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
2009 Monitoring Season

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Vern Freeman Diversion Facility
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Annual Report
2009 Monitoring Season

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UNITED WATER CONSERVATION DISTRICT

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2009

Cover Photos (by Steve Howard): clockwise from top: Freeman Diversion Dam, 2009 Potential Steelhead Kelt, 2009 Santa Clara River Adult Steelhead

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The water year of 2009 was considered a “low-normal year” meaning it wasn’t wet or dry although normal and average are terms that do not fit well when attempting to characterize water years in this dynamic southern California climate. Rainfall in wet years can reach 40+ inches in the lower coastal plain and even more in the mountain areas. Rainfall in dry years can be close to zero to a few inches. A total of 11.47 inches of rain was measured at the United Water Conservation District gauge (Station 245A) located in Santa Paula during the 2009 season. The largest monthly rain total was 5.24 inches in February.

The sandbar at the Santa Clara River Estuary (SCRE) was open to the ocean from February 7 to March 30 and was closed during the remainder of the steelhead migration season (January through June). Smolt trapping at the Freeman Diversion started on January 5 and ended on May 22, 2009. Steelhead smolts were first observed in the fish trap on January 30 and last observed on May 15, 2009. The fish ladder was in operation from February 9 to February 13, from February 18 to March 11.

One adult steelhead traversed the fish ladder in 2009. One potential steelhead kelt, 160 steelhead smolts, 3 resident coastal rainbow trout, and 0 young-of-the-year coastal rainbow trout were trapped at the Freeman Diversion Fish Trap. No Pacific lamprey were observed during the 2009 migration season although a small number of adult lamprey could have traversed the fish ladder since 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 2009.

Water temperature monitoring occurred in the estuary, mainstem Santa Clara River, Santa Paula Creek, Sespe Creek and Piru Creek.

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 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 unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*). The threespine stickleback is comprised of two sub-species in the Santa Clara River, the partially-armored (*Gasterosteus aculeatus microcephalus*) 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 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 breading (*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 2009 rain season (10/1/2008-9/30/2009), Santa Paula had 66.1% of normal rainfall totaling 11.47 inches (Ventura County Watershed Protection District website, Santa Paula-UWCD Gauge 245A). The most rainfall in a 24 hour period was 1.59 inches on December 15, 2008 and the highest monthly rain fall occurred in February with a monthly total of 5.24 inches (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. 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 have fish passage facilities.

The main steelhead bearing tributaries in the Santa Clara River are Santa Paula and Sespe Creeks. These tributaries were flowing during the entire 2009 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 observed between March and May. In 2009, smolts were observed at the Freeman Diversion as late in the season as July. These late smolts appeared to be losing their silvery appearance and were "fatter" than the earlier smolts that had the typical stream-line shape and low condition factor. The smolt migration period continues sometimes for months following storm events and these fish most likely enter the mainstem directly following storm events and rear and feed in the mainstem Santa Clara River during their migration to the ocean. The smolts tend to be shorter early in the season (180 millimeters or 7.1 inches average in March and April) and longer and more robust toward the end of the migration season (239 millimeters or 9.4 inches average from May through July). The smolts that are in the river later in the season are most likely feeding on the spring larvae of Santa Ana and Owens sucker and arroyo chub. There is the potential that the increased biomass from the spring spawn of non-native fishes is affecting smolt migration behavior by delaying or even stopping migration due to the increased food source. The effects on native fishes by the presence of non-native and exotic species can 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 (District) Vern Freeman Diversion Fish Passage Facility on the Santa Clara River in 2009.

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 2009 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 2009 up to 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 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 anadromous downstream migration data in the Santa Clara River. Since there is a lack of scientific information 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 and regionally. 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 with or without diversions occurring at the Freeman Diversion.

2.2 METHODS

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 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.

Downstream migrant steelhead smolts, kelts, lamprey macropthalmia and other fish entering the fish screen bay 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 a downstream migrant fish trap. If fish trapping is not warranted due to sufficient migration flows in the lower river, the downstream migrant trap is lifted from the fish trap bay and all downstream migrants 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 macropthalmia trapped at the facility are transported in aerated coolers by truck to the Santa Clara River Estuary. Resident coastal rainbow trout that are not exhibiting phenotypic smolting characteristics and lamprey ammocoetes are 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 are returned to the river upstream of the diversion. Non-native and exotic aquatic species are 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 is checked daily in the morning and downstream migrants are removed from the trap with a dip net, counted and measured. Other trapped aquatic species are counted and documented during each trap check. All fisheries personnel are trained in species identification and handling. A species identification handbook drafted by Steve Howard (lead biologist) is also available.

Data Collection – Steelhead smolts were measured (fork length) to the nearest millimeter in a wet fish measuring board. This is typically done with fish out of water no more than 10 seconds. 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 so these activities occur early in the morning. 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. 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 site with a multi-parameter water quality meter. Photos were taken with a digital camera of all salmonids and lamprey collected and transported. 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 depends 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 are known to be low in oxygen are avoided.

Acclimation Schedule - Fish are 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 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 AND WEIGHT MEASUREMENTS

Trapped smolts were measured to fork length (Photo 6, Appendix A) and weighed to the nearest tenth of a gram (Photo 7, Appendix B). Lengths were measured by placing the fish in a fish measurement cradle for no more that 10

seconds. The fish was then placed on a scale (Ohaus® Pro 600) for no more than an additional 10 seconds. The fish were not sedated. If an individual fish could not be measured and weighed in less than 20 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 May 22, 2009. Smolts entered the trap from March 13 to May 15, 2009 (Figure 3, Appendix A). Smolt surveys continued during operational flushes and fish screen bay checks through the end of July. A total of 160 steelhead smolts (Photo 8, Appendix B), 1 steelhead kelt (Photo 9 Appendix B) and 3 resident coastal rainbow trout (Photo 10, Appendix B) were trapped and relocated during the 2009 migration season. The kelt arrived on April 16 and the 3 resident coastal rainbow trout arrived on February 16, May 14 and 15, 2009 respectively. All of the 160 steelhead smolts trapped at the Freeman Diversion were transported to the SCRE. No lamprey ammocoetes or macropthalmia were observed or collected at the Freeman Diversion facility in 2009.

The appearance and size of the potential kelt were not typical of a fish that entered freshwater, spawned and was returning to the ocean. Kelts are typically pale in color, skinny and as long as a typical anadromous steelhead which can be as long as 30 inches. This fish was silvery, 18.5 inches long and didn't appear spent (spawned out).

Below are emails Steve Howard sent to Terry Roelofs (professor emeritus Humboldt State University) and Bill Trush (fisheries consultant) and the National Marine Fisheries Service regarding the steelhead kelt that was trapped and relocated to the Santa Clara River Estuary on April 15:

> Hi Terry and Bill,
>
> > We had an 18 inch (470 mm FL) O. mykiss in our trap yesterday. The strange thing is that it was very silvery. The fish ladder has been out of operation for over a month now (about a month and a week) so no upstream migration could have occurred for some time. My first thought

was that it was a kelt but I have never observed a kelt of this coloration before. The fish was trim but it really didn't appear to be a spent fish but I am not entirely sure. The kelts I have had experience with are very skinny and definitely not silvery. Since it was silvery and heading downstream, I transported it to the estuary. I took some scale samples and photos. Attached is a photo of the fish and a scale. Please let me know what you think.

Hey Guys (Anthony Spina and Darren Brumback, NMFS biologists),

Below is an email I sent to Terry Roelofs and Bill Trush regarding the fish we had in the Freeman Trap last Thursday (April 16). The fish actually measured 18.5 inches (FL); I stated 18 inches in the email below. Based on the growth annuli on the scale, which appears to be a one year regenerated, there appears to be extended growth after a two year freshwater residency indicating a potential salt water phase in its life cycle. We transported the fish to the estuary since it was silvery and going that way. Strange fish! Any ideas, thoughts?

The trapping of this fish and the emails sent by Steve Howard created a large stream of emails sent between biologists throughout the state. The general consensus was that this fish most likely had an ocean phase during its life cycle but there was uncertainty regarding that assessment due to the appearance of the fish (silvery, 18.5 inches (FL)).

Additional fish collected in the Freeman downstream migrant trap included: partially armored threespine stickleback (N=927), Arroyo chub (N=2019), Santa Ana sucker (N=376), Owens sucker (N=202), Santa Ana/Owens sucker hybrids (N=117), fathead minnow (N=54), largemouth bass (N=7), green sunfish (N=14), brown bullhead (N=10), black bullhead (N=1), prickly sculpin (N=159) and mosquitofish (N=94) (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=16), bullfrog (N=517 mostly larvae), African clawed frog (N=37), tree frog (N=13) and Western pond turtle (N=4) (Table 5, Appendix A). A healthy pond turtle population exists directly above and below the Freeman

Diversion Dam.

2.3.2 SMOLT LENGTH AND WEIGHT MEASUREMENTS

A total of 134 smolts were measured. The average length of the 2009 smolts was 184.6 mm (standard deviation 16.3 mm) and the average weight was 70.1 g (standard deviation 21.2 g). A length frequency histogram was generated from the 134 smolts measured (Figure 4, Appendix A). The equation using an exponential regression used to generate a smolt weight-length relationship was $W = 3.1327e^{0.0164L}$, $R^2 = 0.923$ (Figure 5, Appendix A).

Growth rates were calculated by length and weight during the trapping season and there was a weak relationship analyzing temporal growth rate using a liner regression analysis (Figure 6, Appendix A). Thanks to Scott Lewis at Casitas Water for analyzing the data.

The weak linear relationship between growth and time could be explained by the observed wide spatial and temporal variation in water temperatures within habitats in southern California drainages. A fish that finds thermal refuge in a pool with a cold spring will grow slower than a fish that is sequestered from thermal refugia and must survive in warmer water by increasing feeding rates to survive a higher metabolism. Also, there are most likely temporal affects on growth rates when the plethora of non-native fish species spawn in the spring producing large numbers of larvae as food. Another causal affect could be from the high annual variation in the dynamic weather patterns and resulting flow conditions in southern California.

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). There is some uncertainty regarding how many steelhead have passed the diversion dam because of lack of an efficient monitoring program due to extreme environmental constraints. Even with the uncertainties in the data, alow number of wild adult steelhead (N=9) have been observed at the diversiondam since it was constructed in 1991. Two additional adult steelhead that were 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, adult upstream migrants observed and/or relocated, numbers of fish 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. Water quality data were collected 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 migrants when they jump over a false weir and through an infrared (IR) scanning devise. 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 upstream migration monitoring 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.

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 7, Appendix A).

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 glides appears 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 have narrower active channels (wetted perimeter) 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.*

The operating criteria are as follows: From January 1st to March 31st the fish ladder will be 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 will be 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 will be reduced to 2/3 of the previous day's flow; on the last day a flow of 20 cfs will be provided. This ramp down scenario would occur 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 2009 are presented in Tables 6 and 7, Appendix A.

3.2.2 VIDEO MIGRATION MONITORING

Upstream migration monitoring was conducted using a false weir and infrared counter (Photo 11, 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 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 Pacific lamprey to pass the false weir. It is unclear if Pacific lamprey will be able to pass through the bar screen based on 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.

When steelhead traverse the fish ladder and jump over the false weir, two video monitoring systems document the event as well as species identification and size. A Digital Video Recorder (DVR) was the primary device used and a Video Cassette Recorder (VCR) was used as a back-up system (Photo 12, Appendix B). Both systems received the same image from a single camera mounted on the side of the ladder four feet upstream of the false weir. The camera was positioned to capture images of upstream migrant steelhead jumping over the weir structure. A twenty-five watt fluorescent light was 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 invisible beams that when broken by a fish jumping through the beams, it signals the DVR to record the event. The DVR recorded events for twenty seconds before and then ten seconds after being triggered.

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 DVR were reviewed by staff during these checks.

3.2.3 LADDER SHUTDOWNS

During shutdowns/dewatering of the ladder, a thorough examination of the entire fish ladder was conducted to check for the presence of any fish species. The ladder was shut down for operational 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 February 8 to February 13 and February 18 to March 11, 2009. No steelhead or Pacific lamprey were observed traversing the fish ladder in 2009. We did encounter some problems with the infrared scanners for a short time on February 12 and the video resolution at night was poor even with lighting. One adult steelhead did pass the ladder on March 4, 2009 but was apparently detected by the migration monitoring equipment but not filmed due to low light (Photo 13, Appendix B). This fish was observed in the fish screen bay during a turn-out event resulting from high turbidity during a small spring freshet. Since this fish was observed during a stranding survey in the fish screen bay, results regarding activities with this fish are described in section 4.2.1. This was the first year we monitored flows daily at locations downstream of the Freeman Diversion. We had a learning curve working with and communicating with the operators at the dam regarding how much flow to release and how to monitor natural flow recession upstream of the dam to

maintain the prescribed flow downstream. We learned quite a bit this year and flow management should go more smoothly next year.

3.3.2 VIDEO MIGRATION OBSERVATION

The DVR and VHS recording equipment were operated continually from February 8 to February 13 and February 18 to March 11, 2009; during the operation of the fish ladder. Throughout this period the alarm trigger system and video recordings were monitored and checked daily.

