UNITED WATER CONSERVATION DISTRICT
"Conserving Water Since 1927"

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

Annual Report 2010 Monitoring Season

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Vern Freeman Diversion Facility
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Annual Report
2010 Monitoring Season

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2010

Cover Photos: top to bottom*:* Flow over Freeman Diversion Dam (2/6/10), Santa Clara River steelhead smolt (4/9/10), bypass flow monitoring above Freeman Diversion (4/5/10).

Page

Page

Page

Page

The water year of 2010 was considered a “normal year” because it was not predominantly wet or dry. However “normal” and “average” are not terms that fit well when attempting to characterize a water year in the dynamic southern California climate. Rainfall in wet years can exceed 40 inches in the lower coastal plain and even more in the mountain areas. Rainfall in dry years can range from close to zero to a few inches. A total of 18.48 inches of rain was measured at the United Water Conservation District gauge (Station 245A) located in Santa Paula during the 2010 season. The highest monthly rain total was 6.89 inches in January.

The sandbar at the Santa Clara River Estuary (SCRE) was open to the ocean from January 18 to March 29 and from April 8 through May 11. The estuary was closed the remainder of the steelhead migration season (January through June). Smolt trapping at the Freeman Diversion started on January 5 and ended on June 29, 2010. Steelhead smolts were first observed in the fish trap on March 18 and last observed on May 28, 2010. Additional smolts were observed during flushing events that occurred on June 17 and July 19, 2010. Very few smolts were trapped during the new, extended bypass flow releases. Consequently, it appears that during fish ladder and bypass flow operations the majority of smolts bypass the fish screen bay and fish trap by swimming over the dam or through the fish ladder. The fish ladder was in operation from January 23 to March 22 and from April 7 to April 19. No adult steelhead were observed or detected in 2010.

A total of 72 steelhead smolts, 5 resident coastal rainbow trout, and 23 young-of-the-year coastal rainbow trout were trapped at the Freeman Diversion Fish Trap in 2010. No Pacific lamprey were observed during the 2010 migration season although a small number of adult lamprey could have traversed the fish ladder because there is currently no way to detect lamprey in the fish ladder except when the ladder is drained. Table 1, Appendix A summarizes the daily fish ladder operations as well as the *O. mykiss* and physical data collected during monitoring activities in 2010.

Water temperature monitoring occurred in the estuary, Santa Paula Creek, Sespe Creek and Piru Creek. The mainstem Santa Clara River temperature logger was lost due to a flood event during the 2010 monitoring season.

1.1 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 divert surface water from the Santa Clara River to conserve groundwater resources in the Oxnard plain through percolation to the groundwater aquifer. The facility is comprised of a concrete dam, a denil fishway (fish ladder), a fish screen bay, a downstream migrant trap, various canals and spreading grounds (Figure 1, Appendix A). The concrete dam is a complete barrier to steelhead and Pacific lamprey upstream migration. To avoid or minimize affects to migrating adult steelhead and Pacific lamprey, a fish ladder was constructed to facilitate anadromous migration through the facility. The fish screen bay 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. A fish bypass pipe that can be used to direct fish back to the river when there is sufficient flow to allow for volitional migration to the estuary is located at the end of the fish screen bay.

1.2 FISH SPECIES COMPOSITION

The Santa Clara River is home to two native, anadromous fish species, the southern steelhead trout (*Oncorhynchus mykiss irideus*) and the Pacific lamprey (*Entosphenus tridentatus*). Steelhead and resident rainbow trout are known collectively as coastal rainbow trout. Steelhead is the common name for anadromous coastal rainbow trout. Anadromous or anadromy is a life cycle or life history trait that refers to fish species that live in the ocean and return to freshwater to spawn. Resident coastal rainbow trout live their entire lives in freshwater. Both resident as well as anadromous coastal rainbow trout exist in the Santa Clara River. Evidence from data collected at the Freeman Diversion suggests that resident rainbow trout can produce progeny that will migrate to the ocean. A steelhead that migrates from freshwater to the ocean between the ages of 1 to 3 years is referred to as a smolt. The term smolt reflects the physical and physiological changes coastal rainbow trout experience when preparing for life in saltwater. An adult steelhead that has entered freshwater to spawn and later the same year, or the following year, returns back to the ocean is referred to as a kelt.

Pacific lamprey are strictly anadromous and do not persist in freshwater alone. A downstream migrant Pacific lamprey is referred to as a macropthalmia. The term macropthalmia, similar to smolt, reflects the physical and physiological changes juvenile Pacific lamprey experience when preparing for life in saltwater. Juvenile lamprey that live in freshwater for up to seven years before migrating to the ocean are referred to as ammocoetes. Southern steelhead are federally listed as endangered and Pacific lamprey currently have no federal protection. Pacific lamprey numbers have dropped precipitously since the early 2000's 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-endangered 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 (*Gasterosteus aculeatus microcephalus*) and unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*). 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 a federal and California endangered species and a California fully-protected species. The unarmored sub-species are currently not known to occur 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 in various forms of cross breeding (*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*), Mississippi (inland) silverside (*Menidia audens*), threadfin shad (*Dorosoma petenense*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*) and mosquitofish (*Gambusia affinis*). See Table 2, Appendix A.

1.3 ENVIRONMENTAL SETTING

The Santa Clara River is comprised of the largest watershed in southern California south of Point Conception and drains 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.

Rainfall

During the 2010 rain season (10/1/2009-9/30/2010), Santa Paula had 106.5% of normal rainfall totaling 18.48 inches (Ventura Watershed Protection District website, Santa Paula-UWCD Gauge 245A). The most rainfall in a 24 hour period was 2.35 inches on October 15, 2009 and the second highest was 1.58 inches on January 21, 2010. The highest monthly rain fall was 6.89 inches in January. (Figure 2, Appendix A).

Tributaries

The major tributaries of the Santa Clara River include Santa Paula Creek, Sespe Creek, and Piru Creek. Santa Paula Creek has two fish passage facilities located within the first four miles of the lower creek (USACE and Canyon Irrigation fish ladders) that have numerous physical and operational problems that result in blocking upstream passage either intermittently or completely depending on maintenance or damage in any given year. Sespe Creek is free flowing and currently has some issues regarding illegal crossings within the lower river that could block both upstream and downstream passage at certain flows. Piru Creek has two major dams (Santa Felicia Dam and Pyramid Dam) that do not include fish passage facilities.

The main tributaries in the Santa Clara River that are considered to be the main steelhead-bearing drainages are Santa Paula and Sespe Creeks. These tributaries were flowing during the entire 2010 migration season although water depths decreased dramatically by mid-April (direct observations). It is unknown when steelhead smolts emigrate from the tributaries to the mainstem Santa Clara River. Currently, it is assumed that smolts emigrate from the tributaries following storm pulses based on data collected in the Santa Ynez River (Tim Robinson pers.com.). Steelhead smolts are observed at the Freeman Diversion from January to June but the majority of these fish are typically observed in March, April, and May. In 2010, smolts were observed at the Freeman Diversion through July. These smolts appeared to be losing their silvery appearance and were “fatter” than the earlier smolts that had the characteristic stream-line shape and low condition factor. On average smolts tend to be shorter early in the season (average 183 millimeters or 7.2 inches average in March and April, 2010) and longer and more robust toward the end of the migration season (average 193 millimeters or 7.6 inches average from May through July, 2010). Although there are no known data or published research documenting this, there is the potential that smolts rearing or migrating through the mainstem later in the season are feeding on the spring larvae of Santa Ana and Owens sucker and arroyo chub. Consequently, increased biomass from the spring spawn of non-native fishes could provide an ample food supply and could affect smolt migration behavior by delaying or even stopping migration due to the increased food resource. The effects on native fishes by the presence of non-native and exotic species could be far reaching above the basic principles of predation and/or competition for space.

1.4 REGULATORY STATUS (STEELHEAD)

NOAA Fisheries, otherwise known as the National Marine Fisheries Service (NMFS), listed the southern California steelhead, *Oncorhynchus mykiss*, as endangered in 1997 (NMFS 1997) under the Endangered Species Act (ESA) of 1973. Steelhead were organized into stocks (i.e., groups) of evolutionary significant units (ESU) and represented groupings that were considered to be substantially isolated from other steelhead stocks reproductively and were an important part of the evolutionary legacy of the species. Currently, the southern California steelhead ESU includes populations from the Santa Maria River in San Luis Obispo County south to the US/Mexican border in San Diego County (NMFS 2003). NOAA Fisheries later recognized the anadromous life history form of *O. mykiss* as a distinct population segment (DPS) under the ESA (NMFS 2005). The DPS policy differs from the ESU by delineating a group of organisms by “marked separation” rather than “substantial reproductive isolation”. In the case of *O. mykiss* of the southern California steelhead ESU, this marked separation between the two life history forms was considered valid because of physical, physiological, ecological, and behavioral factors related to its anadromous life history characteristics. Both resident and anadromous *O. mykiss*, where the two forms co-occur and are not reproductively isolated and exist below complete barriers, are still part of the ESU; however, the anadromous *O. mykiss* (steelhead) are now part of a smaller subset identified as the southern California steelhead DPS (CMWD 2008).

The remainder of this report summarizes the monitoring and study methods and results at the United Water Conservation District (hereafter, District) Vern Freeman Diversion Fish Passage Facility on the Santa Clara River in 2010.

2.1 INTRODUCTION

In southern California, steelhead and Pacific lamprey migrate downstream from their natal streams to the Pacific Ocean in the spring. Data collected from 1991 to 2010 at the Freeman Diversion indicate that the majority of downstream migration occurs in March, April, and May although migration can occur from January through June and in 2010 was observed into July. 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 macropthalmia during their downstream migration to the Pacific Ocean when there is not sufficient flow in the lower river. This reduction in flow could be natural and/or the result of diversions at the Freeman Diversion. 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 useful during the steelhead recovery planning process and for managers of anadromous fishes in the Santa Clara River as well as the region as a whole. Additionally, trapping activities aid in monitoring fish movement and assemblages within the Santa Clara River and can potentially mitigate for stranding and predation when conditions are not favorable in the lower river due to natural conditions or to diversions occurring at the Freeman Diversion.

2.2 METHODS

2.2.1 DOWNSTREAM MIGRANT TRAP CHECKS

Trapping was triggered when there was not sufficient flow in the lower river based on depth criteria at critical riffles. The current flow threshold for sufficient upstream migration is 160 cfs measured at critical riffles in the lower Santa Clara

River. This threshold was developed from the results of a steelhead migration instream flow study conducted by Thomas R. Payne and Associates in the lower Santa Clara River (TRPA 2005). This study evaluated surface water depths at various flows to understand what minimum flows would be required for steelhead to successfully migrate from the ocean to the Freeman Diversion Fish Ladder. The current minimum flow threshold for downstream migration is 120 cfs measured within a sandy glide habitat unit near the critical riffle site in the lower Santa Clara River. This threshold was developed from the results of depth, velocity and wetted width measurements at various flows within long, sandy glides, resulting in a target flow of 120 cfs where more than 50% of the wetted stream channel was greater than 0.5 feet deep. Trapping commenced when flow receded to 80 cfs at the sandy glide flow measurement site. The trapping trigger of 80 cfs was chosen because only a narrow width (10 % or less of the wetted stream channel) was greater than 0.5 feet deep. A smolt radio telemetry study is in development to address uncertainties regarding smolt migration behavior and rate of migration in the lower Santa Clara River. This study is planned to be implemented in 2012. The primary objective of this study will be to evaluate smolt migration rates and success at various flows to inform a future smolt bypass flow plan.

Downstream migrant steelhead smolts, kelts, lamprey macropthalmia and other fish entering the fish screen bay within the diversion facility were prevented from entering the diversion canal by a self-cleaning, 3/16-inch mesh screen which directs the fish to a downstream migrant fish trap. If fish trapping was not warranted due to sufficient flows in the lower river for downstream migration, the downstream migrant trap was lifted from the fish trap bay and all downstream migrants entered a fish bypass pipe and exited to the river downstream of the diversion. When flow between the diversion and the ocean was not contiguous and greater than 80 cfs, fish were collected in the downstream migrant trap. Steelhead smolts, kelts and lamprey macropthalmia trapped at the facility were transported in aerated coolers by truck to the Santa Clara River Estuary. Resident coastal rainbow trout that were not exhibiting phenotypic smolting characteristics and lamprey ammocoetes were transported, depending on flow conditions, to the Santa Clara River, Santa Paula Creek, or Sespe Creek. Currently, Sespe Creek is the preferred relocation site for resident coastal rainbow trout and lamprey ammocoetes. All other native aquatic species were returned to the river upstream of the diversion. Non-native and exotic aquatic species were removed from the river unless they are considered special status species in neighboring watersheds such as, but not limited to the Santa Ana sucker.

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 fish screen bay. The trap is situated to keep all intercepted fish immersed in at least two feet of flowing water.

The trap was checked daily in the morning and downstream migrants were removed from the trap with a dip net, counted and measured. Other trapped aquatic species were counted and documented during each trap check. All fisheries personnel were trained in species identification and handling. A species identification handbook drafted by Steve Howard (lead biologist) was also available.

Data Collection – Steelhead smolts were measured (fork length) to the nearest millimeter in a wet fish measuring board. Measurements typically took no more than 10 seconds per individual. Lamprey ammocoetes and macropthalmia, when observed, are measured to total length from head to tail. Smolt condition factor (Wedemeyer 1996) will be quantified in the future by weighing and measuring each fish. Water temperature was measured in the fish trap prior to handling fish and monitored in the transport cooler during transport. Fish were not transported at temperatures above 20°C and these activities were performed early in the morning to minimize stress to the fish. General fish condition was assessed as well as degree of smoltification or smolt condition. Smolt condition or level of smoltification will be quantified in the future based on methods in Haner et al. (1995). Haner et al. (1995) found that mean skin reflectance of steelhead and spring Chinook salmon was significantly correlated with mean gill ATPase activity and mean skin guanine concentration. Water temperature, dissolved oxygen, pH, conductivity, salinity and turbidity were measured at the relocation sites with a multi-parameter water quality meter. When possible, photos of steelhead and lamprey collected and transported were taken with a digital camera. All data were documented on standardized datasheets and transferred daily to an electronic database.

Fish Transportation – Fish were collected from the fish trap with 1/8th inch or smaller mesh dip nets, data were collected and compiled on datasheets and the fish were typically placed in 100 quart aerated coolers. No more than 25 smolts, ammocoetes or macropthalmia were placed in an individual cooler. No more than one adult steelhead or kelt was placed in individual coolers. If a low number of smolts or macropthalmia are collected, these fish might be placed in aerated buckets to minimize handling during release. Fish handling and transport time was generally no more than one hour.

Fish Transport Locations

Anadromous Fish

All anadromous downstream migrant fish (steelhead smolts and kelts, Pacific lamprey macropthalmia) were transported from the Freeman Diversion to the Santa Clara River Estuary (Photo 1 and 2, Appendix B). The specific relocation site in the estuary depended on the condition of the dynamic estuary. The estuary was monitored daily during the migration season to inform relocation activities. Generally fish are released to freshwater in the estuary that has at least 1 foot of depth and instream cover nearby. Areas of the estuary that were known to be low in oxygen were avoided.

Acclimation Schedule - Fish were acclimated to the receiving water using the schedule in Table 3.

Table 3 – Fish acclimation schedule.

Degree Differential (between cooler and receiving water)	Acclimation Minutes
0-2	10
3-5	20
6-7	30
8 and over*	40

* Fish transportation should not occur when the water temperature is too high (>20°C). If this occurs we will need to change our fish transport time schedule. If the estuary water temperature is over 23°C the lead fisheries biologist will be contacted before acclimating.

Non-Anadromous Fish

Non-anadromous fish (resident rainbow trout and Pacific lamprey ammocoetes) were transported via aerated coolers to either the mainstem Santa Clara River in Santa Paula or Sespe Creek (Photo 3, 4 and 5, Appendix B). Depending on conditions in Sespe Creek and access problems, resident rainbow trout might be transported to Santa Paula Creek upstream of Steckel Park. All other native, non-anadromous fish and aquatic species were transported and released upstream of the Freeman Diversion Dam.

2.2.2 Smolt Length Measurements

Trapped smolts were measured to fork length (Photo 6, Appendix A). Lengths were measured by placing the fish in a fish measurement cradle for no more than 10 seconds. The fish were not sedated. If an individual fish could not be measured in less than 10 seconds, the fish was placed back in an aerated cooler and not measured again.

2.3 Results

2.3.1 Downstream Migrant Trap Checks

The downstream migrant trap was in operation from January 5 to June 29, 2010. Smolts entered the trap from March 18 to June 17, 2010 (Figure 3, Appendix A). Smolt surveys continued during operational flushes and fish screen bay checks through the end of July. A total of 72 steelhead smolts (Photo 7, Appendix B), and 5 resident coastal rainbow trout (Photo 8, Appendix B) were trapped and relocated during the 2010 migration season. The 5 resident coastal rainbow trout arrived on February 11 and June 1, 2 and 8, 2010 respectively. All of the 72 steelhead smolts trapped at the Freeman Diversion were transported to the Santa Clara River Estuary. No Pacific lamprey ammocoetes or macropthalmia were observed or collected at the Freeman Diversion facility in 2010. The resident coastal rainbow trout were either transported to Sespe or Santa Paula

Creeks depending on flow and water temperature conditions.

