2021 Robles Fish Passage Facility Progress Report

O. mykiss were observed at several locations in the Ventura River basin indicating the early stages of population recovery following the Thomas Fire and multiple consecutive dry years. Top photo is an *O. mykiss* observed passing downstream through the Robles Fish Passage Facility on 10 March 2021. It was 27 cm TL and exhibited typical resident *O. mykiss* phenotypic characteristics. Bottom photos are a resident *O. mykiss* adult and fry in Murietta Canyon upstream of Matilija Dam on 14 April 2021.

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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 2021 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 2020 to 30 June 2021.

The monitoring and evaluation studies related to the Robles Fish Facility conducted during the 2020-2021 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.

Below normal precipitation occurred in the Ventura River Basin during the 2021 fish passage season. No BO-defined storm events occurred at the Robles Fish Facility. The sandbar at the mouth of the Ventura River was open for the entire fish migration season and provided opportunity for steelhead passage through the lower mainstem Ventura River. One resident *Oncorhynchus mykiss* was detected passing downstream through the Robles Fish Facility on 10 March 2021, during the fish migration period.

2.0 GENERAL INTRODUCTION

The National Marine Fisheries Service (NMFS) listed the southern California steelhead, *Oncorhynchus mykiss*, as endangered in 1997 (NMFS 1997) under the Endangered Species Act (ESA, 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, NMFS 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 “steelhead trout” and the resident form are “rainbow trout”. Throughout the range of coastal rainbow trout, the anadromous life history form is widespread (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-run steelhead are typically found in the coastal systems where river systems are smaller. The winter-run pattern is the more common of the two anadromous life histories 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, all objectives of the monitoring and evaluation program have not yet been accomplished. This was exacerbated by the historic 5-year exceptional drought affecting much of California, and in particular, the southern coast of California that includes the Ventura River Basin. After the 2017 season, the drought in the Ventura River basin had diminished to a moderate level, which continued into 2018 and 2019. At the start of the 2021 fish passage season, severe drought returned to the basin and increased to an exceptional level by the end of the season (August 2021, US Drought Monitor).

Each aspect of the monitoring and evaluation program is assessed annually to determine if sufficient information has been collected to complete each objective. While significant progress has been made, it is recommended that several aspects of the monitoring and evaluation for the Robles Fish Facility be continued during 2022. Sufficient data have been collected for the upstream fish migration impediment evaluation to begin data analysis; the final results will be used to make recommendations for long-term fish flow operations.

3.0 UPSTREAM FISH MIGRATION IMPEDIMENT EVALUATION

Introduction

The ability of adult steelhead to swim upstream can be impeded during migration at times of low-river flow (NMFS 2003a). Evaluations at shallow water habitat units (i.e., critical riffles) have commonly been conducted to determine if passage 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). Because of this channel morphology and geology, alluvial channels like the Robles Reach have high infiltration rates and cause surface flow to rapidly recede and cease relatively quickly after rain events (Cooke et al. 1992).

An initial assessment of Ventura River 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 to meet critical criteria 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 never validated as a minimum condition for passage. Adult salmonids have been observed passing 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 migrating upstream to the Robles Fish Facility (NMFS 2003a). Because low-river flows have the potential to impede upstream fish migration in the Robles Reach, characterizing the effect of flows on critical riffles in this reach 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 (with the upper limit dependent on the ability to safely conduct the surveys), which was 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, previous surveys, and time constraints due to other aspects of the monitoring and evaluation program. Impediment surveys have been conducted over a number of years given the natural variation of water conditions. The currently selected impediment sites (Appendix 2) were resurveyed multiple times to develop a statistically rigorous data set, given the natural variability of discharge, to evaluate fish passage in relation to Robles Fish Facility discharge.

Site Selection Process

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 completion of initial assessment of the 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.

A 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 2010 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 3. However, at the time 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 a 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).

ENTRIX Study Site Assessments

An effort was made to locate and determine the status of the ENTRIX (1999) study sites during 2009. Because there were numerous bed-mobilizing runoff events after the study was completed, the current status of all study 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 7 sites originally identified by ENTRIX (1999), only 4 sites were located with some degree of certainty. Of those 4 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).

Results

During the reporting period for 2021, no BO-defined storm events occurred. River flows were less than the targeted priority discharges for the remaining impediment study sites (Appendix 3). The targeted priority discharges are generally > 100 cfs, however the largest mean daily inflow to Robles never exceeded 36 cfs during the 2021 fish passage season. Therefore, no water depth transects were conducted during the 2021 fish passage season.

Discussion

Data sampled from the population of sites identified as “critical riffles” will be pooled for evaluation to inform recommendations on flows to facilitate fish passage. This includes data collected over 6 seasons and a range of discharges. All impediment sites will be pooled individually across all years for this initial step of final analyses. Pooling the data broadly characterized the full range of data collected at the different impediment sites across a range of hydrologic conditions. All previous impediments will be included for this initial analysis.

Exploratory data analyses are needed to determine the most appropriate and informative methods for analyzing the data, including data pooling, any needed data transformations, other model explorations, outlier determinations, and final model ranking and selection. This process will proceed on a parallel track within the BC, culminating in flow recommendations to the Management Committee based on the BC’s evaluation.

3.1 *Sandbar Monitoring*

Introduction

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 extends from 01 January through 30 June of each year and commences 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 01 January 2021 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 2020 through June 2021, the mouth of the Ventura River was inspected 15 times to determine if the sandbar was open or closed. There were 8 observations that occurred during the fish passage augmentation season (January through June 2021) and 7 observations outside of the season. The sandbar was open on 01 January 2021 through 30 June 2021 for volitional fish passage (Appendix 4). On days the sandbar was inspected during the reporting period, the mean daily discharge at the USGS Foster Park gage station and the Robles Fish Facility ranged from approximately 2 to 11 cfs and 0 to 10 cfs, respectively. The sandbar was open during the entire reporting period and the river was observed exiting only from the east side of the estuary.

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. This typical pattern where the sandbar remains open during the fish passage season is illustrated for most years (Appendix 5). This pattern commonly includes a period, during the summer and fall, when the sandbar is closed. A single low precipitation year can produce longer periods of closure (e.g., 2007, 2012, and 2016). Consecutive dry years may cause a closure to persist into the fish passage season, opening only during short periods following rain events (e.g., 2013-2015).

The tendency of the sandbar to remain open during the fish passage season, in all but very dry years, is likely due to a several 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 upstream of the confluence with San Antonio Creek and continues to increase slightly proceeding downstream. Additionally, tributary flow from San Antonio Creek contributes to the Ventura River through a surface or subsurface connection throughout the year. Finally, treated effluent water from the Ojai Valley Sanitary District at rkm 7.5 increases the river discharge by approximately 3 cfs. Continued lower evapotranspiration caused by the Thomas Fire and above average rainfall in 2019 have likely combined to produce longer periods of surface/subsurface flow and contributed to keeping the sandbar open. Together, these hydrologic features and effects have contributed water to the Ventura River and likely prevent the sandbar from fully forming. Consequently, the sandbar has remained open during most fish passage seasons, which has been approximately 80% of the time.

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*, respectively. It appears that passage conditions remain suitable during most seasons when steelhead are typically immigrating and smolts are emigrating. However, lagoon conditions optimal for juvenile rearing (i.e., when the sandbar closes and causes the estuary to form into a deeper freshwater lagoon; Bond et al. 2008) appear limited during years with potential smolt recruitment for the study period beginning in 2006.

4.0 EVALUATE FISH MOVEMENT THROUGH THE PASSAGE FACILITY

4.1 *Water Velocity and Depth Validation Evaluation*

No performance testing or evaluations occurred during the 2021 fish passage season because of insufficient flows into the Robles Fish Facility (Table 1).

Table 1. Performance testing completion status and remaining priorities.

Component	Completed/ Year	Flow Required	Required Flow duration	Anticipated completion	Comments	Completed By	Priority-Flows 30-50 cfs	Priority Flows 700 cfs +
Screens	Yes/2011	671 cfs in channel				Consultant		
Diversion Flume	Yes/2006							
Fishway Vertical Slots	Yes/2018	25-35 cfs in Fishway **(34 cfs)**	24 hours			Casitas		
	Yes/2020	50 cfs in fishway **(50 cfs)**	24 hours			Casitas		
	No	50 cfs in fishway + 121 cfs in Auxiliary Pipe	24 hours	After 121 cfs is achieved through the Auxiliary Pipe	River must flow at 2000 cfs for 24 hours to accomplish this task	Casitas		7
Fishway Entrance Gates	Yes/2018	25-35 cfs in Fishway **(#5 @ 34 cfs)**	24 hours			Casitas		
	Yes/2018	50 cfs in fishway **(#5 @ 44 and 50 cfs, #4 @ 50 cfs)**	24 hours			Casitas		
	No	50 cfs in fishway + 121 cfs in Auxiliary Pipe **(#5 @ 72 cfs, #4 @ 72 cfs, 2019)**	24 hours	After 121 cfs is achieved through the Auxiliary Pipe	River must flow at 2000 cfs for 24 hours to accomplish this task	Casitas		3
Auxiliary Water	No	121 CFS in Aux Pipe	24 hours	After 121 cfs is achieved through the Auxiliary Pipe	River must flow at 2000 cfs for 24 hours to accomplish this task	Casitas		4
Entrance Pool	No	400-600 cfs in spillway **(400 cfs spill and 50 cfs ladder method testing, 2019)**	8 hours	After 121 cfs is achieved through the Auxiliary Pipe		Casitas		1
	No	1200-1500 cfs in spillway	8 hours	After 121 cfs is achieved through the Auxiliary Pipe		Casitas		2
	No	2500-3500 cfs in spillway	8 hours	After 121 cfs is achieved through the Auxiliary Pipe		Casitas		6
Interim Rock Weirs	Yes/2017	20 cfs	4 hours			Casitas		
	Yes/2017	30-40 cfs	4 hours			Casitas		
	Yes/2017	50 cfs	4 hours			Casitas		
Fish Guidance System	No	671 cfs in channel	4 hours			Casitas		8
Forebay	No	1000-2000 cfs	4 hours			Casitas		5
High Flow Fish Exit	Yes/2006	150-200 cfs in channel	4 hours		HF has a continuous read flow meter	Casitas		
	No	600-700 cfs in channel	4 hours			Casitas		9
Low Flow Fish Exit	Yes/2018	20-40 cfs **(26 cfs)**	2 hours			Casitas		

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 are needed to ensure successful passage (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 downstream migrating fish 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 (i.e., attraction flow) at the entrance of 171 cfs (50 cfs through the entire ladder and an additional 121 cfs supplemented at the lower end of the ladder). The reach downstream of the fish ladder entrance is composed of habitats that steelhead may use during migrations. 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 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 that covered a range of spatial and temporal scales were employed to determine the presence of *O. mykiss* for the Fish Attraction Evaluation. 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 June of 2021 when water was present, dry conditions were documented at any location. 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 6-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. When present, fish species are 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 conducted in the entrance pool during the ramp-down period for all BO-defined storms. This consisted of daily surveys during the 10-12 day augmentation period after a storm event. Beginning the day after a BO-

defined peak event, a Secchi depth was measured in the entrance pool to determine when surveys could begin. Bank surveys were conducted when visibility was poor and snorkel surveys were 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 conducted after a BO-defined storm and during the ramp-down period. After the storm event occurred, video cameras were installed at the entrance of the fish ladder. The video cameras were mounted on a bracket adjacent to the fish ladder entrance and lowered into place to provide monitoring following the storm event. The cameras recorded the entire 10-12 day ramp-down period to a digital video recorder (DVR) and reviewed at a later date.

<u>*Results*</u>

1) A total of 19 surveys (14 bank and 5 snorkel) were completed during the weekly surveys and no *O. mykiss* were observed (Appendix 6). During the 6-month period, a total of 3,645 m was surveyed by either bank or snorkel methods. Water temperatures during the study period ranged from 9.0 °C to 21.0 °C and turbidity ranged from 1.4 to 32.8 NTUs when the surveys were conducted. The mean daily discharge at the Robles Fish Facility ranged from 0 to 13 cfs at the time of the surveys.

