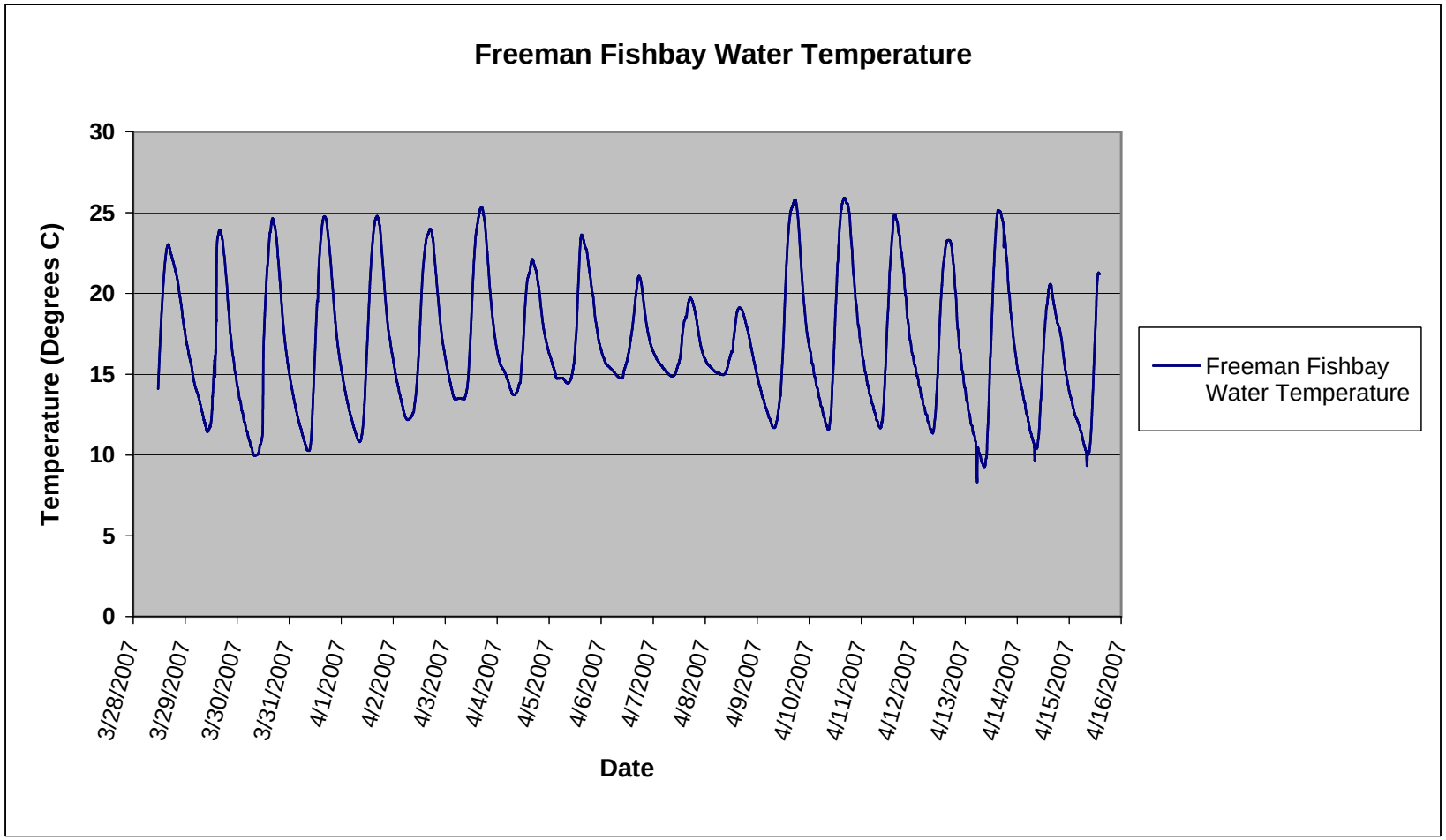


Figure 4 - Santa Clara River water temperature data (Freeman Diversion) 6/20/07 to 10/12/07