Additional fish collected in the Freeman downstream migrant trap included: partially armored threespine stickleback (N=129), Arroyo chub (N=850), Santa Ana sucker (N=153), Owens sucker (N=34), Santa Ana/Owens sucker hybrids (N=22), fathead minnow (N=21), largemouth bass (N=19), green sunfish (N=15), brown bullhead (N=19), black bullhead (N=2), prickly sculpin (N=97) and mosquitofish (N=18) (Table 4, Appendix A). Sucker species were identified based on lip morphology but the validity of this method is questionable.

Amphibians and reptiles collected in the Freeman downstream migrant fish trap included: Western toad (N=44), bullfrog (N=49 mostly larvae), African clawed frog (N=112), tree frog (N=20) and Southwestern pond turtle (N=10) (Table 5, Appendix A). A healthy pond turtle population exists directly above and below the Freeman Diversion Dam.

2.3.2 SMOLT LENGTH MEASUREMENTS

A total of 72 smolts were measured. The average length of the 2010 smolts was 189.7 mm (standard deviation 35.6 mm). A length frequency histogram was generated from the 71 smolts measured (Figure 4, Appendix A). Also a scatter plot chart was generated representing temporal growth throughout the smolt migration season (Figure 5, Appendix A). The results of temporal growth indicate a weak relationship between time and growth throughout most of the season except in June and July when the fish were noticeably larger.

3.1 INTRODUCTION

The Freeman Diversion Facility is equipped with a denil fish ladder (fishway) that was constructed to facilitate steelhead and Pacific lamprey upstream migration over the concrete diversion dam. Although denil fishways are not ideal for lamprey passage, the fish ladder did pass hundreds of lamprey in the 1990's (Chase 2001, Swift and Howard 2009). There is some uncertainty regarding how many steelhead have passed the diversion dam because of a previous inefficient monitoring program due to antiquated technology, and also regulatory constraints, and extreme environmental constraints (flashy flows, high turbidity). Even with the uncertainties in the data, a low number of native adult steelhead (N=9) have been observed at the diversion dam since it was constructed in 1991. Two additional adult steelhead of hatchery origin were observed in the fish ladder in 2008.

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 were collected using standardized data sheets that include: date and time, number of adult upstream migrants observed and/or relocated, numbers of other aquatic species observed, flow and water quality parameters, and photos were taken to document the physical condition of individual fish. Fork length measurements were taken when possible to the nearest millimeter in a wet measuring board. Water quality data were collected using a Horiba multi-parameter U-20 series meter or a Hydrolab multi-parameter quanta 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 migrants when they jump over a false weir and through an infrared (IR) scanning device. The IR scanning device was checked daily by running an object through the beams. The results of these checks were documented on data sheets. To date, no fish have been documented by the counter. The only other option for monitoring upstream migration through the diversion facility is during fish ladder shutdowns 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 steelhead recovery efforts and increase knowledge regarding Pacific lamprey migration if an 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.

A Dual-frequency Identification Sonar (DIDSON) was purchased during the 2010 steelhead monitoring season. The sonar is a substitute for optical systems in turbid water where optical systems fail. DIDSON can provide unambiguous, near-photographic quality images that can be used to quantify migrating steelhead and evaluate migration behavior and timing. This system was in the testing phase in 2010 and should be ready to start collecting images in 2011.

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

3.2.1 Bypass Flow Monitoring and Ladder Operation

During fish ladder operations, bypass flows were monitored at two sites between the Freeman Diversion and Highway 101 to ensure that a minimum of 160 cfs was maintained at the most downstream monitoring site located approximately 0.6 miles upstream of the Highway 101 Bridge. The two monitoring sites were located approximately 0.14 miles below the Freeman Diversion Dam and 5.5 miles downstream of the Freeman Diversion or 0.6 miles upstream of the 101 Bridge (Figure 6, Appendix A). The most downstream monitoring site was located near the end of the losing reach of the river where surface water is lost to groundwater.

Flow was measured with a YSI/SonTek FlowTracker Acoustic Doppler Velocimeter. Flow measurements were conducted using USGS standards for measuring flow using acoustic Doppler technology in open channels. The measurement site (critical riffle area) was located within a long-wide sandy glide. The existence of numerous shallow glides appears (S. Howard personal observations) to be the critical habitat type (migration bottlenecks and delay) regarding velocity and depth for steelhead migration in the Santa Clara River. The actual critical riffles (typical area to measure shallow conditions) have narrower active channels (wetted width) than glide habitats resulting in deeper conditions compared to the wide, sandy glides.

The Freeman Diversion Fish Ladder was operated based on results from negotiations between NMFS biologists and the District hydrologist and biologist. These new operating criteria were revised in the United States Bureau of Reclamation's *Biological Assessment of the Operation of the Vern Freeman Diversion Dam and Fish Ladder, Santa Clara River, Ventura County, California* and later revised in the Proposed 2009 Interim Operations Plan.

The current bypass flow operating criteria are as follows:

When United starts diverting water after a storm (turn-in), diversion rates are limited when total river flow is less than or equal to 750 cfs. When turning in at total river flow greater than 635 cfs and less than or equal to 750 cfs, only 30% of the remaining river can be diverted providing that the required bypass flows for steelhead are met. When turning in at total river flow less than or equal to 635 cfs, only 20% of the remaining river can be diverted providing that the required bypass flows for steelhead are met. These diversion restrictions apply only to turning-in procedures undertaken during the principal steelhead migration season (January through May) when total river discharge is less than or equal to 750 cfs.

From January 1st to March 31st the fish ladder is operated for up to 18 days after the peak of any storm large enough to allow upstream migration (increase of 200 cfs peak running 24-hour average over the base flow). From April 1st to May 31st (which includes the peak of the downstream migration) the ladder is operated for up to 30 days after the peak of any storm large enough to meet the ladder initiation criteria. On the last four days of the operation of the ladder the flows are reduced to 2/3 of the previous day's flow; on the last day a flow of 20 cfs is provided. This ramp down scenario occurs during the 15th through the 18th days of the ladder operations after storms with a peak occurring from January through March, or on the 27th through the 30th days after storms with a peak occurring from April 1st through May 31st.

The bypass flow schedules for 2010 are presented in Tables 6 and 7, Appendix A.

3.2.2 Video Migration Monitoring

Upstream migration monitoring was conducted using a false weir, infrared scanners and a computer based surveillance system. (Photo 9, 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 plunge” to continue upstream. Consequently, the migrating steelhead jump through the infrared scanner that detects the migration event, 3 cameras film each fish that negotiates the weir and the surveillance system records the events on a computer hard drive. The weir was designed with a bar screen at the bottom of the structure to allow Pacific lamprey to pass the false weir. It is unclear if Pacific lamprey are able to pass through the bar screen due to a lack of data regarding approach water velocities at the screen. Approach velocities at the bar screen and potential monitoring alternatives will be evaluated during the next couple of years of operations.

A computer based surveillance system was purchased and deployed in 2010 to detect and monitor steelhead traversing the fish ladder (Photo 10, Appendix B). In previous year a DVR system with a single low resolution camera was used to monitor steelhead migration through the fish ladder. The new computer based system has multiple functions to detect movement. During 2010 we only used the IR scanners to detect movement over the false weir. Although the surveillance software can detect movement, it is difficult to tease out detection of fish from the water moving in the background. When steelhead traverse the fish ladder and jump over the false weir, the computer based monitoring system documents the event by saving a 20 second video on the computer hard drive. When an event is detected a flashing alarm shows up on computer screen. The event is saved as a file that can be reviewed. The computer system also records continuously and there is enough storage on the 1 TB hard drive to save video for close to a week depending on the number of cameras in use. Once the hard drive is full, new data is saved over old data, starting at the beginning of the old file. Passage events that are detected can first be reviewed from the 20 second file and later reviewed from the continuous file if needed. The surveillance system receives digital video from two low-light, high resolution, above-water cameras placed upstream and downstream of the false weir, as well as an underwater camera placed downstream focused on the false weir. Three twenty-five watt fluorescent lights were used to illuminate the false weir at night.

The IR scanner device was equipped with sensors on both sides of the false weir with multiple closely-spaced infrared beams. When the beams are broken by a fish jumping over the weir, the IR scanner signals the surveillance system to record the event.

To evaluate the efficiency of the IR scanner device, the video monitoring system was checked daily to ensure proper function. Triggered alarms were reviewed and any necessary adjustments were made to the water levels, scanning devices, or recording equipment. Any recorded images saved on the computer were reviewed by staff during these checks.

3.2.3 PIT Tag Monitoring

A Biomark FS2001 PIT tag scanner along with a 24” x 24” antennae was deployed in the fish ladder with the objective of detecting any steelhead that were tagged in 2008 or any tagged out-of-basin steelhead that might stray into the Santa Clara River. PIT Tags (Passive Integrated Transponder) or what are now called RFID (radio frequency identification) tags have no battery so the microchip remains inactive until read with a scanner. The scanner sends a low frequency signal to the microchip within the tag providing the power needed to send its unique code back to the scanner and positively identifying the individual fish. Passive tags are designed to last the life of the fish providing a reliable, long term identification method.

3.2.4 Ladder Shutdowns

A thorough examination of the entire fish ladder was conducted to check for the presence of any fish species during shutdown or dewatering of the ladder. The ladder was shut down for operational or maintenance reasons such as high storms flows, channel flushes, and/or removal of debris from the weir. Also, the ladder was periodically shut down opportunistically to survey the facility for steelhead and/or Pacific lamprey migrants.

3.3 RESULTS

3.3.1 BYPASS FLOW MONITORING AND LADDER OPERATION

The fish ladder was in operation from January 21 to March 22 and April 7 to April 19, 2010. No steelhead or Pacific lamprey were observed traversing the fish ladder in 2010. Bypass flow monitoring results can be found in Table 8, Appendix A.

3.3.2 VIDEO MIGRATION OBSERVATION

The surveillance system was operated continually from January 23 to March 2 and April 7 to April 19, 2010; during the operation of the fish ladder except during the turn-outs on February 27 and 28. Throughout this period the alarm trigger system and video recordings were monitored and checked daily.

In 2010, all triggered alarms were determined to be “false hits” (i.e., triggered by something other than steelhead).

3.3.3 PIT TAG MONITORING

No tagged fish were detected during the 2010 monitoring season. A total of 81 Santa Clara River steelhead smolts were implanted with PIT tags during a 2008 study (Kelley 2008). None of these fish or any other PIT tagged fish were detected in the Freeman Diversion fish ladder in 2010. PIT tagging is currently occurring on the Ventura River and Topanga Creek and there is the potential that some of the steelhead from these creeks could stray into the Santa Clara River following their ocean residency.

3.3.4 LADDER SHUTDOWNS

The fish ladder was shut down from February 27 and 28, 2010 during a turn-out following a storm.

4.1 INTRODUCTION

During high flow events when the river is highly turbid from elevated concentrations of total suspended solids (over 3000 ntu's), District operations staff "turn-out" all river flows from the facility and the fish screen bay section of the diversion structure can become dewatered or extremely shallow. When the water is turned out of the facility, head gates are closed to retain sufficient depth in the fish screen bay to avoid potential predation from birds. Additional operations and maintenance activities include "flushes" where District operations staff "turn-out" all river flows from the facility to maintain the active channel toward the facility headworks or to conduct maintenance of the canal gates and screens. During all "turn-out" events when the fish ladder is in operation, the fish ladder must be shut down and inspected for potential stranded fish. When the fish ladder is shut down it slowly dewaters and this can result in fish becoming stranded in the fish ladder.

The primary objective of fish stranding surveys is to rescue any fish that become stranded when diversion operations cause river flow to rapidly diminish downstream of the Freeman Diversion in the Santa Clara River and within the fish screen bay and fish ladder during dewatering operations.

4.2 METHODS

4.2.1 FISH SCREEN BAY STRANDING SURVEYS

During turn-out and flushing events, the fish screen bay was thoroughly examined for the presence of steelhead, Pacific lamprey and other aquatic species. Two or more biologists surveyed the fish screen bay as it dewatered. These surveys were conducted by seining the entire area with either 3/8 or 1/4 inch mesh brailed seines that are 4 feet deep and from 10 to 20 feet long (Photo 11, Appendix B). The primary objective of these surveys was to capture and relocate steelhead and Pacific lamprey stranded during dewatering of the fish screen bay to appropriate habitats either in the estuary (smolts, kelts, macropthalmia) or the Santa Clara River or associated tributaries (resident coastal rainbow trout and Pacific lamprey ammocoetes). Also, the fish screen bay was periodically dewatered opportunistically to look for steelhead and Pacific lamprey migrants that could potentially be held up in the fish screen bay. All fish were transported via aerated coolers. Non-native aquatic species were removed from the river. All data collected during stranding surveys were documented on standardized datasheets. Fish were transported utilizing materials and methods described in Section 2.2 of this report.

4.2.2 Lower Santa Clara River Stranding Surveys

Stranding surveys were conducted in the Santa Clara River below the Freeman Diversion when bypass flows were significantly reduced or when releases were stopped all together, due to turn-out or flushing events. These surveys were conducted by entering the non-wetted area of the floodplain via a Polaris Ranger All-Terrain Vehicle that was stocked with equipment necessary to collect, hold and transport stranded fish. Stranded fish were captured either with dip nets or 1/8 inch to 1/4 inch mesh brailed seines and placed in aerated coolers. In 2010, no upstream migrant steelhead or Pacific lamprey were collected during these surveys. In years when upstream migrant steelhead and Pacific lamprey are collected during these surveys they will be relocated upstream of the Freeman Diversion Dam. Downstream migrant steelhead (smolts) were relocated to the Santa Clara River Estuary. In 2010, no downstream migrant Pacific lamprey were collected. In years when downstream migrant Pacific lamprey (macropthalmia) are collected during these surveys they will be relocated to the estuary.

4.2.3 Fish Ladder Stranding Surveys

Stranding surveys were conducted in the fish ladder during turn-out and flushing events. When the fish ladder is in operation and one of these events occurs, the fish ladder becomes dewatered and the potential exists for steelhead and Pacific lamprey to become stranded either between the denil plates or in resting pools in the fish ladder. A biologist was present and conducted surveys when these operations occurred by walking the length of the ladder searching for any stranded fish as the ladder dewatered. Dip nets and buckets were used to rescue any stranded fish.

Fish ladder stranding surveys were also periodically conducted by briefly dewatering the ladder to visually survey for steelhead and Pacific lamprey that that might be held up in the fish ladder. If a fish was observed in the denil sections of the ladder it was captured with a dip net, placed in a bucket and relocated to an appropriate location based on its life stage. If a fish was observed in one of the resting pools of the ladder and appeared to not be in immediate danger, flow was turned back in the ladder to allow the fish to continue migrating upstream on its own.

4.3 RESULTS

4.3.1 FISH SCREEN BAY STRANDING SURVEYS

A total of 2 turn-out events lasting 6 days occurred during the 2010 water year. The two turn-out events were conducted due to high turbidity levels from high sediment loads following storm peaks. Four fish screen bay stranding surveys were conducted in 2010 during the turn-out events. The fish screen bay survey conducted on July 19 yielded a single steelhead smolt and the other three surveys yielded no smolts (Table 9, Appendix A).

4.3.2 LOWER SANTA CLARA RIVER STRANDING SURVEYS

Two sediment flushes occurred on June 17 and July 19 toward the end of the smolt season. Sediment flushes are conducted when excessive sand volumes have accumulated near the Freeman Diversion headworks as a result of bed load movement. The two river surveys that were conducted during the June 17 and July 19 flushes yielded 13 smolts and 1 smolt respectively (Table 9, Appendix A). Seven of the smolts captured on June 17 died following the flush. The remaining 6 smolts captured on July 17 and the single smolt captured on July 19 were relocated to the Santa Clara River Estuary. In the future, United will attempt to manage maintenance flushes to occur either during bypass flow releases or after the smolt season. It appears that late season smolts might stop their downstream migration above the diversion and rear in the forebay above the dam. One reason that smolts were not observed late in the season in past years could be that smolts passed the dam during the historically more frequent flushing events preventing them from rearing in the forebay.

4.3.3 Fish Ladder Stranding Surveys

There were a total of 4 turn-out and flushing events but only 2 required ladder checks when the fish ladder was in operation. A biologist walked the length of the fish ladder during each event as the ladder dewatered. No *O. mykiss* were observed stranded in the fish ladder during these surveys.

5.1 INTRODUCTION

Water quality monitoring for 2010 was conducted to monitor water quality conditions that steelhead and Pacific lamprey are exposed to in various areas within the watershed. Water quality parameters such as dissolved oxygen, pH, conductivity, salinity, and turbidity were collected. Water temperature monitoring was conducted in various locations in the watershed and water quality measurements were focused primarily in the Santa Clara River Estuary, Santa Paula Creek, Sespe Creek, Piru Creek and the main stem Santa Clara River where coastal rainbow trout were relocated during the 2010 monitoring season.

