2016 Robles Fish Passage Facility Progress Report

Two *O. mykiss* parr persisting in the refuge of North Fork Matilija Creek in 2016, which was the fifth year of an exceptional drought.

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1.0 EXECUTIVE SUMMARY

Casitas Municipal Water District (CMWD) is implementing the Robles Fish Passage Facility Project (Robles Fish Facility) described in the Proposed Action of the Bureau of Reclamation's Biological Assessment (BA); (USBOR 2003). The effects of the Robles Fish Facility were analyzed in the Biological Opinion (BO) prepared by the National Marine Fisheries Service (NMFS 2003a). This 2016 Robles Fish Passage Facility Progress Report, as described by the BO, is the culmination of monitoring, evaluation, and operational data collected during the reporting period of 01 July 2015 to 30 June 2016.

The monitoring and evaluation studies related to the Robles Fish Facility conducted during the 2015-2016 reporting period are included in two main sections of this progress report. The Fisheries Monitoring and Evaluation section includes: upstream fish migration, impediment evaluation, sandbar monitoring at the mouth of the Ventura River, fish attraction evaluation, fish passage monitoring, downstream fish passage evaluations, and downstream fish migration through the Robles Reach. The Facility Operation section includes: information and data on the facility status, flow observations and control, costs associated with operation and monitoring, assessment of the effectiveness to provide fish passage, recommendations of priorities for future activities, and revisions deemed necessary to the operations.

The 2016 fish passage season was dominated by the effects from the continuing five-year exceptional drought throughout much of California. River flows during the drought were too low, or nonexistent, to collect data for most aspects of the monitoring and evaluation program. The sandbar at the mouth of the Ventura River was open for a substantial period of time during the fish migration season but lack of flow provided little opportunity for steelhead passage through the lower mainstem Ventura River except for a brief period in January and March. No *O. mykiss* were detected passing through the Robles Fish Facility during the fish migration period of 2016.

2.0 GENERAL INTRODUCTION

NOAA Fisheries listed the southern California steelhead, *Oncorhynchus mykiss*, as endangered in 1997 (NMFS 1997) under the Endangered Species Act (ESA, 16 U.S.C. § 1531 et. seq.) of 1973, as amended. Steelhead were organized into stocks (i.e., groups) of evolutionary significant units (ESU) that were considered to be substantially reproductively isolated from other steelhead stocks and were an important part of the evolutionary legacy of the species. The southern California steelhead ESU included, at that time, steelhead populations from the Santa Maria River in San Luis Obispo County south to Malibu Creek in Los Angeles County. The ESU was later extended to the US/Mexican border in San Diego County during 2002 (NMFS 2003b). In a later delineating approach, NOAA Fisheries categorized the anadromous life history form of *O. mykiss* as a distinct population segment (DPS) as described 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” as originally listed. 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, are still part of the ESU; however, the anadromous *O. mykiss* (i.e., steelhead) are now part of a smaller subset identified as the southern California steelhead DPS. Anadromous *O. mykiss* in the southern California DPS exhibit a winter run life history pattern during their spawning migrations; see life history discussion below.

Rainbow trout (*O. mykiss*) can be generally organized into four large groupings (Behnke 1992; Scott and Crossman 1973): 1) coastal rainbow trout that extend from northern Baja California to northern Alaska near the Kuskokwim River and also the Kamchatkan Peninsula of northeastern Asia, 2) redband trout of the inland Columbia and Frazer River basins, 3) redband trout of the central valley of California, and 4) trout of the Gulf of California drainages. The taxonomic group of coastal rainbow trout, *O. m. irideus*, exhibit two life history forms; anadromous and resident. The common name for the anadromous life history form is termed steelhead trout and the resident form is generally termed rainbow trout. Throughout the range of coastal rainbow trout, there is a widespread occurrence of the anadromous life history form (Behnke 1992). There are two general life history patterns exhibited by adult anadromous steelhead when they return from the ocean to spawn in fresh water. The patterns are grouped by either summer or winter spawning runs. There are many exceptions to this pattern, but this general characterization has been used to group steelhead runs by the season in which the peak spawning occurs as they return from the ocean (Busby et al. 1996). Summer steelhead are generally found in river systems that drain from farther inland, such as the Columbia River basin. Winter steelhead runs are typically found in the coastal systems where river systems are smaller. The winter run pattern is the most abundant anadromous life history within the natural range of the species (Busby et al. 1996).

Monitoring and Research of the Robles Diversion and Fish Passage Facility

As stated in the BO (NMFS 2003a), the "Modifications to the Robles Diversion Facility and associated operation criteria have been targeted at improving fish passage conditions within the Robles Reach of the Ventura River while maintaining suitable conditions through the Fish Passage Facility." The monitoring and evaluation studies and activities related to the modification of the Robles Facility, as outlined in the BO (NMFS 2003a), were intended to achieve three main objectives:

I. Monitor Fish Passage Facility operations and performance.
II. Determine if the Fish Passage Facility functions and operates in such a fashion that migrating steelhead:
    a. Successfully navigate into and through the facility, and
    b. Move through the facility in good physical condition.
III. Determine if the operations at the Robles Diversion are enhancing the opportunity for:
    a. Adult steelhead to migrate upstream to the Robles Facility, and
    b. Smolts and kelts to migrate downstream through the Robles Reach.

5-year Reevaluation of Initial Evaluation and Monitoring Activities

As described in the BO, a 5-year reevaluation of the initial fish flow operations would be conducted to determine if monitoring and evaluations have been completed (NMFS 2003a). The initiation of the 5-year period began in 2006, which was the first year the Robles Fish Facility was fully operational. An annual and ongoing reevaluation began after the 2010 fish passage season. Through the Cooperative Decision Making Process, the Robles Biological Committee will review annually each of the specific evaluations and determine if the original objectives have been addressed and could be discontinued or if additional study would be needed. Due to the variable water conditions and insufficient numbers of adult and juvenile steelhead, the objectives of the monitoring and evaluation program have not been accomplished. This has only been exacerbated by the ongoing historic 5-year exceptional drought affecting much of California, and particularly the southern coast of California including the Ventura River Basin. Each aspect of the monitoring and evaluation program will be assessed annually to determine if sufficient information has been collected to complete each objective. It is recommended that all aspects of the monitoring and evaluation for the Robles Fish Facility be continued during 2017.

3.0 UPSTREAM FISH MIGRATION IMPEDIMENT EVALUATION

Introduction

The ability of adult steelhead to swim upstream can be impeded during the migration season at times of low-river flow (NMFS 2003a). Evaluations at shallow water habitat units (i.e., critical riffles) have been commonly used as a method to determine if impediments exist for adult and juvenile steelhead in California rivers (Dettman and Kelley 1986; Bratovich and Kelley 1988; Hagar 1996). The Robles Reach, which extends downstream from the Robles Fish Facility approximately 6.5 km (NMFS 2003a) to just upstream of the Santa Ana Boulevard bridge (Appendix 1), is a wide alluvial section of the Ventura River that is composed of active wash deposits of unconsolidated silt, sand, gravel, and boulders (Tan and Jones 2006). Due to this type of channel morphology and geology, alluvial channels like the Robles Reach have high infiltration rates that cause channel surface flow to rapidly recede and cease shortly after storm events (Cooke et al. 1992).

An initial assessment of potential passage impediments in relation to river discharge was completed by ENTRIX (1999). The physical characteristics of seven potential impediments were evaluated using the Thompson (1972) passage criteria. The Thompson (1972) passage criteria for adult steelhead at critical riffles is a water depth of 0.6 ft for 25% of the total transect width and a continuous portion equal to 10% of the total transect width. ENTRIX (1999) also evaluated the potential impediments using criteria of 0.5 ft and 0.6 ft depth for 25% of the total width and a total width of 8 ft for both depths. The resulting discharge required was estimated to be between 40 and 65 cfs. There have been several modifications to the Thompson passage criteria by other researchers; Dettman and Kelly (1986) on the Carmel River used a depth of 0.6 ft over a 5 ft continuous section, a criteria of 0.6 ft depth over an 8 ft section was used on the Santa Ynez River (SYRTAC 2000), and Harrison et al. (2006) used a criteria of 0.6 ft depth over a 10 ft section on the Santa Clara River. Thompson's (1972) depth criterion of 0.6 ft was not based on actual migration observations and was never validated as a minimum condition for passage. It has been observed that adult salmonids can successfully move through riffles shallower than the 0.6 ft criterion (Mosley 1982).

The objective of the impediment evaluation is to assess factors that may impede steelhead's ability to migrate to the Robles Fish Facility (NMFS 2003a). Because of the potential for low-river flows to impede upstream fish migration in the Robles Reach, it will be the primary focus of the impediment evaluations (NMFS 2003a).

Methods

Selected channel features that may pose an impediment to upstream passage were surveyed multiple times during the fish migration season (January through June) to measure water depth, velocity, and channel width along a transect at each site. The selected sites were planned to be surveyed over a range of discharges from approximately 30-171 cfs (the upper limit is dependent on the ability to safely conduct the surveys), which is correlated with discharge at the Robles Fish Facility. The number of repeated surveys has depended on the number and duration of significant rain events, rate of hydrograph recession, and time constraints due to other aspects of the monitoring and evaluation program. Impediment surveys will likely be conducted over a number of years given the natural variation of water conditions. The selected impediment sites will be resurveyed as many times as needed to develop a statistically rigorous data set to evaluate fish passage in relation to Robles Fish Facility discharge.

During the initial phase, the Ventura River was surveyed from the mouth to the Robles Fish Facility (23 km) using standard stream survey techniques and was completed in 2008 (CMWD 2008). This provided physical measurements of all habitat units for the selection process. The survey methodology followed Moore et al. (2002) and was equivalent to a level IV survey as described in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 2002).

Over the course of three meetings and one conference call between 24 January and 18 June of 2009, the Biological Committee (BC) for the Robles Fish Facility completed an impediment site selection process that culminated in the original selection of eight sites that would be monitored for the impediment evaluation. The BC reviewed physical parameters of the 379 habitat units surveyed and general river characteristics that included: unit type, length, width, water depth, slope, longitudinal location (river km), step height on step units, discharge at Foster Park and the Robles Fish Facility at the time of the surveys, and a river profile for the 23 km of the Ventura River below the Robles Fish Facility. Upon completing an initial assessment of this data, a list of potential sites was developed that the BC visited in the field on 27 May 2009 to determine if monitoring was warranted. This data and field assessment included regular BC members (at the time of the assessment) Mike Kinsey (BOR), Stan Glowacki (NMFS), Mary Larson (CDFW), and Scott Lewis (CMWD). Mike Gibson (CMWD), hydrologists Bob Hughes (CDFW), and David Crowder (NMFS) also participated in this assessment and selection process.

The flow event that peaked on 20 March 2011 at approximately 20,000 cfs at the USGS Foster Park gage station, a recurrence interval of about 6 years, significantly altered some impediments sites that necessitated modifications to the monitoring. See CMWD (2011) for a detailed description of the high-flow caused site alterations. A Biological Committee (BC) field assessment on 11 January 2012 was conducted to review alterations that occurred and select replacement sites for ones that no longer appeared to be impediments. Regular BC members (at the time of the assessment) Ned Gruenhagen (BOR), Rick Bush (NMFS), Mary Larson (CDFW), and Scott Lewis (CMWD) participated in this review and site-selection process; Mike Gibson (CMWD) and hydrologist Bob Hughes (CDFW) were also involved in this assessment and selection process. Based on this field review, Site 2 was no longer considered a potential impediment. Site 10 was identified as a replacement site during the January field trip. Site 8, which was originally selected during dry conditions, was not considered as restrictive as other potential sites after evaluating data collected during 2010 and 2011. Consequently, Site 8 was replaced with Site 9 during the January field trip. The complete list of current impediment sites that the BC visited and determined to be satisfactory for monitoring during the 2012 season can be found in Appendix 2. However, at the time the new site selections were made (i.e., 11 January 2012), insufficient flows were available to make final site selection or transect placements. Until March of 2014, the lack of precipitation and subsequent insufficient surface flow, did not allow for confirmation of these new sites. This confirmation was completed after the March 2014 storm provided the first notable surface flows in 3 years and allowed available members of the BC to visit sites 9 and 10 on 03 March 2014. The confirmation was conducted by Scott Lewis (CMWD), Dana McCanne (CDFW), and Mike Gibson (CMWD).

<u>ENTRIX Site Assessments</u>

An effort was made to locate and determine the status of the ENTRIX (1999) study sites during 2009. Because there had been numerous bed-mobilizing runoff events after the study was completed, the current status of the sites was unknown. Based on the site descriptions in the ENTRIX (1999) study report, field surveys were conducted to locate and describe the existing channel conditions at the original site locations. Of the seven sites originally identified by ENTRIX (1999), only four sites were located with any degree of certainty. Of those four sites, all were no longer in the primary low-flow channel. A more detailed description of the ENTRIX sites can be found in a previous progress report (CMWD 2011).

<u>Results</u>

During the reporting period, no BO-defined storm events occurred. Precipitation in the Ventura River basin ranged from approximately 40-60% of normal for the 2016 water year. A total of 14.5 inches of precipitation was measured in Matilija Canyon (Ventura County site 207c). Daily mean discharge into the Robles Fish Facility ranged from 0 to 18 cfs. However, flow evaluations were not able to be conducted in 2016 and no data were collected due to the ongoing exceptional 5-year drought. Even though no data were collected during 2016, Appendix 3 was included in this progress report to provide the current status of data collection for each impediment site.

3.1 *Sandbar Monitoring*

<u>Introduction</u>

The Ventura River, like many other California rivers, frequently develops a seasonal sandbar at the mouth during the late spring or summer that is breached by higher river flows in the late fall or winter. If a sandbar develops, which occurs more often during dry years, the resulting lagoon can provide important rearing habitat for steelhead juveniles because of the abundant food resources available. Additionally, this can facilitate the physiological and behavioral changes associated with smoltification (Cannata 1998) and also enhance marine survival (Bond et al. 2008).

The primary objective of the sandbar monitoring is to determine if the criteria for initiation of the fish passage augmentation season have been met (NMFS 2003a). As stipulated in the BO, the fish passage augmentation season will extend from 01 January through 30 June of each year and will commence after the sandbar has been breached at least once during the current year's fish flow operations season. During the fish passage augmentation season, several Robles Fish Facility operation criteria must also be implemented (see NMFS 2003a for a complete list of operational criteria).

Methods

During each sandbar inspection, observations and recordings were made that included: date, time, status of the sandbar, general location of the mouth, tidal stage, water temperature, and discharge at the Robles Fish Facility and the USGS Foster Park gage station. The sandbar was open on 05 January 2016 and its status was monitored once every two weeks through June. Outside of the fish passage augmentation season the sandbar was monitored at least monthly.

Results

During the reporting period, July 2015 through June 2016, the mouth of the Ventura River was inspected 26 times to determine if the sandbar was open or closed. There were 16 observations that occurred during the fish passage augmentation season (January through June 2016) and 10 observations outside of the season. The sandbar was open the majority of the time during the fish passage augmentation season (Appendix 4). The sandbar was closed to start the fish passage augmentation season, but opened on 05 January 2016 when volitional passage into the estuary became possible. In mid and late January the sandbar was closed, but re-opened after a small rain event in early February. The sandbar remained open until June. On the days the sandbar was inspected during the reporting period, the mean daily discharge at the USGS Foster Park gage station ranged from approximately 0 to 6 cfs and 0 to 5 cfs at the Robles Fish Facility. When the sandbar was open, the river was observed primarily exiting from the east side of the estuary during the reporting period.

Discussion

The sandbar at the mouth of the Ventura River tends to remain open during average and above average precipitation years and closes only during years with few significant rain events (Lewis et al. 2010). This typical pattern of the sandbar remaining open during the fish passage season is illustrated from 2008 to 2011 (Appendix 5). This pattern typically includes a period during the summer and into the fall months that the sandbar will be closed. A single low precipitation year can produce a longer period of closure, as occurred in 2007 and 2012. Consecutive dry years may cause a closure to persist into the fish passage season, only opening during short periods following rain events, such as in 2013 through 2015.

The tendency of the sandbar to remain open in all but very dry years is likely due to a few probable factors. Although the middle reach of the Ventura River goes dry every year, during most years subsurface water continues to flow and eventually begins to resurface just upstream of the confluence with San Antonio Creek and continues to increase slightly proceeding downstream. Additionally, treated effluent water from the Ojai Valley Sanitary District at rkm 7.5 increases the river discharge by approximately 3 cfs. Finally, tributary flow from San Antonio Creek also adds to the Ventura River through a surface or subsurface connection throughout the year. These factors likely contributed water to the Ventura River keeping the sandbar from fully forming and therefore remaining open during most years. The status of the sandbar indicates changes in the estuary/lagoon that may help determine potential entry and exit conditions for adult steelhead and juvenile *O. mykiss* migrating to the ocean. It appears that passage conditions remain suitable during most seasons when steelhead are likely migrating. However, lagoon conditions optimal for juvenile rearing (i.e., when a sandbar closes and results in an estuary forming a deeper freshwater lagoon; Bond et al. 2008), appear to have been limited during years with potential smolt recruitment for the study period beginning in 2005. The ongoing drought of five consecutive years of below-normal precipitation (about 40-60% of average) have created conditions at the mouth of the Ventura River causing the sandbar to be closed for the majority of the time during the monitoring period. Unlike the previous three years, the sandbar remained opened for the majority of the 2016 fish passage season even though it had similar below-normal precipitation. An extremely high surf event that occurred in mid-December 2015 caused heavy beach erosion at the river mouth similar to what can occur during a large storm event. This may have temporarily reduced the base flow needed to maintain an open connection with the ocean.