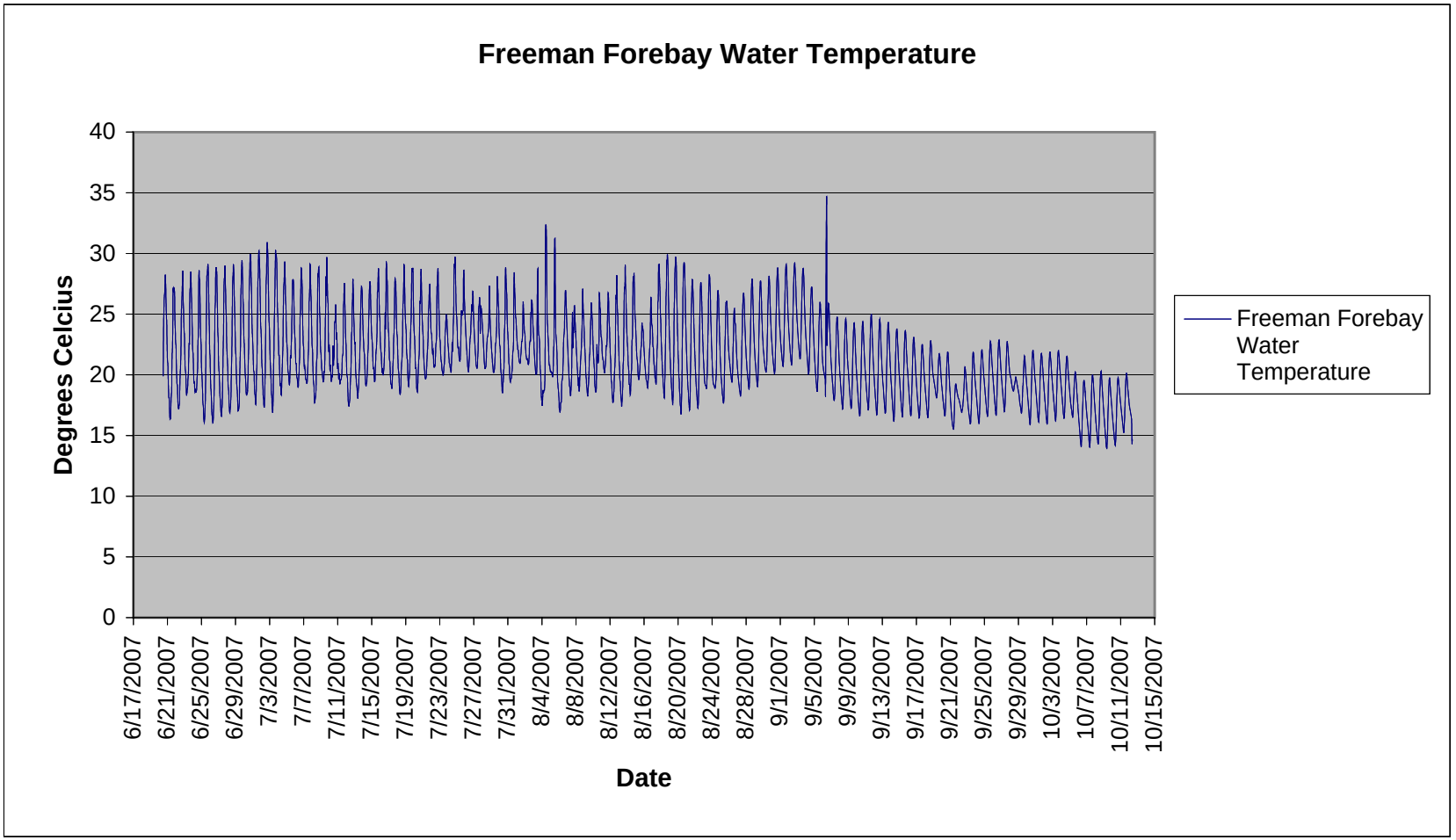
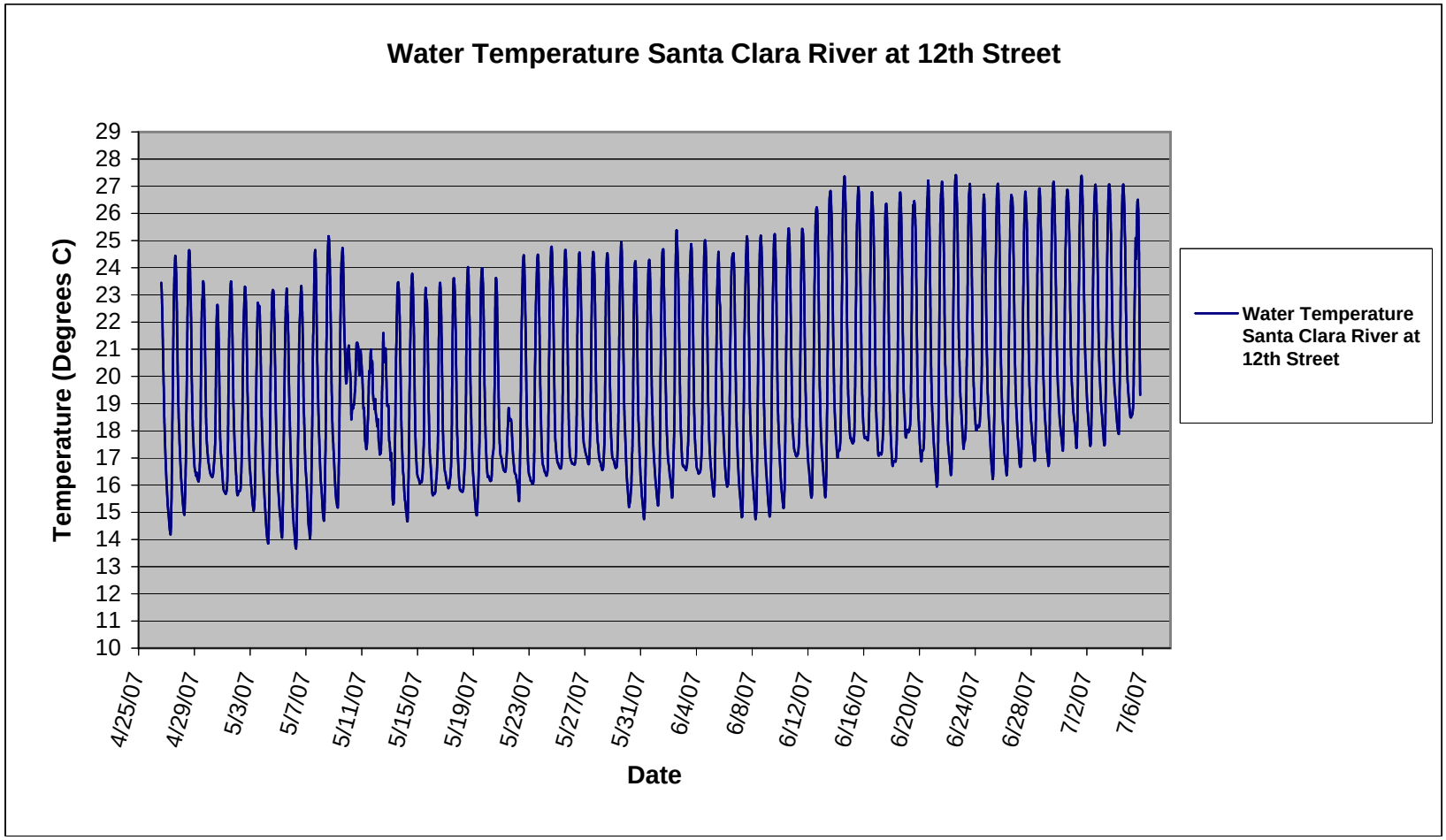