5.2 METHODS

Water quality monitoring for 2010 included water temperature measurements utilizing Onset Hobo® temperature loggers at various sites within the Santa Clara River watershed and in-situ water quality measurements taken during fish relocation activities using a Horiba U-10 multi-parameter water quality meter. The majority of the temperature loggers were placed in pool habitats at mid-depth and programmed to take measurements every hour. The standardized data collection dates were January 1, 2010 through August 1, 2010 which includes the entirety of the steelhead migration season. In-situ water quality measurements were collected when steelhead were relocated to the Santa Clara River Estuary, main stem Santa Clara River or Sespe Creek. The objective of water temperature monitoring is to monitor ambient water temperatures at selected sites throughout the Santa Clara River watershed where steelhead spawn, rear, or migrate. Additional water temperature monitoring of habitats with hyporheic influences (thermal refuge) is planned to occur at selected sites in the future.

Water temperature monitoring occurred at the following eleven sites:

- Site 1 - Santa Clara River Estuary
- Site 2 - Freeman Fish Trap Bay

- Site 3 - Freeman Fish Screen Bay
- Site 4 - Santa Paula Creek Upstream of Harvey Diversion
- Site 5 - Santa Paula Creek at Steckel Park
- Site 6 - Santa Paula Creek Directly Downstream of Sisar Creek Confluence
- Site 7 - Sespe Creek at Grand Avenue
- Site 8 - Piru Creek Downstream of Temescal's Property Line
- Site 9 - Piru Creek at the Old USGS Gauge
- Site 10 - Piru Creek at the USGS Gauge Directly Downstream of Santa Felicia Dam

A map identifying each monitoring site can be found in Figure 7, Appendix A. Graphs depicting data at these eleven sites are in Figures 8-17, Appendix A. Specific information regarding each site can be found in Table 10 Appendix A.

5.3 RESULTS

5.3.1 SANTA CLARA RIVER ESTUARY

The Santa Clara River Estuary water temperature monitoring site was located near the north bank approximately 500 feet downstream of the Harbor Boulevard Bridge (Photo 12, Appendix B). The logger was placed at a depth and location so that when the sandbar breeches, the logger will be out of water (~0.5 feet from the bottom). The objective at this location was to monitor water temperatures at or near the steelhead smolt release point and to potentially monitor sandbar breeching when there is a loss of water at the monitoring point. The estuary was closed to the ocean from approximately January 5, 2010 to January 17, 2010 and from March 30, 2010 through April 7, 2010 and May 12, 2010 through the end of the trapping season. We performed two separate analyses of water temperature, one for estuary closed and one for estuary open. When the estuary was closed the minimum water temperature collected at this site was 14.1 ºC and the maximum temperature was 26.3 ºC. When the estuary was open the minimum water temperature collected at this site was 7.0 ºC and the maximum was 27.3 ºC (Table 11, Appendix A).

5.3.2 FREEMAN FISH TRAP BAY

The Santa Clara River Freeman Fish Trap Bay water temperature monitoring site was located within the fish trap bay at the Freeman Diversion in Saticoy. The logger was attached to a rung of a permanent ladder structure within the fish trap bay. The logger was attached with zip ties approximately 1.0 feet from the bottom of the bay (Photo 13, Appendix B). The objective at this location was to monitor water temperatures in the fish trap bay where the downstream migrant fish trap is located. Steelhead smolts and several other aquatic species were trapped at this location during the migration season (typically January-June). Temperature monitoring is critical at this location as this is where the fish remain until the daily trap check occurs. Occasionally resident and young-of-the-year coastal rainbow trout as well as steelhead kelts may also be found in the trap. The minimum water temperature collected at this site was 7.6 ºC and the maximum temperature was 28.2 ºC (Table 11, Appendix A).

5.3.3 FREEMAN FISH SCREEN BAY

The Santa Clara River Freeman Fish Screen Bay water temperature monitoring site was located within the fish screen bay. The fish screen bay consists of a concrete channel where downstream migrants enter the diversion and migrate to the downstream migrant fish trap. The logger was located approximately 50 feet downstream from the intake to fish screen bay and attached to an eye hook 0.5 feet from the bottom along a concrete wall (Photo 14, Appendix B). The objective at this location was to monitor water temperatures in the main stem as river flow enters the Freeman Facility. Downstream migrant steelhead, Pacific lamprey and other aquatic species temporarily rear in the fish screen bay prior to entering the trap. The downstream migrant fish trap is typically taken out of operation between June and December and all fish that enter the facility rear in the fish screen bay until trapping operations begin in January. The minimum water temperature collected at this site was 1.8 ºC and the maximum temperature was 30.6 ºC (Table 11, Appendix A).

5.3.4 SANTA PAULA CREEK UPSTREAM OF HARVEY DIVERSION

The Santa Paula Creek upstream of Harvey Diversion water temperature monitoring site was located in a low gradient riffle habitat type approximately 500 feet upstream from Harvey Diversion along Highway 150 in Santa Paula. The logger was attached to a fence post with zip ties 0.4 inches from the bottom (Photo 15, Appendix B). The objective at this location was to monitor water temperatures in Santa Paula Creek. The minimum water temperature collected at this site was 8.0 ºC and the maximum temperature was 21.8 ºC (Table 11, Appendix A).

5.3.5 Santa Paula Creek at Steckel Park

The Santa Paula Creek at Steckel Park water temperature monitoring site was located in a glide habitat type ~50 feet upstream of the Steckel Park Bridge. The logger was attached 0.2 feet from the bottom with zip ties to a fence post. The fence post was located under a boulder and was secured to an alder tree via cable along the bank (Photo 16, Appendix B). This location was ideal for monitoring temperatures due to adequate flow, areas of scour, and in-stream cover. The minimum water temperature collected at this site was 8.1 ºC and the maximum temperature was 27.6 ºC (Table 11, Appendix A).

5.3.6 Santa Paula Creek Directly Downstream of Sisar Creek Confluence

The Santa Paula Creek directly downstream of Sisar Creek confluence water temperature monitoring site was located in a pool habitat type approximately 35 feet downstream of the Sisar Creek confluence. The logger is attached 7 inches from the bottom with zip ties to a fence post (Photo 17, Appendix B). This habitat was ideal for water temperature monitoring because of the scoured pool and direct observation of resident *O. mykiss* at this site. The objective at this location was to monitor water temperatures in Santa Paula Creek. The minimum water temperature collected at this site was 8.1 ºC and the maximum temperature was 24.6 ºC (Table 11, Appendix A).

5.3.7 Sespe Creek at Grand Avenue

The Sespe Creek at Grand Avenue water temperature monitoring site was located directly downstream of the USGS Gauge along Grand Avenue. The logger was attached to a steel pipe with zip ties 2 feet from the bottom along the bank (Photo 18, Appendix B). The objective at this location was to monitor water temperatures at the release location for resident and young-of-the-year coastal rainbow trout in Sespe Creek. This was an easily accessible pool with sufficient flow creating areas of scour and abundant in-stream cover, primarily riparian vegetation and boulder substrate. The minimum water temperature collected at this site was 6.8 ºC and the maximum temperature was 30.8 ºC (Table 11,

Appendix A).

5.3.8 PIRU CREEK DOWNSTREAM OF TEMESCAL'S PROPERTY LINE

The Piru Creek downstream of Temescal's property line water temperature monitoring site was located in a pool habitat type approximately 1.5 miles upstream of the confluence with the Santa Clara River. The logger was attached 0.6 inches from the bottom with zip ties to a fencepost and secured to a willow tree with cable (Photo 19, Appendix B). The objective at this location was to monitor water temperatures in lower Piru Creek. The minimum water temperature collected at this site was 7.7 ºC and the maximum temperature was 24.1 ºC (Table 11, Appendix A).

5.3.9 PIRU CREEK AT THE OLD USGS GAUGE

The Piru Creek at the old USGS Gauge water temperature monitoring site was located in low gradient riffle habitat, approximately 3 miles upstream from the confluence with the Santa Clara River. The logger was attached 0.6 inches from the bottom with zip ties to a pre-existing pipe (Photo 20, Appendix B). The objective at this location was to monitor water temperatures in lower Piru Creek. The minimum water temperature collected at this site was 7.0 ºC and the maximum temperature was 31.0 ºC (Table 11, Appendix A).

5.3.10 PIRU CREEK AT THE USGS GAUGE DIRECTLY DOWNSTREAM OF SANTA FELICIA DAM

The Piru Creek at USGS Gauge directly downstream of Santa Felicia Dam water temperature monitoring site was located in a pool habitat type approximately 700 feet downstream of Santa Felicia Dam. The logger was attached 0.3 inches from the bottom with zip ties to a permanent staff gauge (Photo 21, Appendix B). The objective at this location was to monitor water temperatures in lower Piru Creek. The minimum water temperature collected at this site was 5.3 ºC and the maximum temperature was 24.0 ºC (Table 11, Appendix A).

5.4 DISCUSSION

The maximum water temperatures at most sites exceeded 25 ºC, which is commonly cited as the chronic or incipient upper lethal temperature limit for many anadromous salmonids. However, higher temperatures exceeding 29 ºC can be tolerated for a short period of time (Myrick and Cech 2001) if other water quality parameters are favorable. The maximum water temperature of 31.0 ºC occurred in Piru Creek at the old USGS gauge site during the summer. Extreme water temperatures are not uncommon in southern California. Southern California coastal rainbow trout have adapted to a wide variation in water temperatures by seeking out thermal refuge when available. Other behavioral responses to temperatures near the upper thermal extremes include increased feeding when food is available to offset the cost of an elevated metabolic rate. Although feeding declines above 19 ºC, growth can still occur up to 25 ºC (Myrick and Cech 2000). Also, the duration of exposure is important since these fish will experience upper thermal limits over a period of a few hours during any given day and only seasonally and these fish can maintain body weight at 25 ºC for 30 days (Myrick and Cech 2000). In drainages where thermal refuge is absent and low food production occurs, thermal stress alone can cause mortalities.

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

Behler, J. L. and F. W. King. 1996. National Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, Inc. New York.

California Department of Fish and Game. 2009. California Natural Diversity Database, Special Animals (883 taxa). The Natural Resources Agency, Biogeographic Data Branch.

Chase, S. 2001. Contributions to the life history of adult Pacific lamprey (*Lampetra tridentata*) in the Santa Clara River of southern California. Bulletin of the Southern California Academy of Sciences 100(2):74–85.

CMWD. 2008. 2008 Annual progress report for the Robles Diversion Fish Passage Facility. Casitas Municipal Water District, Oak View, CA.

Haner, Philip V., J.C. Faler, R.M. Shrock, D.W. Rondorf, and A. G. Maule. 1995. Skin reflectance as a nonlethal measure of smoltification for juvenile salmonids. North American Journal of Fisheries Management 15: 814 - 822.

Kelley, E. 2008. Steelhead trout smolt survival in the Santa Clara and Santa Ynez River Estuaries. Prepared for The California Department of Fish and Game Fisheries Restoration Grant Program University of California, Santa Barbara. August 2008. 61 pp

Myrick, C. A., and J. J. Cech, Jr. 2000. Temperature influences on California rainbow trout physiological performance. Fish Physiology and Biochemistry 22(3):245–254.

Myrick, C. A. and J. J. Cech, Jr. 2001. Bay-Delta Modeling Forum. Technical publication 01-1. Temperature effects on Chinook salmon and steelhead: a review focusing on California's Central Valley populations.

National Marine Fisheries Service. 1997. Endangered and Threatened Species: Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead. Federal Register, 50 CFR Parts 222 and 227 [Docket No. 960730210–7193–02; I.D. 050294D] RIN 0648–XX65. Vol. 62, page 43937.

National Marine Fisheries Service. 2003. Endangered and Threatened Species: Range Extension for Endangered Steelhead in Southern California. Federal Register, 50 CFR Part 224 [Docket No. 001025296-2079-02; I.D. 072600A] RIN 0648-AO05. Vol. 67 page 21586.

Swift, C. C. and S. R. Howard. 2009. Current status and distribution of the Pacific lamprey, south of Point Conception, coastal Southern California, USA. Pages 269-278 in L. R. Brown, S. D. Chase, M. G. Mesa, R. J. Beamish, and P. B. Moyle, editors. Biology, management and conservation of lampreys in North American. American Fisheries Society. Symposium 72, Bethesda, Maryland.

Thomas R. Payne and Associates (TRPA). 2005. Assessing passage of steelhead over riffles in the lower Santa Clara River. Draft Final Report. 31 pp.

Wedemeyer, G.A. 1996. Physiology of Fish in Intensive Culture Systems. Chapman and Hall, New York, New York.

Appendix A

Tables and Figures

Table 1 - Freeman Diversion Operations and Steelhead Monitoring Data

January

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder Operation																															
Smolt Trapping																															
Smolts																															
Adult Steelhead																															
Steelhead Kelt																															
Turbidity (ntu)					4.9	5.2	4.9	6.6	12.8	6.6	7.2	6.1	6.1	6.8	4.7	4.8	5.1							317.0	170.0	174.0	84.5	65.5	65.9	64.7	45.8
Estuary	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open

February

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Ladder Operation																												
Smolt Trapping																												
Smolts																												
Adult Steelhead																												
Steelhead Kelt																												
Turbidity (ntu)	40.7	39.8	45.0	25.8	35.0				136.0	1000+	246.0	176.0	76.3	63.8	64.7	61.9	53.1	42.7	30.3		29.5	32.1	32.7	37.6	35.4	34.3		
Estuary	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open

March

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder Operation																															
Smolt Trapping																															
Smolts																		1			1		1			1				2	
Adult Steelhead																															
Steelhead Kelt																															
Turbidity (ntu)	209.0	237.0	158.0	132.0	75.9	56.6	59.7	85.5		49.6	40.4	46.4	68.8	39.5	34.4	27.6	34.6	23.1	15.6	17.6	26.6	20.3	17.5	16.3	13.7	14.8	83.7	82.1	64.3	15.3	13.7
Estuary	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closed	Closed

April

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ladder Operation																														
Smolt Trapping																														
Smolts	1			3				1	3	3	3										1									
Adult Steelhead																														
Steelhead Kelt																														
Turbidity (ntu)	11.6	18.3	24.4	10.4	17.4	131.0	35.0	60.0	120.0	19.3	31.7	3896	595.0	74.8	71.8	52.1	32.4	31.1	29.8	23.2	33.6	44.3	31.1	24.9	24.3	23.3	13.6	19.2	19.5	14.9
Estuary	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open

May

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder Operation																															
Smolt Trapping																															
Smolts	4	2		1	5	1	1	1	1	3		1		1		1		1		1	3	1						8			
Adult Steelhead																															
Steelhead Kelt																															
Turbidity (ntu)	14.4	8.1	9.2	5.5	9.0	6.1	16.5	11.9	22.4	8.8	4.4	14.0	9.6	22.5	7.6	3.6	3.9	6.9	5.5	6.0	9.6	4.0	4.0	5.1	31.4	6.7	4.1	16.4	4.6	8.3	4.0
Estuary	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed

*Blank cells mean no activity (Ladder Operations and Smolt Trapping) or a zero datum value for that day.

Table 1 Continued - Freeman Diversion Operations and Steelhead Monitoring Data

June

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ladder Operation																														
Smolt Trapping																														*End of Trapping*
Smolts																	13													
Adult Steelhead																														
Steelhead Kelt																														
Turbidity (ntu)	6.3	16.4	6.8	4.9	3.7	9.9		4.3	3.7	4.2	3.7	3.2	10.1	6.1	2.6	7.2		2.9	6.5	4.4	11.6	6.2	7.2	5.9		5.1	3.9	9.9	7.4	
Estuary	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed

July

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder Operation	*Steelhead Trapping Complete (Fish Screen Bay and Flush Monitoring Continued through August)*																			End of Monitoring Season											
Other Monitoring																															
Smolts																			2												
Adult Steelhead																															
Steelhead Kelt																															
Turbidity (ntu)																															
Estuary	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed												

August

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder Operation																															
Other Monitoring																															
Smolts																															
Adult Steelhead																															
Turbidity (ntu)																															
Estuary																															

*Blank cells mean no activity (Ladder Operations and Smolt Trapping) for a zero datum value or that day.

Table 2 - Santa Clara River Fish Species

Common Name	Scientific Name	Status	Resident - Anadromous	Regulatory Status
Tidewater Goby	*Eucyclogobius newberryi*	Native	Resident	FE, DFG: SSC
Partially Armored Stickleback	*G. a. microcephalus*	Native	Resident	--
Unarmored Stickleback	*G.a. williamsoni*	Native	Resident	FE, SE, DFG: FP
Arroyo Chub	*Gila orcuttii*	Native	Resident	DFG: SSC
Pacific Lamprey	*Entosphenus tridentatus*	Native	Anadromous	--
Rainbow Trout	*Oncorhynchus mykiss*	Native	Resident	--
Steelhead Trout	*Oncorhynchus mykiss irideus*	Native	Anadromous	FE, DFG: SSC
Black Bullhead	*Ameiurus melas*	Introduced	Resident	--
Brown Bullhead	*Ameiurus nebulosus*	Introduced	Resident	--
Santa Ana Sucker	*Catostomus santaanae*	Introduced*	Resident	*FT, DFG: SSC
Owens Sucker	*Catostomus fumeiventris*	Introduced	Resident	**DFG: SSC
Hybrid Sucker	*C.santaanae x C. fumeiventris*	Introduced	Resident	--
Prickly Sculpin	*Cottus asper*	Introduced	Resident	--
Common Carp	*Cyprinus carpio*	Introduced	Resident	--
Goldfish	*Carassius auratus*	Introduced	Resident	--
Threadfin Shad	*Dorosoma petenense*	Introduced	Resident	--
Mosquitofish	*Gambusia affinis*	Introduced	Resident	--
Channel Catfish	*Ictalurus punctatus*	Introduced	Resident	--
Green Sunfish	*Lepomis cyanellus*	Introduced	Resident	--
Bluegill	*Lepomis macrochirus*	Introduced	Resident	--
Mississippi Silverside	*Menidia audens*	Introduced	Resident	--
Largemouth Bass	*Micropterus salmoides*	Introduced	Resident	--
Fathead Minnow	*Pimephales promelas*	Introduced	Resident	--
Black Crappie	*Pomoxis nigromaculatus*	Introduced	Resident	--
White Crappie	*Pomoxis annularis*	Introduced	Resident	--
Brown Trout	*Salmo trutta trutta*	Introduced	Resident	--

FE = Federally Endangered Species; FT = Federally Threatened Species; SE = State Endangered Species; DFG: FP = California Department of Fish and Game - Fully Protected Species; DFG: SSC = California Department of Fish and Game - Species of Special Concern.