4.0 EVALUATE FISH MOVEMENT THROUGH THE PASSAGE FACILITY

4.1 *Water Velocity and Depth Validation Evaluation*

Insufficient flows during the 2015-2016 season prevented data collection for the performance testing evaluation.

4.2 *Fish Attraction Evaluation*

Introduction

River discharge has been shown to be one of several key environmental factors initiating and facilitating steelhead, and other salmonids, adult and juvenile migrations in natural fluvial environments (Shapovalov and Taft 1954; Banks 1969; Spina et al. 2005). As adults and juveniles approach fish passage facilities, suitable discharge and water velocities become even more important to ensure successful passage through any facility (Clay 1995; Beeman and Maule 2001).

The entrance of the fish ladder at the Robles Fish Facility is located approximately 20 m downstream of the spillway gates and is where fish migrating upstream enter and where fish migrating downstream exit the facility (i.e., two-way passage facility). The downstream end of the ladder is adjacent to a large pool (entrance pool). The ladder was designed for a maximum discharge at the exit of 171 cfs (50 cfs through the entire ladder and an additional 121 cfs can be supplemented at the lower end of the ladder). The distance downstream from the entrance pool to the lower most rock weir is approximately 200 m. This reach includes all four rock weirs and the facility's discharge measurement weir, which also functions as a low-flow road crossing. The habitat unit types that can be used by migrants in this reach include the four pools created by the weirs, a glide created by the discharge measurement weir, a riffle, and the entrance pool.

The objective of the fish attraction evaluation is to determine if adult or juvenile steelhead are holding immediately downstream of the Robles Fish Facility during the fish passage augmentation season (NMFS 2003a).

Methods

Three separate methods were employed to determine the presence of *O. mykiss* for the Fish Attraction Evaluation to encompass a range of spatial and temporal scales. The methods used included: 1) Weekly bank/snorkel survey during the fish passage season, 2) post-storm bank/snorkel surveys in the entrance pool during the BO-defined ramp-down period, and 3) post-storm underwater video monitoring at the fish ladder entrance during the ramp-down period.

1) Weekly bank/snorkel fish attraction surveys, a methodology used since 2007, were conducted during the fish passage season from January through April of 2016 when water was present. During 2016, small storms occurred in January, February, and March. These storms created surface flows and allowed surveys to be completed for approximately 4 months. Robles went dry shortly after the early January rain event, and

was not surveyed again until February when surface flow returned. The particular survey methodology used (i.e., bank or snorkel) was determined based on water visibility, river discharge, expected steelhead life history stage present at the time of the survey, and safety of surveyors. A combination of bank and snorkel surveys were conducted during the 4-month period. Bank surveys were conducted by one or two surveyors in an upstream direction. The surveyors wore polarized sunglasses to reduce water-surface reflection. Snorkel surveys were conducted by one or two surveyors in an upstream direction. If present, fish species were identified and enumerated to the greatest extent possible permitted by the ambient river conditions and fish densities at the time of each survey. If *O. mykiss* were present, lengths of each fish was estimated to the nearest cm if only a few individuals (generally <10) were present. In order to collect additional information that may help determine *O. mykiss* upstream and downstream movements through the Robles Fish Facility, an upstream study reach was added in 2009. The upstream study reach included observations in the screenbay of the facility and the area immediately upstream of the low-flow fish exit in the forebay. The total distance of this upstream reach was approximately 140 m.

2) Post-storm bank/snorkel surveys were to be conducted in the entrance pool during the ramp-down period for any BO-defined storm. This would have consisted of daily surveys during the 10-12 day augmentation period. Beginning the day after a BO-defined peak event, a Secchi visibility would be measured in the entrance pool to determine when surveys could begin. Bank surveys would be conducted while visibility was poor and snorkel surveys would be conducted after visibility increased (> 1.0 m Secchi), assuming this would allow *O. mykiss* to be observed.

3) The post-storm underwater video monitoring was to be conducted after a BO-defined storm and during the ramp-down period. After the storm event occurred, video cameras would be installed at the entrance of the fish ladder. The video cameras would be mounted on a bracket adjacent to the fish ladder entrance and lowered into place to provide monitoring following the storm event. The cameras record the entire 10-12 day ramp-down period to a digital video recorder (DVR) to be reviewed at a later date.

Results

1) A total of 11 surveys were completed during the weekly surveys and no *O. mykiss* were observed (Appendix 6). During the 4-month period, a total of 3,190 m were surveyed by either bank or snorkel methods. The water temperatures during the study period ranged from 11 °C to 19 °C and turbidity was less than 9 NTUs when the surveys were conducted. The mean daily discharge at the Robles Fish Facility ranged from 0 to 6 cfs at the time of the surveys. Flowing water remained in the upper portions of the survey reach (< 1 cfs) even though no flow was passing over the measurement weir prior to the entire survey reach going dry.

2) There were no BO-defined storm events thus no post-storm fish attraction surveys were conducted.

3) There were no BO-defined storm events thus no post-storm underwater video monitoring was conducted.

4.3 *Downstream Fish Passage Evaluation*

Introduction

Passage evaluations of salmonids migrating through fish passage facilities have been conducted throughout the western United States for many years (Odeh 2000). Methods to determine if a facility is operating as designed and not causing harm to the intended fish species vary. Early work typically entailed trapping and tagging fish before entering a facility and recapturing them after exiting. Trapping and visual inspections for injuries, PIT tagging, radio telemetry, and acoustical telemetry has been conducted extensively as well.

There are two objectives for the downstream fish passage evaluation. The first objective is to determine if downstream migrants are successfully passing through the

Robles Fish Facility. The second objective is to capture and examine steelhead smolts and kelts and determine if injuries are occurring as they pass downstream through the Robles Fish Facility (NMFS 2003a).

Methods

Due to low precipitation, trapping was not conducted during 2016 and no data were collected for the Downstream Passage Evaluation. For a full description of evaluation methods, see the 2016 CMWD monitoring and evaluation study plan (Lewis et al. 2015).

5.0 DOWNSTREAM FISH MIGRATION THROUGH THE ROBLES REACH

Introduction

When the number of fish physically handled in a study is of concern, such as with an endangered species, radio telemetry can be a useful method over others like extensive trapping (Hockersmith et al. 2000). Telemetry migration information of steelhead smolts in the Ventura River would allow for the determination of survival, travel time and rates through select reaches, migration relative to river discharge, habitat use, and passage success through critical riffles. By tracking the tagged fish until the batteries die, it is anticipated that downstream migration can be monitored all the way to the Ventura River estuary/lagoon and could provide important data on estuary rearing and emigration behavior.

The purpose of the downstream migration evaluation is to determine how successful smolts are at migrating through the Robles Reach (NMFS 2003a). Because of the limited number of steelhead smolts likely passing downstream through the facility, a NMFS approved pilot study using radio telemetry was used for evaluations.

Due to low precipitation, trapping was not conducted during 2016 and no data were collected for the Downstream Fish Migration through the Robles Reach evaluation. For a full description of evaluation methods, see the 2016 CMWD monitoring and evaluation study plan (Lewis et al. 2015).

6.0 LONG-TERM MONITORING COMPONENTS

6.1 *Monitoring Robles Facility Operations*

6.1.1 Facility Status

The Robles Fish Passage Facility started the 2015-2016 season fully functional at existing capabilities. The 2015-2016 season was characterized by a below average rainfall year as measured at Casitas Dam. A total of 14.64 inches of rain were measured at Casitas Dam between October 1, 2015 and July 30, 2016. The average rainfall at the dam is 23.70 inches. This was the fifth straight year with below-average rainfall. The Ventura River watershed has previously experienced six straight years of below average rainfall during the 1946-1951 period. This period was part of the critical drought period used to determine the safe yield for the lake. As of August 12, 2016, the lake elevation was at 491.8 feet above sea level. This equates to 38.4% full or 97,500 acre feet of water in storage.

The BO contains Critical Drought Protection Measures (pages 12-13). The drought protection measures require Casitas to implement Stage 2 of the Water Efficacy Allocation Program (WEAP) once the lake has fallen below 127,000 acre feet. Casitas implemented Stage 2 of the WEAP on April 11, 2015. As of July 1, 2016, Casitas entered into Stage 3 of the WEAP. The implementation of the WEAP to reduce water demand has been successful, with water usage falling from 19,093 acre feet sold in FY 2013/14 to 14,345 acre feet sold in FY 2015/16, a 25% reduction. This is especially remarkable in that during previous drought cycles, Casitas' water production has gone up as ground water supplies are reduced and groundwater pumpers use more Casitas water.

As outlined in the BO Critical Drought Protection Measures, the Biological Committee would analyze options to reduce fish flow operations and make a recommendation to the Management Committee. The Management Committee would review the options and recommendations by the Biological Committee and provide a recommendation to Bureau of Reclamation. The Bureau of Reclamation would then provide the Management Committee's recommendation to NMFS, along with and any required supporting materials. Once NMFS notifies Reclamation that the recommendation is consistent with the BO, CMWD would be authorized to implement the recommendation when the volume of water stored in Lake Casitas drops below 100,000 acre feet. As of October 2016, Lake Casitas had 91,000 acre feet of water storage, which is below the 100,000 acre feet threshold. The CDPM are designed to be temporary measures to prevent Lake Casitas water storage from dropping below a critical level of 17,000 acre feet. If similar rainfall occurs over the next two years that has occurred over the last 5 years, water storage in Lake Casitas is likely to reach 65,000 acre feet by the end of the second year, even with implementation of Stage 4 and 5 water restrictions.

No water was downloaded from Lake Matilija to Robles and no valves were operated at Matilija Dam.

The 2015 Report identified several projects to be completed during the summer and fall. The principal projects were:

- Modify the differential level sensors at the fish ladder entrance to individually read water levels or install an additional level sensor.
- Design and submit for approval an alternate diffuser design for the fish screens and the auxiliary water supply.

A brief description of each project and the project's status is listed below:

Modify the differential level sensors at the fish ladder entrance to individually read water levels- this has proven to be more difficult than was expected. Casitas is intending to install an additional level sensor in lieu of modifying the differential sensor to provide the entrance pool water level information. This is not a BO requirement.

The alternate diffuser design for the fish screens and the auxiliary water system received concurrence from NMFS on June 22, 2016. A contract to complete the project was awarded by the Casitas Board on August 10, 2016. Casitas anticipates the material to arrive in early October and the work to be complete by mid-November 2016.

Erosion and scour occurs in the entrance pool during times of spill. This hydraulic scour undercuts structural concrete on both sides of the entrance pool and periodic replacement of substrate is required. This was conducted during 2016 and will be conducted in the future during dry conditions.

6.1.2 Flow Observations and Control

Flow and level measurement devices are located at various locations within the Robles Fish Passage Facility. The primary points for measuring and recording stream flows entering, flowing through, and leaving the Robles Fish Passage Facility are:

- <u>Matilija Creek at Matilija Hot Springs</u>—Located approximately 2,100 feet downstream of Matilija Dam – good rating for low to moderate flows – operated by Casitas Municipal Water District, formerly a USGS station. A second gaging station at this location is operated by Ventura County.
- <u>Matilija Dam Stage Bubbler</u>—Located at the dam, this gage provides the lake elevation. Under high flows, the dam acts as a weir. This is the primary flow measurement location under high flows and to determine if, and when, a peak has occurred.
- <u>North Fork Matilija Creek</u>—Located approximately 3,000 feet upstream of its confluence with Matilija Creek – good rating for low to moderate flows – operated by the Ventura County Watershed District.

- Robles-Casitas Diversion Canal—Located on the diversion canal approximately 1,300 feet downstream of the Robles headworks – trapezoidal channel with a good rating for flows up to 600 cfs.
- Ventura River near Meiners Oaks (VRNMO or Measurement Weir)—Located approximately 540 feet downstream of the Robles Fish Passage spillway – concrete weir section – good rating to 100 cfs, use of equations above 100 cfs with no verifications at higher flows above 1000 cfs. This is the most reliable flow measurement for the fish passage and downstream releases with a 50-year plus history. This site was formerly a USGS site.
- Fish Ladder—A 4 path flow meter by Accusonics located near the Riverwatcher. This flow meter has not been accurate since the installation of the replacement Vaki shroud. This flow measurement device was functional during the 2013-14 and 2014-15 seasons but the readings were erratic. It appears that the Vaki shroud is still influencing the readings at this location. A Sontek IQ Plus flow meter has been added to this location to measure flow in the fish passage and will be evaluated as soon as sufficient flow occurs.
- Auxiliary Water Supply—An American Sigma flow meter. This meter has not provided reliable readings. Troubleshooting is problematic because of infrequent flows necessitating the use of the auxiliary (attraction flow) flow system. This meter reads “zero” even though there were flows in the pipe. This meter will be left in place and the back-up transducer will be used in the future. A Sontek IQ Pipe flow meter has been installed to obtain flow measurements in the auxiliary water supply and will be evaluated as soon as sufficient flow occurs.

Biological Opinion Defined Peak Determination Methodology

The biological opinion defines a “peak” on page 7 under “Definition of a storm event”. The determination if a storm flow peak has occurred and therefore fish passage flow augmentation is required is dependent on Robles inflow measurements. Casitas uses a variety of instruments to measure and verify the flow into the Robles Fish Passage Facility.

The methodology to determine the size and timing of a peak begins with the weather report. Casitas reviews the National Weather Service 7-day discussion page to see if a significant rainfall event is likely to occur in the watershed above Robles. “Significant rainfall event” is different depending on current flow conditions through Robles. If there is no surface flow at Robles and there has not been any rain for 30 days, a “significant rainfall event” would be a prediction of approximately 4 inches or more of rain. If Robles has 20 cfs or higher flow, then a 2-inch or more rain storm could be significant.

Once rain begins, the Ventura County Watershed Protection District (WPD) website is monitored on a regular basis along with remote monitoring of Robles via Casitas’ SCADA system. The WPD website allows Casitas to monitor both the rainfall and the flow at various watershed locations. The primary flow gaging stations that are monitored are Matilija Dam and North Fork Matilija Creek on the WPD web page. The primary rain gages that are monitored on the WPD website are Old Man Mountain and Upper Matilija.

Beginning at 8 am after a rain storm and sometimes sooner, the data are gathered to determine if a BO-defined peak has occurred. A flow assessment worksheet is filled out by Engineering or Fisheries staff and the required fish passage augmentation flow requirements are posted for Robles operators to follow. The flow is adjusted to the new augmented flow each day by noon. The flow typically takes about an hour to adjust and stabilize.

On peaks of 500 cfs or less, the Ventura River at Meiners Oaks flow gage (VRMO) gage, also known as the Robles weir (low-flow crossing) is added to the flow measured in the canal near Robles. To verify the VRMO, the fish passage and the auxiliary water flow meters (if fully operational) are added together. The fish passage and auxiliary water flow meters added together should be approximately the same as VRMO. Visual verification is also made of the weir flow if needed.

The canal flow is verified with the flow gage located at the end of the canal near Lake Casitas and with visual checks of the stream gage at the Robles bridge over the canal.

To further confirm the observations at Robles, flows are obtained from the Watershed Protection District's website that provides nearly real time flow over the Matilija Dam (VC690), Matilija Creek upstream of the dam (VC603) and North Fork Matilija Creek (VC604). If there is any question about the Matilija flow, Casitas manually obtains data from the gage station downstream of the dam

To determine the timing of the peak, the County's website for Matilija Dam is used along with the Robles operation system as displayed on the SCADA system. The Matilija Dam peak is generally about 2 hours before the Robles peak.

To determine the size and timing of peaks greater than 500 cfs, Casitas uses the Matilija Dam flow gage added to the North Fork Matilija gage. This is because the VRMO gage has only been verified up to 100 cfs. Casitas does anticipate verifying the calculated flows at VRMO when the opportunity to do so occurs. North Fork Matilija's peak flows occur prior to Matilija Dam's peak. So the peak flow is determined by adding the peak flow from Matilija Dam with the flow at North Fork Matilija Dam at the time of the Matilija Dam peak. This flow number is then compared with the flows at Robles for verification. A new (2015) WPD feature calculates Matilija and North Fork Matilija creeks discharges to easily determine flow the Ventura River upstream of Robles (VC 609).

To summarize, the steps taken beginning at 8 am after a rain event:

- Monitor the WPD website for rain amounts and rising flows.
- Monitor flows at VRMO and canal via SCADA or at Robles.
- Casitas personnel review the BO definition of a storm event.
- If a "peak" meeting the definition of a storm event has or is likely to occur, Casitas staff proceeds to fill out the work sheet.
- Flow data is verified by alternate gaging stations and visual confirmation as needed.
- By noon, the downstream release is set for the following 24 hours, based on the BO requirements.
- Downstream release requirements for the complete 12-day ramp down are posted at Robles.

All of the instruments can suffer from inaccuracies from time to time. The inaccuracies can be caused by clogging of bubbler lines, electronic creep, debris accumulating on sensors, changes to the measured cross sections, human interactions and equipment problems. For this reason, the data is verified against field measurements and observations. The information gathered from each of these locations has been reduced to the mean daily flows in cfs (Appendix 7). The data logger/transmitter at the measurement weir was found to be unresponsive on several occasions and was replaced with a back-up logger on April 04, 2016. The majority of these periods occurred when discharge was less than 5 cfs. There was a four hour period on January 31, 2016 when the logger was reporting zero flow across the weir while the fishway flow meter was reporting between 1 and 32 cfs; there was no spill during this period. The mean daily Robles Fish Facility discharge, turbidity, and temperature measurements for the entire Fish Passage Season are presented in Appendix 8.