2) No BO-defined storm events occurred during 2021 and therefore no post-storm fish attraction surveys completed.

3) No BO-defined storm events occurred during 2021 and therefore 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 have 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 to determine if injuries are occurring as they pass downstream through the Robles Fish Passage Facility (NMFS 2003a).

Methods

For a full description of evaluation methods, see section 5.0.

Results

No evaluations for the Downstream Passage Evaluation were conducted during 2021. The trap was not installed because there was no surface flow connection downstream of the Robles Fish Passage Facility.

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 to the Ventura River estuary/lagoon, which is important to understand 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.

Methods

A weir trap was to be placed and operated approximately 40 m downstream of the Robles Fish Facility. The weir trap consists of a live-box (120 cm for all three dimensions) with an internal fyke. The trap was to be situated in the center of the river channel and thalweg. The live-box internal frame is constructed of PVC pipe and covered with plastic fencing with 1.9-cm diagonal openings. A plastic fence (3-cm openings) supported by T-bar fence posts was to be extended upstream on both sides of the live-box at 30° angles into the river channel. A 1-m gap on the right bank was designed so any adult steelhead could bypass the trap location and move upstream. Because the vast majority of downstream steelhead migrants were expected to be captured from mid-March through mid-June (Shapovalov and Taft 1954; Dettman and

Kelley 1986), the trap was intended to be operated from mid-March through June 2020 or until water temperatures exceeded a daily mean of 22 °C, which could negatively impact captured fish (SYRTAC 2000), or the surface water connection was lost in the mainstem of the Ventura River. For a full description of evaluation methods, see the 2021 CMWD monitoring and evaluation study plan (Lewis and Gibson 2021).

Results

As noted previously, the trap was not installed and operated during 2021 and therefore no *O. mykiss* were captured during 2021.

6.0 LONG-TERM MONITORING COMPONENTS

6.1 *Monitoring Robles Facility Operations*

6.1.1 Facility Status

The 2020-2021 season was a below average rainfall year as measured in Matilija Canyon. The 8.10 inches of rain measured at the Matilija Canyon Ventura County station during the 2020-2021 water year was 23.6% of the average annual rainfall. No BO-defined storm events occurred during 2021 and yet surface flow over the measurement weir was present until 14 June 2021.

Previous annual reports had identified several projects to be completed or reported on as to their current status. The principal projects were:

- Install repaired Sontek IQ pipe flow meter in the auxiliary water supply pipe. The flow meters had numerous communication issues during 2019 that needed to be resolved before the 2020 season; however, water levels did not recede enough to access the supply pipe for repairs. A new Sontek flow meter was installed in the fishway during 2020 and has remained operational.

- Level and flow sensors repair or replacement. Install level sensors at the fish ladder entrance to read water levels in the entrance pool. In previous years this item was not successfully completed due to presumed sensor and SCADA limitations. However, CMWD contracted with a SCADA technician during late 2019 and early 2020 who was able to use the existing level sensors to record this data. Additionally, the technician was able to provide numerous updated monitoring and control modifications to the Robles SCADA system. These included: ability to monitor the entrance pool elevation directly, auxiliary and fishway gate levels displayed on SCADA PC screen, and backup fishway flow calculation from elevation. Additionally, many of the primary monitoring and controls can now be tracked or adjusted from the CMWD office without being on-site and provides more accurate operations. It is assumed the original sensors are reaching their working life limit and will be replaced with radar sensors as budget allows. Through June of 2021, three of the original seven ultrasonic water level sensors have been replaced with radar sensors. Radar level sensors are more accurate, dependable, and less affected by temperature variations.

- New diffuser perforated plate for the fish screens and the auxiliary water supply. During the 9 BO-defined storms in 2019 and three during 2020, the new diffuser perforated panels did not become obstructed with debris as before and appear at this time to have corrected the issue of lower than anticipated flow presumably due to debris obstruction. Continued evaluations will be conducted to verify their effectiveness. The diffusers were opportunistically cleaned while the facility was shut down for sediment removal and only low levels of debris was present. They will continue to be monitored during future storms.

- Prototype evaluation of screen cleaning modifications. Two vertical fish screens were replaced with horizontal screens during 2020 (one on each side of the V-screen). This, along with several other modifications were intended to be installed for evaluation. A screen back-wash system was not installed do to expected chance of significant rain and cost of the system. Double brush arm screen cleaners were installed on the west-side of the V-screen during late 2020 and early 2021. After installation of all brush arms, a significant amount of time was needed to adjust and evaluate all components of the brush cleaning system. This included adjusting individual strips of bristles to the screen face, counterweight amounts, cable guides, cable tension, and cable sheaves. Most of these evaluations were facilitated by the use of a cable dynamometer that recorded cable load to ensure the cleaning system was not exceeding design specifications.

- Forebay sediment removal. Sediment in the Robles forebay was removed and placed downstream of the cut-off wall during November of 2019. The total amount of sediment removed was approximately 35,000 yd^3. A remaining 15,300 yd^3 not removed due to budget and Covid-19 Pandemic constraints will be removed in the fall of 2021 and placed in high-flow channel.

- Auxiliary pipeline box debris cover. To prevent debris from entering the auxiliary water supply, a perforated aluminum plate with ¼" holes was installed on top of the grating, which has 1 x 3" openings. The grating covers the access opening of this area for maintenance and repair. During high spill flows, the entrance pool water elevation is higher than the top of the fish ladder and water floods into the lower portion of the fish ladder and allows debris to enter through the 1 x 3" openings of the grating. Once in the auxiliary system, debris larger than the baffle holes becomes impinged and could reduce flow from of the auxiliary system into the fish ladder. The cover was installed in November of 2020 after BOR completed a "no effect" determination in October 2020.

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 of measuring and recording stream flows entering, flowing through, and leaving the Robles Fish Passage Facility are:

- Matilija Creek at Matilija Hot Springs—located approximately 2,100 feet downstream of Matilija Dam with good rating for low to moderate flows and operated by Casitas Municipal Water District, formerly a USGS station. The gage data is now remotely accessible by CMWD after communication upgrades. A second gaging station at this location is operated by Ventura County and has intermittent operational issues. It was operational throughout the 2021 fish passage season.
- Matilija Dam Stage Bubbler—located at the dam, this gage provides the lake elevation. Under high flows, the dam acts as a weir. This is one of the primary flow measurement locations and to determine if a peak has occurred. Ventura County extended the bubbler line to a lower elevation in the fall of 2020 to capture future downloads and drawdowns to the water inlet level.
- North Fork Matilija Creek—located approximately 3,000 feet upstream of its confluence with Matilija Creek with good rating for low to moderate flows and 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 in a trapezoidal channel with 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 at a concrete weir section with 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—Sontek IQ Plus has been added to this location to measure flow in the fish ladder. It operated normally with ongoing assessment.
- Auxiliary Water Supply—Sontek IQ Pipe has been installed to obtain flow measurements in the auxiliary water supply. It has had intermittent operational issues, but because water has remained in the lower fish ladder throughout the

year, an inspection could not be done. This inspection should be possible in the summer or fall of 2021 due to dry conditions.

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, vandalism, or equipment problems. For this reason, the data is verified against field measurements and observations when available. The information gathered from each of these locations has been summarized as mean daily flows (Appendix 7). The mean daily Robles Fish Facility discharge and corresponding turbidity and temperature measurements for the entire fish passage season are presented in Appendix 8.

Noticeable sediment deposition did not appear to occur in the Robles forebay during 2021. A sediment survey will have to be conducted to fully evaluate the sedimentation from the 2021 season. No sediment-related issue occurred in the screenbay during 2021.

Critical Drought Protection Measures—No BO-defined storm events occurred during 2021 and therefore no CDPM downloads were conducted. A rain event on 28 January 2021 would have likely produced a BO-defined storm event if Matilija Dam had been full at the time. However, Ventura County had drained Matilija Dam reservoir in July 2020 due to seismic and safety requirements specified by the California State Division of Safety of Dams. The rising limb of the season’s first storm was used to refill Matilija Dam (USBOR 2018). Once Matilija Dam filled, the peak discharge downstream of Matilija Dam was 62 cfs at the Ventura County Hot Springs gage. Depending on channel infiltration rates and timing of subbasin peak flows, the peak inflow to Robles Fish Passage Facility could have been up to approximately 250 cfs if Matilija Dam had been full at the time of the rain event.

6.1.3 Costs Associated with Operation and Monitoring

The BA/BO specified that CMWD provide the costs that are associated with the activity. The following is a summary estimate of direct costs incurred by CMWD during the 2020-21 fiscal year:

- **<u>Fisheries Monitoring</u>**:

Salaries & Benefits	$	520,659
Equipment/Material	$	68,982

- **<u>Facility Operations</u>**:

Salaries & Benefits	$	14,261
Equipment/Materials	$	13,599
Outside Contracts	$	3,285
Utilities	$	4,354
Permit	$	623

- **<u>Capital Improvements</u>**:

Forebay Restoration	$	1,266,225
Prototype Design/Support	$	217,452
Prototype Equip/MTL	$	552,514

6.1.4 Water Velocity and Depth Validation Evaluation

Water velocity data were not collected in the fish passage facility during the 2021 season. No BO-defined storms occurred to provide the needed Robles Fish Passage Facility inflows for remaining evaluation objectives, which generally would need > 400 cfs (see section 4.1). All performance future testing will be completed in general accordance with the NMFS approved Performance Evaluation Program and Biological Committee priorities in section 4.1.

6.1.5 Recommendations Regarding the Prioritization of Future Activities

The Robles Fish Facility has completed its 16th season with operational. An assessment of the current fish screens and cleaning system was initiated to determine if modifications could be made to improve fish passage and diversion operations. A prototype evaluation plan was completed and distributed to the BC for review during 2019 and implementation of the evaluation plan was ongoing for the 2021 fish passage season.

6.1.6 Recommendations Deemed Necessary to the Operations

Forebay sedimentation caused significant operational issues during 2019 and much of the sediment was removed during 2019, however the remaining sediment will be removed during the fall of 2021. Casitas continues to recommend the 15-weir project remain on hold until the Matilija Dam Removal Project (which includes modifications to Robles to efficient bypass sediment downstream) is completed. Plans for the High Flow Sediment Bypass and High Flow Fish Passage portion of the Matilija Dam Removal Project will likely require significant facility modifications that are yet to be determined.

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 upstream adults and downstream kelts migrating through the Robles Fish Facility (NMFS 2003a). Although the Riverwatcher has the ability to detect smolt-sized steelhead, the manufacturer recommends it for monitoring fish with body depths ≥ 40 mm (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. During periods of higher debris loads, cleaning and inspections occur multiple times per day. Cleaning and inspections occur only once every 2-3 days during periods of low debris. At times of very low flow (< 1-2 cfs), the crowder may only be cleaned once per week.

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. It is NMFS' belief that supporting data do not exist to distinguish between the resident and anadromous forms of *O. mykiss*. 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), 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 and Discussion

The Riverwatcher was operated from 01 January 2021 through 17 June 2021, which was 98% of the time it could have operated. It was removed from the fishway due to low water levels. The Riverwatcher was not operated for 2 days due to high turbidities. During this fish passage season, the crowder was removed from the fish bypass channel and cleaned or inspected approximately 76 times. A total of 588 false detections were recorded by the Riverwatcher, of which 360 were upstream and 228 were downstream. There were a total of 21 non-*O. mykiss* detected passing upstream or downstream through the Riverwatcher; all were Largemouth Bass (Appendix 10).

During the 2021 fish migration season, the Riverwatcher detected one *O. mykiss* passing downstream through the Robles Fish Facility. This was the first *O. mykiss* passing through the Robles Fish Passage Facility in 4 years. It passed downstream on 10 March at 14:57 h and was an estimated 27 cm TL. Based on phenotypic characteristics, it was in all likelihood a resident rainbow trout. At 27 cm, the length was greater than previous *O. mykiss* smolts trapped emigrating downstream at the Robles Fish Passage Facility (range 17-26 cm, mean = 21 cm). The body and caudal peduncle were robust and the *O. mykiss* did not exhibit the typical slender smolt morphology that occurs from differential growth (i.e., increase of length relative to weight). The margins of the dorsal and caudal fins were not darkened, and abundant spots were visible on the fins and across the body. The fish did not exhibit the typical silvering associated with smolting, but did have the typical rainbow trout blue/green color dorsally and a red/pink hue along the lateral area. At the time of the detection, there was no surface flow connection in the Robles Reach and surface flow ended just upstream of the Hwy 150 bridge.

