WY2016 ANNUAL MONITORING SUMMARY

For:

THE BIOLOGICAL OPINION FOR THE OPERATION AND MAINTENANCE OF THE CACHUMA PROJECT ON THE SANTA YNEZ RIVER IN SANTA BARBARA COUNTY, CALIFORNIA

Drying habitat in the Hwy 154 Reach on 6/2/16

Prepared by:

CACHUMA OPERATION AND MAINTENANCE BOARD

FISHERIES DIVISION

CONSISTENT WITH REQUIREMENTS SET FORTH IN THE 2000 CACHUMA PROJECT BIOLOGICAL OPINION

APRIL 22, 2019

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Executive Summary

The WY2016 Annual Monitoring Summary (AMS) presents the data and summarizes the results of monitoring Southern California steelhead/rainbow trout (*Oncorhynchus mykiss, O. mykiss*) and water quality conditions in the Lower Santa Ynez River (LSYR) below Bradbury Dam during Water Year 2016 (WY2016, 10/1/15 – 9/30/16). Although the report was finalized in 2019, the monitoring data are from WY2016. This report also incorporates historical context of the water year type since WY2000, advancements of identified tributary restoration projects, and recommendations for the next water year's monitoring efforts.

The monitoring tasks completed in WY2016 were performed below Bradbury Dam in the LSYR watershed and in Lake Cachuma, which is approximately half the drainage area (450 square miles) and stream distance (48 miles) to the ocean compared to the entire watershed. The area is within the Southern California Steelhead Distinct Population Segment (DPS) and the Monte Arido Highland Biogeographic Population Group (BPG) in the Southern Steelhead Recovery Planning Area (NMFS, 2012). Monitoring focused on three management reaches (Highway 154, Refugio, and Alisal reaches) and the Cadwell Reach on the LSYR mainstem, and tributaries (Hilton, Quiota, El Jaro, and Salsipuedes creeks) known to support suitable habitat for *O. mykiss* (Figure ES-1).

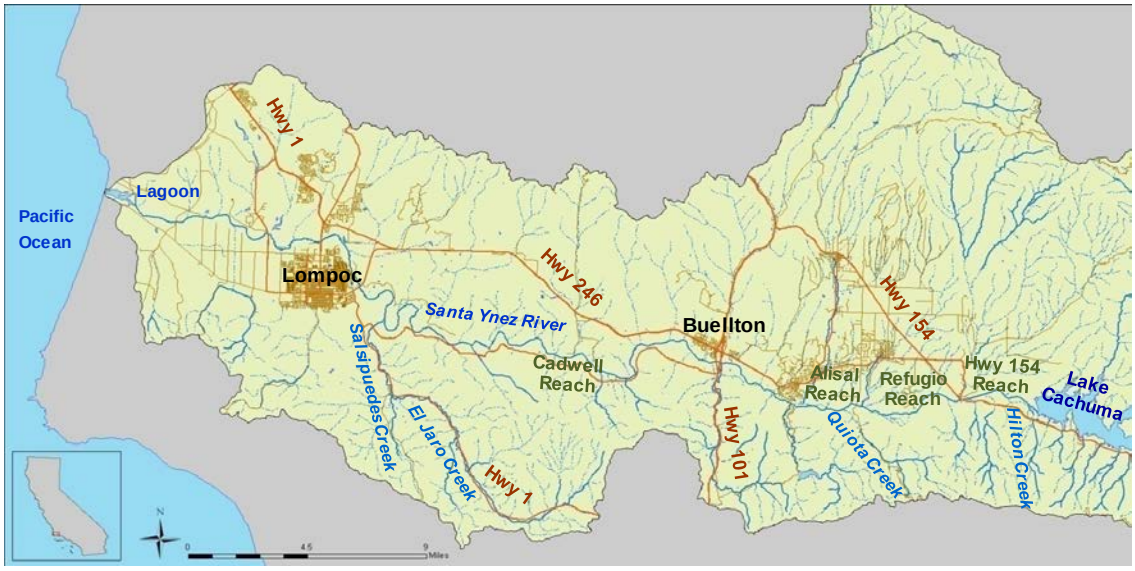

Figure ES-1: LSYR from Bradbury Dam and Lake Cachuma to the Pacific Ocean west of Lompoc, showing tributary creeks and management reaches of interest for the LSYR Fish Monitoring Program.

This report summarizes data gathered since the WY2015 Annual Monitoring Summary (COMB, 2018b) and fulfills the annual 2016 reporting requirements of the Cachuma Project Biological Opinion (BiOp). The BiOp was issued by the National Marine Fisheries Service (NMFS) to U.S. Department of the Interior Bureau of Reclamation (USBR or Reclamation) in 2000 for the operation and maintenance of the Cachuma Project (NMFS, 2000). This report was prepared by the Cachuma Operation and

Maintenance Board (COMB) Fisheries Division (FD) with the monitoring and data analyses prepared by COMB-FD staff. In WY2016, some deviations to the monitoring program as described in the BiOp (NMFS, 2000), Biological Assessment (BA) (USBR, 2000), LSYR Fish Management Plan (FMP) (SYRTAC, 2000) and prior Annual Monitoring Reports/Summaries were necessary, specifically in relation to water quality monitoring, redd surveys, and migrant trapping. The modifications were required due to landowner access constraints, drought-related (specifically reaching critical drought) conditions, or program evolution from acquired field knowledge. A shortened version of this report, the WY2016 Annual Monitoring Report (AMR) is prepared by COMB-FD and provided by Reclamation to NMFS for compliance reporting established in the 2000 BiOp.

This report is organized into five sections: (1) introduction, (2) background information, (3) monitoring results for water quality and fisheries observations, (4) discussion, and (5) conclusions with recommendations. The appendices contain (A) a list of acronyms and abbreviations used in the report, (B) quality assurance and control procedures, (C) a list of photo points, and (D) a list of reports generated during the year in support of the fisheries program and for BiOp compliance.

WY2016 was a dry year (11.45 inches of precipitation measured at Bradbury Dam; long-term average, 1953-2016, is 19.91 inches) with the highest amount of rainfall occurring in January. This was the fifteenth driest year over the period of record with 2007 being the driest at 7.41 inches of rain at Bradbury Dam. The largest storm of WY2016 (1.9 inches of rain) occurred on 1/5/16. The LSYR lagoon was never opened to the ocean during the water year. Bradbury Dam did not spill during the water year. Since it was the fifth year after a spill (WY2011) and reservoir storage was less than 120,000 acre-feet (af) at the beginning of the water year (32,989 af on 10/1/15), target flows for rearing were maintained at Hilton Creek (2 cubic feet per second (cfs) minimum) and the Highway (Hwy) 154 Bridge (2.5 cfs minimum) until critical drought conditions were determined in July and water deliveries to Hilton Creek were less than 30 af of water per month with no target flows to the Highway 154 Bridge and Alisal Bridge as described in the BiOp. There was no fish passage supplementation because the minimum criteria for a wetted watershed were not met. A Water Rights (WR) 89-18 release was conducted from 7/12/16 until 8/29/16 during which 11,620 af of water was released over a period of 49 days.

Due to critical drought conditions, the reach of Hilton Creek from the Upper Release Point (URP) to the Lower Release Point (LRP) was dewatered and all fish needed to be rescued and relocated downstream. 247 *O. mykiss* and 7 sculpin were rescued and relocated and there were 11 *O. mykiss* and 5 sculpin mortalities.

Stream water quality data (temperature and dissolved oxygen concentration) are presented for the LSYR mainstem below Bradbury Dam and its tributaries where *O. mykiss* historically have been observed. Given the complexity of the dataset, details are summarized in the Monitoring Results Section (3.2) only when there were observations of note, such as the presence of native and non-native fish species.

Since the issuance of the BiOp in 2000, Reclamation with assistance from COMB, has completed many conservation actions for the benefit of southern steelhead including: the construction and operation of the HCWS; the completion of tributary passage enhancement projects on Hilton, Quiota, El Jaro, and Salsipuedes creeks; the completion of the bank stabilization and erosion control projects on El Jaro Creek; water releases to maintain the LSYR mainstem and Hilton Creek flow targets; and the implementation and management of the Fish Passage Supplementation Program. COMB was involved in the planning, design, permitting, and construction of all the tributary projects (except the HCWS and Cascade Chute Project in Hilton Creek) and was successful in acquiring grant funding for these project from state and federal programs. These funds were supplemented by funding from the Cachuma Member Units which allowed for the construction of 11 projects (by the end of WY2016) restoring access to the streams in the lower Santa Ynez River Watershed for steelhead. A description and photos of all habitat enhancement projects are presented in Section 4. The fish passage project at Quiota Creek Crossing 0A and Crossing 4 were successfully completed in WY2016. Plans have moved forward for the completion of another fish passage project on Quiota Creek for Crossing 5 to be built in WY2017.

The following are recommendations to improve the monitoring program from WY2016 onward and are not listed by priority; some are subject to funding availability:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000) and BiOp (NMFS, 2000) to evaluate *O. mykiss* and their habitat within the LSYR for long-term trend analyses and improve consistency of the monitoring effort for better year-to-year comparisons;
- Continue the collaboration with CDFW regarding operation of their Dual-Frequency Identification Sonar (DIDSON) in Salsipuedes Creek;
- Continue annual development and implementation of a Migrant Trapping Plan in collaboration with Reclamation that would be reviewed and approved by NMFS to assure compliance with take limits set forth in the 2000 BiOp;
- Conduct basic stomach content analyses of non-native piscivorous fish whenever possible (during migrant trapping, fish rescue, and stranding surveys), specifically in habitats known to support *O. mykiss* and non-native fish;
- Encourage Reclamation to improve their system operation for delivering lake water to Hilton Creek with one or a combination of the HCWS, HCEBS, Hilton Creek Tanks, and Stilling Basin submersible pumps to provide continuous flow to Hilton Creek without interruption;
- Collaborate with Reclamation regarding Critical Drought Conditions (i.e., flow adjustments to Hilton Creek and the LYSR mainstem, target flows, etc.) and downstream water releases for the fishery during drought conditions;
- Continue to maintain and develop landowner relationships in the LSYR basin to foster cooperation and gain access to reaches for all monitoring and restoration tasks;
- Continue efforts to remove fish passage impediments within the LSYR basin as listed in the proposed actions of the BiOp, utilizing grant funding wherever possible, specifically within the Quiota Creek watershed;

- Continue to maintain the LSYR *O. mykiss* scale inventory and conduct analyses of growth rates, evidence of life-history strategies such as fresh verses marine water rearing, signs of spawning, etc. in support of ongoing fisheries investigations;
- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships;
- Develop a more fluid data recording and reporting procedure in regards to temperature probes on the Outlet Works of Bradbury Dam in order to keep track of the temperature of the water being released into the Stilling Basin, specifically to document BiOp compliance (18 ^{o}C maximum release temperature);
- Continue to work closely with the Santa Ynez River Water Conservation District during WR 89-18 releases to conduct trapping to monitor *O. mykiss* movement and remove non-native fish moving with the release and out of the Stilling Basin at the very beginning of the release;
- Work with Reclamation to develop a Stilling Basin Dewatering and Fish Removal Plan that would further efforts initiated during this water year for non-native fish management downstream of Bradbury Dam;
- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin; and
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WY2016 Annual Monitoring Summary

1. Introduction

The 2000 Cachuma Project Biological Opinion (BiOp) requires the U. S. Department of the Interior Bureau of Reclamation (USBR or Reclamation) to provide an annual monitoring report to the National Marine Fisheries Service (NMFS) as stipulated in Reasonable and Prudent Measure (RPM) 11 and Term and Condition (T&C) 11.1 (NMFS, 2000) and further described in the Biological Assessment (BA) (USBR, 2000) and the Lower Santa Ynez River Fish Management Plan (FMP) (SYRTAC, 2000):

> ***RPM 11:*** "Reclamation shall provide NMFS with monitoring data and reports evaluating the effects of the proposed project on steelhead." *(Page 72)*
>
> ***T&C 11.1:*** "Monitoring of the Cachuma Project shall occur as described above and as described in the revised project description (USBR, 2000) under the direction of a qualified biologist. Reclamation shall provide NMFS with yearly reports (unless otherwise noted) that include the data taken each year and preliminary data analysis. Especially important for monitoring the effects of the Cachuma Project will be monitoring of: steelhead movement during migration supplementation, successful access, spawning, and rearing of steelhead in previously inaccessible and/or access restricted tributary habitat, and mainstem flow targets and the condition of steelhead in the mainstem." *(Page 79)*

The objective of this WY2016 Annual Monitoring Summary (AMS) is to present the monitoring data collected in Water Year 2016 (WY2016, 10/1/15-9/30/16) and to provide preliminary data analysis. Data collected on Southern California steelhead/rainbow trout (*Oncorhynchus mykiss* or *O. mykiss*) in the Lower Santa Ynez River (LSYR) below Bradbury Dam throughout WY2016 regarding (1) hydrologic condition, (2) water quality, (3) habitat quality, (4) migration, and (5) reproduction and rearing are analyzed and presented in this report. The biological monitoring program as outlined in the revised Section 3 of the Cachuma Project Biological Assessment (USBR, 2000) incorporates all elements within RPM 11 and T&C 11.1 of the BiOp and provides scientific data to conduct trend analyses over time in association with habitat and migration enhancement projects. Observations of population variations are presented in the 1993-2004 Synthesis Report (AMC, 2009), 2008 Annual Monitoring Report and Trend Analysis for 2005-2008 (USBR, 2011), 2009 Annual Monitoring Report (USBR, 2012), 2010 Annual Monitoring Report (USBR, 2013), 2011 Annual Monitoring Summary (COMB, 2013), 2012 Annual Monitoring Summary (COMB, 2016a), the WY2013 Annual Monitoring Summary (COMB, 2017), the WY2014 Annual Monitoring Summary (COMB, 2018a), and the WY2015 Annual Monitoring Summary (COMB, 2018b).

The data summarized in this report describe the habitat conditions and the fishery observations in the LSYR during WY2016. This period roughly encompasses the annual reproductive cycle of steelhead; including migration, spawning, rearing, and

oversummering as those activities relate to the wet and dry periods of the year. Although fall snorkel surveys occur in October or November (of the following water year), they have been included in the current water year's annual report as they show *O. mykiss* survival over the dry season. Throughout this report, LSYR stream network locations are assigned alpha-numeric site-codes indicating the mainstem of the LSYR or a tributary (i.e., EJC for El Jaro Creek), and a river-mile distance downstream of Bradbury Dam on the LSYR mainstem or upstream from the confluence of the mainstem with a tributary (e.g., LSYR-0.5 is the Long Pool, which is 0.5 miles downstream from the dam; HC-0.14 is on Hilton Creek 0.14 miles upstream of its confluence with the mainstem).

WY2016 was classified as a dry year with only 11.45 inches of precipitation recorded at Bradbury Dam (long-term average, 1953-2016, is 19.91 inches; fifteenth lowest year over the period of record with WY2007 being the lowest at 7.41 inches). This was the seventh lowest rainfall year since issuance of the 2000 BiOp with 9 of 16 years classified as dry (WY2007, WY2013, WY2002, WY2015, WY2014, WY2004, WY2016, WY2012, and WY2009 listed in order of severity). Dry years, in general, are often associated with a reduction of the *O. mykiss* population due to the lack of flow, limited availability of habitat, and reduced or no ocean connectivity for anadromous reproduction (Lake, 2003; COMB, 2013). However, dry years can result in an increase in resident *O. mykiss* reproduction due to limited stormflow events capable of washing out redds.

Migrant trapping was conducted in WY2016 and all BiOp take limits were followed. Reproduction and population status was monitored through spawner (redd) surveys and snorkel surveys.

There was one planned interruption of flow to Hilton Creek starting on 11/23/15 and ending on 12/2/15 as Reclamation needed to switch the delivery system to the creek from the Hilton Creek Watering System (HCWS) discharging at the Upper Release Point (URP) to the Hilton Creek Emergency Backup System (HCEBS) on gravity flow to the Lower Release Point (LRP). This was due to critical drought conditions and diminished lake storage. All fish in between the URP and the LRP needed to be relocated downstream since that section of the creek would dry out with the change in operations. The switch resulted in relocating 247 *O. mykiss* (7 Prickly sculpin, *Cottus asper*) and there were 11 *O. mykiss* (5 sculpin) mortalities. A report with details was submitted by Reclamation to NMFS and the necessary operation will only be discussed below in the context of monitored water quality and observed fish through migrant trapping and snorkel surveys.

WY2016 was a complicated year due to the prolonged drought, diminishing water storage and supply in Lake Cachuma, and reaching critical drought conditions. Historic low lake levels were reached that have not been seen since filling of the lake after construction hence requiring management strategies new to the operations of the Cachuma Project since the 2000 BiOp. To assist in understanding the hydrologic condition, the following chronology of events or milestones is provided that directly influenced flow releases for the *O. mykiss* population downstream of Bradbury Dam (including Hilton Creek) throughout the water year:

- 10/1/15 through 11/28/15: routine BiOp compliance releases.
- 11/19/15: 30,000 af of storage in Lake Cachuma (BiOp stated Critical Drought lake level), but Hilton Creek and LSYR releases continued as before until the WR 89-18 release (>30 af/month).
- 12/1/15: HCWS (URP) to HCEBS (LRP) on gravity flow; no streamflow between the URP and the LRP requiring fish rescue and relocation throughout that reach.
- 2/1/16: USBR reporting anomaly within the Daily Operations report.
- 5/12/16: Outlet Works release from 6.0 af to 3.0 af.
- 7/9/16: Hilton Creek Watering Tanks become operational.
- 7/11/16: Trickle flow only is initiated to Hilton Creek at the LRP (<30 af/month) just prior to the WR 89-18 release.
- 7/12/16 through 8/29/16: WR 89-18 releases; no more releases from the HCEBS to LRP for the rest of the water year.
- 7/12/16 through 8/31/16: Hilton Creek Tank flow (~0.03 cfs) to Hilton Creek at the LRP from water truck deliveries.
- 9/1/16 through end of the year: Stilling Basin pumped flow (~0.03 cfs) to Hilton Creek at the LRP (tanks flow stopped and used only for backup).
- 8/29/16: Immediate shutdown of the WR 89-18 release due to Outlet Works valve problems requiring use of the Slide Gate within the Penstock.

Again these dates will be discussed throughout this report and are provided for reference.

2. Background

2.1. Historical Context of the Biological Monitoring Effort

Reclamation, in collaboration with the Cachuma Project Member Units and California Department of Fish and Wildlife (CDFW, previously known as California Department of Fish and Game [CDFG]), and others, began the biological monitoring program for *O. mykiss* in the LSYR in 1993. Since then, the Cachuma Project Member Units have funded and conducted the long-term Fisheries Monitoring Program and habitat enhancement actions within the LSYR through the Cachuma Operation and Maintenance Board's (COMB) Fisheries Division (FD), specifically the COMB-FD staff (previously referred to as the Cachuma Project Biology Staff, CPBS), for Reclamation in compliance with the 2000 BiOp. The program has evolved in scope and specificity of monitoring tasks after southern California steelhead were listed as endangered under the federal Endangered Species Act in 1997 (NMFS, 1997) and since critical habitat was designated in 2000 and 2005 (NOAA, 2005). Further refinements were incorporated into the monitoring program during the development of the BA for the Cachuma Project (USBR, 1999), after the issuance of the BiOp (NMFS, 2000) and through subsequent guidance and regulatory documents (SYRTAC, 2000; USBR, 2000). Three comprehensive data summaries were prepared that synthesized the results of the monitoring effort from 1993 to 1996 (SYRCC and SYRTAC, 1997), from 1993 to 2004 (AMC, 2009), and from 2005 to 2008 (USBR, 2011); and seven Annual Monitoring Reports/Summaries completed for 2009 (USBR, 2012), 2010 (USBR, 2013), 2011 (COMB, 2013), 2012 (COMB, 2016a), 2013 (COMB, 2017), 2014 (COMB, 2018a), and 2015 (COMB, 2018b). All reports fulfilled the annual monitoring reporting requirements set forth in the BiOp (T&C 11.1) for those years.

Rainbow trout (coastal rainbow/freshwater resident) and southern California steelhead are the same species (*O. mykiss*) and visually indistinguishable except for the larger size of a returning ocean run steelhead and color differences of an outmigrating smolt (silver with blackened caudal fin) observed during the latter half of the migration season. Rainbow trout (non-anadromous or freshwater resident) can remain in freshwater for several years, or even generations, before exhibiting smolting characteristics and migrating to the ocean (NMFS, 2012). The two life history types or strategies (anadromous and resident) will be distinguished when possible throughout this report.

2.2. Meteorological and Hydrological Overview

The headwaters of the Santa Ynez River are located approximately 4,000 feet above sea level in the San Rafael Mountains. The river flows in a westerly direction for approximately 90 miles before reaching the Pacific Ocean near the City of Lompoc. The Santa Ynez River watershed is almost entirely contained within Santa Barbara County, with only a small eastern portion in Ventura County. There are three water supply reservoirs on the river: Jameson, Gibraltar, and Cachuma. Lake Cachuma essentially divides the watershed area in half. This region has a Mediterranean-type climate which is typically warm and dry during the summer and cool and wet in the winter. Rainfall is highly variable throughout the watershed with long-term records showing that the region routinely experiences periods of wet and dry cycles that can last for several years. Historically, the majority of the rainfall occurs during the winter and spring (December-May) months with most rain falling from December through April. The migration and spawning season for *O. mykiss* corresponds with the initiation of the wet season, and these activities overlap in both the anadromous and resident forms. The anadromous form of the species begins to migrate to spawning locations once the sandbar at the mouth of the river is breached, and the tributaries begin flowing. This typically occurs sometime after the first major storms of winter. Hence, review of the meteorological and hydrological conditions for each year is essential for the analysis and interpretation of the fisheries data collected during that year.

2.3. Watershed Condition for Southern California Steelhead

Southern California Steelhead and Rainbow Trout require cool water in order to spawn, rear, and survive the dry season and specifically hot summers below Bradbury Dam. They require clean, well-oxygenated water during all life stages, especially for redd ventilation and during metabolically expensive activities such as upstream migration. In general, Southern California steelhead/rainbow trout prefer water temperatures below 20°C and dissolved oxygen (DO) concentrations greater that 4 mg/L (Molony, 2001; Moyle, 2002). Historically, *O. mykiss* residing within the Santa Ynez River and associated tributaries had access to cooler headwaters throughout the watershed. After the construction of Bradbury Dam in 1953, approximately half of the watershed was inaccessible to anadromous fish. Although Southern California Steelhead can tolerate higher temperatures than steelhead residing further north, there are still stressful (sub-lethal) and lethal effects to individuals caught in pools above tolerable thresholds. Stressful and lethal stream temperatures and dissolved oxygen (DO) concentrations limits for southern steelhead are not well defined. Most studies were conducted on *O. mykiss*

from the north and in different hydrologic conditions. A literature review suggests a stream water temperature of 20°C is stressful, 24°C is severely stressful and 29°C is lethal, and DO concentrations at 5 mg/L is stressful and 3 mg/l is lethal for *O. mykiss* (Matthews and Berg, 1997; DeVries, 2013a; DeVries, 2013b). Observations of the *O. mykiss* population within the LSYR basin indicate these suggested limits may not hold true in this area as LSYR basin fish appear to have tolerances higher in stream temperatures and lower in DO concentrations. The thresholds are dependent upon life-stage, exposure time, and access to cool-water refugia.

2.4. Monitoring and Data Quality Assurance and Control

Field monitoring activities for migrant trapping, snorkel surveys, and redd surveys followed established CDFW and NMFS protocols as described in the BiOp and the literature (Hankin and Reeves, 1988; Dolloff et al., 1993). Water quality monitoring followed regulatory and industry guidelines for quality assurance and control, which are presented in Appendix B.

3. Monitoring Results

The results from the WY2016 monitoring effort are organized by (1) hydrologic condition, (2) water quality, (3) habitat quality, (4) migration of *O. mykiss*, (5) reproduction and rearing, (6) tributary enhancements project monitoring, and (7) additional investigations.

3.1. Hydrologic Condition

Precipitation, stream runoff, and Bradbury Dam spills: Historically, water year type for the Santa Ynez River basin has been defined as a dry year when rainfall at Bradbury Dam is equal to or less than 15 inches, a normal year when rainfall is 15 inches to 22 inches, and a wet year when precipitation (e.g., rainfall) is equal to or greater than 22 inches (AMC, 2008). The California State Water Resources Control Board (SWRCB) uses different criteria that focus on river runoff (in this case inflow to the Cachuma Reservoir); a critically dry year when inflow is equal to or less than 4,550 acre-feet (af); a dry year when inflow is between 4,550 af and 15,366 af; a below normal year when inflow is between 15,366 af and 33,707 af; an above normal year when inflow is between 33,708 and 117,842 af; and a wet year when inflow is greater than 117,842 af (SWRCB, 2011). Due to the longstanding classification used in previous AMS/R reports, the SWRCB approach will not be used in this report, although the designation would have been a dry year at 4,697.4 af of computed inflow to Lake Cachuma.

WY2016 had 11.45 inches of rainfall at Bradbury Dam and was therefore classified as a dry year (less than 15 inches) (Table 1). The long-term average (1953-2016) at the dam was 19.91 inches. Very little runoff occurred within the LSYR mainstem and tributaries in WY2016, and the mainstem flow from the dam downstream was insufficient to connect with the LSYR lagoon. There were no days with recorded flow at H Street throughout the water year hence there was no mainstem connectivity to the lagoon and the berm to the ocean was not breached. Upstream migration opportunities from the lagoon or the ocean were non-existent due to low rainfall and limited stream runoff. In Salsipuedes Creek, the highest recorded flow (peak discharge) at the USGS station at

Jalama Bridge in WY2016 was 92.0 cfs, on 1/6/16. Historic minimum, maximum, and WY2016 rainfall data at six locations within the Santa Ynez River basin are presented in Table 2. The precipitation record shows high spatial and inter-year variability between western and eastern locations within the watershed as well as between wet and dry years.

There were 19 precipitation events in WY2016 with rainfall equal to or greater than 0.1 inches at Bradbury Dam (Table 3 and Figure 1). Only 11.45 inches of rain was recorded at Bradbury Dam in WY2016, with the majority of rain (9.82 inches) falling between December and March. No other month during the water year totaled over 1 inch of rainfall (Table 3). The necessary triggers to implement a passage supplementation event were not met in WY2016. In addition, a WR 89-18 Water Rights release was conducted during the summer and fall period from 7/12/16 to 8/29/16.

Annual daily mean discharge hydrographs for the LSYR basin at the Narrows (USGS-11133000), Salsipuedes Creek (USGS-11132500), Solvang (Alisal Bridge) (USGS-11128500), Bradbury Dam (Reclamation), and Los Laureles (USGS-11123500) (upstream of Lake Cachuma) gauges are shown in Figure 2. The lagoon did not open to the ocean in WY2016. To note, the Hilton Creek gauge (USGS-11125600) is a low flow gauge only (less than 50 cfs). The WR 89-18 release is easily seen in the figure.

Peak daily mean discharge recorded by the USGS at the Narrows on the LSYR mainstem and Salsipuedes gauges occurred on 8/6/16 at 57.6 cfs (peak WR 89-18 releases) and 3/6/16 at 15.8 cfs (stormflow), respectively. Peak daily discharge at the Solvang gauge of the LSYR mainstem was 148 cfs on 7/25/16 (peak WR 89-18 releases). It was dry most of the water year at the USGS Los Laureles gauge except in January and March with peak daily mean flows less than 5 cfs on both occasions. The Hilton Creek Gauge recorded no stormflow event from the upper basin, only discharge from Lake Cachuma (Figure 3). The peak release from Bradbury Dam was approximately 185.9 cfs on 7/22/16 during the onset of the 2016 WR 89-18 Release. None of these discharge rates were high enough to cause any changes to the channel or banks within the LSYR. Only localized scour of small vegetation within the wetted channel was observed at a few locations.

Annual hydrographs along the Santa Ynez River at Los Laureles, Solvang, Narrows and Salsipuedes Creek gauges showed lower than normal spring runoff conditions throughout the basin (Figure 2). Baseflows (daily mean discharge) within Hilton Creek were between 1.00 and 3.27 cfs from the start of the Water Year through 7/11/16 just prior to the start of WR 89-18 releases when Reclamation provided trickle flow (< 30 af per month) to the creek through a combination of water deliveries by truck, tank, and small submersible pumps installed in the Stilling Basin directly downstream of Bradbury Dam (Figure 3) (see the Discussion Section for further details). The *O. mykiss* population in Hilton Creek survived throughout the Water Year but conditions were not ideal once trickle flow started.

Ocean connectivity: Since WY2006, the presence of the lagoon sandbar has been monitored daily from Ocean Park (at the lagoon, see Figure ES-1) during the wet season (November through June). The Santa Ynez River lagoon did not breach during WY2016.

This was the fourth year in a row with no connectivity to the ocean (Table 4). There were 3 storms throughout WY2016 that produced some streamflow across the region (1/5/16, 1/31/16, and 3/7/16), none produced any elevated runoff. The remaining storms were not of sufficient magnitude to generate the stream discharge needed to connect to the lagoon and breach the sandbar, allowing upstream anadromous passage. In addition, storms in WY2016 were not consecutive and too small to produce significant runoff, resulting in rain which mostly soaked into the ground. For example, no storm in WY2016 produced any runoff at the Narrows or H Street Bridge USGS gauging stations.

Passage supplementation: There were no passage supplementation events in WY2016 due to dry conditions that resulted in passage supplementation criteria not being met. Passage supplementation protocols are designed to avoid releases in dry years per RPM 3.

Adaptive Management Actions: There were 13 Adaptive Management Committee (AMC) meetings during WY2016. Topics discussed were critical drought conditions and how best to safeguard the LSYR basin *O. mykiss* population particularly within the wetted section of Hilton Creek and the Hwy 154 Reach of the LSYR mainstem. No flow allocations were made by the AMC from the Adaptive Management Account (AMA).

Target flows: There were no spills from Bradbury Dam in WY2016, and reservoir storage remained under 120,000 AF, so long-term BiOp established target flows were maintained of 2.5 cfs at the Hwy 154 Bridge under these conditions with a minimum of 2 cfs released into Hilton Creek until 2/1/16 when less than 2 cfs was released to the creek. Required target flows were met in WY2016 until Lake Cachuma storage dropped below 30,000 af and critical drought conditions were determined as stated in the 2000 BiOp (Figure 3). Lake water releases continued after 2/1/2016 into Hilton Creek at 0.8 to 1.2 cfs and to the LYSR from the Outlet Works (1-3 cfs) until 7/11/16. Lake water was then provided to Hilton Creek through a combination of water trucks, tanks, and submersible pumps installed into the Stilling Basin and connected to the Chute Release Point (CRP) that is further described in Section 4.

Water Rights Releases: Water Rights releases are non-discretionary releases called for by the Santa Ynez River Water Conservation District (downstream Water Rights holders) as described in WR Order 89-18 (WR 89-18). In WY2016, these releases began on 7/12/16 and ended on 8/29/16, with a total release amount of 11,620 af over 49 days (Figure 2). This was a Below Narrows Account (BNA) release that reached just downstream of the Robinson Bridge in Lompoc. Monitoring for fish movement and water quality was conducted by the COMB-FD staff as stipulated in the BiOp RPM 6 and the 2016 Study Plan (monitoring plan for WR 89-18 releases). Snorkel surveys during the releases indicated *O. mykiss* were not encouraged to move downstream of Alisal Bridge throughout the WR 89-18 release. No fish were found stranded during the release or after ramp-down of the release. These findings were consistent with previous monitoring efforts during prior WR 89-18 releases. Further details of the 2016 WR 89-18 release are provided in the RPM 6 Monitoring Report submitted by Reclamation to NMFS (USBR, 2017).

Mixing of State Water Project Waters in the LSYR: Reclamation monitors downstream releases to comply with the 50% mixing criterion required by BiOp RPM 5.1 (NMFS, 2000) for release of State Water Project (SWP) water into the Santa Ynez River below Bradbury Dam. The Central Coast Water Authority (CCWA) in collaboration with Reclamation delivers SWP water to Lake Cachuma. SWP water is mixed with water releases from Lake Cachuma in the penstock and Stilling Basin at the base of the dam. Lake Cachuma water enters Hilton Creek through the Hilton Creek water delivery systems and flows through Hilton Creek into the Long Pool. The determined point for mixing is the Long Pool that receives both water sources (Outlet Works and HCWS/HCEBS). SWP water can be delivered to Lake Cachuma through a by-pass system that eliminates having to use the penstock. The criterion was met for RPM 5.1 throughout WY2016 (Figures 4). Since the issuance of the BiOp in 2000, the 50% mixing criterion has been met 100% of the time during the migration season (December – June), when the lagoon was open, and flow was continuous to the ocean.

3.2. Water Quality Monitoring within the LSYR Basin:

Water quality parameters were monitored within the LSYR Basin during the dry season from approximately May through November to track conditions for over-summering *O. mykiss*. The critical parameters for salmonid survival, water temperature and dissolved oxygen (DO) concentrations, were recorded and are presented below. Additional water parameters were also monitored (i.e., specific conductance, Total Dissolved Solids, pH, and salinity) but not reported.

Stream temperatures play a critical role in salmonid energy conversion by influencing the metabolic requirements for food and governing the rate of food processing as salmonids are not able to regulate their temperature physiologically (Moyle, 2002). They can compensate for thermal conditions behaviorally by adjusting activity rates and metabolic demand in adverse thermal conditions (Nielson et al., 1994). Stream and lake water temperature and DO concentrations are presented below for the LSYR mainstem and selected tributaries.

Stream water temperatures were collected at various locations within the LSYR mainstem and its tributaries of the LSYR with thermographs (recording continuously at the beginning of every hour) and dissolved oxygen concentrations with multi-parameter sondes through multiple day spot deployments (2-5 days at 15-minute or 60-minute intervals) (Figure 5). Since 1995, a thermograph network has been deployed in the LSYR mainstem and tributaries downstream of Bradbury Dam as described in the BA (USBR, 2000), to monitor seasonal trends, diel variations, longitudinal and vertical gradients, and general temperature suitability for *O. mykiss*. Changes in channel configuration and associated pool habitats from spill events have necessitated slightly modifying the thermograph deployment regime and locations described in the BA (USBR, 2000). When presented, the two data sources (thermographs and sondes) will be discussed separately for the LSYR mainstem and tributaries.

Results of water quality monitoring are presented in all cases, but described only if the habitat contained *O. mykiss,* non-native aquatic species, or there was an observation of

particular importance. Data presentations include daily minimum, average, and maximum water temperatures as well as hourly data during the highest maximum water temperatures recorded over the period at that site. Several monitoring locations were added at the beginning of WY2013 to increase the understanding of the thermal regime in various LSYR mainstem and tributary habitats as it relates to fish assemblages.

Water temperature: During 2016, thermographs were deployed in one of two configurations: single units mainly in the tributaries and 3-unit vertical arrays at selected pool locations within the LSYR mainstem (Table 5). At vertical array sites, thermographs were consistently deployed with a surface (approximately 0.5 feet below the surface), middle (center of the water column), and bottom (0.5 feet above the bottom of the monitoring site) units. For reference, a table was prepared with the monitoring sites (habitat name and Stream ID) and whether fish were present or absent during the monitoring period (Table 6). The monitoring results of each unit are presented in separate graphs where the habitat depth is given in the text and the actual placement depth of the instrument is presented in the associated figure caption. Single unit thermograph deployments within the LSYR mainstem and tributaries were uniformly positioned approximately 0.5 feet above the bottom of stream channel.

Most monitoring locations were legacy sites and have been monitored since before the Cachuma Project BiOp (see previous Annual Monitoring Reports) and were originally monitored specifically due to the presence of *O. mykiss* to evaluate seasonal rearing conditions as it relates to temperature. Keeping legacy sites that are now sometimes absent of *O. mykiss* allows for a comparison of how habitats respond to different flow regimes and water year types over time. Other sites were selected and monitored to evaluate the longitudinal thermal gradient along the LSYR, to document the presence of cold water refuge habitat, and to monitor the rearing conditions where *O. mykiss* were present, while some previously monitored locations were discontinued due to habitat alterations (i.e., LSYR-7.3 and LSYR-9.6) or access limitations (2 sites within the Santa Ynez River Lagoon).

In addition, several monitoring locations were discontinued due to the absence of observed fish over several years (Nojoqui Creek), a sequence of impassable barriers prohibiting access for anadromous steelhead (San Miguelito Creek), or a dry stream reach in Salsipuedes Creek (SC-3.80) due to the ongoing drought. In Hilton Creek, single units were deployed at three locations; upstream of the Upper Release Point (URP), just downstream of the Lower Release Point (LRP), and just upstream of the creek's confluence with the LSYR mainstem to monitor stream temperatures in the watered sections of the creek.

There were 8 thermograph units (normally 24) deployed at 4 sites (normally 10) on the LSYR mainstem which are listed below with the number of units in parentheses:

- The north parapet wall of the Stilling Basin (LSYR-0.01 (3));
- The river channel immediately downstream of the Stilling Basin (LSYR-0.25 (1));
- Long Pool (LSYR-0.51 (3));

- LSYR directly downstream of Long Pool and upstream of Reclamation and Crawford-Hall property boundary (LSYR-0.68 (1));
- Encantado Pool (LSYR-4.95, legacy site but dry);
- Double Canopy Pool (LSYR-7.65, legacy site but dry);
- Head of Beaver Pool (LSYR-8.7, legacy site but dry);
- Alisal Bedrock Pool (LSYR-10.2, legacy site but dry);
- Avenue of the Flags (LSYR-13.9, legacy site but dry); and
- Cadwell Pool (LSYR-22.68, no monitoring conducted).

In the tributaries, there were 10 monitoring sites, each with single unit deployments:

- Hilton Creek (HC, 2 sites):
    - HC-lower (HC-0.12);
    - HC-LRP (HC-0.25); and
    - HC-upper (HC-0.54, legacy site but dry).
- Quiota Creek (QC, 1 site):
    - QC-Crossing 6 (QC-2.66).
- Salsipuedes Creek (SC, 4 sites):
    - SC-lower (SC-0.77);
    - SC-Reach 2 (SC-2.2);
    - SC-Highway 1 Bridge (SC-3.0); and
    - SC-Jalama Bridge (SC-3.5);
    - SC-upper (SC-3.8, legacy site but dry).
- El Jaro Creek (EJC, 2 sites):
    - EJC-lower (EJC-3.81, legacy site but dry);
    - EJC-Palos Colorados (EJC-5.4); and
    - EJC-Rancho San Julian (EJC-10.82, legacy site but dry).
- Los Amoles Creek – Tributary to El Jaro (LAC, 1 site):
    - LAC-Los Amoles Creek (LAC-7.0).

Again, all stream temperature monitoring locations are presented in Figure 5 with their deployment period and type in Table 5, and the observed fish species in each habitat in Table 6 for the LSYR mainstem and tributaries.

LSYR Mainstem thermographs: The data are presented by site from upstream to downstream.

Stilling Basin North Parapet Wall (LSYR-0.1)

A 3-unit vertical array was deployed prior to the WR 89-18 releases along the northeast wall of the Stilling Basin from 4/11/16 through 12/31/16 (Figures 6, 7, 8, and 14). The units were deployed at 1-foot, 14-feet, and 28-feet. The Stilling Basin is the largest habitat on the LSYR and measures approximately 866 feet long from the spillway to the downstream riffle crest, is 482 feet wide at its midpoint, and is approximately 36 feet deep when at full capacity. In the absence of high volume water releases, the upper lens of the Stilling Basin water column heats while cooler water sinks to the bottom, particularly during the summer. Water temperatures at this location are greatly influenced by both low and high volume water releases from the Bradbury Dam Outlet Works.

When water is released from the Outlet Works, it is released from the cold hypolimnion at the bottom of the lake.

Stilling Basin water temperatures remained relatively warm from the surface to the bottom prior to the onset of WR 89-18 releases. Water temperature rapidly cooled following the initiation of WR 89-18 releases on 7/12/16. While *O. mykiss* are assumed to reside in the Stilling Basin, none were observed.

Downstream of Stilling Basin (LSYR-0.25)

This unit was deployed at the bottom of a run habitat immediately downstream of the Stilling Basin in approximately 2.0 feet of water with the unit 6-inches above the substrate from 7/12/16 through 8/30/16 (Figure 9). This section of the river was observed to be dry on 5/13/16 and remained dry until the start of WR 89-18 releases on 7/12/16. Following the end of the releases, the habitat quickly dried and the thermograph was removed on 8/31/16 due to lack of water. While no *O. mykiss* were observed at the monitoring location, there were 3 *O. mykiss* captured several hundred feet downstream in the Stilling Basin trap during the WR 89-18 releases. The *O. mykiss* were captured on 7/14/16, 7/15/16, and 7/20/16, were all captured moving downstream, and released in the directions they were moving.

Long Pool (LSYR-0.51)

The Long Pool is approximately 100 feet wide at the widest point and 1,200 feet long with a maximum depth of over 9 feet. It is fed by two water sources when there is no spill or release from the Outlet Works; the chute release (Chute Release Point, CRP) which is part of the HCWS that releases water directly into the Stilling Basin and Hilton Creek proper (URP and LRP of the HCWS/HCEBS and upper natural basin creek flow) both flow sources confluence directly into the Long Pool in two separate channels. The HCWS and HCEBS are cooler water sources that take water at the 65 foot level in Lake Cachuma and from the bottom of the lake, respectively. Mixing of the two sources occurs within the first 200 feet of the Long Pool and well upstream of the thermograph vertical array location. *O. mykiss* are routinely observed rearing in this habitat when water visibility permits.

The Long Pool in recent years has been inhabited by several invasive species (largemouth bass [*Micropterus salmoides*], smallmouth bass [*Micropterus dolomieu*], sunfish species [*Lepomis*], and carp [*Cyprinus carpio*]) that limit *O. mykiss* colonization due to predation and degradation of water quality. This conclusion is based on visual observations of the lack of multi-year age classes within the habitat, particularly smaller 1-2 year old *O. mykiss*. In addition, chronic turbidity which can negatively affect salmonids was observed in both the Stilling Basin and Long Pool due to the presence of large numbers of carp and beaver which stir up bottom sediment with their activity.

The thermograph vertical array was deployed on 4/11/16 and removed on 11/9/16 at the deepest point of the pool at 9 feet (Figures 10, 11, 12, and 14). Prior to the onset of WR 89-18 releases, the Long Pool was diminishing in volume (drought) due to the ongoing drought and the absence of delivered water both watering sources. Overall, temperatures

rapidly cooled after the start of the WR 89-18 releases. Once the WR 89-18 releases stopped and with no inflow into the Long Pool, the pool rapidly diminished in size with the surface unit being exposed on 9/12/16, the middle unit exposed on 10/11/16, and the bottom unit exposed on 11/8/16. While it was suspected *O. mykiss* were rearing in the habitat, seining efforts prior to the habitat complete drying yielded no *O. mykiss*; only numerous invasive aquatic species were captured during the 2-day seining effort (see the Section 4 for further details).

Downstream of Long Pool (LSYR-0.62)

This single unit was deployed 300 feet downstream of the Long Pool in a shallow run habitat with a maximum depth of 2 feet from 4/11/16 to 9/13/16 (Figure 13). The habitat was dry prior to downstream WR 89-18 releases and quickly dried following the stoppage of the releases with the unit being removed on 9/12/16. No *O. mykiss* were observed in that specific habitat but 1 *O. mykiss* was observed just downstream.

Encantado Pool (LSYR-4.95)

The Encantado Pool was approximately 400 feet long, averaged 30-feet wide and usually has a maximum depth of 7 feet when water is present. No monitoring was conducted at this habitat because it was completely dry prior to WR 89-18 releases and no *O. mykiss* were observed in WY2016 during or after WR 89-18 water rights releases. Largemouth bass and sunfish were observed in this habitat after WR 89-18 releases.

Double Canopy Pool (LSYR-7.65)

The Double Canopy Pool is located directly upstream of the Refugio Bridge. The pool when full is approximately 350 feet long, 40 feet wide, and 4.5 feet deep at its deepest point. Only a small shallow puddle remained of this unit prior to WR 89-18 releases and hence, no water temperature monitoring was conducted. No *O. mykiss* were observed at this habitat during or after WR 89-18 releases although largemouth bass, sunfish and carp were seen in this habitat throughout the monitoring period.

Head of Beaver Pool (LSYR-8.7)

This habitat is located approximately ¼ mile downstream of the Quiota Creek confluence with the Santa Ynez River. The habitat when full is approximately 730 feet long, 50 feet wide, and 7.1 feet at the deepest point. This habitat was completely dry prior to WR 89-18 releases and no water quality monitoring was conducted. No *O. mykiss* were observed at this habitat in WY2016 during or after WR 89-18 water rights releases. Largemouth bass and sunfish were observed in this habitat in the fall.

Alisal Bedrock Pool (LSYR-10.2)

The Alisal Bedrock Pool is a corner scour pool habitat that when full is approximately 60 feet long and 40 feet wide with a maximum depth of 9 feet. This habitat was completely dry prior to WR89-18 and no water quality monitoring was conducted. No *O. mykiss* were observed at this habitat in WY2016 during and after WR 89-18 water rights releases. Centrarchids were observed in this habitat during and after WR 89-18 releases.

Avenue of the Flags (LSYR-13.9)

The habitat when full is approximately 65 feet long and 20 feet wide at its widest point with a maximum depth of approximately 4 feet. This area was dry prior to WR 89-18 and dried soon after releases stopped and no temperature monitoring unit was deployed. No *O. mykiss* were observed in this habitat during WR 89-18 releases although largemouth bass and sunfish were seen in this habitat during the summer and fall during and after the releases.

Cadwell Pool (LSYR-22.68)

The pool when full is approximately 490 feet long and 32 feet wide at the maximum point. Because of the ongoing drought and dry conditions in the LSYR mainstem, no thermograph units were deployed at this location in WY2016. No *O. mykiss* were observed at this location but largemouth bass, sunfish and carp were seen throughout WR2016.

LSYR Mainstem Longitudinal Comparisons

Longitudinal LSYR mainstem (maximum daily) water temperature at the surface thermographs for LSYR-0.1, LSYR-0.25, LSYR-0.51, and LSYR-0.68 are presented in Figure 14. Other legacy sites were not included due to the ongoing drought and no monitoring at those locations. Longitudinal maximum surface temperature comparison was complicated to interpret due to the variety of complex environmental variables all acting in conjunction with each other at each individual site (i.e., flow rate, riparian vegetation development/ riparian shading, ambient air temperatures, groundwater upwelling, pool stratification, etc.). In addition, the analysis only looks at a small portion of the overall habitat and does not reflect the general rearing potential throughout the water column of each of the habitats. For a more complete presentation of each specific habitat, see above.