Surface flow over the measurement weir was first observed from January 05, 2016 through January 09, 2016. Surface flow began again on January 31, 2016 and continued intermittently until February 21, 2016. Flows once again returned on March 06, 2016 and continued intermittently through April 13, 2016 and remained dry for the rest of the 2016 Fish Passage Season. Inflow peaked on January 31, 2016 at approximately 45 cfs–65 cfs. Rising water levels near this peak caused debris to begin accumulating in the forebay, screenbay, and fishladder. The spillway gates were briefly opened to flush debris from the forebay downstream of the Robles Fish Passage Facility. There were no BO-defined peak flow events during the 2016 Fish Passage Season and no diversions occurred during the 2015–2016 monitoring period.

6.1.3 Costs Associated with Operation and Monitoring

The BA/BO specified that the District provide the costs that are associated with the activity. The following is a summary of the direct costs incurred by the District during the 2015-16 fiscal year:

- **Fisheries Monitoring**:

Salaries & Benefits	$408,743
Equipment/Material	$ 18,137
	$426,880

- **Facility Operations**:

Salaries & Benefits	$ 16,300
Equipment/Materials	$ 2,649
Outside Contracts	$ 6,196
Utilities & Phone	$ 2,221
Permit	$ 0
	$ 27,366

- **Capital Improvements**: 0

Casitas has awarded a contract to modify the diffuser panels in the amount of $53,500. As this has not yet been paid out by Casitas, this amount will be included in next year's report.

6.1.4 Water Velocity and Depth Validation Evaluation

Casitas entered into an agreement with HydroScientific West to complete the first phase of the performance (hydraulic) testing. Performance testing of the fish screen was completed March 25, 2011. Because of inadequate flows, no additional performance testing was completed during the 2015-2016 season. Casitas priorities for 2016-2017 season include completing flow measurements in the spillway-entrance box channel (per NMFS request) and completing flow measurements at the auxiliary water screen in the entrance box. Both of these measurements require flows of 671 CFS for a minimum of 24 hours to complete.

Additionally, Casitas has purchased a Hach (Marsh-McBirney) FH 950 flow meter to assist in obtaining flow measurements in the fish ladder under the criteria specified in the Performance Evaluation Program. These measurements can be completed under moderate flow conditions (i.e., up to 171 cfs).

All performance testing will be completed in general accordance with the NMFS approved Performance Evaluation Program and Biological Committee recommendations.

6.1.5 Recommendations Regarding the Prioritization of Future Activities

The District has completed its tenth season with the Robles Fish Facility operational. Several projects have been identified to improve the functionality and reliability of the system. Other items require repairs. The summer and fall work list for 2016 include:

- Install repaired Sontek IQ Pipe flow meter in the auxiliary water supply pipe.
- Install level sensor at the fish ladder entrance to read water levels in the entrance pool.
- Install new diffuser perforated plate for the fish screens and the auxiliary water supply.

6.1.6 Recommendations Deemed Necessary to the Operations

Casitas continues to recommend that the construction of the 15-weir portion of the project be put on hold at least until the Matilija Dam Removal Project is completed. Preliminary plans for the High Flow Sediment Bypass and High Flow Fish Passage portion of the Matilija Dam Removal Project require this area to be graded to new elevations. The existing temporary weir system has proven to be passable by adult *O. mykiss*.

6.2 *Fish Passage Monitoring*

Introduction

Monitoring of migratory fish moving through fish passage facilities has been conducted using many different methods that include: visual counting, trapping and hand counting, continuous video recording, PIT tagging, radio telemetry, and acoustical telemetry. In each fish passage application, the particular physical and biological conditions (e.g., variable discharge, turbidity, debris, size of facility, and number of fish) usually dictate which method would be most effective. New technologies have been employed to improve fish passage monitoring in turbid conditions specifically. One such monitoring device is the Vaki Riverwatcher® (Riverwatcher). The Riverwatcher has the capability to operate in greater turbidity than more traditional monitoring equipment. Because of this advertised capability, the Riverwatcher was selected to be used in the Robles Fish Facility by the Technical Advisory Group during original facility design.

The primary objective of fish passage monitoring is to provide a long-term index of the number of upstream adults and downstream kelts migrating through the Robles Fish Facility (NMFS 2003a). The Riverwatcher has the ability to detect smolt-sized steelhead, but it's recommended for fish body depths ≥ 40 mm by the manufacturer (Vaki 2003). Consequently, it was not known how well it would work at detecting smolt-sized fish given the debris load of the Ventura River (NMFS 2003a).

Methods

Fish migrating upstream and downstream through the Robles Fish Facility were monitored using the Riverwatcher. The Riverwatcher is located in the fish bypass channel, which is the channel between the fish ladder and fish screens. The Riverwatcher consists of two scanner plates with light diodes that transmit beams of infrared light through the water to a corresponding receiver plate. When a fish swims (or debris drifts) through the infrared light beams, it breaks the light signal and a digital silhouette of the fish is recorded on a computer. Other data recorded when the Riverwatcher scanner is triggered are: date and time, total length (TL) of the fish (from a length/height ratio), swimming speed (m/sec), and direction of the fish movement (upstream or downstream). In addition, the scanner triggers an underwater camera to record a 10-second video clip (25 frames/sec).

The Riverwatcher was experiencing technical issues of malfunctioning video during the 2015 monitoring season. In the fall of 2015 the Riverwatcher was sent to Vaki for servicing. Through diagnostic testing, Vaki concluded no repairs were necessary and did not experience any issues with malfunctioning video. Vaki stated recent improvements to the Riverwatcher system could be integrated into older systems, and recommended upgrading the Robles Riverwatcher. This recommendation was discussed and approved by BC members at the 2015 committee meeting. The primary upgrade was changing from an analog camera to a digital camera. In conjunction with updated software, the camera now records video for both upstream and downstream detections. Additional upgrades to the Riverwatcher included: white and infrared lights, cabling, multiplexor, and power supply. To improve video detection of fish, an additional camera was installed and is located upstream of the Riverwatcher scanners in an aluminum tunnel below the Riverwatcher camera. A second DVR camera is located above the Riverwatcher and pointed at the scanner plates. These two DVR cameras are independent of the Riverwatcher system and have to be reviewed separately for detections. The digital cameras recorded continuously at 12 frames/sec and capture about 5 weeks of data until the DVR data storage drive is full. Once the DVR memory is full, it can be exchanged with a second DVR and data can be reviewed.

The Riverwatcher scanner and cameras are positioned at the bottom of an aluminum frame (crowder) covered with 1/2 inch aluminum bars, spaced 1 1/2 inches on center resulting in 1-inch spacing between the bars, which directs the fish to swim between the scanner plates. The crowder can be raised and lowered in guide slots of the fish bypass channel with the aid of an A-frame hoist for cleaning or repair. The Riverwatcher is usually operated during the entire flow augmentation season as long as sufficient water elevations in the fish bypass are present and debris and turbidity are low enough so that the crowder will not be damaged and the Riverwatcher will function.

The Riverwatcher was operated from 01 February 2016 to 20 April 2016 of the reporting period. During this fish passage season, the crowder was removed from the fish bypass channel and cleaned or inspected 25 times. Typically, during times of higher debris, the cleaning and inspections occur multiple times per day, and at times of low debris, cleaning and inspections occur only once every 2-3 days. At times of very low flow (< 1-2 cfs), the crowder may only be cleaned once per week. The crowder was removed for cleaning for a combined total of approximately 6 h during the operation period. The Riverwatcher was operated a total of 68 days, 88% of the time any surface water flow was measured in the Robles Fish Facility during the fish augmentation period. The upgraded Riverwatcher system was received from Vaki on 04 January. Time was needed to integrate the updated system into the existing Robles infrastructure, and the Riverwatcher was not operated when Robles was first wetted from 05 January through 09 January. During this time, flows did not exceed 8 cfs and there was no river connection. The Riverwatcher was removed from the fishway for 95 hours, about 6% of the time flow was measured in the fishway, in anticipation of increased turbidity and debris associated with two rain events. There was no river connection while the Riverwatcher was removed from the fishway.

Prior to 2010, each upstream and downstream Riverwatcher detection was reviewed and classified as either: an adult steelhead, *O. mykiss* non-adult steelhead, other species if identifiable, unknown fish, fish probable, or false detection (see Appendix 9 for detection classification flow chart). At the request of NMFS, this classification system was modified during the review process of the 2010 progress report. All confirmed *O. mykiss* were classified solely as *O. mykiss*. The classifications were determined by using a combination of the silhouette images, estimated lengths, and video clips. In addition, if larger adult sized *O. mykiss* were detected and a useful video clip was recorded, measurements of eye diameter and standard length (SL) were estimated from the video clip to calculate morphometric ratios that were compared to known steelhead and rainbow trout. A commonly used morphological method to discriminate differences is to develop ratios of body measurements for comparison to remove the effects of body size (Strauss and Bond 1990). This is done by comparing SL to the ratio of eye diameter in linear regression. Standard length is the length from the snout to the end of the hypural plate near the end of the fleshy caudal peduncle, which is unaffected by caudal fin deformities (Anderson and Neumann 1996). Before

2010, the adult steelhead classification was used if the fish observed was an *O. mykiss* and displayed the typical characteristics of an anadromous adult steelhead, such as black spotting on dorsal, adipose, and caudal fins, black spotting on dorsal side of body, silvery body, vertical edge to caudal fin, ≥ 38 cm TL (Shapovalov and Taft 1954), and had an eye diameter/SL ratio ≤ 0.045 (CMWD 2008). The new classification method may include juvenile resident, smolts, adult resident, and adult anadromous *O. mykiss* migrating throughout the basin. Conceivably, after more data are collected from the downstream trapping component, or from other Ventura River basin research projects, a more thorough classification system of Riverwatcher detections could be used again.

The "fish unknown" classification was used if a detection was identified to be a fish based on video evidence, but further classification could not be determined due to high turbidity or an inadequate amount of the fish captured within the camera's field of view. The "fish probable" classification was used if no fish was observed in the video, but the silhouette was similar to that of a typical fish silhouette confirmed by video evidence. Even with reasonably good video coverage, smaller fish are still able to pass through the Riverwatcher undetected by the video cameras. This occurs if fish swim very close, high, or low relative to the cameras. In addition, this can happen if a fish swims upstream through the scanners but stops before entering the video field of view. High turbidity can also obscure the video detection and identification of fish. The "false detection" classification was used when no fish was observed in the video and the silhouette was not similar to that of a typical fish silhouette. Because false detections tended to occur frequently during higher discharges, when turbidity and debris also were high, it was likely that most false detections during these periods are caused by debris, high turbidity, and water turbulence. A second video camera is directed at the Riverwatcher scanner plates to help determine the cause of many of the false detections. After reviewing selected times where many assumed false detections occurred, it was concluded that debris, air bubbles, and turbulence were indeed the source of the detections. During low-flow periods (<10 cfs), which was 99.9% of the time the Riverwatcher was operating, surface water turbulence was likely the cause of most false detections. When turbidity exceeds about 100 NTUs, hundreds of false detections can occur per hour due to high concentration of suspended solids breaking the infrared beams of the scanner plates. When turbidity is less than about 100 NTUs, false detections from suspended solids are not as frequent, but poor camera visibility does not always allow for video confirmation, depending on how close to the camera that a fish swims during passage. Once the turbidity falls below about 25-30 NTUs, turbidity does not limit the Riverwatcher's capability for detecting and confirming fish (Table 1). In spring 2016, the Riverwatcher was tested in an above-ground pool with wooden fish silhouettes at varying water turbidities. This was intended to simulate natural stream conditions to provide further resolution of the operational capabilities of the Riverwatcher (Lewis et al. 2016).

Table 1. Riverwatcher general operational status for ranges of water turbidity (NTUs).

Approximate Turbidity (NTUs)	Riverwatcher status
> 200	Not functional
100-200	Many false scanner detections, not fully functional
30-100	Scanner functional, but unable to confirm with video
< 30	Scanner functional, grid detectable for video confirmation

A standardization test for the Riverwatcher was developed using wooden silhouettes of a typical smolt and adult steelhead. To confirm the Riverwatcher is functioning correctly, this test was conducted before the Riverwatcher was operated during the 2016 fish passage season. A more detailed description of this test can be found in Lewis et al. (2016).

Results

During the 2016 fish migration season, the Riverwatcher did not record any fish detections. Only false detections were recorded, of which 143 were upstream and 178 were downstream (Appendix 10).

The pre-season Riverwatcher standardized model test was conducted on 14 January 2016. The Riverwatcher estimated the mean body depth of the adult model passed upstream head-first as 123.9, which is 4.9 mm (5%) less than actual body depth of 128.8 mm. The smolt model passed downstream head-first had an estimated mean body depth of 38.8 mm, which is 3.2 mm (8%) less than actual body depth of 42.0 mm. The smolt model passed downstream tail-first had an estimated mean body depth of 31.8mm, which is 10.2 mm (24%) less than actual body depth of 42.0 mm. The detection rates were 100% (30/30) for the adult model, 73% (11/15) for the smolt model head-first, and 73% (11/15) for the smolt model tail-first.

Discussion

There were 321 false detections recorded by the Riverwatcher. All detections were assumed to be false detections from turbidity, debris, turbulence, air bubbles, and settings of the Riverwatcher to detect smaller fish. The review of the second DVR camera directed at the Riverwatcher scanner plates provides confidence that these are the likely causes of the false detections. None of the detections produced silhouettes that appeared to be fish based on previous experience operating the Riverwatcher. In the event that one of these silhouettes could have been caused by a fish, all detection video clips created by the Riverwatcher were reviewed and no fish were observed. For the 2016 season, the minimum height remained at 28 mm so that a large number of false detections could be eliminated while still attempting to detect steelhead smolts. Based on available data from the Ventura Basin, a height of 28 mm was determined to be similar to some of the smallest steelhead smolts expected to emigrate downstream through the Robles Fish Facility. This height corresponds to 146 mm TL and 139 mm FL. The estimated fish detection rate from a Riverwatcher verification study indicated that up to 93% of smolt sized *O. mykiss* will not be detected by the Riverwatcher (Lewis et al. 2016). Additionally, it was concluded that larger-sized fish (i.e., height > 80 mm) appeared to be detected nearly 100% of the time. This height is equal to about 475 mm TL. Shapovalov and Taft’s (1954) 9-year study documented only 4% of the total number of adult steelhead were smaller than 475 mm. Therefore, the number of small adult steelhead that may not be detected would likely be low. However, the vast majority of adult steelhead would be detected.

7.0 ADDITIONAL BIOLOGICAL AND ENVIRONMENTAL MONITORING STUDIES

7.1 *O. mykiss Presence/Absence Surveys*

Methods

In addition to the fish attraction monitoring, *O. mykiss* presence/absence surveys were conducted in the Ventura River mainstem between the Robles Fish Facility and the Ventura River mouth and San Antonio Creek. Surveys were conducted upstream of the Robles Fish Facility in Matilija and North Fork Matilija creeks. These additional sites were surveyed using both bank and snorkeling methods (depending on water conditions and expected life history stage) but were conducted primarily after storm events for adults and during the rest of the year for smolts, parr, and fry. Methods to estimate fish size and numbers were the same as those used in the fish attraction evaluation. A total of 14 sites were monitored and both pool and riffle habitat at each site were included (Appendix 11). These additional areas were surveyed to determine if adult steelhead were entering the Ventura River, migrating upstream, holding and spawning, and if they were successfully passing through the Robles Fish Facility. Also, juvenile *O. mykiss* (smolts and residents) were surveyed to learn spatial and temporal patterns.

The sites were initially selected based on ease of access, coverage of basin, and presumed chance of detecting *O. mykiss*. However, after all habitat surveys were completed, site selection was also based on quantitative measurements identifying high-quality habitats used for *O. mykiss* juvenile rearing and adult holding.

Results

Peak snorkel counts within each year have generally been between 350 and 400 *O. mykiss* until 2013. Due to the exceptional drought in its fifth year, the peak numbers of

O. mykiss have dropped substantially (Appendix 12). The peak count of *O. mykiss* was 14 during 2016, six of which were fry estimated to be ≤ 3 cm.

7.2 *O. mykiss Index Spawning Surveys*

Methods

Spawning surveys were conducted throughout the Ventura Basin that is accessible to adult steelhead and only resident rainbow upstream of Matilija Dam. A total of 21 index sites or reaches were subjectively selected (Appendix 13) with small to medium size gravel that are suitable for steelhead spawning (Shapovalov and Taft 1954; Orcutt et al. 1968). During 2008, the spawning index sites selected were initially distributed broadly within the basin to capture general spawning locations and timing. Since 2008, longer reaches have been added to incorporate and replace previously surveyed discrete sites to accommodate for spawning gravel redistribution after storm events. Additional sites have been added to capture quality spawning habitat and to be more representative of each surveyed sub-basin. This initial information will used to establish long-term index sites to capture population trends. The spawning surveys were conducted biweekly from January through June, or until no further spawning was observed, and observations were made at sites to identify and count *O. mykiss* redds; redds were identified by typical characteristics (Orcutt et al. 1968; Chapman 1988). Once a redd was identified, physical measurements similar to those recorded by Zimmerman and Reeves (2000) were collected to characterize the redd. The physical measurements were only recorded during the first three years because it was felt sufficient data was collected to characterize redds. Currently, only larger redds (likely anadromous) have all measurements collected. Pit and tailspill lengths were measured from the upstream end to the downstream end of each, respectively. Redd width was measured at the widest point of the tailspill (Appendix 14). Water depth was measured at four locations: in the pit, adjacent to the pit, upstream of the pit, and at the tailspill. The surface median (D_{50}) and maximum substrate size of each redd tailspill was estimated. All adjacent measurements were taken on the thalweg side of each redd. Photos and GPS locations were also recorded for all redds identified. This information will help determine steelhead spawning habitat selection characteristics.

Results

Spawning surveys started in 2008, numbers initially increased from only 3 redds to a high of 165 redds in 2012. Over the last 4 years, as the current drought intensified, the available habitat diminished, causing dramatic losses to the adult and juvenile *O. mykiss* populations resulting in significantly lower redd counts. In 2016, the total count was 7 redds (Appendix 15).