The 588 false detections recorded by the Riverwatcher were assumed to be caused 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 cause of 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 2021 season, the minimum threshold height remained at 28 mm so large numbers 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* relative abundance index 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, 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 survey 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 were generally between 350 and 400 *O. mykiss* until 2013. Due to the exceptional 5-year drought (2012-2016) and post Thomas Fire effects, the peak numbers of *O. mykiss* dropped substantially (Appendix 12). No *O. mykiss* were observed during the reporting period ending in June 2021. However, opportunistic snorkeling upstream of Matilija Dam in Murietta Canyon and Upper North Fork Matilija Creek revealed adult and young-of-the-year *O. mykiss* (see cover photos) indicating successful reproduction and early stages of population increase.

7.2 *O. mykiss Index Spawning Surveys*

Methods

Spawning surveys were conducted throughout the Ventura Basin accessible to anadromous steelhead or only to resident rainbow trout (i.e., 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, 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 5 years, as the current drought intensified or was sustain, the available habitat diminished, and there have been corresponding losses to the adult and juvenile *O. mykiss* populations with significantly lower redd counts. In 2021, no redds were observed in the index areas (Appendix 15).

7.3 *Ambient Water Quality Monitoring*

To evaluate 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 temperature loggers recorded 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 is representative of the turbidity in the Ventura River. All locations were monitored if sufficient water was present. A weather station at the Robles Fish Facility collects various atmospheric data including: rainfall, temperature, pressure, wind, humidity, and dew point (Appendix 17).

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 dynamics of the Ventura River sandbar and how it may affect fish passage throughout the year, and potential estuary/lagoon 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. However, the spring 2020 survey was not conducted because of COVID-19 protocol issues with having two people in one kayak. 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 estuary/lagoon depth and size varied. However, since the beginning of the drought in 2012, estuary/lagoon depth and surface area 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 and wet precipitation years, there are typically surface flows throughout the length of the Ventura River mainstem during the fish passage season lasting 9 to 29 weeks. However, even during these years, the Robles Reach can go dry shortly after storms occur. Beginning with the drought in 2012, the Robles Reach was dry for extensive periods of time, even extending downstream of the reach to below the San Antonio Creek confluence. This drought-induced pattern significantly contracted, both spatial and temporal, due to increased precipitation and runoff during the 2017 monitoring period. During 2020, precipitation was about 88% of average and surface flow continued for a longer period and farther downstream than typical (Appendix 19).

These longer base flows may be related to Thomas Fire effects that modified the watershed hydrologic cycle. In addition, the much higher than average flows of 2019 probably contributed to the observed increased base flows. Below average precipitation during 2021 produced little runoff and insignificant surface flow in the Robles Reach; only one brief surface connection occurred (≈ 6 h) following a rain event on 28 January 2021 (Appendix 19). This brief surface connection represented approximately 0.1% of the time a surface connection occurred during normal to wet years since 2005.

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 2020 and March 2021. 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 2014.

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 recording were reviewed to determine presence or absence and relative numbers of *O. mykiss*. If this pilot study is successful, it may be expanded and developed into a more quantitative monitoring tool. This system was also used at the fish ladder entrance during post-storm observations. Underwater video monitoring was not conducted during the 2021 fish passage season.

7.8 *Stranding Surveys*

Stranding surveys were conducted during the reporting period as part of other monitoring and evaluations (i.e., impediment, snorkel, and spawning surveys). No stranded *O. mykiss* were observed.

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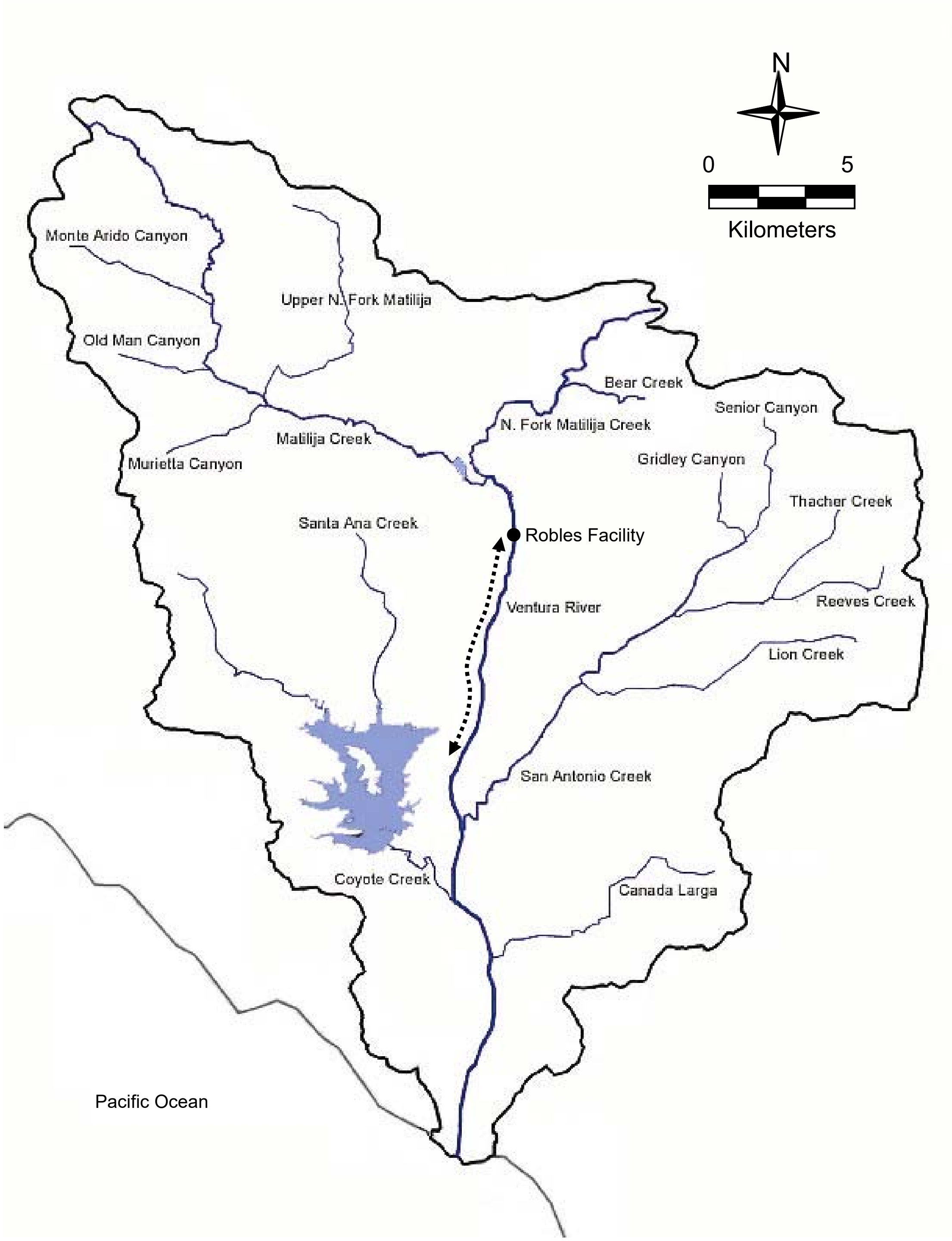
9.0 APPENDICES



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 current impediment sites 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)
10-2	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[c]	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
6-5[c]	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.
[c]Site was substantially alter by high flows and sediment during 2019 and is no longer monitored.

Appendix 3. Completed transects through 2021 at impediment sites for target downstream discharge releases from the Robles Fish Facility.

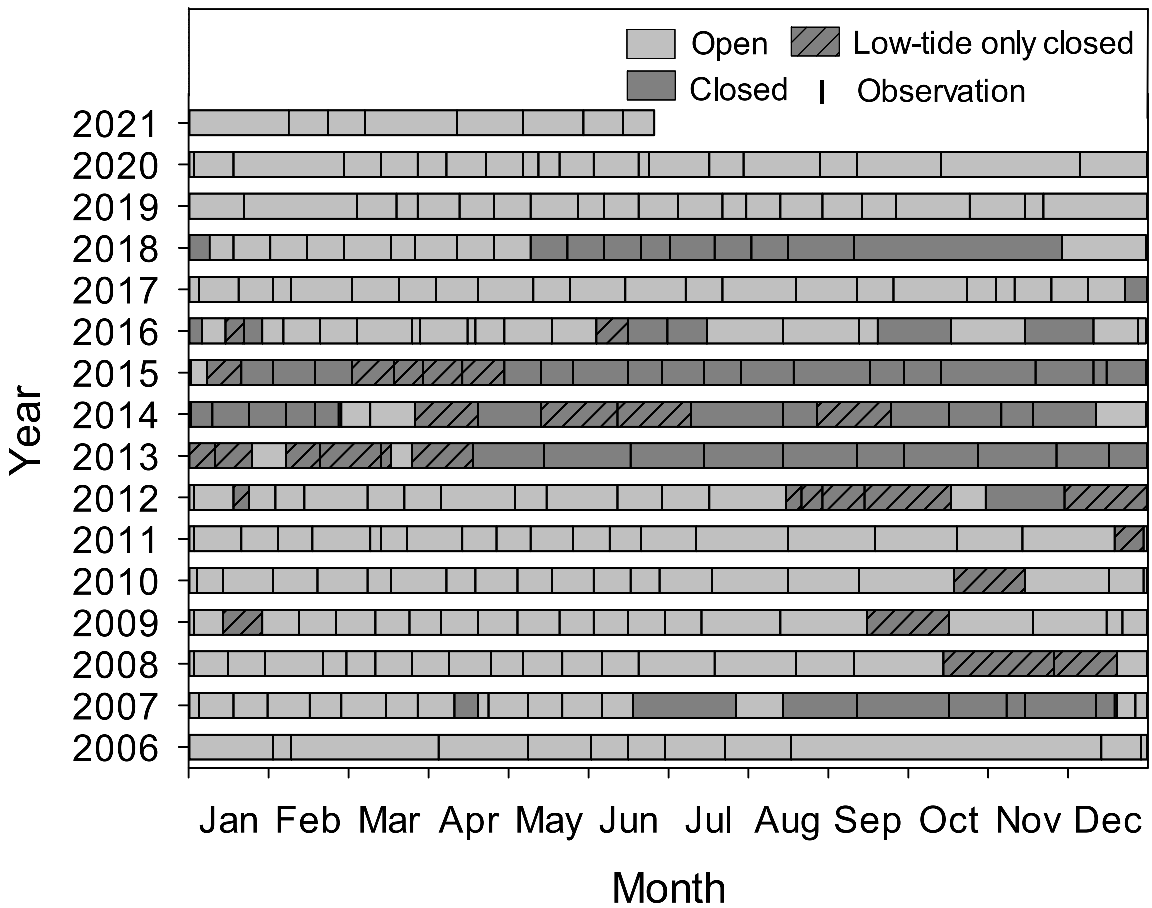
Robles Discharge (cfs)	Impediment Sites: 3-2	4	5-2	6-2 6-3	6-4 6-5	7	9	10	10-2
171	x		x	x, x			x	x	
100	x	x	x			x	x	x	x
82	x, x	x	x		x	x, x	x, x	x	x
74	x	x	x, x	x, x	x	x	x		x
68	x		x		x	x	x		x
62	x	x, x, x, x	x	x		x	x	x	x
56	x		x	x	x	x	x	dry	x
50	x	x	x	x, x	x	x, x	x	x, x	x
40	x	x, x, x	x, x	x	x	x, x,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

Completed transects rounded to nearest Robles discharge (e.g., the four transects measured for Site 4 at 62 cfs ranged from 61-63 cfs) based on mean 2.6 rkm/h lag time and averaging hourly discharge of released water from Robles. Colors correspond to year of survey: x = 2010, x = 2011, x = 2014, x = 2017, x = 2018, and x = 2019. Sites 4, 6-2 through 6-5, and 10 (gray columns) were alter by storm flows over time and data are no longer collected.