*Santa Ana Sucker is listed as FT and DFG:SSC in its native drainage; this does not include the Santa Clara River.

**Owens Sucker is listed as DFG: SSC in its native drainage; this does not include the Santa Clara River.

Table 4 - Freeman Diversion Fish Monitoring Species Totals 2010

<u>**Fish Species:**</u> **STK** = Steelhead Adult Kelt, **ST =** Steelhead Adult**, 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 Hybrid**, FM =** Fathead Minnow**, LB =** Largemouth Bass**, GS =** Green Sunfish**, BB=** Brown Bullhead**, BC =** Black Bullhead**, PS =** Prickly Sculpin**, MF =** Mosquitofish

<u>**Amphibian & Reptile Species**</u>**:** **WT** = Western Toad, **AT** = Arroyo Toad, **SFT** = Spadefoot Toad, **BF** = Bullfrog, **CRLF** = Red-legged Frog, **PT** = Pond Turtle, **AF** = African Clawed Frog, **TF** = Tree Frog

	Native Fishes									Non-native Fishes									
	STK	ST	RS	RT	YOY	PL (Adult)	PL (Am)	TS	AC	SS	OS	SS x OS	FM	LB	GS	BB	BC	PS	MF
Total	0	0	72	5	23	0	0	129	850	153	34	22	21	19	15	19	2	97	48

	Amphibians and Reptiles							
	WT	AT	SFT	CRLF	BF	AF	TF	PT
Total	44	0	0	0	49	112	20	10

Biologists: Steve Howard, Sara Gray, **Fish Technicians:** Chris In, Amanda Goldstein, Tim Madison, Domenic Giudice

Table 5 - Santa Clara River Reptile and Amphibian Species

Common Name	Scientific Name	Status	Regulatory Status
Two-striped Garter Snake	*Thamnophis couchi hammondi*	Native	DFG: SSC
Southwestern Pond Turtle	*Clemmys marmorata pallida*	Native	DFG: SSC
Red-earred Slider	*Chrysemys scripta elegans*	Introduced	--
California Treefrog	*Hyla cadaverina*	Native	--
Pacific Treefrog	*Hyla regilla*	Native	--
Western Toad	*Bufo boreas*	Native	--
Bullfrog	*Rana catesbeiana*	Introduced	--
African Clawed Frog	*Xenopus laevis*	Introduced	--

DFG: SSC = California Department of Fish & Game - Species of Special Concern

Table 6 - Bypass Flow Schedule from January 1st to March 31st.

Day of Fish Ladder Operation	Designated Minimum Flows at Critical Riffle (cfs)
1	160
2	160
3	160
4	160
5	160
6	160
7	150
8	140
9	130
10	120
11	110
12	100
13	90
14	80
15	2/3 of previous day*
16	2/3 of previous day*
17	2/3 of previous day*
18	20*

*Ramping down flow measured at the Freeman Diversion

Table 7 - Bypass Flow Schedule from April 1st to May 31st.

Day of Fish Ladder Operation	Designated Minimum Flows at Critical Riffle (cfs)
1	160
2	160
3	160
4	160
5	160
6	160
7	160
8	160
9	160
10	160
11	160
12	160
13	160
14	160
15	160
16	160
17	160
18	160
19	150
20	140
21	130
22	120
23	110
24	100
25	90
26	80
27	2/3 of previous day*
28	2/3 of previous day*
29	2/3 of previous day*
30	20*

*Ramping down flow measured at the Freeman Diversion

Table 8 - Freeman Diversion Steelhead Bypass Flow Monitoring Results

Date	Fish Ladder Flow(cfs)	Auxillary Gate Flow (cfs)	Total River Flow Below the Freeman (cfs) "this eqauls all flow measured below the diversion dam"	Critical Riffle Flow (cfs) (~5.5 miles downstream of Freeman)	Surface Water Loss to Groundwater (Between Freeman at Critical Riffle Site)	Crit Rif Target
1/18/2010	**Turned Out**					
1/19/2010						
1/20/2010						
1/21/2010						160
1/22/2010						160
1/23/2010	40	80	N/D	N/D		160
1/24/2010	40	80	N/D	468		160
1/25/2010	40	80	305	N/D		160
1/26/2010	40	80	292	167	125	160
1/27/2010	40	80	286	162	124	160
1/28/2010	40	80	289	153	136	150
1/29/2010	40	80	249	137	112	140
1/30/2010	40	80	283	N/D		130
1/31/2010	40	80	260	N/D		120
2/1/2010	40	80	247	139	108	110
2/2/2010	40	80	205	107	98	100
2/3/2010	40	80	202	96	106	90
2/4/2010	40	80	186	85	102	80
2/5/2010	40	80	242	N/D		2/3 of previous day
2/6/2010	**Turned out**					160
2/7/2010	40	80	N/D	N/D		160
2/8/2010	40	80	N/D	N/D		160
2/9/2010	40	80	157	N/D		160
2/10/2010	40	80	288	214	74	160
2/11/2010	40	80	287	197	90	160
2/12/2010	40	80	257	174	83	160
2/13/2010	40	80	227	123	103	150
2/14/2010	40	80	218	157	61	140
2/15/2010	40	80	220	155	65	130
2/16/2010	40	80	183	138	45	120
2/17/2010	40	80	179	114	65	110
2/18/2010	40	80	190	115	75	100
2/19/2010	40	80	174	100	74	90
2/20/2010	40	80	190	ND		2/3 of previous day
2/21/2010	40	80	153	ND		2/3 of previous day
2/22/2010	40	80	141	83	58	2/3 of previous day
2/23/2010	40	50	92	37	55	20

Table 8 - Freeman Diversion Steelhead Bypass Flow Monitoring Results (cont.)

Date	Fish Ladder Flow(cfs)	Auxillary Gate Flow (cfs)	Total River Flow Below the Freeman (cfs) "this eqauls all flow measured below the diversion dam"	Critical Riffle Flow (cfs) (~5.5 miles downstream of Freeman)	Surface Water Loss to Groundwater (Between Freeman at Critical Riffle Site)	Crit Rif Target
2/24/2010	40	50	117	59	57	
2/25/2010	40	50	81	24	58	
2/26/2010	40	0	43	0	43+	
2/27/2010	**Turned out**					
2/28/2010	40	50	N/D	N/D		160
3/1/2010	40	50	360	N/D		160
3/2/2010	40	50	183	N/D		160
3/3/2010	40	50	233	167	67	160
3/4/2010	40	50	224	175	49	160
3/5/2010	40	50	205	141	65	160
3/6/2010	40	50	252	181	71	160
3/7/2010	40	50	343	302	41	150
3/8/2010	40	50	N/D	187		140
3/9/2010	40	50	166	98	67	130
3/10/2010	40	50	200	152	48	120
3/11/2010	40	50	220	163	57	110
3/12/2010	0	0	301	N/D		100
3/13/2010	40	50	160	92	68	90
3/14/2010	40	50	148	N/D		2/3 of previous day
3/15/2010	40	50	183	N/D		2/3 of previous day
3/16/2010	40	50	128	81	46	2/3 of previous day
3/17/2010	40	50	127	79	48	20
3/18/2010	40	50	87	35	52	
3/19/2010	40	40	79	23	56	
3/20/2010	40	0	40	0		
3/21/2010	38	0	38	0		
3/22/2010	37	0	37	0		
3/23/2010	5	0	0	0		
3/24/2010	5	0				
3/25/2010	5	0				
3/26/2010	5	0				
3/27/2010	5	0				
3/28/2010	5	0				
3/29/2010	5	0				
3/30/2010	5	0				
3/31/2010	5	0				
4/1/2010	5	0				

Table 8 - Freeman Diversion Steelhead Bypass Flow Monitoring Results (cont.)

Date	Fish Ladder Flow(cfs)	Auxillary Gate Flow (cfs)	Total River Flow Below the Freeman (cfs) "this eqauls all flow measured below the diversion dam"	Critical Riffle Flow (cfs) (~5.5 miles downstream of Freeman)	Surface Water Loss to Groundwater (Between Freeman at Critical Riffle Site)	Crit Rif Target
4/2/2010	5	0				
4/3/2010	5	0				
4/4/2010	5	0				
4/5/2010	5	0				
4/6/2010	40	50	130-129	N/D		
4/7/2010	40	50	166	75	91	
4/8/2010	40	50	148	68	80	
4/9/2010	40	40 over dam	76	9	67	
4/10/2010	30	0	0	0		
4/11/2010	30	0	0	0		
4/12/2010	40	50	N/D	N/D		160
4/13/2010	40	50	208	163	45	160
4/14/2010	40	50	210	139	71	160
4/15/2010	40	50	200	162	38	160
4/16/2010	40	0	198	151	47	160
4/17/2010	40	0	205	155	50	160
4/18/2010	40	0	189	131	58	80-120
4/19/2010	40	0	161	106	55	80-120
4/20/2010	0	0	152	99	53	80-120
4/21/2010	0	0	N/D	125	N/D	80-120
4/22/2010	0	0	174	132	42	80-120
4/23/2010	0	0	163	111	52	80-120
4/24/2010	0	0	152	99	53	80-120
4/25/2010	0	0	142	94	47	80-120
4/26/2010	0	0	130	73	57	80-120
4/27/2010	0	0	119	69	50	
4/28/2010	0	0	87	32	55	
4/29/2010	0	0	55	N/D	N/D	
4/30/2010	0	0	28	N/D	N/D	

END OF SMOLT BYPASS FLOWS

Table 9 – Fish Stranding Survey Results

Stranding Survey Location	Adult Steelhead	Smolts	Resident *O. mykiss*	Total
Freeman Fish Screen Bay	0	1	0	1
Lower Santa Clara River	0	14	0	14
Fish Ladder	0	0	0	0

Table 10 - Temperature Logger Sites

Location	Logger #	Date Deployed	Max Depth (ft)	Logger Depth (feet from bottom)	Habitat Type	Photo
Santa Clara River Estuary	1044855	4/26/2007	4.0	0.5	Estuary	12
Freeman Fish Trap Bay	1269160	5/16/2008	3.0	1.0	Pool	13
Freeman Fish Screen Bay	1269166	12/8/2008	2.5	0.5	Pool	14
Santa Paula Creek at Steckel Park	1269161	3/27/2008	1.8	0.2	Pool	15
Santa Paula Creek Upstream of Harvey Diversion	2250243	1/16/2009	1.0	0.4	Riffle	16
Santa Paula Creek Directly Downstream of Sisar Creek Confluence	2250248	1/16/2009	2.25	0.7	Pool	17
Sespe Creek at Grand Avenue	1269163	4/31/2008	4.0	2.0	Pool	18
Piru Creek Downstream of Temescal's Property Line	1269167	9/3/2008	1.0	0.5	Pool	19
Piru Creek at Old USGS Gauge	1269168	8/29/2008	0.7	0.5	Run	20
Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam	1269164	8/27/2008	0.5	0.25	Pool	21

Table 11 - Water Temperature Statistics by Logger Site (January1, 2010 TO August 1, 2010)

Location	Max Temp (Degrees C)	Date Max Temp	Min Temp (Degrees C)	Date Min Temp	Mean Temp (Degrees C)
Santa Clara River Estuary (Estuary Closed)	26.26	5/31/2010	14.05	2/27/2010	20.51
Santa Clara River Estuary (Estuary Open)	27.33	5/3/2010	6.99	2/23/2010	15.23
Freeman Fish Trap Bay	28.171	6/14/2010	7.619	1/23/2010	16.719
Freeman Fish Screen Bay	30.596	7/14/2010	1.778	1/23/2010	17.150
***Santa Paula Creek Upstream of Harvey Diversion**	21.724	7/13/2010	7.97	1/23/2010	14.723
Santa Paula Creek at Steckel Park	27.604	7/17/2010	8.095	1/23/2010	15.176
Santa Paula Creek Directly Downstream of Sisar Creek Confluence	24.557	7/17/2010	8.145	1/23/2010	14.696
***Sespe Creek at Grand Avenue**	30.773	7/14/2010	6.763	1/23/2010	15.725
Piru Creek Downstream of Temescal's Property Line	24.146	7/17/2010	7.72	1/23/2010	15.722
Piru Creek at Old USGS Gauge	30.976	7/15/2010	7.041	1/5/2010	16.578
Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam	24.026	7/17/2010	5.334	3/5/2010	13.171