7.3 *Ambient Water Quality Monitoring*

In order to fully evaluate several aspects of the monitoring and evaluation program, water quality data is collected throughout the Ventura River basin (Appendix 16). Water temperatures are recorded at 12 locations throughout the Ventura River basin. The locations include the Ventura River estuary and mainstem, Coyote Creek, San Antonio Creek, North Fork Matilija Creek, and Matilija Creek upstream and downstream of Matilija Dam. The loggers record at 30-min intervals. Monthly grab samples are also collected at the same locations with a multiprobe that measures: dissolved oxygen, pH, conductivity, salinity, TDS, and temperature. A monthly water quality profile is also collected in the estuary/lagoon. The profiles are collected at approximately the mid-point of the estuary/lagoon and at least four depths are recorded. A continuous turbidity probe is also installed in the Robles Fish Facility near the Riverwatcher. It records water turbidity at 1-hr intervals when the bypass is operational. Turbidity measurements are also collected at several sites upstream, downstream, and within the Robles Fish Facility to ensure the continuous probe is located in a position that will be representative of the turbidity in the Ventura River. All locations are monitored if sufficient water was present. Given the current drought, many of the monitoring sites were dry. A weather station has been installed at the Robles Fish Facility to collect various atmospheric data including rainfall, temperature, pressure, wind, humidity, and dew point (Appendix 17).

The weather station used since 2012 for monitoring failed, which resulted in several months of lost data. A new weather station was installed in November of 2015.

7.4 *Estuary/Lagoon Monitoring*

The sandbar is monitored during the fish passage season to determine if it is open. If open, Robles Fish Facility operating criteria must be met per the BO. Outside of the passage season, monitoring has been conducted and expanded to better understand the nature of the Ventura River sandbar and how it may affect fish passage year round, and also potential rearing capacity. The estuary/lagoon has been monitored monthly for water depth as part of the water quality monitoring. In addition, the surface area has been measured every 6 months. Together, these physical measurements can provide some general index of rearing capacity of the Ventura River estuary/lagoon over time. From 2008 through 2011, which were wetter years, the sandbar status and estuary/lagoon depth and size varied with conditions. However, since the beginning of the current drought in 2012, conditions have remained somewhat uniform (Appendix 18).

7.5 *Surface Flow Monitoring*

The Ventura River, like most rivers in southern California, have significant reaches that lose surface flow during most years after storm flows recede. To quantify this natural pattern, surface flows have been observed and documented beginning at the end of 2007. Like the sandbar monitoring, clear patterns have become apparent. During normal precipitation years, there are typically surface flows throughout the length of the Ventura River mainstem during the fish passage season. Even during normal years, the Robles Reach goes dry shortly after storms occur. However, beginning with the current drought, the Robles Reach has been dry for extensive periods of time, even extending downstream of the San Antonio Creek confluence. This dry pattern persisted throughout the 2016 monitoring period (Appendix 19).

7.6 *Photographic Index Sites*

Photographic index sites were established throughout the Ventura River basin in 2007 to monitor general changes of the stream channel morphology, water conditions, and riparian zones. There are a total of 14 sites where an upstream and downstream photo are taken (Appendix 20). The sites were re-visited twice during the reporting period, in September 2015 and March 2016. As a representation of the general patterns within the mainstem of the Ventura River, Appendix 21 shows the general trend that has been observed of increasing riparian and within channel vegetation over time since 2009.

7.7 *Underwater Video Monitoring*

As time allowed, a pilot study of an underwater video monitoring system was continued to determine if remote monitoring for adults or smolts is feasible within the Ventura River or tributaries. The monitoring system was placed at selected locations when water conditions were suitable to record fish rearing, holding, or migrating. The system consisted of an underwater video camera attached to a DVR that can record for 6-8 hours at a time. The system was powered by a 12 volt DC battery so the system could be placed anywhere within the basin. The video was reviewed to determine presence or absence and relative numbers of steelhead, if present. If this pilot study is successful, it may be expanded and developed into a more quantitative monitoring tool. This is the same system that was used at the fish ladder entrance during post-storm observations. Underwater video monitoring was not conducted during the 2016 fish passage season.

7.8 *Stranding Surveys*

No stranding surveys were conducted due to dry river conditions during the reporting period.

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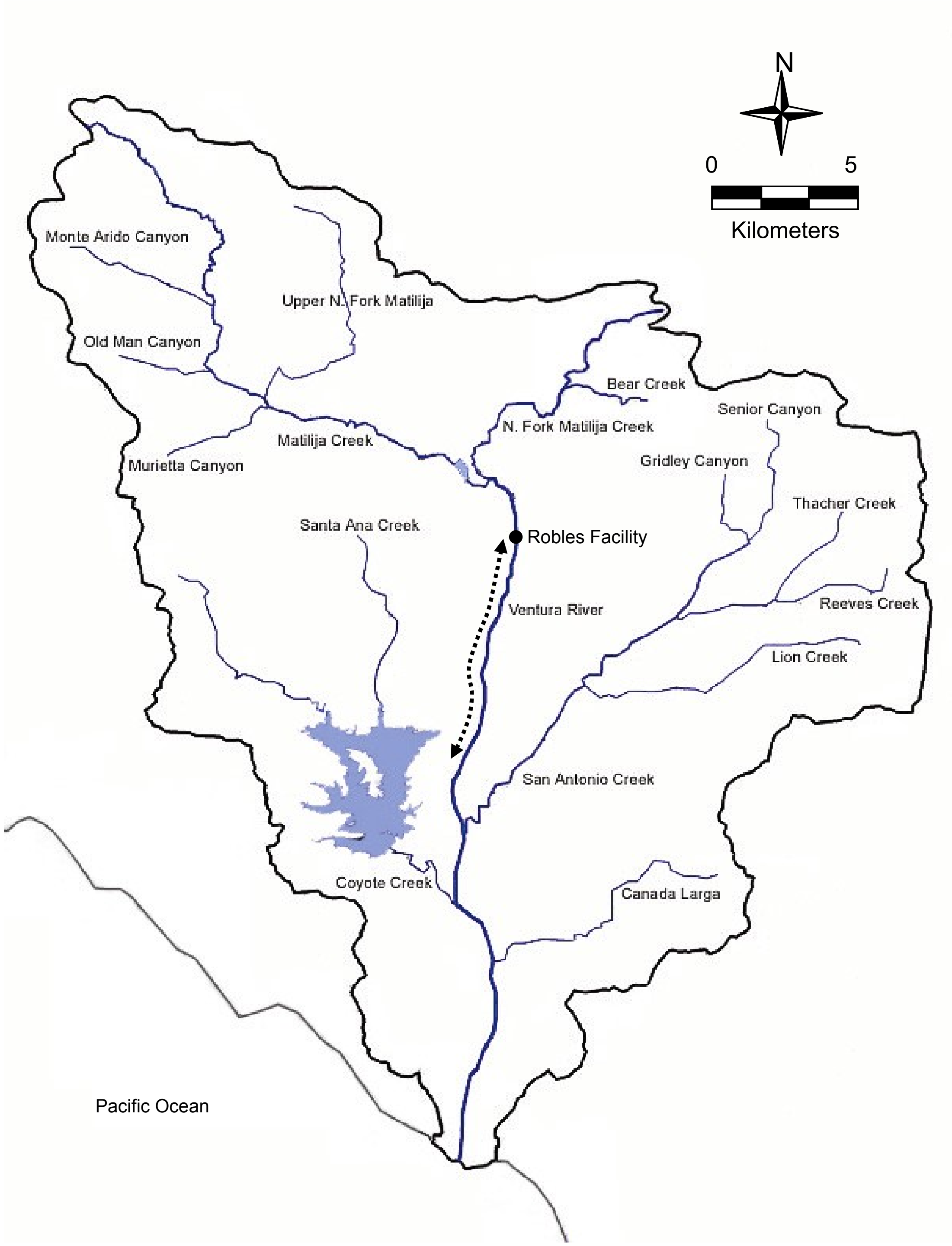
9.0 APPENDICES



Appendix 1. Basin map of the Ventura River. The Robles Fish Passage Facility is identified by the black dot and the Robles Reach is identified by the dashed line downstream of the Robles Facility.

Appendix 2. Summary data of impediment sites selected for upstream fish migration impediment evaluations.

Site No.	Latitude (N)	Longitude (W)	km	Habitat Type[a]	Site Description	Length (m)	Slope (%)	Percent Substrate[b] SO	SD	GR	CB	BD	BR	Active Channel Width (m)
10	34.365265°	119.311082°	11	RI	Near Casitas Springs at bottom of levy	38.2	1.0	0	0	10	70	20	0	44.5
3-2	34.373789°	119.308417°	12	RB	Near Casitas Springs at top of levy	22.0	3.7	10	5	10	65	10	0	27.0
4	34.384743°	119.310030°	14	RI	0.5 km upstream of San Antonio Cr. confluence	23.8	5.0	0	0	0	15	85	0	27.9
5-2	34.396095°	119.309537°	15	RI	0.4 km downstream of Santa Ana Blvd. bridge	8.4	7.0	0	5	5	45	45	0	50.6
6-2	34.411318°	119.301491°	17	CB	1.4 km upstream of Santa Ana Blvd. bridge	26.1	5.0	0	0	0	65	35	0	33.8
9	34.426708°	119.301831°	19	RI	0.2 km upstream of Hwy 150 bridge	67.9	1.5	0	0	0	30	70	0	32.4
7	34.438184°	119.299528°	20	RB	1.1 km upstream of Hwy 150 bridge	31.6	2.0	5	0	10	40	45	0	65.9

[a]The habitat types are: RB = rapid with protruding boulders, RI = riffle, and CB = cascade over boulders.
[b]The substrate types are: SO = silt and organics, SD = sand, GR = gravel, CB = cobble, BD = boulders, and BR = bedrock.

Appendix 3. Completed transects at impediment sites for ramp down target discharges from the Robles Fish Facility through 2016.

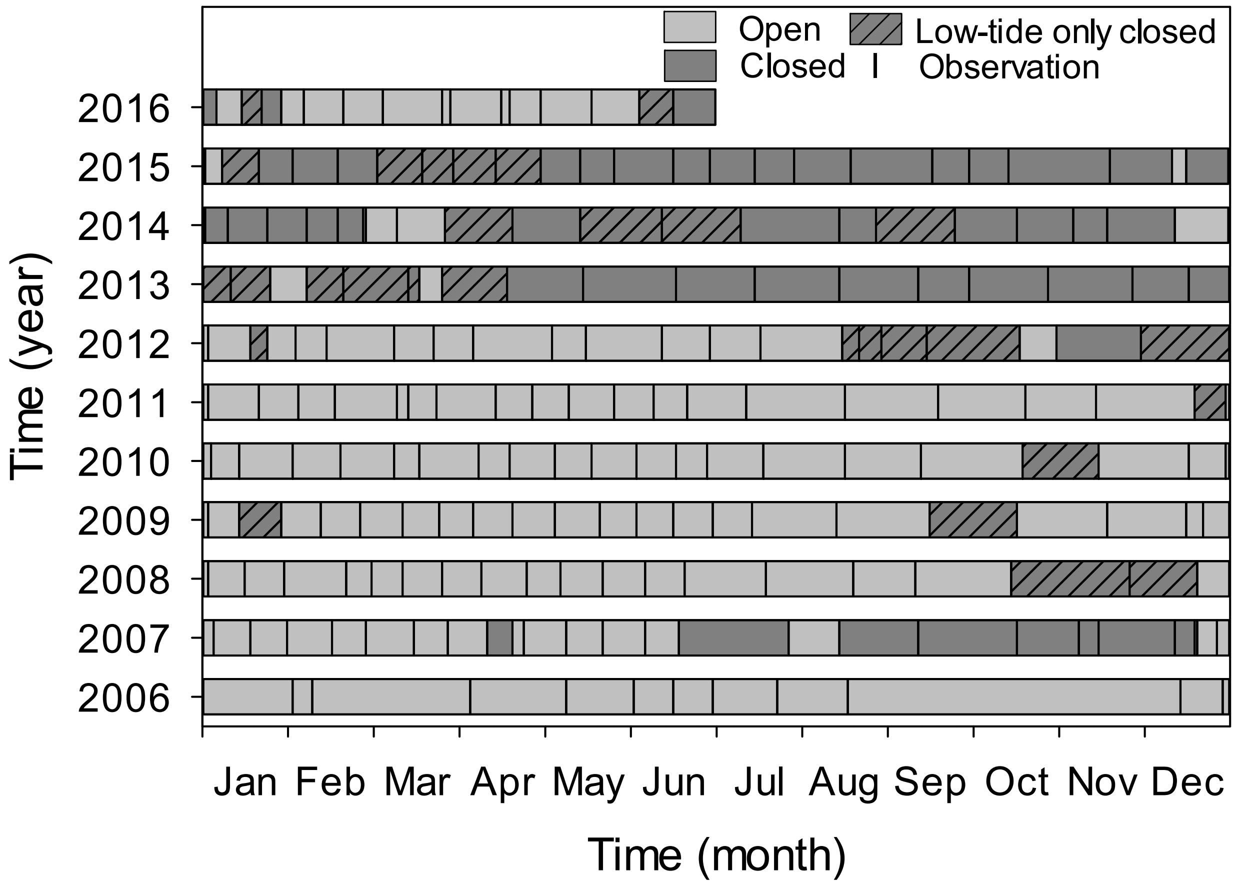
Robles Discharge (cfs)	Impediment Sites: 3-2	4	5-2	6-2	7	9	10
171	x (2014)						
100		x (2010)			x (2010)		
82	x (2014)	x (2014)			x (2014)	x (2014)	x (2014)
74		x (2011)	x (2011), x (2014)	x (2011), x (2014)	x (2011)		
68	x (2011)				x (2010)		
62		x (2010), x (2010), x (2011), x (2011)	x (2011)	x (2011)			
56	x (2011)		x (2011)	x (2011)			dry (2014)
50		x (2011)	x (2011)		x (2011), x (2010)	x (2014)	
40	x (2011)	x (2010), x (2010), x (2011)	x (2011), x (2011)	x (2011)	x (2010), x (2010), x (2011)	x (2014)	
30	x (2011)	x (2010), x (2011)	x (2011)	x (2011)	x (2010), x (2011), x (2011)	x (2014)	
20		x (2010)					

Completed transects rounded to nearest Robles discharge (e.g., the four transects measured at site 4 ranged from 61-63 cfs) based on a 2 rkm/hr lag time and averaging hourly discharge of released water from Robles. Colors correspond to year of survey: x = 2010, x = 2011, x = 2014.

Appendix 4. Ventura River sandbar monitoring data from July 2015 through June 2016.

Date	Sandbar Breached (Y/N)	Time (24h)	Tide Height (ft)	Tidal State	High Tide Time (24h)	High Tide Height (ft)	Low Tide Time (24h)	Low Tide Height (ft)	Mean Daily Discharge at Foster[a] (cfs)	Mean Daily Discharge at Robles (cfs)	Notes
7/16/2015	N	9:00	3.01	flood	11:09	4.16	4:49	-0.73	3.2	0	If breached, west bank
7/30/2015	N	17:00	2.67	flood	21:16	6.61	15:08	1.70	0.9	0	If breached, west bank
8/19/2015	N	9:00	2.37	flood	12:56	4.52	6:32	1.30	0.2	0	If breached, west bank
9/17/2015	N	9:10	3.60	flood	11:56	4.92	5:44	1.76	0	0	If breached, west bank
9/30/2015	N	11:05	6.26	slack	11:18	6.27	5:12	0.89	0	0	If breached, west bank
10/14/2015	N	9:35	5.37	flood	10:19	5.52	4:15	1.55	0	0	If breached, west bank
11/19/2015	N	10:15	2.59	slack	15:12	4.15	9:52	2.59	0	0	If breached, west bank
12/11/2015	Y	13:10	1.23	ebb	8:28	6.10	15:46	-0.65	0	0	Open, east bank
12/16/2015	N	9:30	3.82	flood	12:00	4.75	6:19	2.60	0	0	If breached, east bank
12/31/2015	N	14:45	3.23	ebb	12:50	3.66	19:54	0.99	0	0	If breached, east bank
1/5/2016	Y	17:10	2.48	flood	19:22	3.24	13:17	0.39	0	4.7	Open, east bank
1/14/2016	Y	9:40	3.77	flood	11:52	4.72	6:10	1.89	0	0	Open, east bank
1/21/2016	N[b]	9:10	4.76	ebb	7:01	6.19	14:17	-1.09	0	0	If breached, east bank
1/28/2016	N	13:30	3.44	ebb	11:24	4.23	18:10	0.61	0	0	If breached, east bank
2/5/2016	Y	10:10	2.79	ebb	6:42	5.52	14:00	-0.60	<0.1	1.2	Open, east bank
2/19/2016	Y	10:50	1.97	ebb	6:55	5.64	14:03	-0.80	0.1	0.5	Open, east bank
3/4/2016	Y	12:25	-0.06	slack	5:30	4.76	12:52	-0.11	0	0	Open, east bank
3/25/2016	Y	11:00	4.14	slack	11:15	4.16	17:11	0.93	0.1	0.6	Open, east bank
3/28/2016	Y	11:00	2.23	flood	13:30	2.96	7:24	0.78	0.3	0.1	Open, east bank
4/15/2016	Y	9:26	1.85	ebb	5:26	4.22	12:34	0.12	5.6	0	Open, east bank
4/18/2016	Y	14:03	0.44	ebb	8:13	4.37	14:30	0.39	5.9	0	Open, east bank
4/29/2016	Y	10:30	0.46	slack	17:33	3.42	10:18	0.44	2.3	0	Open, east bank
5/17/2016	Y	9:10	3.42	slack	7:54	3.73	13:43	1.08	1.4	0	Open, east bank
6/3/2016	N[b]	11:20	3.12	ebb	9:12	4.16	14:34	1.10	2.2	0	If breached, east bank
6/16/2016	N	10:12	2.50	ebb	7:35	3.26	12:52	1.70	0.2	0	If breached, east bank
6/30/2016	N[b]	12:40	1.46	slack	18:59	6.14	12:32	1.46	0.1	0	If breached, east bank

[a]USGS gauging station number 11118500, downstream of Foster Park.
[b]Sandbar was closed at low tide, but intermittent saltwater intrusions occurred overtopping the sandbar during some high tides.