WY2016 was the fifth consecutive dry year and drought symptoms were observed throughout the LSYR mainstem and its tributaries. Santa Barbara County proclaimed a local emergency for drought on 1/24/14 and has monthly re-ratified those conditions throughout the rest of the water year. Because of the low reservoir elevation, rearing target flows were only available through the HCWS and HCEBS which delivered approximately 1.0 to 3.0 cfs of water to Hilton Creek and a small amount from the Outlet Works (<1 cfs) to the LSYR mainstem. These were the only source of water flowing into the LSYR mainstem that wetted less than 3.2 miles of the mainstem river (Highway 154 Reach) until 7/12/16 when WR 89-18 releases started and trickle flow to Hilton Creek was provided by water truck, water tanks and/or the submersible pumps in the Stilling Basin that delivered at approximately 0.03 cfs through the rest of the water year. Most habitats contracted as flows diminished. Unlike previous years, water did not resurface at downstream locations as it had in the past. Prior to and after the WR 89-18 releases, much of the LSYR mainstem dried completely. Most of the mainstem thermograph units could not be deployed due to the absence of water prior to the WR 89-18 releases. Notable exceptions were the monitoring locations immediately downstream of the dam (LSYR-0.20, LSYR-0.25, LSYR-0.51, and LSYR-0.68) that remained wetted with flowing conditions to the Hwy 154 Bridge. The drying of habitats made longitudinal

comparison problematic. Extensive riparian vegetation died off due to the ongoing drought as observed within the Refugio, Alisal, and Avenue reaches in WY2016.

Factors influencing surface water temperatures along the longitudinal profile presented in Figure 14 are: (1) thermally-warmed Stilling Basin surface water moving downstream resulting in an increase in stream temperature; (2) dry cobble bars with extensive exposure to the sun that warm the leading edge of any released waters moving downstream that can cause elevated temperatures usually over a short period of time until the full rate of the release arrives and cools the water column thereafter; and (3) the arrival of a WR 89-18 release that elevates water temperatures (associated with the aforementioned factors) for a short period (1-2 hours) followed by a drop in water temperature to favorable conditions for *O. mykiss*. During the WR 89-18 release from July through August, thermal heating was more apparent further downstream of about 1-2°C from LSYR-0.1 to LSYR-0.68. For the remainder of the year, water temperatures gradually warmed during the summer period peaking in early September. Thereafter water temperatures decreased across the system throughout the rest of the monitoring period. Late season peak temperatures in October were associated with a heat wave.

Thermograph 5-minute data collected from the surface, middle, and bottom of the habitat were plotted for both the Stilling Basin and Long Pool before, during, and after the WR 89-18 release (Figure 15). Data at both sites showed warm stratified conditions throughout the water column before the release, cool uni-thermal conditions during the release, with stratified conditions rapidly developing once the release stopped as seen at both surface units. Once the release stopped, the Long Pool rapidly began to lose volume, before drying by the end of the year (the surface unit was pulled shortly after the end of the WR 89-18 releases due to being exposed to the air).

O. mykiss and Water Temperature Criteria within the LSYR Mainstem

With the exception of the Hwy 154 Reach, the majority of the LSYR dried during the spring and summer of WY2016. Few habitats remained throughout the river and those that were present did not maintain residual pool depth and continued to decrease prior to the WR 89-18 Release. No *O. mykiss* were observed downstream of the Hwy 154 Reach just prior to and throughout the WR 89-18 releases. Non-native warm water fish species were observed in multiple habitats in the Hwy 154, Refugio, and Alisal reaches as well as in Reach 3 downstream of Alisal Bridge (Table 6). Most of these habitat locations were inhabited by one or more species of largemouth bass, sunfish, and carp, and many were dried out (except for LSYR-7.65 and LSYR-22.68) by the middle of the summer prior to the release.

Tributary thermographs: The data from single thermograph deployments are presented by site from downstream to upstream along the creek (Figure 5 and Tables 5 and 6).

Lower Hilton Creek (HC-0.12)

This thermograph was deployed in a riffle habitat approximately 100 feet upstream of the confluence with the LSYR mainstem in approximately 1-foot of water (0.5 feet from the bottom) from 7/9/16 to 8/29/16. The monitoring site was nearly dry due to drought

conditions and a reduced release rate to Hilton Creek from Lake Cachuma. The thermograph unit was deployed just prior to WR 89-18 releases as that area is inundated with release water and remained in place until that segment of the creek dried out after the release (Figure 16). Following the release, the lower sections of the creek quickly dried as minimal flow (0.03 cfs) released from the LRP was insufficient to maintain residual pool habitat in much of the lower creek, but sunk underground several hundred feet upstream of the monitoring location. The observations from this site were very similar to what was recorded at LSYR-0.25, a relatively close distance away. After the front of the release passed, water temperatures were less than 20°C then slowly increased due to thermal heating to less than 23°C before the release ended and the stream dried out. *No O. mykiss* were observed at this location.

Hilton Creek at LRP (HC-0.25)

A single thermograph was deployed immediately downstream of the LRP in a shallow run habitat from 6/16/16 through 11/29/16 to monitor the water temperatures during the various low flow scenarios the creek was subject to during WY2016 (Figure 17). Water temperature showed a rapid increase following the switch from higher volume LRP releases from the HCEBS on gravity flow to the very low truck/tank releases following the start of WR 89-18 releases on 7/12/16. Maximum water temperatures stayed less than 24°C except for one brief spike in mid-August and showed a cooling trend beginning in September, particularly when the release switched from tank to Stilling Basin pumped flow. While water temperatures appear high, the bedrock formations and abundant riparian vegetation immediately downstream of the LRP created several hundred feet of microclimate that effectively cooled the water as it moved downstream (Figures 26-28). *O. mykiss* were occupying habitat both upstream and downstream of the monitoring location and successfully reared in the creek during WY2016.

Quiota Creek (QC-2.66)

A single thermograph was deployed approximately 50 feet upstream of Crossing 6 on Refugio Road from 5/3/16 through 8/15/16. The unit was placed 0.5 feet above the bottom of a run habitat 30 feet long and 10 feet wide with a depth of approximately 2.5 feet. This site was selected because rearing *O. mykiss* have been regularly observed over the years during routine snorkel surveys. The thermograph was removed on 8/15/16 due to the habitat being dry (Figure 18). All *O. mykiss* appear to have perished from this site in WY2014 due to the continuing dry stream conditions that have persisted well into WY2016 due to the ongoing drought. No *O. mykiss* were observed in WY2016 at this location when flow was present.

Lower Salsipuedes Creek (SC-0.77)

A single thermograph was deployed on the bottom of the creek from 5/12/16 through 9/18/16 within a run habitat with a maximum depth of 1 foot, approximately 300 feet upstream of the Santa Rosa Bridge and approximately 0.77 miles upstream of the confluence with the LSYR. This site is also immediately downstream of the Salsipuedes Creek trapping location. Water temperatures at the Lower Salsipuedes Creek monitoring location were noticeably lower compared to previous years and may be due to groundwater upwelling at the monitoring site coupled with a decrease in surface flow

(drought) allowing the cooler groundwater entering the run to exert more influence in the shrinking habitat (Figure 19). This was particularly apparent from August onward. The habitat was essentially dry when the thermograph was removed on 9/18/16. No *O. mykiss* were observed at this monitoring site.

Salsipuedes Creek-Reach 2-Bedrock Section (SC-2.20)

A single thermograph was deployed in a pool habitat approximately 4-feet below the surface at 0.5 feet from the bottom from 5/11/16 through 11/21/16. This is the fourth year a thermograph has been deployed at this location and was done to better understand the water temperature regime in this reach with remaining flow and adequate *O. mykiss* rearing conditions during the prolonged drought. Reach 2 is a short bedrock section with deep pools, extends approximately 1/3 of a mile, and represents some of the best and only remaining viable habitat for rearing *O. mykiss* within the entire Salsipuedes/El Jaro creek watershed due to the presence of numerous bedrock formed pools. The monitored habitat is approximately 40 feet long, 15 feet wide, and 6-feet deep at its deepest point. *O. mykiss* have been routinely observed at this location when visibility permits. Spawning surveys routinely document *O. mykiss* redds in this reach of the creek.

Water temperatures were among the coolest observed along the creek at this monitoring location, with maximum water temperatures remaining less than 21°C throughout the monitoring period (Figure 20). No *O. mykiss* were observed at this location due to poor visibility during WY2016.

Salsipuedes Creek – Highway 1 Bridge (SC-3.0)

A single thermograph was deployed along the side of a pool habitat approximately 4-feet below the surface, directly downstream of the Hwy 1 fish ladder from 5/11/16 through 11/21/16. The pool habitat is approximately 85 feet long and 18 feet wide with a maximum depth of 7-feet. This area routinely holds *O. mykiss*, though none were observed in WY2016 due to turbid conditions from upstream beaver and cattle activities. This is the fourth year a thermograph has been deployed at this location and was done to better understand the temperature regime throughout the creek, particularly in reaches that may be holding viable oversummering habitat for *O. mykiss*. This thermograph location represents the top of Reach 4, the second significant bedrock influenced section of the creek. Reach 4 is similar to Reach 2 in that there are numerous deep pool habitats formed in the bedrock that offer excellent oversummering opportunities for rearing *O. mykiss*.

Water temperatures remained relatively cool at this monitoring location with maximum temperatures remaining less than 21°C except for a brief period at the beginning of August during a heat wave (Figure 21). No *O. mykiss* were observed at this location during WY2016 due to turbid conditions.

Salsipuedes Creek – Jalama Bridge (SC-3.5)

A single thermograph was deployed in a pool habitat approximately 4 feet below the surface, directly downstream of the Jalama Bridge fish ladder from 5/11/16 through 11/21/16. The pool is approximately 30 feet long, 18 feet wide and 6 feet in depth. This

area routinely holds oversummering *O. mykiss* though no *O. mykiss* were observed in this habitat during snorkel surveys in WY2016 due to turbid conditions from upstream beaver activities.

Maximum water temperatures remained less than 21°C for the majority of the year except for a brief spike to nearly 22°C at the beginning of August (Figure 22).

Upper Salsipuedes Creek (SC-3.8)

For the third consecutive year since the LSYR fisheries studies began in 1993, Upper Salsipuedes Creek was dry during the spring of WY2016. For the past 24 years of monitoring, Upper Salsipuedes Creek has remained one of the most important creeks in the lower tributary system due to its optimal rearing conditions for *O. mykiss*. Past snorkel and redd surveys have documented many different age classes of *O. mykiss* in addition to large redd excavations that can only come from anadromous steelhead. Poor rainfall during WY2016 coupled with the fifth straight year of dry conditions and an ongoing severe drought has dried most of Upper Salsipuedes Creek. This is particularly concerning considering this reach has provided excellent rearing opportunities for oversummering *O. mykiss* and has been one of the primary seed populations in the lower tributary system. Under improved flow conditions, this rearing habitat supplements recruitment in other reaches of the creek and the LSYR watershed overall. No *O. mykiss* were observed at this site during WY2016.

Lower El Jaro Creek Upstream of Salsipuedes Confluence (EJC-3.81)

No thermograph was deployed at this location during WY2016 due to dry conditions from the ongoing drought. Prior to the drought, this monitoring location routinely held rearing *O. mykiss*. However, this site was dry on 8/16/16 and any rearing trout perished.

El Jaro Creek – Palos Colorados (EJC-5.4)

A single thermograph was deployed 0.5 feet from the bottom of a boulder influenced pool habitat from 5/12/16 through 11/21/16. The habitat measured approximately 35 feet long, 7 feet wide and 3.5 feet deep. This was the fourth year a thermograph was deployed in this section of the creek and was done to better understand potential oversummering and rearing habitat for *O. mykiss* in El Jaro Creek. *O. mykiss*, including young of the year, juveniles and adults have been observed sporadically within this area over the past several years. This area is influenced by Palos Colorados Creek that confluences with El Jaro Creek approximately 1/8 of a mile upstream of the monitoring pool. In WY 2016, the spring kept approximately 0.5 miles downstream viable for rearing *O. mykiss*.

Water temperatures remained relatively cool during the entire deployment time. Overall, maximum water temperatures remained less than 22°C during the warmest portion of the year except for a brief period at the beginning of August (Figure 23). No *O. mykiss* were observed at this location in WY2016.

EL Jaro Creek – Rancho San Julian (EJC-10.82)

O. mykiss have regularly been observed within the plunge pool and fish ladder in past years; however, due to the ongoing drought no *O. mykiss* were observed at or near this

habitat. No thermograph was deployed at this location in WY2016 due to the dry conditions.

Los Amoles Creek – Tributary to El Jaro – (LAC-7.0)

A single thermograph was deployed 0.5 feet from the bottom of a corner scour pool habitat from 5/12/16 through 11/21/16. The habitat is 30 feet long, 15 feet wide, and 3.0 feet deep and is located approximately 1/8 of a mile upstream from the confluence with El Jaro Creek. Los Amoles Creek has regularly held various age classes of *O. mykiss* and spawning sites have been identified in the creek over the years. Drought conditions have negatively impacted water flow through most of the creek with vast sections of Los Amoles Creek dry several hundred feet upstream of the monitoring location. An unnamed spring enters the creek approximately 150 yards upstream of the monitoring locations and most likely provides the sole source of water for that section of the creek. Maximum water temperatures in Los Amoles Creek were the warmest of all the tributary monitoring locations approaching 24°C during the warmest part of the summer (Figure 24). No *O. mykiss* were observed at this monitoring location.

Salsipuedes Creek Longitudinal Comparisons

Longitudinal maximum daily water temperatures for Salsipuedes Creek and El Jaro Creek are shown in Figure 25 for the thermographs at lower Salsipuedes Creek (SC-0.77), Salsipuedes Creek in the Reach 2 Bedrock Section (SC-2.2), Salsipuedes Creek at Highway 1 Bridge (SC-3.0), Salsipuedes Creek at Jalama Bridge (SC-3.5), and Palos Colorados (EJC-5.4). Also included in the graph is the Los Amoles Creek monitoring location (LAC-7.0) which is a tributary to El Jaro Creek and approximately 2.5 miles upstream of EJC-5.4.

Large sections of El Jaro and upper Salsipuedes creeks were dry during the summer and fall of WY2016. Flow values measured at the USGS gauging station 11132500 in Salsipuedes Creek (Jalama Road Bridge) showed a continuing spring to fall pattern of extremely low flows. Maximum flow rates of 0.1 cfs were recorded for only a few days in May and November. During the summer through early fall period flows further decreased and remained between 0.03-0.05 cfs. It is speculated that stream flow may have been from cool upwelling groundwater that may have influenced the overall temperature regime at the various monitoring sites as pools likely stratified to a greater extent. Maximum daily water temperatures remained clustered within a few degrees at all monitoring locations and remained less than 22°C for the entire monitoring period excepting for a brief temperature spike in early August coincident with a heat wave (Figure 25). Warmest stream temperatures were recorded in Los Amoles Creek during the hottest months of the year. Water temperatures appeared suitable for rearing *O. mykiss* at all creek monitoring stations in WY2016.

O. mykiss and Water Temperature Criteria within the Tributaries

The Salsipuedes/El Jaro Creek watershed is a dynamic system with many variables that influence water temperatures at any given time. The amount of surface flow, groundwater upwelling, ambient air temperatures, and presence/absence of riparian vegetation all contribute in influencing the thermal regime within individual habitats in the watershed.

In addition to the above listed variables, the region is experiencing its fifth straight year of dry conditions and tributary habitat throughout the watershed is contracting significantly.

Large sections of El Jaro Creek and Upper Salsipuedes Creek completely dried again in WY2016. The thermographs usually deployed at the Upper Salsipuedes confluence (SC-3.80), the El Jaro confluence (EJC-3.81), and San Julian Ranch (EJC-10.82) were not deployed due to dry creek conditions. There was only one flowing section of El Jaro Creek resulting from contribution of Palos Colorados Creek which confluences upstream of EJC-5.4. The creek contribution was small and only extended for approximately 0.25 miles downstream before sinking back underground. The confluence between El Jaro and Upper Salsipuedes completely dried with Upper Salsipuedes Creek upstream of the confluence also going dry. Surface streamflow reappeared approximately 250 yards downstream of the El Jaro/Salsipuedes Creek confluence providing wetted stream conditions from there downstream to near the confluence with the LSYR (approximately 3 miles). Flow measured at the USGS gauging station on Salsipuedes Creek (11132500) was less than 0.05 cfs from June through late November.

Temperature monitoring within the watershed highlights the variability of individual habitats and impacts of the ongoing drought, with significant portions of El Jaro Creek completely dry and Salsipuedes Creek as having the most optimal water temperatures for rearing *O. mykiss*, primarily through the bedrock sections of Lower Salsipuedes Creek. Specific numbers of observed *O. mykiss* and their survival over the dry season are presented in the snorkel survey section below.

Hilton Creek – Alternative Lake Water Release Regime during Critical Drought

Because of extreme low reservoir elevations, water releases to Hilton Creek in support of the *O. mykiss* population experienced several different low flow delivery scenarios throughout 2016. After extensive discussions with the NMFS, Reclamation and the Adaptive Management Committee (AMC), it was decided that providing trickle flow to the creek was more favorable than the risk of rescue and relocation of all fish in the entire wetted section of Hilton Creek due to the potential for stress or mortality from that level of operation. In addition, potential relocation spots throughout the lower watershed were evaluated and deemed insufficient in providing the habitat requirements necessary to ensure *O. mykiss* survival after relocation. Moving fish temporarily to a hatchery was discussed multiple times but permitting limitations with CDFW and NMFS eliminated this option. The only solution was to allow the fish to remain in the creek and provide trickle flow sufficient enough to maintain residual pool depth specifically in the deep bedrock pool habitats downstream of the LRP. This approach had already been tested successfully during prolonged HCWS outages in 2014-2015 where a 2000 gallon water tanker truck provided trickle flow directly to the LRP energy diffuser box and served to keep all the *O. mykiss* alive for several days during small outages and up to 16 days during longer outages.

Three of the deepest pool habitats in that bedrock section of Hilton Creek were monitored for water quality using a paired vertical array or a single unit of U-26 dissolved oxygen

and temperature loggers. The loggers were attached to an 8 foot long electrical metal pipe conduit and configured with one unit located one foot below the surface and the second unit located one foot above the bottom. The single array was placed with the unit one foot above the bottom of the substrate due to shallower stream conditions. The units were programmed to collect measurements every 15-minutes.

On 7/12/16 just prior to the start of the WR 89-18 releases, stream discharge from the HCEBS to the LRP was stopped and trickle flow was provided to the creek at a rate of approximately 0.03 cfs for the remainder of the year. Trickle flow was provided by: 1) tank flow from 7/12/16 – 8/31/16 and 2) Stilling Basin pump flows from 9/1/16 to the end of the year. The Hilton Creek Watering Tanks (four 5000 gallon plastic and insulated storage tanks placed adjacent to the LRP) were continually filled during the day utilizing a 2000 gallon water truck that obtained water from the Outlet Works (OW) during working hours that provided trickle flow throughout the day and through the night. Towards the end of August, Reclamation installed 2 electrical well pumps (one for backup) in the Stilling Basin and connected them to the lowest most discharge point of the HCWS, the Chute Release Point (CRP). The extraction point was deep in the pool of the Stilling Basin where stratified conditions provided a cool water source. The system was activated on 9/1/16 and provided the desired stream discharge throughout the rest of the year. Both methods were successful in providing enough flow to maintain all Hilton Creek habitat and keep the fish alive.

Water Temperature: The water temperature recorded at the LRP (HC-0.3) showed maximum values between 21-24°C from 7/12/16-9/1/16 during truck/tank releases and then decreasing to between 21-22°C when Stilling Basin pump flows were established that accessed cooler water (Figure 17). In general as released waters move through the bedrock section of the creek, they are influenced by the cool microclimates within the canyon that act to slightly cool the water as it moves downstream. Comparing recorded LRP temperatures with the Honeymoon Pool (HC-0.26, approximately 200 feet downstream) shows gradual cooling of 1-3°C at the surface site that persisted throughout the monitoring period (Figure 26). Water temperatures at the bottom cooled further, likely the result of thermal stratification. All in all, maximum water temperatures at both the surface and bottom remained less than 22°C during the entire deployment with bottom temperatures generally remaining less than 20°C. Water temperatures at the Spawning Pool (HC-0.25, approximately 300 feet downstream of the LRP) surface cooled further, generally remaining less than 21°C and the bottom remaining less than 20°C (Figure 27). In the Perched Boulder Pool (HC-0.20, approximately 300 feet downstream) there was a slight warming to just over 22°C early in the deployment period as the trickle flow transitioned from the bedrock canyon into a series of shallow run/riffle where solar heating may have had an influence (Figure 28). By the beginning of August, temperatures had cooled to around 20°C at this location. In the case of all three of these habitats, *O. mykiss* were observed and successfully survived the dry season.

Dissolved Oxygen: DO concentrations at the surface of the Honeymoon Pool (HC-0.26) remained greater than 7 mg/L for the majority of the deployment except during the last week of October when the surface unit registered periodic readings between 2-5 mg/L.

Bottom concentrations showed a wider range of low values over the period particularly in October and middle of December (Figure 26). DO concentrations recorded at the Spawning Pool (HC-0.25) showed wider fluctuations, particularly at the surface early in the deployment period that may have been a result of instrument drift from fouling as bottom readings showed higher oxygen concentrations (Figure 27). For the majority of the deployment (except in July and October), DO remained generally greater than 5 mg/L at the surface. Bottom readings show slightly lower concentrations and wider fluctuations compared to the surface. DO concentrations at the Perched Boulder Pool (HC-0.20) remained greater than 5 mg/L for the majority of the deployment with brief decreases to less than 4 mg/L after October (Figure 28). These low recordings could also be attributed to instrument drift. Again, *O. mykiss* were observed to successfully rear at this habitat throughout the year.

Lake Cachuma water quality profiles: Water quality profiles were collected at Bradbury Dam near the intake for the HCWS on 3/3/16, 4/11/16, 6/9/16, 7/21/16, 8/24/16, 9/27/16, and 11/8/16 (Figure 29). The purpose of collecting lake profiles is to gather vertical temperature and DO concentrations to assure that the depth of the adjustable intake hose for the HCWS is set to provide optimum conditions for *O. mykiss* in Hilton Creek, at or below 18 °C as stipulated in the BiOp. Lake profiles are not obtained from the deepest part of the lake; rather, profiles are obtained near the HCWS intake to look at water quality conditions going to Hilton Creek. Lake profile measurements are taken approximately 50 feet away from the HCWS intake pipe so that the submerged monitoring equipment is not sucked into the intake. The HCWS intake has been set at a depth of 65 feet below the water surface, and temperatures of the released water were well below 18°C prior to WY2015. However, due to lowering reservoir elevations (less stratification to provide cooler water), water temperatures being released through the HCWS went above 18°C in June of WY2016 and remained over 18°C until conditions cooled in the late fall. The HCEBS (intake at the bottom of the lake) started delivering flows to the LRP of Hilton Creek beginning on 12/1/15 and ending on 7/12/16.

The first profile of the year was measured in March and showed relatively cool temperatures from top to bottom, ranging from 11.7 °C – 14.7 °C (Figure 29). The second profile in late April generally showed a 2-4 °C increase at all depths compared to March. Summertime profiles in June and July showed warm surface waters ranging from 22.4 °C – 23.2 °C, with the thermocline depth between 23-43 feet. During the same months, bottom temperatures ranged between 17.2 °C – 19.4 °C. Profiles in August and September showed unithermal conditions to depth with the surface to bottom differential in August and September only 1 °C and 1.1 °C, respectively. This was very unusual to have no summer time stratification and was attributed to a shallow lake depth. The final lake profile in November indicated that the surface waters had cooled and the lake had experienced a turnover event with cooler temperatures top (17.7 °C) to bottom (17.4 °C).

DO concentrations were highest on the surface of the lake in April, measuring 10.03 mg/l, and ranged between 7.3 mg/l – 9.06 mg/l for the remainder of the profiles (figure 29). Hypolimnetic oxygen depletion at depth didn't appear in earnest until June, with DO concentrations less than 3 mg/l found at 32 feet of depth and below. The final profile in

November showed uniform DO conditions ranging from 7.53 mg/l at the bottom and 8.05 mg/l at the surface.

3.3. Habitat Quality within the LSYR Basin

Habitat quality monitoring during WY2016 within the LSYR Basin continued to be done via photo documentation, specifically by maintaining a long standing record of photo point locations using digital cameras. The comparison provided in the following figures documents the changes at various locations from 2005 to 2016. Photographs were taken at designated locations (photo points) to track long-term and short-term changes that had occurred as a result of storm flows, spill events, phreatophyte growth, changes in canopy coverage and type, periods of drought, and the results of management activities in the drainage. Appropriate photo point locations are those that provide the best vantage point to show representative changes over time. A list of WY2016 photo points is provided in Appendix C (Table C-1 and Table C-2). The locations of all photo point sites are presented in Figure C-1.

LSYR mainstem photo point locations include all bridges from the Hwy 154 Bridge to the Highway 246 Robinson Bridge near Lompoc. Several other mainstem photo point locations are located on Reclamation property near Bradbury Dam, within the Refugio and Alisal reaches and at the LSYR lagoon. Tributary photo points include various locations on Hilton, Quiota, Alisal, Nojoqui, Salsipuedes, El Jaro, Ytias, and San Miguelito creeks.

Photo point comparison between 2005 and 2016 showed LSYR mainstem riparian vegetation growth since the initiation of BiOp target flows to Alisal Bridge, approximately 10.5 miles downstream from Bradbury Dam (Figures 30-34). While there are a few instances within the mainstem riparian corridor of significant willow, sycamore, and cottonwood growth in excess of 15 feet, in general riparian vegetation is exhibiting signs of stress and die-off from the drought, lack of flowing water, and the absence of target flows to Alisal Bridge due to declining reservoir elevation. The last Bradbury Dam spill event occurred in WY2011. Since WY2011, the region has experienced 5 consecutive years of dry conditions and decreased flows in the mainstem.

Tributary photo point comparisons between 2005 and 2016 are presented in Figures 35-36. Hilton Creek continues to show a maturing riparian zone, particularly within the reach between the URP and LRP which was initially activated in 2005. Larger trees (willows, alders, sycamores, and cottonwoods) are replacing the smaller understory within the drainage. Salsipuedes and El Jaro Creeks showed rapid recolonization of riparian vegetation in WY2016 due to five consecutive years of below average rainfall and an absence of channel changing flow events (Figures 37-39). Large flows are important in both the LSYR mainstem and its tributaries as they clear out potential passage barriers/impediments and remove debris/silt and generally clean out potential spawning locations for mating *O. mykiss.*

3.4. Migration – Trapping

Migrant trapping activities to monitor both migrating anadromous and resident *O. mykiss* have been conducted on the Santa Ynez River and/or several of its tributaries every year since 1993. There were a few exceptions to this due to the endangered listing of steelhead (1997), and threatened listing of California red-legged frog (2000) which caused trapping delays due to scientific permitting issues during those years, and WY2013 due to a misinterpretation of a NMFS request by Reclamation. Results from this year's migrant trapping effort cannot be compared to past years due to the truncated trapping effort required by NMFS to remain below the BiOp established Incidental Take Statement (ITS) limits.

WY2016 was the third year since issuance of the 2000 Cachuma Project BiOp that NMFS required staying within the juvenile (110) and adult (150) take limits as described within the BiOp ITS, even though juvenile take had been exceeded multiple times since 2000 and was reported to NMFS. In some previous years, the adult take limit was reached but not exceeded; hence the juvenile take exceedance was the concern.

To stay within the limits of the ITS and to maximize data gathering with limited take, the trapping effort was focused on upstream adult migration early in the migration season and downstream smolt (juvenile) migration from the middle to the end of the season. The downstream traps were modified to allow for a pass-through gate system that allowed the trap to be easily opened and closed. A 12-inch HDPE pipe approximately 15-feet long was secured to the back of the traps below the water level that allowed any fish within the trap to continue to move downstream unhindered. During the WY2016 trapping season, the HDPE pipe was attached to the trap as proposed, but was not needed as the total number of juvenile captured did not approach the established take limits.

In past years, three sets of paired upstream and downstream migrant traps were deployed for various periods of time at: (1) lower Hilton Creek (tributary farthest from the ocean) 0.14 miles upstream from the confluence with the mainstem LSYR (HC-0.14); (2) lower Salsipuedes Creek (tributary closest to ocean) 0.7 miles upstream of the confluence with the mainstem LSYR (SC-0.7); and (3) in the LSYR mainstem LSYR 7.3 miles downstream of Bradbury Dam (LSYR-7.3).

WY2016 represented the fifth consecutive year of dry conditions (the drought was officially proclaimed by the County on 1/24/14) with a greatly reduced number of storms and limited migration opportunities for *O. mykiss*, particularly in the LSYR mainstem downstream of Highway 154 Bridge and all of Salsipuedes Creek. Hilton Creek offered the only opportunity to capture upstream and downstream migrating fish due to the HCWS which provided enough water to allow upstream migrating resident *O. mykiss* on Reclamation property and in the Highway 154 Reach to access the creek to spawn prior to initiating trickle flows to the creek on 7/12/16. Both upstream and downstream migrant traps were installed at Hilton Creek on 2/16/16 and removed on 5/2/16 (Table 7). The Salsipuedes Creek and LSYR mainstem traps were not deployed due to low flow conditions during the migration season. Catch per unit effort (CPUE) for the WY2016 migrant trapping effort is presented in Table 9 and described in the Discussion Section.

Nighttime fish movement is a well-documented adaptation to avoid predation during migration (Mains and Smith, 1964; Krcma and Raleigh, 1970; Meehan and Bjornn, 1991; Brege et al., 1996). Others found that elevated turbidity can also reduce predation, specifically during stormflow events, suggesting migration during the receding limb of storm hydrographs (Knutsen and Ward, 1991; Gregory and Levings, 1998). The COMB-FD staff checks each trap a minimum of 4 times per 24-hour period. Fish captures are recorded into the following time categories; 1st AM (05:00-10:00), 2nd AM (10:01-14:00), 1st PM (18:00-22:00) and 2nd PM (22:01-01:59) depending on when they were captured (Table 8).

The lack of significant storms contributed to poor migration opportunities in the mainstem and tributaries due to lack of flow. For example, in Salsipuedes Creek between 12/1/15 and 4/30/16, the maximum instantaneous rate was 92 cfs recorded on 1/6/16 during the migration period which wasn't sufficient to breach the lagoon and allow for ocean connectivity. In the LSYR mainstem, the maximum instantaneous rate at Solvang was 10.2 cfs on 3/11/16 then diminished to 0.0 cfs on 4/4/16 for the rest of the water year, outside of dry season WR 89-18 releases.

Hilton Creek Migrant Traps: The upstream and downstream migrant traps were operated from 2/16/16 through 5/2/16. There were 8 upstream migrants captured from 2/19/16 through 4/22/16 ranging in size from 97 mm (5.7 inches) to 304 mm (12.0 inches) (Figures 40-42). The upstream migrating fish were captured in February (2), March (3), and April (3) with no upstream migrating fish captured in May. There were 4 upstream migrating *O. mykiss* identified as juveniles (<= 254 mm) and 4 identified as adults (=>255mm). The size class distribution for upstream migrating fish shown in Figure 42 suggests that there may have been 2 separate age cohorts captured this year.

There were 95 downstream migrants captured from 2/19/16 through 4/28/16, ranging in size from 88 mm (3.5 inches) to 208 mm (8.2 inches) (Figures 40-42). All of the fish captured moving downstream were classified as juveniles. In total, 90 of the 95 fish captured (94.7%) exhibited smolting characteristics with 56 identified as smolts and 34 identified as pre-smolt (Figure 40). The majority of smolts were captured in March (53), followed by April (29) and February (8). The average length of the smolts captured in February was 142.6 mm, increased to 153.8 mm in March, and increased again to 165.0 mm in April suggesting good growth and rearing conditions were available during the spring.

Of the 103 total fish captured migrating upstream and downstream, 97 (94.2%) were captured during the second evening and first morning trap checks showing that the majority of migrating fish were moving during the hours of darkness when predation possibilities are reduced (Table 8). The last smolt of the year was captured on 4/28/18. A breakdown of smolts, pre-smolts, and resident trout for each size category is presented in Table 10.

Because the USGS gauging station at Hilton Creek (11125600) was not functioning (Lake Cachuma releases to Hilton Creek were through the LRP downstream of the USGS gauge), both upstream (Figure 43a) and downstream (Figure 43b) captures in Hilton Creek were graphed with the flow information of the closest monitoring location downstream at Alisal Bridge in Solvang (11128500) (Figure 43). Of note and independent of any flow cues to trigger downstream smolt migration, smolts were recorded leaving the creek soon after the traps were installed with the first smolt captured on 2/19/16, 3 days after the traps were installed (Figure 40).

The upstream trap was operated for a period of 76 days with a trapping efficiency of 100% and a catch per unit effort (CPUE) of 0.11 captures/day while the downstream trap was operated for 73 days with a 96% trapping efficiency and a CPUE of 1.30 captures/day (Table 9). A summary of trapping results between Hilton Creek and Salsipuedes Creek by size class is provided in Table 10.

Salsipuedes Creek Migrant Traps: No trapping was conducted in Salsipuedes Creek due to poor flow conditions and no migration opportunities. The 5 consecutive years of drought coupled with the lack of channel changing flow events have created a dense, nearly impenetrable riparian vegetation corridor that makes it challenging for fish that inhabit the creek to move in any distances with such low flows. This is primarily due to riffle crests being too shallow to allow movement or have abundant leaf drift which essentially creates a small dam at many riffle crests, thereby preventing movement by *O. mykiss* up and down the creek. Only one storm (3/6/16) generated flow greater than 10 cfs and did not connect with the lagoon. Maximum flow rate of that stormflow event was only 15.8 cfs recorded at the USGS Salsipuedes Creek gauging station (11132500) (Figure 44). Flow quickly attenuated to 0.83 cfs by 3/10/16.

LSYR Mainstem Trap: No trapping was conducted at the LSYR mainstem trapping location in WY2016. LSYR mainstem flow recorded at the USGS Solvang gauge (11128500) showed peak flow on 3/14/16 at 4.2 cfs with no flow starting on 4/5/16 until WR 89-18 releases in July.

3.5. Reproduction and Rearing

Reproduction and rearing of *O. mykiss* in the LSYR basin were monitored through redd surveys (winter and spring) and snorkel surveys (end of the spring, summer and fall). The results are presented below.

Redd Surveys: Redd (spawning) surveys are typically conducted opportunistically once a month in the LSYR mainstem (Refugio and Alisal reaches) and bi-monthly in the tributaries (Hilton, Salsipuedes, and El Jaro [including Los Amoles and Ytias] creeks) in the winter and spring within the reaches where access is permitted. WY2016 was a poor year for resident and anadromous steelhead migration within the LSYR basin as neither the lagoon was breached nor was there LSYR mainstem flow to the lagoon at any point during the migration season. Fragmented habitat, beaver dams, and low flows essentially eliminated longitudinal *O. mykiss* movement within the LSYR mainstem and tributaries (except Hilton Creek). Spawning conditions in general were poor, particularly in the

LSYR mainstem, due to the absence of significant stormflow events and dry river conditions downstream of the Highway 154 Bridge by May.

Survey results are presented for the tributaries in Table 11 and Table 12. Redd surveys within the LSYR tributaries began in mid-January and ended in May. Due to the low flow conditions and continuing drought, spawning locations were limited to locations in Hilton Creek, 1 site in Salsipuedes Creek, and 1 site in Quiota Creek. Surveyors noted that many potential spawning locations in Salsipuedes and Quiota creeks were buried in leaf litter or silt as no significant flow events occurred to clean the substrate and create a migratory corridor.

The first spawning site of the season was observed in Salsipuedes Creek on 3/3/16. Two additional sites were identified on Hilton Creek on 3/24/16. The final redd site was identified in Quiota Creek on 5/3/16. The site in Quiota was identified at the end of April but was being actively worked by the fish so no data were collected at that time. All redd sites were assumed to be constructed by resident *O. mykiss* based on the smaller excavation dimensions, coupled with no LSYR mainstem connectivity to the ocean with the closed lagoon or river connectivity to the lagoon preventing access by anadromous steelhead. No redd sites were identified in the Highway 154 Reach. The Refugio and Alisal reaches were too dry for spawning, hence no surveys were conducted during WY2016 (Table 13).

Snorkel surveys: Snorkel surveys in WY2016 were conducted in the spring, summer, and fall within the LSYR mainstem (Figures 45-46 and Table 14). Surveys within the tributaries were more limited due to the ongoing drought (i.e., lack of water and/or poor visibility). Standard and accepted single-pass snorkel survey protocols were followed (Hankin and Reeves, 1988). Spring snorkel surveys were completed in July and were meant to record baseline conditions after the spawning season and prior to the critical summer rearing season. Spring surveys are designed to document the number and location of YOY produced, as well as the standing crop of *O. mykiss* going into the over-summering period. Summer surveys were conducted in the LSYR mainstem in September, commensurate with the during-release phase of the WR 89-18 Release. Fall LSYR mainstem snorkel surveys were followed soon after the summer survey due to the need for post-release surveys of the WR 89-18 Release. Fall surveys are meant to evaluate the population of over-summering *O. mykiss* going into the following water year.

The COMB-FD staff applied the same level of effort for each of the three surveys and covered the same spatial area during the spring, summer, and fall. However, factors such as turbidity, beaver activity, and lack of water influenced that objective and diminished the spatial extent of any of the three surveys as conditions changed throughout the year. The COMB-FD staff continues to solicit landowner cooperation and gain access to new reaches, particularly when conducting tributary project performance evaluations within upstream tributary reaches.

Snorkel survey locations within the LSYR mainstem were predominately pool habitats where the majority of *O. mykiss* reared during the dry season. However, in the tributaries the full suite of habitat types (pool, run, riffle, and glide) is typically snorkeled. The results of the surveys are broken out by 3-inch size classes of fish. The total number of *O. mykiss* observed during all three snorkel surveys is shown in Figure 46 with all survey dates shown in Table 14 and Table 17 for the LSYR mainstem and its tributaries.

LSYR Mainstem: LSYR mainstem snorkel surveys were conducted during the spring, summer, and fall within the Hwy 154, Refugio, Alisal, and Avenue of the Flags reaches (Figure 45). Spring surveys carefully locate all dry season rearing habitats for *O. mykiss* after wet season runoff and spawning (winter and spring). The summer and fall surveys then focus on those habitats with associated surveys in the habitats between to assure no fish were missed.

Hwy 154 Reach

Although the Hwy 154 Reach extends from the Stilling Basin (LSYR-0.0) to the Hwy 154 Bridge (LSYR-3.2), due to access constraints and the size and poor clarity of the Stilling Basin and the Long Pool, the only areas snorkeled were the habitats below the Long Pool to the Reclamation property boundary (LSYR-0.5 to LSYR-0.7). Snorkel survey results for the Hwy 154 Reach are shown in Figure 47 and Tables 15 and 16. No *O. mykiss* were observed in the reach below the Long Pool to the Reclamation property boundary during the spring survey (pre-release survey) (LSYR-0.5 to LSYR-0.7).

As mentioned above, a WR 89-18 Release was conducted in WY2016, which called for post-release surveys within the Hwy 154 Reach soon after the release was over. Divers returned to the Hwy 154 Reach in September to conduct a post WR 89-18 snorkel survey. The COMB-FD observed a total of 1 9-12 inch *O. mykiss* during this post survey.

Refugio Reach

The Refugio Reach ranges from the Hwy 154 Bridge (LSYR-3.2) downstream to Refugio Bridge (LSYR-7.8); however, the section of river between LSYR-3.2 to LSYR-4.9 is not snorkeled due to access limitations (Figure 45). Snorkel surveys (spring, summer, and fall) were conducted in relation to the timing of the 2016 WR 89-18 Release, as well as the predetermined number and location of habitats snorkeled. A total of 7 habitat units were visited during each survey; 6 pool habitats and 1 run habitat (Table 15 and 16). No *O. mykiss* were observed within any habitat during the spring (dry), summer, or fall snorkel surveys within the Refugio Reach. This marks the third time since the initiation of target flows to Alisal Bridge (LSYR-10.5) that *O. mykiss* have not been observed within the Refugio Reach the entire year.

Alisal Reach

The Alisal Reach extends from Refugio Bridge (LSYR-7.8) downstream to the Alisal Bridge (LSYR-10.5) (Figure 45). Snorkel surveys (spring, summer, and fall) were conducted in relation to the timing of the 2016 WR 89-18 Release, as well as the predetermined number and location of habitats snorkeled. A total of 7 habitat units were snorkeled during each survey; 6 pool habitats and 1 run habitat (Table 15 and 16). No *O.*

mykiss were observed during any of the spring (dry), summer, or fall snorkel surveys within the Alisal Reach. This marks the third time since the initiation of target flows to Alisal Bridge (LSYR-10.5) that *O. mykiss* haven't been observed within the Alisal Reach the entire year.

*Avenue of the Flags Reac*h

The Avenue of the Flags Reach is located from Alisal Bridge (LSYR-10.5) down to the Avenue of the Flags Bridge (LSYR-13.9) (Figure 45 and Table 15 and 16). The river towards the upper half of the reach has noticeably been changed by anthropogenic means, insofar as where Buellflat, Granite and other mining companies have been altering the riparian channel. The downstream half of the reach consists of a mature, unaltered riparian canopy. The COMB-FD staff attempted a spring snorkel survey in the Avenue of the Flags Reach in July, but conditions had already deteriorated and it was dry (LSYR-11.4). With WR 89-18 Release flows making it down past the Avenue of the Flags Reach in the summer, staff conducted surveys in the summer ("during-release") and fall ("post-release"). A total of 9 habitat units were surveyed, comprised of 4 runs and 5 pools. No *O. mykiss* were observed within the Avenue of the Flags Reach during any of the spring (dry), summer and fall snorkel surveys.

Cadwell Reach

The mainstem downstream of the Avenue of Flags Bridge is mostly comprised of private property that is categorized into sub-reaches (Sanford, Cadwell, Cargasacchi, etc.) where the COMB-FD staff has been granted access. Due to a large spill event in WR2011 (peak releases from Bradbury Dam of approximately 14, 250 cfs with 31.09 inches of rain at the dam that water year; see the Discussion Section for further historical hydrologic context) and subsequent *O. mykiss* observations in the lower reaches of the LSYR in WY2011, the staff uses the Cadwell Reach as one of the permanent monitoring locations for both snorkel activities and water quality monitoring (Figure 45 and Tables 15-16). The Cadwell Property (LSYR-22.0-23.0) contains one large bedrock pool approximately 18 feet in depth with several smaller pools located further upstream that can provide rearing habitat during wet years as has been observed. No *O. mykiss* were observed within the reach during any of the three WY2016 surveys and like other locations further upstream, the majority of the reach was drying out with residual pool depth not being maintained prior to the WR 89-18 Release in the summer.

Tributaries: Tributary snorkel surveys were conducted in the spring, summer, and fall in WY2016 at most of the long-term monitoring locations within Hilton, Quiota, Salsipuedes, and El Jaro creeks (Figure 45 and Table 17). Again, snorkel surveys were limited in the tributaries due to record drought conditions and the lack of surface water conditions.

Hilton Creek

Hilton Creek surveys are conducted on Reclamation property from the confluence of the LSYR upstream to the Reclamation property boundary, which is approximately 100 feet above the URP of the HCWS and a total distance of approximately 3,000 feet (Table 17 and Figure 48). Hilton Creek is divided into 6 reaches, separated by geomorphic breaks in

creek and channel morphology. Since Hilton Creek is supplemented with year-round flow from the lake through a relatively short stretch that contains a relatively high density of *O. mykiss*, all habitats within Hilton Creek are snorkeled and have been since the installation of the HCWS in 2001.

No surveys were conducted in the spring or fall due to extremely poor visibility. The COMB-FD staff conducted summer snorkel surveys in June within Hilton Creek as visibility temporarily improved, but the survey was still hampered by poor visibility in deeper pool habitats (Figure 48 and Tables 18 and 19). Divers noted that visibility was poorest near the release points (URP and LRP), with a settling of suspended sediment and better clarity further away from each release point. Despite the marginal water clarity during the summer survey, a total of 57 *O. mykiss* were observed, with 0 falling into the 0-3 inch size category and 28 (49.1%) falling into the 3-6 inch size category. The larger size classes of *O. mykiss* consisted of 22 (38.6%) 6-9 inch, 6 (10.5%) 9-12 inch fish and 1 (1.8%) 12-15 inch.

Quiota Creek

A historic section of Quiota Creek, located between Crossing 5 to Crossing 7, typically contains perennial flow and habitat of which staff routinely snorkels (Figure 45 and Table 18). WY2016 was yet another dry year and the conditions within this drainage continued to deteriorate during the oversummering period. Snorkel surveys were conducted on 4/13/16 with no *O. mykiss* observed. Summer and fall surveys were not conducted due to the lack of surface water.

Salsipuedes Creek

Lower Salsipuedes Creek contains five reaches that the COMB-FD staff separates by fluvial geomorphic changes in the stream channel. Reaches 1 through 4 are located between Santa Rosa Bridge (on Santa Rosa Road) upstream to the Jalama Road Bridge, a distance of approximately 2.85 stream miles (Figure 45). Reach 5 extends upstream from Jalama Road Bridge to the confluence of El Jaro Creek, a distance of approximately 0.45 miles. Reach 5 has been a historic monitoring location because of its reliable water clarity, presence of *O. mykiss*, and relatively easy access. All of the reaches within Salsipuedes Creek in WY2016 contained extremely turbid, low flow conditions during the entire year due to continued drought conditions. Snorkel surveys were attempted multiple times but divers encountered unfavorable conditions throughout the creek (Table 18 and Table 19). Visibilities ranged between 1-2 feet hence no reliable snorkel surveys could be conducted.

El Jaro Creek

A 0.40 mile long section of El Jaro Creek, just upstream of its confluence with Salsipuedes Creek, is typically surveyed by the COMB-FD in the spring, summer, and fall of each year (Figure 45, Tables 17-19). Divers arrived in early June to conduct spring snorkel surveys but poor water clarity and limited surface water provided poor survey conditions. Surveys were attempted in the poor conditions and no *O. mykiss* were observed. Most of lower El Jaro Creek near the confluence with Salsipuedes Creek was

dry by August, hence no snorkel surveys (i.e. summer and fall surveys) were conducted for the remainder of the year.

Other Fish Species Observed: All warm-water non-native fish species in the LSYR mainstem are counted during routine snorkel surveys conducted in the spring, summer, and fall (Figure 49 and Figure 50). Fish species that inhabit Lake Cachuma are often found throughout the LSYR mainstem downstream of the lake. Typically, the most numerous species observed during snorkel surveys include largemouth bass (*Micropterus salmoides*), three sunfish species including bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and redear sunfish (*Lepomis microlophus*), common carp (*Cyprinus carpio*), and two catfish species, specifically the black bullhead (*Ameriurus melas*) and the channel catfish (*Ictalurus punctatus*). It is thought that these fish travel downstream during spill event from the lake to the lower river via the Bradbury Dam spillway (not the penstock due to high pressure and small aperture release valves), take up residency in the Stilling Basin or habitats downstream and reproduce as conditions allow. Bass, sunfish and catfish are known predators of *O. mykiss*, particularly the younger life stages. Carp and catfish can stir up the bottom of the substrate and greatly reduce water clarity. Historically warm-water species are not observed in any of the three tributary drainages (Salsipuedes, Quiota, and Hilton) that the COMB-FD staff monitors. However, snorkel survey results within lower Hilton Creek did contain some warm-water fish in WY2016.