*Santa Paula Creek and Sespe Creek monitoring ended on July 14, 2010

Figure 1 – Schematic of Freeman Diversion Facility

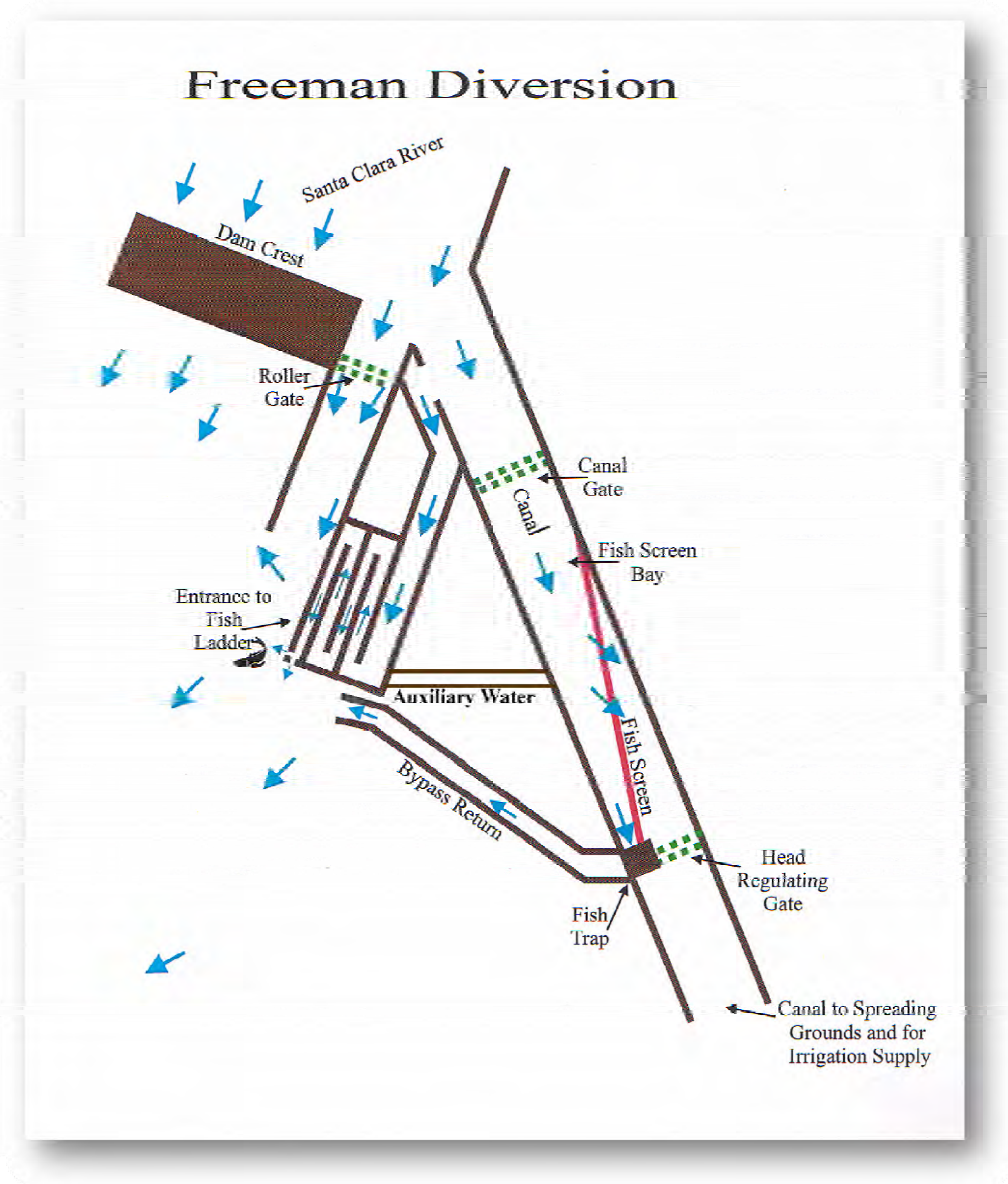


Figure 2 - Daily Rainfall Totals in Santa Paula, CA

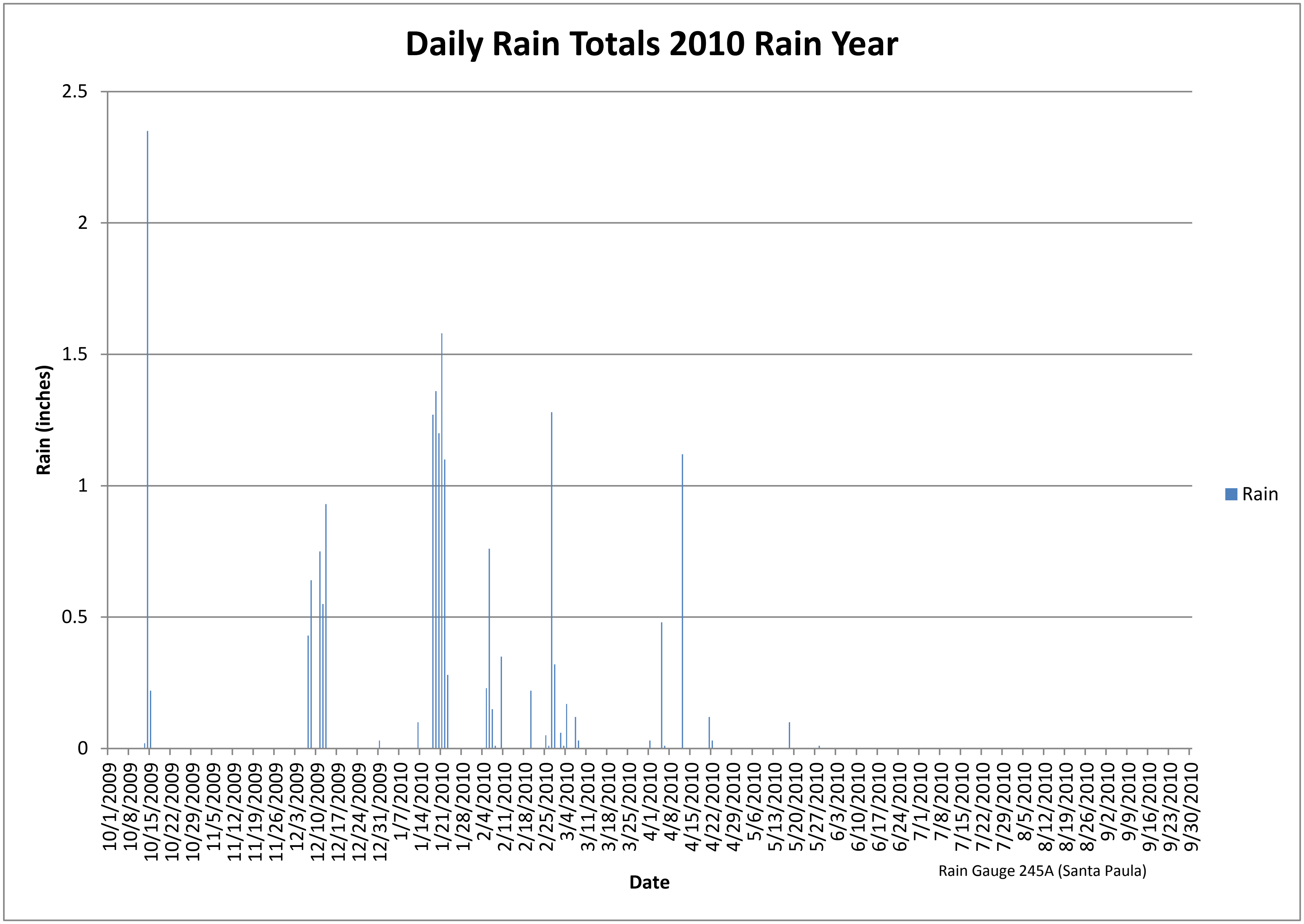


Figure 3 - Steelhead monitoring results

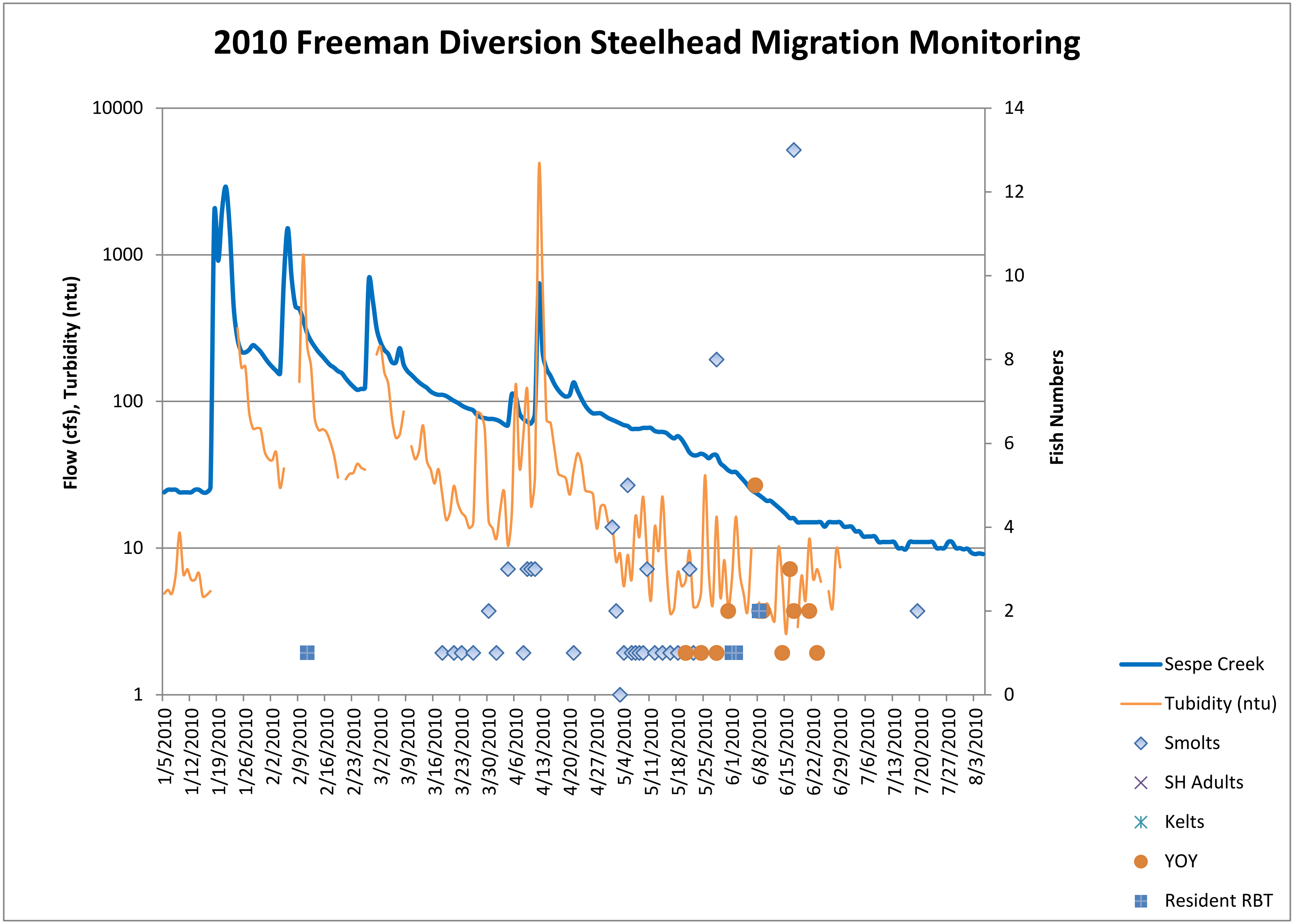


Figure 4 - Steelhead Length Frequency Histogram

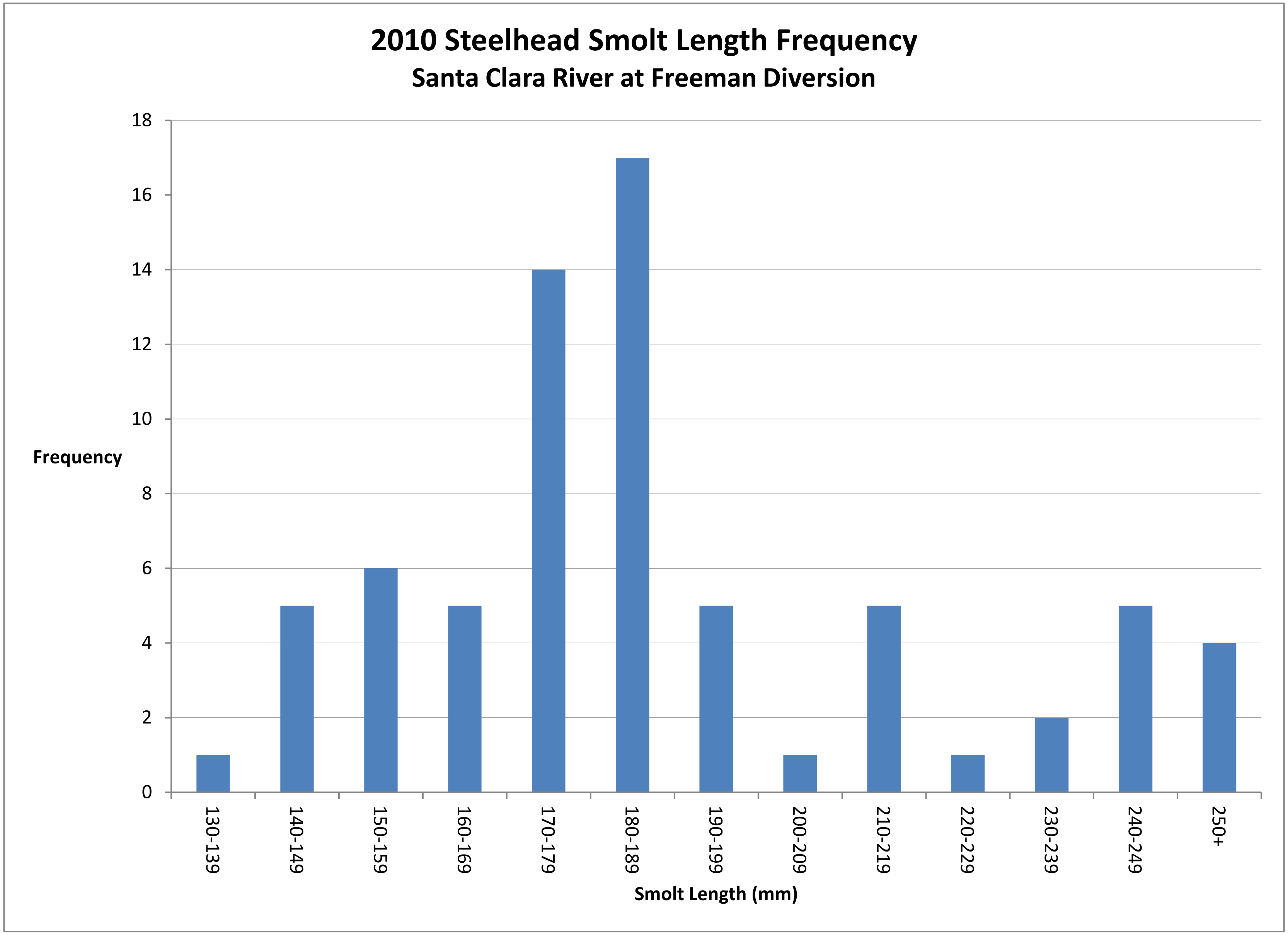


Figure 5 - Steelhead Lengths by Date

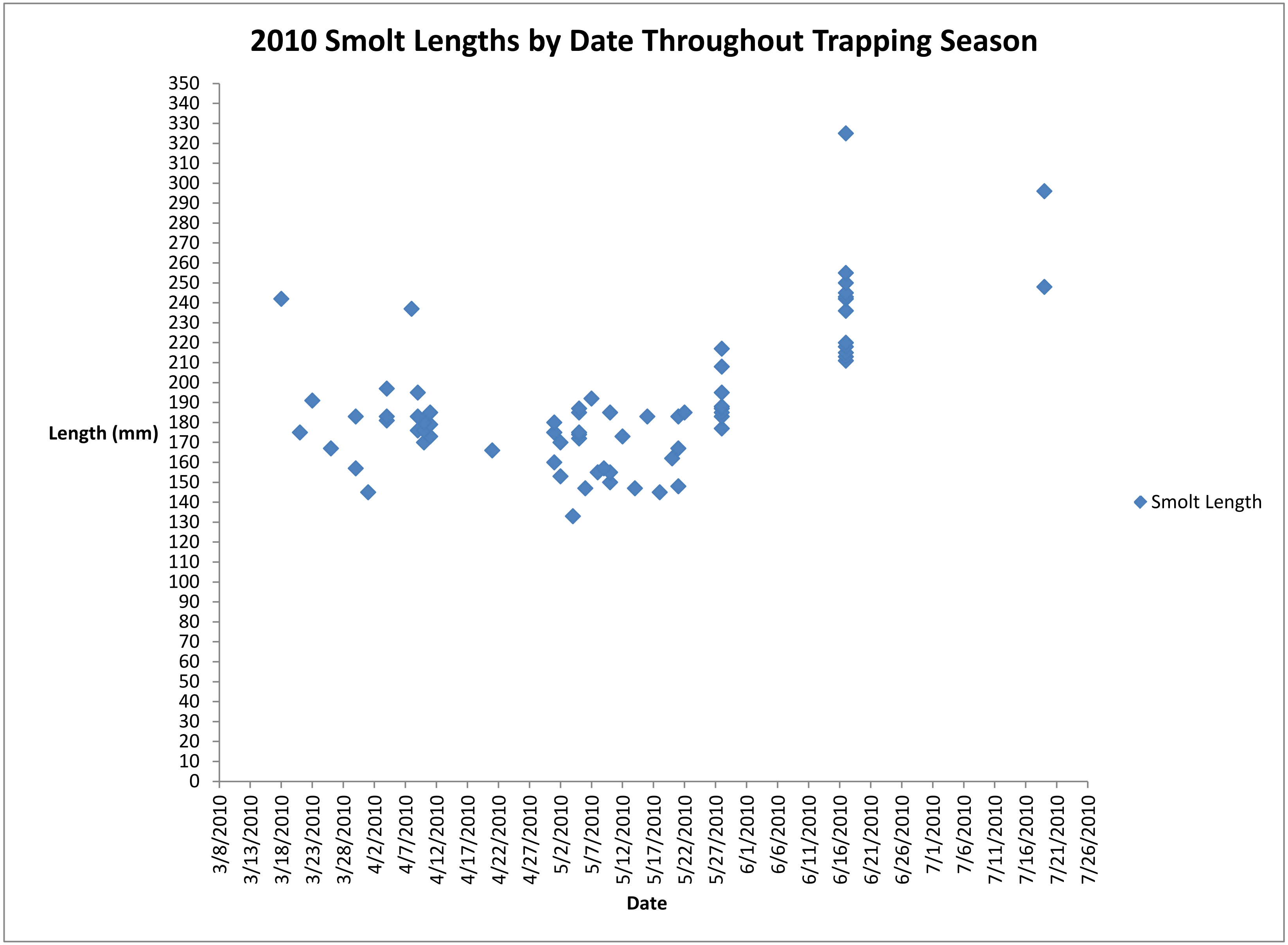
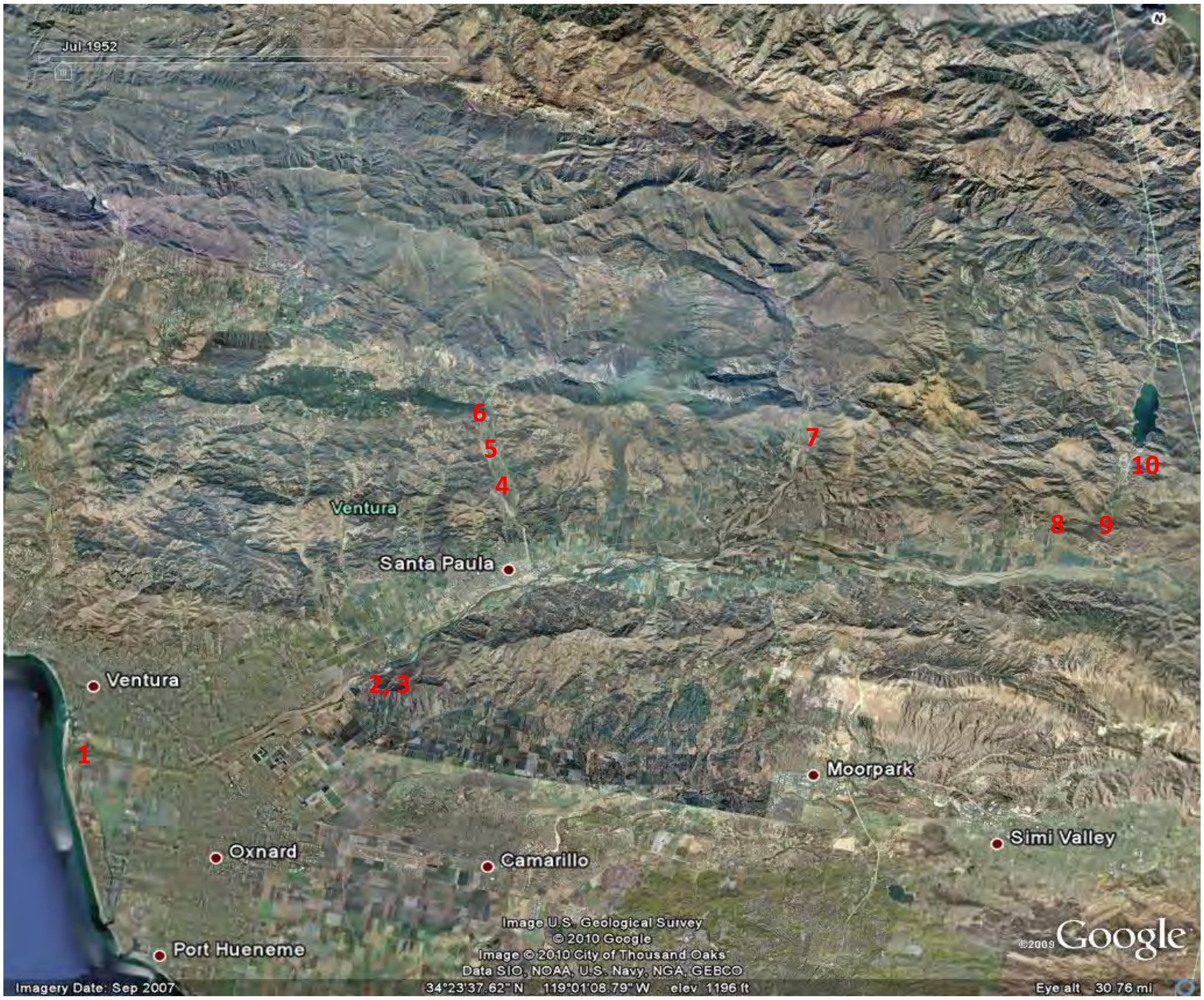