Appendix 4. Ventura River sandbar monitoring data from July 2020 through June 2021.

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
07/16/2020	Y	9:22	3.1	ebb	8:28	3.2	12:47	2.4	10.6	10	Open, east bank
07/29/2020	Y	15:07	4.1	flood	18:10	5.9	11:33	2.2	10.8	9	Open, east bank
08/27/2020	Y	15:56	4.8	flood	17:55	5.6	11:37	2.8	6.1	2	Open, east bank
09/10/2020	Y	10:05	3.3	flood	15:44	4.5	7:27	3.1	5.4	2	Open, east bank
10/12/2020	Y	15:57	3.8	flood	18:42	5.3	13:02	2.4	3.5	3	Open, east bank
12/04/2020	Y	10:07	5.4	slack	10:37	5.4	18:35	0.1	2.0	3	Open, east bank
12/31/2020	Y	9:29	6.1	slack	9:15	6.1	16:50	-0.9	1.7	4	Open, east bank
01/04/2021	Y	8:52	3.2	flood	12:19	4.5	6:47	2.6	1.7	5	Open, east bank
02/11/2021	Y	9:20	6.0	ebb	8:42	6.2	15:49	1.3	1.7	8	Open, east bank
02/26/2021	Y	9:10	5.8	ebb	8:19	6.1	15.21	-1.2	2.1	7	Open, east bank
03/12/2021	Y	9:20	5.4	ebb	8:33	5.5	15:17	-0.7	2.8	9	Open, east bank
04/16/2021	Y	9:05	1.0	flood	13:33	2.8	7:02	0.3	4.4	3	Open, east bank
05/11/2021	Y	10:37	3.7	slack	10:28	3.7	15:36	1.6	3.2	1	Open, east bank
06/03/2021	Y	7:52	2.7	ebb	5:15	3.7	11:50	0.6	2.8	1	Open, east bank
06/18/2021	Y	10:32	0.7	slack	3:40	3.8	10:32	0.7	2.1	0	Open, east bank

[a]USGS gauging station number 11118500, downstream of Foster Park.



Appendix 5. Sandbar status at the mouth of the Ventura River from 2006 through June of 2021. Each observation is indicated by a vertical line and the sandbar status was assumed to remain unchanged until the next observation.

Appendix 6. Weekly fish attraction counts at the Robles Fish Facility during 2021.

Date	Method	Direction	Length (m)	Temp (°C)	Turbidity (NTU)	Robles Discharge (cfs)[a]	Species[b]	Count
01/06/2021	BANK	Downstream	200	11.5	7.0	5	NFO	0
01/06/2021	BANK	Upstream	140	11.5	7.0	5	NFO	0
01/14/2021	BANK	Downstream	200	10.8	9.3	5	NFO	0
01/14/2021	BANK	Upstream	140	10.8	9.3	5	NFO	0
01/22/2021	BANK	Downstream	200	10.2	32.8	4	NFO	0
01/22/2021	BANK	Upstream	140	10.2	32.8	4	NFO	0
01/25/2021	SNORKEL	Downstream	200	9.0	3.5	5	NFO	0
01/25/2021	SNORKEL	Upstream	140	9.0	3.5	5	NFO	0
02/03/2021	BANK	Downstream	200	11.7	14.5	13	NFO	0
02/03/2021	BANK	Upstream	140	11.7	14.5	13	NFO	0
02/25/2021	SNORKEL	Downstream	200	11.0	3.4	7	NFO	0
02/25/2021	SNORKEL	Upstream	140	11.0	3.4	7	NFO	0
03/05/2021	BANK	Downstream	200	10.2	3.7	7	NFO	0
03/05/2021	BANK	Upstream	140	10.2	3.7	7	NFO	0
03/12/2021	BANK	Downstream	200	12.0	3.7	9	NFO	0
03/12/2021	BANK	Upstream	140	12.0	3.7	9	NFO	0
03/26/2021	SNORKEL	Downstream	200	11.0	1.4	6	NFO	0
03/26/2021	SNORKEL	Upstream	140	11.0	1.4	6	NFO	0
04/02/2021	BANK	Downstream	200	19.9	6.1	4	NFO	0
04/02/2021	BANK	Upstream	140	19.9	6.1	4	NFO	0
04/08/2021	BANK	Downstream	200	12.2	5.7	4	NFO	0
04/08/2021	BANK	Upstream	140	12.2	5.7	4	NFO	0
04/14/2021	BANK	Downstream	200	11.0	14.8	4	NFO	0
04/14/2021	BANK	Upstream	140	11.0	14.8	4	NFO	0
04/28/2021	SNORKEL	Downstream	200	15.0	4.4	3	NFO	0
04/28/2021	SNORKEL	Upstream	140	15.0	4.4	3	NFO	0
05/14/2021	BANK	Downstream	200	19.0	3.2	1	NFO	0
05/14/2021	BANK	Upstream	140	19.0	3.2	1	NFO	0
05/18/2021	BANK	Downstream	200	16.4	3.2	1	NFO	0
05/18/2021	BANK	Upstream	140	16.4	3.2	1	NFO	0
05/25/2021	SNORKEL	Downstream	200	18.0	8.0	1	NFO	0
05/25/2021	SNORKEL	Upstream	140	18.0	8.0	1	NFO	0
06/01/2021	BANK	Downstream	200	15.0	3.3	1	NFO	0
06/01/2021	BANK	Upstream	140	15.0	3.3	1	NFO	0
06/07/2021	BANK	Downstream	200	20.0	3.7	1	NFO	0
06/07/2021	BANK	Upstream	140	20.0	3.7	1	NFO	0
06/14/2021	BANK	Downstream	85	21.0	1.9	0	NFO	0
06/14/2021	BANK	Upstream	140	21.0	1.9	0	NFO	0
		Upstream	2,660 m				Upstream	0
		Downstream	3,685 m				Downstream	0
		Total	6,345 m				Total	0

[a]Daily mean discharge recorded with instrumentation at the Robles Fish Passage Facility (Appendix 7).
[b]OMY = *O. mykiss* and NFO = no fish observed.

Appendix 7. Monthly flow summary for Robles Fish Facility, reporting year 2020-2021.

Ventura River Flow
Assessment Reporting
Year 2020 -2021

	(1)	(2)	(1) + (2)	B.O. Required Flow Release (cfs)	(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				**Robles Facility Mean Daily Flows**				
Jul-20	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	41	5	46	20	28	0	26	1	27
2	52	5	57	20	61	0	51	0	51
3	14	5	19	20	30	0	25	0	25
4	12	5	17	20	16	0	13	0	13
5	12	5	17	20	15	0	19	0	19
6	12	5	17	20	13	0	27	0	27
7	10	5	15	20	12	0	23	0	23
8	11	6	17	20	12	0	10	0	10
9	10	6	16	20	11	0	11	0	11
10	10	5	15	20	11	0	12	0	12
11	9	5	14	20	10	0	11	0	11
12	10	5	15	20	9	0	10	0	10
13	10	5	14	20	9	0	10	0	10
14	10	4	14	20	9	0	10	0	10
15	9	4	13	20	10	0	10	0	10
16	9	4	13	20	10	0	10	0	10
17	8	4	12	20	9	0	10	0	10
18	8	4	12	20	10	0	10	0	10
19	8	4	12	20	9	0	10	0	10
20	8	4	12	20	9	0	10	0	10
21	7	4	11	20	9	0	9	0	9
22	7	4	11	20	9	0	10	0	10
23	7	4	11	20	9	0	10	0	10
24	7	3	10	20	9	0	10	0	10
25	7	4	10	20	11	0	11	0	11
26	7	4	10	20	9	0	10	0	10
27	7	3	10	20	9	0	10	0	10
28	7	3	10	20	9	0	9	0	9
29	7	3	10	20	9	0	9	0	9
30	7	3	10	20	8	0	9	0	9
31	6	3	10	20	8	0	8	0	8
Totals	348	133	481	620	400	0	427	1	428

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated Fishway flow meter malfunction. Discharge calculated using Fishway stage height equation.

VRNMO Weir impacted by sediment. Discharge estimated as Fishway flow + Auxiliary Pipe flow

Ventura River Flow Assessment

Reporting Year 2020 - 2021

Aug-20	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
1	6	3	9		20	7	0	8	0	8
2	6	3	9		20	7	0	8	0	8
3	5	3	9		20	6	0	7	0	7
4	5	3	8		20	6	0	7	0	7
5	5	3	8		20	6	0	7	0	7
6	5	3	8		20	6	0	8	0	8
7	5	3	8		20	6	0	8	0	8
8	5	3	8		20	5	0	8	0	8
9	5	3	8		20	5	0	8	0	8
10	5	3	7		20	5	0	6	0	6
11	4	3	7		20	5	0	4	0	4
12	4	3	7		20	5	0	4	0	4
13	4	3	7		20	5	0	4	0	4
14	4	3	7		20	5	0	4	0	4
15	4	3	6		20	4	0	3	0	3
16	4	3	6		20	4	0	3	0	3
17	4	3	6		20	4	0	3	0	3
18	4	3	6		20	4	0	3	0	3
19	4	3	6		20	3	0	3	0	3
20	3	3	6		20	3	0	2	0	2
21	3	3	6		20	3	0	2	0	2
22	3	3	6		20	3	0	3	0	3
23	4	3	6		20	4	0	3	0	3
24	4	3	6		20	4	0	3	0	3
25	4	3	6		20	4	0	3	0	3
26	3	3	6		20	3	0	3	0	3
27	3	3	6		20	3	0	2	0	2
28	3	3	6		20	3	0	2	0	2
29	3	3	6		20	3	0	2	0	2
30	4	3	6		20	3	0	3	0	3
31	4	3	6		20	3	0	3	0	3
Totals	126	88	214		620	136	0	139	0	139

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

Discharge Estimated

Ventura River Flow Assessment
Reporting Year 2020 -2021

Sep-20	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
1	4	3	6		20	3	0	3	0	3
2	4	3	6		20	3	0	3	0	3
3	4	3	6		20	3	0	3	0	3
4	3	3	6		20	3	0	3	0	3
5	3	3	6		20	3	0	2	0	2
6	3	3	6		20	2	0	2	0	2
7	3	3	6		20	2	0	2	0	2
8	3	3	6		20	3	0	2	0	2
9	4	3	6		20	3	0	3	0	3
10	4	3	6		20	3	0	2	0	2
11	4	3	7		20	3	0	4	0	4
12	4	3	7		20	3	0	4	0	4
13	4	3	6		20	3	0	3	0	3
14	4	3	6		20	3	0	3	0	3
15	4	3	6		20	3	0	3	0	3
16	4	3	6		20	3	0	4	0	4
17	4	3	6		20	3	0	4	0	4
18	3	3	6		20	3	0	3	0	3
19	3	3	7		20	3	0	3	0	3
20	3	3	6		20	3	0	3	0	3
21	4	3	6		20	3	0	4	0	4
22	4	3	7		20	3	0	4	0	4
23	3	3	7		20	3	0	4	0	4
24	3	3	7		20	3	0	4	0	4
25	3	4	7		20	3	0	4	0	4
26	3	4	7		20	3	0	4	0	4
27	4	4	7		20	3	0	4	0	4
28	3	4	7		20	3	0	3	0	3
29	3	4	7		20	3	0	2	0	2
30	3	4	7		20	3	0	2	0	2
Totals	103	88	191	0	600	84	0	92	0	92