Hilton Creek

In the summer, the COMB-FD staff observed 2 largemouth bass (0-3 inch) and 11 sunfish species (8 0-3 inches and 3 3-6 inches) within Reach 1 in lower Hilton Creek. Water clarity made conditions unsuitable for snorkeling in the spring and fall. Prior to WY2015, it was uncommon to observe non-native fish species in Hilton Creek.

LSYR mainstem

Largemouth Bass: Largemouth bass were observed in low to moderate numbers within the LSYR mainstem in WY2016 (Figure 49). Spring snorkel surveys within the Refugio and Alisal reaches resulted in 4 largemouth bass being observed within each reach. Coincident with WR 89-18 releases, largemouth bass observations slightly increased during the summer with 5 observed in Refugio Reach and 9 observed in the Alisal Reach. Significant increases in largemouth bass numbers came during the fall snorkel survey with 163 observed in the Refugio Reach and 24 observed in the Alisal Reach.

Sunfish Species: There are multiple sunfish species (green, red-ear, and bluegill) inhabiting the LSYR mainstem, which can be especially difficult to distinguish in juvenile form. Although the COMB-FD staff differentiates between them during routine snorkel surveys when possible, all three species are lumped into a single sunfish category for the purposes of this report. No sunfish were observed within the Refugio or Alisal reaches during the spring survey (or pre WR 89-18 Release) (Figure 49). In the summer (or during WR 89-18 Release) survey, no sunfish were observed within the Refugio Reach and 55 sunfish were observed within the Alisal Reach. The fall (post WR 89-18 Release) survey showed 19 sunfish in the Refugio Reach and 24 sunfish in the Alisal Reach. The majority of summer and fall sunfish observations occurred in habitats that

were previously de-watered prior to WR 89-18 Releases, indicating successful dispersal from other habitats most likely from upstream.

Catfish Species: There are two species of catfish present in the LSYR mainstem, bullhead and channel catfish. Although the COMB-FD staff differentiates between them during routine snorkel surveys, they are lumped into a single catfish category for the purposes of this report. In WY2016, no catfish were observed during any of the spring, summer and fall surveys within the LSYR mainstem (Figure 50).

Carp: Despite hundreds of carp being observed from the bank in the Stilling Basin (LSYR-0.1) and Long Pool (LSYR-0.51) within the Hwy 154 Reach, very few were observed downstream within the Refugio and Alisal Reaches (Figure 50) in WY2016. No carp were observed in the Alisal Reach in the spring as most of the mainstem in that reach had dried. Two carp were observed in the Alisal Reach during the summer with none found during the fall survey. In the Refugio Reach, 12, 2 and 12 carp were observed in the spring, summer and fall surveys, respectively.

3.6. Tributary Enhancement Project Monitoring

All tributary enhancement projects are subject to biological monitoring and permitting requirements as stipulated in the BiOp (RPM 8). This includes pre- and post-project monitoring, as well as monitoring during construction. Construction monitoring of *O. mykiss* includes relocating fish outside of the project area, as well as monitoring water quality to assure there are no impacts from water being discharged to stream habitats downstream of the project area. In WY2015, the Quiota Creek Crossing 0A Project and Quiota Creek Crossing 4 were completed (December of WY2016). These projects removed two Arizona-type concrete crossings and replaced them with bottomless arched culvert to allow for complete adult and juvenile fish passage. Prior to removal of the low water crossings, these impediments were considered partial barriers to *O. mykiss* within Quiota Creek.

The Quiota Creek Crossing 0A and 4 Projects did not require the removal or relocation of *O. mykiss* because those portions of the stream were completely dry throughout the construction period. Project monitoring details for Crossing 0A and 4, including all plans and post-project monitoring results have all been sent to the appropriate regulatory agencies.

Post-project monitoring continued at completed tributary enhancement projects within Salsipuedes (including the Cattle Exclusionary Fencing Project), El Jaro, Quiota, and Hilton creeks. Snorkel surveys, redd surveys, water quality, hydrologic modeling, vegetation maintenance (watering, weeding) and photo documentation were all conducted in accordance with the post-project monitoring requirements at each location.

3.7. Additional Investigations

Genetic Analysis: Tissue samples from all of the migrant captures during WY2016 were sent to Dr. Carlos Garza of NOAA Southwest Science Center at UC Santa Cruz. Results

suggest captured and sampled migrating *O. mykiss* showed a strong genetic correlation to their streams of origin.

Beaver Activity: The North American Beaver (*Castor canadensis*), according to all of the scientific literature found on the historic and current distribution of beaver in North America, was introduced into the Santa Ynez River system sometime in the late 1940s to help foster the fur trade following World War II (Hensley, 1946; Baker and Hill, 2003; CDFG, 2005). Over time and with the increased amount of flow in the river since 2000 as a result of the target flow requirements set by the 2000 BiOp, the number and spatial distribution of beavers and their dams have increased throughout the LSYR mainstem. After Lake Cachuma was surcharged for the first time and the long-term target flows were initiated in 2005, beaver dams expanded in large numbers from Bradbury Dam to the Narrows. Portions of the LSYR mainstem downstream of the Lompoc Waste Water Treatment Plant (WWTP) and upstream of the Santa Ynez River lagoon have also been colonized. In WY2016, beavers continue to inhabit the Salsipuedes/El Jaro Creek watershed. Well established beaver dams can be of sufficient strength and breadth to remain in place during stormflows, and may create passage impediments and/or barriers for migrating *O. mykiss* during low to moderate flows.

Beaver dams and the associated ponds can have a negative impact on migrating and resident *O. mykiss*, especially during periods of drought when dam heights can be sufficient to create passage barriers, and the time between flushing flows can be large or not of sufficient magnitude to clear debris. Dams and ponds may inundate riffles/runs/spawning gravels, increase thermal heating of stream waters, inhibit movement of juvenile and adult fish, increase siltation, and create favorable habitat for bass, sunfish species, catfish, and carp. Beaver dams also fragment habitats and reduce migration opportunities during low flow periods. Additionally, beaver dams are typically built at the control point of pool habitats which are the prime spawning areas for resident and anadromous *O. mykiss* and may be reducing the amount of available spawning areas in the system. Beaver dams can affect operational flows of the Fish Passage Supplementation Program, target flow releases, and downstream water right releases. For example, the challenges in meeting target flows at Alisal Bridge in WY2007 were associated with beaver dams, which attenuated the release by spreading and ponding target flow waters and led to the need for greater water releases to meet target flow objectives.

As a result of continued beaver activity in the watershed and concern about the effectiveness of the Fish Passage Supplementation Program, an additional monitoring element has been added to the Fisheries Program to track the number, extent (size), and distribution (location) of beaver dams within the LSYR mainstem and tributaries below Bradbury Dam. This survey is conducted prior to the steelhead migration season.

Over a multiple day period in December and January of WY2016, the COMB-FD completed the LSYR mainstem beaver dam survey from the dam (LSYR-0.0) to the LSYR lagoon approximately the Narrows, downstream of the Salsipuedes Creek confluence with the Santa Ynez River (approximately LSYR-34.4), except within the

Hwy 154 Reach on the San Lucas Ranch (due to lack of access). The survey also included the section of the river downstream of the Lompoc Waste Water Treatment Plant (approximately LSYR-42.0) to the lagoon (approximately LSYR-46.6). The survey also included LSYR mainstem tributaries where beaver have been known to populate (i.e., Salsipuedes Creek watershed).

Dams were classified as barriers, impediments, or passable, utilizing CDFW passage criteria, as well as active or non-active. In order for upstream migrating *O. mykiss* to pass over barriers, CDFW criteria states that the depth of a pool at the downstream end of a passage barrier needs to be 1.5 times the height of a dam to allow fish passage. Surveyors measured dam height and the depth of the downstream habitat to determine if a fish could make the jump at the flow rate at the time of the survey. Dams were classified as barriers if the habitat downstream was less than 1.5 times the height of the dam. Barrier dams were large in height and were typically built at habitat control points (i.e., riffles) resulting in minimal depth downstream to allow fish to jump over the dams. Barrier dams spanned the river channel with no flanking flows. Impediment dams were generally smaller in height, had greater depths at their downstream side and/or were flanked by flow along one or both channel margins which would allow fish to swim around the impediment. Passable barriers were all small in height with deeper habitats immediately downstream of the dam with some measure of flanking present.

Over the past 6 years, the number, extent, and size of beaver dams has fluctuated in both the mainstem and tributaries. In 2011, Bradbury Dam spilled, removing many beaver dams and killing an indeterminate number of individual beavers in both the mainstem and tributaries either through the high flows or burying their dens. This was especially true in the Salsipuedes/El Jaro creeks watershed where only 5 beaver dams were identified in 2011 (Table 20). The population of beaver rebounded and the highest total number of dams identified in the mainstem (132) occurred in WY2013 and tributaries (36) occurred in WY2014. Mainstem dams identified in WY2016 (45) represent the lowest number of beaver dams identified in the mainstem since surveys started in 2010. It also represents a 58.3% reduction compared to the previous year. This is primarily due to the fact that the Santa Barbara County region entered its fifth year of drought with surface flows disappearing in many locations throughout the mainstem creating unfavorable conditions for beavers to thrive. Several beaver carcasses have been observed by COMB-FD in dried stretches of river during routine surveys in 2015 and 2016.

The number of active beaver dams along the LSYR mainstem was 1 in the Hwy154 Reach, 3 in the Refugio Reach, 1 in the Alisal Reach, 1 in the Avenue Reach, 10 in the Avenue of the Flags Reach downstream to the Narrows, and 1 on Vandenberg Airforce Base. The number and extent of beaver dams identified in WY2016 serves to illustrate the amount of habitat fragmentation caused by the dams within those wetted reaches along the LSYR; specifically 3 dams that were between 3-4 feet in height (Table 20).

There were 8 beaver dams identified in the Salsipuedes/El Jaro watershed; 5 in Salsipuedes and 3 in El Jaro Creek which was a 61.9% reduction compared to WY2015 (Table 20). More than half of the dams were classified as barriers, not so much from the

height of the dams, but because of the extreme low flow conditions. Six of the 8 dams were between 1-2 feet in height with only 1 dam between 2-3 feet in height. There were no beaver dams found in Hilton Creek and Quiota Creek.

4. Discussion

This section provides (4.1) additional historical context for the WY2016 results presented above, specifically since the issuance of the 2000 BiOp, (4.2-4.10) discussion as needed on specific topics of interest or concern, and (4.11) the status of last year's Annual Report recommendations. Summaries of the LSYR Fisheries Monitoring Program (Annual Monitoring Reports/Summaries) have been compiled for 1993-1997 (SYRCC and SYRTAC, 1997),1993-2004 (AMC, 2008), 2005-2008 (USBR, 2011), 2009 (USBR, 2012), 2010 (USBR, 2013), 2011 (COMB, 2013), 2012 (COMB, 2016a), 2013 (COMB, 2017), 2014 (COMB, 2018a), and 2015 (COMB, 2018b)

4.1. Water Year Type since WY2000

The rainfall (Table 21), runoff (Table 22), and water year type with the years that Lake Cachuma spilled (Figure 52) are presented since WY2000.

4.2. Comparison of Salsipuedes Creek and Hilton Creek Migrant Trapping Results

Comparison of trapping results between the two creeks was not possible in WY2016 due to extremely low flows in Salsipuedes Creek that prohibited trapping operations in that creek.

4.3. Tributary Passage Enhancement Projects

By December 2015, 11 (14 as of the date of this report) tributary passage enhancement projects had been completed within the LSYR basin: Salsipuedes Creek Highway 1 Bridge Fish Ladder, Salsipuedes Creek Jalama Road Bridge Fish Ladder, Hilton Creek Cascade Chute, El Jaro Creek Rancho San Julian Fish Ladder, Quiota Creek Crossing 6 Bridge, Cross Creek Ranch Fish Passage Project on El Jaro Creek, Quiota Creek Crossing 2 Bridge, Quiota Creek Crossing 7 Bridge, Quiota Creek Crossing 1, Quiota Creek Crossing 3, Salsipuedes Creek Cattle Exclusionary Fencing (not included in the specific fish passage enhancement project tables but described below), Quiota Creek Crossing 0A, and Quiota Creek Crossing 4, as well as the HCWS and HCEBS which supplies water year round to Hilton Creek from Lake Cachuma (Tables 23-24 and Figures 53-56). All documented anthropogenic passage impediments within the Salsipuedes/El Jaro Creek watershed have now been removed, allowing for full adult and juvenile *O. mykiss* passage throughout the stream. Fish have been observed moving through all of the fish passage facilities, and in cases where fish ladders were installed, fish are using the ladders for refuge and oversummering habitats. Hilton Creek and Quiota Creek continue to have a few anthropogenic passage impediments that are being addressed as time and funding become available.

The HCWS has transformed Hilton Creek into a dense riparian zone where there is little thermal heating from the URP to the confluence with the LSYR mainstem (Figures 35-36). In 2005, completion of the Hilton Creek Cascade Chute Project doubled the

available habitat for *O. mykiss* in the watered section of Hilton Creek (Figure 56) and releases from the URP provided for extensive riparian vegetation growth that has shaded and cooled the stream water (Figure 57). Due to critical drought conditions and no releases from the URP, though, the larger riparian trees between the URP and the LRP that need continuous water (i.e., alders and cottonwoods) have been stressed or have died that has resulted in some thermal heating in that upper reach (Figure 57).

In addition to the tributary passage enhancement projects mentioned above, there were three bank stabilization and erosion control projects that were completed in 2004 on El Jaro Creek. All these tributary projects removed potential passage barriers for adult and juvenile *O. mykiss*, reduced sediment supply to the stream, and/or provided for passage, spawning, and rearing of *O. mykiss* upstream of the project area. Many of the completed tributary projects also enhanced the footprint of the project by creating additional pools and refuge habitat, and by increasing native riparian vegetation.

Cattle Exclusionary Fencing Project:
A cattle exclusionary fencing project was completed on Rancho Salsipuedes on the lower reaches of Salsipuedes Creek in the winter of 2014. The project continued to be a success in WY2016 as cattle have been excluded from the stream corridor. Excluding cattle has limited nitrogen/phosphorous/pathogens inputs and prevented streambank trampling, grazing, and cattle-trail erosion which can add suspended solids to streams. COMB-FD staff are in close communication with the rancher and are regularly monitoring in-stream fencing of watering corridors as well as the permanent fencing above the banks. Several minor fencing repairs were needed and successfully completed in WY2016. The rancher and landowner are pleased with the outcome of the project.

4.4. Water Hyacinth Discovery and Removal

Invasive water hyacinth (*Eichhornia crassipes*) was first discovered in the LSYR during beaver dam surveys in December 2013 approximately 2 miles downstream of the Avenue of the Flags Bridge in Buellton. The infestation extended approximately 1.2 miles downstream and was contained by COMB-FD staff within that section of the river channel. Staff surveyed that section of river in WY2016 on multiple occasions and removed several small patches of water hyacinth. This has become a routine field monitoring activity.

Water hyacinth is native to the Amazon Basin in South America and has emerged as a major weed in more than 50 countries in the tropical and subtropical regions of the world with profuse and profound impacts. In California, the weed has caused severe ecological impacts in the Sacramento-San Joaquin River Delta by: 1) destroying biodiversity, 2) depleting oxygen and reducing water quality, 3) providing breeding grounds for pests and other vectors, and 4) generally blocking waterways hampering agriculture, fisheries, recreation, and hydropower (Villamagna and Murphy, 2010) .

4.5. HCWS Switch to HCEBS, Fish Rescue/Relocation from Hilton Creek

Critical drought conditions and limitations with lake water delivery systems to Hilton Creek required turning off HCWS pumped flows to the URP and transferring deliveries

to the HCEBS at the LRP, and subsequently dewatering the reach between the URP and the LRP (Figure 58). As described in a fish relocation proposal submitted by Reclamation to NMFS on 11/21/15 and reported on 12/16/15 (COMB-FD and CDFW, 2015), the effort was undertaken to conduct the following:

- Transfer lake water delivered to HCWS at the URP to the HCEBS at the LRP,
- Transfer that release from the URP to the LRP adhering to the established 2000 BiOp ramp-down rate of no greater than a 0.5 cfs per every 4 hours,
- Relocate all fish within Reach 5 (URP to the LRP) to downstream of the LRP, and
- Reduce HCEBS delivered flows to gravity feed only, rescuing fish as needed in the small side channels downstream of the LRP to the confluence with the LSYR.

The effort to capture and relocate fish required dip netting and electrofishing that was conducted by CDFW and COMB-FD staff. 247 *O. mykiss* and 7 sculpin were successfully relocated to refuge habitats downstream of the LRP. Unfortunately there were 11 *O. mykiss* and 5 sculpin mortalities over the 6 day effort, none associated with electrofishing.

4.6. Bradbury Dam Stilling Basin Non-Native Fish Removal

On 5/26/16 and 6/14/16, the Cachuma Project AMC discussed and then recommended conducting an operation to remove non-native fish from the Stilling Basin (LSYR-0.1) downstream of Bradbury Dam. On 6/6/16, NMFS provided Reclamation with a letter supporting the operation. The objective of the operation was to remove as many non-native fish as possible from the Stilling Basin by seining to: 1) enhance the Stilling Basin habitat should possible relocation of endangered southern steelhead (*O. mykiss*) from Hilton Creek to the Stilling Basin be needed due to critical drought conditions and limitations on lake water delivery to the creek, and 2) remove non-native fish species from that habitat prior to the 2016 WR 89-18 release when some of those fish could possibly move downstream with the release. Ned Gruenhagen (chair of the AMC) from Reclamation was tasked with coordinating the effort with assistance from NMFS, CDFW, and COMB-FD. A report of the operation was submitted by Reclamation to NMFS on 5/9/18 (Gruenhagen et al., 2018).

Fish were captured and removed from the Stilling Basin on 6/22/16 and 6/23/16 (Figure 59). A variety of methods were used alone or in combination to capture non-native fish. Seine hauls were made by personnel on the shore and in a motorized inflatable boat. Block nets were strategically placed to restrict fish movement to areas which were then seined. An entanglement set (gillnet) was deployed, then baited with canned cat food and bread that was submersed in permeable bags to lure fish to shallow water where seining was conducted. Additionally, a backpack electrofisher was used in areas with shallow water. The Stilling Basin seine was pulled 9 times in various locations within the habitat on 6/22/16. The seine pulls were limited by the length of the pocket seine (100 feet). Several block nets were deployed in the wadeable portions of the pool to help localize fish in areas where the primary seine was being pulled. On the second day of the

operation and in addition to seining, a backpack electrofisher (Smith-Root LR-24) was used on the shallow western and northern margins of the Stilling Basin.

Over the course of the 2 day operation, a total of 1,724 non-native fish were collected in addition to 5 crayfish (*Atascidae*) and 1 larval chorus frog (*Pseudacris triseriata*) during the operation. All non-native fish and crayfish captured were removed and dispatched. No *O. mykiss* or other native fish were captured or observed during the operation.

The largest number of fish collected in a given classification was fry of an unknown species (likely sunfish and carp) (Figure 59). These fry accounted for over 83% of the fish captured (1,440 of 1,724 fish). The second most abundant fish captured were bass, which accounted for about 9% of captures (157 of 1,724 fish). Sunfish species (most likely green sunfish) contributed 108 individuals to the count, or approximately 5% of the captures. Few adult carp and catfish were captured, but compared with other groups; the carp were larger, commonly observed, and likely comprised the greatest amount of biomass but were most adept at eluding capture.

The operation was a collaborative effort among the groups involved and was conducted in short order with limited preparation time. However, due to the extensive size and depth of the Stilling Basin and limitations of the gear used, the operation did not capture as many fish as were suspected of populating the Stilling Basin. Some fish escaped/eluded capture and the desire on the part of the AMC to remove all non-native fish, particularly piscivores, from that habitat was not accomplished. Hundreds to thousands of non-native fish of multiple species and size classes likely remained in the Stilling Basin after the operation. To effectively remove all (or most) non-native fish from the Stilling Basin, more extensive preparation and equipment would be needed and the Stilling Basin would need to be drained to allow for effective and complete seining.

4.7. Critical Drought Conditions in the LSYR Hwy 154 Reach and Hilton Creek

In WY2016, the drought continued to impact Santa Barbara County for the 5th consecutive year. No meaningful runoff to the lake, river, or tributaries occurred from WY2012-WY2016. With no runoff from storm events to replenish the lake, reservoir storage declined from a high of 195,763 acre-feet (af) in WY2011 to a low of 14,222 af at the end of WY2016 or 7.4% of capacity.

Leading up to the proposed 2016 WR 89-18 release in mid-July, and due to the critically low reservoir elevation, it was known that water releases into Hilton Creek through the HCWS or the HCEBS were no longer feasible once the WR 89-18 release commenced due to extremely low reservoir elevations. The elevation of the reservoir at the start of the WR 89-18 release on 7/12/16 was 663.01 (26,841 af) and most of the LSYR below Lake Cachuma had gone dry including most of the Hwy 154 Reach downstream of the Long Pool.

In order to avoid the need for fish rescues/relocations which initiates take and added risk of mortality due to the stress involved with the capture, handling, transport and relocation of *O. mykiss*, it was deemed prudent to minimize rescue/relocation efforts and keep the

fish in Hilton Creek. In addition, potential relocation spots throughout the lower watershed were evaluated and deemed insufficient in providing the seasonal habitat requirements necessary to ensure *O. mykiss* survival if relocated. No hatchery options for temporary storage were available. The optimal solution was to allow *O. mykiss* to continue to inhabit Hilton Creek below the LRP and provide trickle flow to the creek at the LRP to maintain residual pool depth in the deep bedrock pool habitats just downstream.

Prior to the start of WR 89-18 release on 7/12/16, lake discharge to Hilton Creek was maintained by HCEBS gravity flow to the LRP that reached approximately 1,500 feet of creek habitat just downstream. The HCEBS would no longer provide gravity flow to Hilton Creek once the WR 89-18 release started due to low reservoir head and high release rates out of the Outlet Works. As a result, the Fish Rescue Team (FRT) was called upon by Reclamation to rescue and relocate *O. mykiss* within the lower most section of Hilton Creek near the LSYR confluence and move them to larger pool habitats located downstream of the LRP. The operation took 2 days (7/11/16 and 7/12/16) and was done just prior to the start of the WR 89-18 release, focusing on Reach 1 and Reach 3 of Hilton Creek (Figure 60). Participants in the rescue operations included CDFW, NMFS, COMB-FD, and Reclamation. A total of 33 *O. mykiss* were captured and relocated to the Spawning Pool and Honeymoon Pool of Hilton Creek within Reach 4. A total of 245 sculpin were captured and relocated to the Long Pool. Several non-native species (green sunfish and largemouth bass juveniles) were also captured within Reach 1 and were dispatched. A report was provided to Reclamation with the results of the operation (COMB, 2016d).

Once the WR 89-18 release started on 7/12/16, trickle flow was provided to the creek at a rate of approximately 0.03 cfs for the remainder of the year. Trickle flow was provided by 1) the newly installed Hilton Creek Tanks (4 5-thousand gallon plastic tanks plumbed to discharge to the LRP) flow from 7/12/16 to 8/31/16 (Figure 61 and Figures 26-28) and 2) Stilling Basin pump flow from 9/1/16 to the end of the year (Figure 62). Continuous tank flow was possible by repeatedly filling the Hilton Creek Tanks utilizing a 2,000 gallon water tanker truck that obtained water from the Outlet Works during working hours and provided trickle flow throughout the day and through the night. This process was repeated for 51 consecutive days (7 days a week) and provided sufficient stream flow to sustain the remaining *O. mykiss* in Hilton Creek. The Stilling Basin pumps were submersible well pumps, one for operation and one for backup that allowed the Hilton Creek tanks to be used only for emergencies if the pumps turned off. The system was quite reliable with minimal interruptions of flow to the creek.

4.8. WR 89-18 Release Trapping:

The COMB-FD operated and maintained two trapping locations from the start of the release on 7/12/16 for a period of 2-3 weeks depending on the trap location (Figure 63). The Long Pool traps were deployed from 7/12/16 through 7/29/16, while the Stilling Basin traps were deployed from 7/12/16 through the afternoon of 7/27/16. All traps were blocked by 7/27/16 due to no fish being captured at either trap site in either direction for several days. Once blocked, all traps and associated weir panels were left in place to

prevent potential movement of *O. mykiss* out of the Long Pool and into reaches with potential for stranding after the end of the WR 89-18 release. Results of all the monitoring efforts were reported in the RPM 6 report (USBR, 2017) .

In the Stilling Basin trap, 3 *O. mykiss* (185 mm and 237 mm [captured twice] all in the going downstream), 8 largemouth bass (1 adult and 7 fry), and approximately 8,500 sunfish (including 4 adults) were captured in the downstream trap. No fish were captured in the upstream trap. In the Long Pool trap, 2 *O. mykiss* (303 mm and 206 mm, both going downstream), 3 largemouth bass (1 adult and 2 fry), 14 sunfish fry, 2 adult catfish and 2 sculpin were captured in the downstream trap. In addition, 5 pond turtles and 12 bullfrog tadpoles were captured. In the upstream trap, only 2 sculpin were captured during the entire deployment.

4.9. End of WR 89-18 Release Emergency Operations:

Emergency operations dealing with the inability to ramp down WR 89-18 Release, a switch of water supply to maintain minimum water delivery to Hilton Creek, and a fish rescue/relocation effort all occurred during consecutive days from 8/29/16 through 9/2/16 just after the end of the WR 89-18 release. A report was provided to Reclamation that summarized the suite of activities (COMB, 2016b).

The ability of Reclamation to ramp down the 2016 WR 89-18 Releases from Bradbury Dam in accordance with the rampdown schedule outlined in the 2000 Cachuma Project BiOp was not possible due to a malfunctioning valve within the penstock of the Outlet Works. As a result, no rampdown could be conducted below 76 cfs. On the morning of 8/29/16, Reclamation closed the Guard Gate of the lake end of Penstock below the dam which stopped flow to the LSYR and evacuated all the water within the penstock. Upon closing the Guard Gate, water was not available at the Outlet Works to supply the tanker truck that was delivering water to the Hilton Creek tanks at the time to maintain fish and habitat within the creek.

An alternative extraction point to fill the water tanks was located along the shores of Lake Cachuma via a trash pump to a water truck (Figure 64). This procedure was continued through 9/2/16 at which point the contract for the tanker truck expired. With that eventuality in mind, Reclamation installed on 8/26/16 the submersible electric (well) pumps (operational and backup) in the Stilling Basin that were connected to the Chute Release Point (CRP) of the HCWS (Figure 62). The system allowed for water extraction from near the bottom of the Stilling Basin where water temperatures were the coolest and delivered it directly to the LPR where it cascaded down into the creek and provided minimum stream flow to sustain the remaining *O. mykiss* population in Hilton Creek. The low discharge rate from the submersible pump maintained approximately 0.03 cfs, which was a similar discharge rate to what was being provided previously by the Hilton Creek Tanks during the WR 89-18 Release.

The abrupt end of the WR 89-18 Release necessitated an emergency fish rescue/relocation effort downstream of the Stilling Basin and within the accessible areas of the Highway 154 Reach from 8/29/16 to 9/2/16 by COMB-FD staff and CDFW personnel (Figure 64). The COMB-FD conducted several passes each day using bank

personnel with dip nets, while CDFW used electrofishing with COMB-FD staff assisting on 8/31/16. Rescued fish included: one *O. mykiss* (approximately 152 mm in length) and 47 sculpin that were relocated into the Long Pool. Mortalities included one *O. mykiss* (182 mm) that was hidden under detached reeds in a dry run habitat between the Stilling Basin and the Long Pool and was found early in the morning once surface water went underground overnight. In addition, there were 57 sculpin mortalities discovered throughout the two rescue locations. In total, there were 616 invasive warm water species (sunfish, largemouth bass, and catfish) as well as many crayfish and bullfrog tadpoles that were captured using dipnets and were subsequently dispatched. There were also 28 sculpin rescued and released and 72 invasive species captured and dispatched by the CDFW electrofishing crew on 8/31/16.

4.10. Long Pool Fish Rescue:

On 10/19/16, after discussion with NMFS, Reclamation approved a fish rescue, relocation, and non-native fish removal effort within the Long Pool (LSYR-0.51) due to the ongoing drought and drying conditions of that habitat after the cessation of the 2016 WR 89-18 Release (Figure 65). With assistance from CDFW, COMB-FD carried out a fish rescue on 10/20/16 and 10/26/16 within the Long Pool. The objective of the operation was to capture and relocate any remaining *O. mykiss* from the Long Pool and move them to Hilton Creek, with a secondary objective of removing and dispatching any non-native fish species from that habitat. A report was provided to Reclamation (COMB, 2016c).

A 100 by 4 foot weighted seine was used to capture fish species from within the Long Pool (Figure 65). An additional 75 by 3 foot weighted seine was also used to cordon off the shallow habitat located at the end point of the larger seine, to prevent fish moving into an inaccessible area. Crews pulled the large beach seine from one end of the Long Pool to the other and moved across the entire width of the pool, being careful to maintain connection with the bottom of the pool. The first and second day of the seining effort consisted of 3 passes each day, totaling 6 passes. No *O. mykiss* were observed or captured during the two day effort. In total, adult warm-water species captured included 79 carp, 3 sunfish species, 91 largemouth bass, and 32 channel catfish. A total of 82 pond turtles were captured and successfully relocated to the Stilling Basin. There were approximately 20.5 gallons of juvenile sunfish and largemouth bass fry captured and dispatched, with several threadfin shad captured during the first day.

The number of invasive species captured during this effort further reinforced the need for predator management below Bradbury Dam. Although there were likely *O. mykiss* present in the weeks leading up to this seining effort (last known *O. mykiss* occurrence was 8/29/16 during WR 89-18 Release rampdown), the Long Pool most likely had recently receded to a size that no longer offered refuge from predation. In the case of future fish rescues within the Long Pool, it is recommended that seining efforts commence soon after the first signs of losing residual pool depth within that habitat as well as removing non-native species from that habitat whenever possible.

4.11. Status of WY2015 Annual Monitoring Summary recommendations

The following is a status report (i.e., completed, ongoing, no longer applicable, or should carry forward to next year) for all the recommendations listed in the WY2015 Annual Monitoring Summary to improve the monitoring program pending available funding:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000) and BiOp (NMFS, 2000) to evaluate *O. mykiss* and their habitat within the LSYR for long-term trend analyses and improve consistency of the monitoring effort for better year-to-year comparisons:
    - Status: This recommendation is being followed and is ongoing.

- Continue the collaboration with CDFW regarding operation of their Dual-Frequency Identification Sonar (DIDSON) in Salsipuedes Creek:
    - Status: This recommendation is being followed and is ongoing.

- Continue annual development and implementation of a Migrant Trapping Plan in collaboration with Reclamation that would be reviewed and approved by NMFS to assure compliance with take limits set forth in the 2000 BiOp:
    - Status: This recommendation is being followed and is ongoing.

- Conduct basic stomach content analyses of non-native piscivorous fish whenever possible (during migrant trapping, fish rescue, and stranding surveys) specifically in habitats known to support *O. mykiss* and non-native fish:
    - Status: This recommendation is being followed and is ongoing whenever possible in association with any trapping of fish removal efforts.

- Encourage Reclamation to improve the reliability of their HCWS and HCEBS to deliver water and provide continuous flow to Hilton Creek without interruption:
    - Status: This recommendation is being followed and is ongoing for the HCWS and HCEBS.

- Collaborate with Reclamation regarding Critical Drought Conditions (i.e., flow adjustments to Hilton Creek and the LYSR mainstem, target flows, etc.) and downstream water releases for the fishery during drought conditions:
    - Status: This recommendation is being followed and is ongoing as possible.

- Continue to maintain and improve relationships with landowners to foster cooperation and gain access to additional reaches within the LSYR mainstem and its tributaries for all monitoring tasks, and particularly when conducting tributary project performance evaluations within upstream tributary reaches:
    - Status: This recommendation is being followed and is ongoing.

- Continue efforts to remove fish passage impediments within the LSYR basin as listed in the proposed actions of the BiOp, utilizing grant funding wherever possible, specifically within the Quiota Creek watershed:

    - Status: This recommendation is being followed and is ongoing. A grant has been written for the Quiota Creek Crossing 5 Project for next year.

- Continue to maintain the LSYR *O. mykiss* scale inventory and conduct analyses of growth rates, evidence of life-history strategies such as fresh versus marine water rearing, signs of spawning, etc. in support of ongoing fisheries investigations:
    - Status: This recommendation is being followed and is ongoing, but greater effort is needed for more complete analyses.

- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships:
    - Status: This recommendation is being followed and is ongoing.

- Develop a more fluid data recording and reporting procedure with regard to temperature probes on the Outlet Works of Bradbury Dam in order to keep track of the temperature of the water being released into the Stilling Basin, specifically to document BiOp compliance (18 ^{o}C maximum release temperature):
    - Status: This continues to be difficult as Reclamation does not routinely record the data nor input the recorded temperature values into their digital database. Further encouragement is suggested.

- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin:
    - Status: This continues to be a valuable recommendation with progress being addressed through the Reconsultation process between Reclamation and NMFS.

- Continue working with other *O. mykiss* monitoring programs within the Southern California Steelhead DPS and the Monte Arido Highland Biogeographic Region to improve collective knowledge, collaboration, and dissemination of information:
    - Status: This recommendation is being followed and is ongoing.

5. Conclusions and Recommendations

WY2016 was the fifth consecutive year of dry conditions with only 11.45 inches of rainfall recorded at Bradbury Dam. As a result, Lake Cachuma did not spill, the lagoon did not open to the ocean nor connect with the mainstem, and thus, there was no ocean connectivity with the LSYR mainstem throughout the water year. The lake reached historic low levels at 7% capacity resulting in only trickle flow available for the downstream fishery. The year was too dry to meet the criteria for fish passage supplementation. BiOp target flows for *O. mykiss* were met at Hilton Creek and Highway 154 Bridge for the initial part of the year but upon reaching critical drought conditions only target flows to Hilton Creek were met and those were further decreased to trickle flow in July for the duration of the water year. Reproduction in the LSYR basin was

observed through redd surveys within only the Salsipuedes Creek, Quiota Creek, and Hilton Creek; no redds were observed during surveys in the LYSR mainstem and El Jaro, Los Amoles, and Ytias creeks. The limited spawning success was substantiated through spring, summer, and fall snorkel surveys. Water quality conditions were difficult for *O. mykiss* survival in the Refugio and Alisal reaches where all fish either migrated out or perished due to drying conditions. Dewatering of the reach between the URP and the LRP on Hilton Creek in December resulted in 247 *O. mykiss* and 7 sculpin rescues and relocations plus 11 *O. mykiss* and 5 sculpin mortalities.

Monitoring tributary and LSYR mainstem *O. mykiss* populations has resulted in observations that fluctuate by water year type, instream flows, spawning success, and oversummering conditions. The continuation of the long-term monitoring program within the LSYR basin is essential for tracking population trends, particularly as restoration efforts are completed and adaptive management actions are realized. Collaboration with other local monitoring programs within the Southern California Steelhead DPS and Monte Arido Highland Biogeographical Region is desirable to better understand population viability and restoration potential at a regional scale.

Recommendations to improve the monitoring program: Based on observations and gained knowledge, the following suggestions (consistent with WY2015 recommendations) are provided by the COMB-FD's staff to improve the ongoing fisheries monitoring program in the LSYR basin in accordance with the BiOp, BA and FMP from WY2016 onward:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000) and BiOp (NMFS, 2000) to evaluate *O. mykiss* and their habitat within the LSYR for long-term trend analyses and improve consistency of the monitoring effort for better year-to-year comparisons;
- Continue the collaboration with CDFW regarding operation of their Dual-Frequency Identification Sonar (DIDSON) in Salsipuedes Creek;
- Continue annual development and implementation of a Migrant Trapping Plan in collaboration with Reclamation that would be reviewed and approved by NMFS to assure compliance with take limits set forth in the 2000 BiOp;
- Conduct basic stomach content analyses of non-native piscivorous fish whenever possible (during migrant trapping, fish rescue, and stranding surveys), specifically in habitats known to support *O. mykiss* and non-native fish;
- Encourage Reclamation to improve their system operation for delivering lake water to Hilton Creek with one or a combination of the HCWS, HCEBS, Hilton Creek Tanks, and Stilling Basin submersible pumps to provide continuous flow to Hilton Creek without interruption;
- Collaborate with Reclamation regarding Critical Drought Conditions (i.e., flow adjustments to Hilton Creek and the LYSR mainstem, target flows, etc.) and downstream water releases for the fishery during drought conditions;
- Continue to maintain and develop landowner relationships in the LSYR basin to foster cooperation and gain access to reaches for all monitoring and restoration tasks;

- Continue efforts to remove fish passage impediments within the LSYR basin as listed in the proposed actions of the BiOp, utilizing grant funding wherever possible, specifically within the Quiota Creek watershed;
- Continue to maintain the LSYR *O. mykiss* scale inventory and conduct analyses of growth rates, evidence of life-history strategies such as fresh verses marine water rearing, signs of spawning, etc. in support of ongoing fisheries investigations;
- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships;
- Develop a more fluid data recording and reporting procedure in regards to temperature probes on the Outlet Works of Bradbury Dam in order to keep track of the temperature of the water being released into the Stilling Basin, specifically to document BiOp compliance (18 ^{o}C maximum release temperature);
- Continue to work closely with the Santa Ynez River Water Conservation District during WR 89-18 releases to conduct trapping to monitor *O. mykiss* movement and remove non-native fish moving with the release and out of the Stilling Basin at the very beginning of the release;
- Work with Reclamation to develop a Stilling Basin Dewatering and Fish Removal Plan that would further efforts initiated during this water year for non-native fish management downstream of Bradbury Dam;
- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin; and
- Continue working with other *O. mykiss* monitoring programs within the Southern California Steelhead DPS and the Monte Arido Highland Biogeographic Region to improve collective knowledge, collaboration, and dissemination of information.

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3. Monitoring Results

Table 1: WY2000 to WY2016 rainfall at Bradbury Dam, reservoir conditions, passage supplementation, and water rights releases.

Water Year	Rainfall Bradbury* (in)	Year Type**	Spill	Reservoir Condition Storage (max) (af)	Reservoir Condition Elevation (max) (ft)	Passage Supplementation	Water Right Release
2000	21.50	Normal	Yes	192,948	750.83	No	Yes
2001	31.80	Wet	Yes	194,519	751.34	No	No
2002	8.80	Dry	No	173,308	744.99	No	Yes
2003	19.80	Normal	No	130,784	728.39	No	No
2004	10.60	Dry	No	115,342	721.47	No	Yes
2005	44.41	Wet	Yes	197,649	753.11	No	No
2006	24.50	Wet	Yes	197,775	753.15	Yes	No
2007	7.40	Dry	No	180,115	747.35	No	Yes
2008	22.59	Wet	Yes	196,365	752.70	No	No
2009	13.66	Dry	No	168,902	743.81	No	No
2010	23.92	Wet	No	178,075	747.05	Yes	Yes
2011	31.09	Wet	Yes	195,763	753.06	No	No
2012	12.69	Dry	No	180,986	748.06	No	No
2013	7.57	Dry	No	142,970	733.92	No	Yes
2014	9.96	Dry	No	91,922	710.00	No	Yes
2015	9.38	Dry	No	61,107	691.17	No	Yes
2016	11.45	Dry	No	32,989	669.66	No	Yes

* Bradbury Dam rainfall (Cachuma) period of record = 58 years (1953-2016) with an average rainfall of 19.91 inches.

** Year Type: dry =< 15 inches, average = 15 to 22 inches, wet => 22 inches.

Table 2: WY2016 and historic precipitation data for six meteorological stations in the Santa Ynez River Watershed (source: County of Santa Barbara and USBR).

Location	Station	Initial Year	Period of Record	Long-term Average	Minimum Rainfall		Maximum Rainfall		Rainfall (WY2016)
	(#)	(date)	(years)	(in)	(in)	(WY)	(in)	(WY)	(in)
Lompoc	439	1955	60	14.51	5.31	2007	34.42	1983	11.69
Buellton	233	1955	60	16.8	5.87	2014	41.56	1998	10.75
Solvang	393	1965	50	18.55	6.47	2007	43.87	1998	10.20
Santa Ynez	218	1951	64	15.81	6.58	2007	36.36	1998	10.19
Cachuma*	USBR	1953	62	19.86	7.33	2007	53.37	1998	11.71
Gibraltar	230	1920	95	26.45	8.50	2013	73.12	1998	13.08
Jameson	232	1926	89	29.1	8.50	2007	79.52	1969	13.45

* Bradbury Dam USBR rainfall.

Table 3: Rainfall by (a) storm events greater than 0.1 inches and (b) monthly rainfall totals at Bradbury Dam during WY2016; dates reflect the starting day of the storm and not the storm duration.

(a)

#	Date	Precipitation (in.)	SC 10 cfs	Los L 10 cfs
1	10/15/2015	0.24	No	No
2	11/3/2015	0.40	No	No
3	11/16/2015	0.23	No	No
4	12/11/2015	0.19	No	No
5	12/14/2015	0.22	No	No
6	12/20/2015	0.23	No	No
7	12/22/2015	0.45	No	No
8	1/5/2016	1.90	No	No
9	1/7/2016	0.95	No	No
10	1/10/2016	0.14	No	No
11	1/19/2016	0.76	Yes	No
12	1/31/2016	1.20	Yes	Yes
13	2/18/2016	0.67	No	No
14	3/6/2016	0.86	No	No
15	3/7/2016	1.17	Yes	Yes
16	3/12/2016	0.85	No	No
17	3/14/2016	0.13	No	No
18	4/10/2016	0.16	No	No
19	5/7/2016	0.36	No	No

(b)

Month	Rain (in.)
Oct-15	0.30
Nov-15	0.73
Dec-15	1.12
Jan-16	4.03
Feb-16	1.65
Mar-16	3.02
Apr-16	0.24
May-16	0.36
Jun-16	0.00
Jul-16	0.00
Aug-16	0.00
Sep-16	0.00
Total:	**11.45**

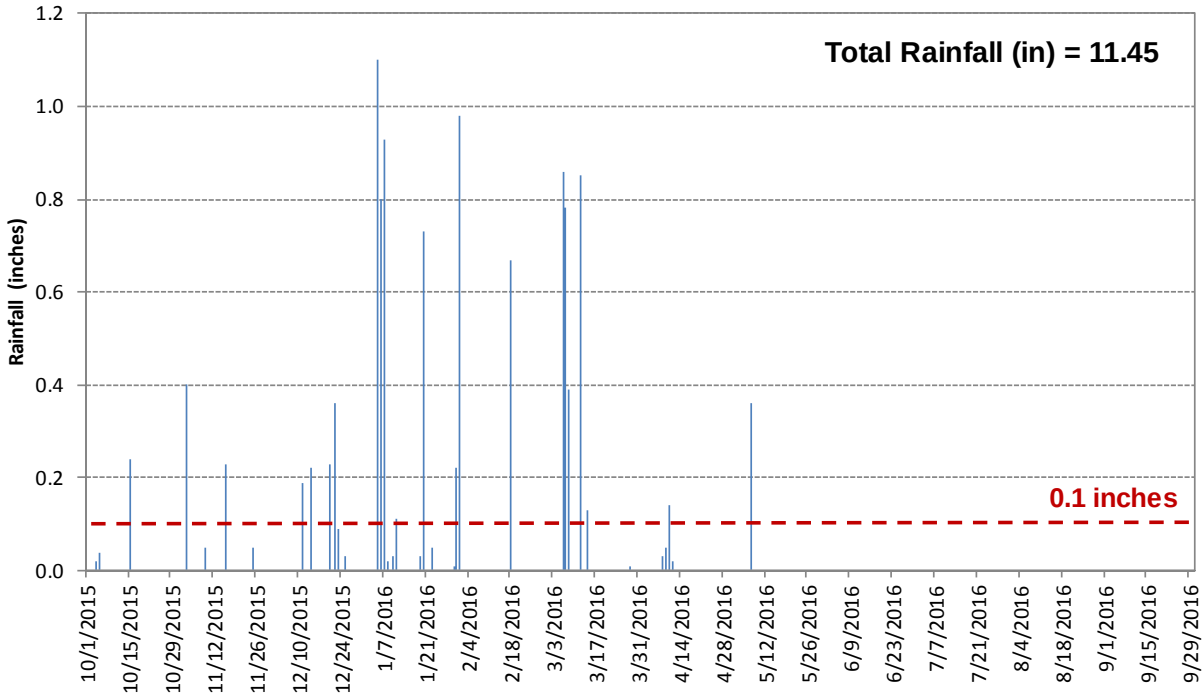


Figure 1: Rainfall in WY2016 recorded at Bradbury Dam (USBR).

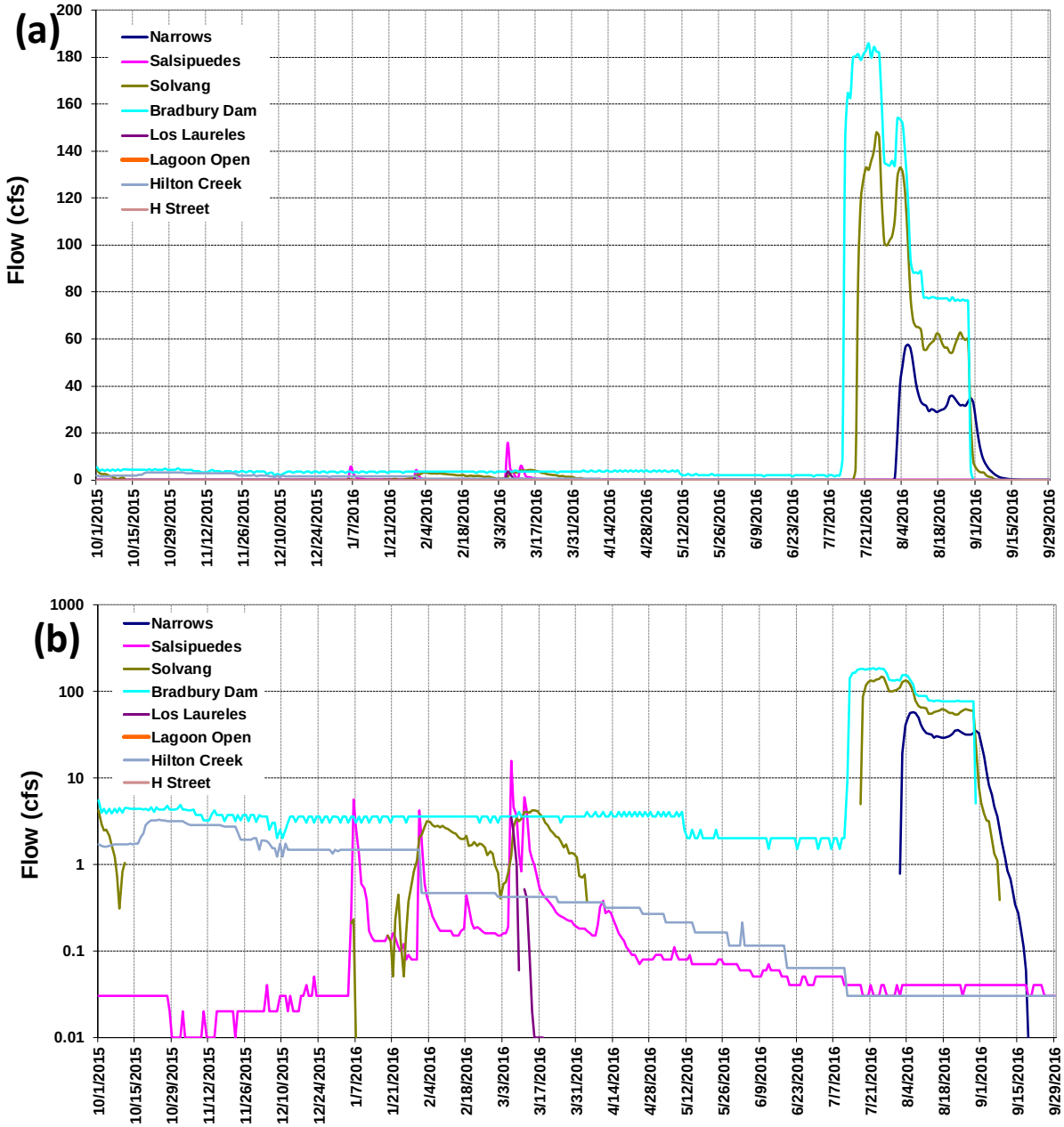


Figure 2: Santa Ynez River and tributary average daily discharge in WY2016 with (a) normal and (b) logarithmic distributions; the Santa Ynez River lagoon was not open in WY2016 (source USGS and USBR).