In 2009, all triggered alarms were determined to be “false hits”; triggered by something other than steelhead. The one steelhead observed in the screened fishbay probably triggered the alarm but numerous “false hits” occurred from surging water during the same time it is assumed the fish passed the ladder. The “false hits” triggered by the scanning devices were most often triggered by surging water levels. Occasionally, birds, insects or debris blowing in the wind would trigger a “false hit”.

In the future, additional video observation monitoring equipment will be incorporated into the current system. The objective of a more extensive monitoring system will be to gain knowledge of steelhead behavior before they enter the ladder and provide timing of passage through the ladder. These data could be extremely useful regarding management of operations at the Freeman Diversion Fish Ladder.

3.3.3 LADDER SHUTDOWNS

The fish ladder was shut down a total of four times in 2009. One shut down event occurred on February 13 and four events occurred in March (4th, 10th & 12th).

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 14, 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 2009, 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 2009, 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 6 turn-out events occurred during the 2009 water year. Two of these events were during gate maintenance that also resulted in flushing sediment from behind the dam. The remaining turn-out events were due to high turbidity levels from high sediment loads. Six fish screen bay stranding surveys were conducted and six additional surveys were conducted to see if smolts were holding in the fish screen bay and not entering the trap. Six of these stranding surveys yielded a total of 44 steelhead smolts (Table 8, Appendix A). All 44 smolts were relocated to the Santa Clara River Estuary. These smolts (n=44) were included in the total smolt trapping results (n=160) section (see section 2.3.1). One adult steelhead was observed in the fish screen bay and was captured and relocated upstream of the Freeman Diversion on March 4th.

Below are excerpts from a letter to NMFS drafted by Steve Howard documenting the activities that occurred following the observation of the adult steelhead on March 4th.

> At approximately 8:15 PM I received a call from an employee of the United Water Conservation District O&M Department that the turbidity levels increased to a level that the diversions would be “turned out” to the river. Turned out means that all river flow will be released downstream of the diversion an all diversions will be halted temporarily. Isolated storms in the foothills of Santa Clara River tributaries including Sespe Creek increased flows as much as 150 cfs. Recent fires have created barren conditions in that watershed and excessive sediment

volumes are entering the river. I arrived approximately 20 minutes following the phone call and started decreasing flow in the fish ladder. I then closed the head gates in the concrete forebay (screened fishbay) to maintain sufficient water depth until I was ready to survey that area. At approximately 9:00 PM Sara Gray (assistant fisheries biologists) arrived and she assisted me in surveying the fish ladder and forebay for potential stranded fish including steelhead and Pacific lamprey.

No fish were observed in the fish ladder following an extensive stranding survey that occurred for approximately 30 to 45 minutes. Fish ladder stranding surveys were conducted by slowly dewatering the area and one or more biologists entered the ladder and conducted a thorough survey usually visually or with a brailed seine. Once the ladder was cleared, we decreased the water depth in the concrete forebay (screened fishbay) to approximately 0.8 feet. Once the water depth decreased Sara and I entered the forebay and a large fish was observed making a wake in the turbid water. I suspected the fish might be a largemouth bass but when I approached the fish, it was clear that it was an adult steelhead.

Sara had prepared an aerated 100 quart (25 gallon) cooler and I netted the steelhead and placed it directly in the cooler. One photograph was taken of the fish when I quickly lifted it from the cooler. The fish was out of the water for no more than 15 seconds. Since the river flow was turned out, we could not relocate the fish directly upstream of the diversion because of excessive water velocities and minimal depth. I decided to relocate the fish to a site below the 12th Street Bridge in Santa Paula. This site has good access and is located downstream of all coastal rainbow trout bearing tributaries so the fish had the opportunity to migrate up its natal stream. Hopefully Santa Paula Creek is not its natal stream because there are numerous fish passage impediments in that drainage. The fish was released to a low velocity edgewater habitat at the 12th Street Bridge site and it swam off and was in good shape. The water temperature at the relocation site was 12°C and the cooler temperature was 14°C. I do not know the total flow in the Santa Cara River at the time of relocation but Sespe Creek was

approximately 300 cfs.

Conclusions:

This fish traversed and exited the ladder at some point on March 4. The infrared scanners were tested at approximately 5:00 PM and they were working so the fish most likely jumped sometime after 5:00 PM. The main light that is used in the fish counter area malfunctioned earlier in the day and we did not have the opportunity to replace it due to other commitments and it was planned to be replaced the following day. There were approximately 20 passage alarms that occurred between 8:00 and 8:30 PM and these were at least partially the result of unforeseen increased flows and surges in the ladder that triggered the camera. One of these alarms could be from this fish jumping over the false weir but the video quality was extremely poor because of low light. We will be watching the video and might even transfer it to a computer so the video can be enhanced to add additional light.

It is possible that this fish exited the fish ladder as the turn-out was starting and was in the area between to ladder exit and the trash racks. When turn-outs occur, this area slowly dewaters and the fish potentially responded to the decrease in water depth and velocities by migrating downstream to the fish screen bay. Another possibility is that this fish was delayed from exiting the trash racks. The fish ladder review panel included in one of the interim improvements to increase the width of the trash racks and included, at least conceptually, something to lead fish toward the wide opening of the trash racks. This was lower on the fish panel's priority list of interim improvements but United is interested in implementing this improvement or modification as soon as possible.

4.3.2 Lower Santa Clara River Stranding Surveys

Six visual stranding surveys were conducted below the Freeman Diversion Dam following turn-out events. During one stranding survey that occurred on July 14, 14 steelhead smolts were observed stranded below the Freeman Diversion following a flush (Table 8, Appendix A). Seven of the fish were found near the base of the diversion dam and were successfully relocated to the Santa Clara River Estuary. The remaining 7 smolts died from thermal stress. These fish

were preserved in a freezer. These 7 mortalities were not included in the trap totals of 160 smolts. No *O. mykiss* were observed below the Freeman Diversion Dam during the five other stranding surveys.

4.3.3 Fish Ladder Stranding Surveys

There were a total of 6 turn-out 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 2009 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 2009 monitoring season.

5.2 METHODS

Water quality monitoring for 2009 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, 2009 through July 31, 2009. 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.

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 Clara River at the VCWPD Project
- Site 5 - Santa Paula Creek Upstream of Harvey Diversion
- Site 6 - Santa Paula Creek at Steckel Park
- Site 7 - Santa Paula Creek Directly Downstream of Sisar Creek Confluence

- Site 8 - Sespe Creek at Grand Avenue
- Site 9 - Piru Creek Downstream of Temescal's Property Line
- Site 10 - Piru Creek at the Old USGS Gauge
- Site 11 - Piru Creek at the USGS Gauge Directly Downstream of Santa Felicia Dam

A map identifying each monitoring site can be found in Figure 8, Appendix A. Graphs depicting data at these eleven sites are in Figures 9-19, Appendix A. Specific information regarding each site can be found in Table 9, 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 15, 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, 2009 to February 8, 2009 and from March 31, 2009 through the end of the trapping season. The analysis of these data includes two separate analyses; one for estuary closed and one for estuary open. When the estuary was closed the minimum water temperature collected at this site was 10.051ºC and the maximum temperature was 24.871ºC. When the estuary was open the minimum water temperature collected at this site was 7.142 ºC and the maximum was 24.823 ºC (Table 10, 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 16, 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 6.255 ºC and the maximum temperature was 29.165 ºC (Table 10, 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 17, 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 reconvene in January. The minimum water temperature collected at this site was 3.801 ºC and the maximum temperature was 29.665 ºC (Table 10, Appendix A).

5.3.4 Santa Clara River at the VCWPD Project

The Santa Clara River at the Ventura County Watershed Protection District (VCWPD) Project water temperature monitoring site was located approximately 100 feet downstream from the most downstream groin at the county bank stabilization project site off South Mountain Road in Santa Paula. The logger was attached to a fence post with zip ties 0.9 feet from the bottom (Photo 18, Appendix B). The objective at this location was to monitor water temperatures in the main stem Santa Clara River between Sespe Creek and the Freeman Diversion. In the future we will be adding more temperature monitoring sites throughout the Santa Clara River to closely monitor temperatures during the steelhead and Pacific lamprey migration season. The minimum water temperature collected at this site was 7.945 ºC and the maximum temperature

was 23.352 ºC (Table 10, Appendix A).

5.3.5 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 19, 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 7.845 ºC and the maximum temperature was 33.94 ºC (Table 10, Appendix A).

5.3.6 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 20, Appendix B). This location was ideal for monitoring temperatures for due to adequate flows, areas of scour and in-stream cover. The minimum water temperature collected at this site was 7.895 ºC and the maximum temperature was 28.295 ºC (Table 10, Appendix A).

5.3.7 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 7.25 inches from the bottom with zip ties to a fence post (Photo 21, 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 7.97 ºC and the maximum temperature was 24.171 ºC (Table 10, Appendix A).

5.3.8 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 2.0 feet from the bottom along the bank (Photo 22, Appendix B). The objective at this location was to monitor water temperatures at the resident and young-of-the-year coastal rainbow trout release location 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 5.668 ºC and the maximum temperature was 31.689 ºC (Table 10, Appendix A).

5.3.9 PIRU CREEK DOWNSTREAM OF TEMESCAL'S PROPERTY LINE

The Piru Creek downstream of Temescal's property line water temperature monitoring site is 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 23, 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 4.61 ºC and the maximum temperature was 30.217 ºC (Table 10, Appendix A).

5.3.10 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 type 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 24, 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 5.179 ºC and the maximum temperature was 31.204 ºC (Table 10, Appendix A).

5.3.11 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 25, Appendix B). The objective at this location was to monitor water temperatures in lower Piru Creek. The analysis of the data excluded January 27, 2009 due to water level/temperature fluctuations that occurred during a routine inspection of Santa Felicia Dam. The minimum water temperature collected at this site was 7.091 ºC and the maximum temperature was 21.008 ºC (Table 10, Appendix A).

5.4 DISCUSSION

The maximum water temperatures at most sites extend above what many believe to be the chronic or incipient upper lethal temperature limit of 25 ºC for many anadromous salmonids although higher temperatures reaching 29 ºC can be tolerated for a short period of time (Myrick and Cech 2001) if water quality conditions are good. The maximum water temperature of 33.94 ºC occurred in Santa Paula Creek upstream of Harvey Diversion during the summer. These 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 refugia when available. Other behavioral responses to upper thermal extremes include increase feeding when food is available to offset the cost of an elevated metabolic rate although feeding does decline after about 19 ºC but 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 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 refugia.

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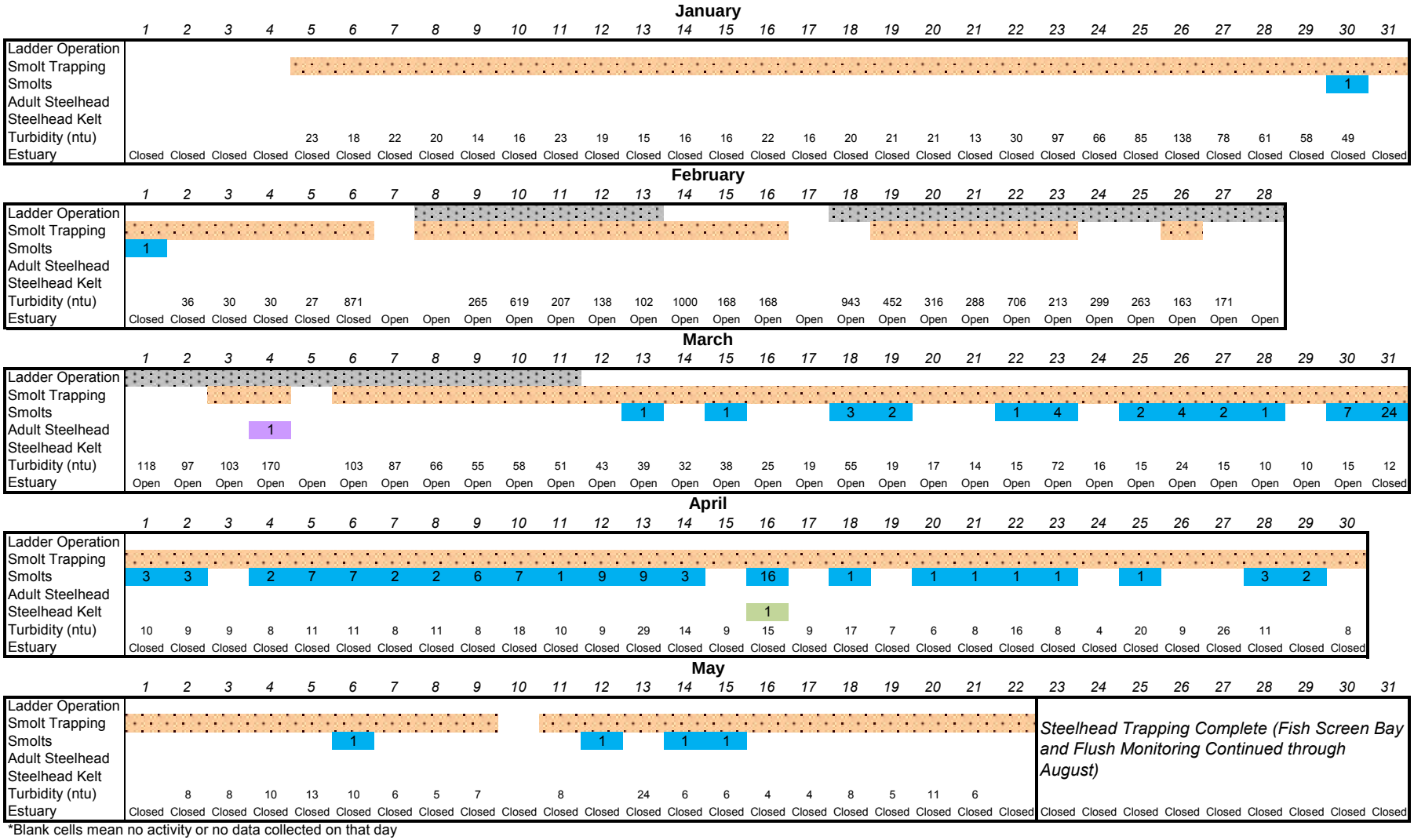
Appendix A