Figure 6 – Flow measurement sites below the Freeman Diversion

Figure 7 – Water temperature monitoring locations



1. Santa Clara River Estuary
2. Freeman Fish Trap Bay
3. Freeman Fish Screen Bay
4. Santa Paula Creek Upstream of Harvey Diversion
5. Santa Paula Creek at Steckel Park
6. Santa Paula Creek Directly Downstream of Sisar Creek Confluence
7. Sespe Creek at Grand Avenue
8. Piru Creek Downstream of Temescal's Property Line
9. Piru Creek at Old USGS Gauge
10. Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam

Figure 8 - Santa Clara River Estuary Water Temperature

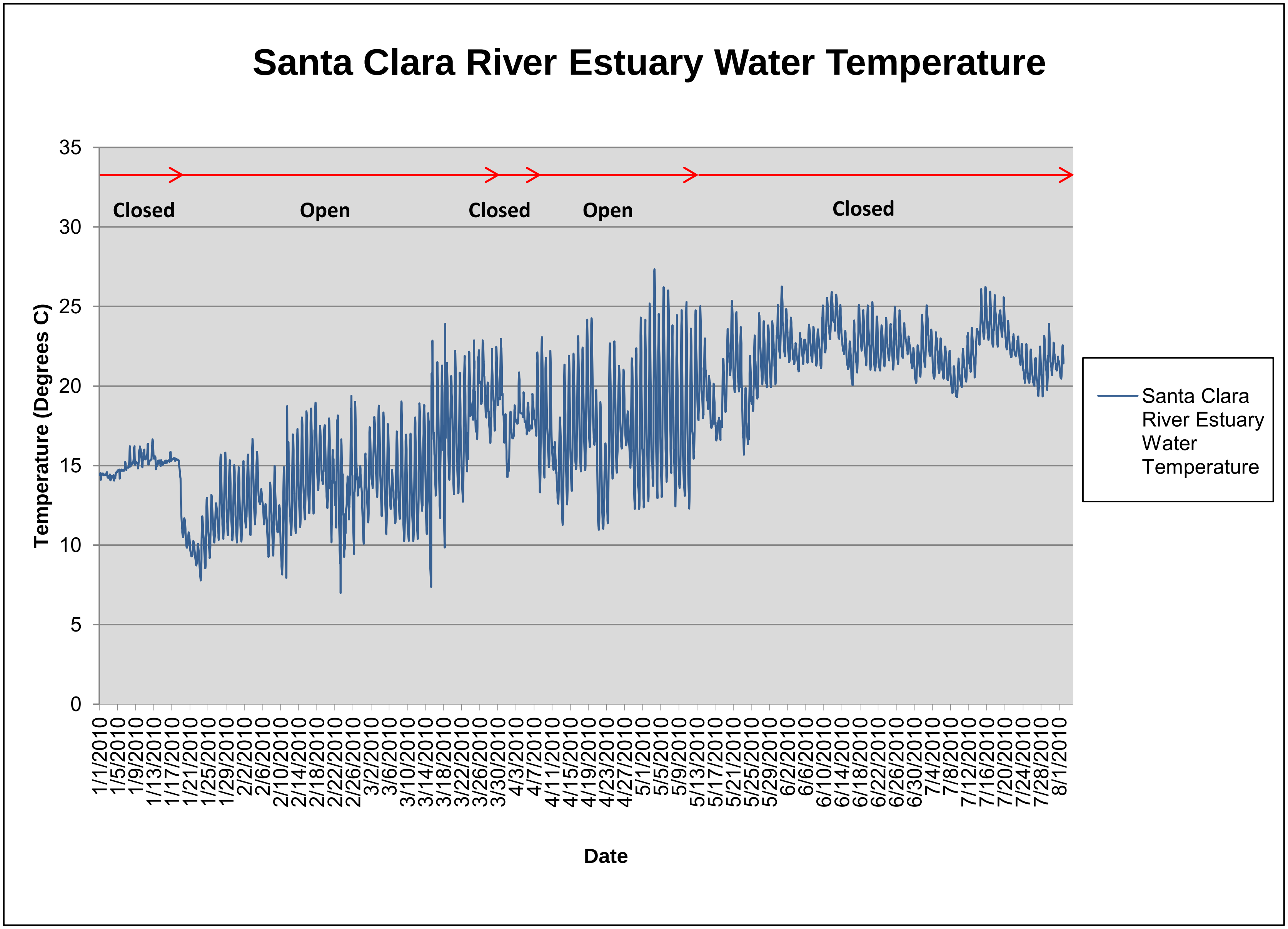


Figure 9 - Freeman Fish Trap Bay Water Temperature

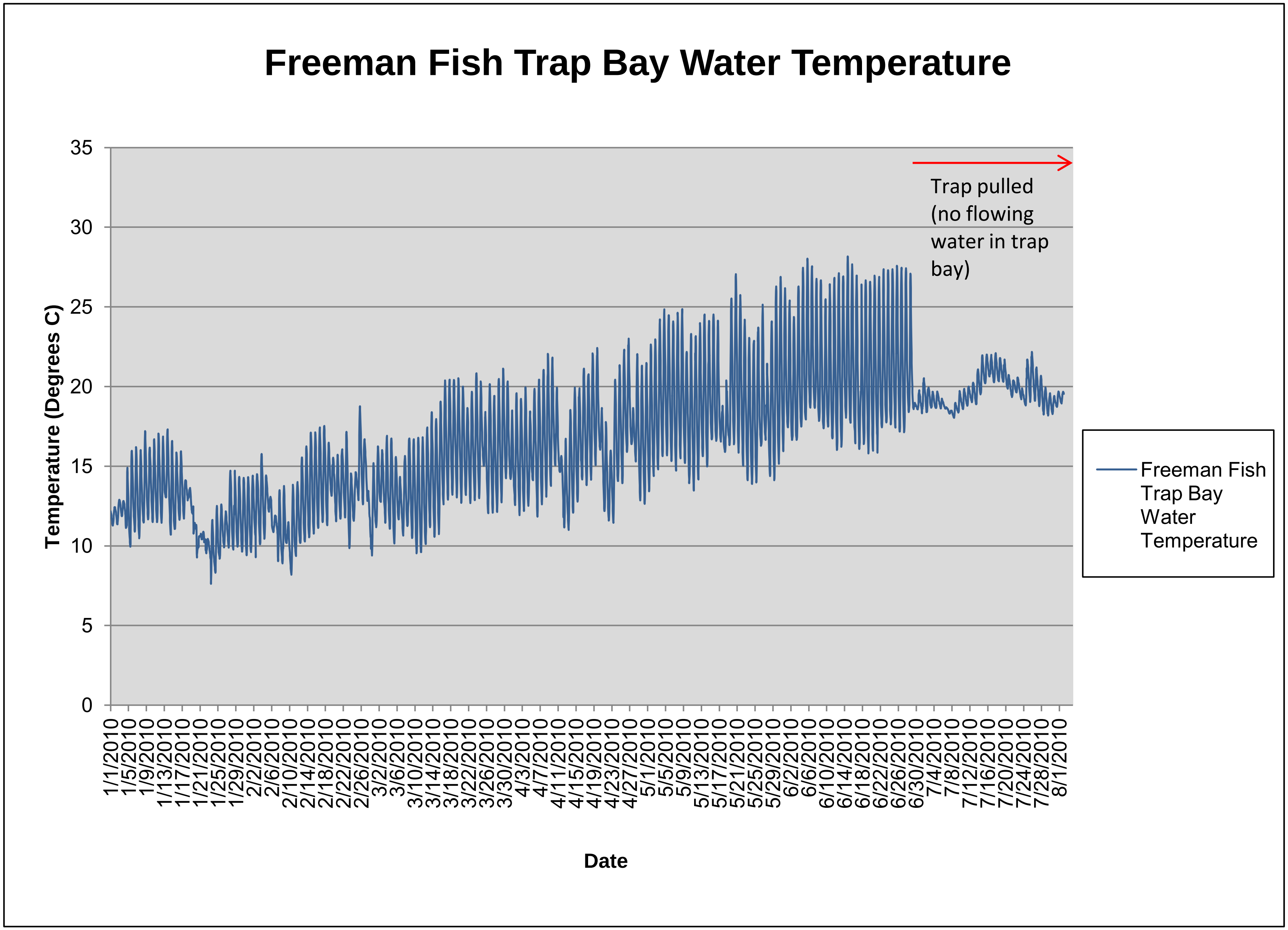


Figure 10 - Freeman Fish Screen Bay Water Temperature

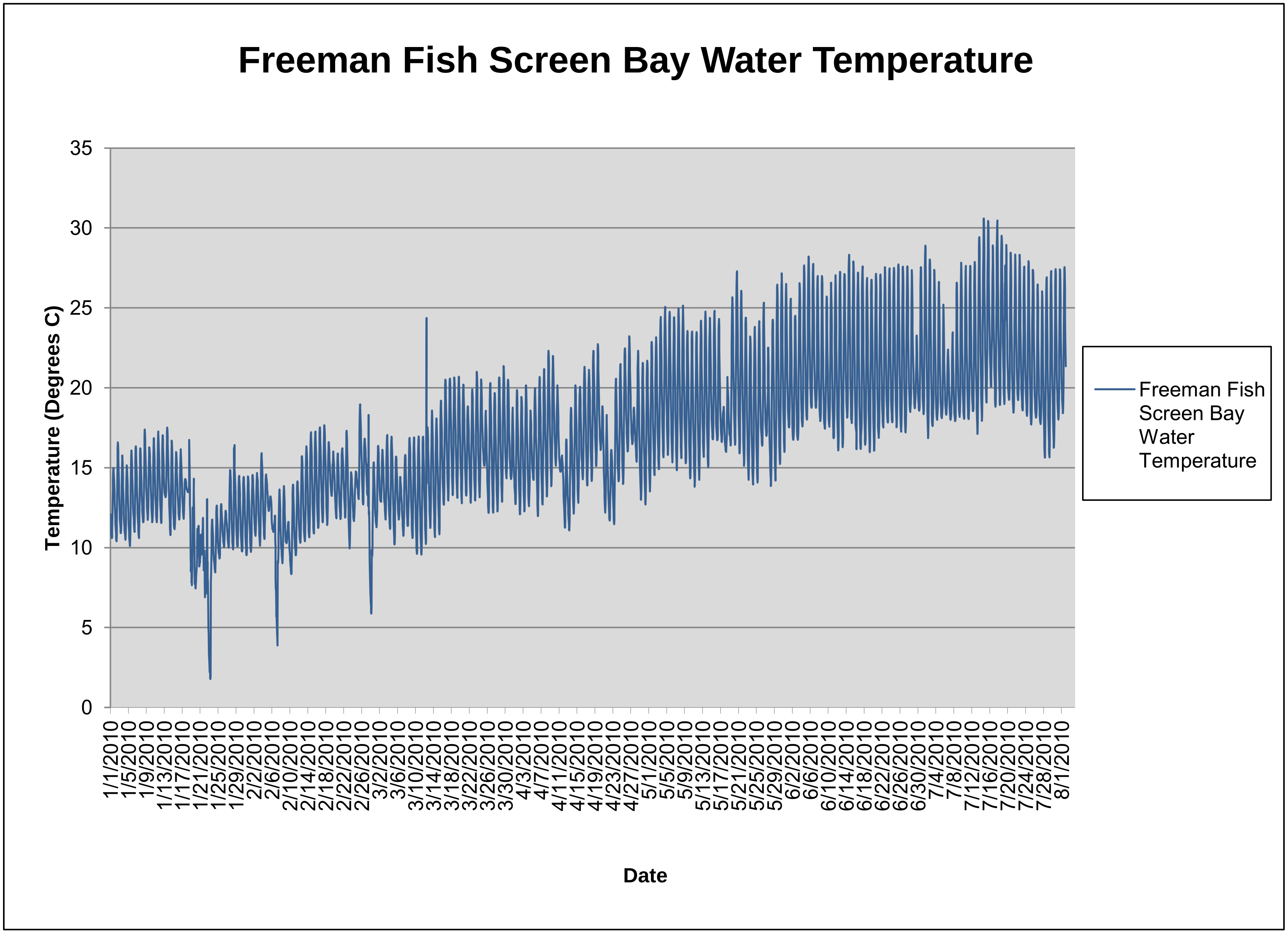


Figure 11 - Santa Paula Creek Upstream of Harvey Diversion Water Temperature

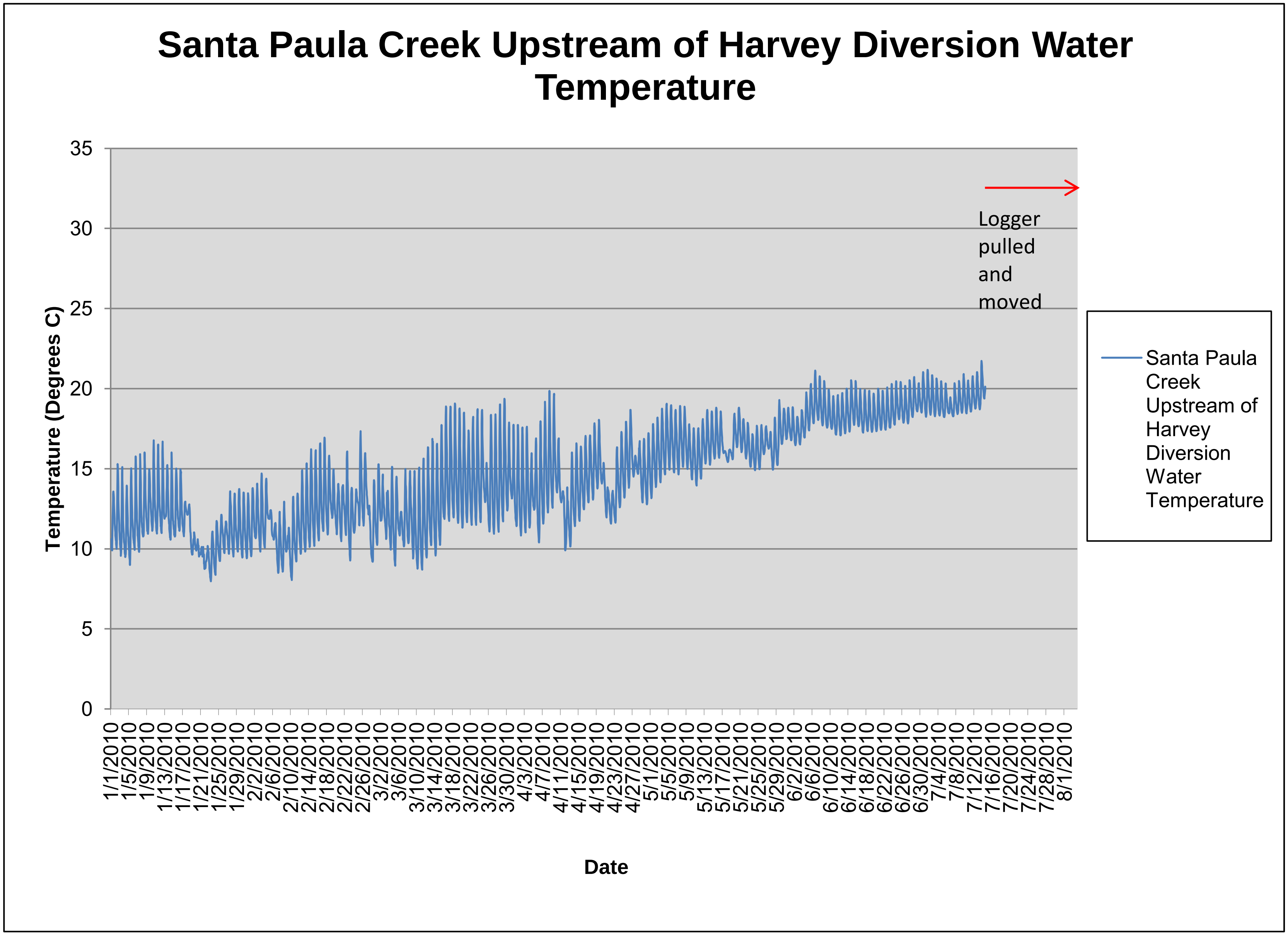


Figure 12 - Santa Paula Creek at Steckel Park Water Temperature

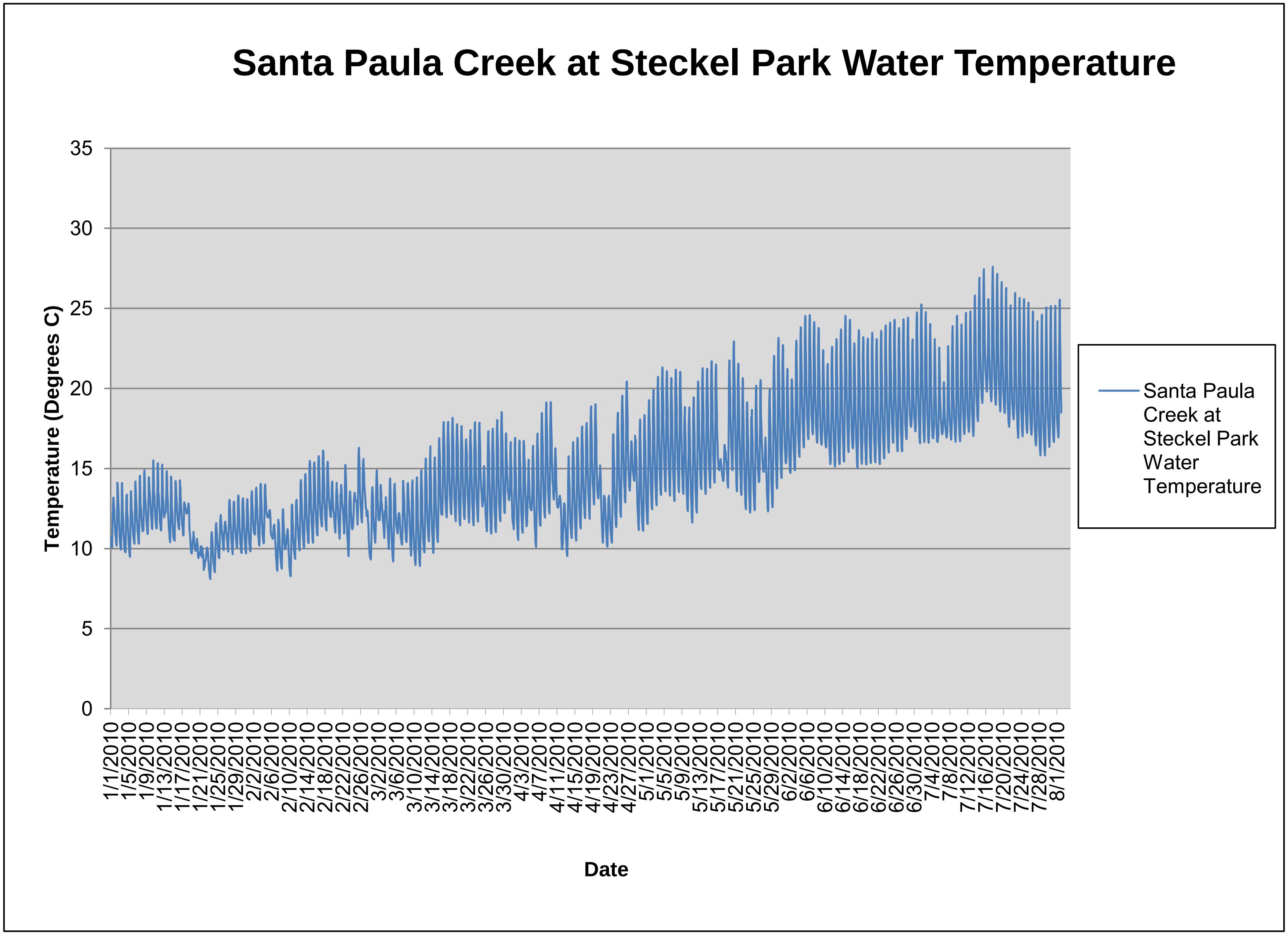


Figure 13 - Santa Paula Creek Downstream of Sisar Creek Confluence Water Temperature