Appendix 5. Sandbar status at the mouth of the Ventura River from 2006 through July of 2016. Each observation is indicated by vertical lines and the sandbar status was assumed to remain the same until the next observation.

Appendix 6. Weekly fish attraction counts at the Robles Fish Facility during 2016.

Date	Method	Direction	Length (m)	Temp. (°C)	Turbidity (NTU)	Robles Mean Discharge (cfs)	Species[a]	Count
1/7/2016	Bank	Downstream	200	11	9	6	NFO	0
1/7/2016	Bank	Upstream	140	11	9	6	NFO	0
2/4/2016	Bank	Downstream	200	13	1	1	NFO	0
2/4/2016	Bank	Upstream	140	13	1	1	NFO	0
2/10/2016[b]	Bank	Downstream	130	19	1	0	NFO	0
2/10/2016	Bank	Upstream	140	19	1	<1	NFO	0
2/16/2016[b]	Bank	Downstream	40	16	1	0	NFO	0
2/16/2016	Bank	Upstream	140	16	1	0	NFO	0
2/25/2016[b]	Snorkel	Downstream	40	15	1	0	NFO	0
2/25/2016	Snorkel	Upstream	140	15	1	0	NFO	0
3/9/2016	Bank	Downstream	200	15	2	6	NFO	0
3/9/2016	Bank	Upstream	140	15	2	6	NFO	0
3/16/2016	Bank	Downstream	200	17	1	1	NFO	0
3/16/2016	Bank	Upstream	140	17	1	1	NFO	0
3/23/2016	Snorkel	Downstream	200	16	1	<1	NFO	0
3/23/2016	Snorkel	Upstream	140	16	1	<1	NFO	0
3/30/2016	Bank	Downstream	200	12	<1	<1	NFO	0
3/30/2016	Bank	Upstream	140	12	<1	<1	NFO	0
4/7/2016[b]	Bank	Downstream	40	16	<1	0	NFO	0
4/7/2016	Bank	Upstream	140	16	<1	0	NFO	0
4/13/2016	Bank	Downstream	200	14	<1	<1	NFO	0
4/13/2016	Bank	Upstream	140	14	<1	<1	NFO	0
		Upstream	1,540 m				Upstream	0
		Downstream	1,650 m				Downstream	0
		Total	3,190 m				Total	0

[a]OMY = *O. mykiss* and NFO = no fish observed.
[b]Partial survey due to dry habitat unit.

Appendix 7. Monthly flow summary for Robles Fish Facility, reporting year 2015-2016.

Jul-15	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	0.5	0.3	0.8	20	0	0	0	0
2	0.4	0.3	0.8	20	0	0	0	0
3	0.5	0.4	0.9	20	0	0	0	0
4	0.6	0.4	0.9	20	0	0	0	0
5	0.5	0.4	0.9	20	0	0	0	0
6	0.5	0.4	0.9	20	0	0	0	0
7	0.5	0.4	0.9	20	0	0	0	0
8	0.6	0.4	0.9	20	0	0	0	0
9	0.6	0.4	1.0	20	0	0	0	0
10	0.6	0.4	1.0	20	0	0	0	0
11	0.7	0.3	1.0	20	0	0	0	0
12	0.7	0.3	1.0	20	0	0	0	0
13	0.6	0.3	1.0	20	0	0	0	0
14	0.5	0.3	0.9	20	0	0	0	0
15	0.6	0.3	0.9	20	0	0	0	0
16	0.6	0.3	0.9	20	0	0	0	0
17	0.6	0.3	0.9	20	0	0	0	0
18	0.6	0.3	0.9	20	0	0	0	0
19	1.9	1.5	3.4	20	0	0	0	0
20	3.3	1.0	4.3	20	0	0	0	0
21	1.3	0.4	1.7	20	0	0	0	0
22	1.1	0.4	1.4	20	0	0	0	0
23	0.9	0.3	1.2	20	0	0	0	0
24	0.8	0.3	1.1	20	0	0	0	0
25	0.7	0.3	1.0	20	0	0	0	0
26	0.7	0.3	1.0	20	0	0	0	0
27	0.8	0.3	1.1	20	0	0	0	0
28	0.7	0.3	1.0	20	0	0	0	0
29	0.3	0.3	0.6	20	0	0	0	0
30	0.3	0.3	0.6	20	0	0	0	0
31	0.3	0.3	0.6	20	0	0	0	0
Totals	24	12	35	620	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Estimated daily data (VCWPD).

Aug-15	(1) Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
	Source Stream Mean Daily Flows				Robles Facility Mean Daily Flows			
1	0.3	0.3	0.6	20	0	0	0	0
2	0.3	0.3	0.6	20	0	0	0	0
3	0.4	0.3	0.6	20	0	0	0	0
4	0.3	0.3	0.6	20	0	0	0	0
5	0.3	0.3	0.6	20	0	0	0	0
6	0.3	0.3	0.5	20	0	0	0	0
7	0.4	0.3	0.7	20	0	0	0	0
8	0.7	0.3	0.9	20	0	0	0	0
9	0.6	0.3	0.9	20	0	0	0	0
10	0.6	0.3	0.8	20	0	0	0	0
11	0.3	0.3	0.6	20	0	0	0	0
12	0.2	0.3	0.5	20	0	0	0	0
13	0.2	0.2	0.5	20	0	0	0	0
14	0.2	0.2	0.5	20	0	0	0	0
15	0.3	0.2	0.5	20	0	0	0	0
16	0.3	0.2	0.5	20	0	0	0	0
17	0.3	0.2	0.5	20	0	0	0	0
18	0.3	0.3	0.5	20	0	0	0	0
19	0.3	0.3	0.6	20	0	0	0	0
20	0.3	0.3	0.6	20	0	0	0	0
21	0.3	0.3	0.6	20	0	0	0	0
22	0.4	0.3	0.6	20	0	0	0	0
23	0.5	0.3	0.7	20	0	0	0	0
24	0.3	0.3	0.6	20	0	0	0	0
25	0.3	0.2	0.6	20	0	0	0	0
26	0.2	0.2	0.5	20	0	0	0	0
27	0.2	0.2	0.5	20	0	0	0	0
28	0.2	0.2	0.5	20	0	0	0	0
29	0.3	0.2	0.5	20	0	0	0	0
30	0.3	0.2	0.5	20	0	0	0	0
31	0.3	0.2	0.5	20	0	0	0	0
Totals	10	8	18	620	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Sep-15	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	0.3	0.2	0.5	20	0	0	0	0
2	0.3	0.2	0.5	20	0	0	0	0
3	0.3	0.2	0.5	20	0	0	0	0
4	0.3	0.2	0.5	20	0	0	0	0
5	0.3	0.2	0.5	20	0	0	0	0
6	0.3	0.2	0.5	20	0	0	0	0
7	0.3	0.2	0.5	20	0	0	0	0
8	0.3	0.2	0.5	20	0	0	0	0
9	0.3	0.2	0.5	20	0	0	0	0
10	0.2	0.2	0.5	20	0	0	0	0
11	0.3	0.2	0.5	20	0	0	0	0
12	0.3	0.2	0.5	20	0	0	0	0
13	0.3	0.2	0.5	20	0	0	0	0
14	0.4	0.2	0.6	20	0	0	0	0
15	0.4	0.3	0.7	20	0	0	0	0
16	0.4	0.3	0.6	20	0	0	0	0
17	0.3	0.3	0.6	20	0	0	0	0
18	0.3	0.3	0.5	20	0	0	0	0
19	0.2	0.3	0.5	20	0	0	0	0
20	0.2	0.2	0.5	20	0	0	0	0
21	0.3	0.3	0.5	20	0	0	0	0
22	0.3	0.3	0.6	20	0	0	0	0
23	0.3	0.3	0.6	20	0	0	0	0
24	0.3	0.3	0.6	20	0	0	0	0
25	0.3	0.3	0.6	20	0	0	0	0
26	0.3	0.3	0.5	20	0	0	0	0
27	0.3	0.3	0.5	20	0	0	0	0
28	0.3	0.3	0.5	20	0	0	0	0
29	0.2	0.3	0.5	20	0	0	0	0
30	0.2	0.3	0.5	20	0	0	0	0
Totals	9	7	16	600	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Oct-15	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	0.2	0.2	0.4	20	0	0	0	0
2	0.3	0.2	0.4	20	0	0	0	0
3	0.3	0.2	0.4	20	0	0	0	0
4	0.3	0.2	0.5	20	0	0	0	0
5	0.3	0.2	0.5	20	0	0	0	0
6	0.3	0.2	0.5	20	0	0	0	0
7	0.3	0.2	0.5	20	0	0	0	0
8	0.3	0.2	0.5	20	0	0	0	0
9	0.4	0.2	0.5	20	0	0	0	0
10	0.5	0.2	0.7	20	0	0	0	0
11	0.6	0.2	0.8	20	0	0	0	0
12	0.6	0.2	0.8	20	0	0	0	0
13	0.5	0.2	0.6	20	0	0	0	0
14	0.4	0.2	0.6	20	0	0	0	0
15	0.4	0.2	0.6	20	0	0	0	0
16	0.4	0.2	0.6	20	0	0	0	0
17	0.4	0.2	0.6	20	0	0	0	0
18	0.4	0.2	0.6	20	0	0	0	0
19	0.4	0.2	0.6	20	0	0	0	0
20	0.4	0.2	0.6	20	0	0	0	0
21	0.5	0.2	0.6	20	0	0	0	0
22	0.4	0.2	0.6	20	0	0	0	0
23	0.5	0.2	0.7	20	0	0	0	0
24	0.5	0.2	0.7	20	0	0	0	0
25	0.5	0.2	0.7	20	0	0	0	0
26	0.5	0.2	0.7	20	0	0	0	0
27	0.5	0.2	0.7	20	0	0	0	0
28	0.5	0.2	0.7	20	0	0	0	0
29	0.6	0.2	0.8	20	0	0	0	0
30	0.7	0.2	0.9	20	0	0	0	0
31	0.6	0.2	0.8	20	0	0	0	0
Totals	13	6	19	620	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Estimated daily data (VCWPD).

Nov-15	(1)	(2)	(1) + (2)	B.O.	(3)	(4)	(5)	(4) + (5)
	Source Stream Mean Daily Flows				Robles Facility Mean Daily Flows			
	Matilija Ck D/S Dam (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)	Required Flow Release (cfs)	Fishway Ladder (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	0.5	0.2	0.8	20	0	0	0	0
2	0.5	0.2	0.7	20	0	0	0	0
3	0.5	0.2	0.8	20	0	0	0	0
4	0.6	0.2	0.8	20	0	0	0	0
5	0.5	0.2	0.7	20	0	0	0	0
6	0.5	0.2	0.7	20	0	0	0	0
7	0.5	0.2	0.8	20	0	0	0	0
8	0.5	0.2	0.7	20	0	0	0	0
9	0.5	0.2	0.7	20	0	0	0	0
10	0.8	0.2	1.0	20	0	0	0	0
11	1.0	0.2	1.2	20	0	0	0	0
12	0.7	0.2	0.9	20	0	0	0	0
13	0.6	0.2	0.8	20	0	0	0	0
14	0.5	0.2	0.8	20	0	0	0	0
15	0.6	0.2	0.8	20	0	0	0	0
16	0.8	0.2	1.0	20	0	0	0	0
17	0.5	0.2	0.8	20	0	0	0	0
18	0.4	0.2	0.7	20	0	0	0	0
19	0.4	0.2	0.7	20	0	0	0	0
20	0.5	0.2	0.7	20	0	0	0	0
21	0.5	0.2	0.7	20	0	0	0	0
22	0.5	0.2	0.8	20	0	0	0	0
23	0.5	0.2	0.8	20	0	0	0	0
24	0.6	0.2	0.8	20	0	0	0	0
25	0.6	0.2	0.8	20	0	0	0	0
26	0.6	0.2	0.8	20	0	0	0	0
27	0.6	0.2	0.9	20	0	0	0	0
28	0.7	0.2	0.9	20	0	0	0	0
29	0.6	0.3	0.9	20	0	0	0	0
30	0.6	0.3	0.9	20	0	0	0	0
Totals	18	7	25	600	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Estimated daily data (VCWPD).

Dec-15	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	0.7	0.3	1.0	20	0	0	0	0
2	0.7	0.3	1.0	20	0	0	0	0
3	0.7	0.3	1.0	20	0	0	0	0
4	0.8	0.3	1.1	20	0	0	0	0
5	0.8	0.3	1.1	20	0	0	0	0
6	0.8	0.3	1.1	20	0	0	0	0
7	0.8	0.3	1.1	20	0	0	0	0
8	0.9	0.3	1.2	20	0	0	0	0
9	1.0	0.3	1.3	20	0	0	0	0
10	1.0	0.3	1.3	20	0	0	0	0
11	1.1	0.3	1.5	20	0	0	0	0
12	1.1	0.4	1.5	20	0	0	0	0
13	0.9	0.4	1.3	20	0	0	0	0
14	1.3	0.4	1.8	20	0	0	0	0
15	2.0	0.4	2.4	20	0	0	0	0
16	1.3	0.5	1.8	20	0	0	0	0
17	0.9	0.5	1.4	20	0	0	0	0
18	0.8	0.5	1.3	20	0	0	0	0
19	0.7	0.5	1.1	20	0	0	0	0
20	0.4	0.5	0.9	20	0	0	0	0
21	0.4	0.5	0.9	20	0	0	0	0
22	0.8	0.5	1.3	20	0	0	0	0
23	1.3	0.5	1.9	20	0	0	0	0
24	1.1	0.6	1.7	20	0	0	0	0
25	1.0	0.6	1.6	20	0	0	0	0
26	1.0	0.6	1.6	20	0	0	0	0
27	0.9	0.6	1.5	20	0	0	0	0
28	0.9	0.6	1.5	20	0	0	0	0
29	1.0	0.6	1.6	20	0	0	0	0
30	1.0	0.6	1.5	20	0	0	0	0
31	0.9	0.5	1.5	20	0	0	0	0
Totals	29	13	43	620	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Jan-16	(1) Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
	Source Stream Mean Daily Flows				Robles Facility Mean Daily Flows			
1	1.0	0.5	1.5	20	0	0	0	0
2	1.0	0.5	1.5	20	0	0	0	0
3	1.0	0.5	1.5	20	0	0	0	0
4	1.0	0.5	1.5	20	0	0	0	0
5	6.2	3.0	9.2	20	4.7	4.7	0	4.7
6	4.8	2.5	7.3	20	7.3	7.3	0	7.3
7	3.7	1.8	5.5	20	6.2	6.2	0	6.2
8	2.1	0.5	2.6	20	0.8	0.8	0	0.8
9	1.7	0.5	2.3	20	0.1	0.1	0	0.1
10	1.6	0.5	2.1	20	0	0	0	0
11	1.9	0.6	2.5	20	0	0	0	0
12	2.1	0.6	2.6	20	0	0	0	0
13	2.0	0.6	2.6	20	0	0	0	0
14	2.0	0.6	2.5	20	0	0	0	0
15	2.0	0.6	2.5	20	0	0	0	0
16	1.9	0.6	2.5	20	0	0	0	0
17	2.0	0.6	2.6	20	0	0	0	0
18	2.0	0.6	2.6	20	0	0	0	0
19	2.4	0.6	3.0	20	0	0	0	0
20	2.6	0.6	3.1	20	0	0	0	0
21	2.6	0.6	3.1	20	0	0	0	0
22	2.2	0.6	2.8	20	0	0	0	0
23	2.2	0.6	2.8	20	0	0	0	0
24	2.2	0.6	2.8	20	0	0	0	0
25	2.1	0.6	2.7	20	0	0	0	0
26	2.2	0.6	2.8	20	0	0	0	0
27	2.1	0.6	2.7	20	0	0	0	0
28	2.1	0.6	2.7	20	0	0	0	0
29	2.2	0.6	2.7	20	0	0	0	0
30	2.2	0.6	2.7	20	0	0	0	0
31	10	10	20	20	13	18	0	18
Totals	78	32	110	620	32	37	0	37

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

(orange) Estimated daily data (VCWPD).

(green) Fishway flowmeter malfunction, discharge set equal to weir.

(purple) Weir data logger malfunction four hours, discharge set equal to fishway.