Tables and Figures

Table 1 - Freeman Diversion Operations and Steelhead Monitoring Data



*Blank cells mean no activity or no data collected on 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																														
Other Monitoring																														
Smolts				1							1								2						4					
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	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																															
Other Monitoring																															
Smolts														7													1				
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	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	Closed	Closed	Closed	Closed	End Of Monitoring Season																										

*Blank cells mean no activity or no data collected on 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 2009

Fish Species: **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

Amphibian & Reptile Species: **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	1	1	160	3	0	0	0	927	2019	376	202	117	54	7	14	10	1	159	94

	Amphibians and Reptiles							
	WT	AT	SFT	CRLF	BF	AF	TF	PT
Total	16	0	0	0	517	37	13	4

Biologists: Steve Howard, Sara Gray, **Fish Technicians:** Chris In, Amanda Goldstein, Kelly McGee

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 - FISH STRANDING SURVEY RESULTS

Stranding Survey Location	Adult Steelhead	Smolts	Resident *O. mykiss*	Total
Freeman Fish Screen Bay	1	44	0	45
Lower Santa Clara River	0	14	0	0
Fish Ladder	0	0	0	0

TABLE 9 - 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	15
Freeman Fish Trap Bay	1269160	5/16/2008	3.0	1.0	Pool	16
Freeman Fish Screen Bay	1269166	12/8/2008	2.5	0.5	Pool	17
Santa Clara River at the VCWPD Project	1269162	3/27/2007	3.1	0.9	Pool	18
Santa Paula Creek at Steckel Park	1269161	3/27/2008	1.8	0.2	Pool	20
Santa Paula Creek Upstream of Harvey Diversion	2250243	1/16/2009	1.0	0.4	Riffle	19
Santa Paula Creek Directly Downstream of Sisar Creek Confluence	2250248	1/16/2009	2.25	0.7	Pool	21
Sespe Creek at Grand Avenue	1269163	4/31/2008	4.0	2.0	Pool	22
Piru Creek Downstream of Temescal's Property Line	1269167	9/3/2008	1.0	0.5	Pool	23
Piru Creek at Old USGS Gauge	1269168	8/29/2008	0.7	0.5	Run	24
Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam	1269164	8/27/2008	0.5	0.25	Pool	25

TABLE 10 - WATER TEMPERATURE STATISTICS BY LOGGER SITE (JANUARY 1, 2009 TO JULY 31, 2009)

***Santa Paula Creek Upstream of Harvey Diversion and Directly Downstream of Sisar Creek Confluence Loggers were Deployed January 16, 2009 (Data Included from January 16, 2009 to July 31, 2009)**

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)	24.871	7/13/09	10.051	2/8/09	19.842
Santa Clara River Estuary (Estuary Open)	24.823	3/18/09	7.142	2/14/09	15.008
Freeman Fish Trap Bay	29.165	5/6/09	6.255	2/18/09	17.081
Freeman Fish Screen Bay	29.665	7/20/09	3.801	2/18/09	17.710
Santa Clara River at the VCWPD Project	23.352	7/6/09	7.945	2/17/09	16.144
Santa Paula Creek Upstream of Harvey Diversion	33.94	7/26/09	7.845	2/10/09	16.533
Santa Paula Creek at Steckel Park	28.295	7/20/09	7.895	2/10/09	16.058
Santa Paula Creek Directly Downstream of Sisar Creek Confluence	24.171	7/20/09	7.97	2/10/09	15.765
Sespe Creek at Grand Avenue	31.689	7/19/09	5.668	2/17/09	17.101
Piru Creek Downstream of Temescal's Property Line	30.217	6/28/09	4.61	1/27/09	17.401
Piru Creek at Old USGS Gauge	31.204	7/19/09	5.179	1/5/09	17.123
Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam	21.008	5/17/09	7.091	1/5/09	12.728