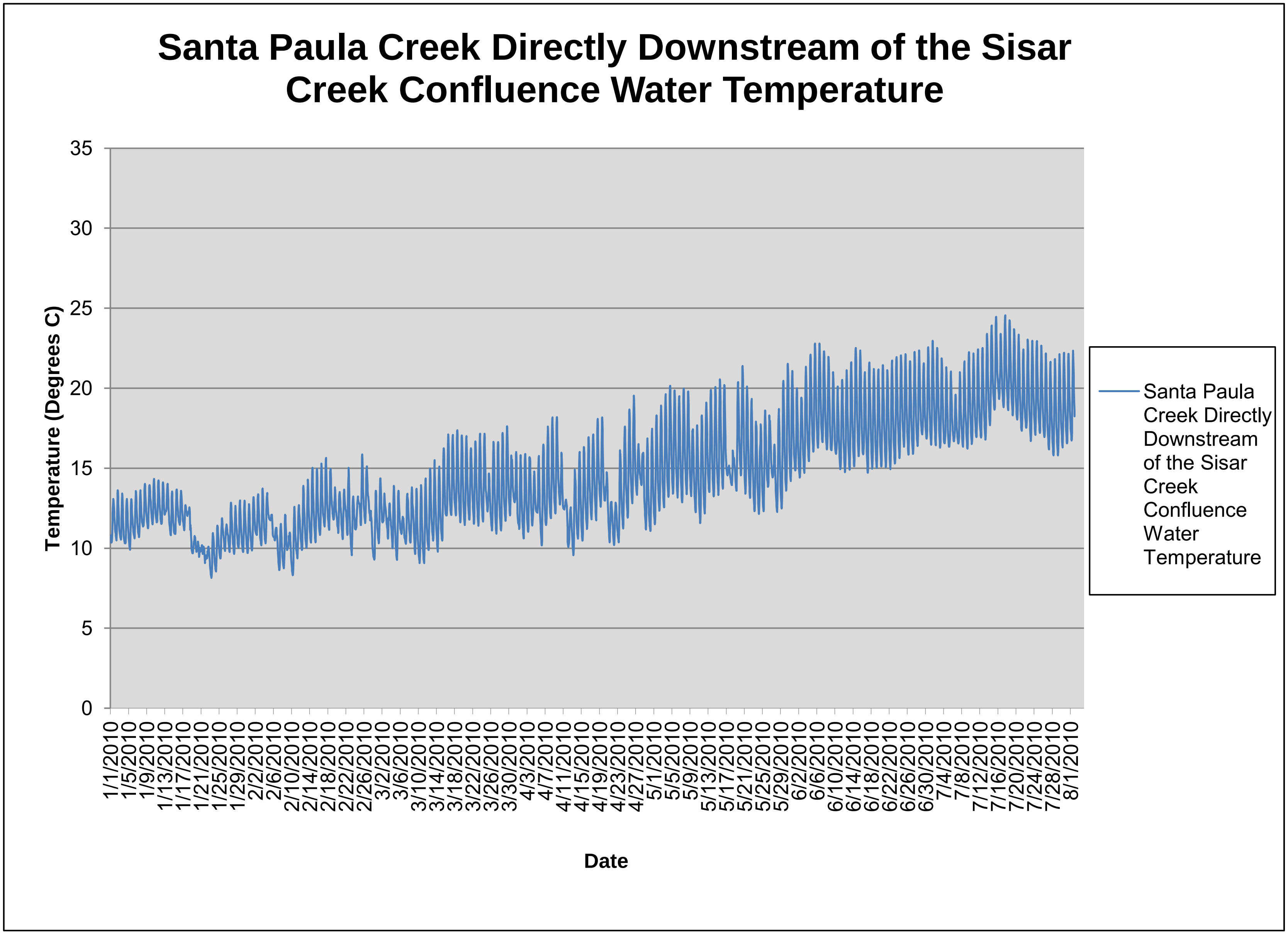


Figure 14 - Sespe Creek at End of Grand Avenue Water Temperature

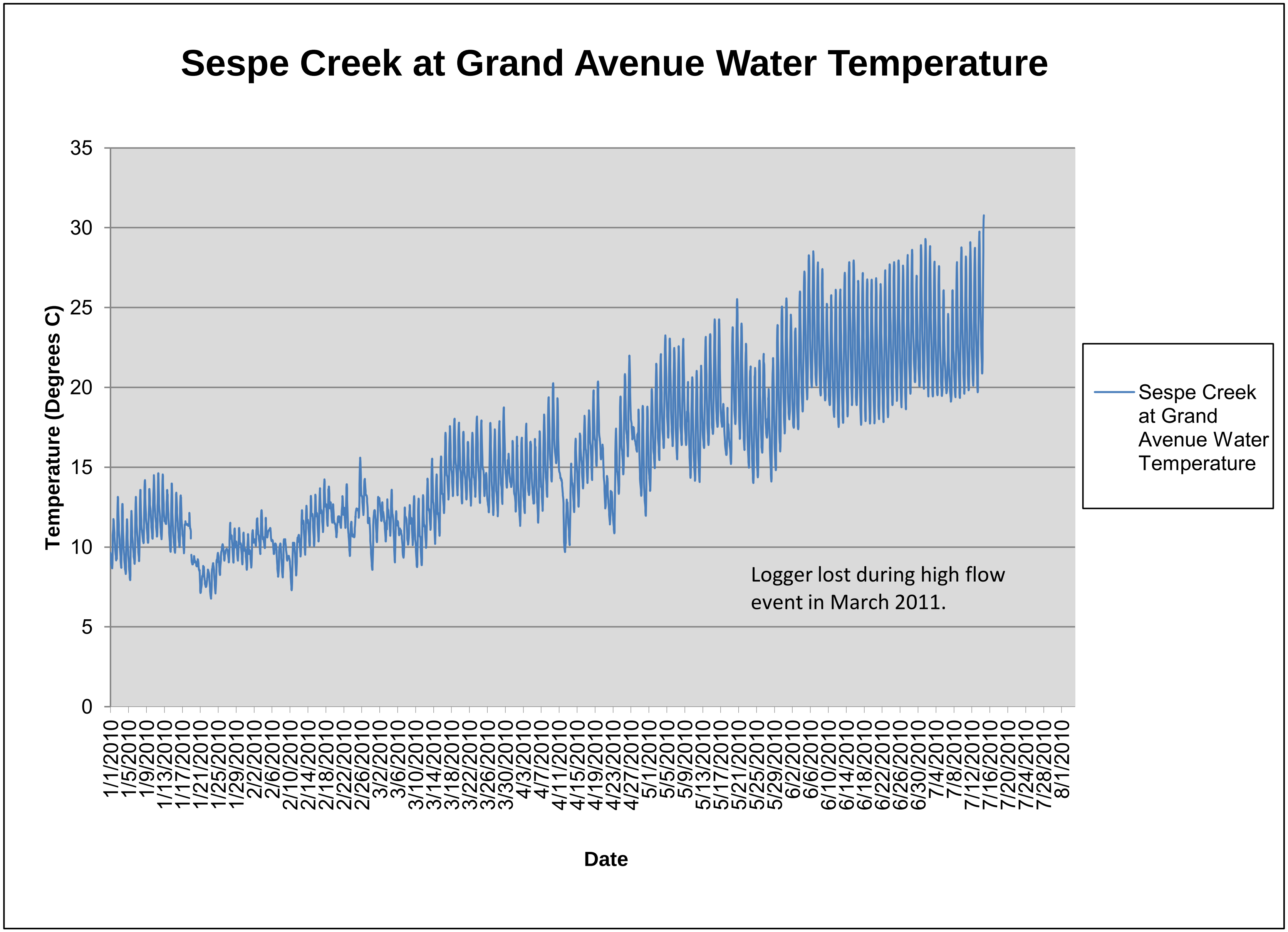


Figure 15 - Piru Creek Downstream of Temescal's Property Line Water Temperature

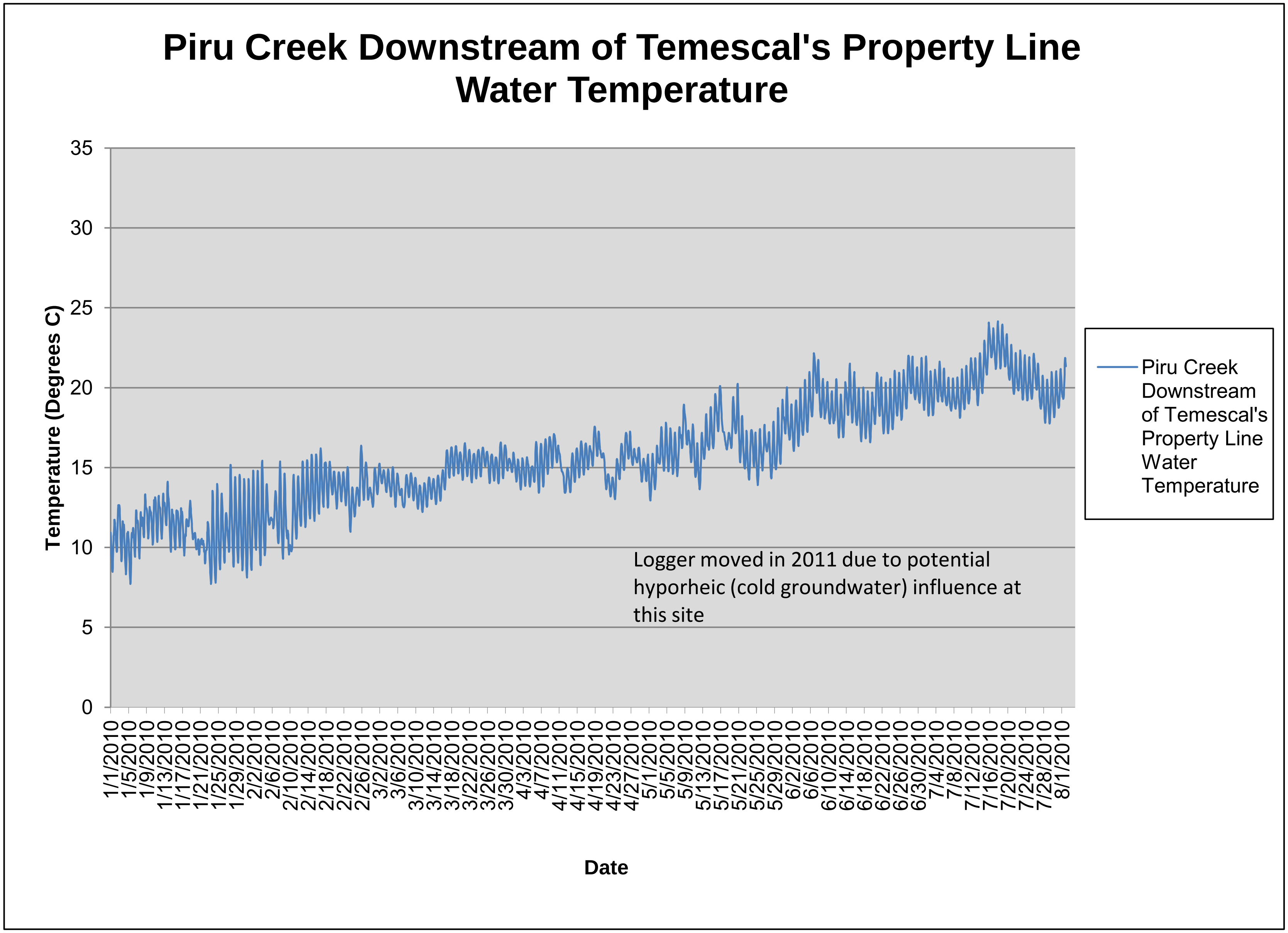


Figure 16 - Piru Creek at Old USGS Gauge Water Temperature

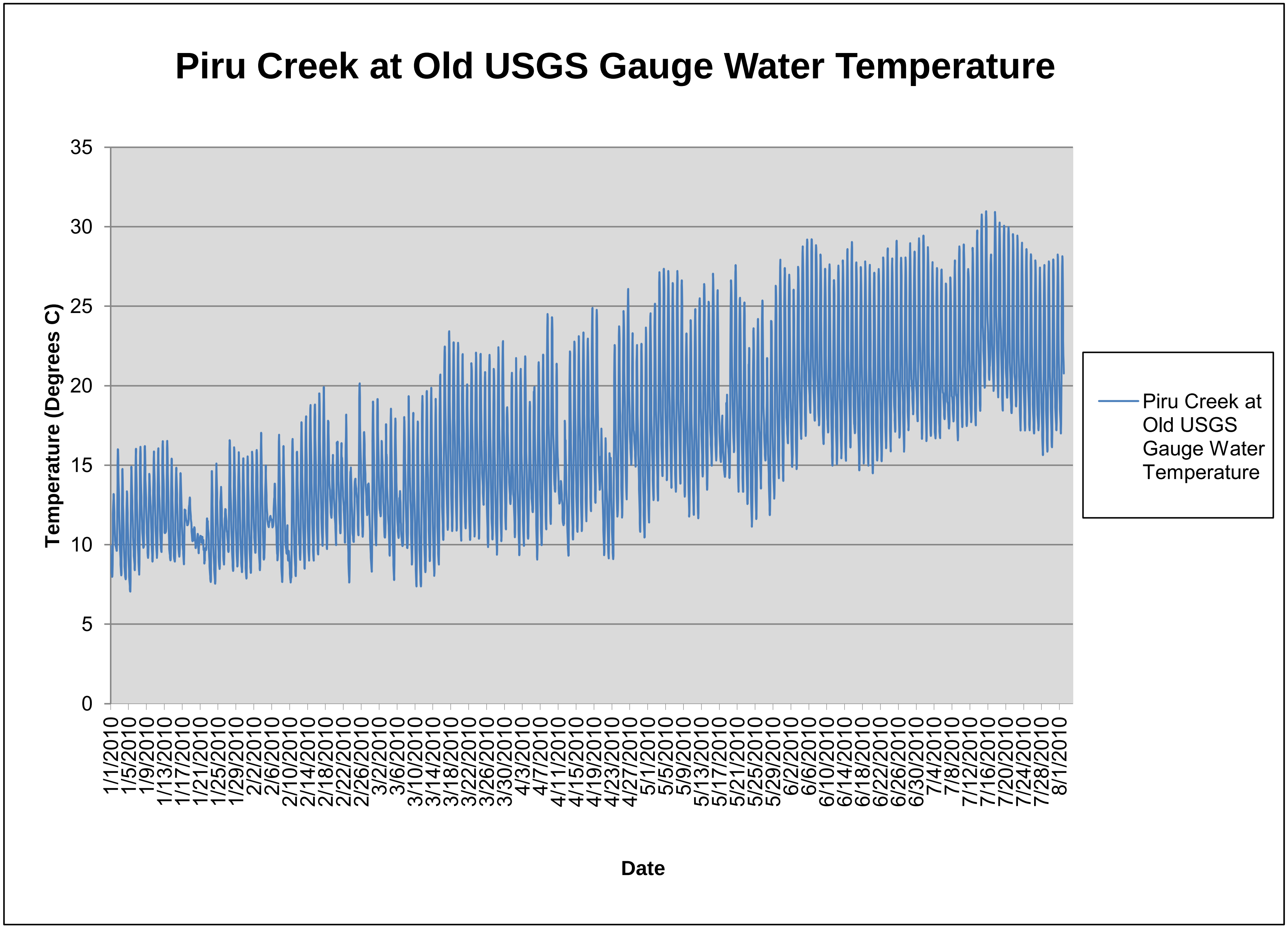
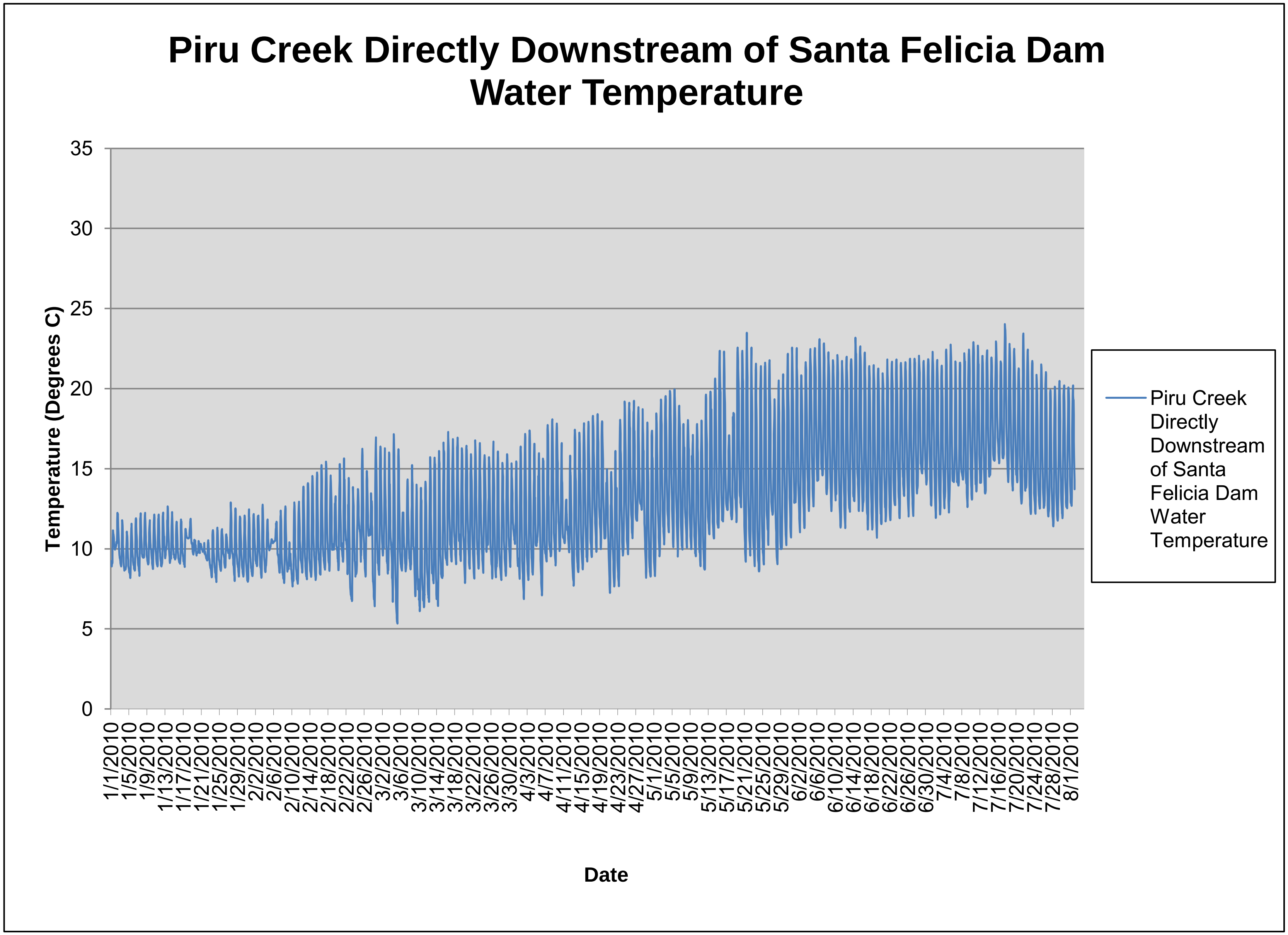


Figure 17 - Piru Creek Downstream of Santa Felicia Dam Water Temperature



Appendix B

Photos

Photo 1 – Santa Clara River Estuary Smolt Relocation Site Open

Photo 2 – Santa Clara River Estuary Smolt Relocation Site Closed

Photo 3 – Santa Clara River (near Santa Paula) Resident Rainbow Trout Relocation Site

Photo 4 – Sespe Creek Resident Rainbow Trout Relocation Site

Photo 5 – Santa Paula Creek Resident Rainbow Trout Relocation Site

Photo 6 – Santa Clara River Steelhead Smolt Length Measurement (4/16/2009)

Photo 7 - Santa Clara River Steelhead Smolt (5/6/10)

Photo 8 – Santa Clara River Resident Rainbow Trout (3/20/08)

Photo 9 - Upstream Migration Monitoring Infrared Scanners

Photo 10 – Upstream Migration Monitoring Surveillance System

Photo 11 – Fish Screen Bay Stranding Survey