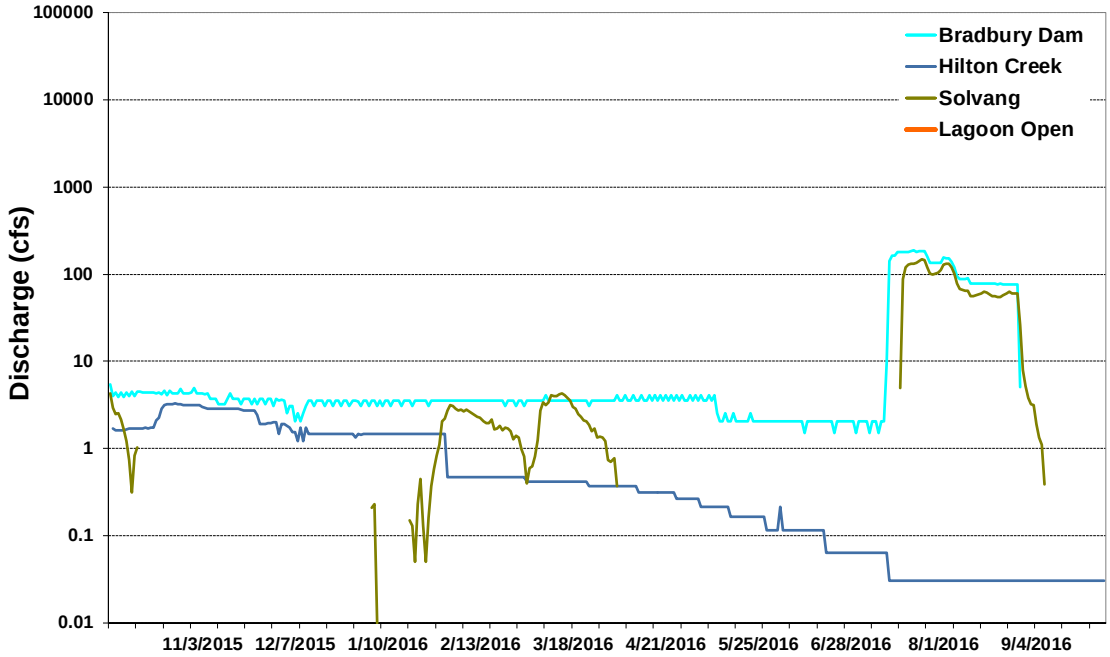


Figure 3: Average daily discharge at Hilton Creek, just downstream of the Upper Release Point, the LSYR mainstem at Solvang (Alisal Bridge) and Bradbury Dam during WY2016; the Hilton Creek USGS gauge is a low flow gauge hence does not record accurately above 50 cfs; the lagoon was not open during WY2016.

Table 4: Ocean connectivity, lagoon status and number of days during the migration season from WY2001 to WY2016.

Water Year	Year Type	Ocean Connectivity	Lagoon Status			# of Days Open in Migration Season*
			Open	Closed	# of Days	
2001	Wet	Yes	1/22/01	5/10/01	109	109
2002	Dry	No	-	-	0	0
2003	Normal	Yes	12/21/02	5/9/03	150	140
2004	Dry	Yes	2/26/04	3/22/04	26	26
2005	Wet	Yes	12/28/04	5/20/05	144	141
2006	Wet	Yes	1/3/06	-	271	151
2007	Dry	Yes	-	11/22/06	52	0
2008	Wet	Yes	1/6/08	5/19/08	134	134
2009	Dry	Yes	2/16/09	3/17/09	30	30
2010	Wet	Yes	1/19/10	5/6/10	107	107
2011	Wet	Yes	12/20/12	-	285	151
2012	Dry	Yes	-	5/17/12**	86	34
2013	Dry	No	-	-	0	0
2014	Dry	No	-	-	0	0
2015	Dry	No	-	-	0	0
2016	Dry	No	-	-	0	0

*Migration Season is January through May.

**Lagoon opened and closed several times during the water year.

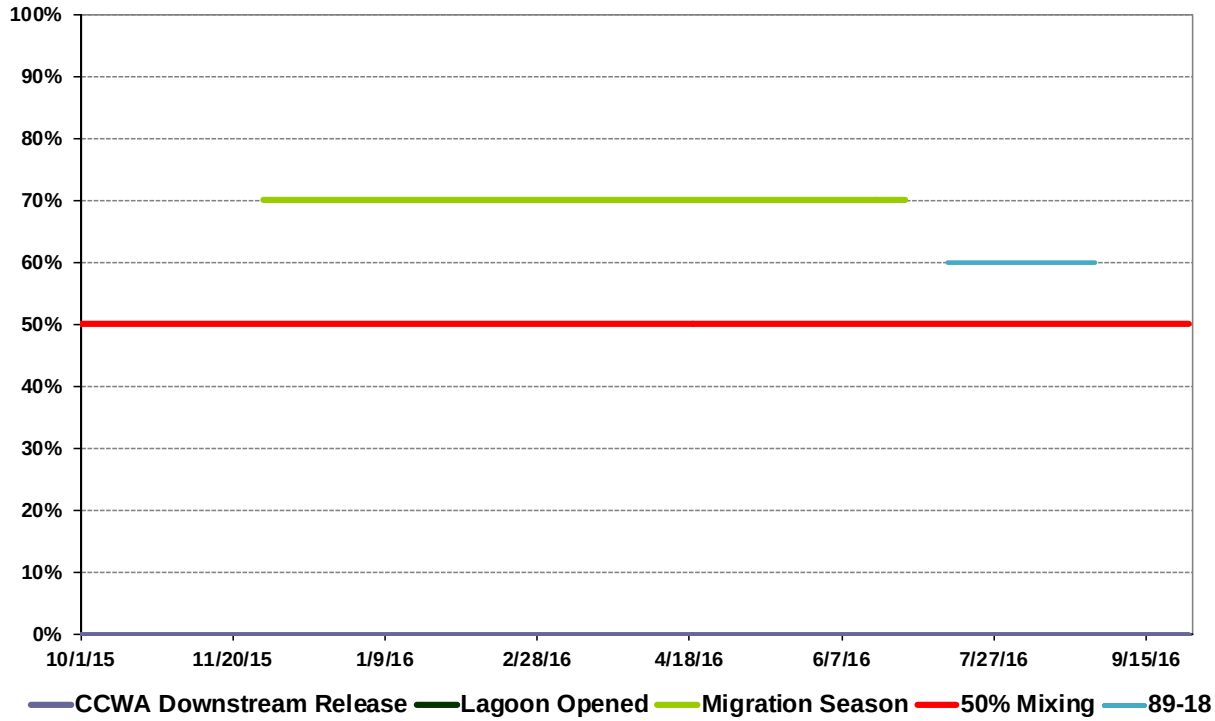


Figure 4: Percentage of CCWA water released from Bradbury Dam downstream to the Long Pool and the Lower Santa Ynez River during the WY2016 migration season (the lagoon open, migration season, and 89-18 releases are inserted for reference and do not relate to y-axis values); the lagoon was not open throughout the monitoring period.

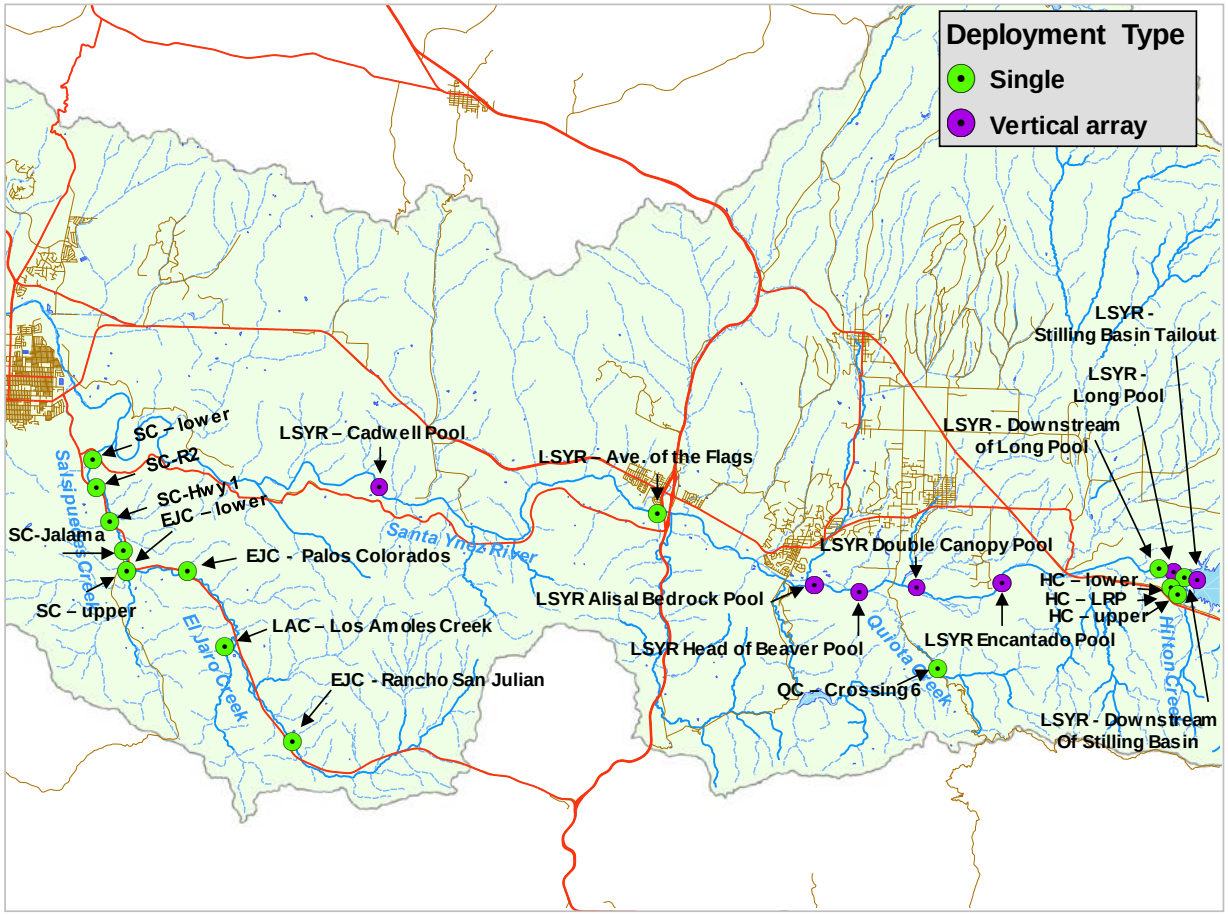


Figure 5: Thermograph single and vertical array deployment locations in WY2016 within the LSYR and its tributaries (HC – Hilton Creek, QC – Quiota Creek, SC – Salsipuedes Creek, and EJC – El Jaro Creek); the El Jaro Creek site and upper Salsipuedes Creek sites are very close together with overlapping symbols.

Table 5: 2016 thermograph network locations and period of record listed from upstream to downstream.

	Location Name	Stream ID	Type	Deployment Date	Retrieval Date	Period of Record (Days)	# of units (#)
Mainstem	Stilling Basin Wall	LSYR-0.1	Vertical Array	4/11/16			3
	LSYR - D/s of Stilling Basin	LSYR-0.25	Single	4/11/16	8/31/2016	139	1
	LSYR - Long Pool	LSYR-0.51	Vertical Array	4/11/16	11/9/2016	208	3
	LSYR - D/s of Long Pool	LSYR-0.62	Single	4/11/16	9/13/2016	152	1
	LSYR - Encantado Pool	LSYR-4.9	Vertical Array	Not Deployed - habitat dry prior to WR89-18			
	LSYR - Double Canopy	LSYR-7.65	Vertical Array	Not Deployed - habitat dry prior to WR89-18			
	LSYR - Head of Beaver	LSYR-8.7	Vertical Array	Not Deployed - habitat dry prior to WR89-18			
	LSYR - Alisal Bedrock Pool	LSYR-10.2	Vertical Array	Not Deployed - habitat dry prior to WR89-18			
	LSYR - Avenue of the Flags	LSYR-13.9	Single	Not Deployed - habitat dry prior to WR89-18			
	LSYR - Cadwell Pool	LSYR-22.68	Vertical Array	Not Deployed - habitat dry prior to WR89-18			
Tributaries	Hilton Creek (HC)-lower	HC-0.12	Single	4/22/2016	8/15/2016	113	1
	HC-at LRP	HC-0.25	Single	7/20/2016	11/30/2016	130	1
	HC-upper	HC-0.54	Single	Upper Release Point Not Functioning			
	Quiota Creek (QC)-Crossing 6	QC-2.66	Single	5/3/2016	8/18/2016	105	1
	Salsipuedes Creek (SC)-lower-Reach 1	SC-0.77	Single	5/11/2016	9/19/2016	128	1
	SC-Reach 2-Bedrock Section	SC-2.2	Single	5/11/2016	11/22/2016	191	1
	SC-Reach 4-Hwy 1 Bridge	SC-3.0	Single	5/11/2016	11/22/2016	191	1
	SC-Reach 5-Jalama Bridge	SC-3.5	Single	5/11/2016	11/22/2016	191	1
	SC-upper at El Jaro confluence	SC-3.8	Single	Not deployed		Dry	
	El Jaro Creek (EJC)-Lower-Confluence	EJC-3.81	Single	Not deployed		Dry	
	EJC-Palos Colorados	EJC-5.4	Single	5/11/2016	11/22/2016	191	1
	EJC-Rancho San Julian Bridge	EJC-10.82	Single	Not deployed		Dry	
	Los Amoles Creek (LAC)-Creek Crossing	LAC-7.0	Single	5/11/2016	11/22/2016	191	1

*Stream distance for El Jaro Creek (a tributary of Salsipuedes Creek) are to the confluence with the LSYR mainstem.

Table 6: Water quality monitoring sites with *O. mykiss* and/or non-native warm water fish species presented as present/absent for reference with the water quality data; blanks indicate no fish species were observed.

Reach	Sub-Reach	Habitat Name	Stream ID	Observed Non-Native Fish Species*: Spring	Summer	Fall
LSYR Mainstem:						
Reach 1	Hwy 154	Stilling Basin	LSYR-0.1	B, C	B, C	B, C
		Long Pool	LSYR-0.51		C	C
		Downstream of Long Pool	LSYR-0.62	B, S	ns	O, B, S
Reach 2	Refugio	Encantado	LSYR-4.95	Dry		B, S
		Double Canopy Pool	LSYR-7.65	B, C	B, C	B, S, C
	Alisal	Head of Beaver Pool	LSYR-8.7	Dry		B, S
		Alisal Bedrock Pool	LSYR-10.2	Dry	B, S	S
Reach 3	Ave. of the Flags	Ave. of the Flags (HWY 101)	LSYR-13.9	Dry	B, S	B, S, C
	Cadwell	Cadwell Pool	LSYR-22.68	B, S, C	B, C	B, C
Tributaries:						
Hilton	Reaches 1-5			O	O	O
Quiota	Crossings 1-9				ns	ns
	Upstream of Crossing 9			O	O	O
Salsipuedes	Reaches 1-4			ns	ns	ns
	Reach 5				ns	ns
El Jaro	Upstream of Confluence				Dry	Dry

* O - *O. mykiss* , B - bass, S - sunfish, C - carp, blank means zero observed.

ns - not snorkeled due to turbidity.

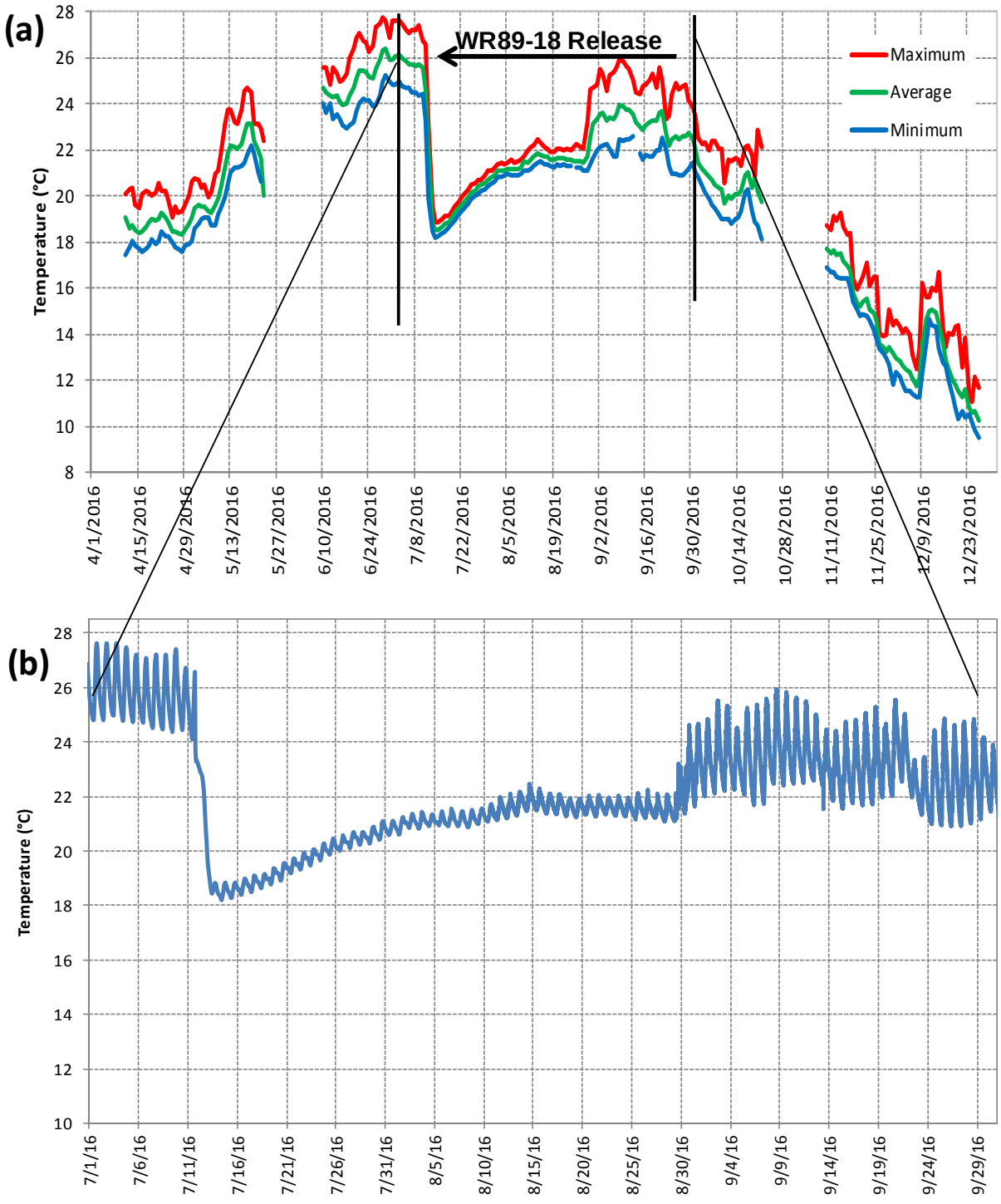


Figure 6: 2016 LSYR-0.1 (Stilling Basin parapet wall) surface (1.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of record.

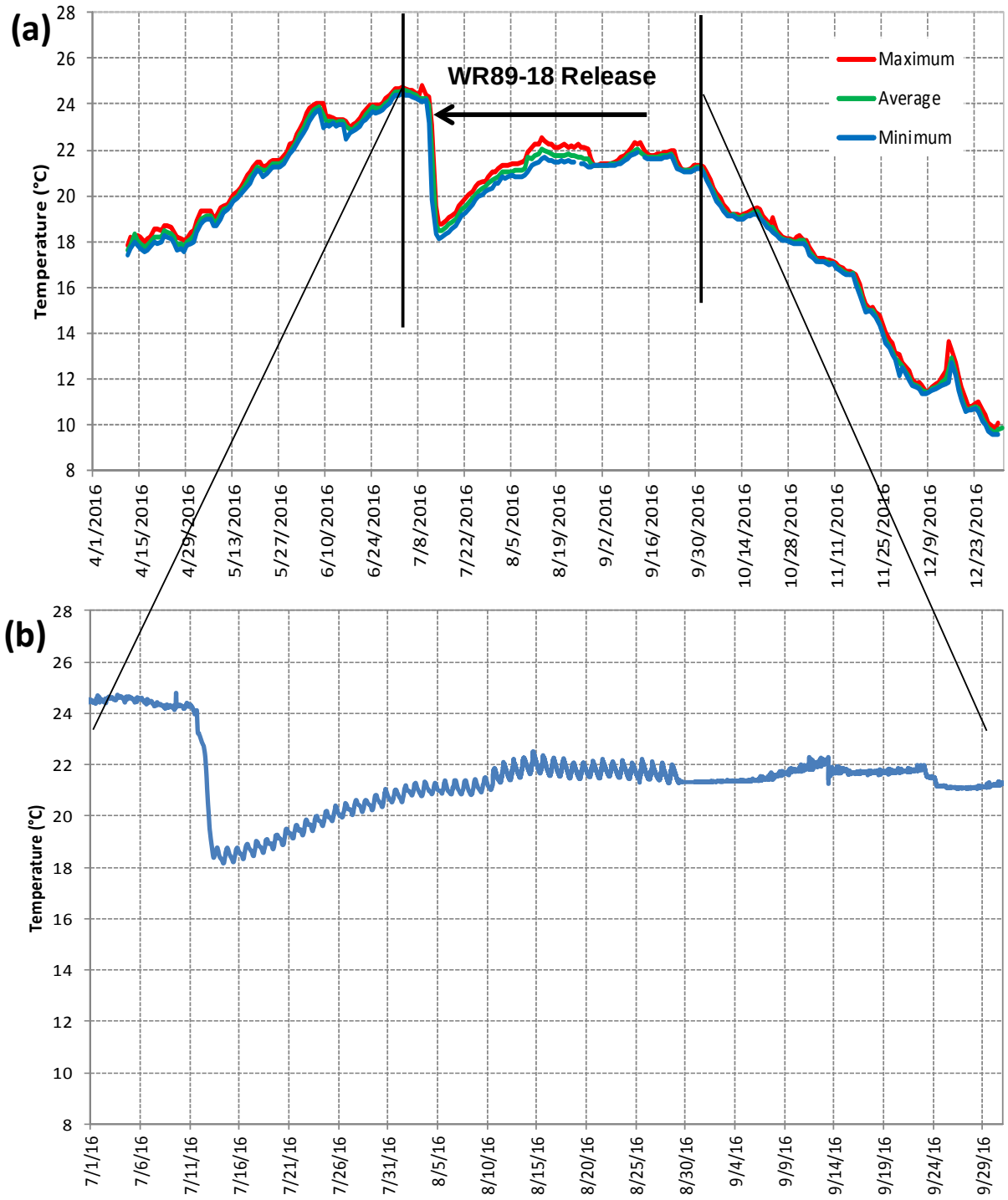


Figure 7: 2016 LSYR-0.1 (Stilling Basin parapet wall) middle (14.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of record.

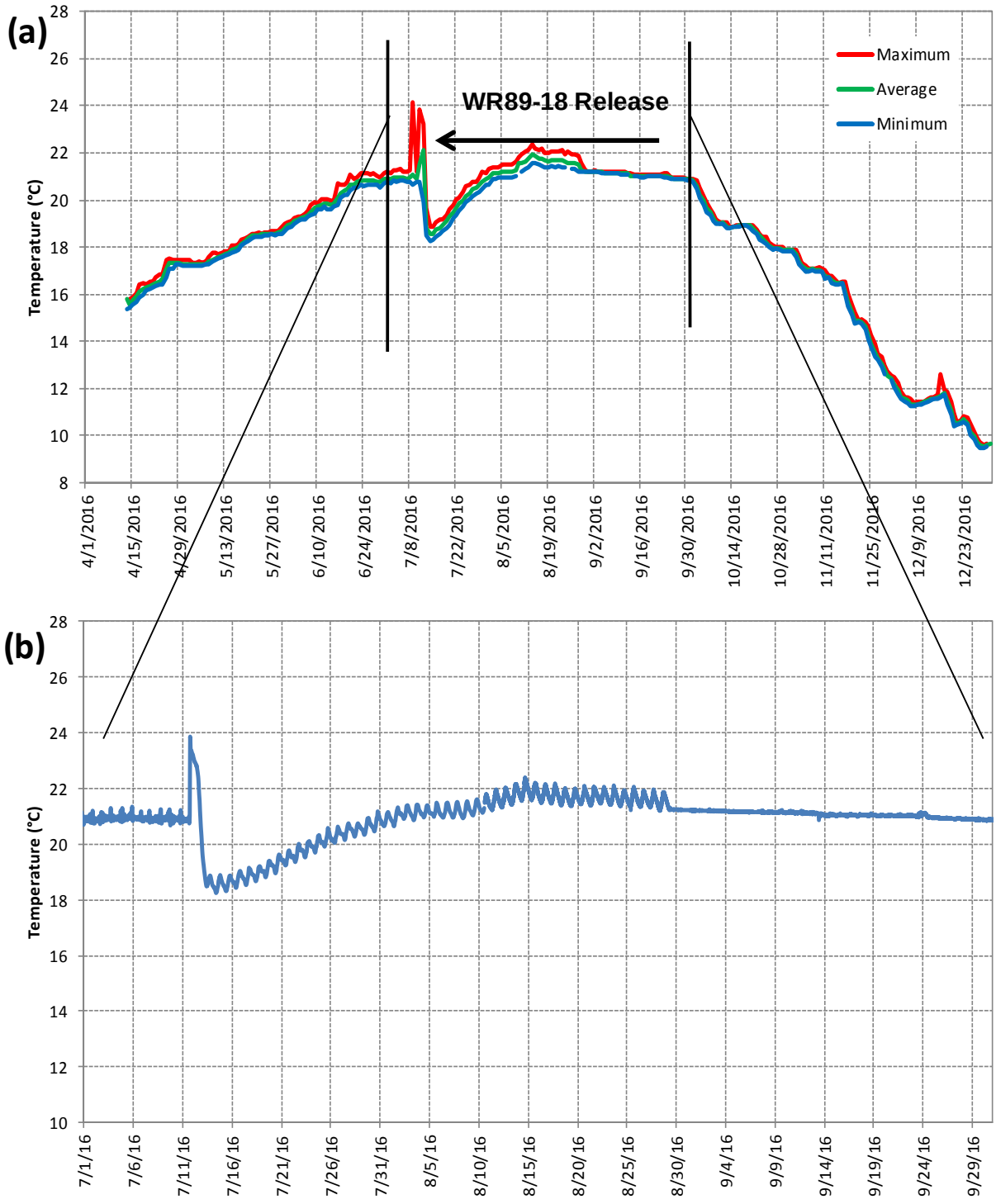


Figure 8: 2016 LSYR-0.1 (Stilling Basin parapet wall) bottom (28.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of record.

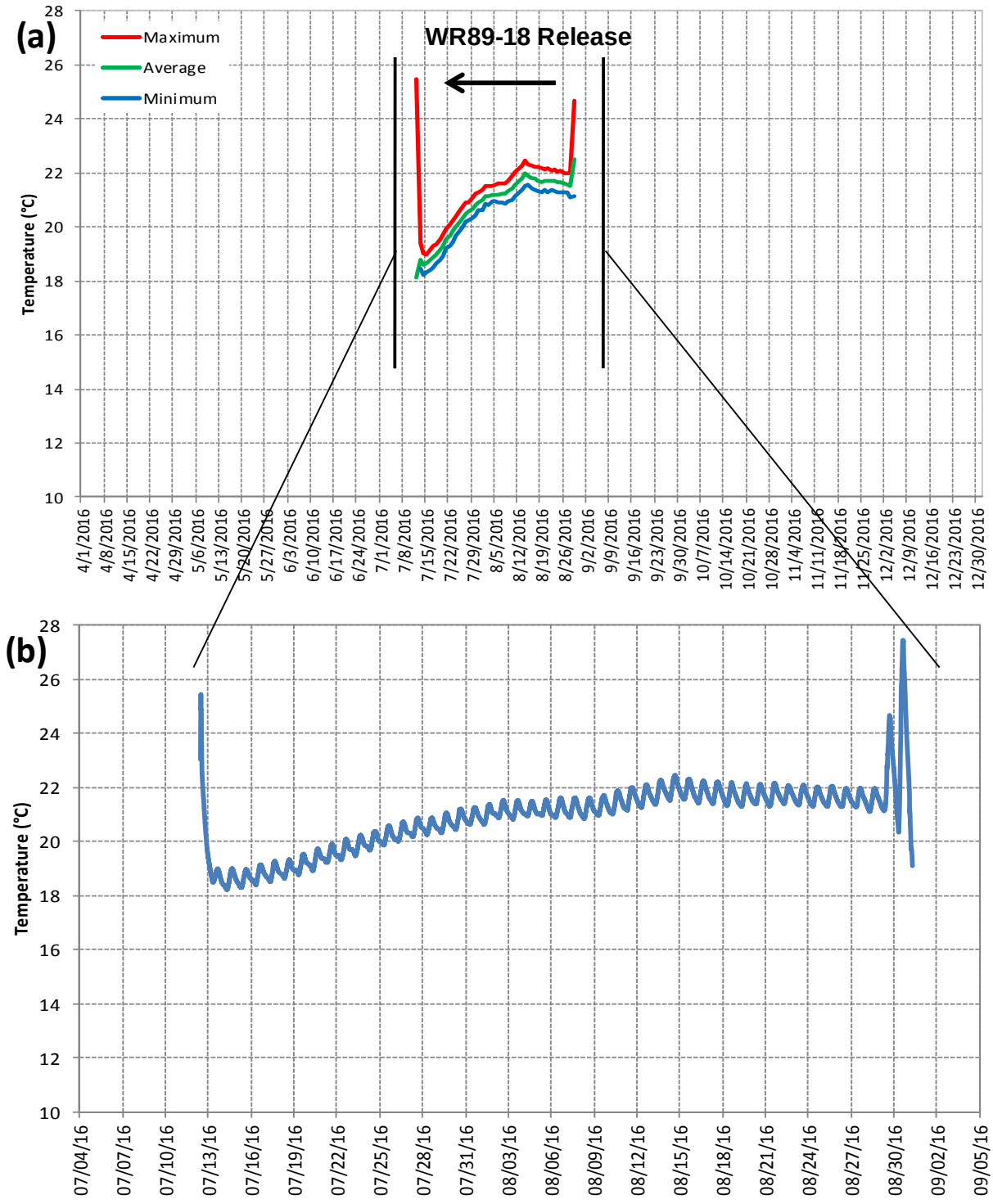


Figure 9: 2016 LSYR-0.25 (Downstream of the Stilling Basin) bottom (1.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of record; habitat was dry before WR89-18 and dewatered (8/30/16) soon after WR89-18 releases stopped.

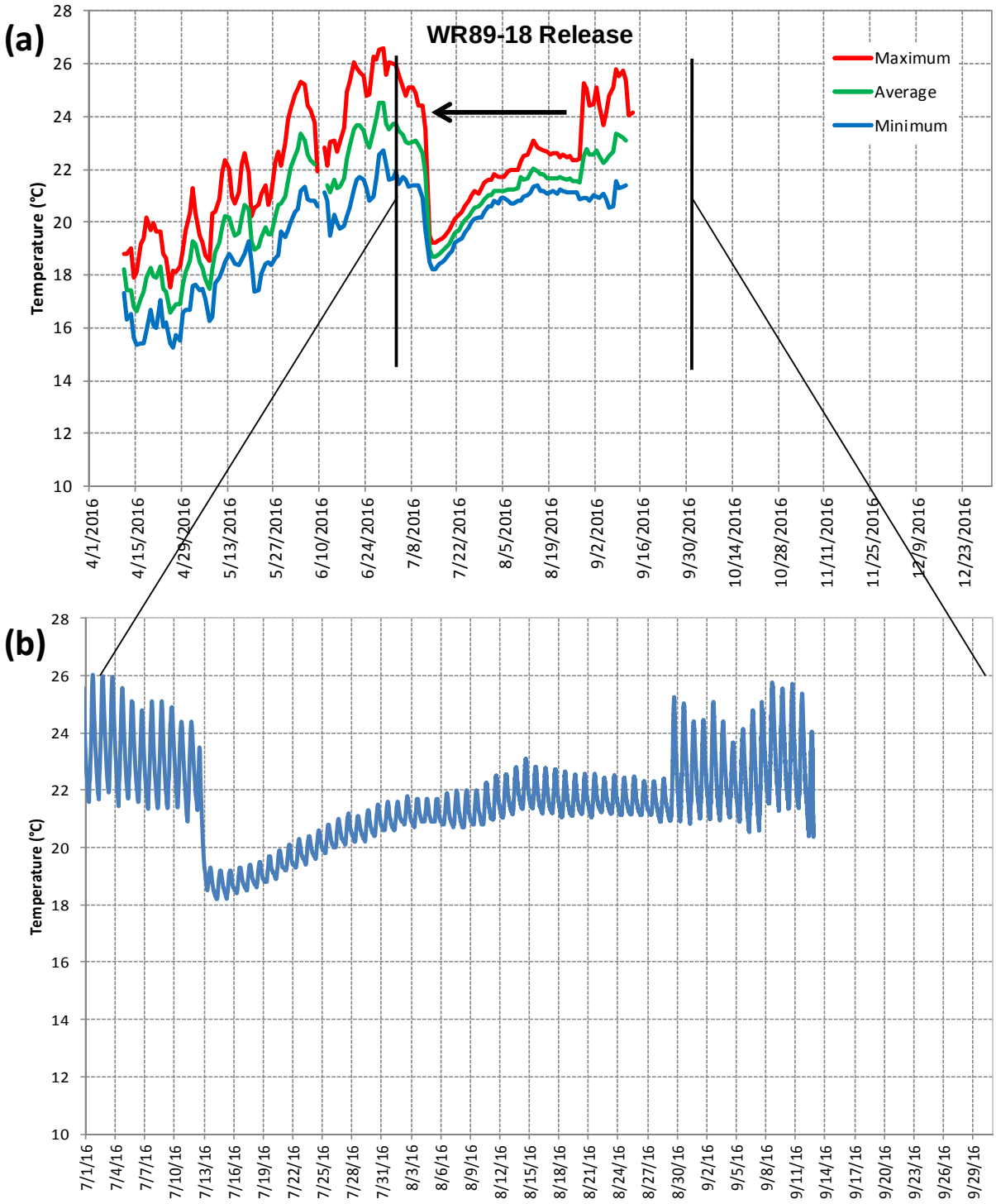


Figure 10: 2016 LSYR-0.51 (Long Pool) surface (1.0 foot) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data for the entire period of record. Surface unit exposed to air on 9/12/16 due to shrinking habitat following WR89-18.

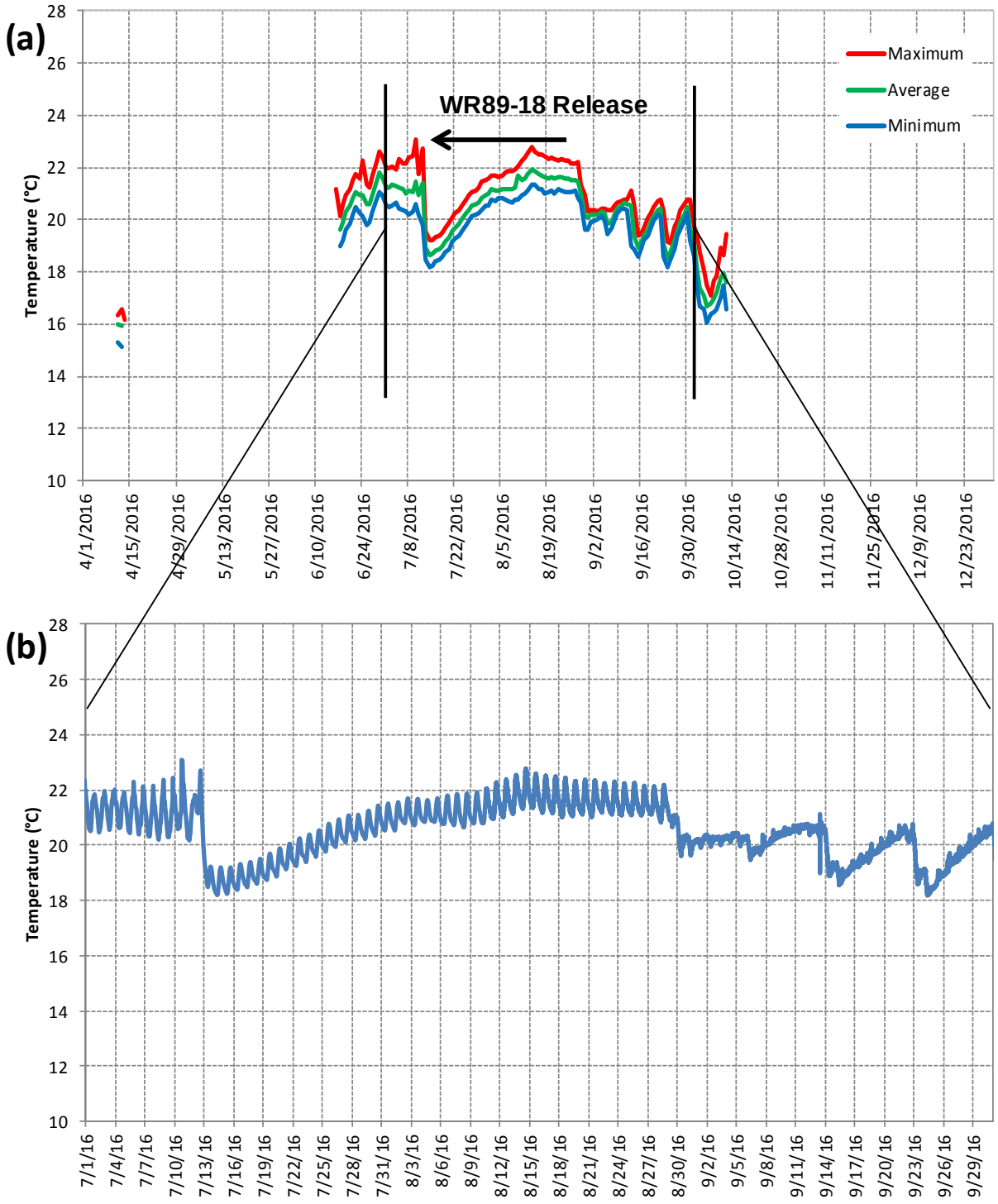


Figure 11: 2016 LSYR-0.51 (Long Pool) middle (4.5 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data for the entire period of record. The middle unit was exposed to air on 10/11/16 due to a shrinking habitat following WR89-18 releases.

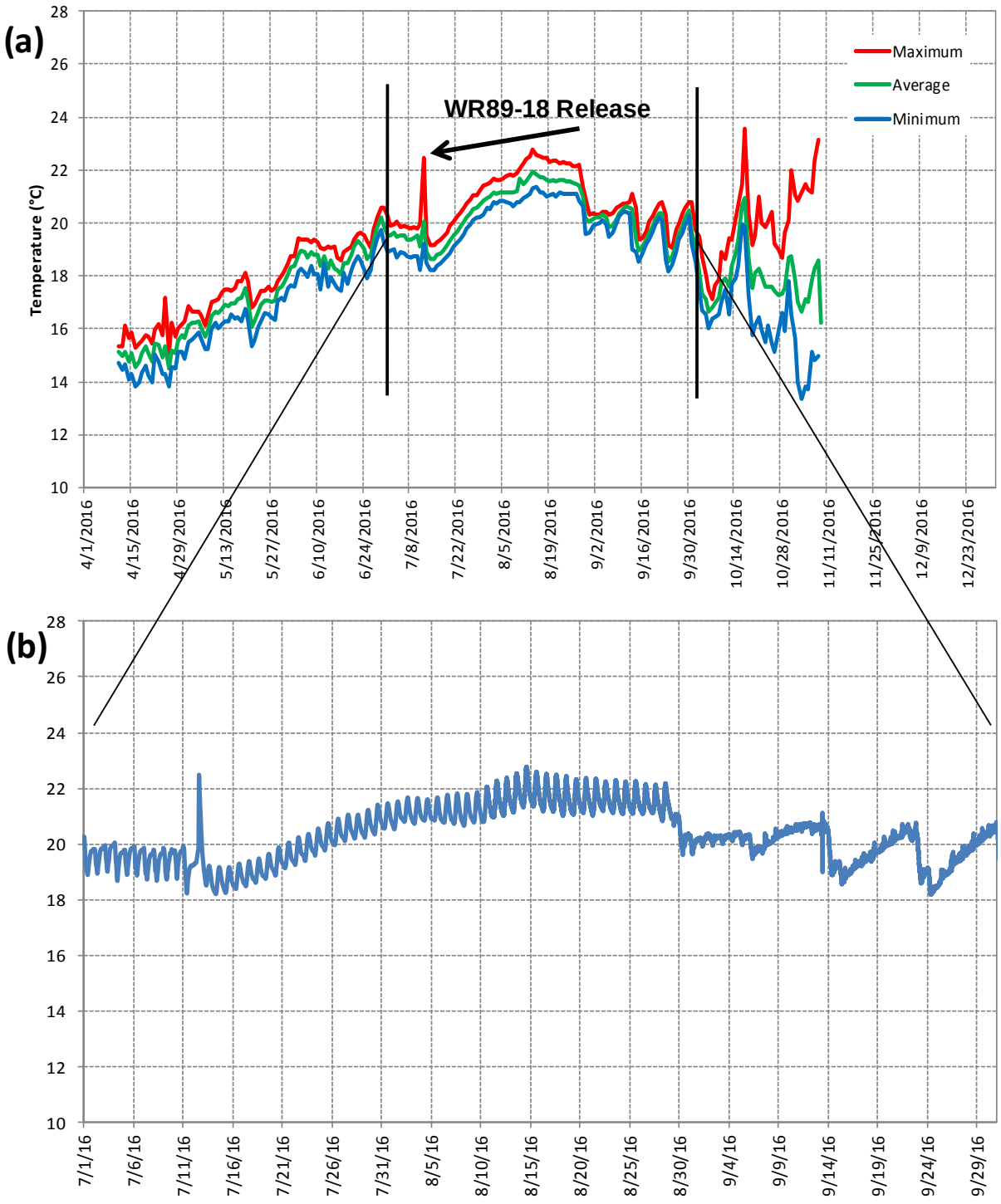


Figure 12: 2016 LSYR-0.51 (Long Pool) bottom (8.5 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data for the entire period of record. The unit was removed on 11/9/16 from a drying habitat.

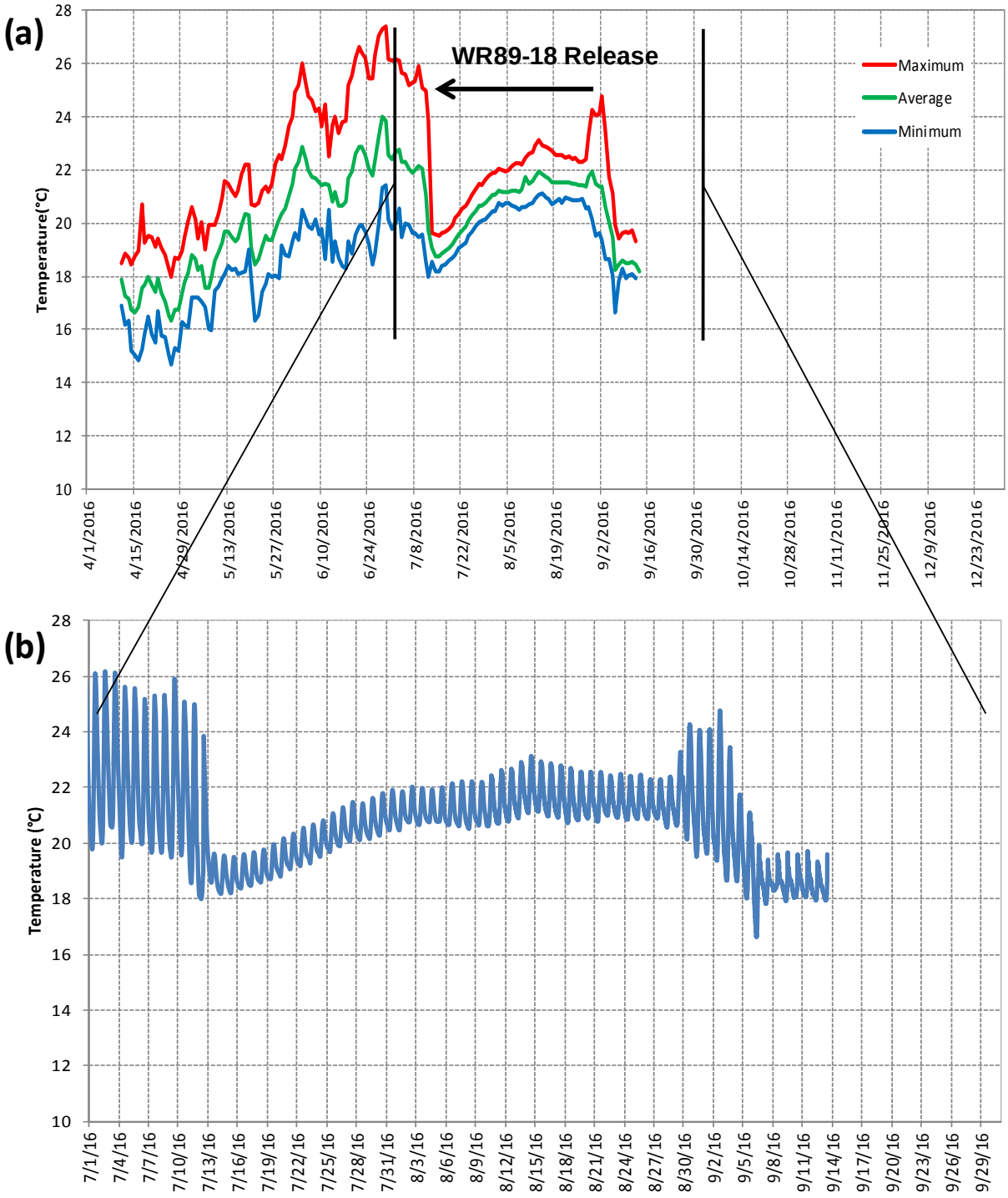


Figure 13: 2016 Reclamation property boundary LSYR 0.68 (downstream of the Long Pool) bottom (2.0 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data for the entire period of record. The habitat was dry prior to WR89-18 and dried on 9/15/16 soon after releases were stopped.