Figure 1 – Schematic of Freeman Diversion Facility

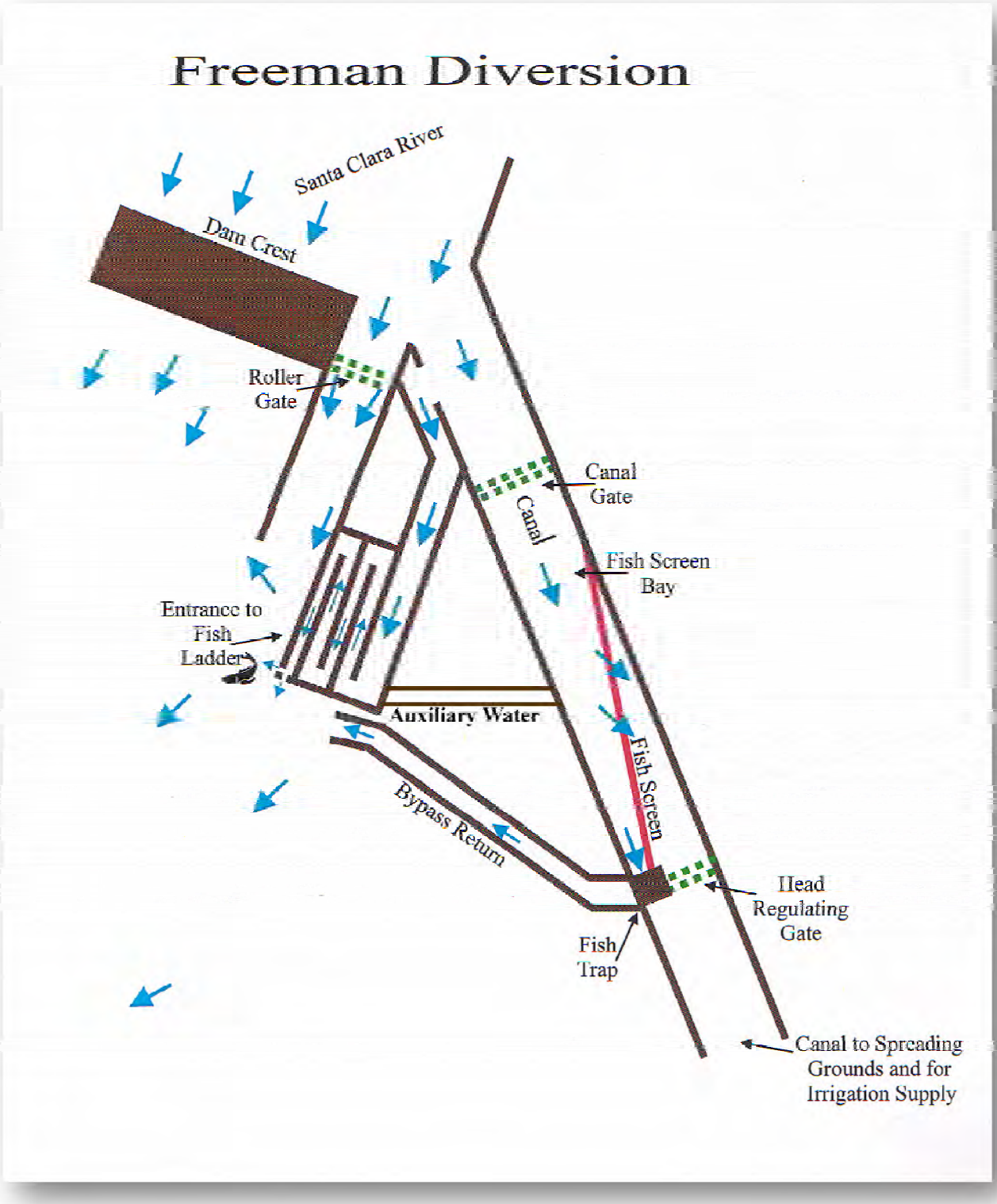


Figure 2 - Daily rainfall totals in Santa Paula, CA

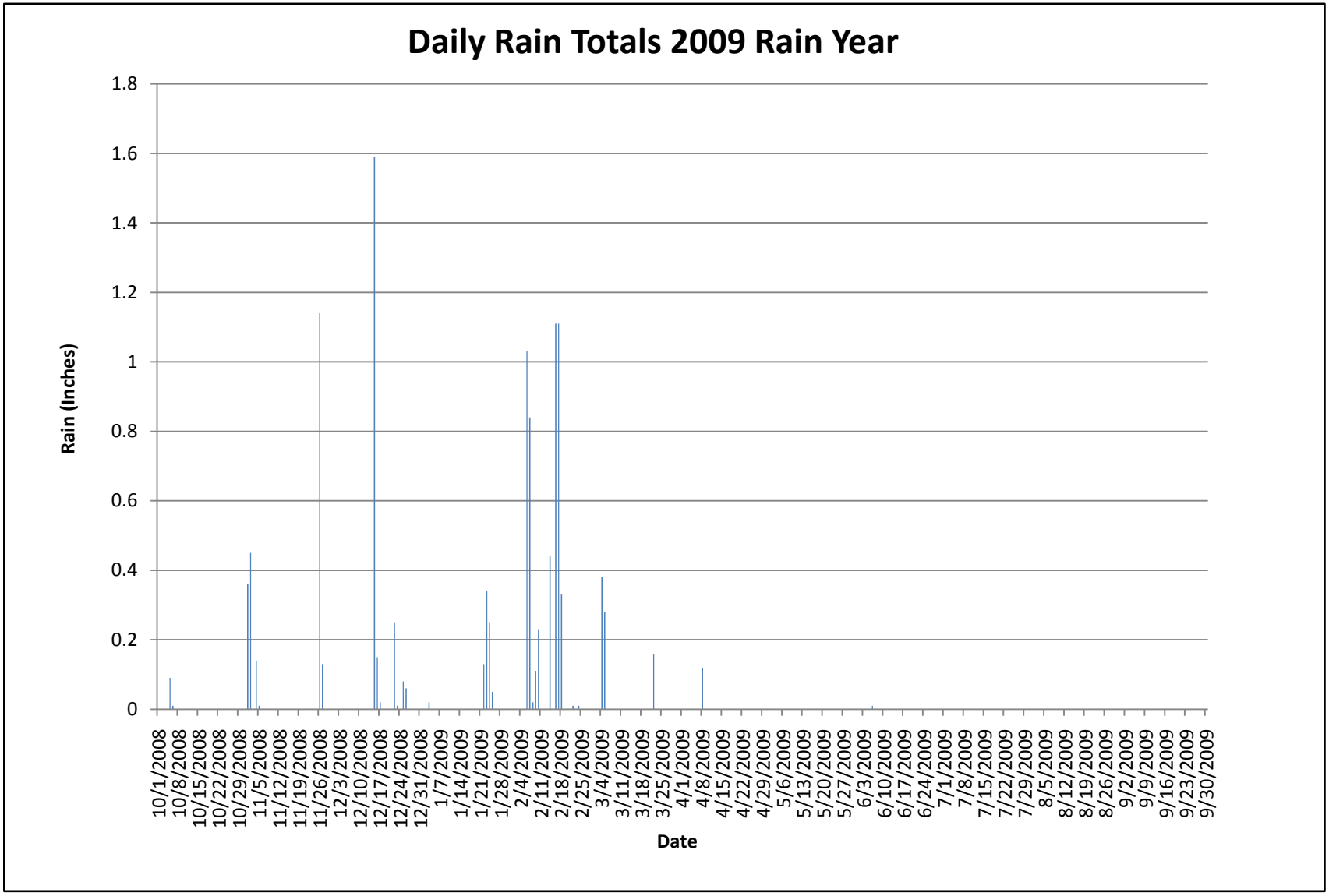


Figure 3 - Steelhead monitoring results

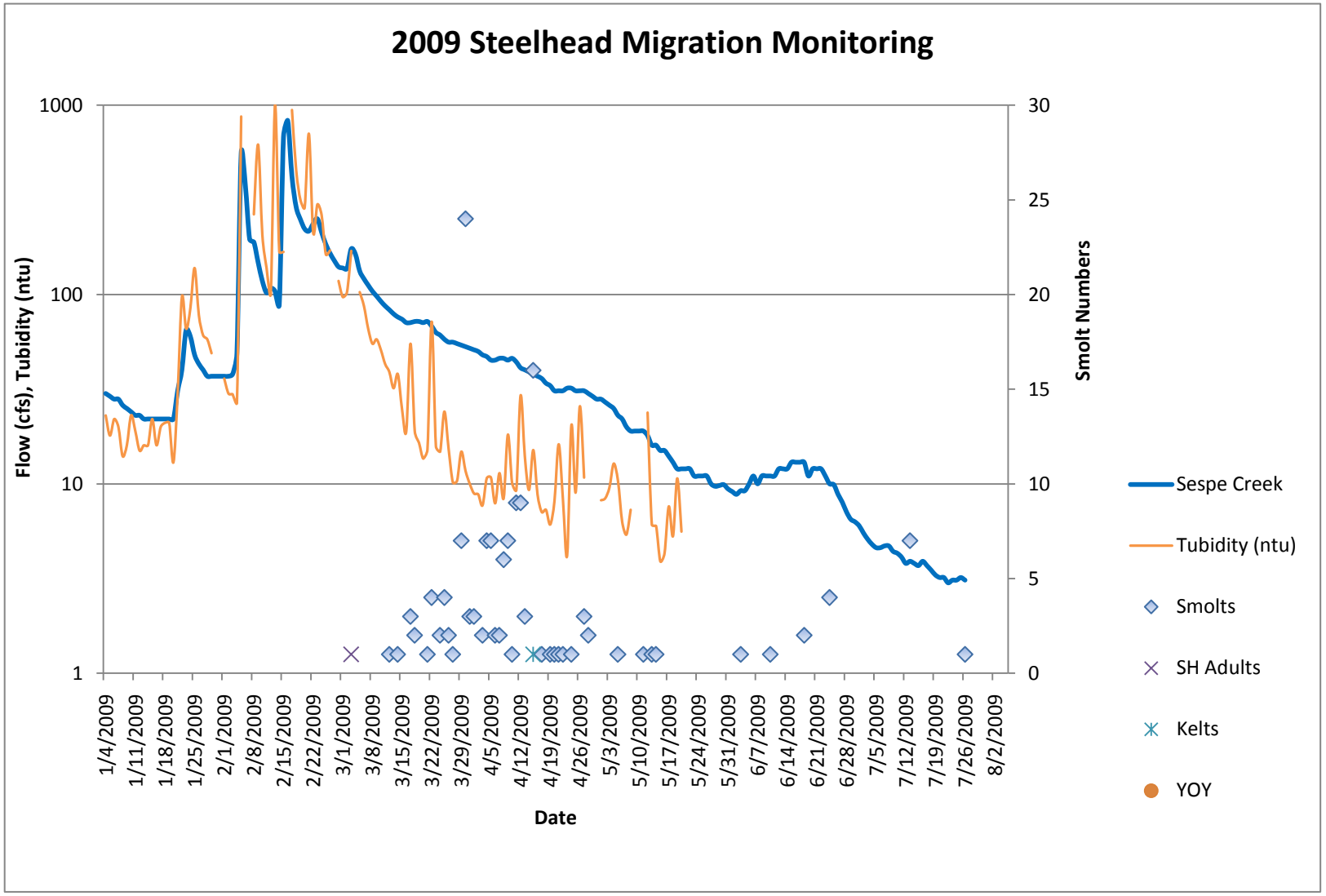


Figure 4 - Steelhead Length Frequency Histogram

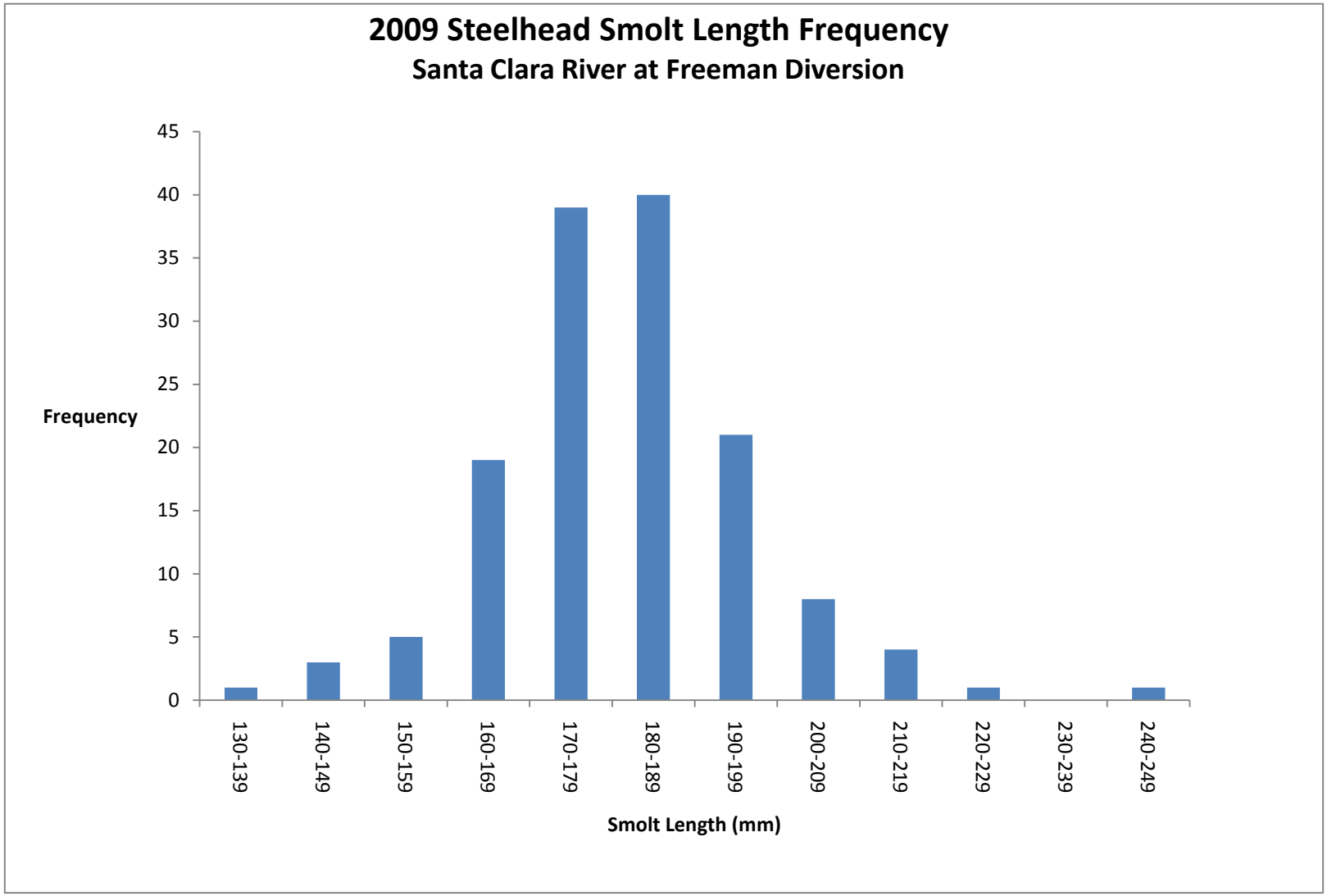


Figure 5 - Steelhead weight-length relationships

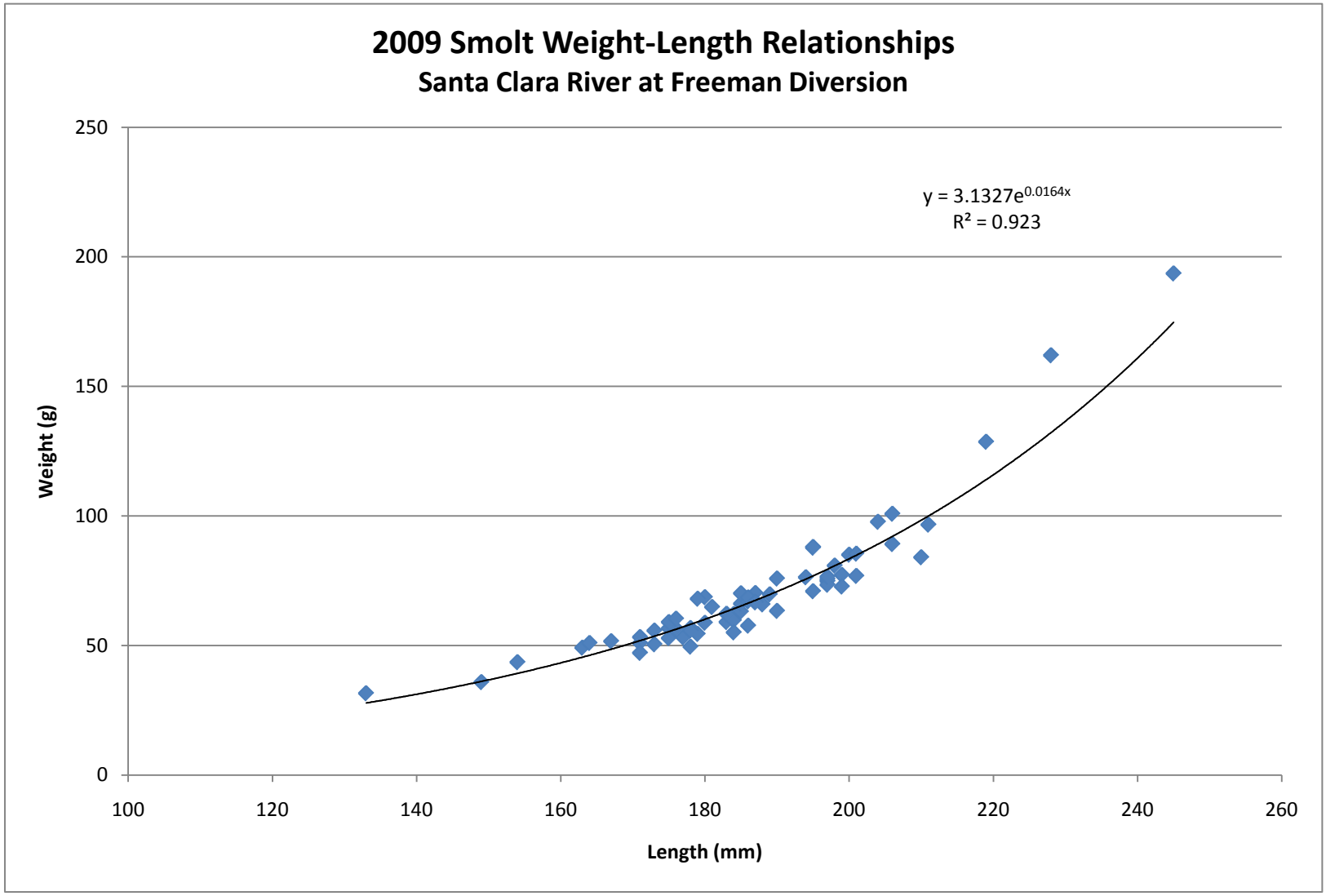
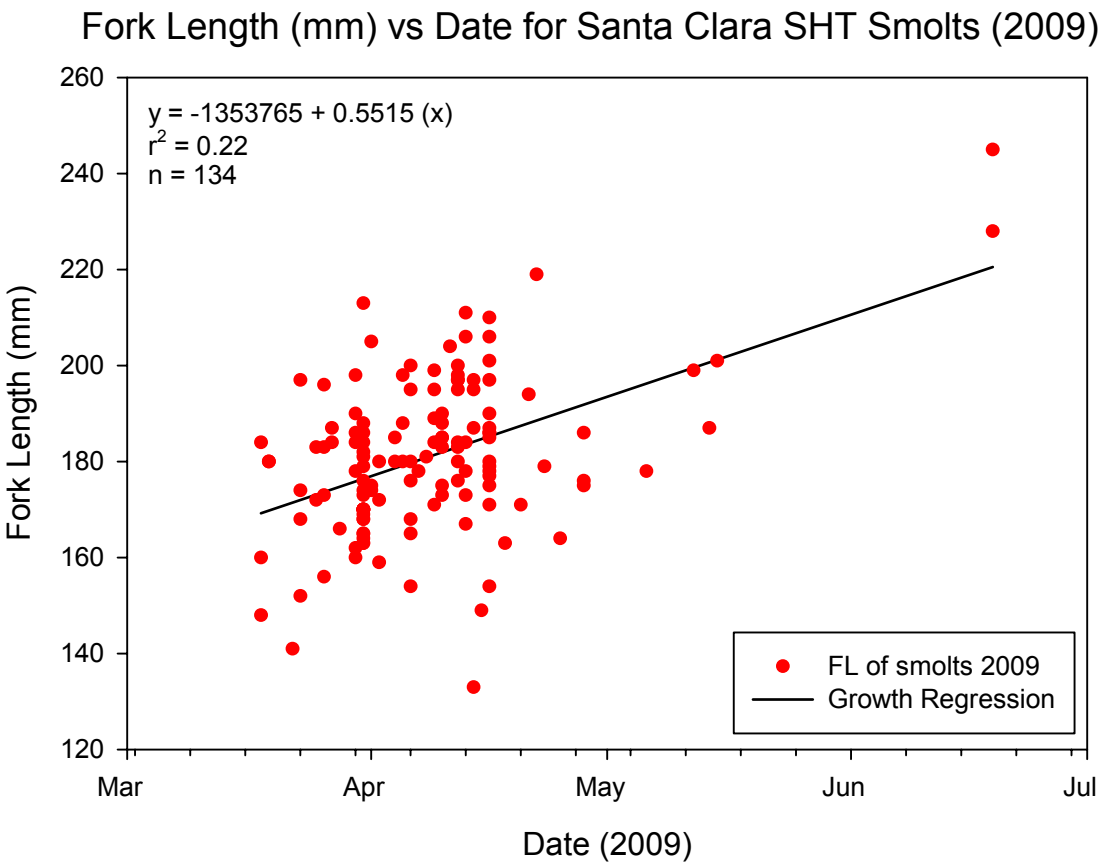