Photo 12 – Santa Clara River Estuary Water Temperature Monitoring Site

Photo 13 – Fish Trap Bay Water Temperature Monitoring Site

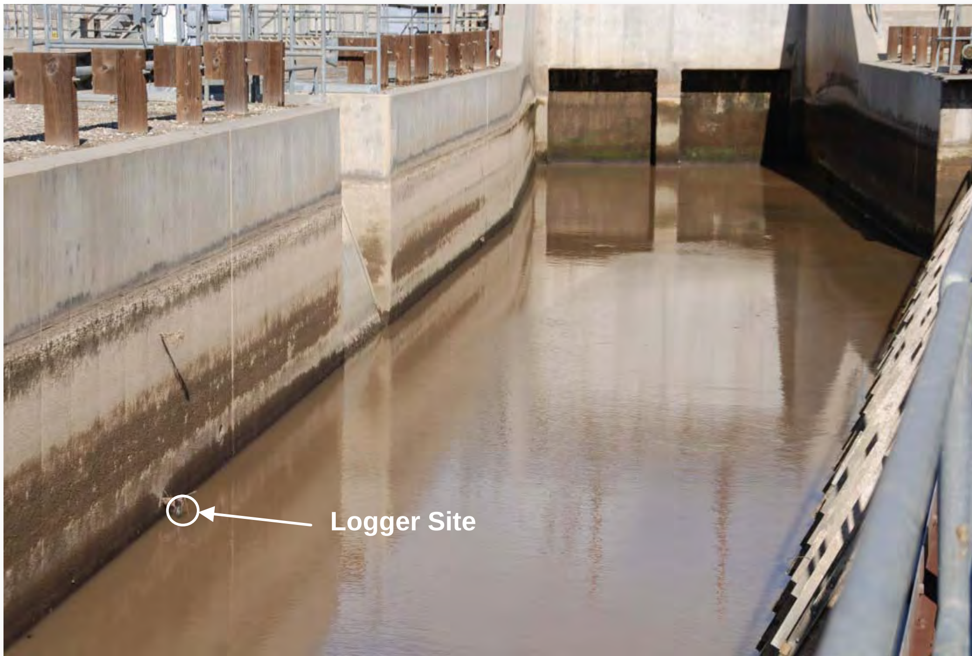


Photo 14 – Fish Screen Bay Water Temperature Monitoring Site

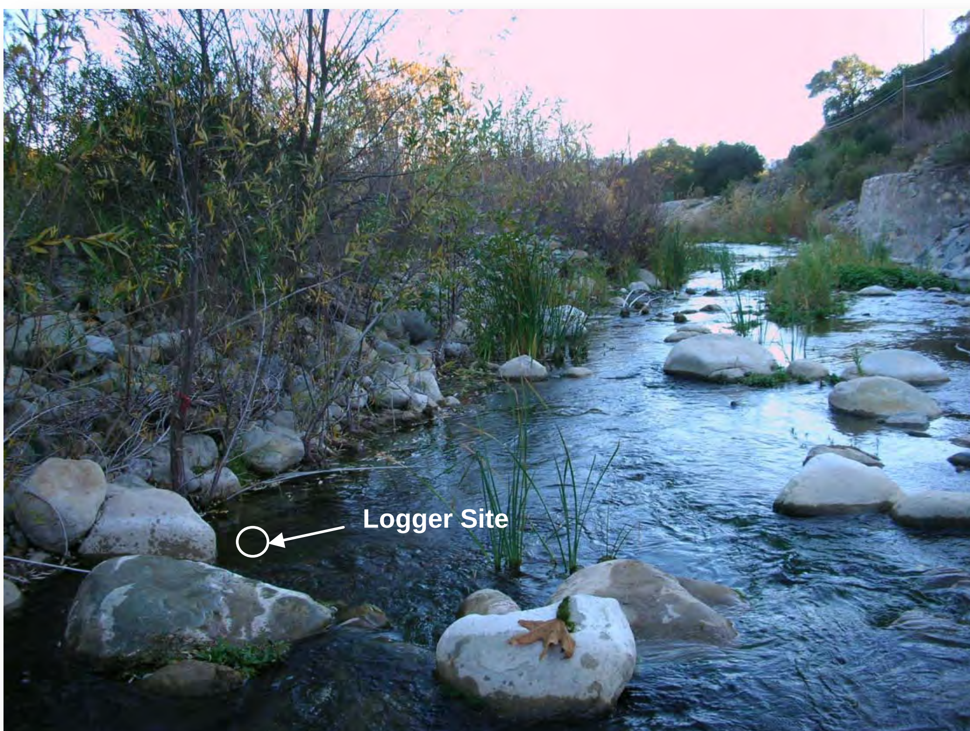


Photo 15 – Santa Paula Creek upstream of Harvey Diversion Water Temperature Monitoring Site

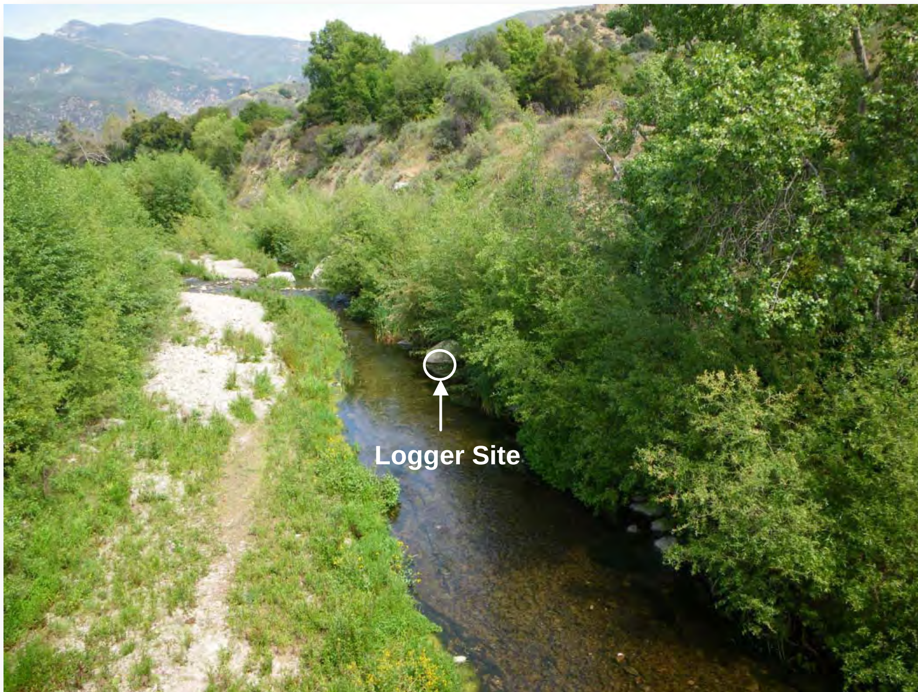


Photo 16 – Santa Paula Creek at Steckel Park Water Temperature Monitoring Site

Photo 17 – Santa Paula Creek below Sisar Creek Confluence Water Temperature Monitoring Site

Photo 18 – Sespe Creek at end of Grand Avenue Water Temperature Monitoring Site

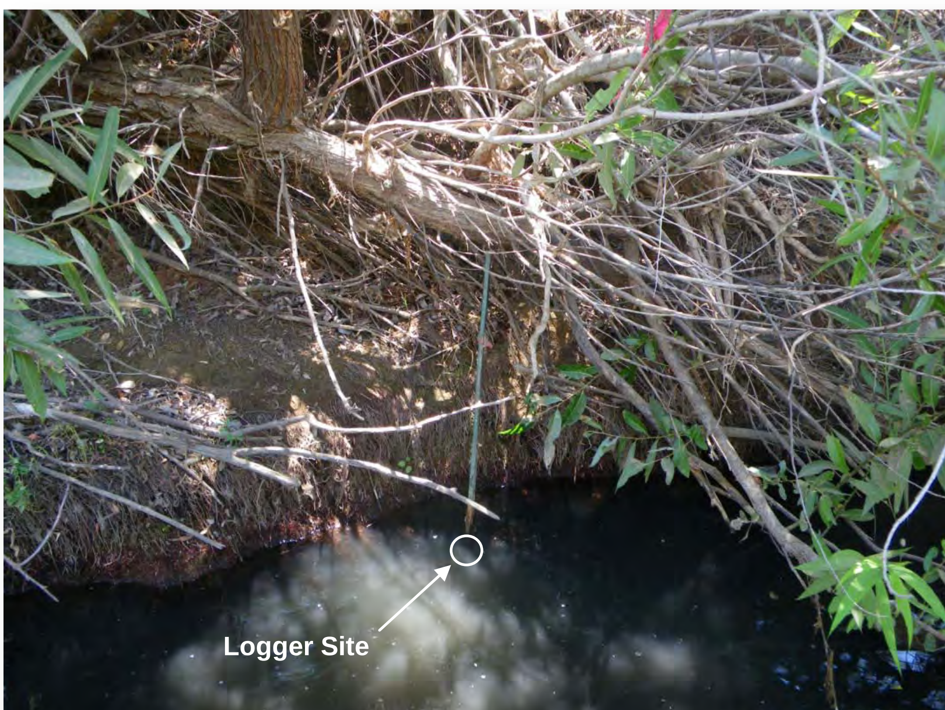


Photo 19 – Piru Creek D/S of Temescal Property Water Temperature Monitoring Site

Photo 20 – Piru Creek at Old USGS Gauge Water Temperature Monitoring Site

Photo 21 – Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam Water Temperature Monitoring Site

Panoramic Photos Below the Freeman Diversion

1/25/10

1/27/10

2/1/10

2/4/10

2/16/10

2/19/10

2/23/10

2/28/10

3/2/10

3/4/10

3/7/10

3/11/10

3/14/10

3/16/10

3/19/10

3/23/10

3/28/10

3/31/10

4/7/10

4/11/10

4/12/10

4/14/10

4/18/10

4/20/10

4/27/10

4/30/10

5/2/10

5/3/10