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

Ventura River Flow Assessment
Reporting Year 2020 -2021

Oct-20	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
	Source Stream Mean Daily Flows					Robles Facility Mean Daily Flows				
1	M	M	TBD		20	2	0	2	0	2
2	M	M	TBD		20	2	0	2	0	2
3	M	M	TBD		20	2	0	2	0	2
4	M	M	TBD		20	2	0	3	0	3
5	M	M	TBD		20	2	0	3	0	3
6	M	M	TBD		20	2	0	2	0	2
7	M	M	TBD		20	2	0	1	0	1
8	M	M	TBD		20	2	0	2	0	2
9	M	M	TBD		20	3	0	2	0	2
10	M	M	TBD		20	3	0	3	0	3
11	M	M	TBD		20	1	0	3	0	3
12	M	M	TBD		20	0	0	3	0	3
13	M	M	TBD		20	0	0	2	0	2
14	M	M	TBD		20	0	0	2	0	2
15	M	M	TBD		20	0	0	2	0	2
16	M	M	TBD		20	0	0	1	0	1
17	M	M	TBD		20	0	0	1	0	1
18	M	M	TBD		20	0	0	2	0	2
19	M	M	TBD		20	0	0	2	0	2
20	M	M	TBD		20	0	0	2	0	2
21	M	M	TBD		20	0	0	2	0	2
22	M	M	TBD		20	0	0	2	0	2
23	M	M	TBD		20	0	0	2	0	2
24	M	M	TBD		20	0	0	3	0	3
25	M	M	TBD		20	0	0	3	0	3
26	M	M	TBD		20	0	0	3	0	3
27	M	M	TBD		20	0	0	3	0	3
28	M	M	TBD		20	0	0	3	0	3
29	M	M	TBD		20	0	0	3	0	3
30	M	M	TBD		20	0	0	3	0	3
31	M	M	TBD		20	0	0	3	0	3
Totals	0	0	0		620	25	0	70	0	70

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment
Reporting Year 2020 -2021

Nov-20	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
	Source Stream Mean Daily Flows					Robles Facility Mean Daily Flows				
1	M	M	TBD		20	0	0	3	0	3
2	M	M	TBD		20	0	0	3	0	3
3	M	M	TBD		20	0	0	3	0	3
4	M	M	TBD		20	0	0	3	0	3
5	M	M	TBD		20	2	0	2	0	2
6	M	M	TBD		20	4	0	2	0	2
7	M	M	TBD		20	4	0	3	0	3
8	M	M	TBD		20	4	0	3	0	3
9	M	M	TBD		20	5	0	3	0	3
10	M	M	TBD		20	5	0	4	0	4
11	M	M	TBD		20	5	0	4	0	4
12	M	M	TBD		20	5	0	4	0	4
13	M	M	TBD		20	5	0	4	0	4
14	M	M	TBD		20	5	0	3	0	3
15	M	M	TBD		20	4	0	3	0	3
16	M	M	TBD		20	4	0	3	0	3
17	M	M	TBD		20	4	0	3	0	3
18	M	M	TBD		20	4	0	3	0	3
19	M	M	TBD		20	4	0	3	0	3
20	M	M	TBD		20	4	0	3	0	3
21	M	M	TBD		20	4	0	3	0	3
22	M	M	TBD		20	4	0	3	0	3
23	M	M	TBD		20	4	0	3	0	3
24	M	M	TBD		20	5	0	3	0	3
25	M	M	TBD		20	5	0	4	0	4
26	M	M	TBD		20	5	0	4	0	4
27	M	M	TBD		20	5	0	4	0	4
28	M	M	TBD		20	5	0	4	0	4
29	M	M	TBD		20	5	0	4	0	4
30	M	M	TBD		20	5	0	4	0	4
Totals	0	0	0		600	114	0	98	0	98

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment
Reporting Year 2020 -2021

Dec-20	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
	Source Stream Mean Daily Flows					Robles Facility Mean Daily Flows				
1	M	M	TBD		20	5	0	4	0	4
2	M	M	TBD		20	5	0	3	0	3
3	M	M	TBD		20	4	0	3	0	3
4	M	*M*	TBD		20	5	0	3	0	3
5	M	*M*	TBD		20	5	0	3	0	3
6	M	M	TBD		20	5	0	3	0	3
7	M	M	TBD		20	4	0	3	0	3
8	M	M	TBD		20	4	0	3	0	3
9	M	M	TBD		20	5	0	3	0	3
10	M	M	TBD		20	5	0	3	0	3
11	M	M	TBD		20	5	0	4	0	4
12	M	M	TBD		20	5	0	4	0	4
13	M	M	TBD		20	5	0	4	0	4
14	M	M	TBD		20	5	0	4	0	4
15	M	M	TBD		20	5	0	4	0	4
16	M	M	TBD		20	5	0	4	0	4
17	M	M	TBD		20	5	0	4	0	4
18	M	M	TBD		20	5	0	4	0	4
19	M	M	TBD		20	5	0	4	0	4
20	M	M	TBD		20	5	0	4	0	4
21	M	M	TBD		20	5	0	4	0	4
22	M	M	TBD		20	5	0	4	0	4
23	M	M	TBD		20	5	0	4	0	4
24	M	M	TBD		20	5	0	3	0	3
25	M	M	TBD		20	5	0	4	0	4
26	M	M	TBD		20	5	0	4	0	4
27	M	M	TBD		20	5	0	4	0	4
28	M	*M*	TBD		20	13	0	12	0	12
29	M	*M*	TBD		20	11	0	9	0	9
30	M	*M*	TBD		20	8	0	7	0	7
31	M	*M*	TBD		20	7	0	6	0	6
Totals	0	0	0		620	164	0	131	0	131

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment

Reporting Year 2020 -2021

	(1)	(2)	(1) + (2)			(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				B.O.	**Robles Facility Mean Daily Flows**				
Jan-21	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Required Flow Release (cfs)	Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	M	*M*	TBD		20	7	0	6	0	6
2	M	*M*	TBD		20	7	0	6	0	6
3	M	*M*	TBD		20	7	0	5	0	5
4	M	*M*	TBD		20	7	0	5	0	5
5	M	*M*	TBD		20	7	0	5	0	5
6	M	*M*	TBD		20	7	0	5	0	5
7	M	M	TBD		20	7	0	5	0	5
8	M	M	TBD		20	6	0	5	0	5
9	M	M	TBD		20	6	0	5	0	5
10	M	M	TBD		20	6	0	5	0	5
11	M	M	TBD		20	6	0	5	0	5
12	M	M	TBD		20	6	0	5	0	5
13	M	M	TBD		20	6	0	5	0	5
14	M	M	TBD		20	6	0	5	0	5
15	M	M	TBD		20	6	0	4	0	4
16	M	M	TBD		20	6	0	4	0	4
17	M	M	TBD		20	6	0	4	0	4
18	M	*M*	TBD		20	6	0	4	0	4
19	M	*M*	TBD		20	5	0	4	0	4
20	M	*M*	TBD		20	5	0	4	0	4
21	M	*M*	TBD		20	6	0	4	0	4
22	M	*M*	TBD		20	6	0	4	0	4
23	M	*M*	TBD		20	6	0	5	0	5
24	M	*M*	TBD		20	7	0	5	0	5
25	M	*M*	TBD		20	6	0	5	0	5
26	M	*M*	TBD		20	6	0	4	0	4
27	M	*M*	TBD		20	9	0	7	0	7
28	M	*M*	TBD		20	18	0	16	0	16
29	M	*M*	TBD		20	24	0	23	13	36
30	M	*M*	TBD		20	22	0	20	3	23
31	M	*M*	TBD		20	20	0	18	0	18
Totals	0	0	0		620	254	0	208	16	223

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment
Reporting Year 2020 -2021

	(1)	(2)	(1) + (2)			(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				B.O.	Robles Facility Mean Daily Flows				
Feb-21	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Required Flow Release (cfs)	Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	M	*M*	TBD		20	17	0	15	0	15
2	M	*M*	TBD		20	14	0	13	0	13
3	M	*M*	TBD		20	14	0	12	0	12
4	M	*M*	TBD		20	14	0	12	1	14
5	M	*M*	TBD		20	13	0	11	0	11
6	M	*M*	TBD		20	13	0	11	0	11
7	M	*M*	TBD		20	12	0	11	0	11
8	M	*M*	TBD		20	12	0	10	0	10
9	M	*M*	TBD		20	11	0	10	0	10
10	M	*M*	TBD		20	11	0	10	0	10
11	M	*M*	TBD		20	11	0	9	0	9
12	M	*M*	TBD		20	11	0	9	0	9
13	M	*M*	TBD		20	10	0	9	0	9
14	M	*M*	TBD		20	10	0	9	0	9
15	M	*M*	TBD		20	10	0	9	0	9
16	M	*M*	TBD		20	10	0	9	0	9
17	M	*M*	TBD		20	9	0	8	0	8
18	M	*M*	TBD		20	9	0	8	0	8
19	M	*M*	TBD		20	9	0	8	0	8
20	M	*M*	TBD		20	9	0	8	0	8
21	M	M	TBD		20	9	0	7	0	7
22	M	M	TBD		20	9	0	8	0	8
23	M	M	TBD		20	9	0	8	0	8
24	M	M	TBD		20	9	0	7	0	7
25	M	M	TBD		20	8	0	7	0	7
26	M	M	TBD		20	8	0	7	0	7
27	M	M	TBD		20	8	0	7	0	7
28	M	M	TBD		20	7	0	7	0	7
Totals	0	0	0		560	296	0	258	1	260

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment

Reporting Year 2020 -2021

	(1)	(2)	(1) + (2)			(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				B.O.	**Robles Facility Mean Daily Flows**				
Mar-21	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Required Flow Release (cfs)	Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	M	M	TBD		20	8	0	7	0	7
2	M	M	TBD		20	8	0	7	0	7
3	M	M	TBD		20	8	0	7	0	7
4	M	M	TBD		20	8	0	7	0	7
5	M	M	TBD		20	8	0	7	0	7
6	M	M	TBD		20	8	0	7	0	7
7	M	M	TBD		20	8	0	7	0	7
8	M	M	TBD		20	7	0	7	0	7
9	M	M	TBD		20	7	0	6	0	6
10	M	M	TBD		20	10	0	10	0	10
11	M	M	TBD		20	11	0	10	0	10
12	M	M	TBD		20	10	0	9	0	9
13	M	M	TBD		20	9	0	8	0	8
14	M	M	TBD		20	9	0	8	0	8
15	M	M	TBD		20	9	0	9	0	9
16	M	M	TBD		20	8	0	8	0	8
17	M	*M*	TBD		20	8	0	8	0	8
18	M	*M*	TBD		20	8	0	7	0	7
19	M	*M*	TBD		20	8	0	7	0	7
20	M	M	TBD		20	8	0	7	0	7
21	M	M	TBD		20	7	0	7	0	7
22	M	M	TBD		20	7	0	6	0	6
23	M	M	TBD		20	7	0	6	0	6
24	M	M	TBD		20	7	0	5	0	5
25	M	M	TBD		20	7	0	6	0	6
26	M	M	TBD		20	8	0	7	0	7
27	M	M	TBD		20	7	0	6	0	6
28	M	M	TBD		20	6	0	6	0	6
29	M	M	TBD		20	6	0	5	0	5
30	M	M	TBD		20	5	0	5	0	5
31	M	M	TBD		20	5	0	4	0	4
Totals	0	0	0		620	240	0	214	0	214

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow Assessment
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Apr-21	(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) Auxiliary Pipe (cfs)	(5) VRNMO Weir (cfs)	(6) Diversion Canal (cfs)	(5) + (6) Total Inflow (cfs)
	Source Stream Mean Daily Flows					Robles Facility Mean Daily Flows				
1	M	M	TBD		20	5	0	4	0	4
2	M	M	TBD		20	4	0	4	0	4
3	M	M	TBD		20	4	0	4	0	4
4	M	M	TBD		20	4	0	4	0	4
5	M	M	TBD		20	4	0	4	0	4
6	M	*M*	TBD		20	4	0	4	0	4
7	M	*M*	TBD		20	4	0	4	0	4
8	M	M	TBD		20	5	0	4	0	4
9	M	M	TBD		20	4	0	4	0	4
10	M	M	TBD		20	3	0	3	0	3
11	M	*M*	TBD		20	3	0	3	0	3
12	M	*M*	TBD		20	3	0	3	0	3
13	M	*M*	TBD		20	4	0	4	0	4
14	M	*M*	TBD		20	4	0	4	0	4
15	M	*M*	TBD		20	4	0	3	0	3
16	M	*M*	TBD		20	3	0	3	0	3
17	M	*M*	TBD		20	3	0	3	0	3
18	M	*M*	TBD		20	3	0	3	0	3
19	M	*M*	TBD		20	2	0	2	0	2
20	M	*M*	TBD		20	3	0	2	0	2
21	M	*M*	TBD		20	3	0	2	0	2
22	M	*M*	TBD		20	3	0	3	0	3
23	M	*M*	TBD		20	3	0	3	0	3
24	M	*M*	TBD		20	3	0	3	0	3
25	M	*M*	TBD		20	3	0	3	0	3
26	M	*M*	TBD		20	3	0	3	0	3
27	M	*M*	TBD		20	3	0	3	0	3
28	M	*M*	TBD		20	3	0	3	0	3
29	M	*M*	TBD		20	2	0	2	0	2
30	M	*M*	TBD		20	2	0	2	0	2
Totals	0	0	0		600	103	0	95	0	95