Figure 6 - Santa Clara River Smolt Growth Regression



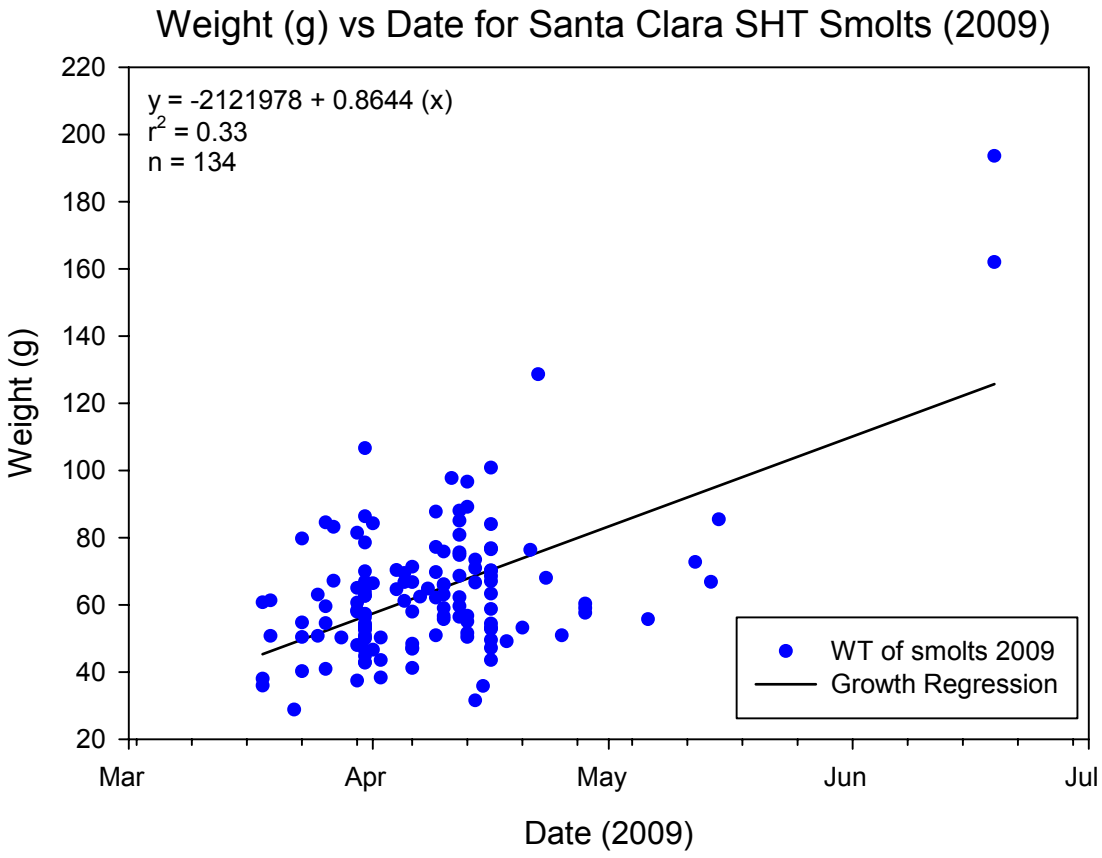


Figure 7 – Flow measurement sites below the Freeman Diversion

Figure 8 – Water temperature monitoring locations

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

Figure 9 - Santa Clara River Estuary Water Temperature

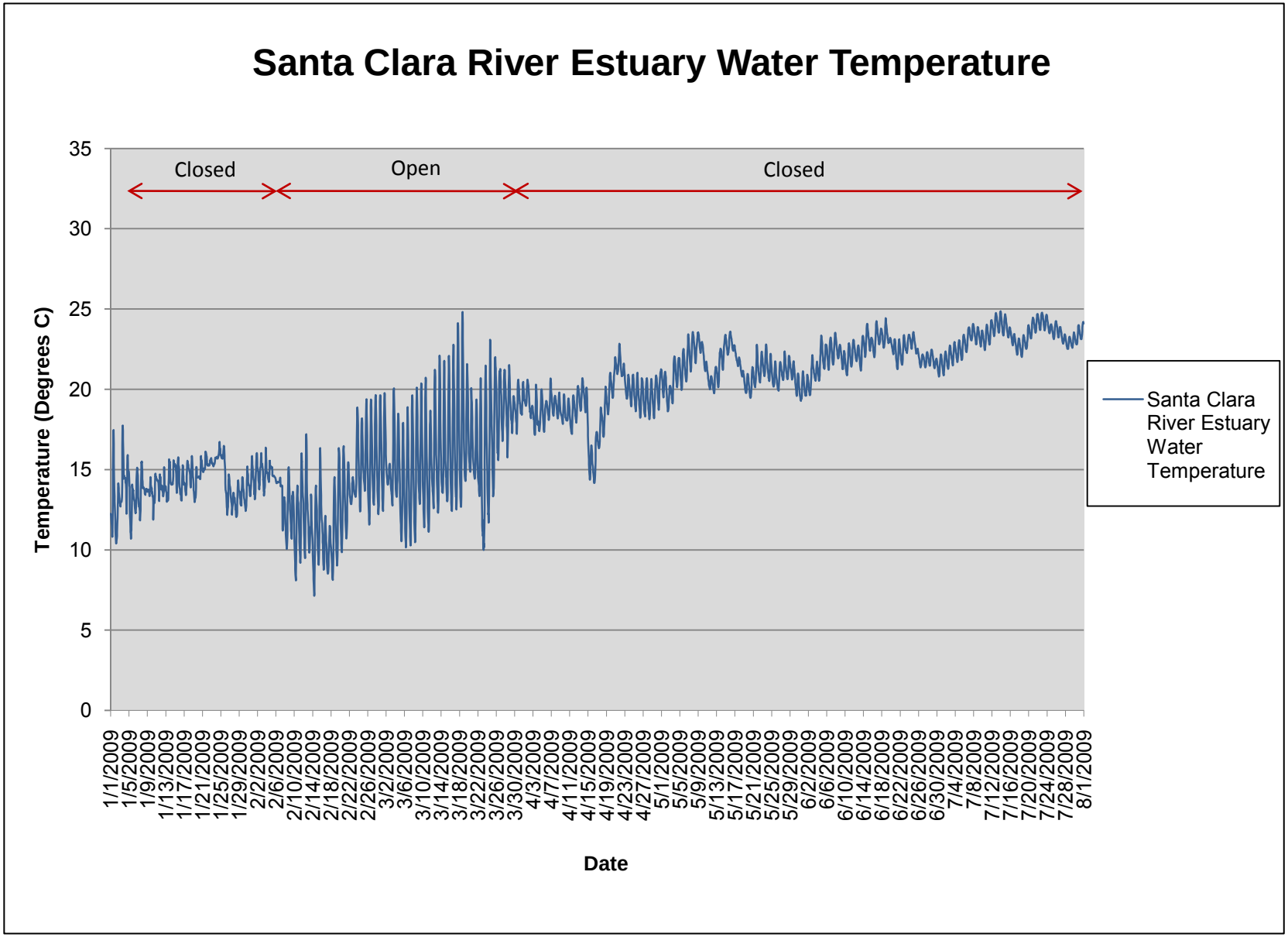


Figure 10 - Freeman Fish Trap Bay Water Temperature

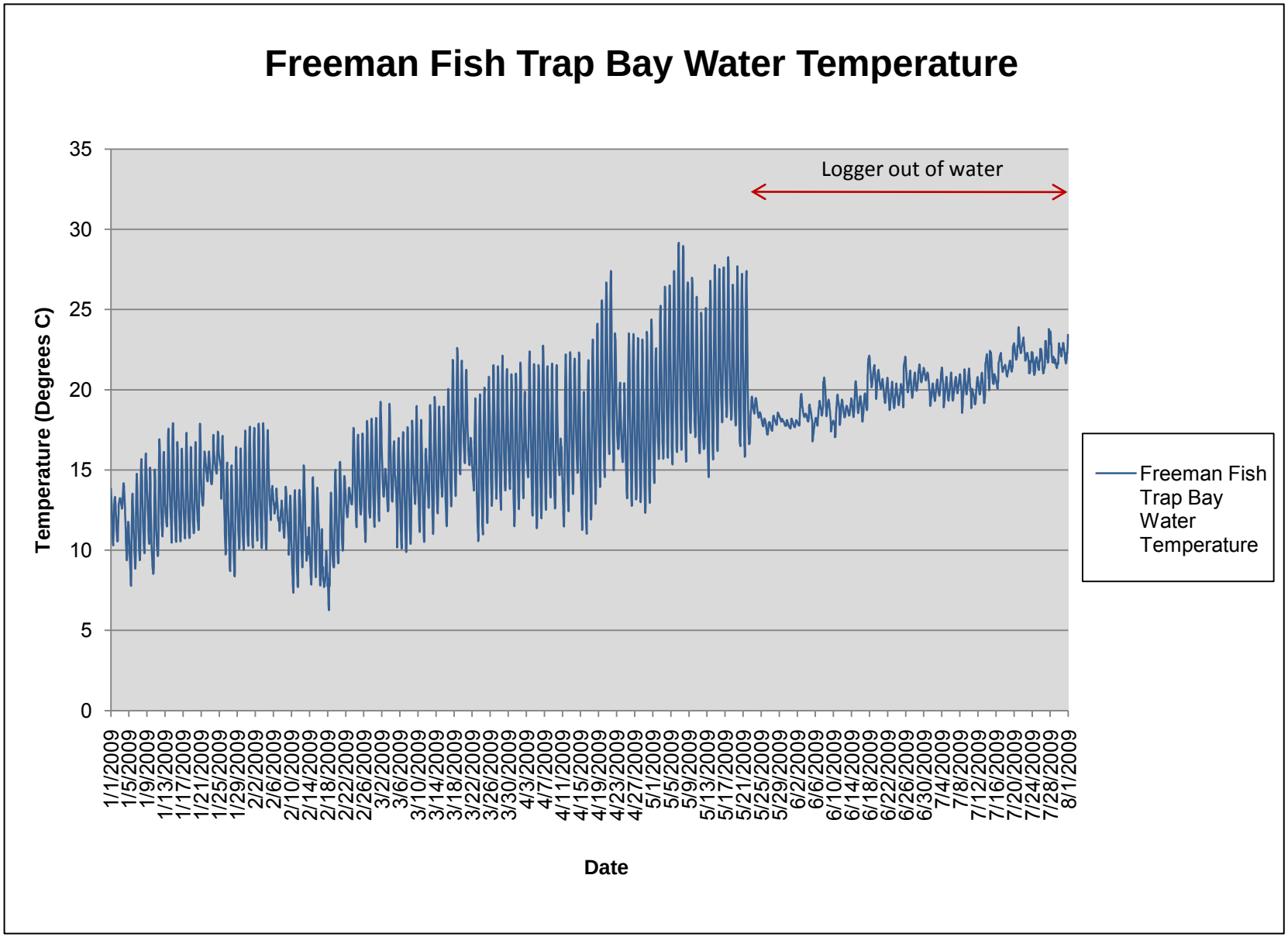


Figure 11 - Freeman Fish Bay Water Temperature