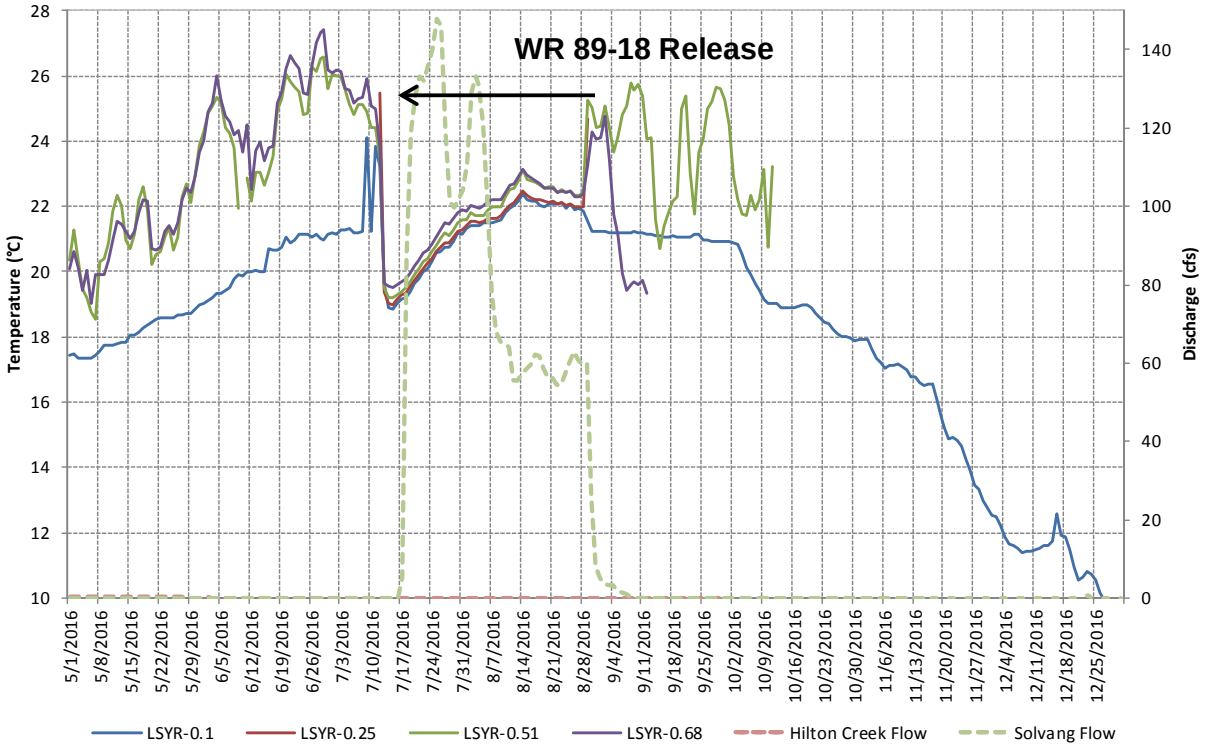


Figure 14: 2016 Longitudinal maximum surface water temperatures at: Stilling Basin parapet wall (LSYR-0.1), Downstream of Stilling Basin (LSYR-0.25), Long Pool (LSYR-0.51), and downstream of the Long Pool (LSYR-0.68) with daily flow (discharge) at the Hilton Creek and Solvang (at the Alisal Bridge) USGS gauges; no water quality monitoring was conducted at many of the downstream mainstem monitoring locations because the river was dry prior to WR89-18 releases.

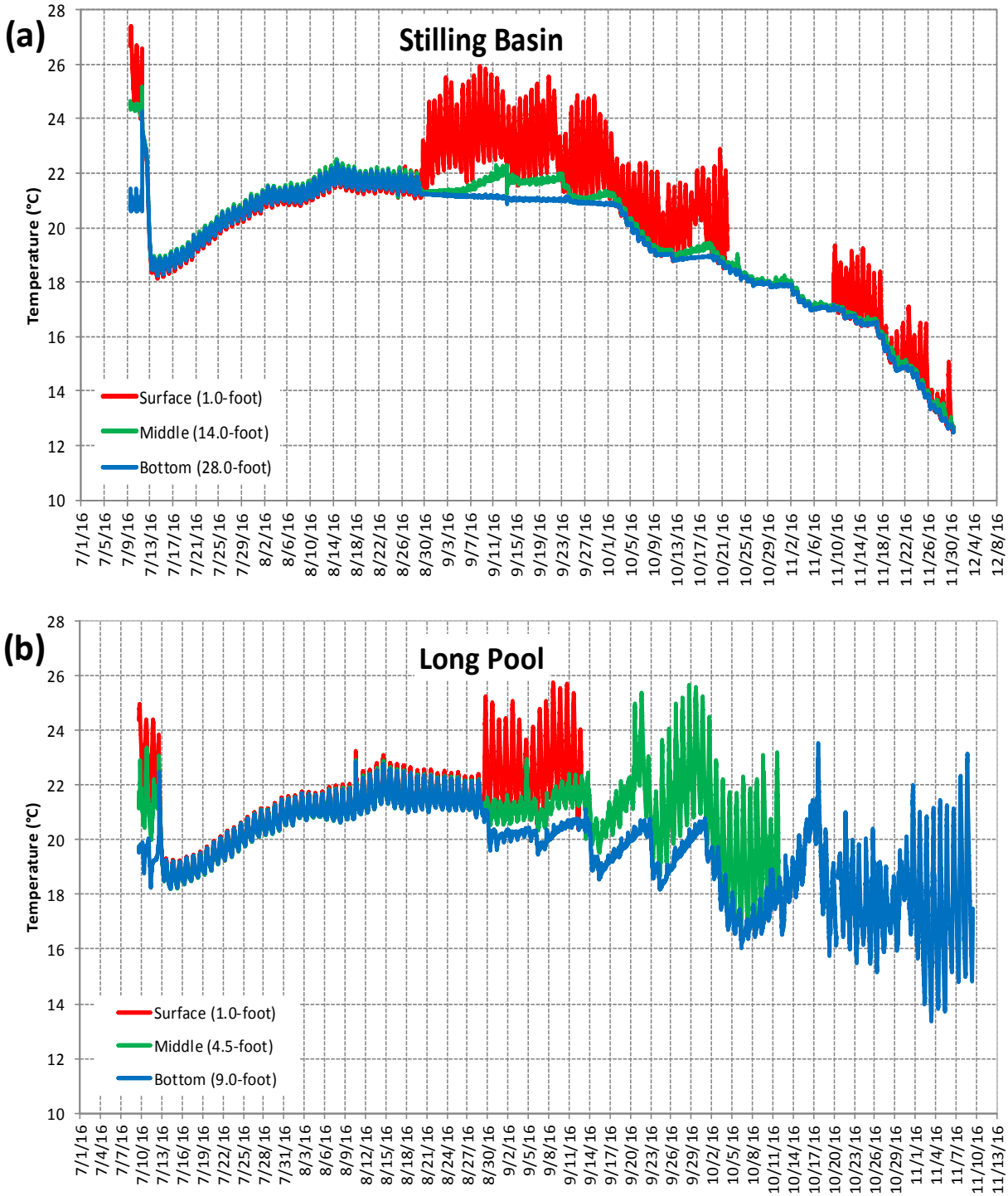


Figure 15: 2016 5-minute data from: a) the Stilling Basin parapet wall (LSYR-0.1) and b) the Long Pool (LSYR-0.51).

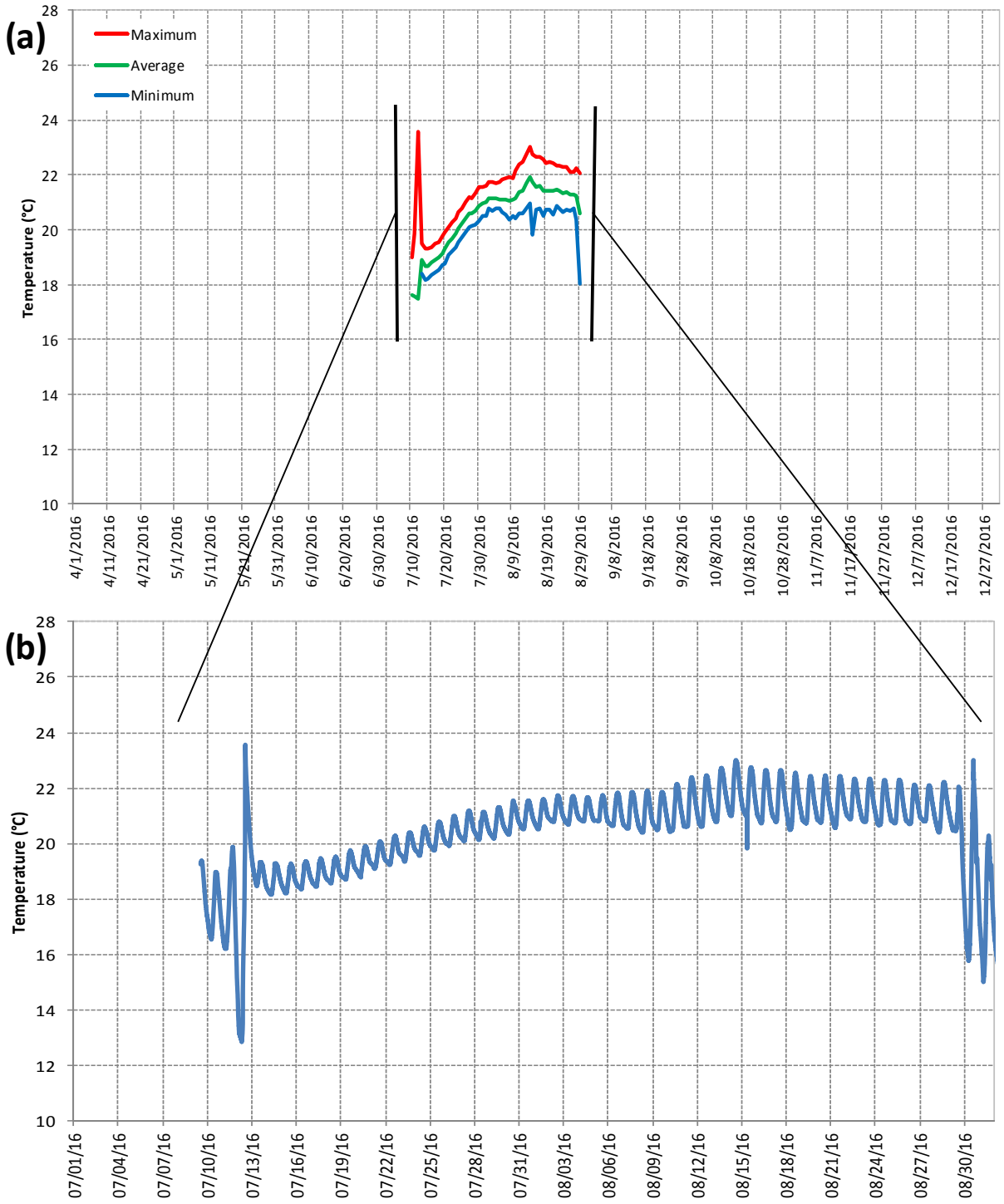


Figure 16: 2016 Lower Hilton Creek (HC-0.12) bottom (0.5 foot) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data for entire period of record. The monitoring location was nearly dry at the start of the WR89-18 release due to declining reservoir volume and the values collected reflect the WR89-18 inundating the monitoring location. The habitat dried immediately following the stoppage of releases.

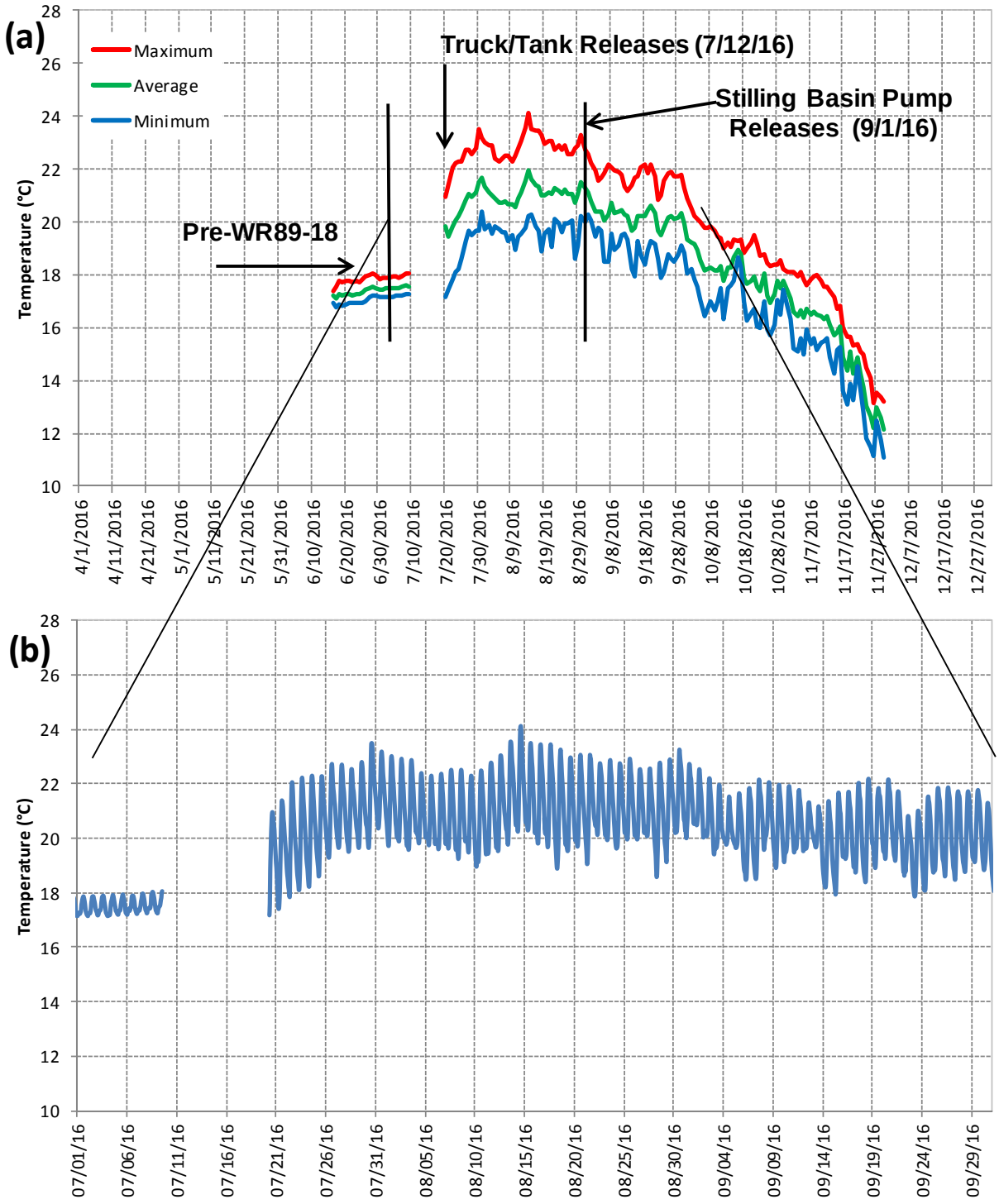


Figure 17: 2016 Hilton Creek at the Lower Release Point (HC-0.25) bottom (0.5 foot) water temperatures for: (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of 7/1/16-10/1/16. Included in the graph are highlights of the various flow scenarios during the year; pre-WR89-18, HC truck/tank releases, and Stilling Basin pump flows into HC.

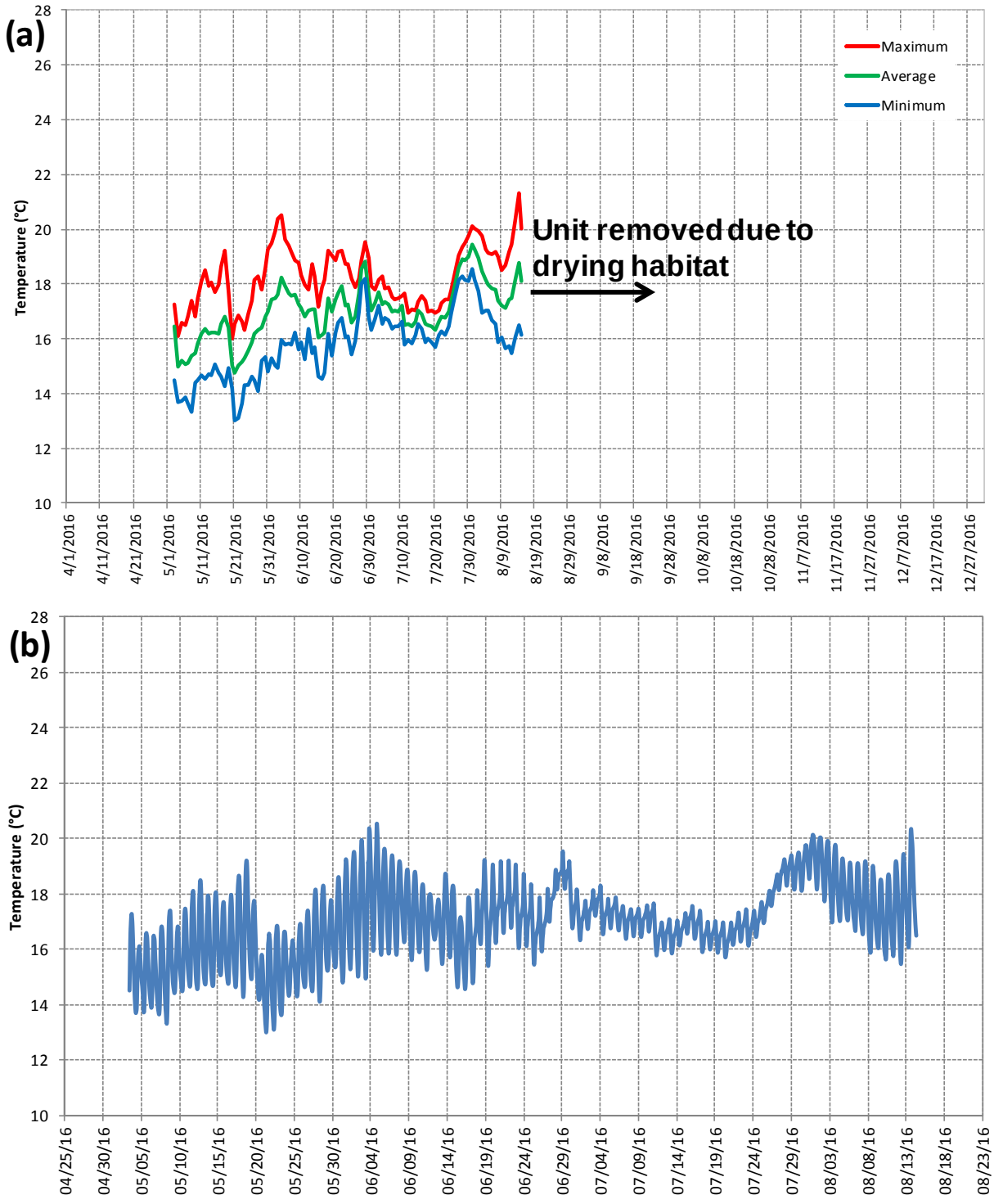


Figure 18: 2016 Quiota Creek (QC-2.66) bottom (2.5 feet) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data for the period 5/3/16 – 8/15/16 (the entire period of deployment).

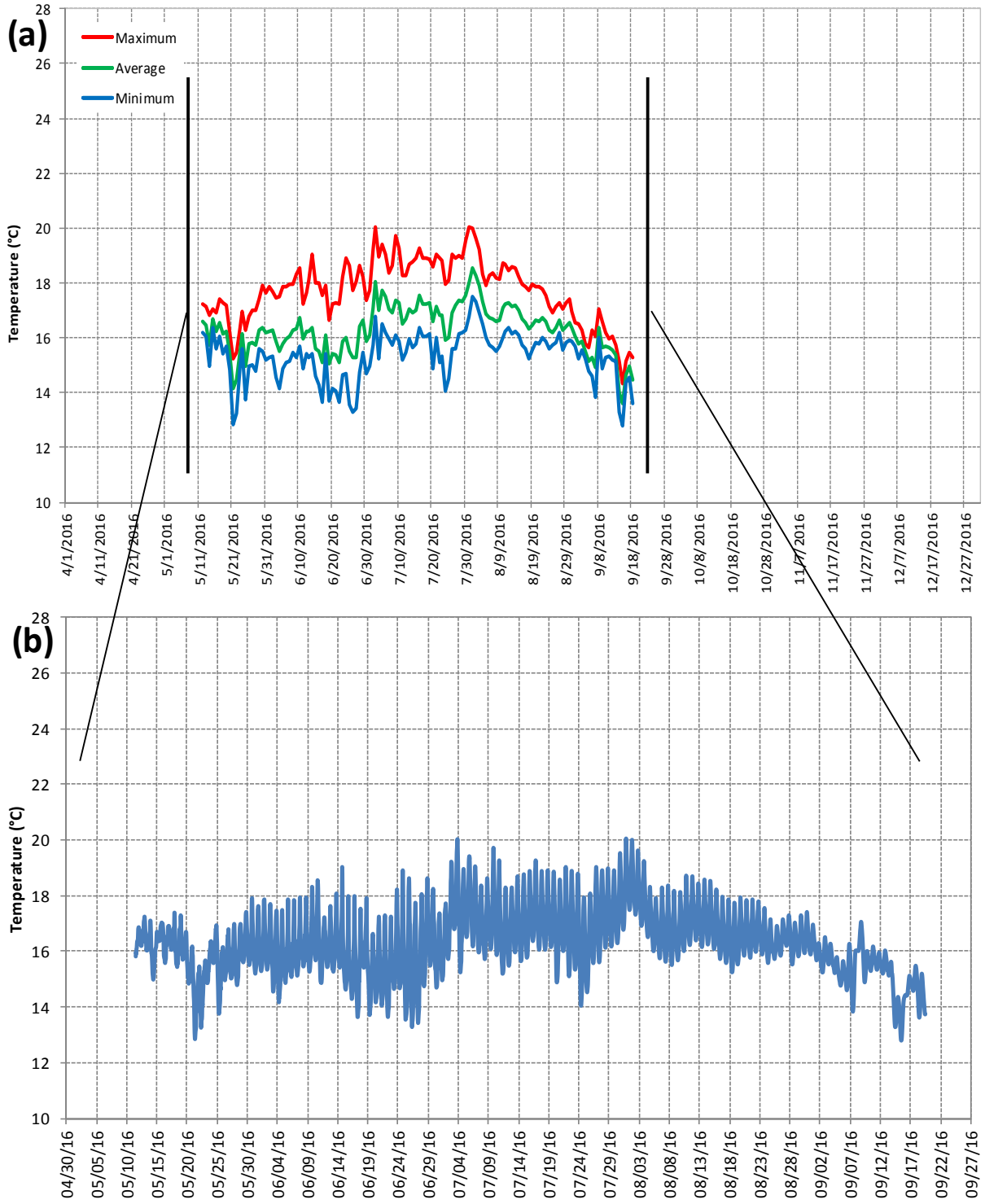


Figure 19: 2016 Lower Salsipuedes Creek (SC-0.77) bottom (0.5 foot) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data for the entire period of record; the habitat was isolated and nearly dry when the unit was removed on 9/18/16.

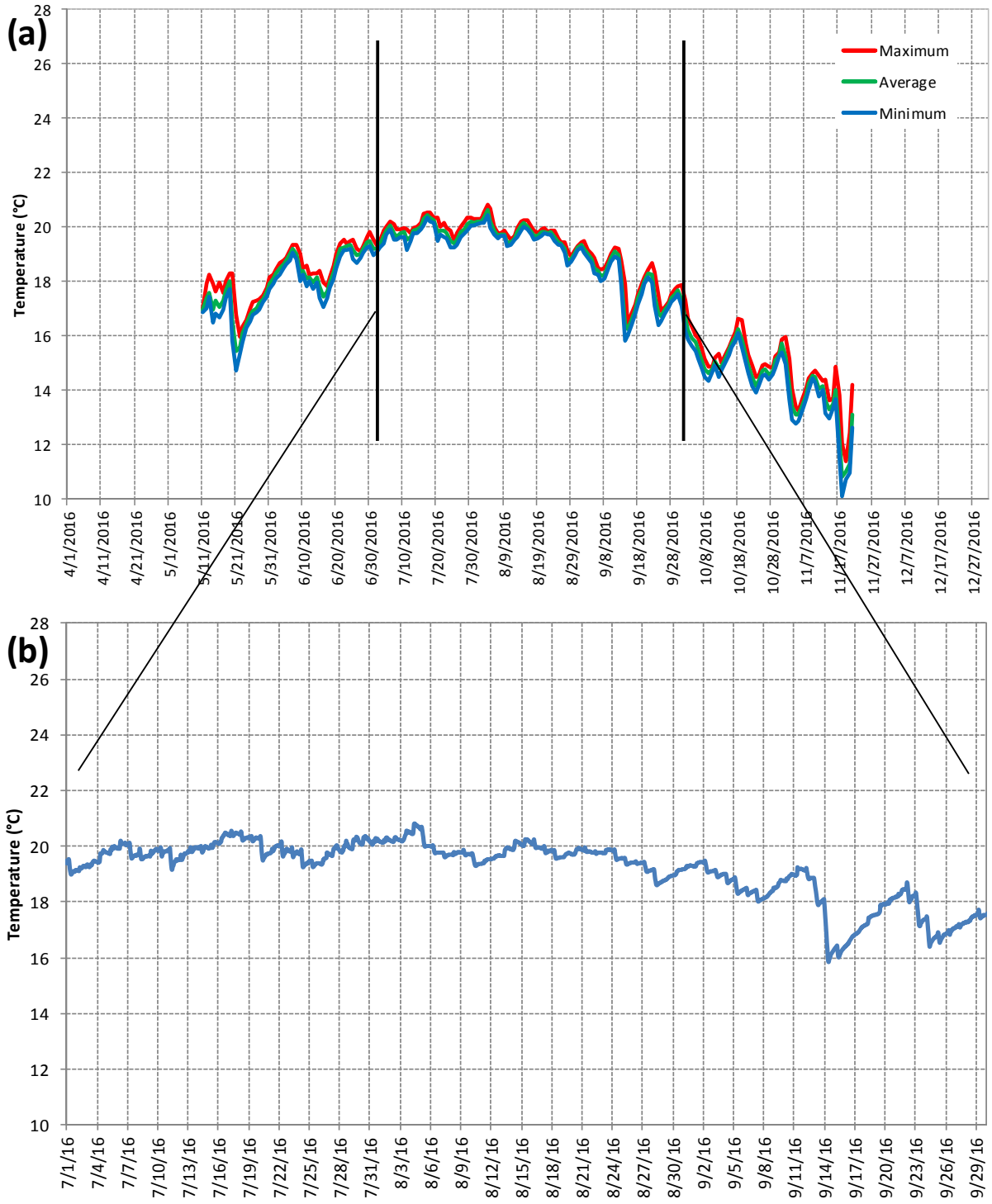


Figure 20: 2016 SC-2.20 (Reach 2 Bedrock Section) bottom (4.0 feet) water temperatures for (a) daily maximum, average, and minimum temperatures for the entire period of deployment and (b) hourly measurements for the period from 7/1/16 – 10/1/16.

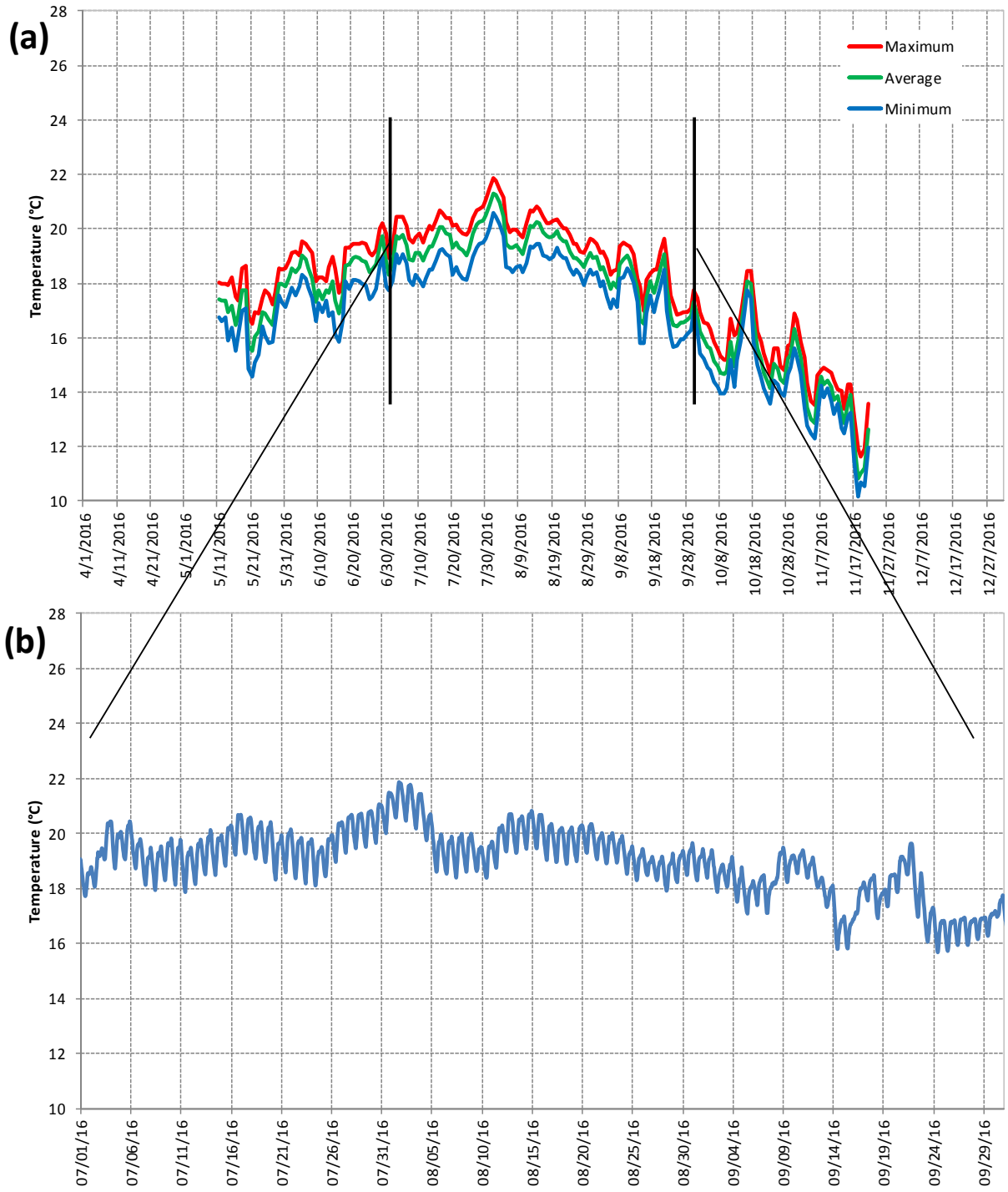


Figure 21: 2016 SC-3.0 (Highway 1 Bridge Pool Habitat) bottom (4.0 feet) water temperature for (a) maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/16 – 10/1/16.

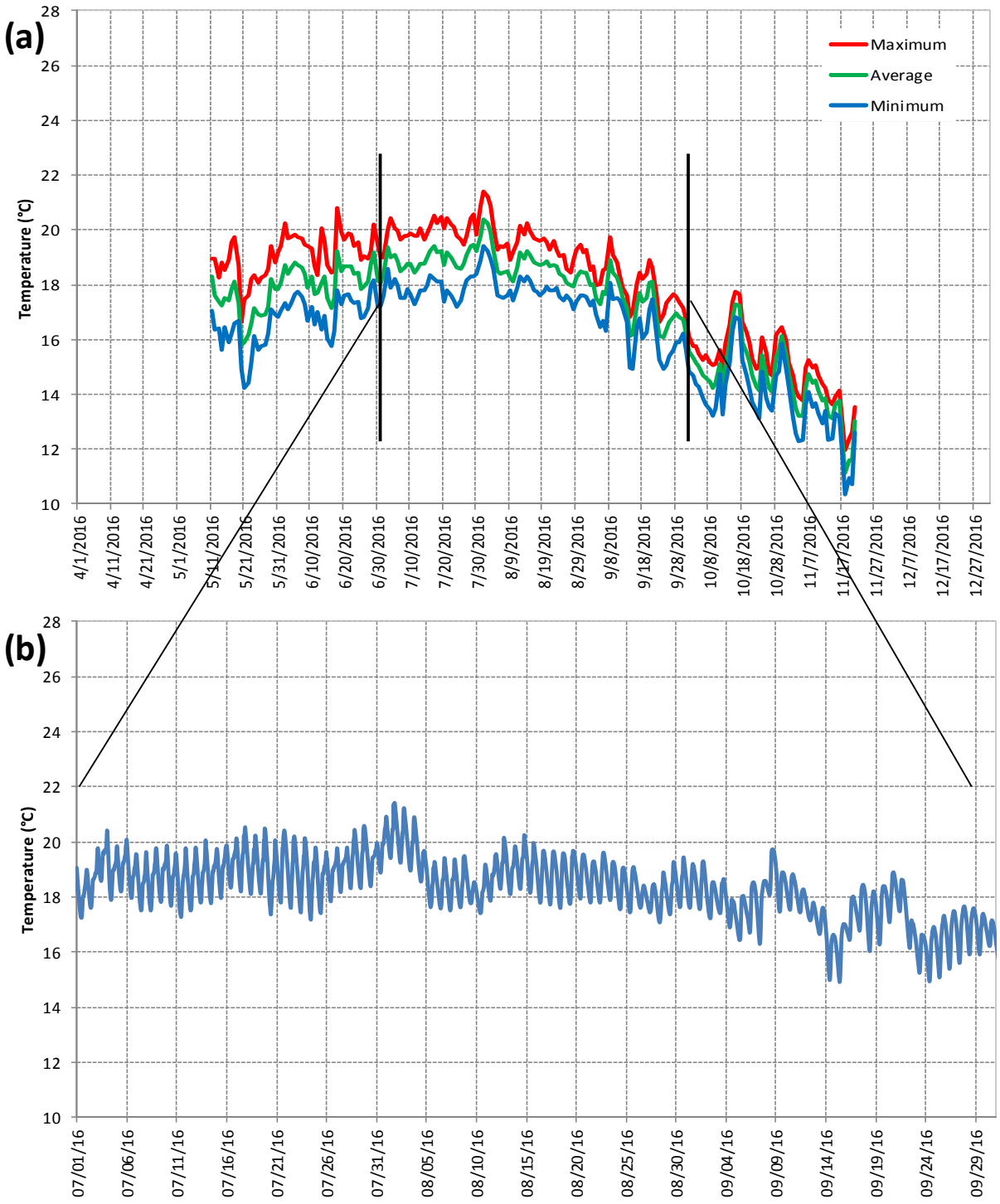


Figure 22: 2016 SC-3.5 (Jalama Bridge Pool Habitat) bottom (4.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/16 – 10/1/16.

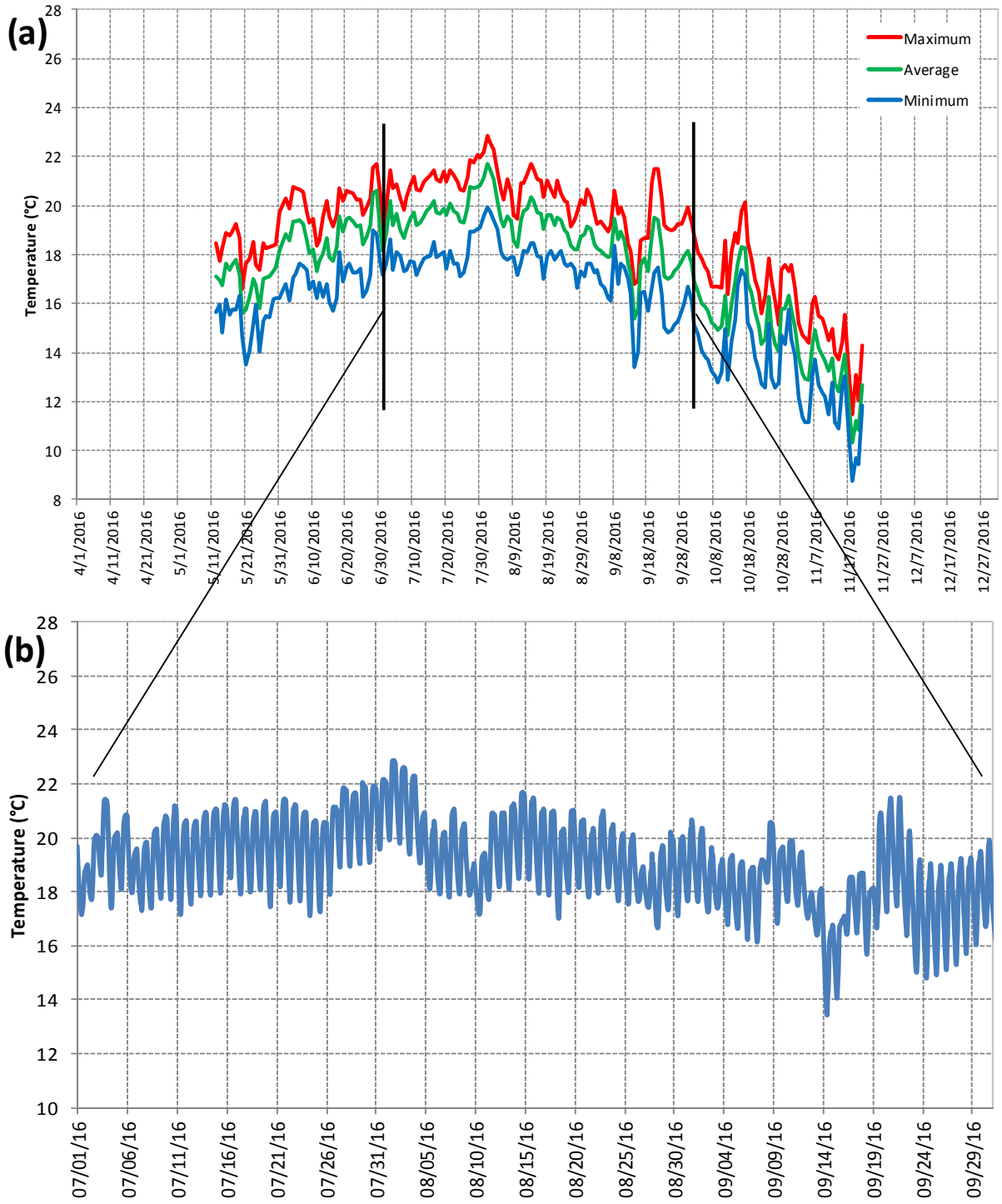


Figure 23: 2016 EJC-5.4 (Palos Colorados Pool Habitat) bottom (3.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/16 – 10/1/16.

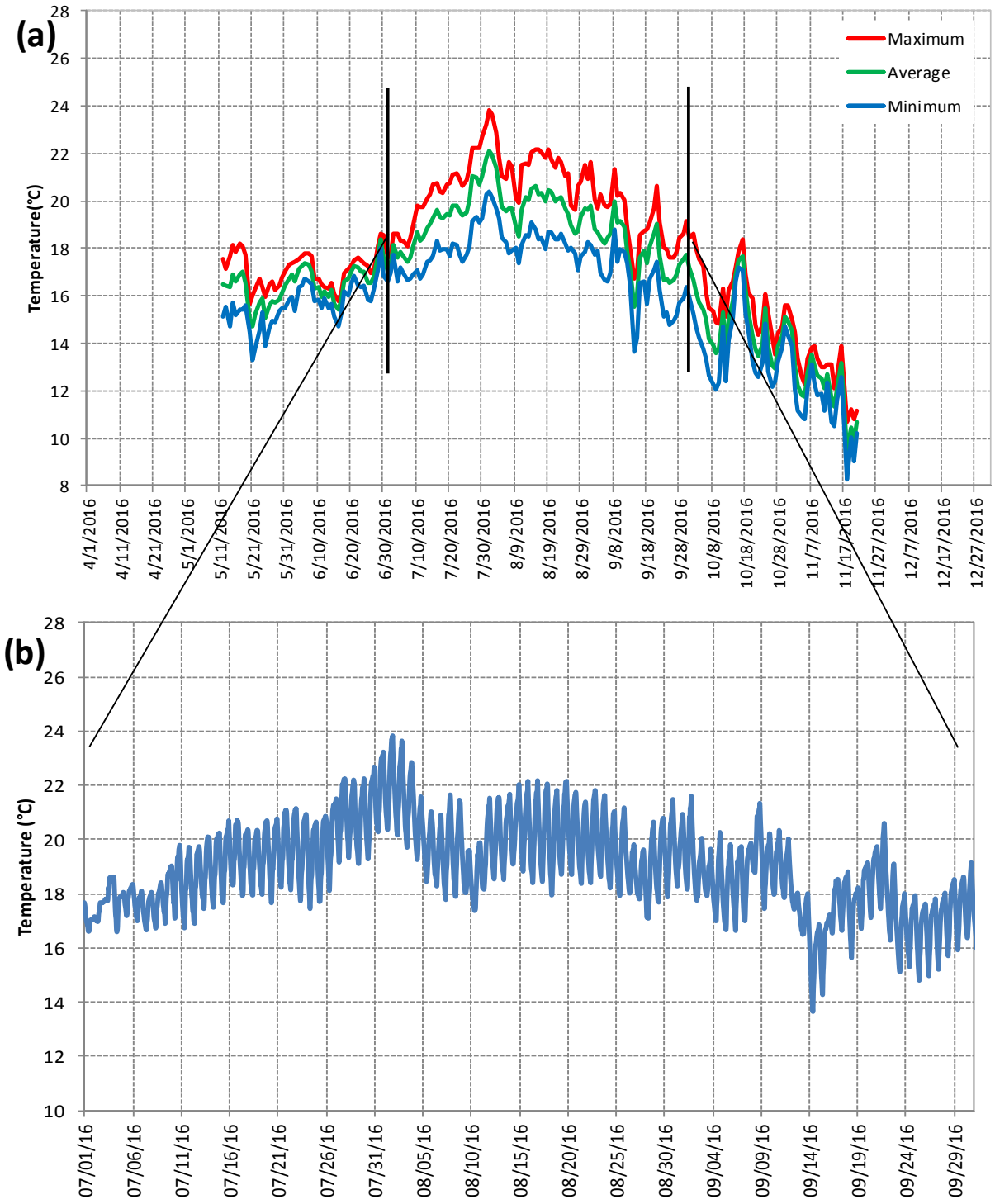


Figure 24: 2016 LAC-7.0 (Los Amoles Creek at Ford Crossing) bottom (3.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/16 – 10/1/16. Los Amoles was dry approximately 150-feet upstream of the thermograph location.

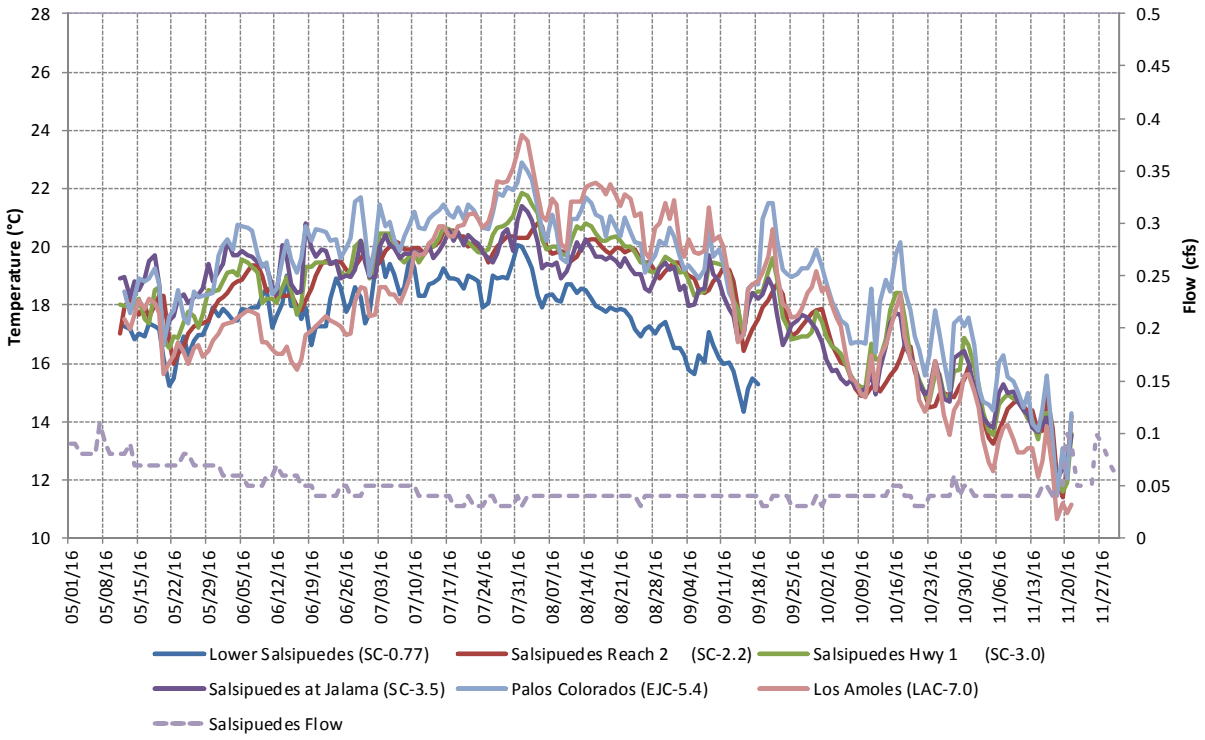


Figure 25: 2016 Longitudinal maximum daily water temperatures within the Salsipuedes Creek watershed which included, Palos Colorados (EJC-5.4), at Jalama Bridge (SC-3.5), at Highway 1 (SC-3.0), at Bedrock Section (SC-2.2), and at lower Salsipuedes Creek (SC-0.77) (DRY –Sept) versus flow (cfs) at the USGS gauging station at Salsipuedes Creek.