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

Ventura River Flow
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Year 2020 -2021

	(1)	(2)	(1) + (2)			(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				B.O.	**Robles Facility Mean Daily Flows**				
May-21	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Required Flow Release (cfs)	Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)	Diversion Canal (cfs)	Total Inflow (cfs)
1	M	*M*	TBD		20	2	0	1	0	1
2	M	*M*	TBD		20	2	0	2	0	2
3	M	*M*	TBD		20	2	0	2	0	2
4	M	*M*	TBD		20	2	0	1	0	1
5	M	*M*	TBD		20	2	0	1	0	1
6	M	*M*	TBD		20	2	0	1	0	1
7	M	*M*	TBD		20	2	0	1	0	1
8	M	M	TBD		20	2	0	2	0	2
9	M	M	TBD		20	2	0	2	0	2
10	M	M	TBD		20	2	0	1	0	1
11	M	M	TBD		20	2	0	2	0	2
12	M	M	TBD		20	2	0	1	0	1
13	M	M	TBD		20	2	0	1	0	1
14	M	M	TBD		20	2	0	1	0	1
15	M	M	TBD		20	2	0	1	0	1
16	M	M	TBD		20	2	0	2	0	2
17	M	M	TBD		20	2	0	2	0	2
18	M	M	TBD		20	2	0	1	0	1
19	M	M	TBD		20	2	0	1	0	1
20	M	M	TBD		20	2	0	1	0	1
21	M	M	TBD		20	1	0	1	0	1
22	M	M	TBD		20	1	0	1	0	1
23	M	M	TBD		20	2	0	1	0	1
24	M	M	TBD		20	1	0	1	0	1
25	M	M	TBD		20	0	0	1	0	1
26	M	*M*	TBD		20	0	0	1	0	1
27	M	*M*	TBD		20	0	0	1	0	1
28	M	*M*	TBD		20	0	0	1	0	1
29	M	*M*	TBD		20	0	0	1	0	1
30	M	*M*	TBD		20	0	0	1	0	1
31	M	*M*	TBD		20	0	0	1	0	1
Totals	0	0	0		620	45	0	38	0	38

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined

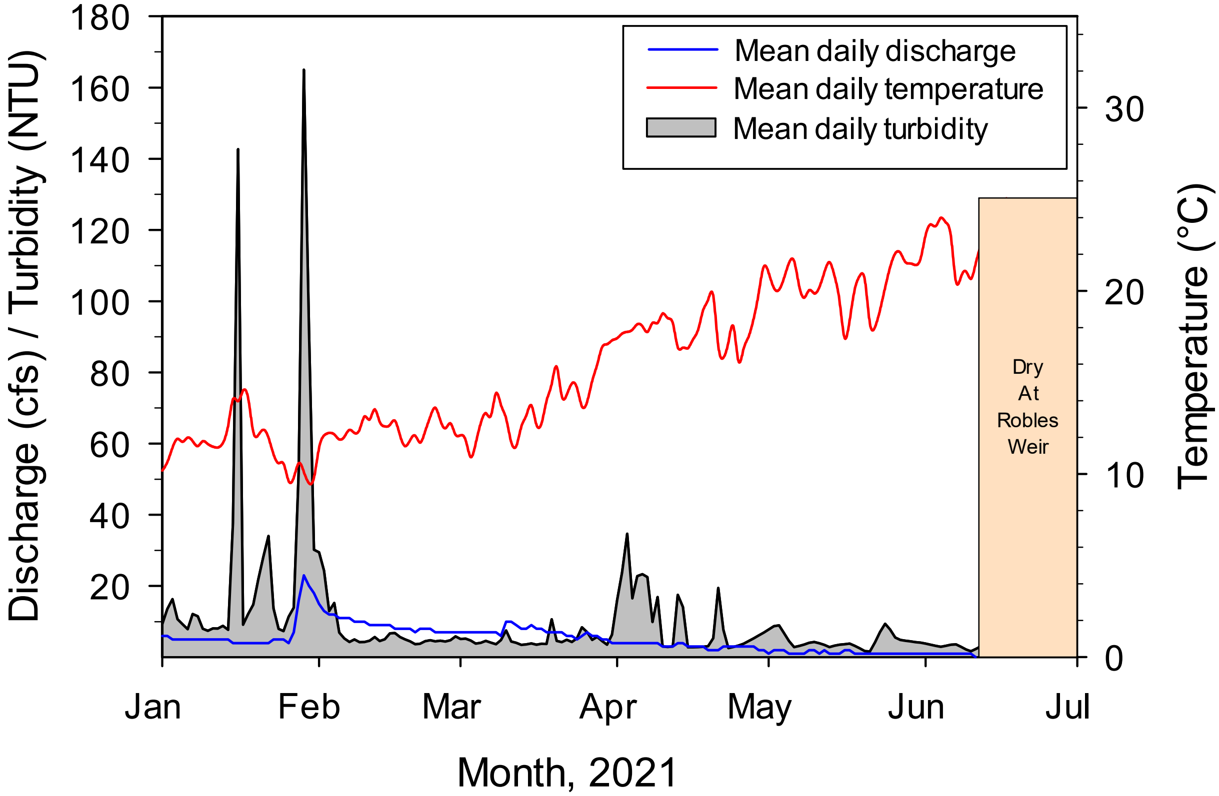
Ventura River Flow Assessment

Reporting Year 2020 -2021

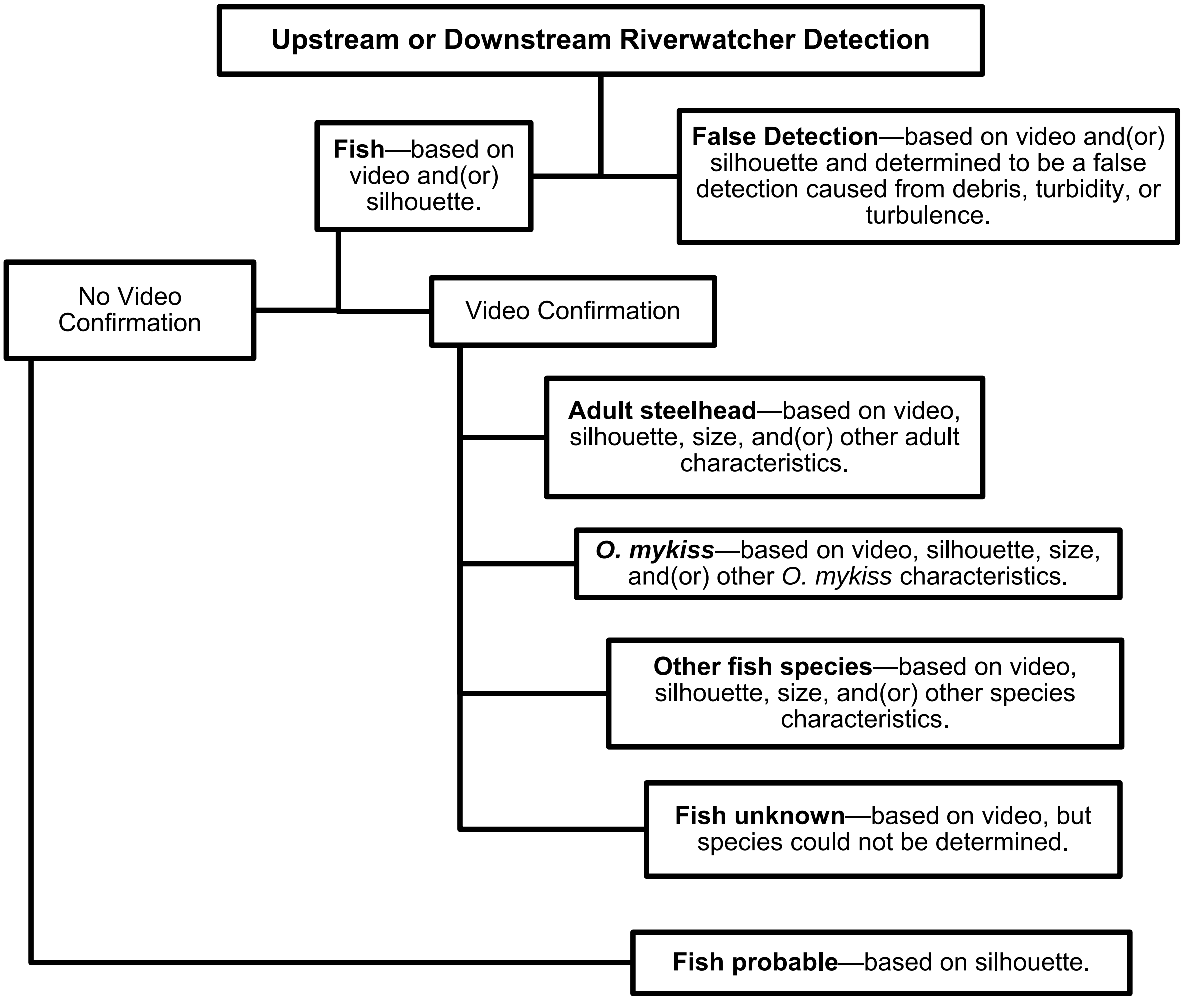
	(1)	(2)	(1) + (2)			(3)	(4)	(5)	(6)	(5) + (6)
	Source Stream Mean Daily Flows				B.O.	**Robles Facility Mean Daily Flows**				
Jun-21	Matilija Ck D/S Dam* (cfs)	North Fork Matilija Ck.* (cfs)	Sum of Creek Flows (cfs)		Required Flow Release (cfs)	Fishway Ladder (cfs)	Auxiliary Pipe (cfs)	VRNMO Weir (cfs)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

*Flow data from Matilija Ck and North Fork Matilija Ck are preliminary and subject to change (VCWPD). Discharge Estimated

M=Missing TBD=To be determined



Appendix 8. Mean daily discharge, water temperature, and turbidity at the Robles Fish Facility during the 2021 fish passage season.