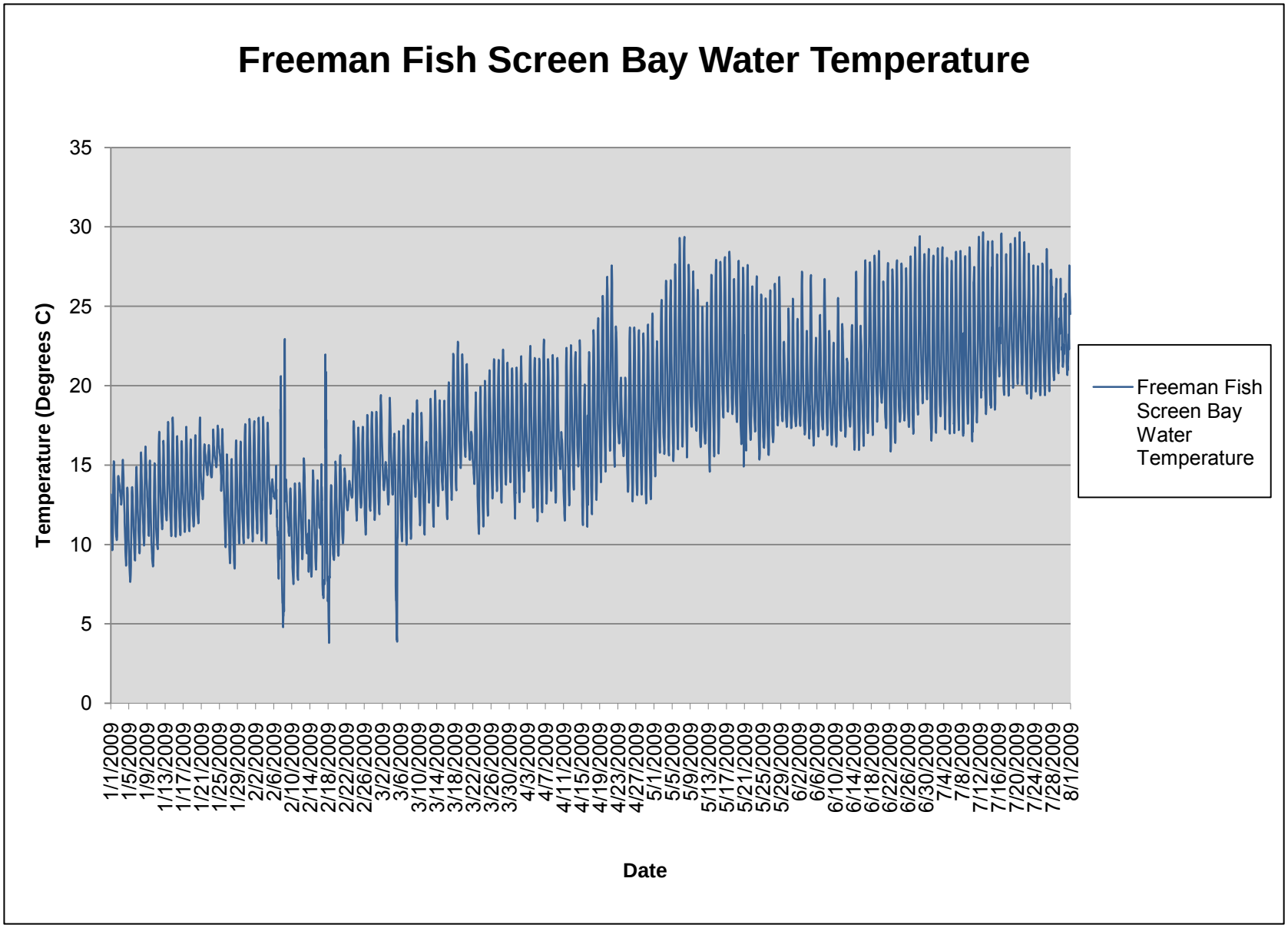


Figure 12 - Santa Clara River Water Temperature Near Santa Paula, CA

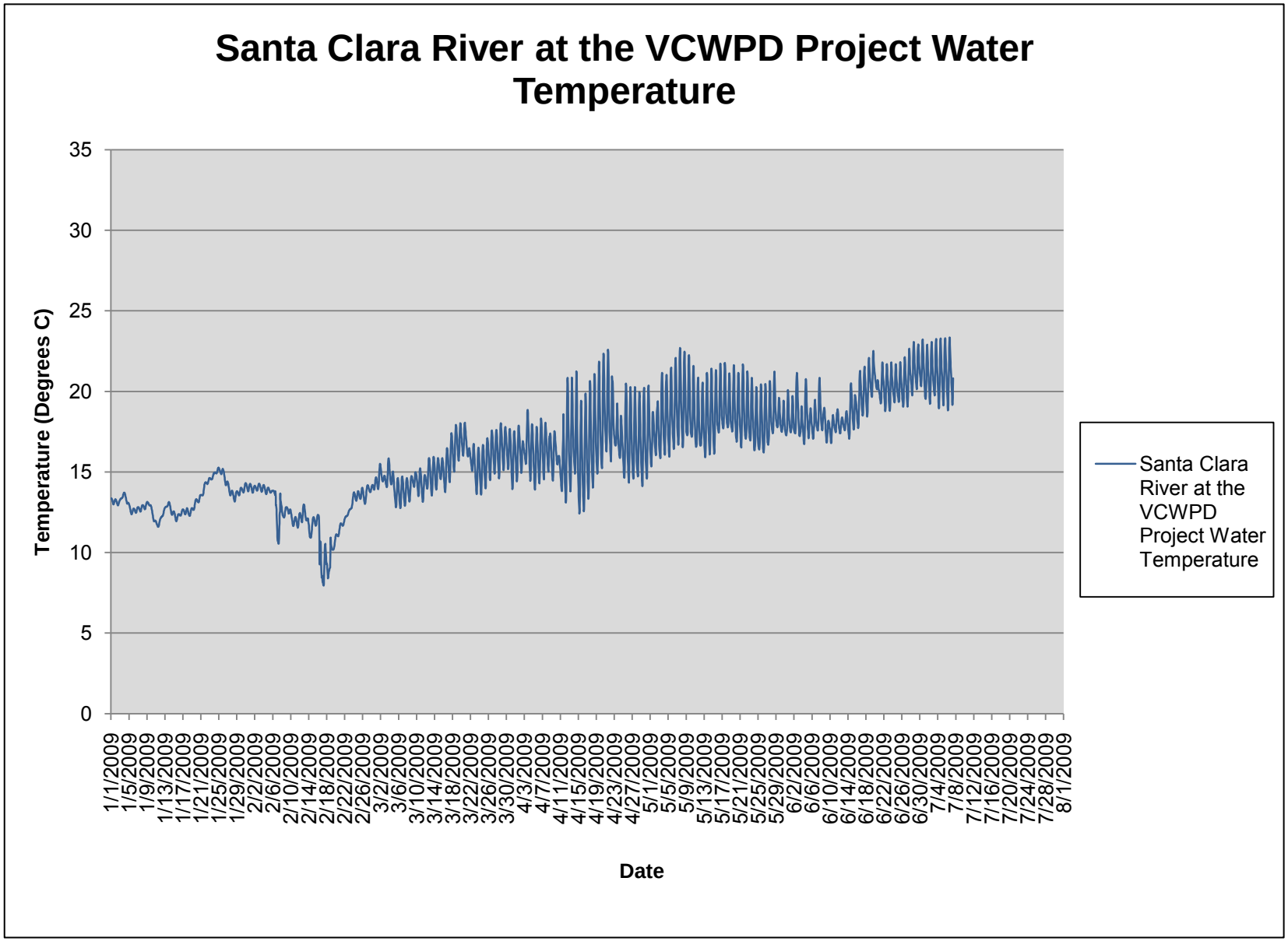


Figure 13 - Santa Paula Creek Upstream of Harvey Diversion Water Temperature

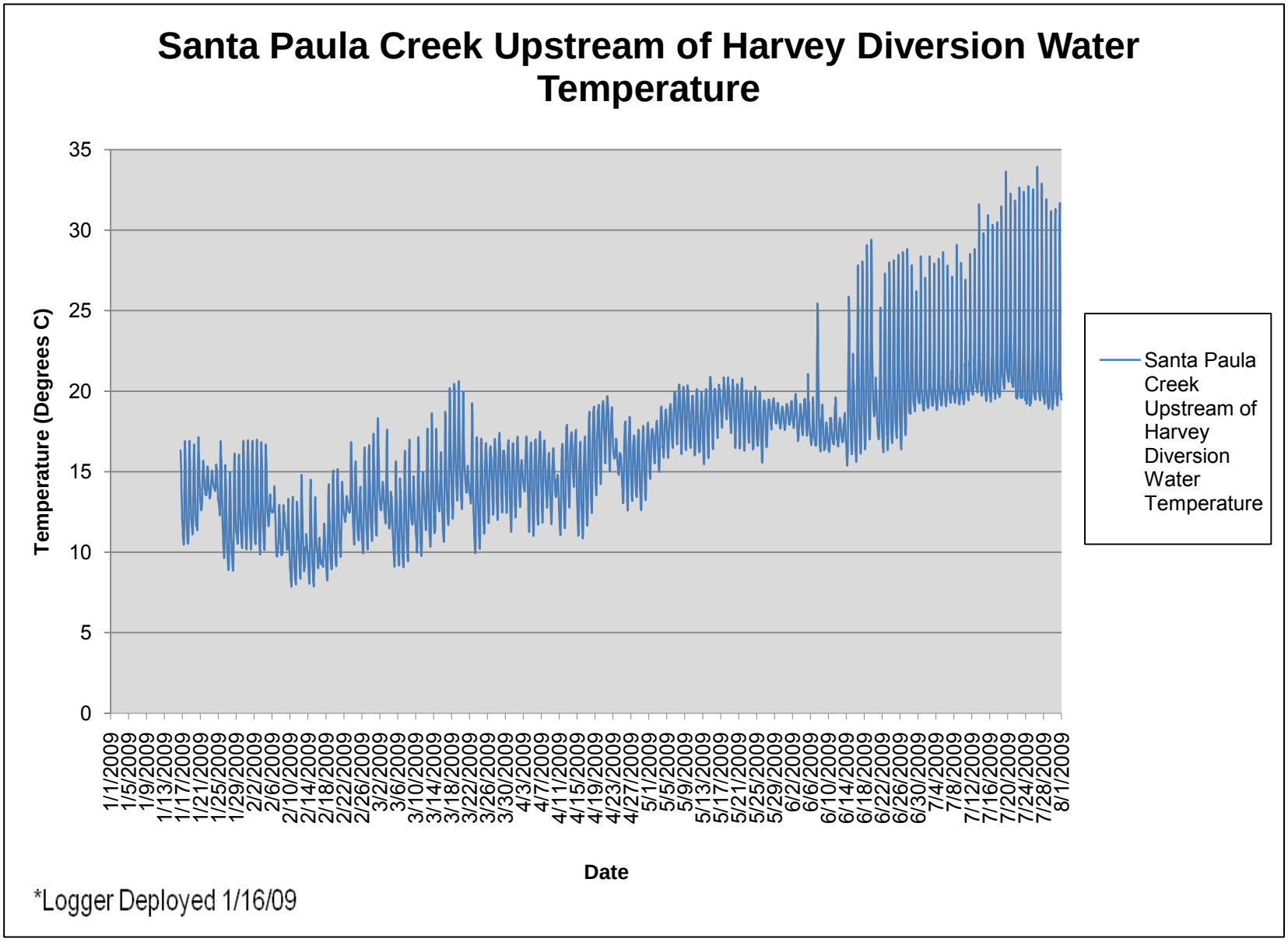


Figure 14 - Santa Paula Creek at Steckel Park Water Temperature

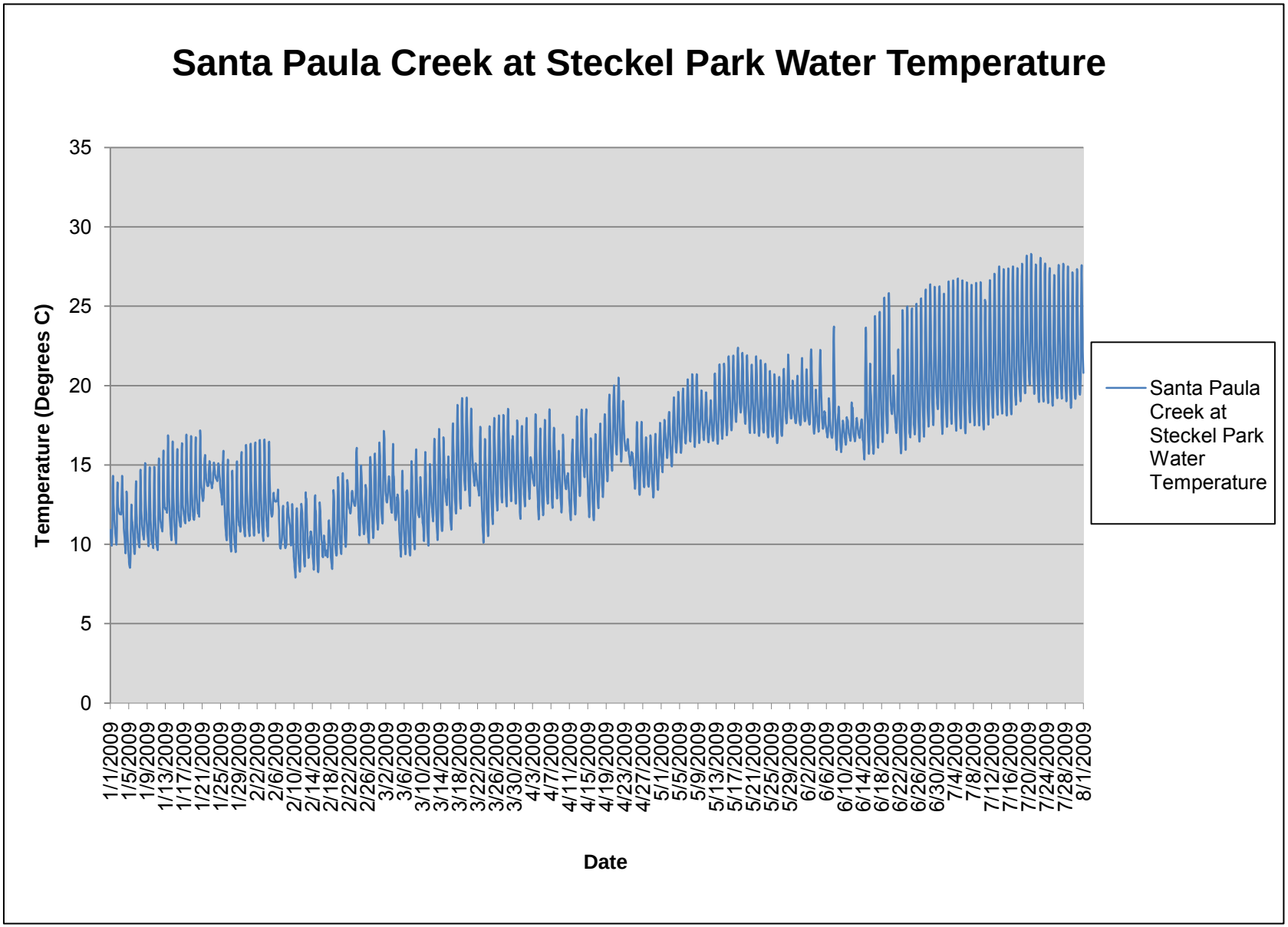


Figure 15 - Santa Paula Creek Downstream of Sisar Creek Confluence Water Temperature