Feb-16	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	4.5	2.6	7.1	20	12	15	0	15
2	3.1	0.5	3.6	20	3.2	3.2	0	3.2
3	3.3	0.5	3.8	20	2.9	1.1	0	1.1
4	3.6	0.6	4.2	20	2.9	1.1	0	1.1
5	3.8	0.6	4.4	20	2.6	1.2	0	1.2
6	3.8	0.6	4.4	20	2.0	0.7	0	0.7
7	3.8	0.6	4.4	20	2.0	0.8	0	0.8
8	3.8	0.6	4.4	20	1.7	0.7	0	0.7
9	3.7	0.6	4.3	20	0	0	0	0
10	3.8	0.6	4.4	20	1.0	0	0	0
11	3.8	0.6	4.4	20	1.0	0.1	0	0.1
12	4.0	0.6	4.5	20	0.9	0	0	0
13	4.0	0.6	4.5	20	1.0	0.2	0	0.2
14	3.9	0.6	4.5	20	0.9	0	0	0
15	3.9	0.6	4.5	20	1.0	0	0	0
16	3.8	0.6	4.4	20	0.4	0	0	0
17	4.0	0.6	4.5	20	0.8	0	0	0
18	5.7	1.1	6.8	20	2.4	0.9	0	0.9
19	4.3	0.9	5.2	20	1.0	0.5	0	0.5
20	4.1	0.8	4.9	20	1.0	0.4	0	0.4
21	3.7	0.7	4.4	20	1.0	0.3	0	0.3
22	3.6	0.7	4.3	20	1.0	0	0	0
23	3.5	0.7	4.2	20	1.0	0	0	0
24	3.5	0.7	4.2	20	0.6	0	0	0
25	3.4	0.7	4.1	20	0.7	0	0	0
26	3.4	0.7	4.1	20	0.7	0	0	0
27	3.4	0.7	4.1	20	0	0	0	0
28	3.4	0.7	4.0	20	0	0	0	0
29	3.3	0.7	3.9	20	0	0	0	0
Totals	110	21	130	580	46	26	0	26

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Estimated daily data (VCWPD).

Weir data logger malfunction, discharge estimated.

Mar-16	(1) Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
	Source Stream Mean Daily Flows				Robles Facility Mean Daily Flows			
1	3.2	0.6	3.8	20	0	0	0	0
2	2.9	0.6	3.6	20	0	0	0	0
3	2.9	0.6	3.5	20	0.1	0	0	0
4	3.0	0.6	3.6	20	0.2	0	0	0
5	3.4	0.6	4.0	20	0.7	0	0	0
6	11	4.3	16	20	14	16	0	16
7	6.7	3.0	10	20	8.3	11	0	11
8	5.2	1.1	6.3	20	5.8	8.7	0	8.7
9	4.8	0.7	5.5	20	3.9	5.9	0	5.9
10	4.7	0.5	5.2	20	3.5	4.4	0	4.4
11	6.4	1.1	7.5	20	5.6	7.3	0	7.3
12	5.6	0.9	6.5	20	5.6	8.6	0	8.6
13	4.8	0.5	5.3	20	3.9	7.0	0	7.0
14	4.7	0.6	5.3	20	3.9	5.9	0	5.9
15	4.4	0.6	5.0	20	3.3	3.8	0	3.8
16	4.2	0.7	4.9	20	3.0	1.5	0	1.5
17	4.1	0.7	4.8	20	2.9	1.5	0	1.5
18	3.9	0.7	4.7	20	2.8	1.0	0	1.0
19	4.0	0.8	4.7	20	3.0	1.3	0	1.3
20	3.9	0.8	4.7	20	2.7	0.9	0	0.9
21	4.0	0.8	4.8	20	2.7	0.9	0	0.9
22	4.4	0.9	5.3	20	3.0	1.0	0	1.0
23	3.6	0.9	4.5	20	1.9	0.9	0	0.9
24	3.5	0.9	4.4	20	2.0	0.7	0	0.7
25	3.7	1.0	4.7	20	2.0	0.6	0	0.6
26	3.4	1.0	4.3	20	1.4	0.5	0	0.5
27	3.3	1.0	4.3	20	0.8	0.2	0	0.2
28	3.7	0.9	4.7	20	1.2	0.1	0	0.1
29	3.4	1.0	4.4	20	1.7	0.4	0	0.4
30	3.5	1.0	4.5	20	1.9	0.7	0	0.7
31	3.4	1.0	4.3	20	1.8	0.6	0	0.6
Totals	134	30	164	620	93	92	0	92

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Estimated daily data (VCWPD).

Periods of weir data logger malfunction, discharge estimated.

Apr-16	(1) Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
	Source Stream Mean Daily Flows				Robles Facility Mean Daily Flows			
1	3.1	1.0	4.1	20	1.2	0.5	0	0.5
2	2.8	0.9	3.8	20	1.2	0.3	0	0.3
3	2.8	0.9	3.6	20	1.0	0.2	0	0.2
4	2.8	0.8	3.6	20	1.0	0	0	0
5	2.7	0.8	3.5	20	0.5	0	0	0
6	2.6	0.8	3.4	20	0	0	0	0
7	2.6	0.8	3.3	20	0.1	0	0	0
8	3.0	0.8	3.9	20	0.5	0	0	0
9	4.0	0.8	4.8	20	2.7	0.6	0	0.6
10	3.5	0.7	4.2	20	2.9	1.9	0	1.9
11	3.2	0.8	4.0	20	1.9	0.4	0	0.4
12	3.0	0.8	3.8	20	1.8	0.4	0	0.4
13	3.0	0.8	3.8	20	1.0	0.1	0	0.1
14	3.3	0.8	4.1	20	1.0	0	0	0
15	2.8	0.8	3.5	20	1.0	0	0	0
16	2.6	0.8	3.3	20	0.5	0	0	0
17	2.6	0.8	3.3	20	0.6	0	0	0
18	2.6	0.7	3.3	20	0.2	0	0	0
19	2.7	0.7	3.4	20	0	0	0	0
20	2.8	0.7	3.5	20	0	0	0	0
21	2.6	0.7	3.2	20	0	0	0	0
22	2.7	0.6	3.3	20	0	0	0	0
23	2.5	0.6	3.1	20	0	0	0	0
24	2.3	0.6	2.9	20	0	0	0	0
25	2.5	0.6	3.0	20	0	0	0	0
26	2.5	0.6	3.0	20	0	0	0	0
27	2.4	0.6	3.0	20	0	0	0	0
28	2.3	0.5	2.9	20	0	0	0	0
29	2.2	0.5	2.7	20	0	0	0	0
30	2.2	0.6	2.8	20	0	0	0	0
Totals	82	22	104	600	19	4	0	4

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

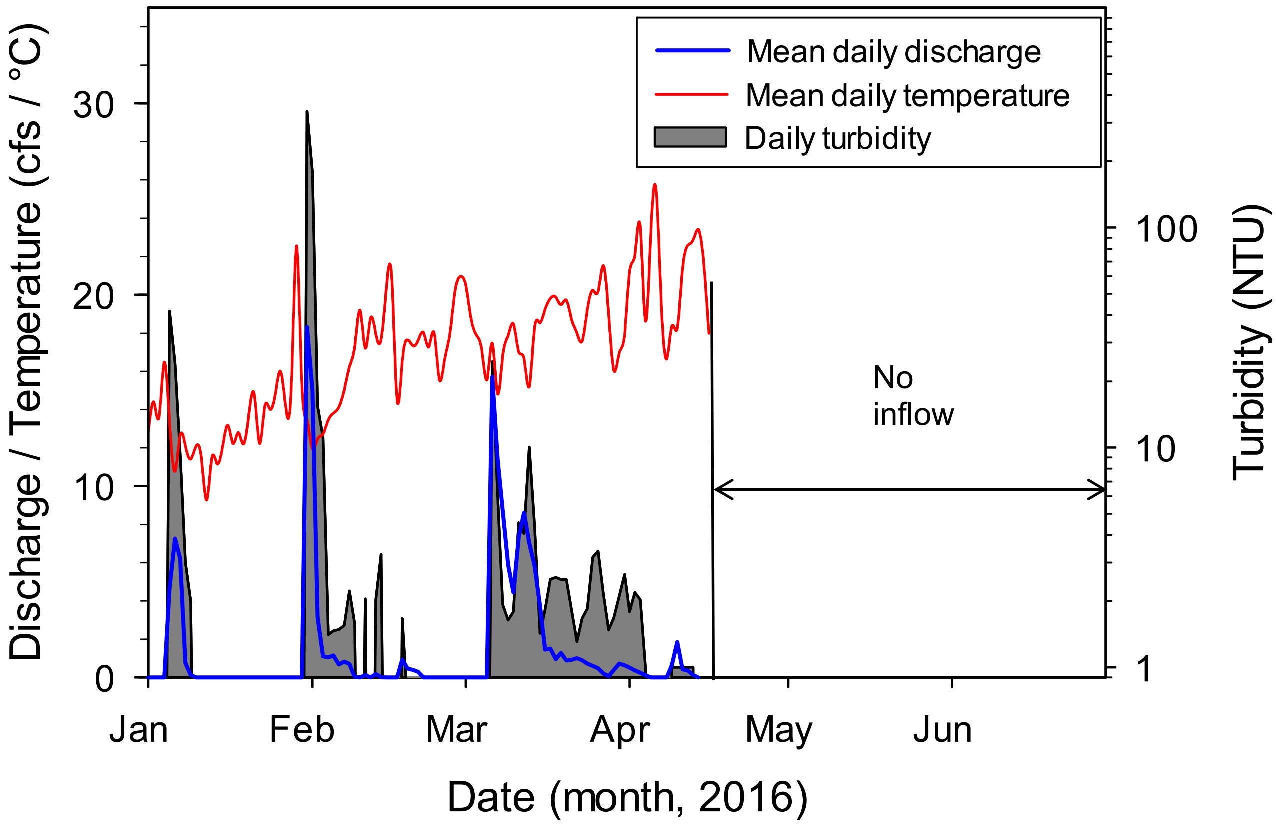
Periods of weir data logger malfunction, discharge estimated. (shaded: VRNMO Weir, days 1–4)

May-16	(1) Source Stream Mean Daily Flows Matilija Ck D/S Dam (cfs)	(2) North Fork Matilija Ck.* (cfs)	(1) + (2) Sum of Creek Flows (cfs)	B.O. Required Flow Release (cfs)	(3) Robles Facility Mean Daily Flows Fishway Ladder (cfs)	(4) VRNMO Weir (cfs)	(5) Diversion Canal (cfs)	(4) + (5) Total Inflow (cfs)
1	2.1	0.6	2.7	20	0	0	0	0
2	2.1	0.5	2.6	20	0	0	0	0
3	2.1	0.5	2.6	20	0	0	0	0
4	2.1	0.5	2.6	20	0	0	0	0
5	2.2	0.5	2.6	20	0	0	0	0
6	2.2	0.6	2.8	20	0	0	0	0
7	2.4	0.6	3.0	20	0	0	0	0
8	2.5	0.5	3.0	20	0	0	0	0
9	2.5	0.5	3.0	20	0	0	0	0
10	2.6	0.5	3.1	20	0	0	0	0
11	2.6	0.5	3.1	20	0	0	0	0
12	2.5	0.5	2.9	20	0	0	0	0
13	2.3	0.5	2.8	20	0	0	0	0
14	2.3	0.5	2.8	20	0	0	0	0
15	2.3	0.5	2.8	20	0	0	0	0
16	2.4	0.5	2.9	20	0	0	0	0
17	2.2	0.5	2.7	20	0	0	0	0
18	2.4	0.5	2.9	20	0	0	0	0
19	2.4	0.5	2.9	20	0	0	0	0
20	2.4	0.5	2.8	20	0	0	0	0
21	2.2	0.5	2.7	20	0	0	0	0
22	2.2	0.5	2.7	20	0	0	0	0
23	2.2	0.5	2.7	20	0	0	0	0
24	2.2	0.5	2.7	20	0	0	0	0
25	2.2	0.5	2.6	20	0	0	0	0
26	2.1	0.5	2.6	20	0	0	0	0
27	2.0	0.5	2.5	20	0	0	0	0
28	2.0	0.4	2.4	20	0	0	0	0
29	2.1	0.4	2.5	20	0	0	0	0
30	2.1	0.4	2.5	20	0	0	0	0
31	1.9	0.4	2.3	20	0	0	0	0
Totals	70	15	85	620	0	0	0	0

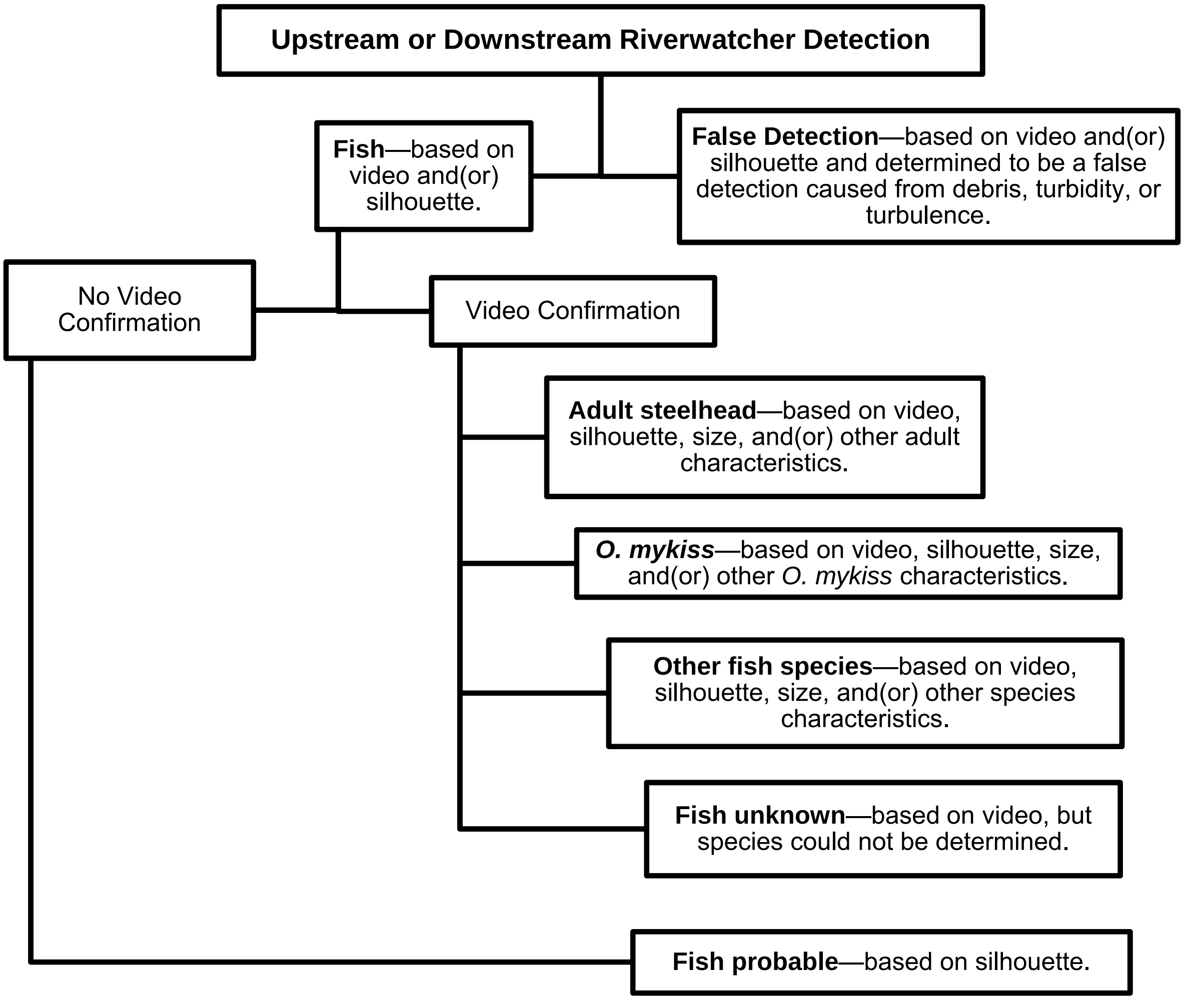
*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).

Jun-16	(1)	(2)	(1) + (2)		(3)	(4)	(5)	(4) + (5)
	Source Stream Mean Daily Flows			B.O.	Robles Facility Mean Daily Flows			
	Matilija Ck	North Fork	Sum of Creek	Required	Fishway	VRNMO	Diversion	Total Inflow
	D/S Dam	Matilija Ck.*	Flows	Flow Release	Ladder	Weir	Canal	
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
1	1.9	0.4	2.3	20	0	0	0	0
2	1.9	0.4	2.2	20	0	0	0	0
3	1.7	0.3	2.0	20	0	0	0	0
4	1.6	0.3	1.9	20	0	0	0	0
5	1.4	0.3	1.7	20	0	0	0	0
6	1.6	0.3	2.0	20	0	0	0	0
7	1.6	0.3	2.0	20	0	0	0	0
8	1.7	0.3	2.0	20	0	0	0	0
9	1.6	0.3	1.9	20	0	0	0	0
10	1.3	0.3	1.6	20	0	0	0	0
11	1.4	0.3	1.7	20	0	0	0	0
12	1.4	0.3	1.8	20	0	0	0	0
13	1.5	0.3	1.8	20	0	0	0	0
14	1.6	0.3	1.9	20	0	0	0	0
15	1.5	0.3	1.8	20	0	0	0	0
16	1.3	0.3	1.6	20	0	0	0	0
17	1.0	0.3	1.3	20	0	0	0	0
18	0.9	0.3	1.2	20	0	0	0	0
19	1.0	0.3	1.3	20	0	0	0	0
20	1.1	0.3	1.4	20	0	0	0	0
21	1.2	0.3	1.4	20	0	0	0	0
22	1.3	0.3	1.6	20	0	0	0	0
23	1.5	0.3	1.7	20	0	0	0	0
24	1.5	0.3	1.8	20	0	0	0	0
25	1.3	0.3	1.5	20	0	0	0	0
26	1.2	0.3	1.5	20	0	0	0	0
27	1.2	0.3	1.5	20	0	0	0	0
28	1.0	0.3	1.3	20	0	0	0	0
29	0.8	0.3	1.0	20	0	0	0	0
30	0.7	0.3	0.9	20	0	0	0	0
Totals	41	9	50	600	0	0	0	0

*Flow data from North Fork Malija Creek are preliminary and subject to change (VCWPD).



Appendix 8. Mean daily discharge, water temperature, and turbidity at the Robles Fish Facility during the 2016 fish passage season.