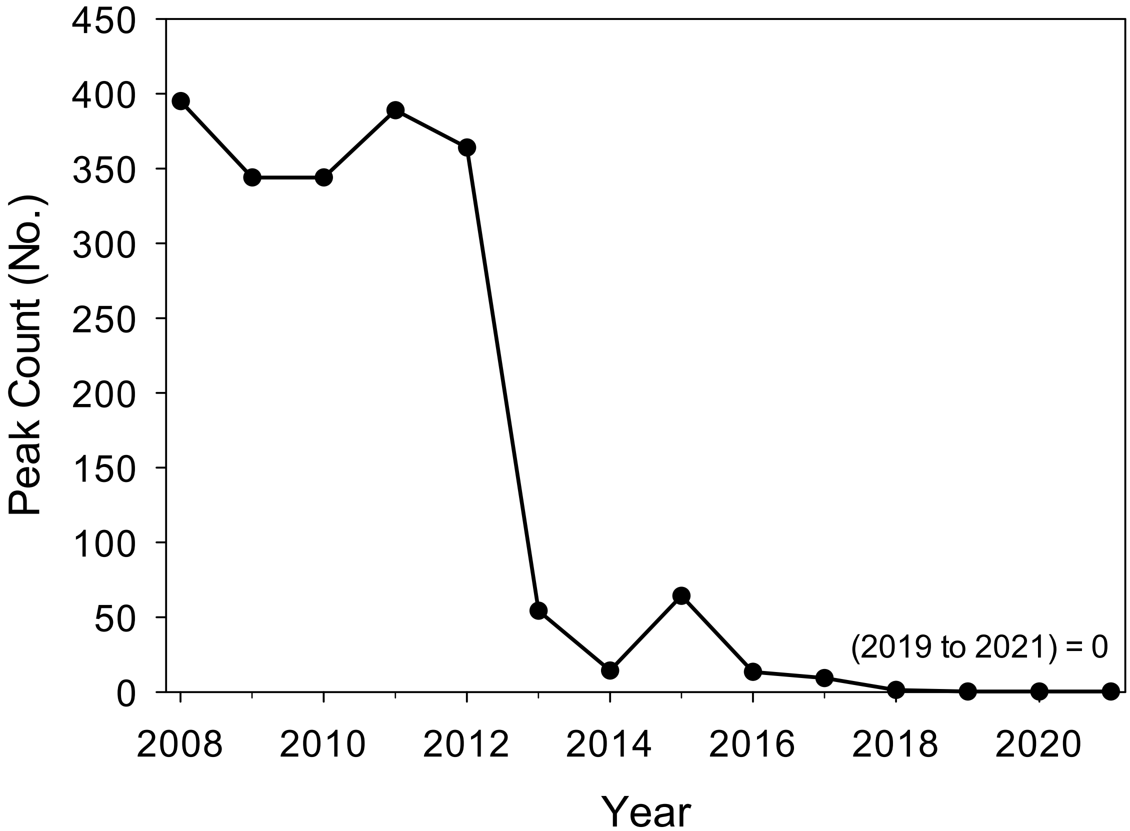
Appendix 9. Riverwatcher detection classification flow chart that outlines the pathways for upstream and downstream detections.

Appendix 10. Summary of Riverwatcher detections classified as fish probable and *O. mykiss* for the 2021 fish passage season.

	Upstream	Downstream
O. mykiss	0	1
Fish, non *O. mykiss*	12	9
Fish, unknown	0	0
Fish, probable	0	0
False detections	360	228
Total	372	238
Mean date - *O. mykiss*	n/a	03/10/21
Mean date - fish, non *O. mykiss*	03/25/21	04/16/21
Mean date - fish, unknown	n/a	n/a
Mean date - fish, probable	n/a	n/a
Mean time - *O. mykiss* (24h)	n/a	14:57
Mean time - fish, non *O. mykiss* (24h)	15:47	15:56
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	26.7
Mean length - fish, non *O. mykiss* (cm)	41.8	40.9
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	13
Mean daily temperature - fish, non *O. mykiss* (°C)	17.1	19.3
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	7.5
Mean daily turbidity - fish, non *O. mykiss* (NTU)	4.8	4.9
Mean daily turbidity - fish, unknown (NTU)	n/a	n/a
Mean daily turbidity - fish, probable (NTU)	n/a	n/a
Mean daily turbidity - false detections (NTU)	82	59
Mean daily discharge - *O. mykiss* (cfs)	n/a	10.0
Mean daily discharge - fish, non O. *mykiss* (cfs)	5.3	2.8
Mean daily discharge - fish, unknown (cfs)	n/a	n/a
Mean daily discharge - fish, probable (cfs)	n/a	n/a
Mean daily discharge - false detections (cfs)	16.4	12.9

Appendix 11. *O. mykiss* relative abundance survey index sites in the Ventura Basin.

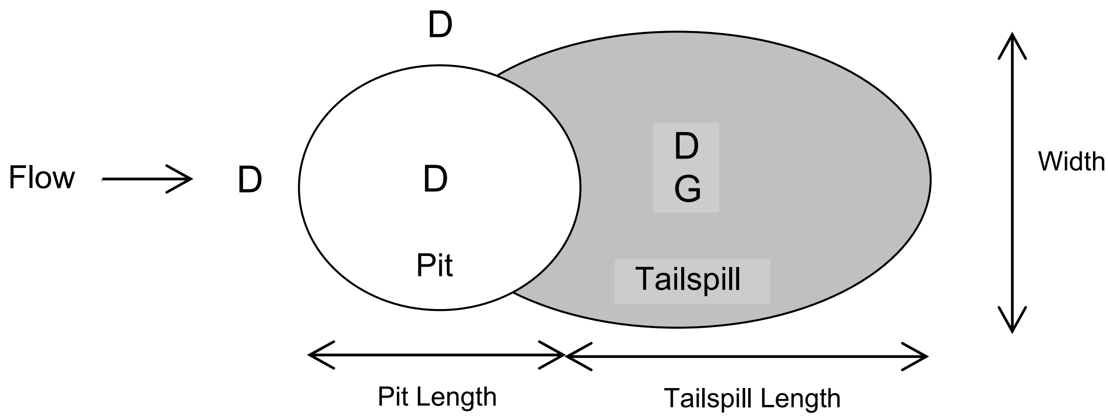
Site No.	Location	River km	Site	Lat.	Long.	Length (m)	Width (m)
1	Ventura River	0.9	Main Street pool	34.28126	-119.30887	25.1	10.0
		0.9	Main Street riffle	34.28164	-119.30893	34.0	8.0
2	Ventura River	9.4	Foster Park pool 1	34.35236	-119.30790	25.0	15.4
		10.0	Foster Park pool 2	34.35508	-119.30988	46.0	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



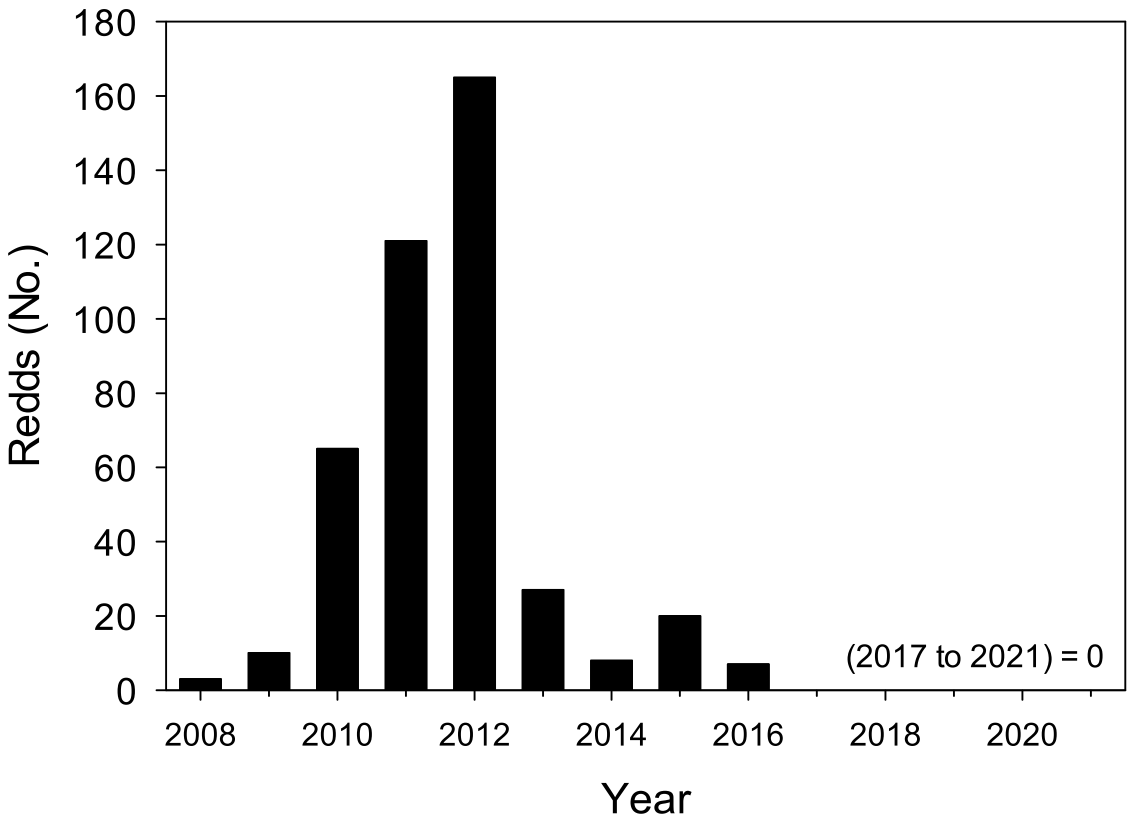
Appendix 12. Peak snorkel counts of *O. mykiss* during the period 2008-2021 at survey index sites in the Ventura Basin.

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 Matilija 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.



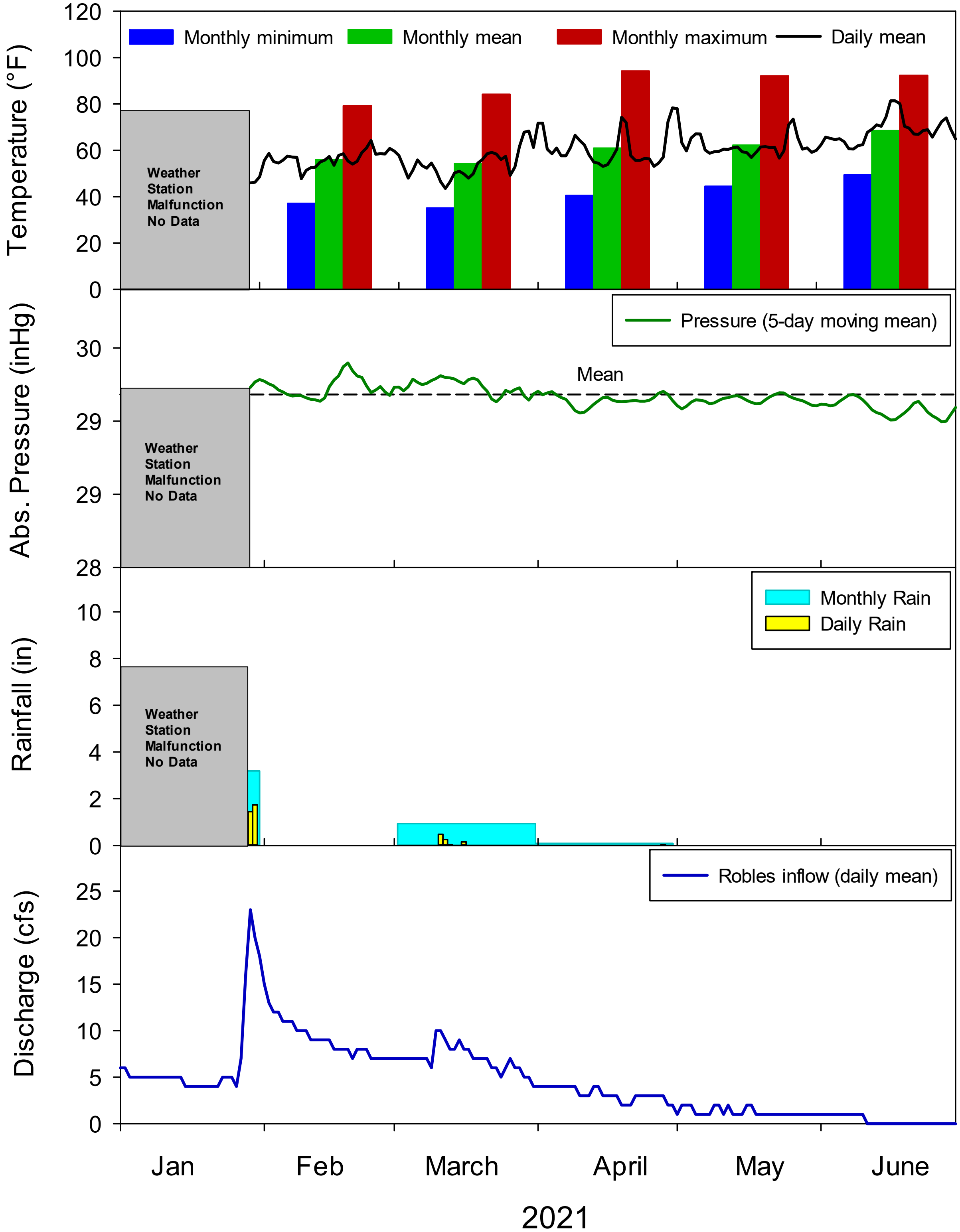
Appendix 15. Total number of *O. mykiss* redds counted at index spawning sites from 2008 through 2021 spawning years.