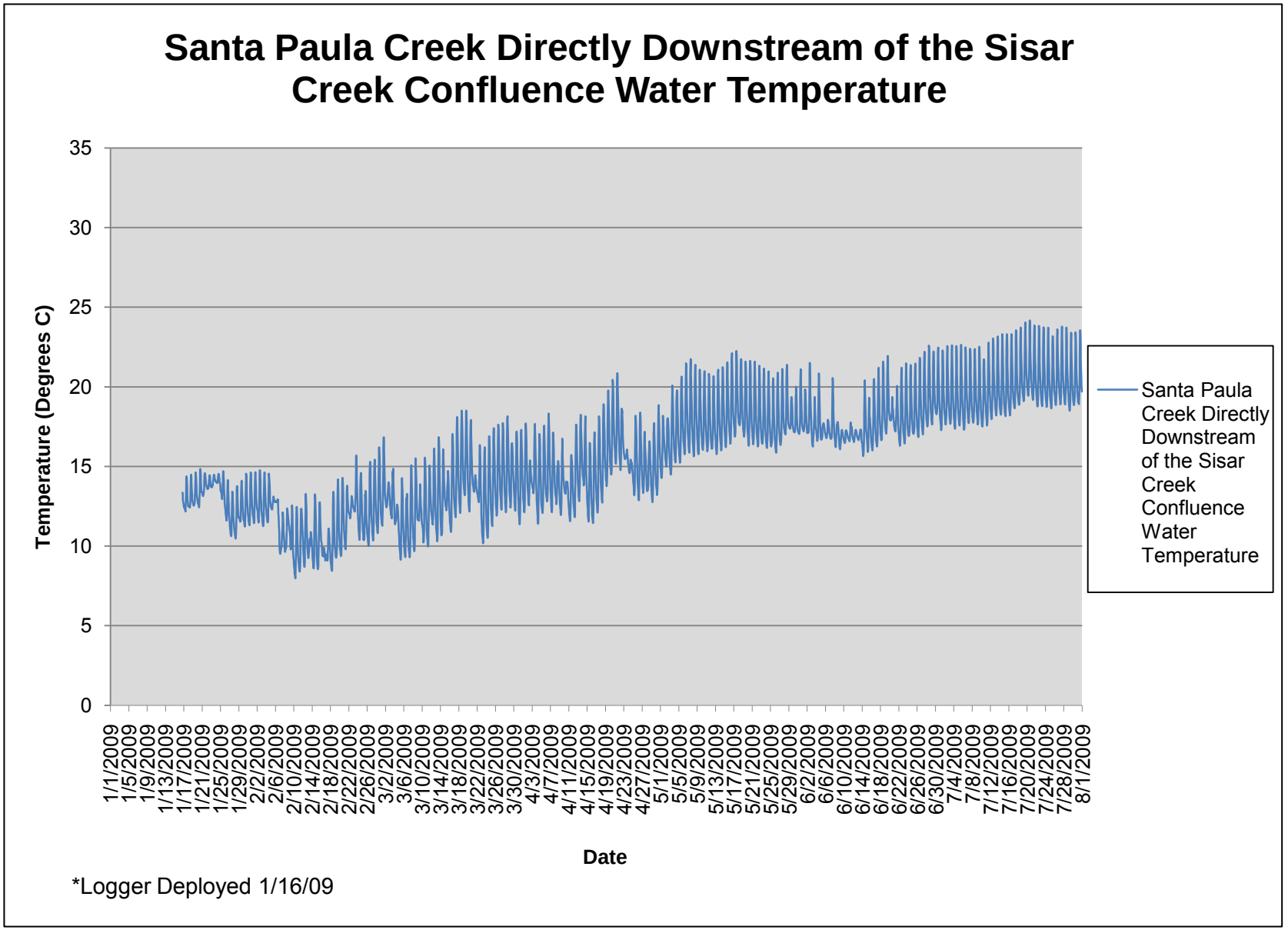


Figure 16 - Sespe Creek at Grand Avenue Water Temperature

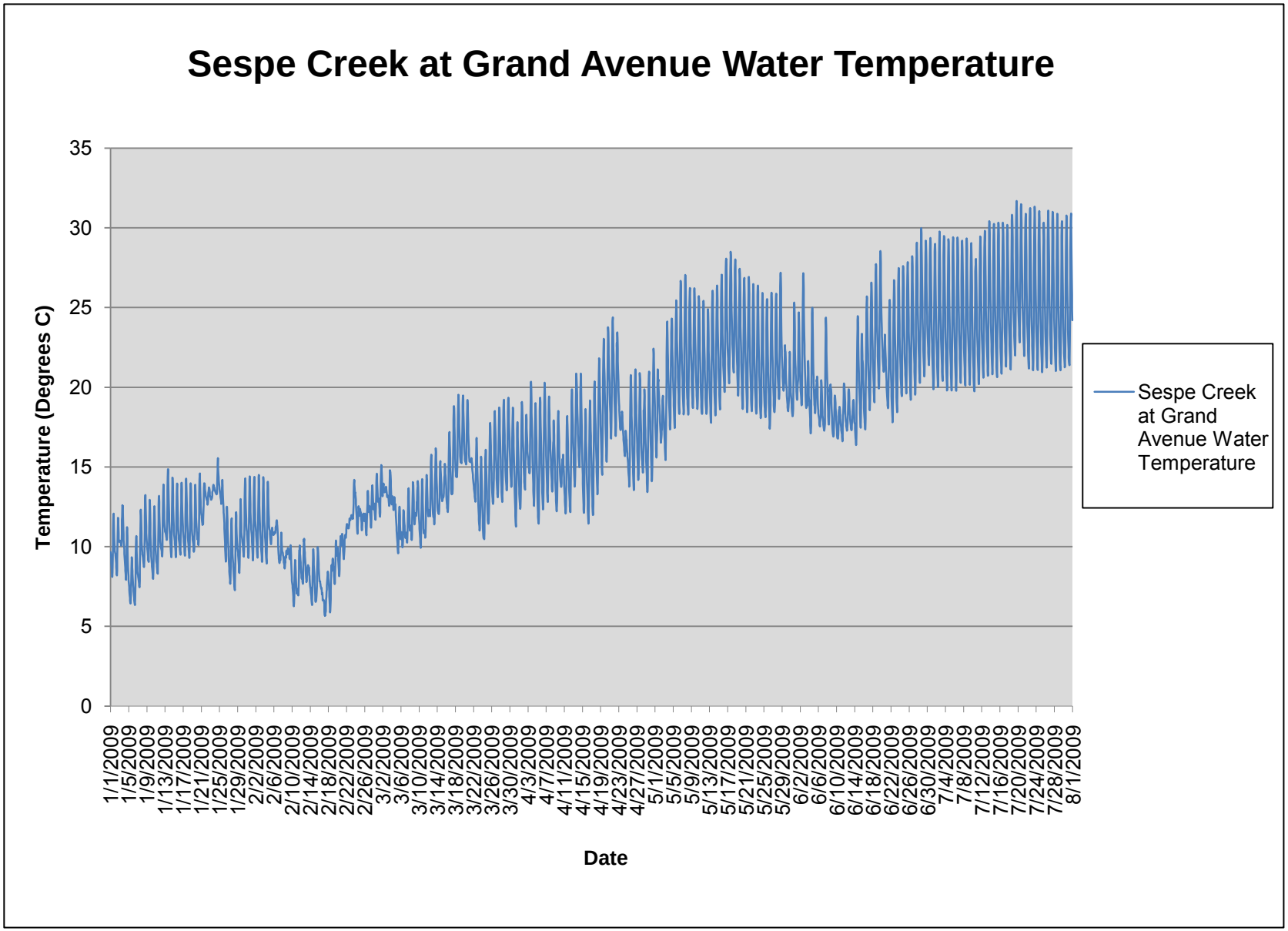


Figure 17 - Piru Creek Near Town of Piru at Temescal's Property Line Water Temperature