Figure 5 - Santa Clara River water temperature data at the 12th Street Bridge



APPENDIX B

PHOTOGRAPHS

Photo 1 - *Oncorhynchus mykiss* steelhead smolt trapped at Freeman Diversion downstream migrant fish trap

Photo 2 - *Oncorhynchus mykiss* young of the year (YOY) trapped at Freeman Diversion downstream migrant fish trap

Photo 3 - False weir and infrared fish counter, Freeman Diversion Fish Ladder

Photo 4 - Digital Video Recorder (DVR) and Video Cassette Recorder (VCR), Freeman Diversion Fish Ladder

Photo 5 - Freeman Diversion Fishbay stranding surveys

Photo 6 - Santa Clara River Estuary temperature monitoring site

Photo 7 - Santa Clara River, Freeman Diversion temperature monitoring site

Photo 8 - Santa Clara River, 12th Street Bridge temperature monitoring site

Photo 9 - Blocknet and seine deployment during exotic species removal surveys at the Santa Clara River, 12th Street Bridge

Photo 10 - Blocknet and seine deployment during exotic species removal surveys at the Santa Clara River, 12th Street Bridge

Photo 11 - Blocknet and seine deployment during exotic species removal surveys at the Santa Clara River, 12th Street Bridge

Photo 12 - Fish species removed during exotic species removal surveys at the Santa Clara River, 12th Street Bridge