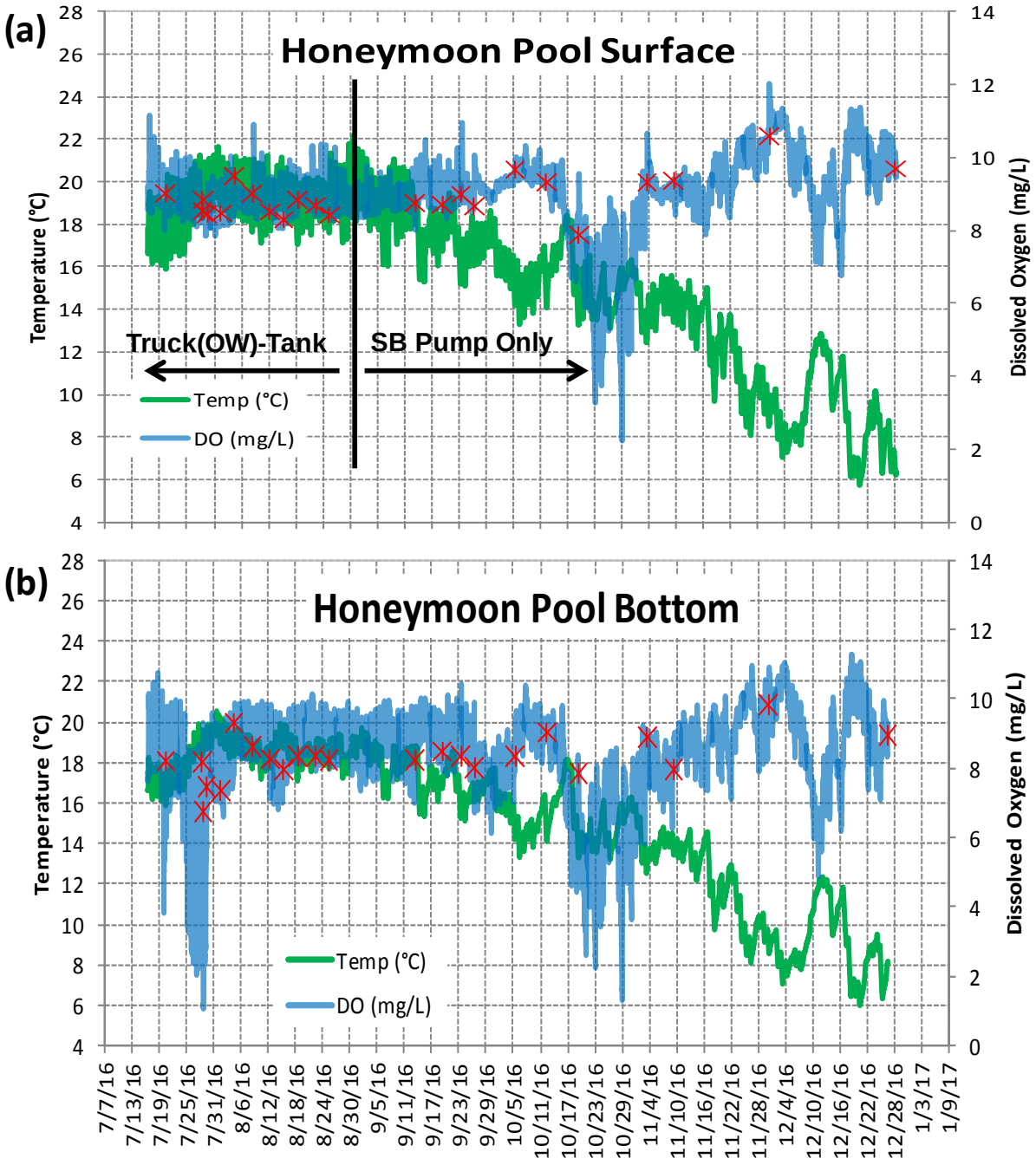


Figure 26: 2016 Hilton Creek (HC-0.26) water temperatures and dissolved oxygen concentrations at the Honeymoon Pool for the (a) surface and (b) bottom of the habitat reflecting the changes in flow delivery regimes over the period (red asterisks indicate when the instruments were downloaded).

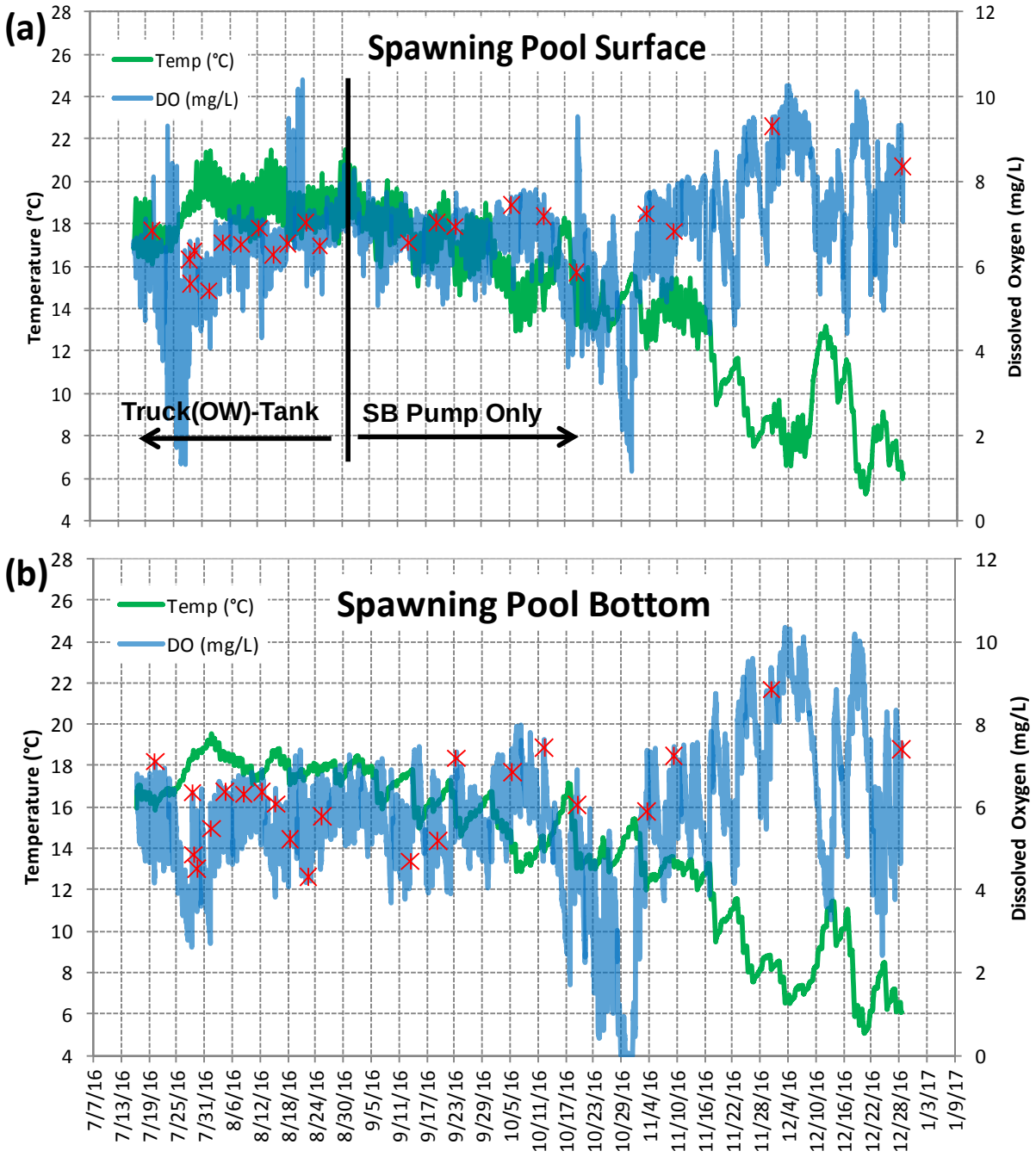


Figure 27: 2016 Hilton Creek (HC-0.25) water temperatures and dissolved oxygen concentrations at the Spawning Pool for the (a) surface and (b) bottom of the habitat reflecting the changes in flow delivery regimes over the period (red asterisks indicate when the instruments were downloaded)

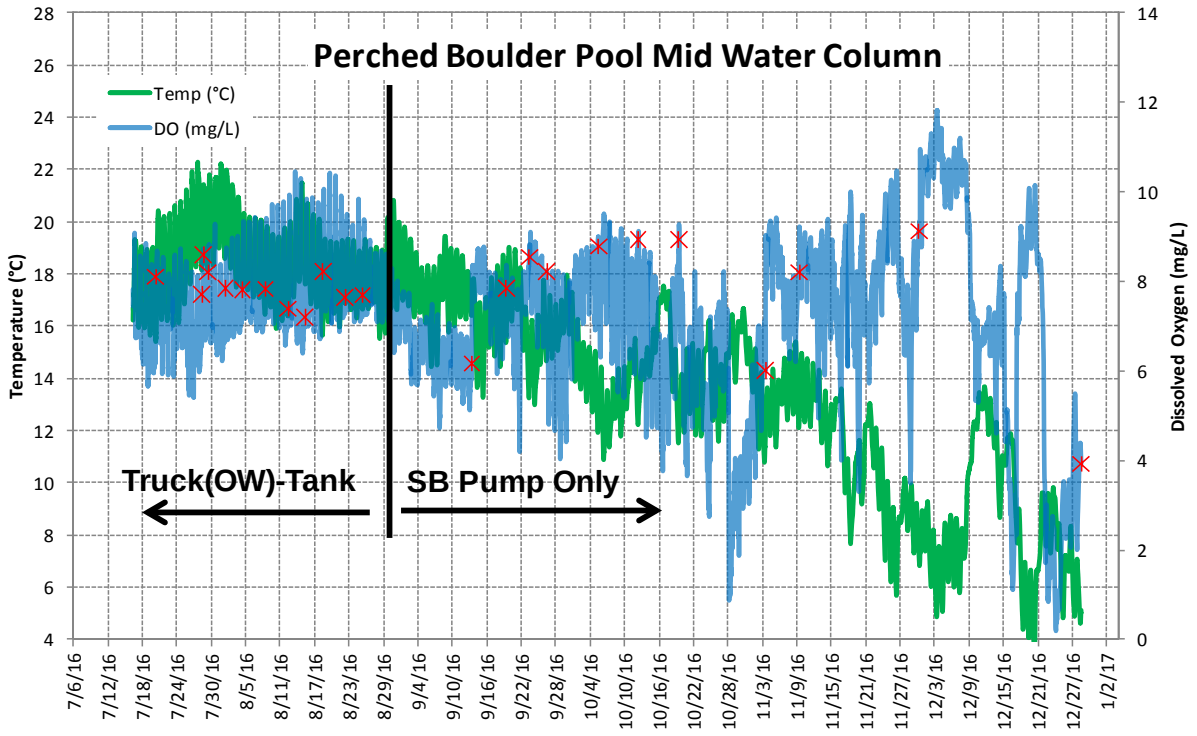


Figure 28: 2016 Hilton Creek (HC-0.20) water temperatures and dissolved oxygen concentrations at the Honeymoon Pool for the (a) surface and (b) bottom of the habitat reflecting the changes in flow delivery regimes over the period (red asterisks indicate when the instruments were downloaded).

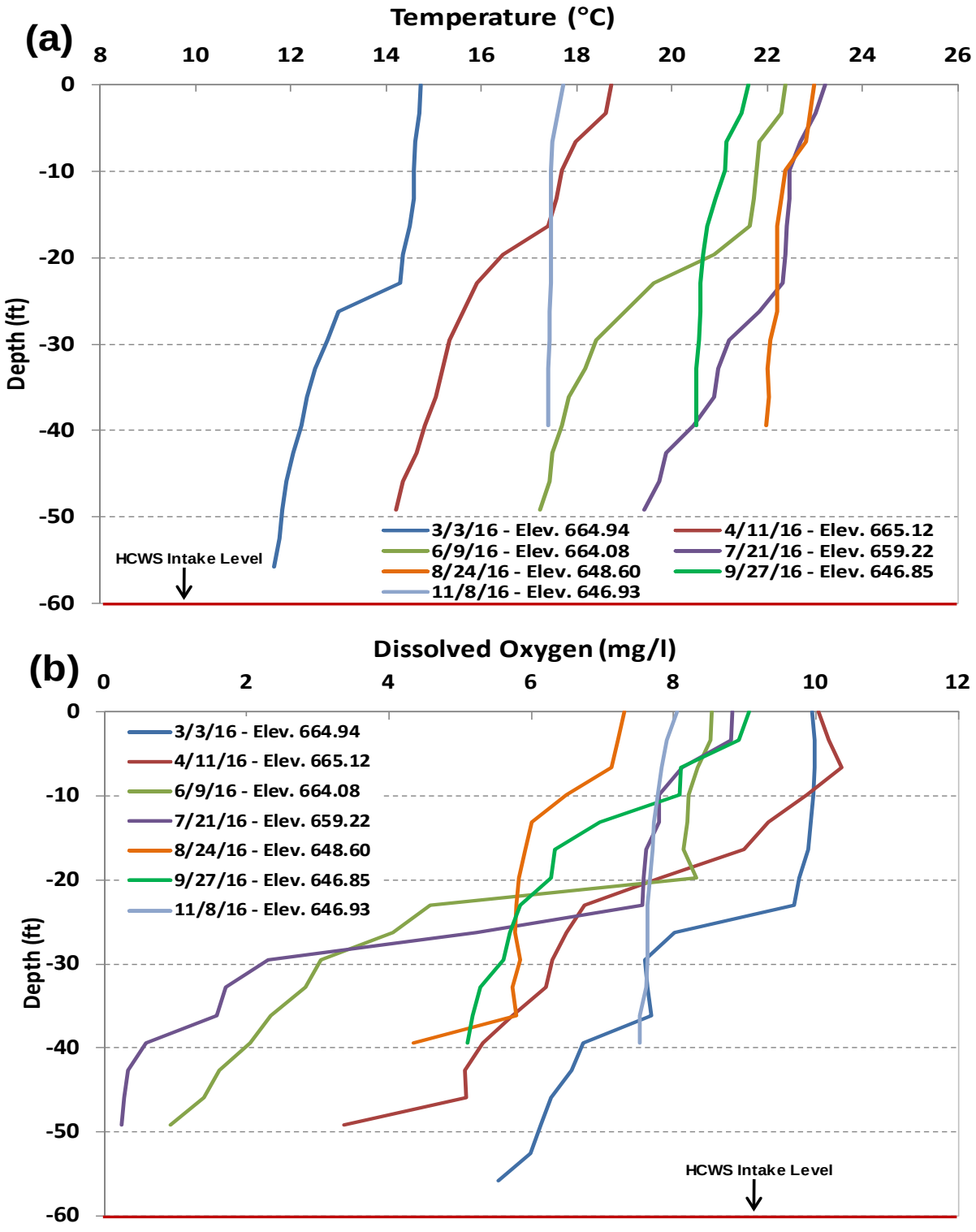


Figure 29: Lake Cachuma 2016 water quality profiles for (a) temperature and (b) dissolved oxygen concentrations at the intake barge for the HCWS. HCWS intake hose level was set at 65 feet of depth throughout the monitoring period.

3.3. Habitat Quality within the LYSR Basin

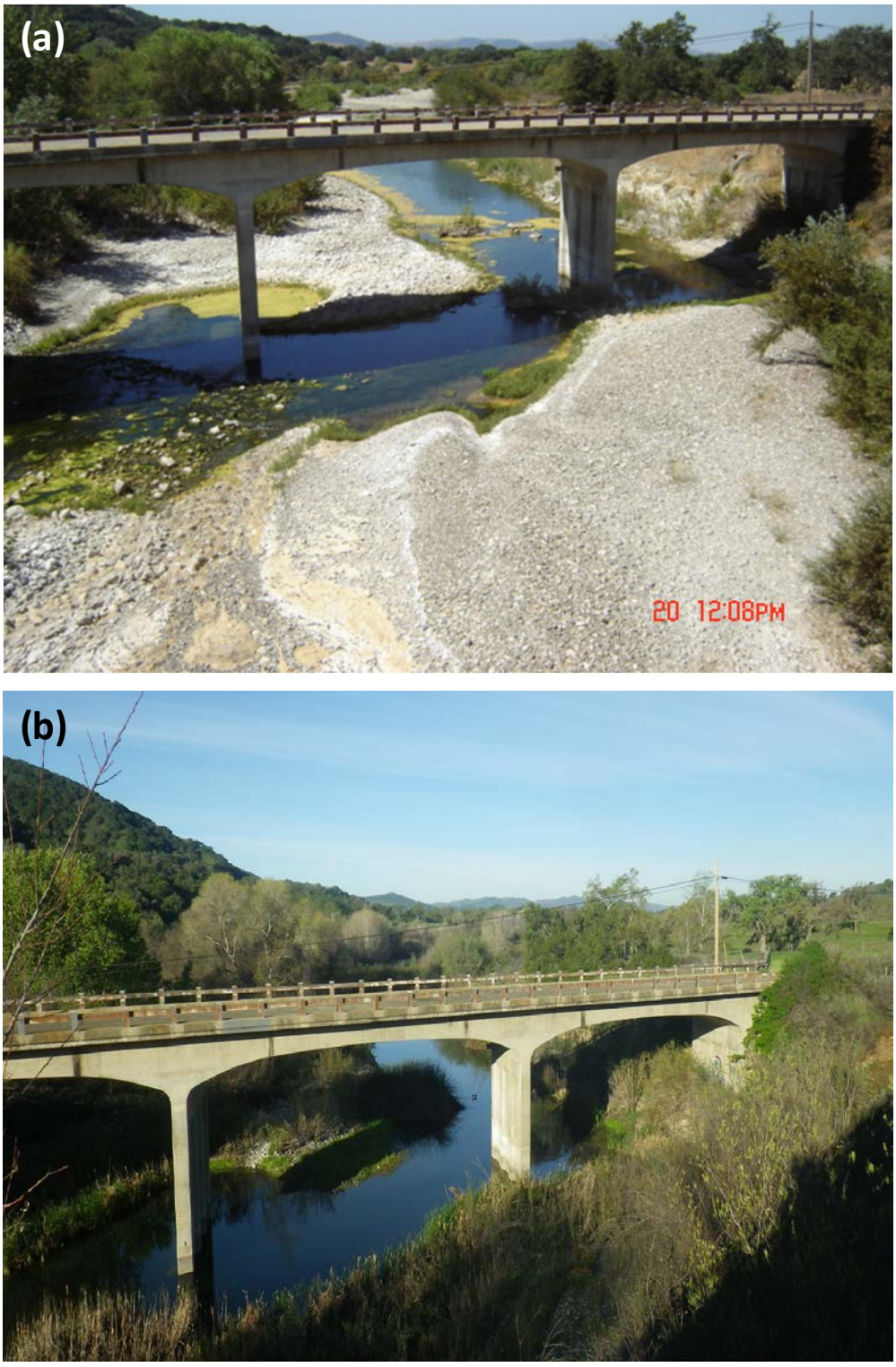


Figure 30: Photo points (M-6) collected at Highway 154 Bridge looking downstream in (a) September 2005 and (b) March 2016.

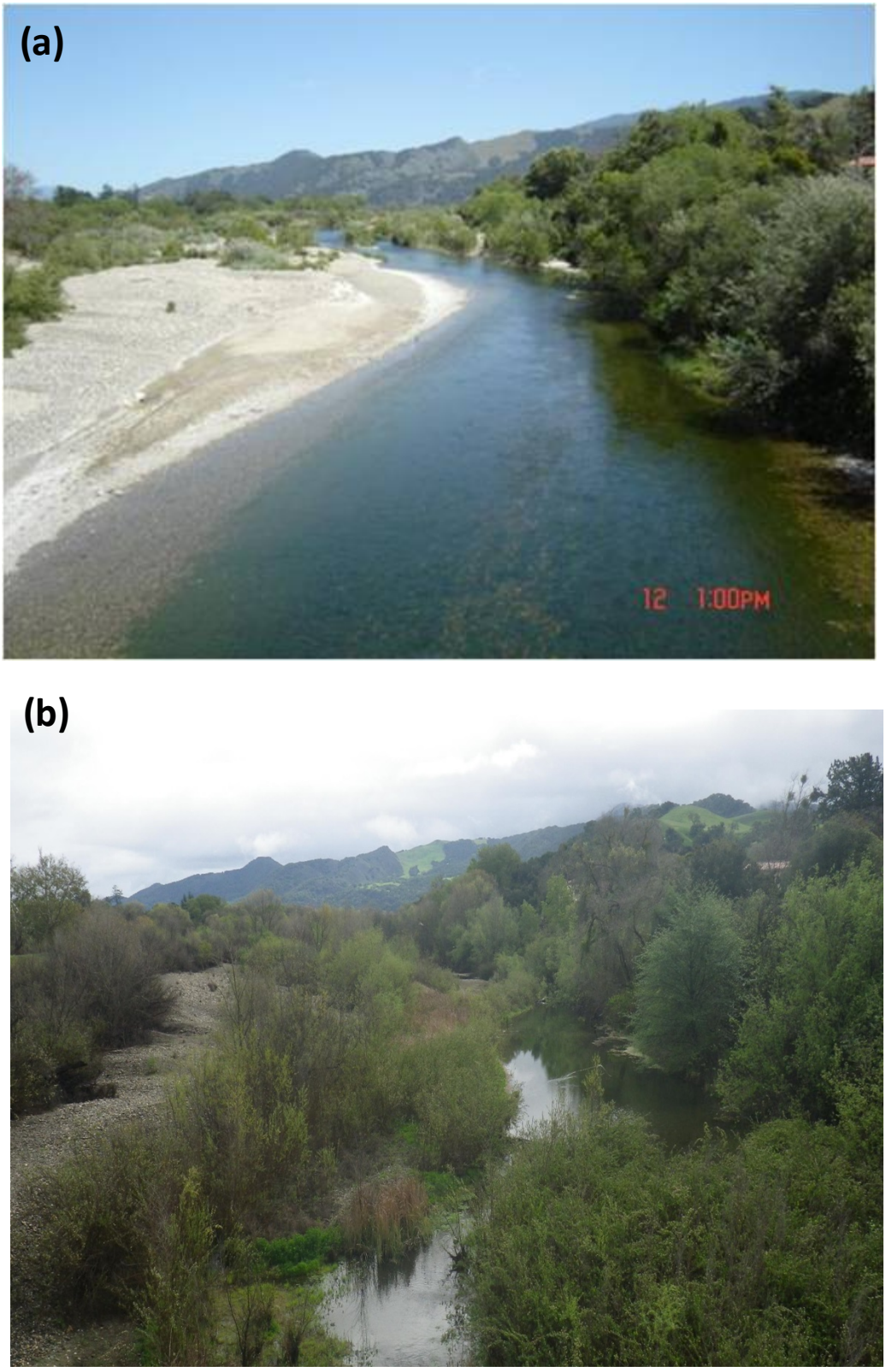


Figure 31: Photo point (M-12) collected at Refugio Bridge looking upstream in (a) May 2005, and (b) March 2016.

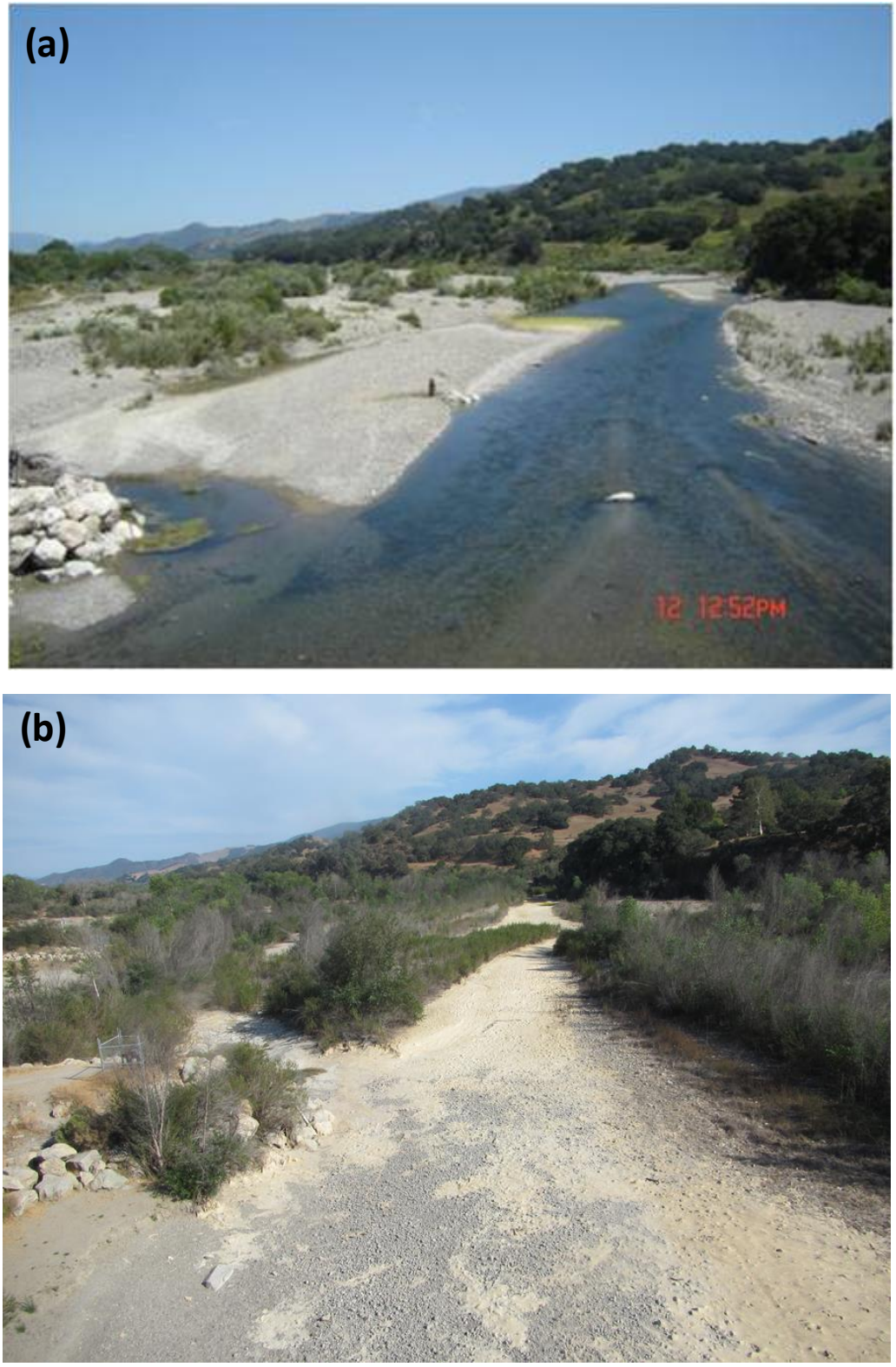


Figure 32: Photo point (M-14) collected at Alisal Bridge looking upstream in a) May 2005, and b) September 2016. Note all the dead riparian vegetation.

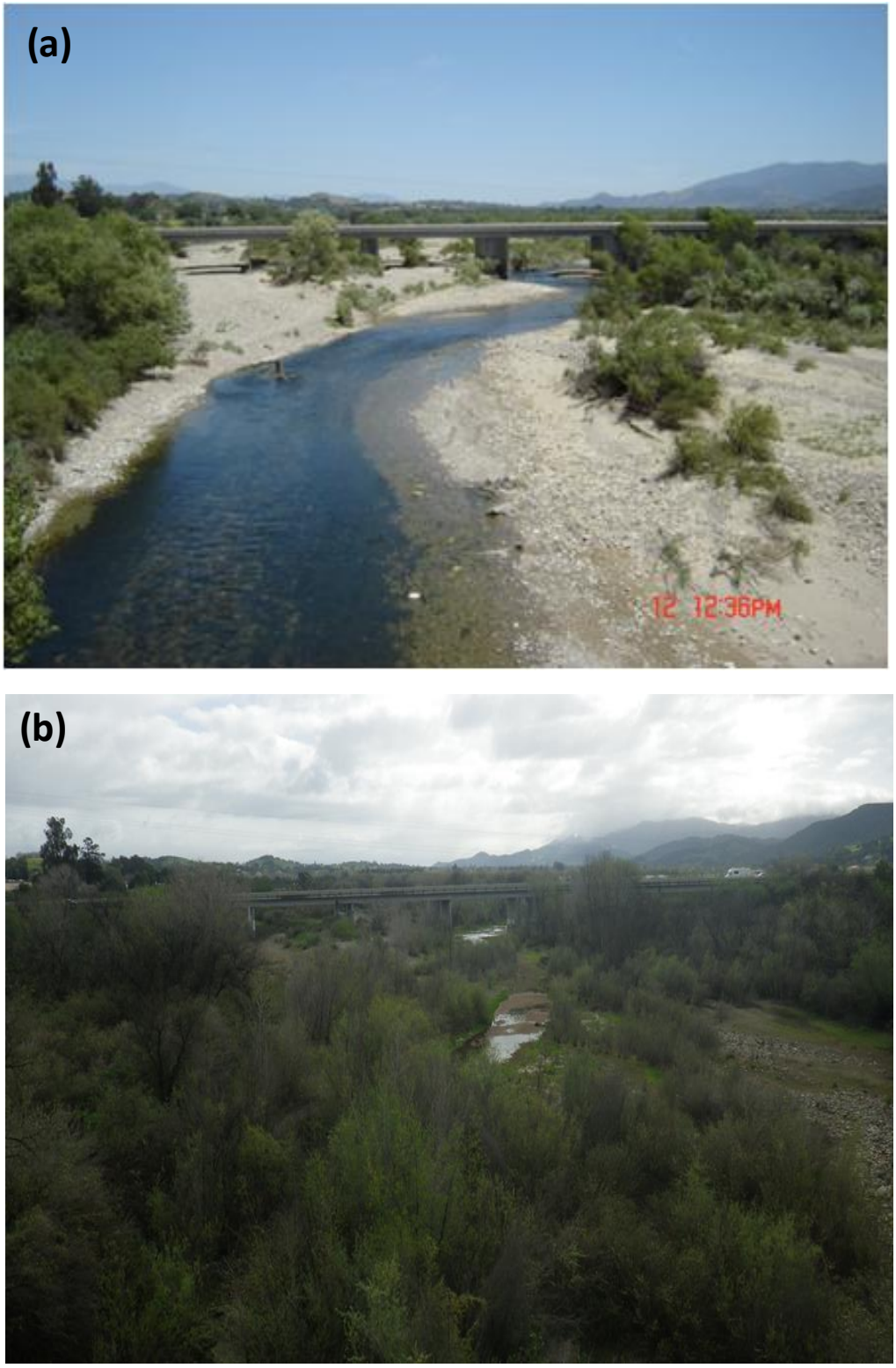


Figure 33: Photo point (M-19) collected at Avenue of the Flags Bridge looking upstream in (a) May 2005, and (b) March 2016.

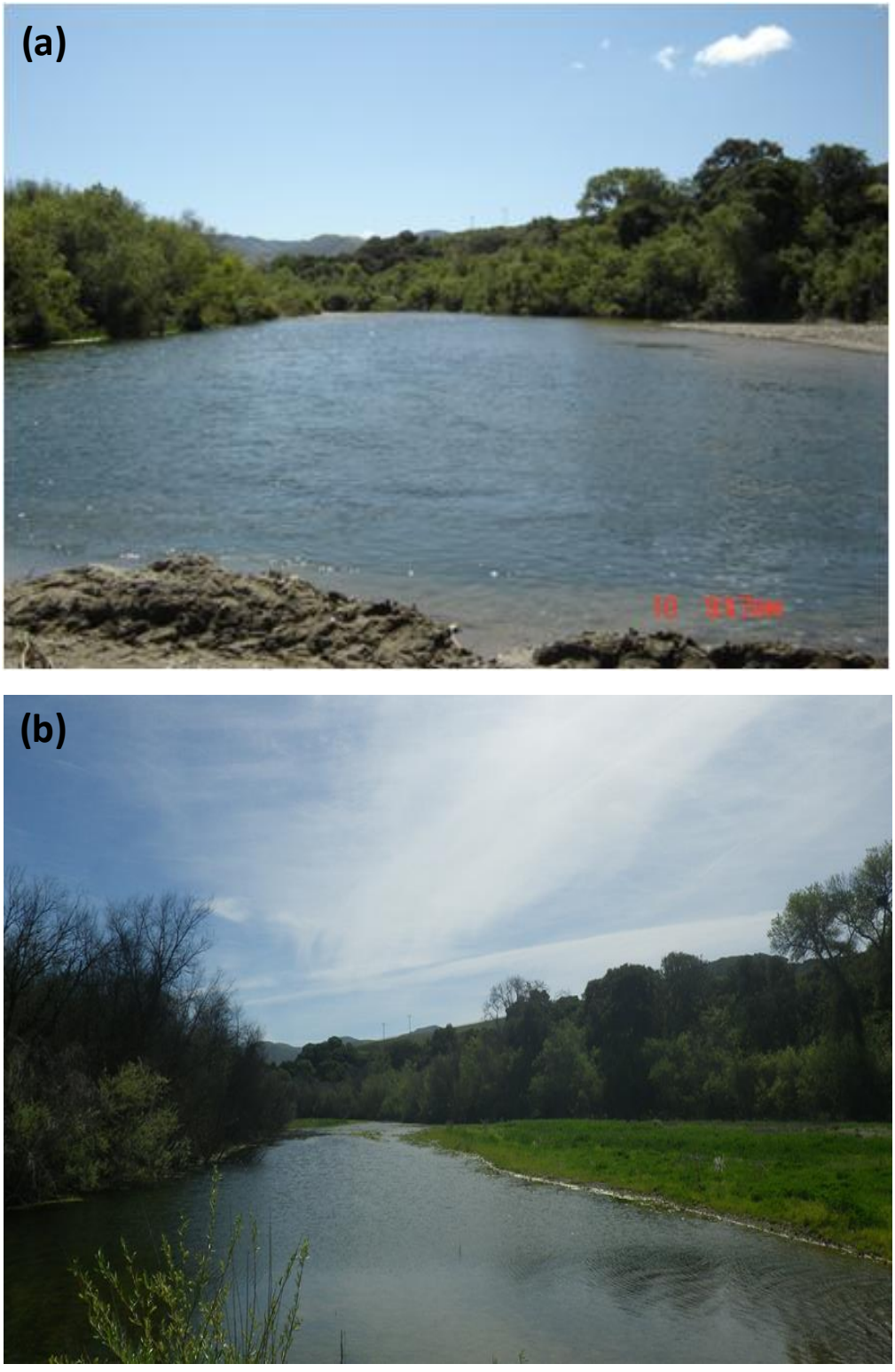


Figure 34: Photo point (M-21) collected at Sweeney Road Crossing looking upstream in (a) May 2005, and (b) March 2016.

Figure 35: Photo point (T-1) collected at Hilton Creek looking upstream towards the trap site on (a) May 2005, and (b) March 2016.

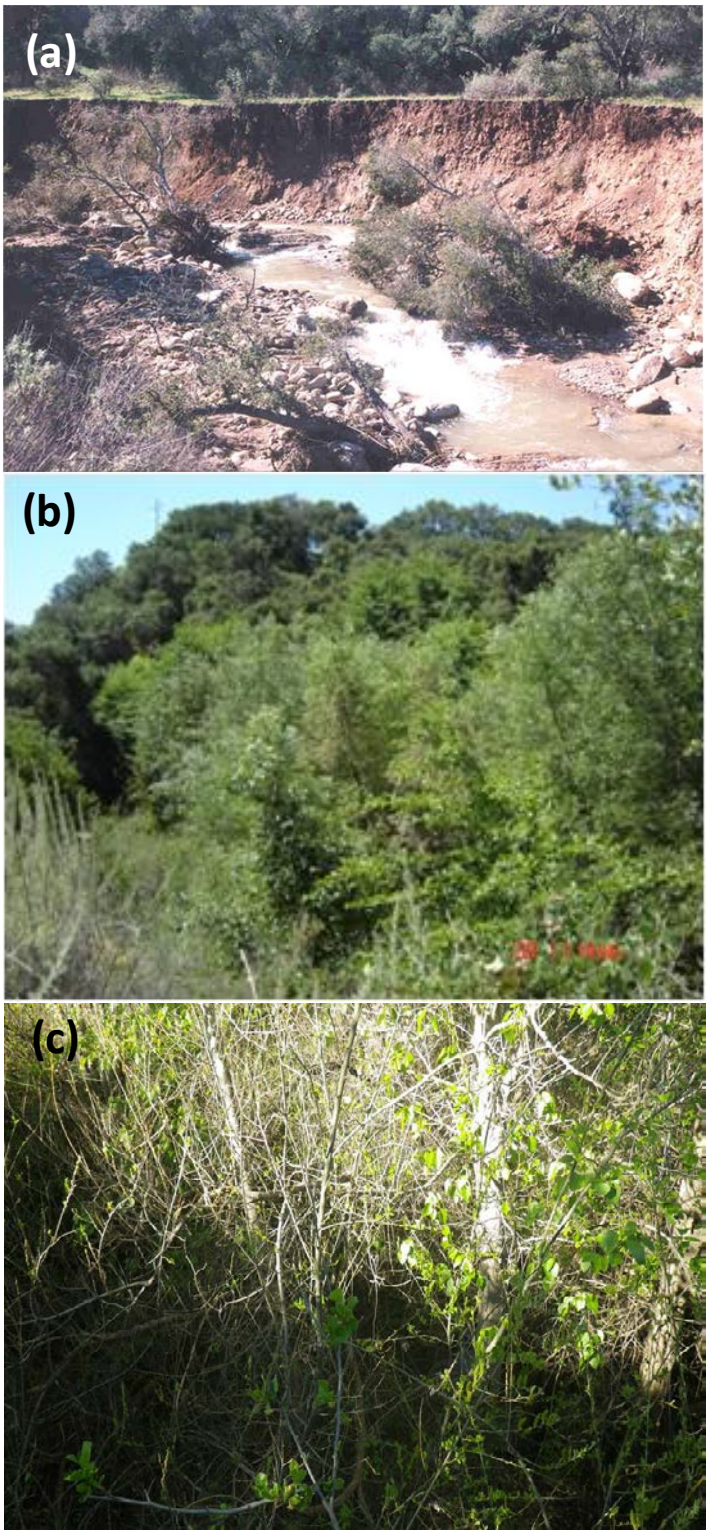


Figure 36: Photo point (T-6) collected at the Hilton Creek ridge trail looking upstream in (a) March 1999, (b) May 2005, and (c) March 2016.

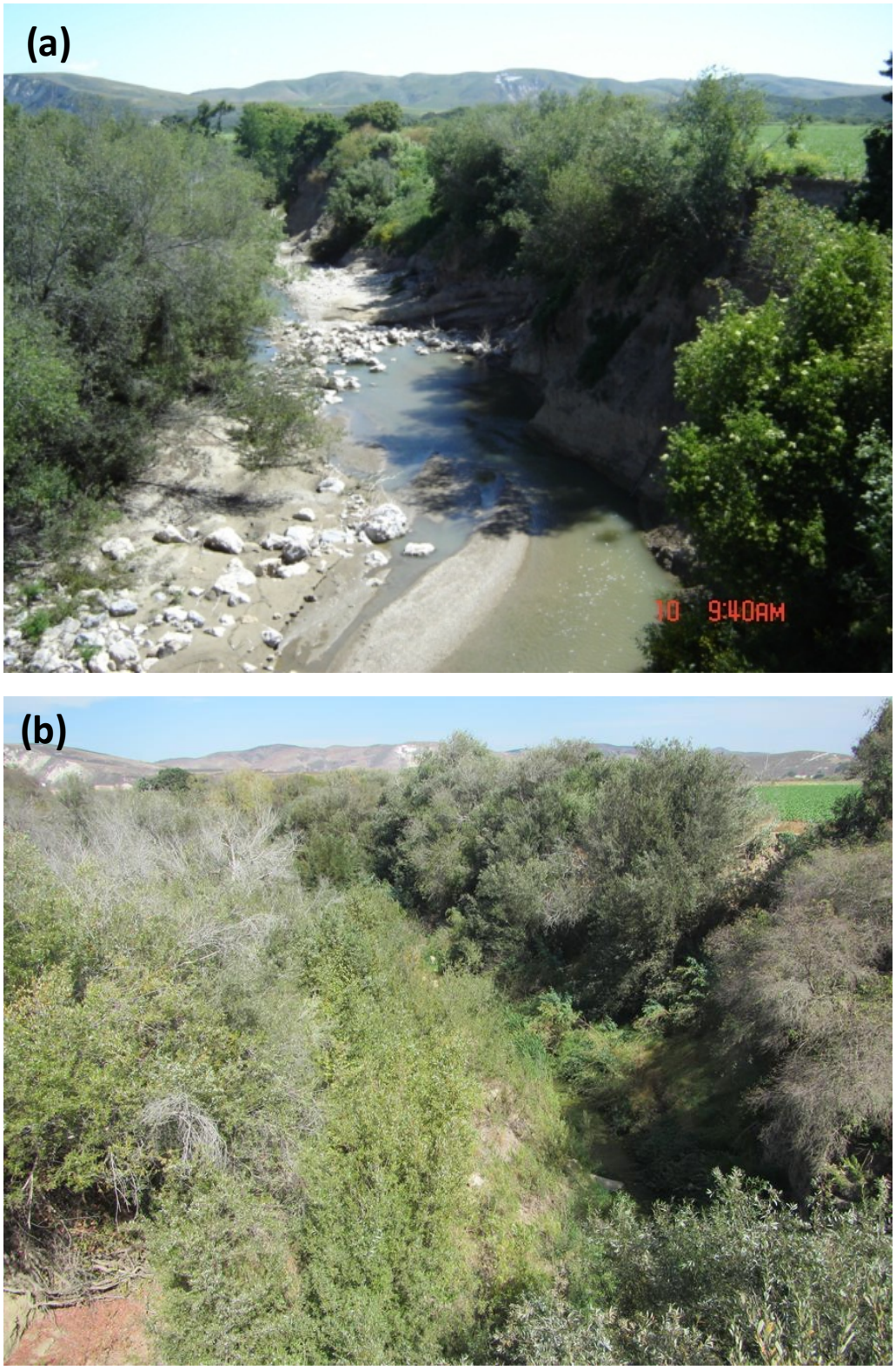


Figure 37: Photo point (T-28) collected at Salsipuedes Creek at Santa Rosa Bridge in (a) May 2005 and (b) September 2016.

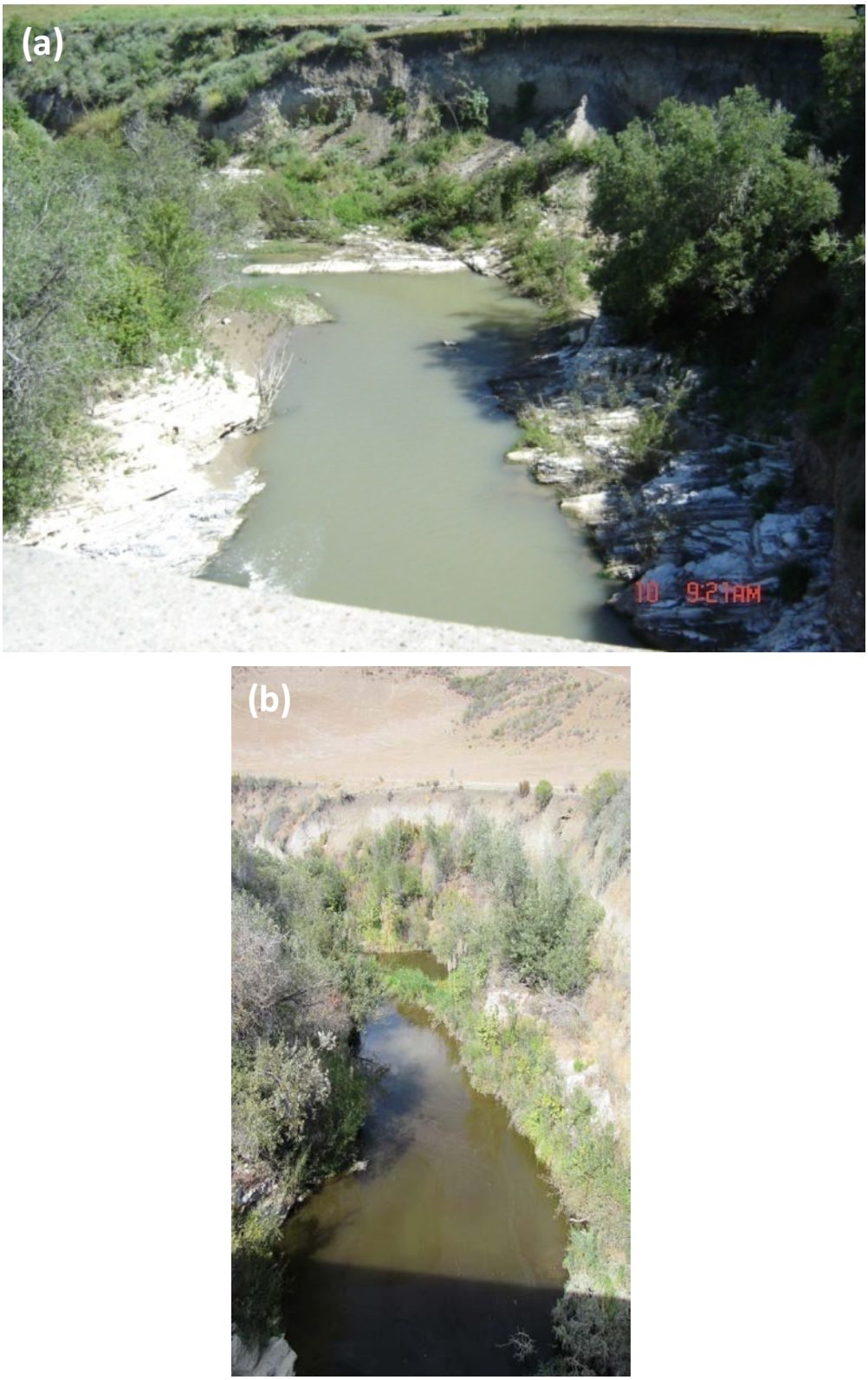


Figure 38: Photo point (T-39) collected at Salsipuedes Creek at Hwy 1 Bridge in May 2005 and (b) September 2016.