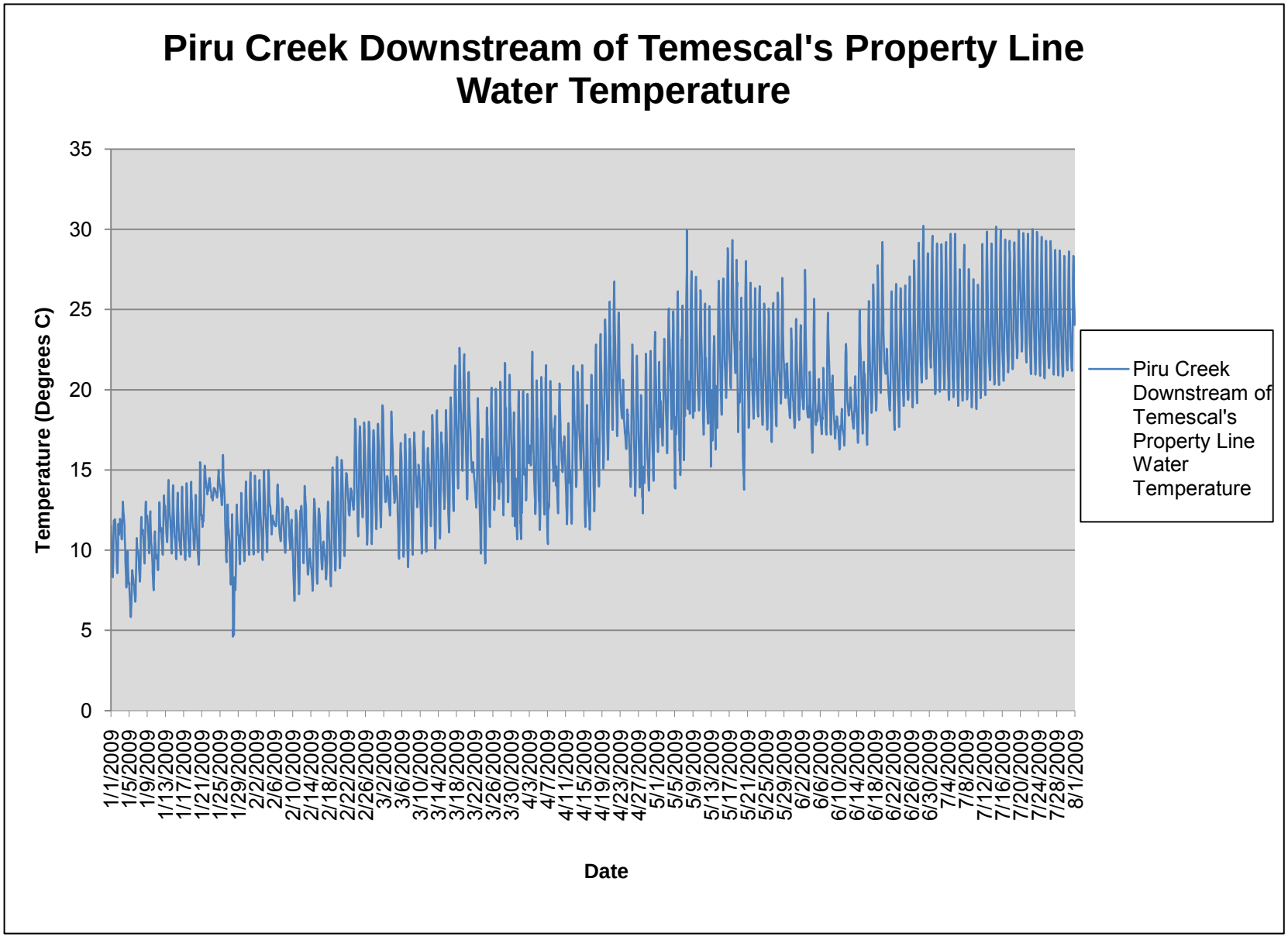


Figure 18 - Piru Creek at Old USGS Stream Gauge Water Temperature

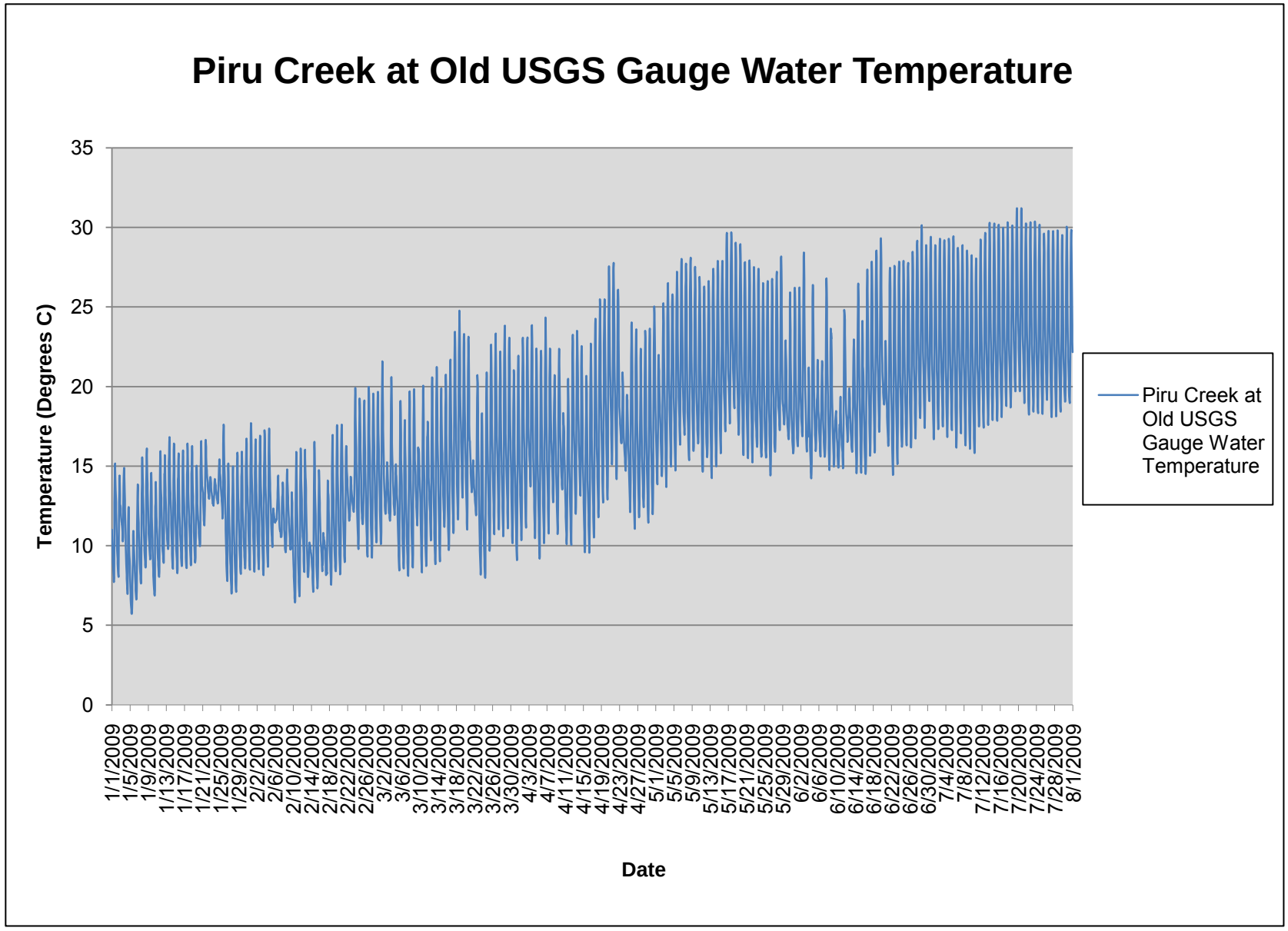
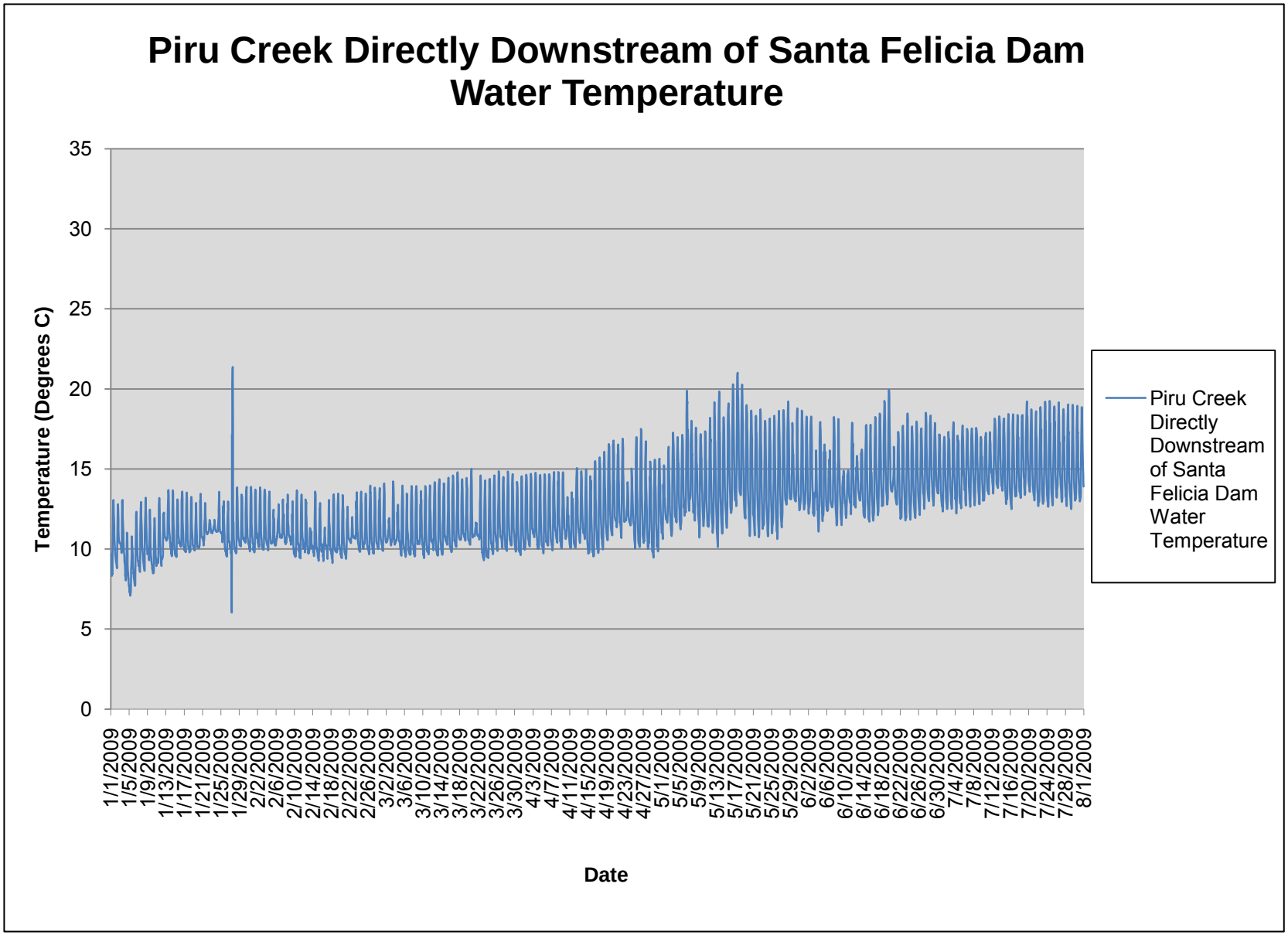


Figure 19 - Piru Creek Directly Downstream of Santa Felicia Dam Water Temperature



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 Weight Measurement (3/30/2009)

Photo 8 - Santa Clara River Steelhead Smolt (3/21/08)

Photo 9 – Potential Steelhead Kelt (scale shows potential ocean growth) (April 16, 2009)

Photo 10 – Santa Clara River Resident Rainbow Trout (3/20/08)

Photo 11 - Upstream Migration Monitoring Infrared Scanners

Photo 12 – Upstream Migration Monitoring DVR/VCR System

Photo 13 – Santa Clara River Adult Steelhead (March 4, 2009)

Photo 14 – Fish Screen Bay Stranding Survey

Photo 15 – Santa Clara River Estuary Water Temperature Monitoring Site

Photo 16 – Fish Trap Bay Water Temperature Monitoring Site

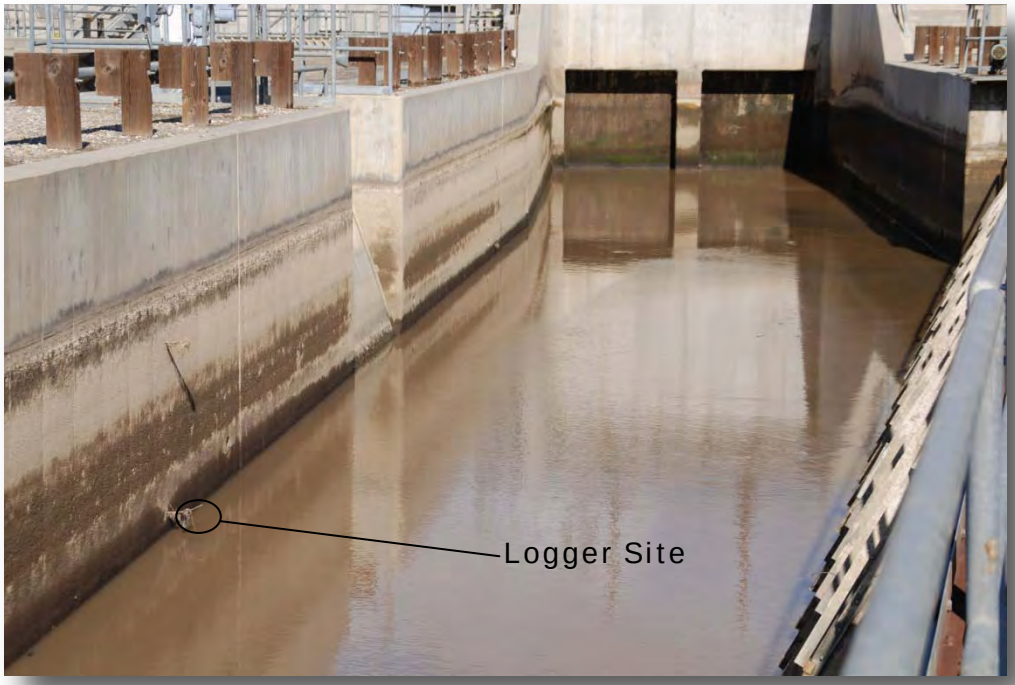


Photo 17 – Fish Screen Bay Water Temperature Monitoring Site

Photo 18 - Santa Clara River Water Temperature Monitoring Site

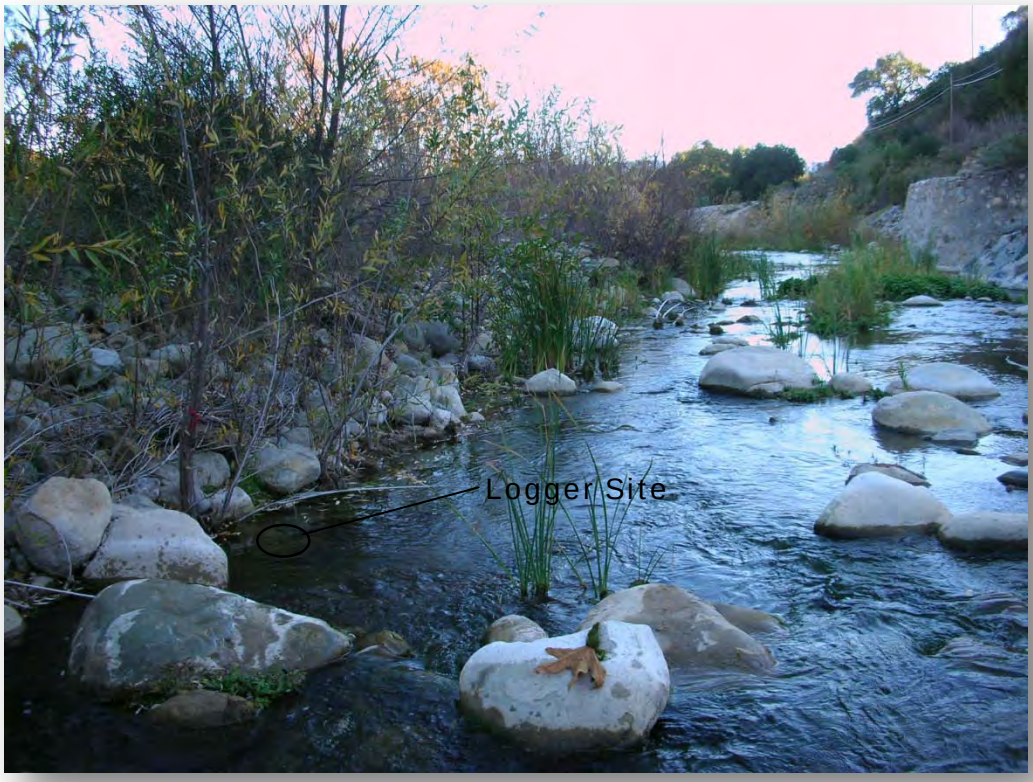


Photo 19 - Santa Paula Creek u/s of Harvey Diversion Water Temperature Monitoring Site

Photo 20 – Santa Paula Creek at Steckel Park Water Temperature Monitoring Site

Photo 21 - Santa Paula Creek below Sisar Creek Water Temperature Monitoring Site

Photo 22 - Sespe Creek Water Temperature Monitoring Site

Photo 23 - Piru Creek D/S of Temescal Property Water Temperature Monitoring Site

Photo 24 - Piru Creek at Old USGS Gauge Temperature Monitoring Site

Photo 25 - Piru Creek at USGS Gauge Directly Downstream of Santa Felicia Dam Temperature Monitoring Site

Panoramic Photos Below the Freeman Diversion

2-9-09

2-14-09

2-21-09

2-24-09

2-26-09

3-1-09

3-2-09

3-3-09 (a sediment flush occurred on this day)

3-4-09 (adult steelhead traverses fish ladder this night)

3-6-09

3-9-09

3-16-09

3-21-09