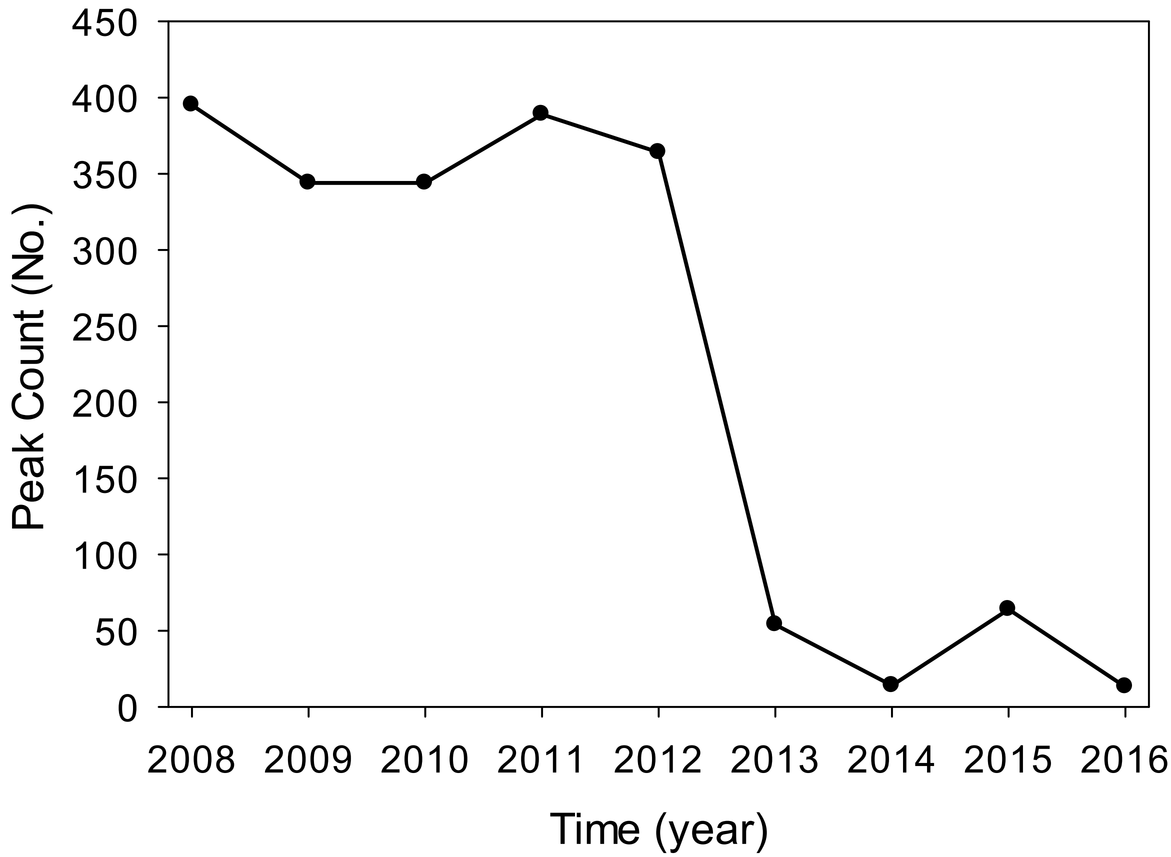
Appendix 9. Riverwatcher detection classification flow chart that outlines the pathways for upstream and downstream detections.

Appendix 10. Summary of Riverwatcher detections classified as fish probable and *O. mykiss* from February through April of 2016.

	Upstream	Downstream
O. *mykiss*	0	0
Fish, non O. *mykiss*	0	0
Fish, unknown	0	0
Fish, probable	0	0
False detections	143	178
Total	143	178
Mean date - O. *mykiss*	n/a	n/a
Mean date - fish, non O. *mykiss*	n/a	n/a
Mean date - fish, unknown	n/a	n/a
Mean date - fish, probable	n/a	n/a
Mean time - O. *mykiss* (24h)	n/a	n/a
Mean time - fish, non O. *mykiss* (24h)	n/a	n/a
Mean time - fish, unknown (24h)	n/a	n/a
Mean time - fish, probable (24h)	n/a	n/a
Mean length- O. *mykiss*(cm)	n/a	n/a
Mean length- fish, non O. *mykiss* (cm)	n/a	n/a
Mean length- fish, unknown (cm)	n/a	n/a
Mean length- fish, probable (cm)	n/a	n/a
Mean daily temperature - O. *mykiss* (°C)	n/a	n/a
Mean daily temperature - fish, non O. *mykiss* (°C)	n/a	n/a
Mean daily temperature - fish, unknown (°C)	n/a	n/a
Mean daily temperature - fish, probable (°C)	n/a	n/a
Mean daily turbidity - O. *mykiss* (NTU)	n/a	n/a
Mean daily turbidity - fish, non O. *mykiss* (NTU)	n/a	n/a
Mean daily turbidity - fish, probable (NTU)	n/a	n/a
Mean daily turbidity - fish, unknown (NTU)	n/a	n/a
Mean daily turbidity - false detections (NTU)	106	90
Mean daily discharge - O. *mykiss*(cfs)	n/a	n/a
Mean daily discharge - fish, non O. *mykiss* (cfs)	n/a	n/a
Mean daily discharge - fish, probable (cfs)	n/a	n/a
Mean daily discharge - fish, unknown (cfs)	n/a	n/a
Mean daily discharge - false detections (cfs)	12	11

Appendix 11. *O. mykiss* presence/absence survey index sites in the Ventura Basin.

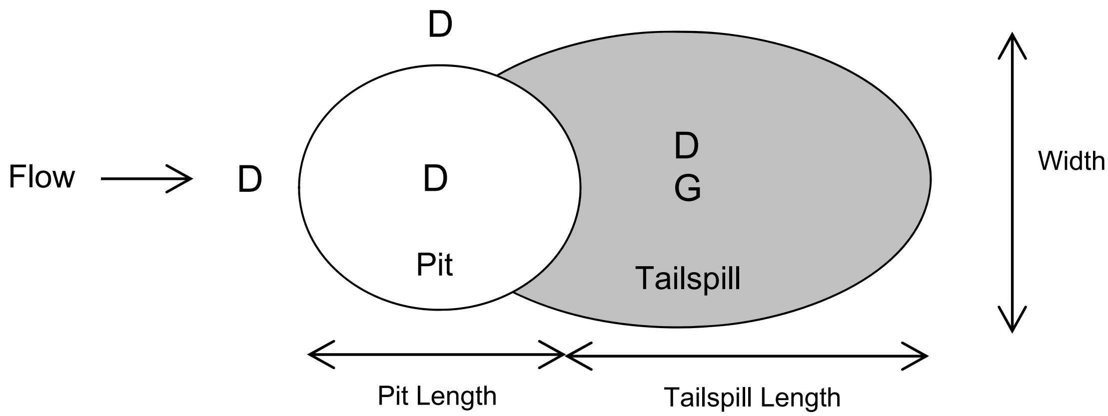
Site No.	Location	River km	Site	Lat.	Long.	Length (m)	Width (m)
1	Ventura River	0.9	Main Street pool	34.28126	-119.30887	25.1	10.0
		0.9	Main Street riffle	34.28164	-119.30893	34.0	8.0
2	Ventura River	9.4	Foster Park pool 1	34.35236	-119.30790	25.0	15.4
		10.0	Foster Park pool 2	34.35508	-119.30988	46.0	16.0
		9.7	Foster Park riffle	34.35308	-119.30877	45.0	11.0
3	Ventura River	13.0	San Antonio conf. pool 1	34.38042	-119.30752	33.0	22.0
		13.0	San Antonio conf. riffle	34.38011	-119.30755	42.0	14.0
		12.9	San Antonio conf. pool 2	34.37969	-119.30781	50.0	10.0
4	Ventura River	18.8	Hwy 150 pool 1	34.42643	-119.30220	43.3	14.0
		18.8	150 pool 2	34.42689	-119.30123	49.5	9.0
		18.7	Hwy 150 riffle	34.42576	-119.30258	43.6	11.0
5	Ventura River	22.1	Land Cons. pool 1	34.45342	-119.29314	50.1	19.1
		22.2	Land Cons. pool 2	34.45448	-119.29293	48.6	15.1
		22.1	Land Cons. Riffle	34.45411	-119.29315	44.6	18.8
6	Ventura River	23.2	Robles weir pools	34.46306	-119.29058	58.7	19.0
		23.3	Robles glide	34.46368	-119.29065	78.3	17.3
		23.4	Robles entrance pool	34.46446	-119.29058	39.8	21.8
		23.4	Fish ladder entrance box	34.46460	-119.29062	15.0	3.0
		23.5	Robles screenbay	34.46451	-119.29133	42.2	13.5
		23.5	Robles forebay	34.46503	-119.29053	33.0	17.2
7	San Antonio Cr.	0.2	Lower San Antonio pool 1	34.38088	-119.30542	16.0	6.0
		0.2	Lower San Antonio riffle	34.38098	-119.30711	20.2	3.5
		0.4	Lower San Antonio pool 2	34.38103	-119.30657	40.0	6.0
8	San Antonio Cr.	9.4	Upper San Antonio riffle	34.43268	-119.25090	25.0	5.0
		9.5	Upper San Antonio pool	34.43241	-119.25095	19.8	5.5
9	NF Matilija Cr.	0.1	Lower NF pool 1	34.48508	-119.30105	7.3	13.3
		0.1	Lower NF pool 2	34.48533	-119.30138	7.9	10.9
		0.2	Lower NF riffle	34.48523	-119.30198	17.8	8.0
10	NF Matilija Cr.	6.6	Upper NF pool	34.50956	-119.27520	29.0	9.0
		6.6	Upper NF riffle	34.50933	-119.27528	33.1	7.5
11	Matilija Cr.	0.3	Lower Matilija pool	34.48282	-119.30170	21.1	24.7
		0.3	Lower Matilija riffle	34.48302	-119.30154	15.9	8.0
12	Matilija Cr.	2.1	Upper Matilija pool	34.49190	-119.31599	89.4	13.7
		2.1	Upper Matilija riffle	34.49233	-119.31704	51.0	9.0
14	San Antonio Cr.	4.3	Fraser St. pool	34.40276	-119.28169	12.8	13.8
		4.4	Fraser St. riffle	34.40291	-119.28157	30.8	5.9
15	Ventura River	8.5	Bedrock pool	34.34539	-119.29931	50.0	17.0
		8.5	Bedrock pool riffle	34.34569	-119.29958	37.0	6.0



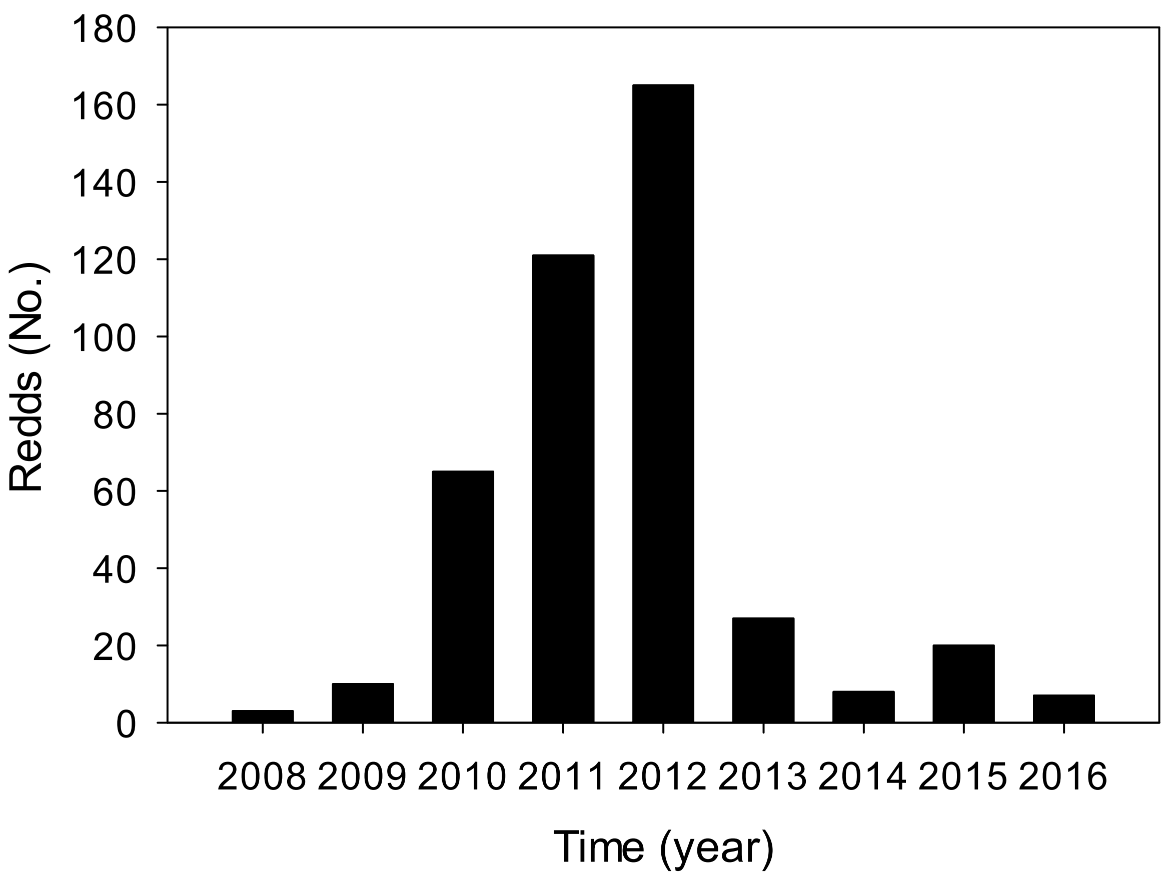
Appendix 12. Peak snorkel counts of *O. mykiss* from 2008-2016 at survey index sites in the Ventura Basin.

Appendix 13. *O. mykiss* spawning index sites in the Ventura Basin.

Site No.	Unit	Location	River km	Description	Lat.	Long.	Length (m)	Width (m)	Spawning Area (m^2)
24	1	Ventura River	0.8	Main St. Bridge	34.28085	-119.30862	220.0	10.0	2,200
2	1	Ventura River	7.9	Near Treatment Plant	34.34030	-119.29782	90.0	18.0	1,620
	2		8.1	Near Treatment Plant	34.34208	-119.29849	39.0	20.0	780
4	1	Ventura River	15.5	Near Santa Ana Blvd bridge	34.39950	-119.30853	26.7	8.0	214
5	1	Ventura River	18.7	Upstream of Hwy 150	34.42641	-119.30227	18.0	10.0	180
6	1	Ventura River	22.1	Land Conservancy pool tailout	34.45334	-119.29309	18.1	19.5	353
	2		22.2	Land Conservancy pool tailout	34.45445	-119.29298	16.3	14.7	240
7	1	Ventura River	23.3	Robles-1st weir pool	34.46334	-119.29061	15.4	23.9	368
	2		23.4	Robles tailout of entrance pool	34.46436	-119.29045	18.2	21.9	399
8	2	Ventura River	24.3	Upstream of Robles	34.46504	-119.29032	6.2	15.4	95
	3		23.4	Upstream of Robles forebay	34.46504	-119.29032	80.0	6.0	480
12	1	NF Matilija Cr.	0.7	Lower NF Matilija Cr.	34.48825	-119.30525	41.0	9.0	369
13	1	NF Matilija Cr.	6.6	Downstream of Wheeler Gorge	34.50911	-119.27501	23.0	8.0	184
	2		6.6	Downstream of Wheeler Gorge	34.50960	-119.27528	22.3	8.0	178
14	1	Matilija Cr.	1.9	Lake Matilija delta	34.49000	-119.31446	26.2	14.6	383
	2		2.1	Upstream of Lake Matilija	34.49198	-119.31645	15.0	10.0	150
	3		2.2	Upstream of Lake Matilija	34.49209	-119.31661	315	9.0	2,835
15	1	Matilija Cr.	8.4	End of Matilija Road	34.50456	-119.37449	20.0	19.0	380
17	1	Ventura River	9.3	DS of Foster to US reach	34.35069	-119.30463	1750	11.0	19,250
18	1	Ventura River	12.3	Casitas Springs	34.37354	-119.30877	60	12.0	960
	2		12.7	Casitas Springs	34.37712	-119.30721	230	9.0	2070
19	1	San Antonio Cr.	0.0	Mouth to end of Old Cr. Rd. reach	34.38030	-119.30738	2160	8.0	17,280
20	1	San Antonio Cr.	4.2	DS to US of Frasier St.	34.40197	-119.28237	180	8.0	1,440
21	1	San Antonio Cr.	7.8	Camp Comfort reach	34.42493	-119.26110	690	5.0	3,450
22	1	San Antonio Cr.	9.5	Upper San Antonio Cr. reach	34.43269	-119.25087	640	5.0	3,200
23	1	NF Matilija Cr.	0.1	Lower NF Matilija Cr.	34.48520	-119.30118	120	6.0	720
25	1	NF Matilija Cr.	4.1	Near Wheeler's Springs Reach	34.50826	-119.28955	300	4.5	1,350
26	1	NF Matilija Cr.	1.0	Downstream of NF gage bridge	34.49049	-119.30586	302	4.3	1,299
27	1	Matilija Cr.	5.7	Upstream Matilja hot springs	34.50030	-119.34993	105	8.0	840
								Total =	63,266



Appendix 14. Diagram of *O. mykiss* redds measurements. (D) = locations of depth measurements and (G) = location of gravel substrate sampling.