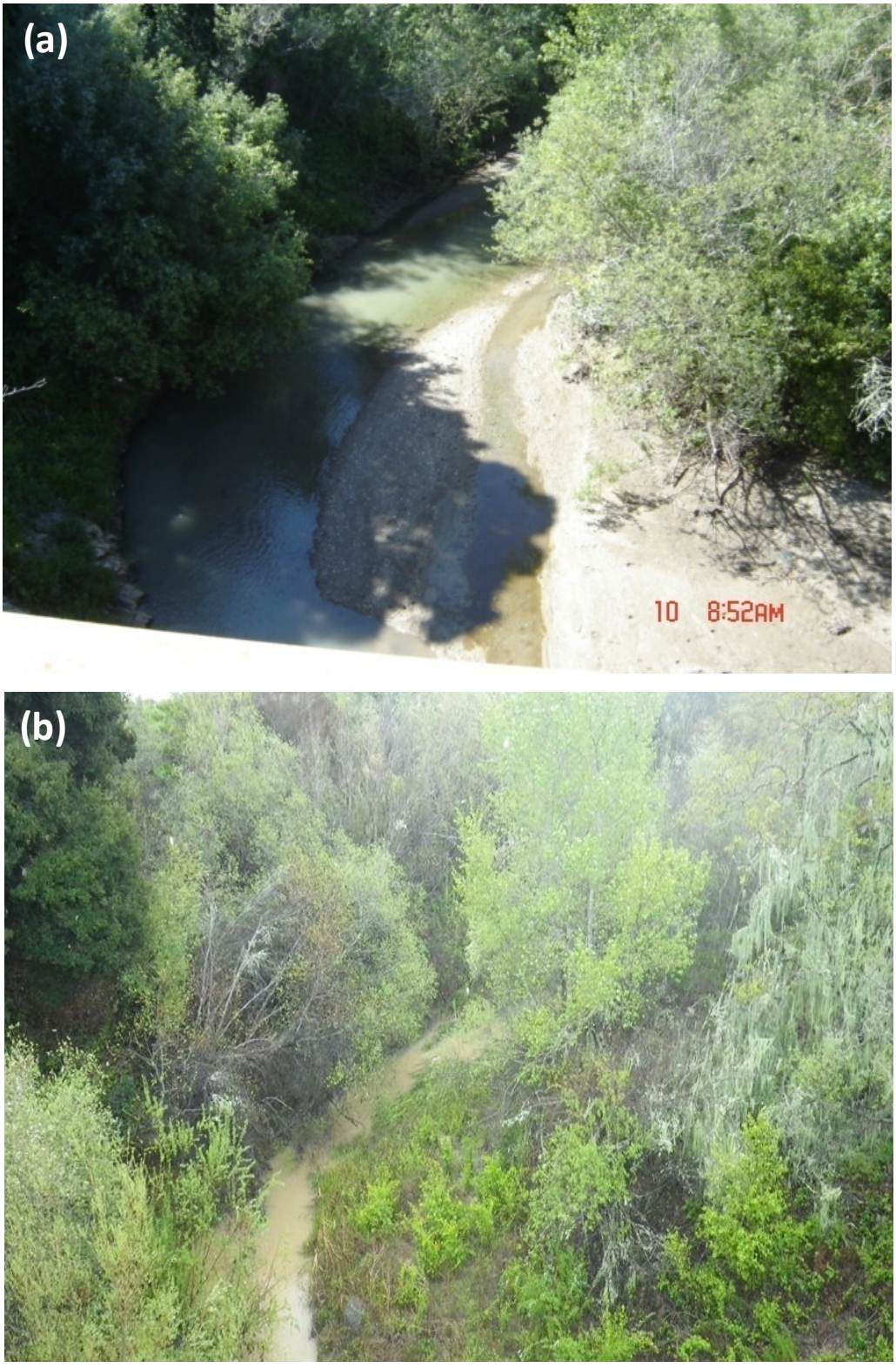


Figure 39: Photo point (T-42) collected at Salsipuedes Creek at Jalama Road Bridge in May 2005 and (b) March 2016.

3.4 Migrant Trapping

Table 7: WY2016 migrant trap deployments; downstream traps opened from 4/4/16 through 4/7/16 due to take limit concerns.

Location	Date Traps Deployed	Date Trap Removed	Date Traps Removed (storm event)	Date Traps Installed (Storm Event)	# of Days Not Trapping	Functional Trapping Days	Functional Trapping %
	(dates)	(dates)	(dates)	(dates)	(days)	(days)	(days)
Hilton u/s Trap	2/16/2016	5/2/2016					
	Total:	76		**Total:**	0	76	100%
Hilton d/s Trap	2/16/2016	5/2/16	4/4/2016	4/7/2016	3		
	Total:	76		**Total:**	3	73	96%
Salsipuedes	Not Installed - Too Dry						
	Total:	N/A		**Total:**	0	N/A	N/A
Mainstem	Not Installed - Too Dry						
	Total:	N/A		**Total:**	0	N/A	N/A

Table 8: Number of migrant captures, including recaptures but not young-of-the-year, associated with each trap check at each trapping location over 24-hours in WY2016; no trapping was conducted in Salsipuedes Creek and the LSYR mainstem.

Location	Trap	Trap Check				Total
		1st AM (05:00-10:00)	2nd AM (10:01-14:00)	1st PM (18:00-22:00)	2nd PM (22:01-01:59)	
Hilton	Upstream	5	1	0	2	8
	Downstream	54	4	1	36	95
	Total:	59	5	1	38	103

Table 9: WY2016 Catch Per Unit Effort (CPUE) for each trapping location.

Location	Upstream Captures	Downstream Captures	Functional Trap Days	Trap Season	Trapping Effeciency	CPUE Upstream	CPUE Downstream	CPUE (Total)	Avg Flow	Median Flow
	(#)	(#)	(days)	(days)	(%)	(Captures/day)	(Captures/day)	(Captures/day)	(cfs)	(cfs)
Hilton UP	8	~	76	76	100%	0.11	0	0.11	N/A	N/A
Hilton DN	~	95	73	76	96%	0	1.30	1.30	N/A	N/A
Salsipuedes	0	0	N/A	N/A	N/A	0.00	0.00	0.00	0.6	0.2
Mainstem	0	0	N/A	N/A	N/A	0.00	0.00	0.00	1.0	0.3

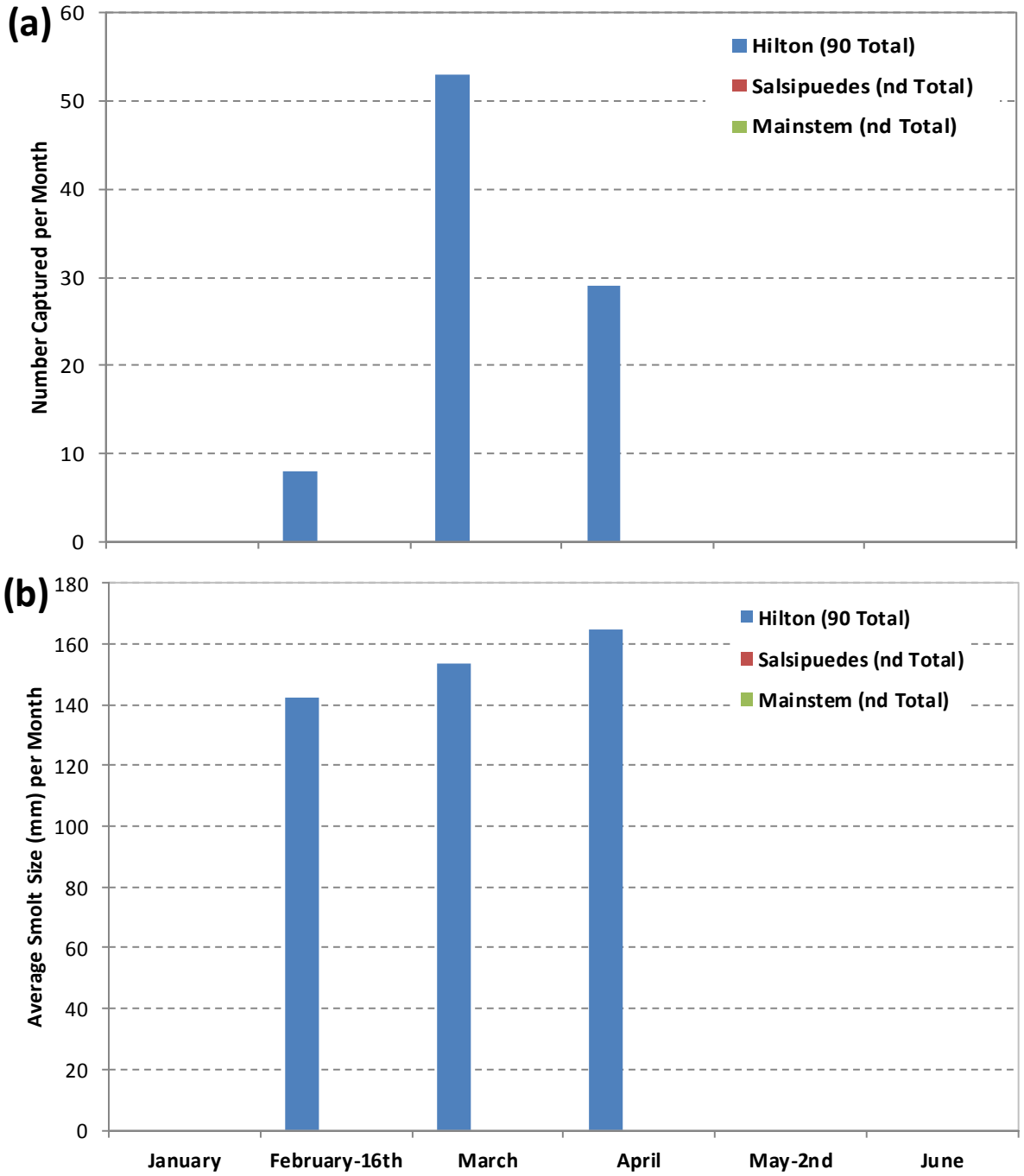


Figure 40: Monthly smolt captures observed at the Hilton Creek, Salsipuedes Creek (nd – no data as not operated), and LSYR mainstem traps in WY2016 showing: (a) number captured at each site and (b) average size of smolts captured by month.

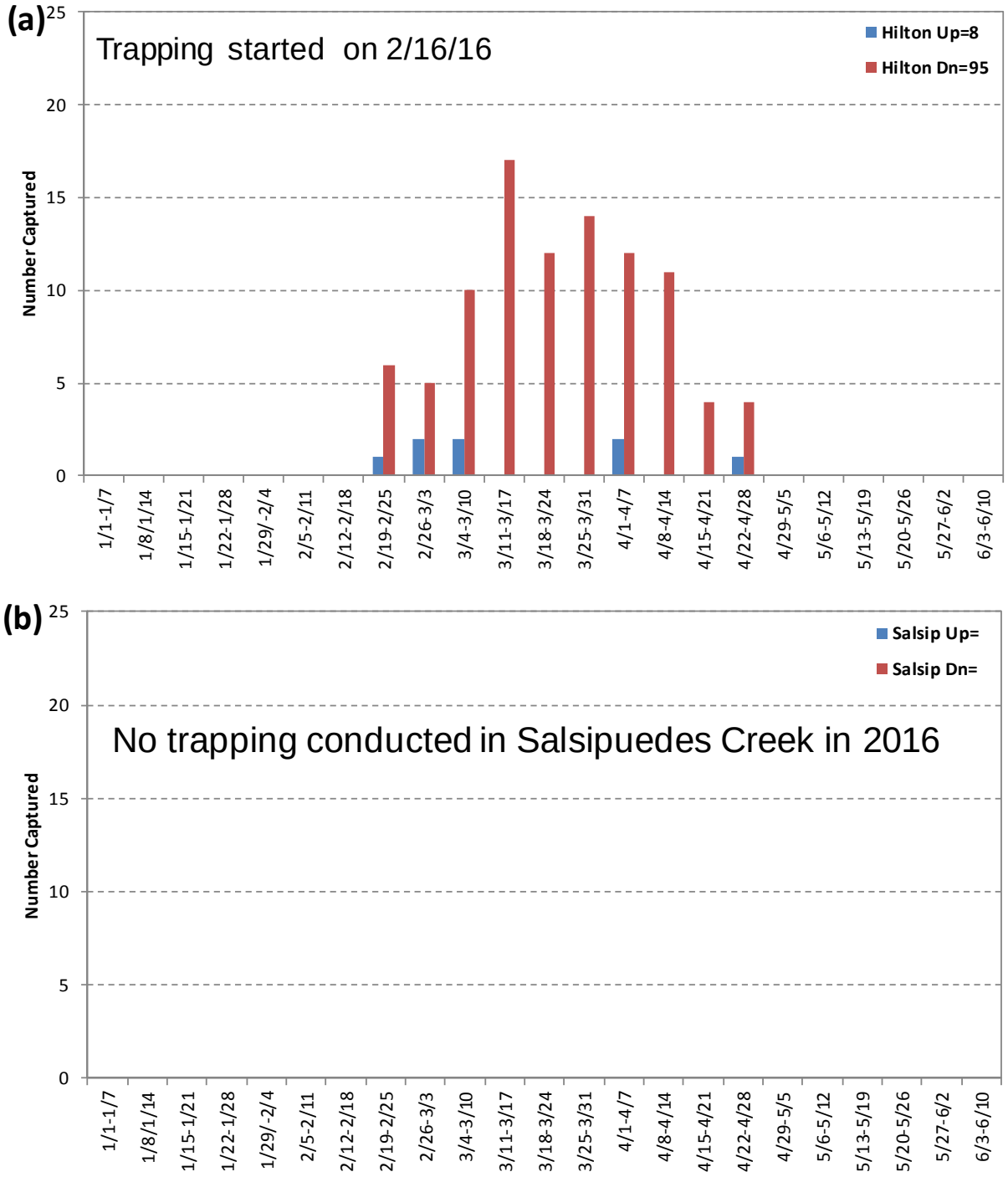


Figure 41: WY2016 paired histogram of weekly upstream and downstream captures of *O. mykiss* by trap site for: (a) Hilton Creek and (b) Salsipuedes Creek (not operated).

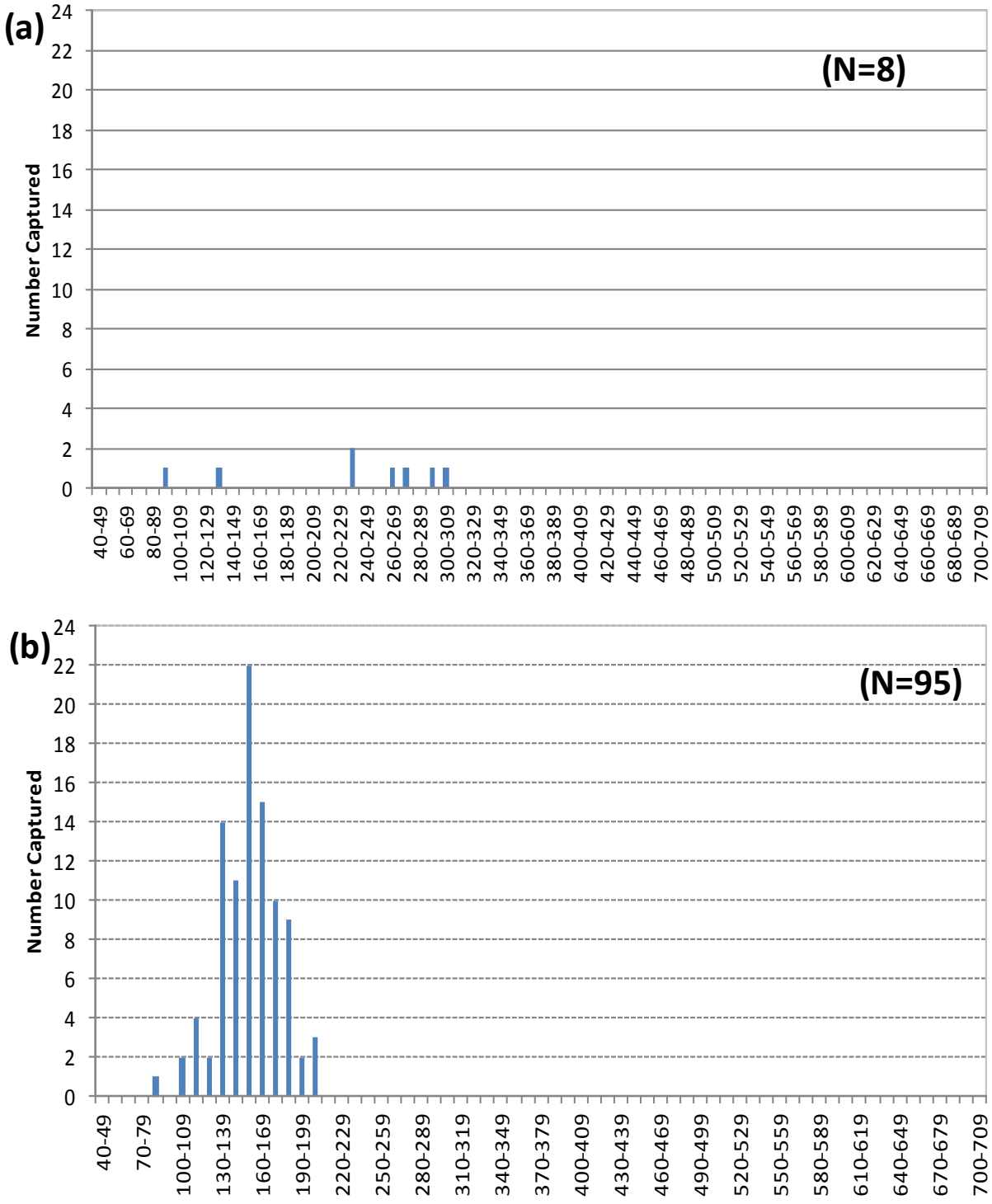


Figure 42: WY2016 Hilton Creek trap length-frequency histogram of *O. mykiss* in 10-millimeter intervals for (a) upstream and (b) downstream migrant captures.

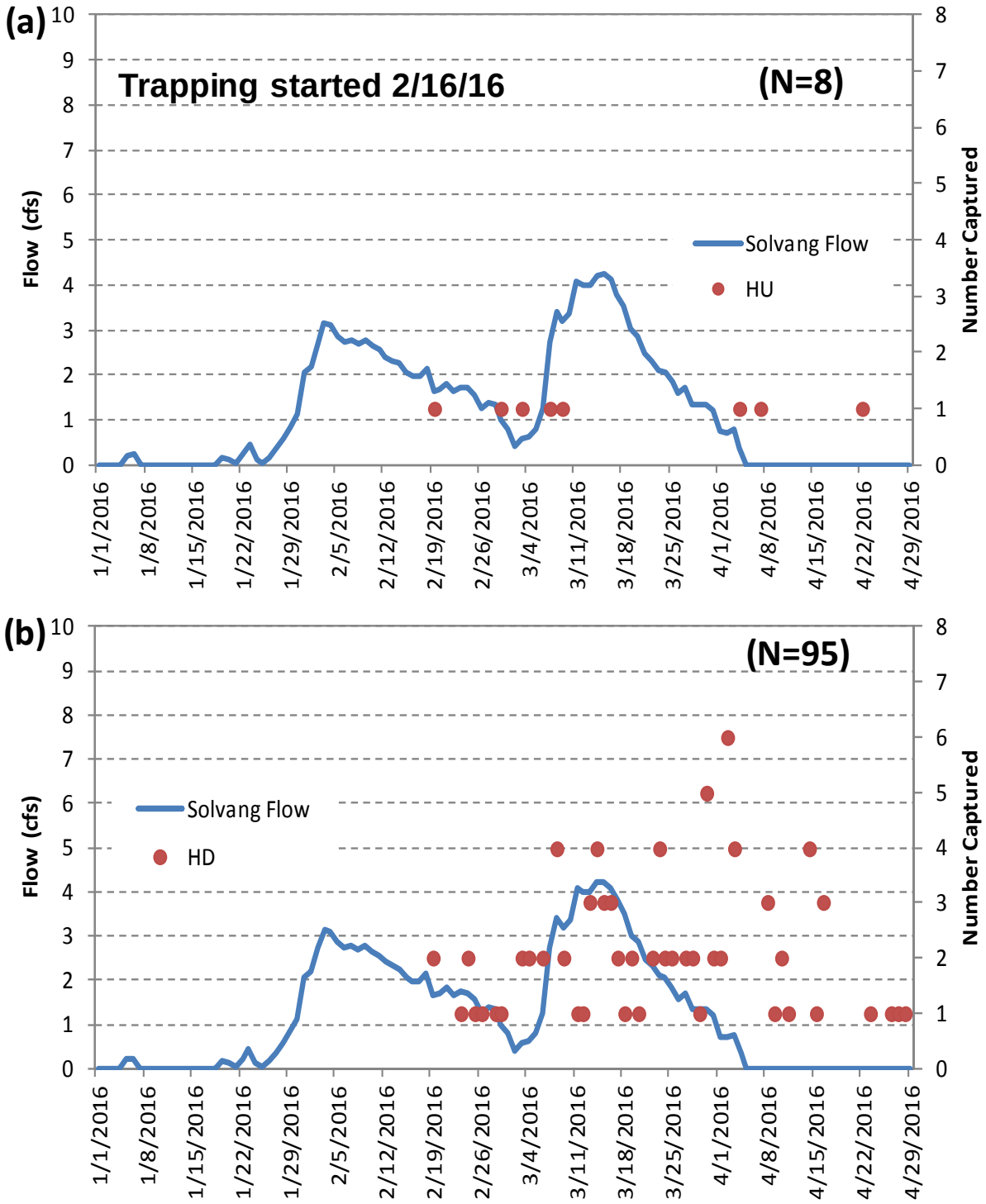


Figure 43: WY2016 Hilton Creek migrant captures of *O. mykiss* (red dots) vs. flow: (a) upstream migrant captures and (b) downstream migrant captures; USGS Solvang flow data were used as a proxy as the Hilton Creek USGS gauge site was dry.

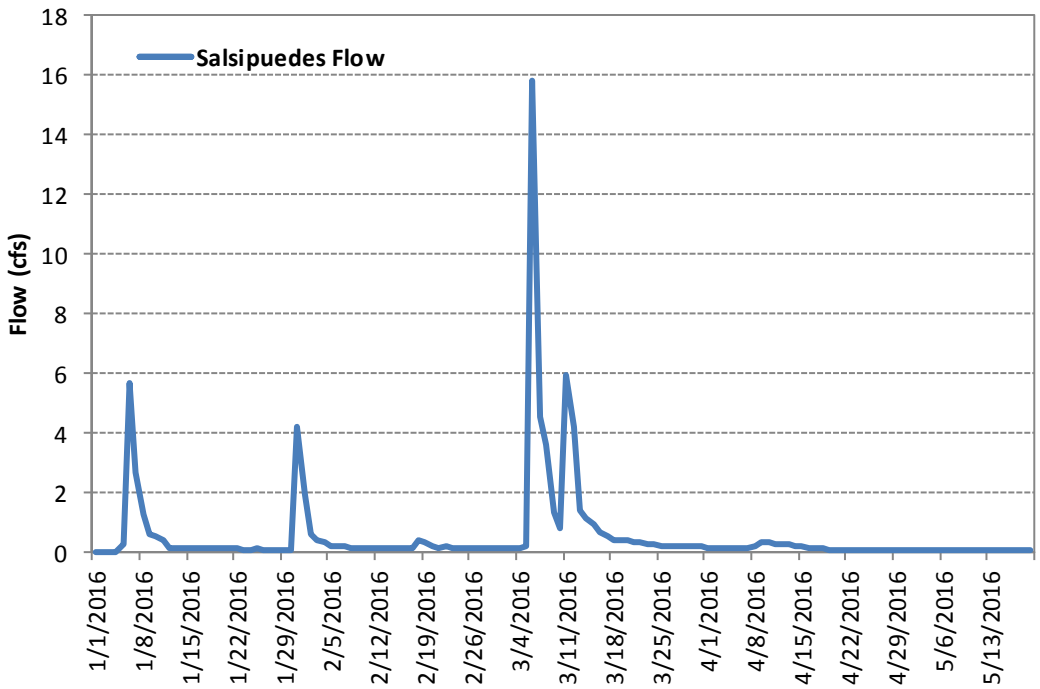


Figure 44: WY2016 Salsipuedes Creek flows during the migration season; the trap in this creek was not operated due to very low stream flows.

Table 10: Tributary upstream and downstream migrant captures of *O. mykiss* for Hilton Creek and Salsipuedes Creek (not trapped) in WY2016. Blue lettering represents breakdown of smolts, pre-smolts, and resident trout for each size category.

Hilton Captures		Size		Salsipuedes Captures
(#)		(mm)		(#)
		Upstream Traps		
0		>700		
0		650-699		
0		600-649		
0		550-599		
0		500-549		
0		450-499		
0		400-449		
1		300-399		
5		200-299		
1		100-199		
1		<99		
8		**Total**		
		Downstream Traps		
0		>700		
0		650-699		
0		600-649		
0		550-599		
0		500-549		
0		450-499		
0		400-449		
0		300-399		
3		200-299		
	2	***Smolts***		
	1	***Pre-Smolt***		
	0	***Res***		
91		100-199		
	54	***Smolts***		
	32	***Pre-Smolt***		
	5	***Res***		
1		<99		
	0	***Smolts***		
	1	***Pre-Smolt***		
	0	***Res***		
95		**Total**		

Table 11: WY2016 tributary redd survey results; lengths and widths are given in feet and Salsipuedes Creek watershed includes Upper Salsipuedes, El Jaro, Ytias, and Los Amoles creeks.

2016 Redd Surveys				
Location	Date	Redd#	*Length	**Width
Tributary Redds				
Hilton Ck	3/24/2016	1	2.70	0.9
	3/24/2016	2	2.40	1.0
Salsipuedes Ck	3/3/2016	1	1.80	1.0
Quiota Ck	5/3/2016	1	1.75	0.7
*=pit length plus tail spill length		4		
**=average of all width measurements				

Table 12: WY2016 tributary redd observations by month for each creek surveyed.

2016 Tributaries						
	January	February	March	April	May	**Total**
Hilton Ck	0	0	2	0	0	2
Quiota Ck	0	0	0	0	1	1
Salsipuedes Ck	0	0	1	0	0	1
El Jaro Ck	0	0	0	0	0	0
Los Amoles CK	n/s	n/s	n/s	n/s	n/s	n/s
Ytias Ck	n/s	Dry	Dry	Dry	Dry	n/s
Total:	0	0	3	0	1	**4**
n/s=not surveyed due to extreme low water						

Table 13: WY2016 LSYR mainstem redd survey results within the management reaches (Refugio and Alisal reaches) by month.

2016 Mainstem						
	January	February	March	April	May	**Total**
Highway 154	0	0	0	0	0	0
Refugio Reach	n/s	n/s	n/s	n/s	n/s	n/s
Alisal Reach	n/s	n/s	n/s	n/s	n/s	n/s
Total:	0	0	0	0	0	**0**
n/s=not surveyed due to extreme low water						

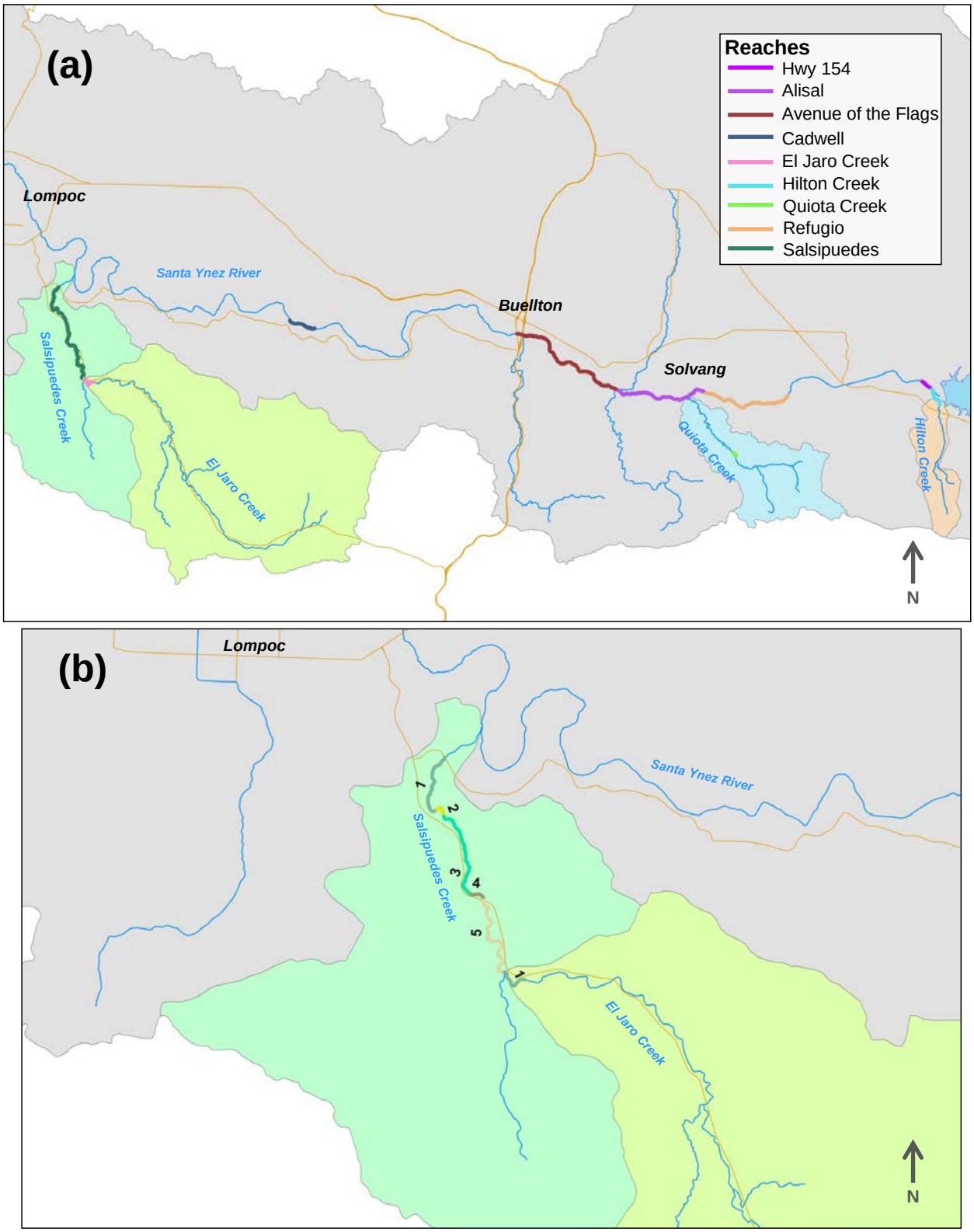


Figure 45: Stream reaches snorkel surveyed in WY2016 with suitable habitat and where access was granted within the (a) LSYR mainstem and its tributaries, and (b) Salsipuedes Creek.

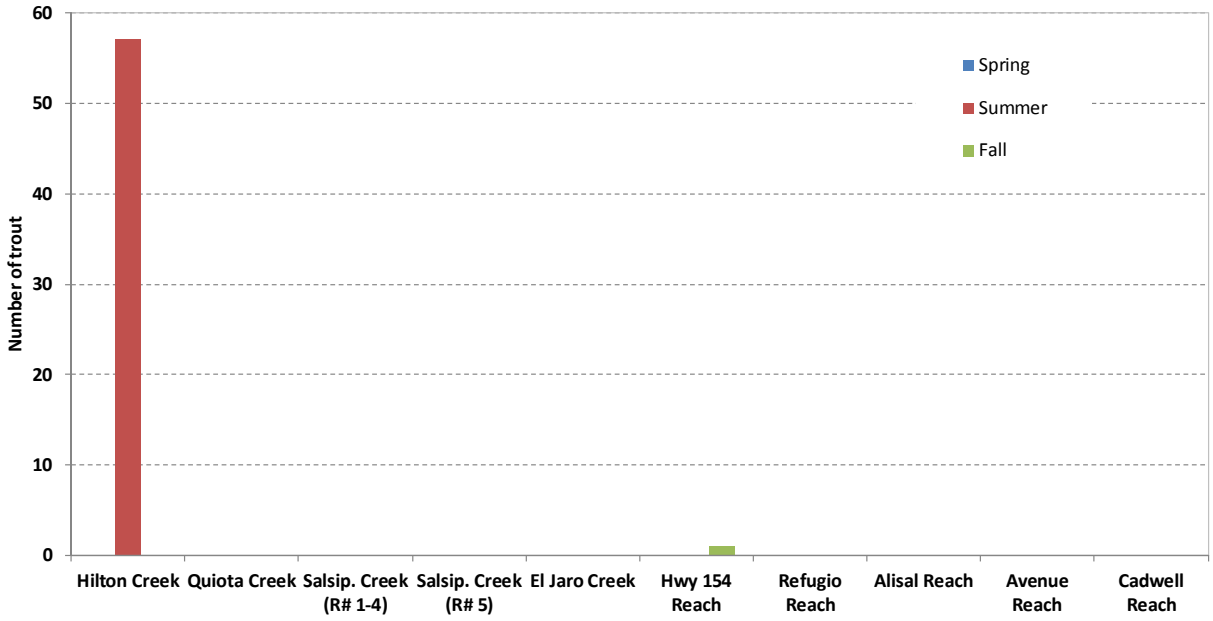


Figure 46: 2016 LSYR *O. mykiss* trout observed during spring, summer and fall snorkel surveys.

Table 14: 2016 LSYR mainstem snorkel survey schedule.

Mainstem/Stream Miles	Season	Survey Date
Hwy 154 Reach	Spring	7/6/2016
(LSYR-0.2 to LSYR-0.7)	Summer	n/s
	Fall	9/2/2016
Refugio Reach	Spring	7/6/2016
(LSYR-4.9 to LSYR-7.8)	Summer	8/23/2016-8/24/2016
	Fall	9/2/2016-9/6/2016
Alisal Reach	Spring	7/6/2016
(LSYR-7.8 to LSYR-10.5)	Summer	8/24/2016-8/25/2016
	Fall	9/6/2016-9/7/2016
Avenue Reach	Spring	7/18/2016
(LSYR-10.5 to LSYR-13.9)	Summer	8/26/2016
	Fall	9/7/2016-9/8/2016
Reach 3 Downstream of Avenue	Spring	7/19/2016
(LSYR-13.9 to LSYR-25.0)	Summer	8/27/2016
	Fall	9/9/2016
*n/s = no survey		

Table 15: LSYR mainstem spring, summer, and fall snorkel survey results of *O. mykiss* in 2016 with the miles surveyed; the level of effort was the same for each snorkel survey.

Mainstem	Spring (# of *O. mykiss*)	Summer (# of *O. mykiss*)	Fall (# of *O. mykiss*)	Survey Distance (miles)
Hwy 154 Reach	0	0	1	0.26
Refugio Reach	0	0	0	2.95
Alisal Reach	0	0	0	2.80
Avenue of the Flags Reach	0	0	0	3.4
Cadwell Reach	0	0	0	0.3

Table 16: LSYR mainstem spring, summer, and fall snorkel survey results in 2016 broken out by three inch size classes of *O. mykiss*.

Survey	Reach	Length Class (inches)									Total
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	
Spring	Hwy 154										0
	Refugio										0
	Alisal										0
	Avenue										0
	Cadwell										0
Summer	Hwy 154										
	Refugio										0
	Alisal										0
	Avenue										0
	Cadwell										0
Fall	Hwy 154				1						1
	Refugio										0
	Alisal										0
	Avenue										0
	Cadwell										0

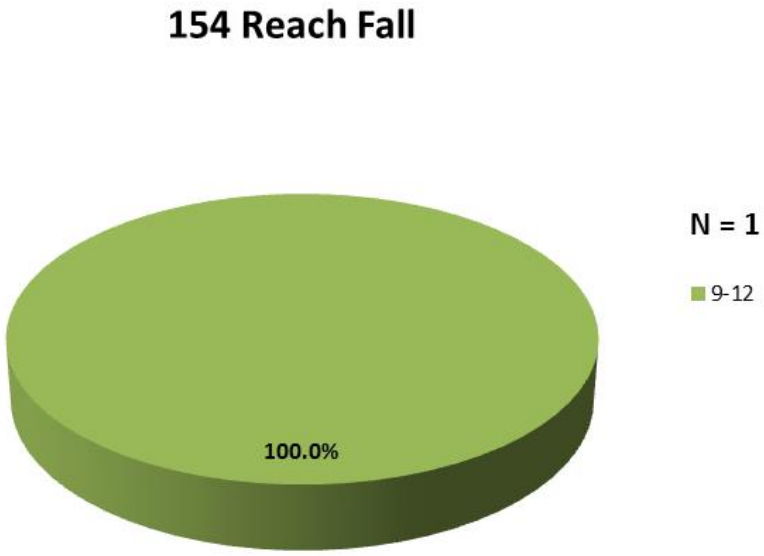


Figure 47: 2016 Hwy 154 Reach fall snorkel survey with size classes (range) of fish observed in inches of *O. mykiss*.

Table 17: 2016 tributary snorkel survey schedule.

Tributaries/Stream Miles	Season	Survey Date
Hilton Creek	Spring	4/12/2016*
(HC-0.0 to HC-0.54)	Summer	6/30/2016
	Fall	n/s
Quiota Creek	Spring	4/14/2016
(QC-2.58 to QC-2.73)	Summer	n/s
	Fall	n/s
Salsipuedes Creek	Spring	4/13/2016
(Reach 5)	Summer	n/s
	Fall	11/22/2016
El Jaro Creek	Spring	4/13/2016
(ELC-0.0 to ELC-0.4)	Summer	n/s
	Fall	11/22/2016
n/s = no survey, turbid conditions or dry		
*Poor visibility in upper half		

Table 18: WY2016 *O. mykiss* observed and miles surveyed during all tributary snorkel surveys; the level of effort was the same for each survey.

Tributaries	Spring (# of *O. mykiss*)*	Summer (# of *O. mykiss*)	Fall (# of *O. mykiss*)	Survey Distance (miles)
Hilton Creek				
Reach 1		1		0.133
Reach 2		20		0.050
Reach 3		4		0.040
Reach 4		32		0.075
Reach 5				0.242
Reach 6				0.014
Total:	n/s	***57***	n/s	***0.554***
Quiota Creek	0	n/s	n/s	0.11
Salsipuedes Creek (Reach 1-4)	n/s	n/s	n/s	2.85
Salsipuedes Creek (Reach 5)	n/s	n/s	n/s	0.45
El Jaro Creek	0	n/s	n/s	0.35
n/s = no survey, turbid conditions				
*Low reservoir elevation causing turbidity within Hilton Creek				

Table 19: WY2016 tributary spring, summer and fall snorkel survey results of *O. mykiss* broken out by three inch size classes.

Survey	Reach	Length Class (inches)									Total
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	
Spring	Hilton	n/a									
	Quiota										0
	Salsipuedes (R 1-4)	n/a									
	Salsipuedes (R-5)	n/a									
	El Jaro										0
Summer	Hilton		28	22	6	1					57
	Quiota	n/a									
	Salsipuedes (R 1-4)	n/a									
	Salsipuedes (R-5)	n/a									
	El Jaro	n/a									
Fall	Hilton	n/a									
	Quiota	n/a									
	Salsipuedes (R 1-4)	n/a									
	Salsipuedes (R-5)	n/a									
	El Jaro	n/a									
n/a = no survey, turbid conditions or dry											

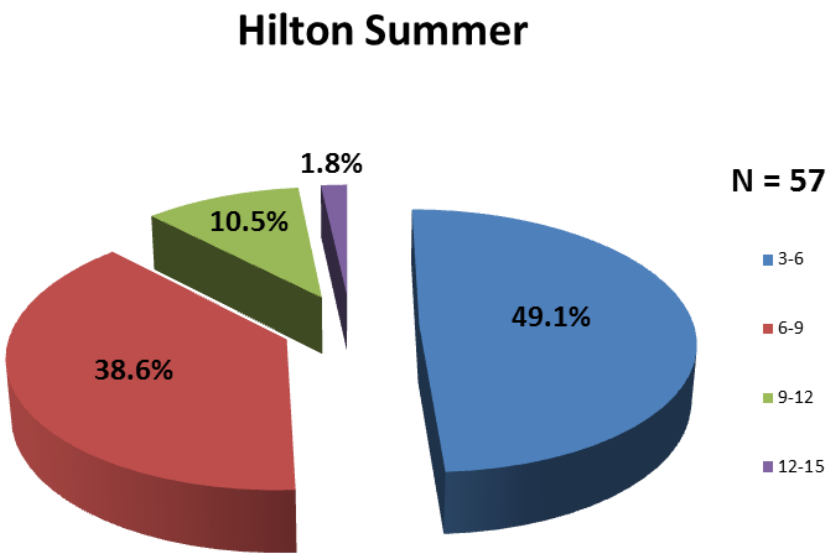


Figure 48: WY2016 Hilton Creek snorkel survey with size classes (range) of *O. mykiss* observed in inches.

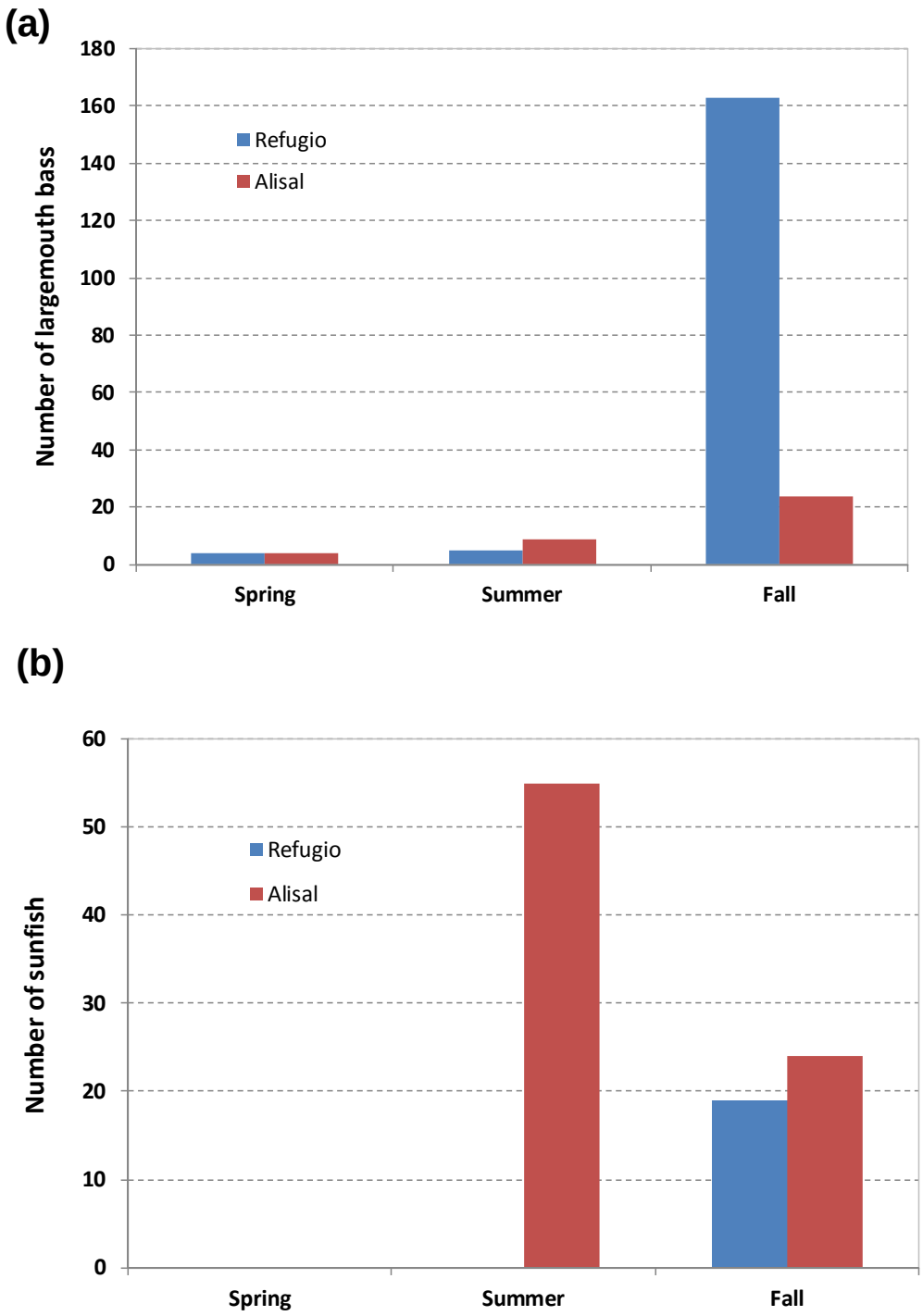


Figure 49: Observed warm water predators during the spring, summer and fall snorkel surveys in WY2016 within the Refugio and Alisal reaches: (a) largemouth bass and (b) sunfish.