Appendix 16. Water quality monitoring sites and sampling summary.

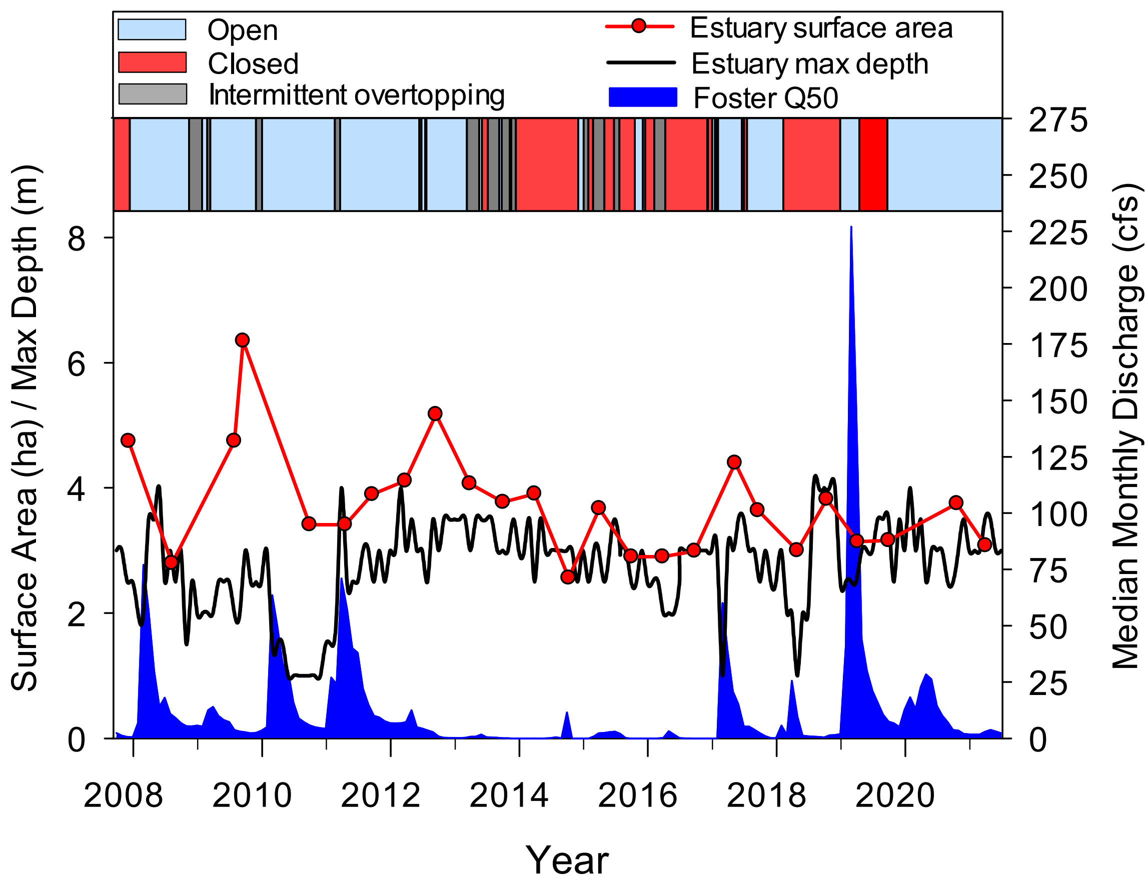
Site Number	Site Description	Site Location[a]	Sampling Method[b]	Sampling Type[c]	Frequency
1	Estuary	V 0.3 km	Multiparameter	Grab profile	Monthly
2	Main St. Bridge	V 1.0 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
3	Foster Park	V 9.7 km	Temperature Multiparameter	Continuous Grab	30 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.

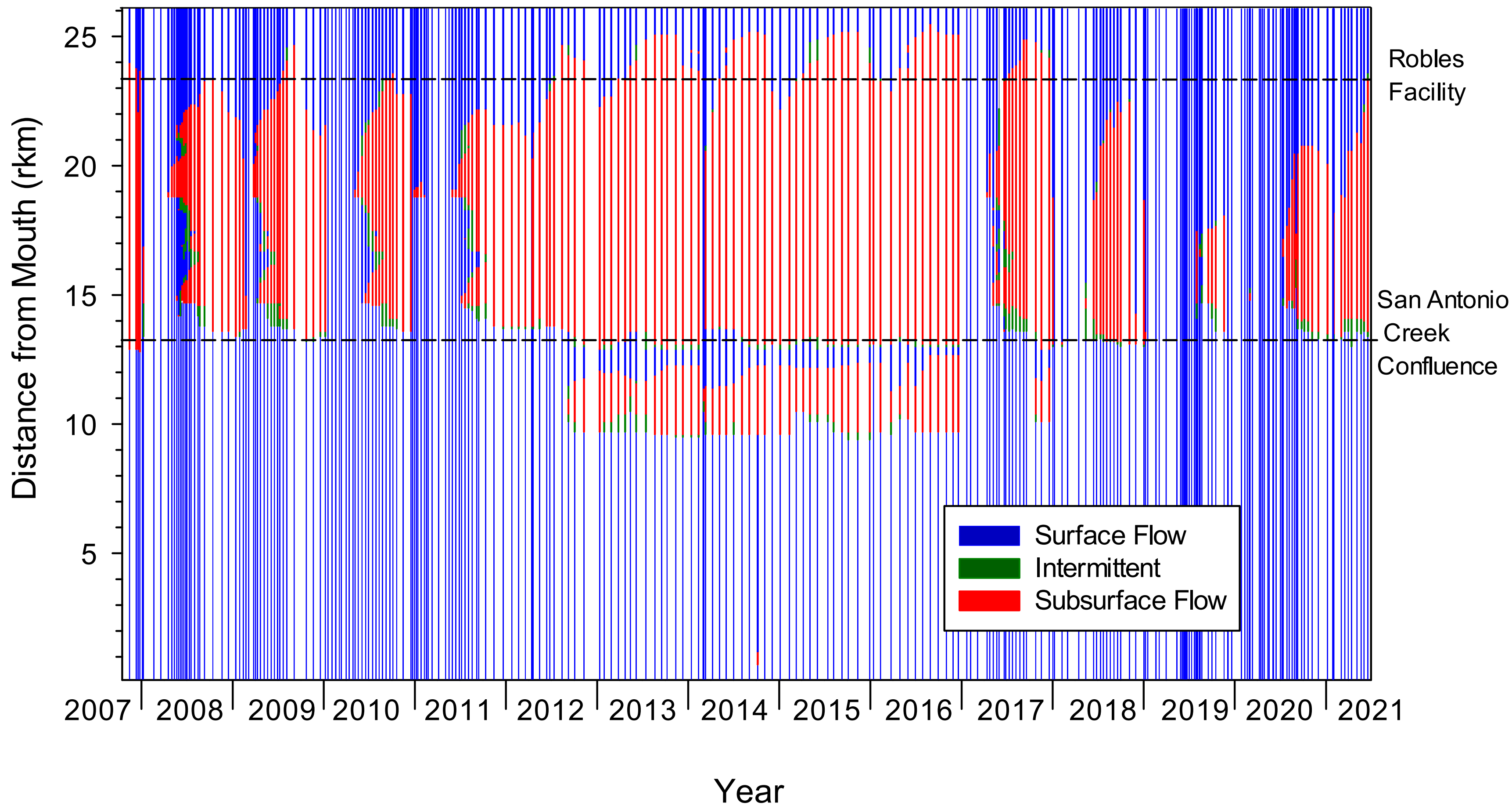
[b]Temperature data were collected using programmable loggers. Multiparameter water quality probe was used to collected water quality data including: temperature, dissolved oxygen, conductivity, salinity, pH, turbidity (separate meter). Turbidity data was collected using a programmable logger.



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 from 2008 to 2021.

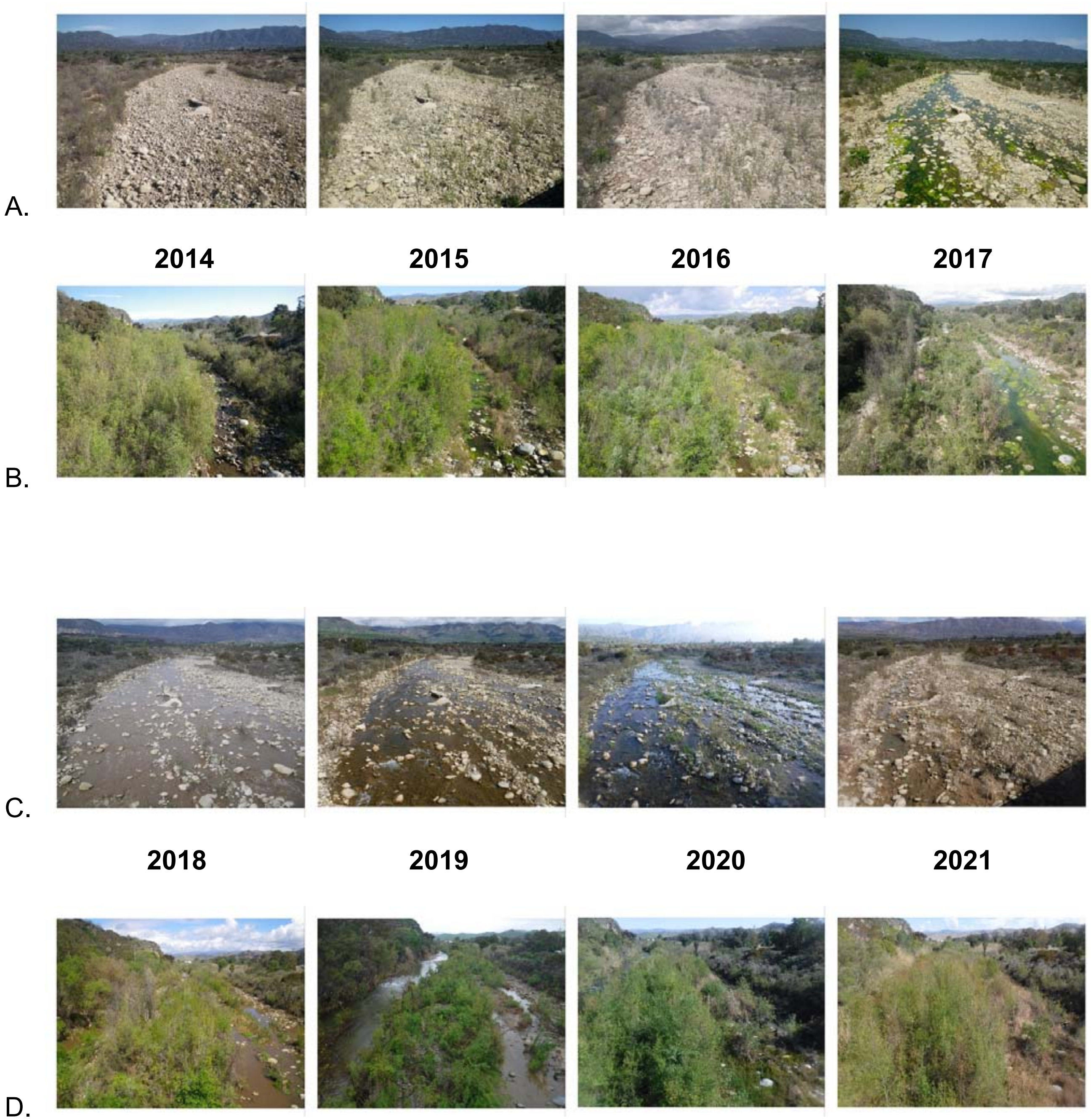


Appendix 19. Ventura River channel surface flow status for the lower 26 km from 2007 to 2021.

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.