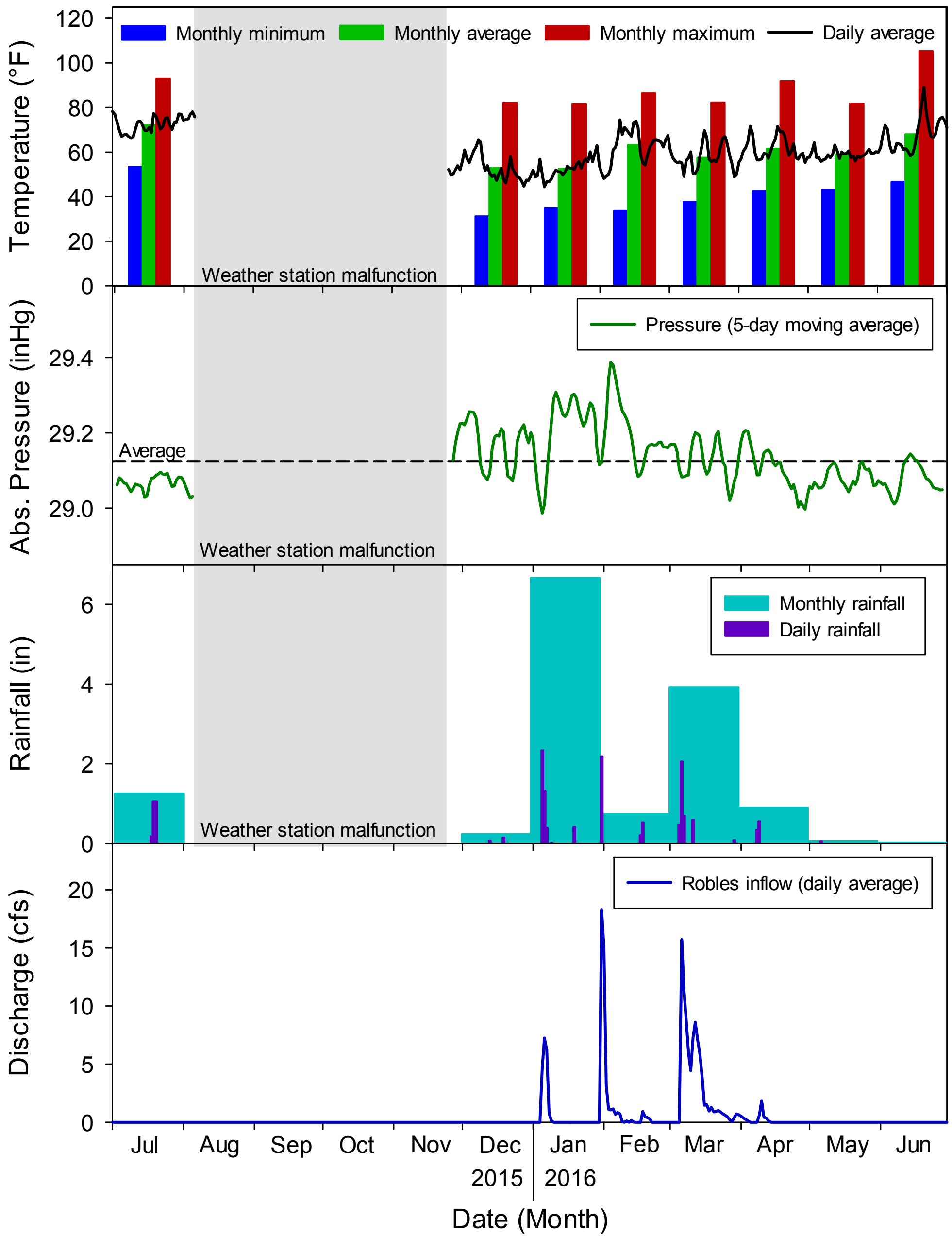
Appendix 15. Total number of *O. mykiss* redds counted at index spawning sites from 2008 through 2016 spawning years.

Appendix 16. Water quality monitoring sites and sampling summary.

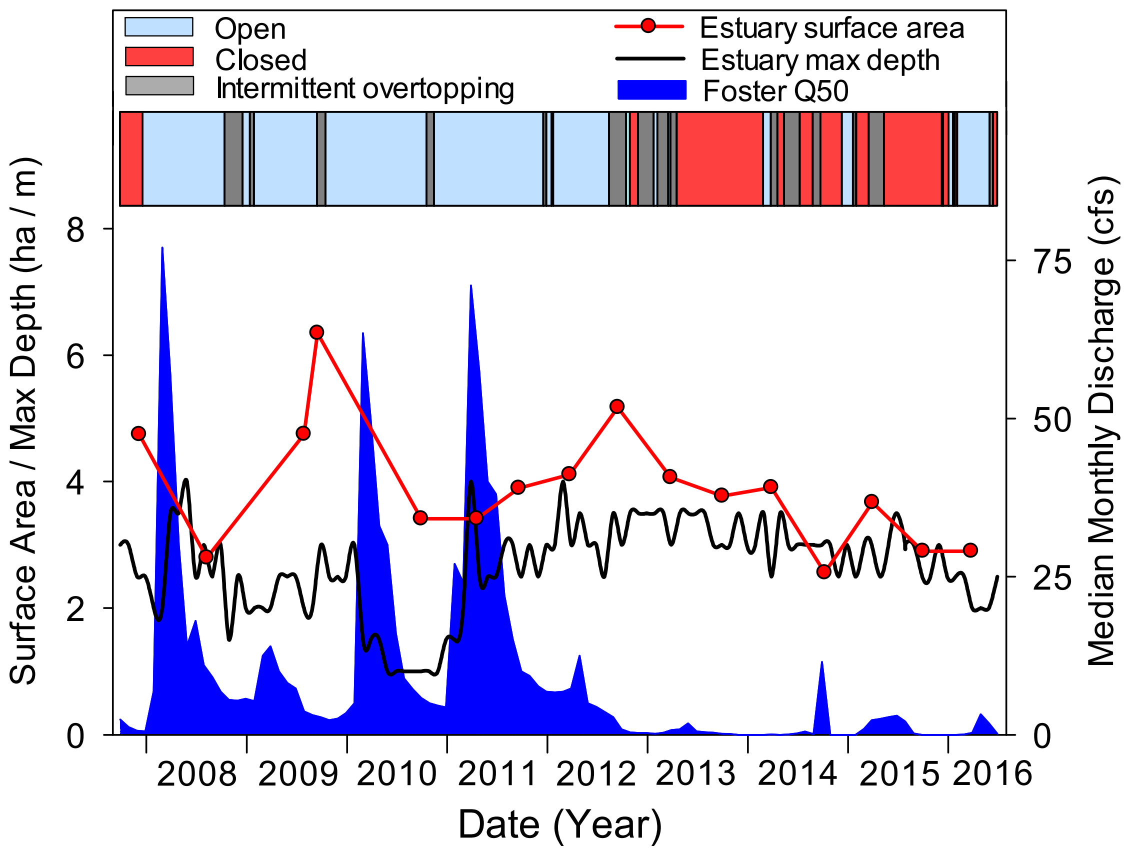
Site Number	Site Description	Site Location[a]	Sampling Method[b]	Sampling Type[c]	Frequency
1	Estuary	V 0.3 km	Multiparameter	Grab profile	Monthly
2	Main St. Bridge	V 1.0 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
3	Foster Park	V 9.7 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
4	Santa Ana Blvd Bridge	V 15.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
5	Hwy 150 Bridge	V 18.7 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
6	Robles Dam	V 23.5 km	Temperature Multiparameter Turbidity Weather	Continuous Grab Continuous Continuous	30 min Monthly Hourly 30 min
7	North Fork Matilija	N 1.3 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
8	Below Matilija Dam	M 1.0 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
9	Above Matilija Dam	M 2.1 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
10	Middle Matilija	M 8.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
11	Lower San Antonio	S 0.3 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
12	Middle San Antonio	S 9.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
13	Lower Coyote	C 0.4 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
14	Fraser St.	S 4.4 km	Temperature	Continuous	30 min

[a]Site location is identified by the river system and kilometers from its confluence. C = Coyote Creek, M = Matilija Creek, N = North Fork Matilija Creek, S = San Antonio Creek, V = Ventura River.

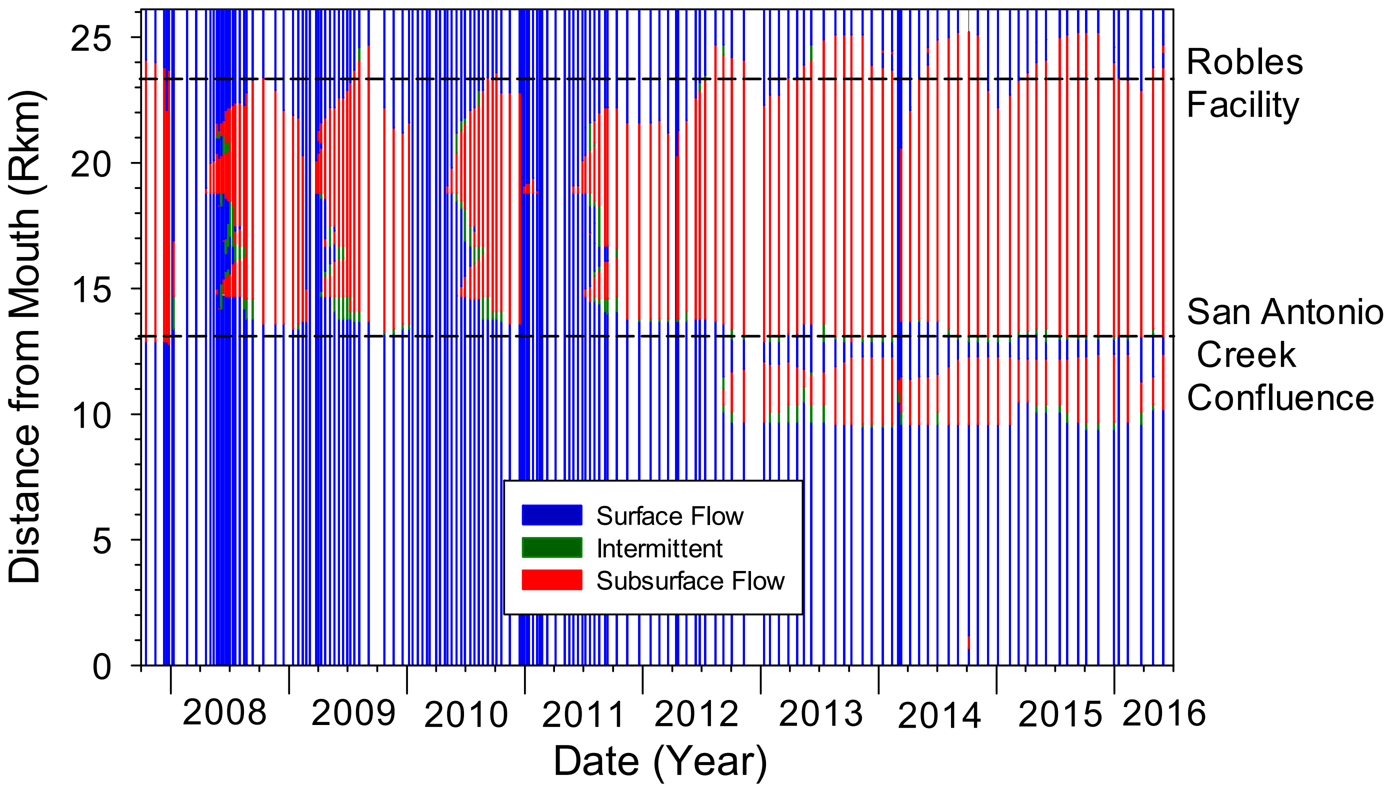
[b]Temperature data were collected using programmable loggers. Multiparameter water quality probe was use to collected water quality data including: temperature, dissolved oxygen, conductivity, salinity, pH, turbidity (separate meter). Turbidity data was collected using a programmable logger.



Appendix 17. Summary of weather and discharge data from the Robles Fish Facility for the reporting period.



Appendix 18. Ventura River estuary/lagoon water depth, surface area, sandbar status, and discharge at Foster Park since 2008.

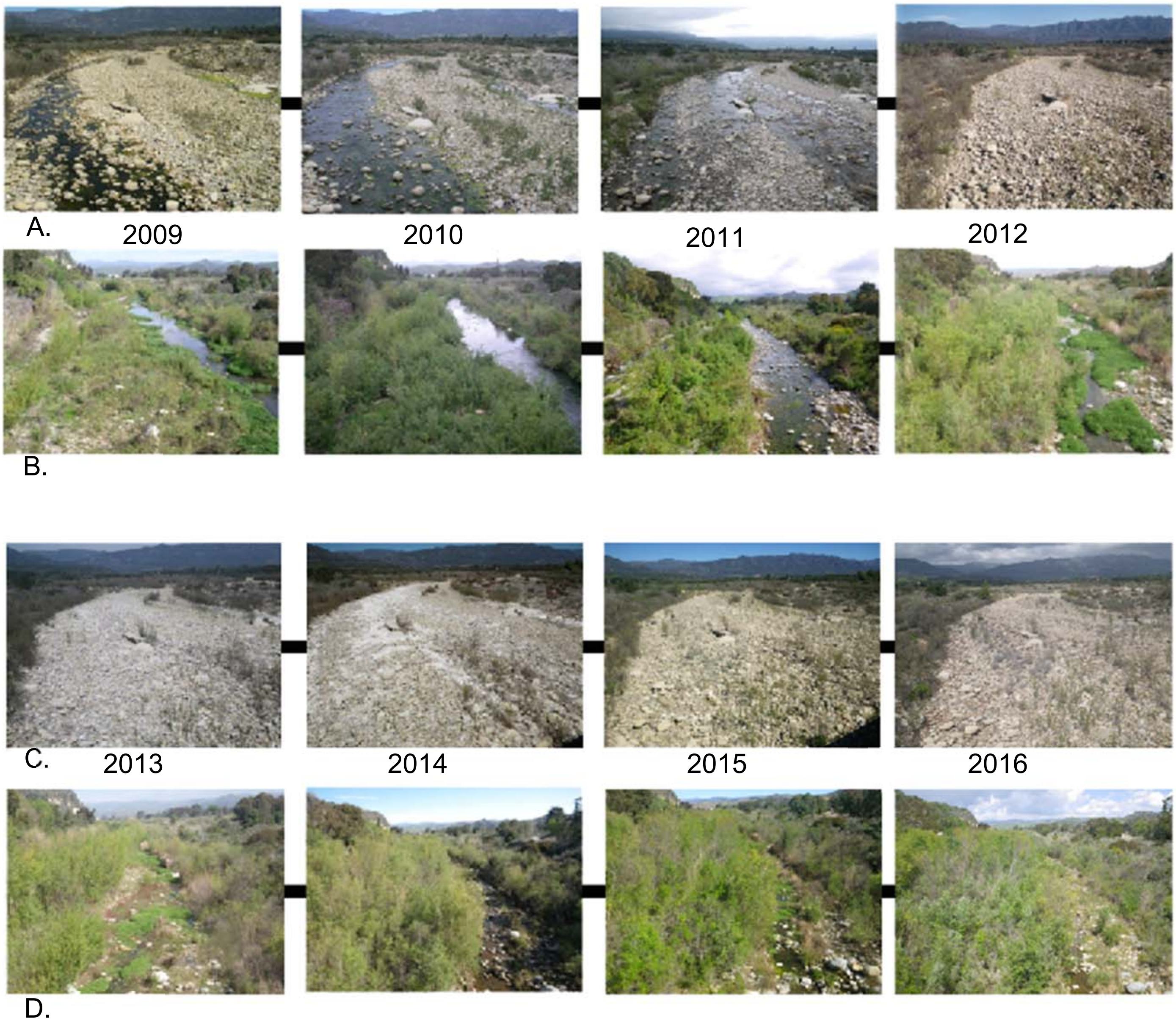


Appendix 19. Ventura River channel surface flow monitoring from 2008 to 2016.

Appendix 20. Photographic monitoring sites within the Ventura River basin.

Site Number	Site Description	Site Location[a]	Photo Direction	Frequency
1	Train bridge in estuary, east bank	V 0.3 km	Downstream	Biannual
2	Train bridge in estuary, west bank	V 0.3 km	Upstream Downstream	Biannual
3	Main Street Bridge	V 1.0 km	Upstream Downstream	Biannual
4	Shell Road Bridge	V 5.2 km	Upstream Downstream	Biannual
5	Casitas Vista Road Bridge (Foster Park)	V 9.7 km	Upstream Downstream	Biannual
6	Santa Ana Boulevard Bridge	V 15.5 km	Upstream Downstream	Biannual
7	Highway 150 Bridge	V 18.7 km	Upstream Downstream	Biannual
8	Robles Fish Passage Facility	V 23.5 km	Downstream	Biannual
9	Camino Cielo Road Bridge	V 25.7 km	Upstream Downstream	Biannual
10	Highway 33 Bridge at NF Matilija USGS Gauging Station	N 1.3 km	Upstream Downstream	Biannual
11	End of North Matilija Road	M 8.5 km	Upstream Downstream	Biannual
12	Highway 33 Bridge near Old Creek Road	S 0.3 km	Upstream Downstream	Biannual
13	Creek Road near Creek Lane	S 9.5 km	Upstream Downstream	Biannual
14	Santa Ana Road Bridge	C 0.4 km	Upstream Downstream	Biannual

[a]Site location is identified by the river or tributary system and kilometers from its confluence. C = Coyote Creek, M = Matilija Creek, N = North Fork Matilija Creek, S = San Antonio Creek, V = Ventura River.



Appendix 21. Multiple year photo comparison of ephemeral and perennial reaches of the Ventura River. Photo series row A and row C are looking upstream from Hwy 150 bridge. Photo series row B and row D are looking upstream from the bridge near the Shell Rd exit off Hwy 33.