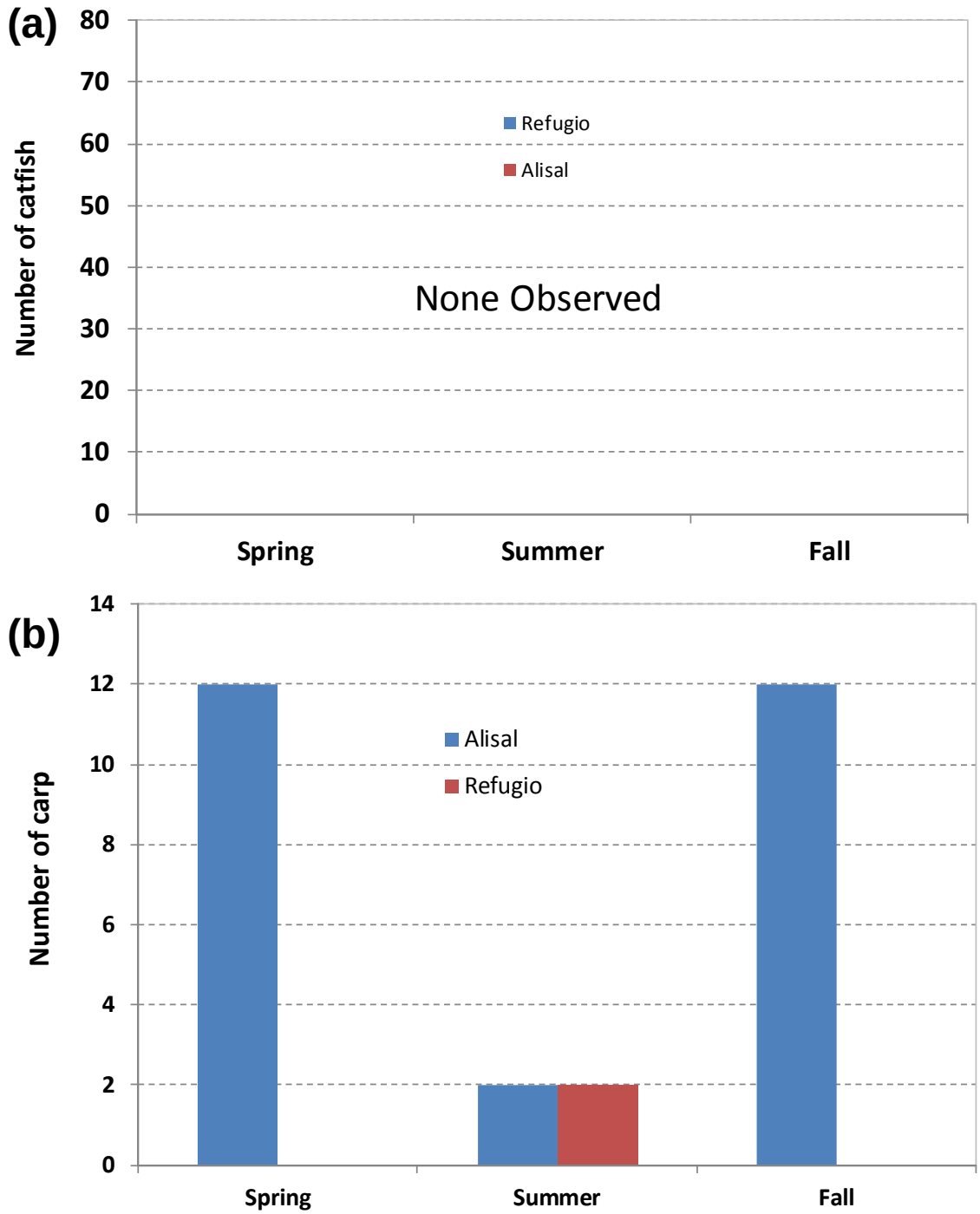
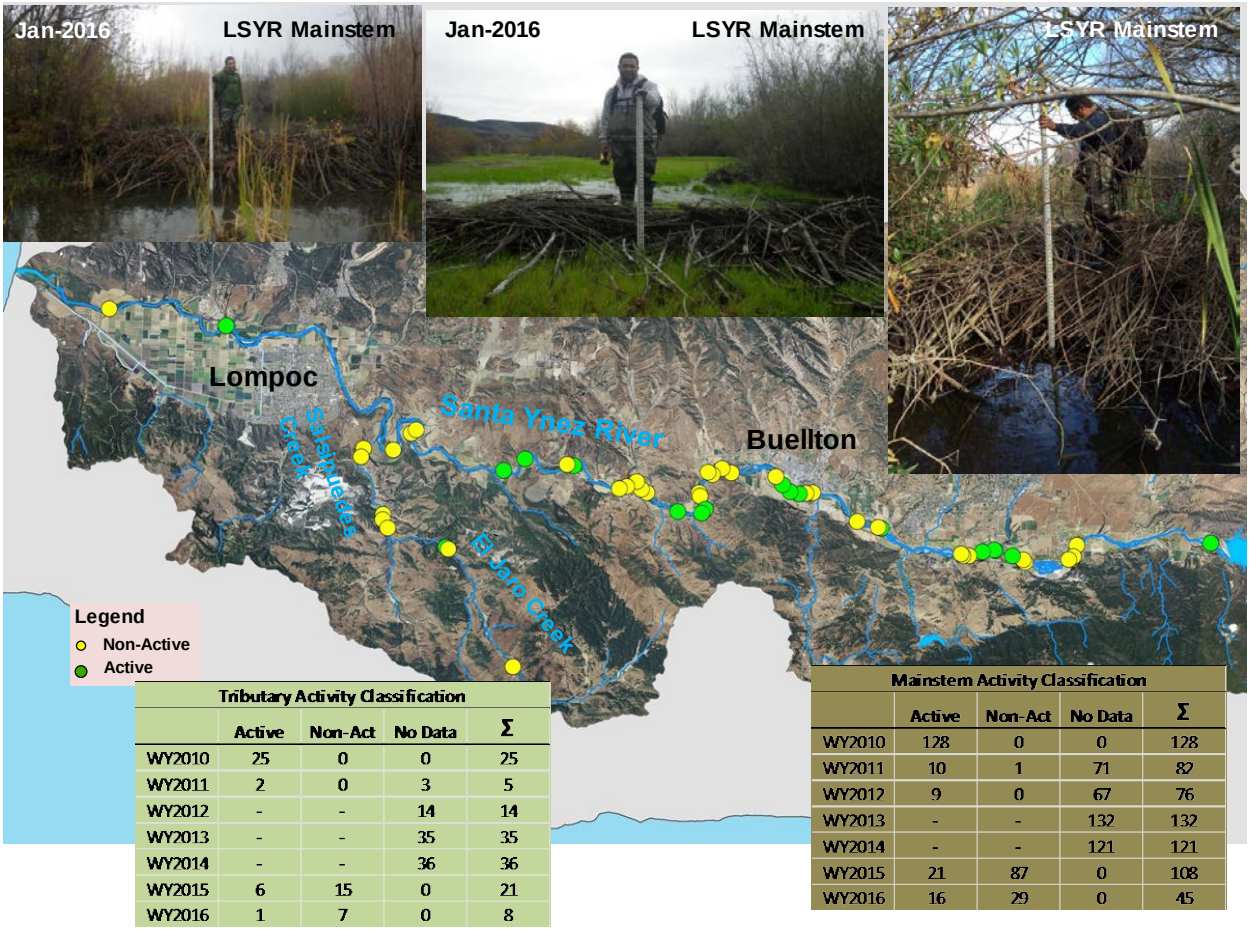


Figure 50: Observed warm water species during the spring, summer and fall snorkel surveys in WY2016 within the Refugio and Alisal reaches: (a) catfish, and (b) carp.



Tributary Activity Classification

	Active	Non-Act	No Data	Σ
WY2010	25	0	0	25
WY2011	2	0	3	5
WY2012	-	-	14	14
WY2013	-	-	35	35
WY2014	-	-	36	36
WY2015	6	15	0	21
WY2016	1	7	0	8

Mainstem Activity Classification

	Active	Non-Act	No Data	Σ
WY2010	128	0	0	128
WY2011	10	1	71	82
WY2012	9	0	67	76
WY2013	-	-	132	132
WY2014	-	-	121	121
WY2015	21	87	0	108
WY2016	16	29	0	45

Figure 51: Spatial extent of beaver dams from the WY2016 survey within the LSYR drainage where 45 dams were observed in the LSYR mainstem and 8 observed in the Salsipuedes Creek watershed.

Table 20: 2010-2016 beaver dams in the LSYR and Salsipuedes/El Jaro watershed broken out by height.

	Mainstem Beaver Dams						Tributary Beaver Dams					
Height Year	0.0-1.0 (ft)	1.1-2.0 (ft)	2.1-3.0 (ft)	3.1-4.0 (ft)	> 4.0 (ft)	Σ	0.0-1.0 (ft)	1.1-2.0 (ft)	2.1-3.0 (ft)	3.1-4.0 (ft)	> 4.0 (ft)	Σ
WY2010	3	65	40	17	3	128	0	17	5	3	0	25
WY2011	5	34	31	10	2	82	3	1	1	0	0	5
WY2012*	9	38	23	4	0	74	5	6	3	0	0	14
WY2013	23	75	27	7	0	132	8	23	4	0	0	35
WY2014	21	48	36	15	1	121	10	24	2	0	0	36
WY2015	19	52	32	4	1	108	9	10	2	0	0	21
WY2016	7	21	14	3	0	45	1	6	1	0	0	8

* There were 76 mainstem beaver dams in 2012, two were not measured

WY2016 Annual Monitoring Summary
Discussion
Figures and Tables

4. Discussion

Table 21: Monthly rainfall totals at Bradbury Dam from WY2000-WY2016.

Month	Water Years:																
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Oct	0	2.64	0.62	0	0	6.38	0.48	0.16	0.34	0.15	2.2	2.24	0.47	0.12	0.34	0.00	0.30
Nov	1.62	0	3.27	2.5	1.2	0.33	1.64	0.2	0.06	3.39	0	1.42	2.82	1.34	1.14	0.87	0.73
Dec	0	0.09	2.66	6.73	2.03	13.25	0.73	1.59	2.39	2.46	3	9.48	0.35	2.95	0.18	5.88	1.12
Jan	1.94	8.4	0.87	0.06	0.32	10.3	7.82	1.3	16.57	0.65	10.34	1.84	1.58	1.75	0.02	0.82	4.03
Feb	10.37	5.71	0.24	3.56	6.52	9.22	3.06	3.03	2.33	5.7	4.92	3.36	0.43	0.40	4.11	0.51	1.65
Mar	2.76	13.44	0.79	2.4	0.48	3.08	4.31	0.15	0.46	0.85	0.26	11.85	3.63	0.80	3.52	0.08	3.02
Apr	4.73	1.35	0.13	2.15	0	1.27	4.89	0.81	0.06	0.19	3.15	0.14	3.21	0.19	0.65	0.36	0.24
May	0.01	0.06	0.12	2.33	0	0.51	1.56	0	0.38	0	0.05	0.42	0.02	0.02	0	0.26	0.36
Jun	0.04	0	0	0.02	0	0.04	0	0	0	0.16	0	0.34	0	0	0	0.42	0.00
Jul	0	0.06	0	0.01	0	0	0	0	0	0	0	0.00	0	0	0	0.03	0.00
Aug	0	0	0	0	0	0	0	0	0	0.03	0	0.00	0	0	0	0.00	0.00
Sept	0	0	0.08	0	0	0.03	0	0.17	0	0.08	0	0.00	0.18	0	0	0.15	0.00
Totals:	***21.47***	***31.8***	***8.78***	***19.8***	***10.55***	***44.41***	***24.5***	***7.41***	***22.59***	***13.66***	***23.92***	***31.09***	***12.69***	***7.57***	***9.96***	***9.38***	***11.45***

Table 22: Monthly average stream discharge at the USGS Solvang and Narrows gauges during WY2001-WY2016.

Month	WY2001		WY2002		WY2003		WY2004		WY2005		WY2006	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	n/d	20.6	n/d	2.06	23.3	18.8	0	0	31.1	29.4	6.05	9.41
Nov	n/d	14.8	n/d	12.3	8.11	15.2	0	0	6.35	14.2	6.94	16
Dec	n/d	14.9	n/d	25.2	22.3	55.5	0	0.02	293.2	478.5	10.7	20.1
Jan	37.3	75.3	n/d	24.6	10.7	26.7	1.6	1.54	2556	2765	40	79.4
Feb	n/d	321	n/d	21.6	12.7	27	8.96	38.4	2296	2555	12.2	28
Mar	n/d	3378	n/d	13.4	24	70.2	4.25	12.4	776.6	929.3	51.2	86.1
Apr	n/d	207.3	n/d	3.93	14.9	22.3	0.295	1.46	206.8	300.8	1317	1053
May	n/d	57.5	n/d	1.44	9.83	19.5	0	0.10	104.3	150.7	131.9	139.6
Jun	n/d	13.6	n/d	0.515	1.64	3.97	0	0	13.8	32.7	20.1	26.5
Jul	n/d	5.08	n/d	0.09	0.01	0.64	53.2	3.69	9.15	14	7.83	4.76
Aug	n/d	2.53	64.8	24.2	0	0.11	59.4	30.9	6.35	2.86	4.69	0.98
Sep	n/d	2.15	37.2	28.9	0	0	39.3	24	6.02	4.15	5.7	1

Month	WY2007		WY2008		WY2009		WY2010		WY2011		WY2012	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	0	0	0	0	0	0	0	0	0	0	7.59	4.28
Nov	0	0	0	0	0	0	0	0	0	0	8.33	11.1
Dec	0	0	0	0	0	0	0	0	0	0	7.91	14.6
Jan	0	0	0	0	0	0	0	0	0	0	7.97	16.9
Feb	0	0	0	0	0	0	0	0	0	0	7.46	14.1
Mar	0	0	0	0	0	0	0	0	0	0	6.01	11.7
Apr	0	0	0	0	0	0	0	0	0	0	8.82	14.7
May	0	0	0	0	0	0	0	0	0	0	5.56	5.53
Jun	0	0	0	0	0	0	0	0	0	0	4.73	0.52
Jul	0	0	0	0	0	0	0	0	0	0	4.58	0.03
Aug	0	0	0	0	0	0	0	0	0	0	4.88	0
Sep	0	0	0	0	0	0	0	0	0	0	6.60	0

Month	WY2013		WY2014		WY2015		WY2016	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	4.5	0	42.6	28.8	13.2	0	0.65	0
Nov	2.7	0	22.7	17.1	5.21	0	0	0
Dec	5.8	0	8.9	8.1	7.1	0	0	0
Jan	6.3	0	4.3	2.2	5.1	0	0.22	0
Feb	6	3.6	6	3.6	4	0	2.14	0
Mar	4.8	4.5	10.6	12.3	1.5	0	2.39	0
Apr	1.7	0.54	3	1.8	0	0	0.09	0
May	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0
Jul	51	3	0	0	0	0	54.8	0
Aug	59.1	27	0	0	79	0	69.4	34.8
Sep	47.9	28	2.7	0	42	0.77	0.67	2.86

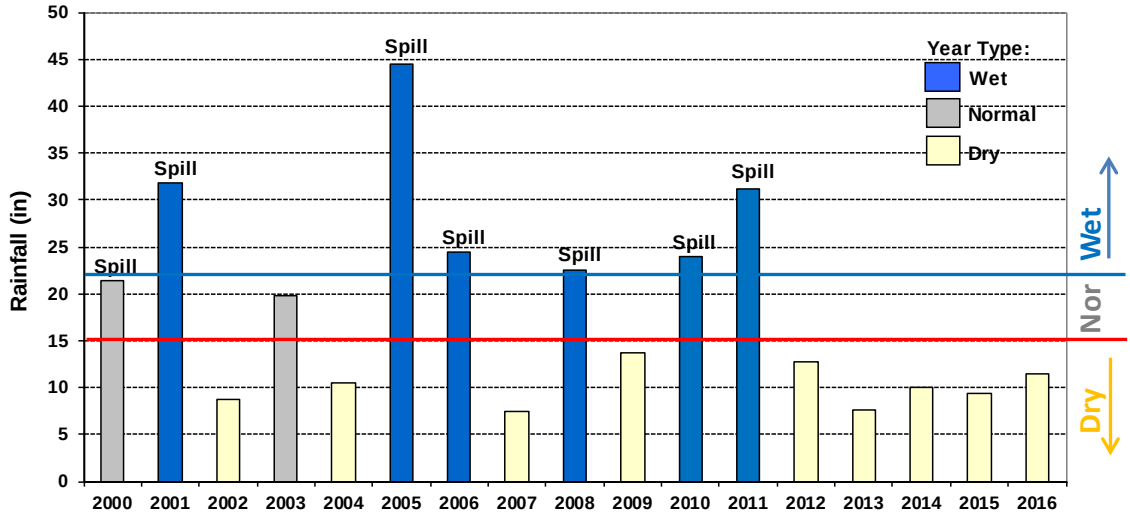


Figure 52: Water year type (wet, normal and dry) and spill years since the issuance of the BO in 2000. Year types are defined as Dry (< 15 inches), Normal (15 to 22 inches) and Wet (> 22 inches) at Bradbury Dam.

Table 23: Biological Opinion (BiOp) tributary project inventory with the completion date specified in the BiOp and their status to date; completed projects are listed by calendar year.

Tributary Projects	BiOp Expected Completion Date	Current Status (as of December 2016)
Hwy 1 Bridge on Salispuedes Creek	2001	Completed (2002)
Cross Creek Ranch on El Jaro Creek	2005	Completed (2009)
Hwy 101 Culvert on Nojoqui Creek	2005	Proposed removal from BiOp[1]
Quiota Creek Crossing 1	2003	Completed (2013)
Quiota Creek Crossing 3	2003	Completed (2015)
Quiota Creek Crossing 4	2003	Completed (2016)
Quiota Creek Crossing 5	2003	Completed (2018)
Quiota Creek Crossing 7	2003	Completed (2012)
Quiota Creek Crossing 9	2003	Completed (2018)
Cascade Chute Passage on Hilton Creek	2000	Completed (2005)
Hwy 154 Culvert on Hilton Creek	2002	Proposed removal from BiOp[1]
Total:	**11**	
Projects completed or funded:	***9***	
Projects suggested to be removed:	***2***	

1. Project proposed for removal from the BiOp.

Table 24: Non-BiOp tributary projects already completed or proposed with their status to date; completed projects are listed by calendar year.

Tributary Projects	Current Status (as of December 2016)
Jalama Road Bridge on Salsipuedes Creek	Completed (2004)
San Julian Ranch on El Jaro Creek	Completed (2008)
Quiota Creek Crossing 0A	Completed (2016)
Quiota Creek Crossing 0B	In design
Quiota Creek Crossing 2	Completed (2011)
Quiota Creek Crossing 6	Completed (2008)
Quiota Creek Crossing 8	Construction (2019)[1]
Total:	**7**
Projects completed:	***5***
Projects remaining:	***2***
1. Grant funding has been secured.	

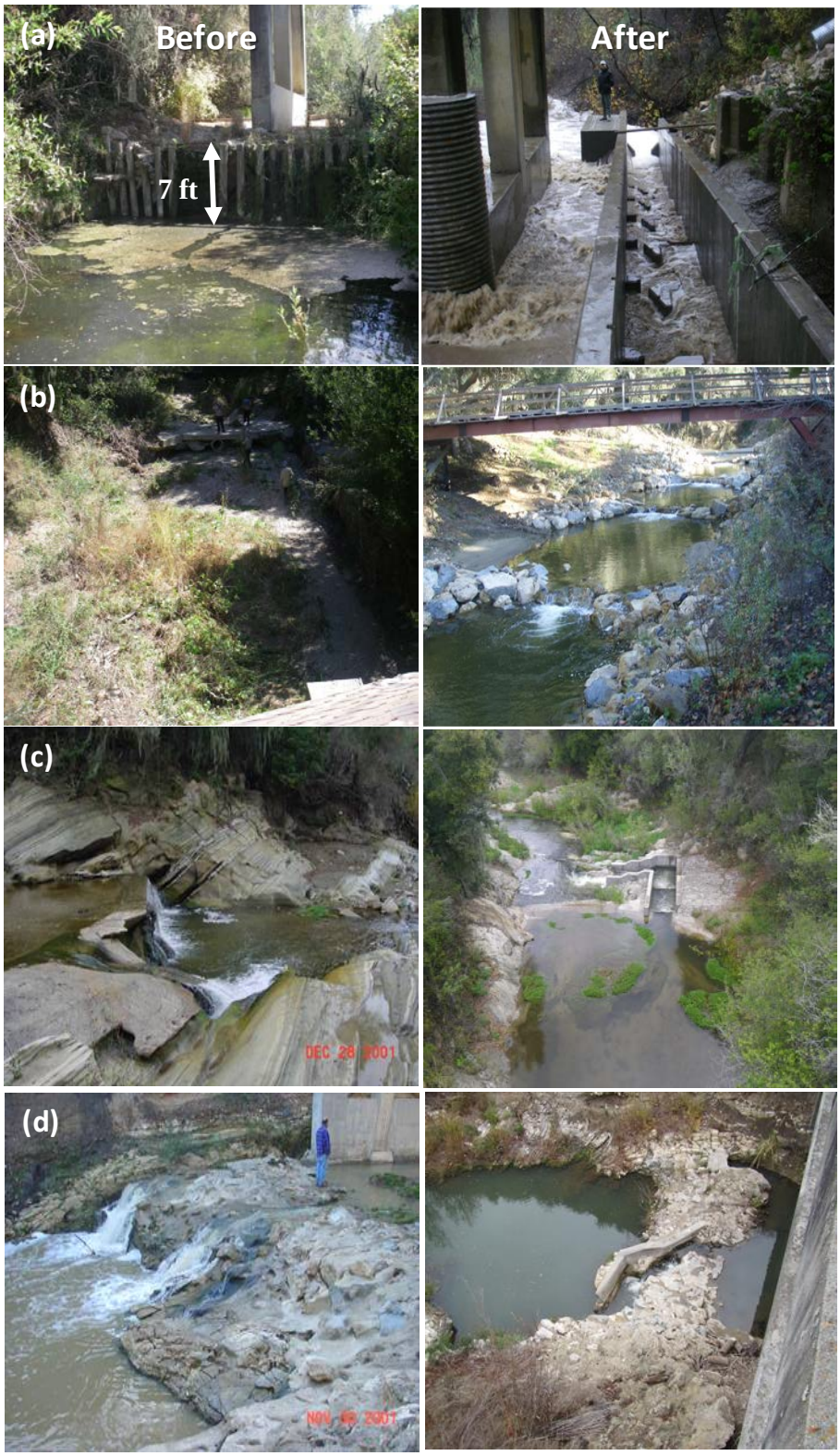


Figure 53: Fish passage and habitat restoration at: at (a) Rancho San Julian Bridge on El Jaro Creek (2008), (b) Cross Creek Ranch on El Jaro Creek (2009), (c) Jalama Road Bridge on Salsipuedes Creek (2004), and (d) Highway 1 Bridge on Salsipuedes Creek (2002).-

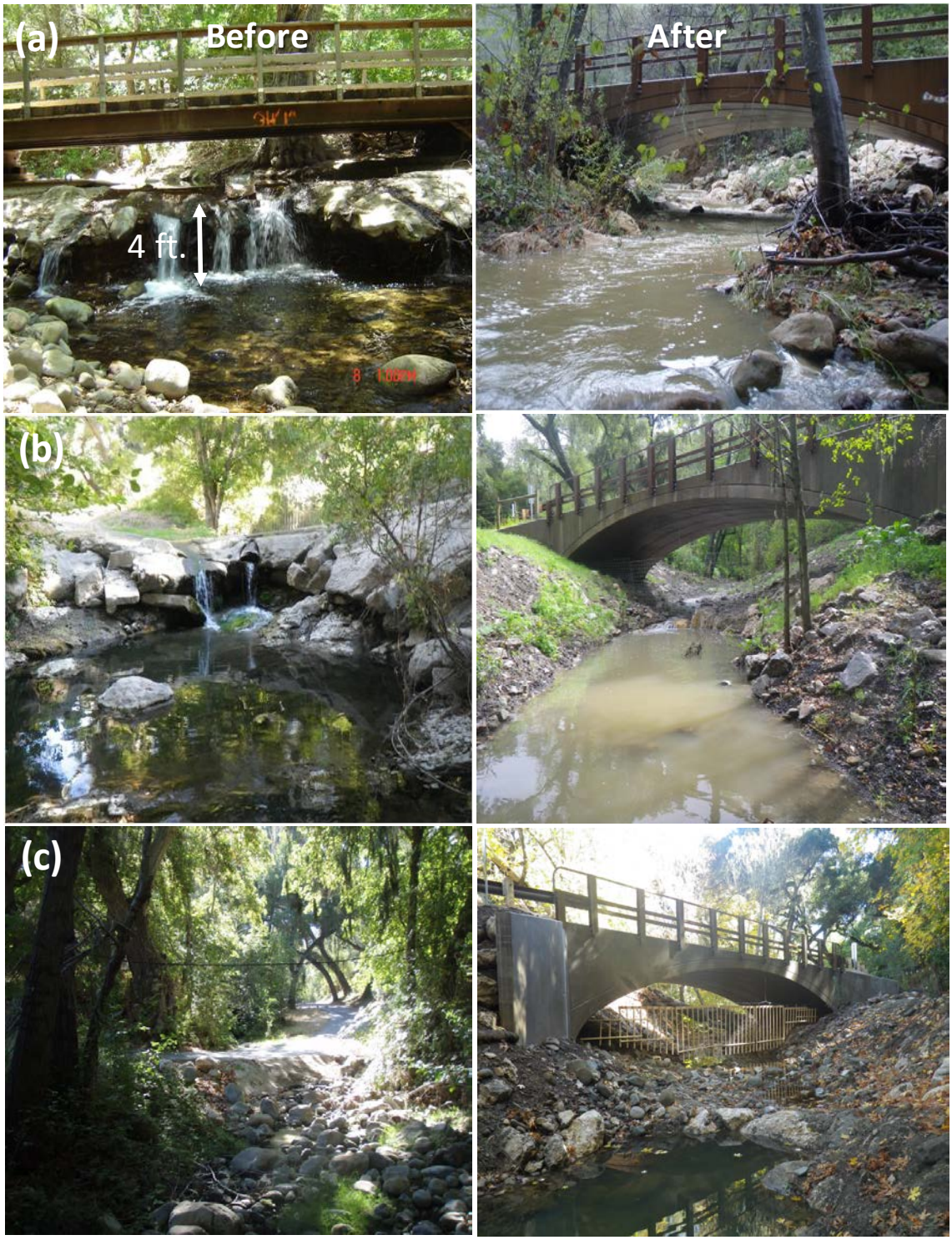


Figure 54: Fish passage and habitat restoration at a) Quiota Creek Crossing 6 (2008), (b) Quiota Creek Crossing 2 (2011), and Quiota Creek Crossing 7 (2013).

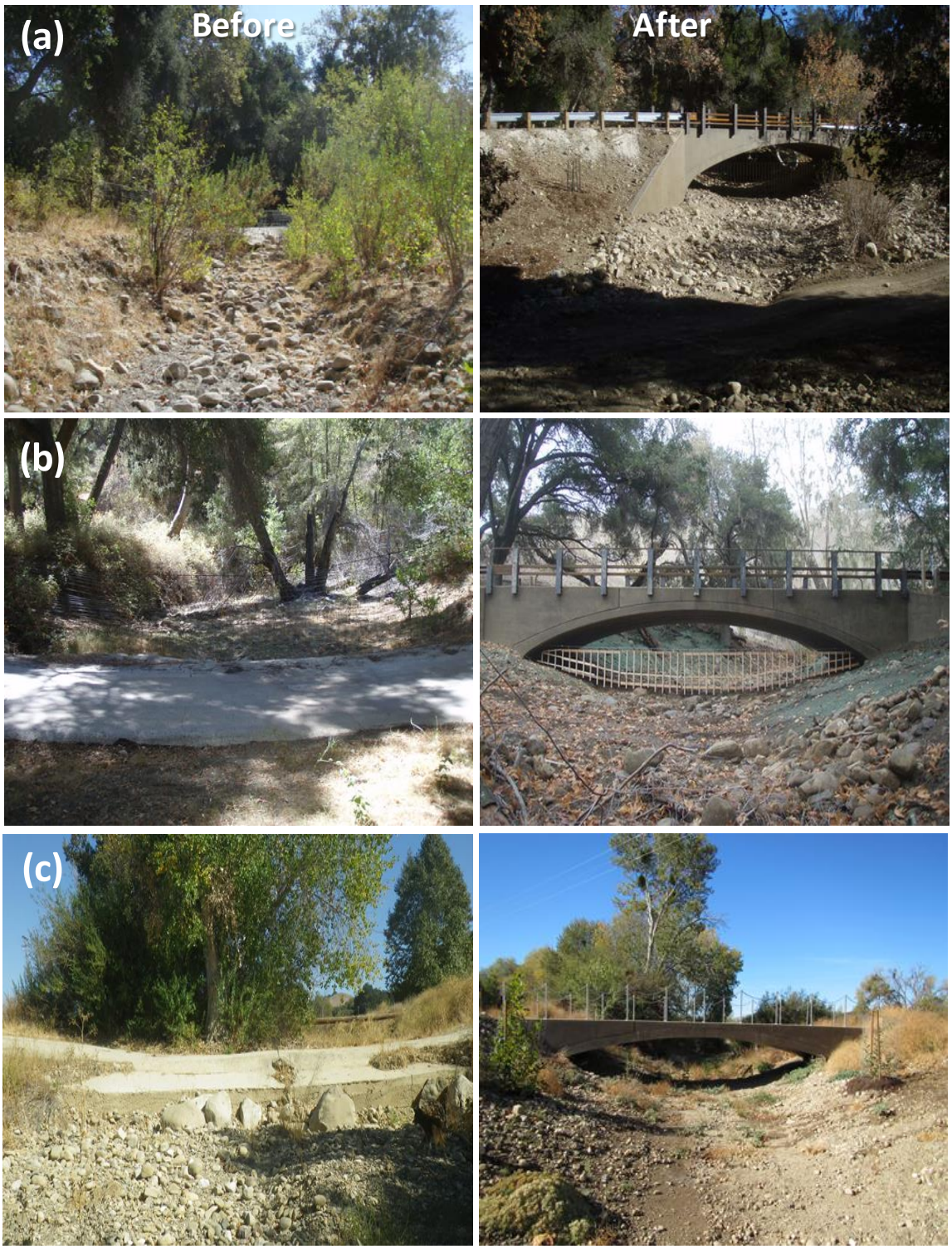


Figure 55: Fish passage and habitat restoration at (a) Quiota Creek Crossing 1 (in 2014), (b) Quiota Creek Crossing 3 (in 2015), and Quiota Creek Crossing 0A (in 2016)..

Figure 56: Fish passage and habitat restoration at (a) Quiota Creek Crossing 4 (completed in 2016) and (b) Hilton Creek at the Cascade Chute Project (completed in 2005).

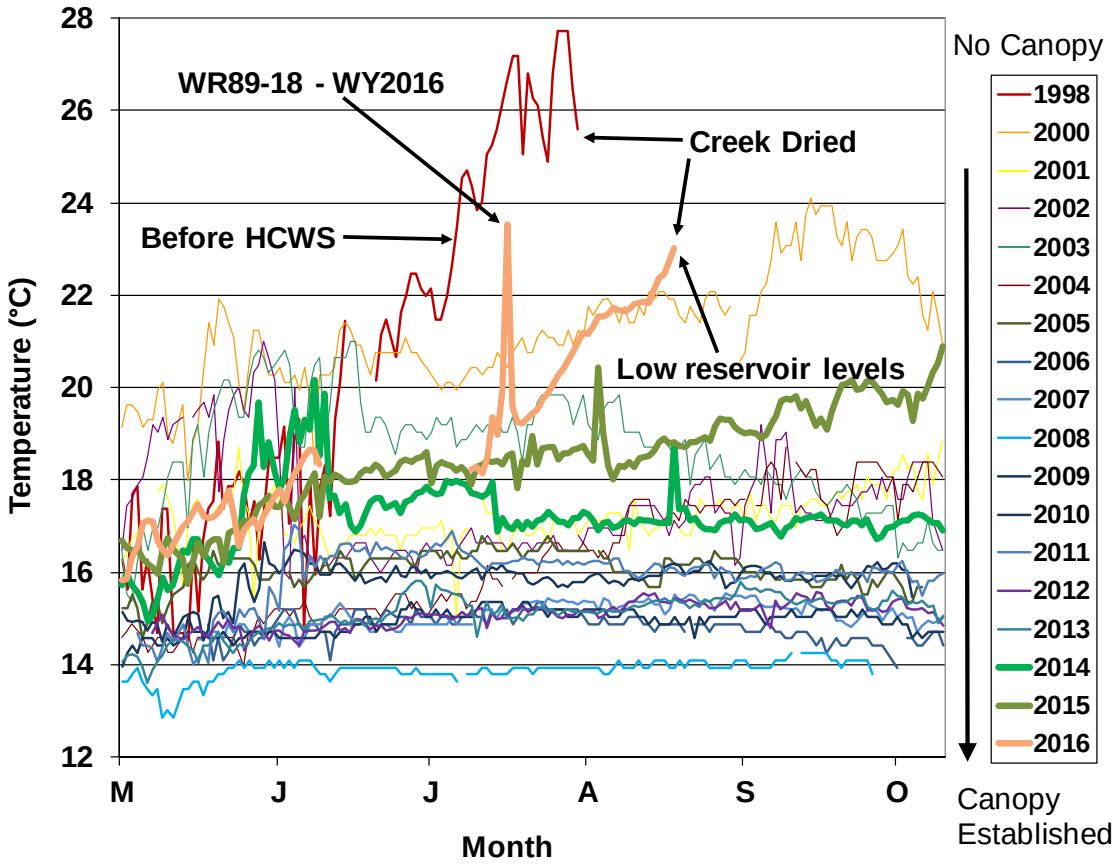


Figure 57: Lower Hilton Creek thermograph maximum water temperature data from 1998 to 2016, the last three years are shown with a wider curve.

Figure 58: Transfer of lake water deliveries to Hilton Creek from the HCWS-URP to the HCEBS-LRP showing (a+b) electrofishing operations, (c) release of rescued fish downstream of the LRP, (d) adjustment of HCEBS valves, (e) monitoring flow rates, and (f) staged water truck to provide emergency water deliveries if needed.

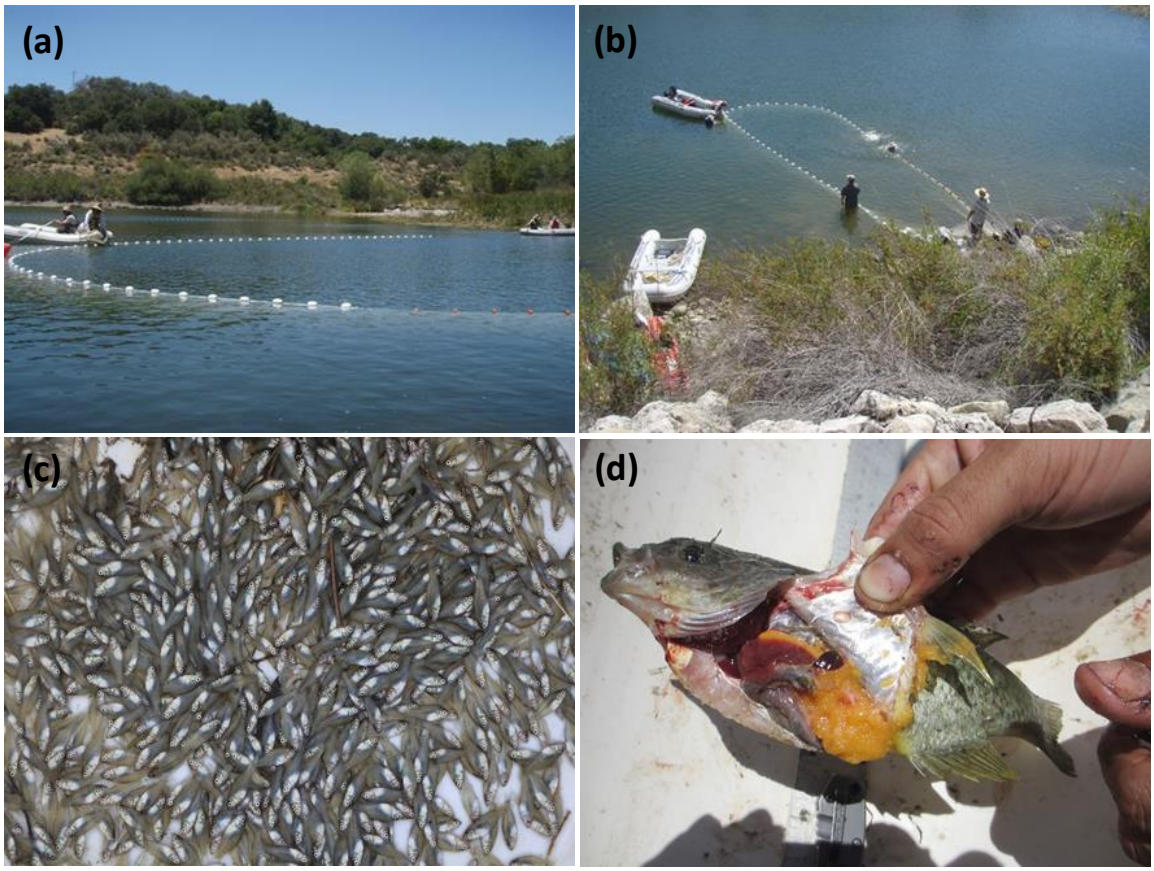


Figure 59: Stilling Basin non-native fish removal efforts showing (a+b) seining activities using an inflatable boat, (c) captured fry, and (d) roe of stomach content of a captured and dispatched non-native fish.

Figure 60: Fish rescue and relocation efforts in lower Hilton Creek just prior to the start of the WR 89-18 release, showing (a+b) electrofishing operations and (c+d) captured fish ready for relocation.

Figure 61: Hilton Creek Water Tanks (5-thousand gallons each): (a) arrival of the tanks, (b) installation, (c) shade protection, and (d) measuring trickle flow at 0.03 cfs.

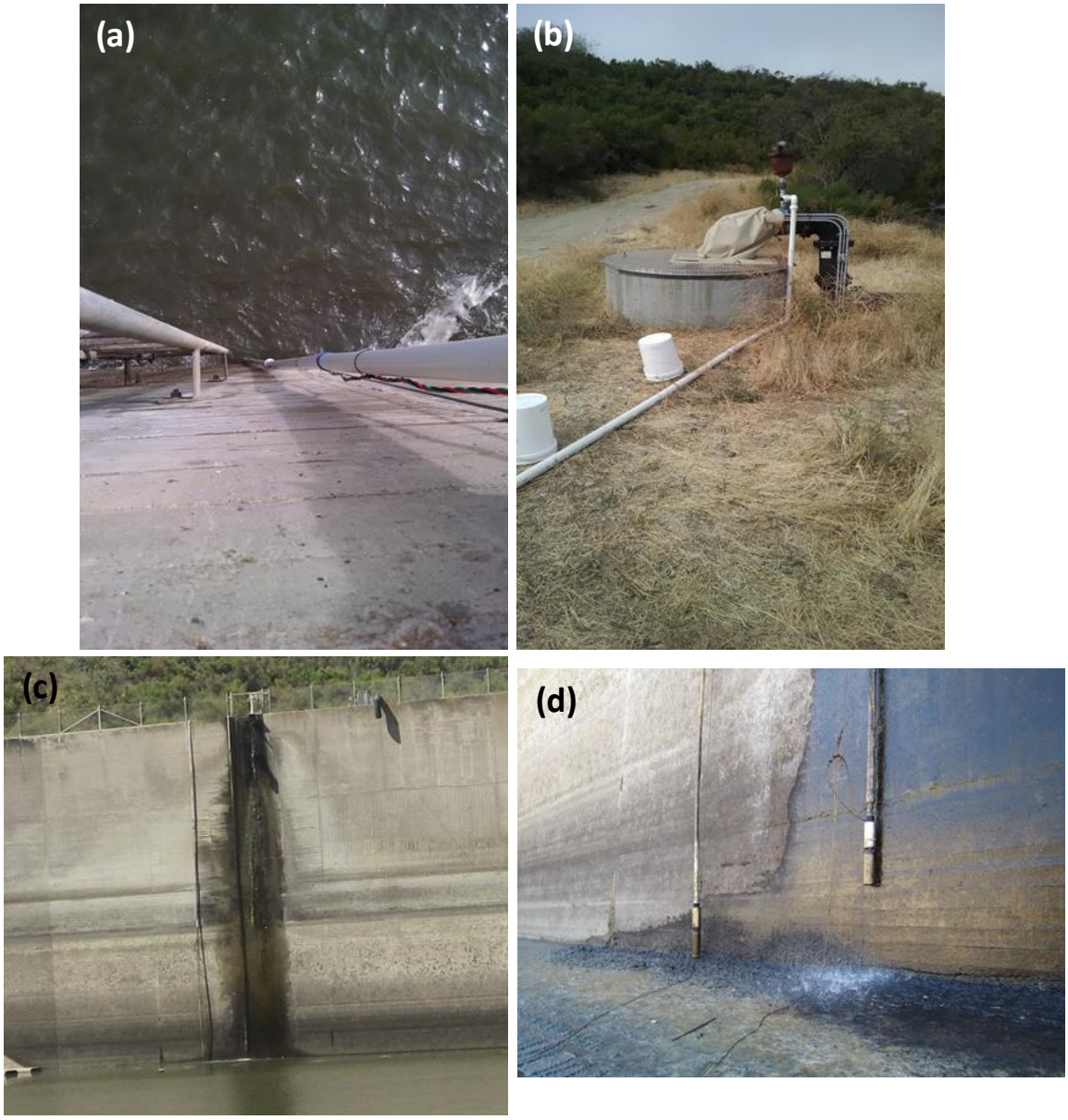


Figure 62: Stilling Basin (well) pumps (operational and backup) that provided trickle flow (0.03 cfs): (a) hanging off of the south parapet wall of the spillway, (b) connection of the pumping pipeline to the Chute Release Point, and (c+d) hanging pumps on the parapet wall during Stilling Basin dewatering efforts in WY2017.

Figure 63: WR 89-18 release trapping operations (a) downstream of the Stilling Basin and (b) at the tailout of the Long Pool, showing a captured *O. mykiss* at (c) the Stilling Basin trap and (d) the Long Pool trap.

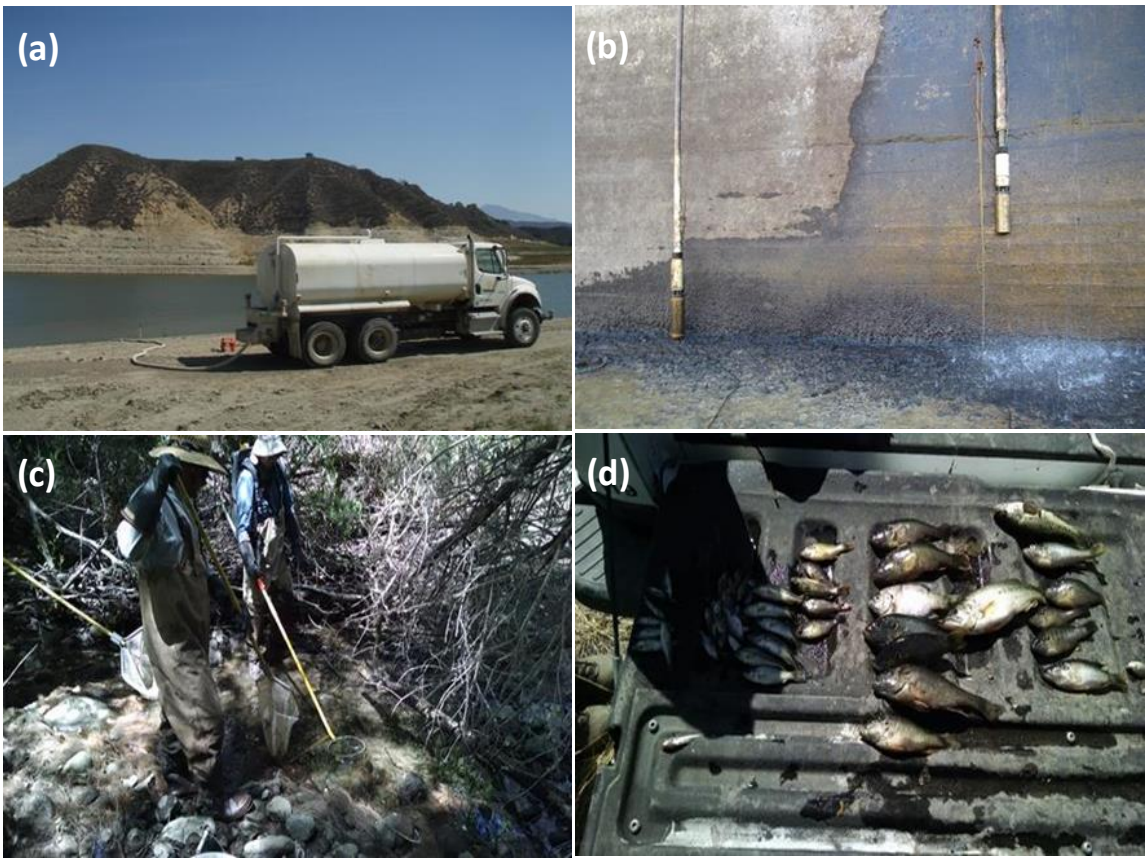


Figure 64: Post WR 89-18 release efforts to maintain trickle flow to Hilton Creek and conduct fish rescue and relocation downstream of the dam, showing (a) water tanker truck filling up on the shores of Lake Cachuma using a trash pump, (b) Stilling Basin submersible pumps during dewatering efforts in 2017, (c) fish rescue operations by electrofishing between the Stilling Basin and Long Pool, and (d) non-native fish removal.

Figure 65: Fish rescue operations at the Long Pool dried out after the end of 2016 WR 89-18 releases showing (a) a swiftly shrinking Long Pool, (b) seining, and (c+d) captured fish from the seine hauls.

WY2016 Annual Monitoring Summary
Appendices

A. Acronyms and Abbreviations

AF: Acre Foot
AMC: Adaptive Management Committee
AMR: Annual Monitoring Report
AMS: Annual Monitoring Summary
BA: Biological Assessment
BiOp: Biological Opinion
BPG: Biogeographic Population Group
CCRB: Cachuma Conservation Release Board
CCWA: Central Coast Water Authority
CDFG: California Department of Fish and Game
CFS: Cubic Feet per Second
COMB: Cachuma Operation and Maintenance Board
CPBS: Cachuma Project Biology Staff
CPUE: Catch Per Unit Effort
CRP: Chute Release Point
DIDSON: Dual Frequency Identification Sonar
DO: Dissolved Oxygen Concentration
DPS: Distinct Population Segment
EJC: El Jaro Creek
HC: Hilton Creek
HCWS: Hilton Creek Watering System
Hwy: Highway
ID: Improvement District
ITS: Incidental Take Statement
LRP: Lower Release Point
LSYR: Lower Santa Ynez River
NMFS: National Marine Fisheries Service
NOAA: National Oceanic Atmospheric Administration
O. mykiss: *Oncorhynchus mykiss*, steelhead/rainbow trout
ORP: Oxidation Reduction Potential
RPM: Reasonable and Prudent Measure
QC: Quiota Creek

RTDG: Real Time Decision Group
SMC: San Miguelito Creek
SWP: State Water Project
SWRCB: California State Water Resources Control Board
SYRCC: Santa Ynez River Consensus Committee
SYRTAC: Santa Ynez River Technical Advisory Committee
T&C: Terms and Conditions
TDS: Total Dissolved Solids
URP: Upper Release Point
USBR: United States Bureau of Reclamation (Reclamation)
USGS: United States Geological Survey
WR: Water Right
WY: Water Year (October 1 through September 30)
YOY: Young-of-the-year *O. mykiss*.

B. QA/QC Procedures

The Cachuma Project Biology Staff (CPBS) maintains and calibrates water quality and flow meter equipment that is used on the LSYR mainstem and tributaries. Water quality equipment is generally used from the spring (May-June) through the fall (October-November). Flow meters are used throughout the year to gather spot flow information, particularly during periods of stormflow in the winter and spring, as well as during the summertime period to monitor whether target flows are being met within the LSYR mainstem. The calibration procedures and timing for water quality and flow meter equipment can be found in Table A-1 (Calibration). The parameters and specifications of each instrument are listed in Table A-2 (instrument calibration, parameters and specifications). All meters on the multi-parameter Sondes are calibrated by the manufacturer or CPBS following manufacturer protocols.

Table B-1: Calibration procedures for thermographs, sonde probes, and flow meters.

Parameter	Instrument	Calibration Frequency	Timing	Standard or Calibration Instrument Used
Temperature	Thermograph	Annually	Spring	Water/ice bath to assure factory specifications and comparability between units.
Dissolved Oxygen	YSI -6920 (650 MDS) - DO meter ONSET -U26 DO Data Logger	Monthly	Monthly when in use	At a minimum, water saturated air, according to manufacturer's instructions. ONSET logger sensor good for 6 months, then replaced.
pH	YSI -6920 (650 MDS) - pH meter	Monthly	Monthly when in use	pH buffer 7.0 and 10.0
Conductivity	YSI -6920 (650 MDS) - Conductivity meter	Monthly	Monthly when in use	Conductivity standard 700 and 2060 µmhos/cm or µS/cm
Redox	YSI -6920 (650 MDS) - Redox	Monthly	Monthly when in use	Factory calibrated
Turbidity	YSI -6920 (650 MDS) - Nephelometer	Monthly	Monthly when in use	For clear ambient conditions use an 1.0 NTU standard, for turbid conditions use an 10.0 NTU standard
TDS	YSI-6920	None	When in use	Conversion from specific conductance to TDS by use of a multiplyer in the instrument
Stream Discharge	Marsh-McBirney 2000 Electromagnetic Flow-Mate	Monthly	Weekly when in use	The probe is lowered into a bucket filled with water and allowed to stand for 10 minutes
Water Level & Temperature	Solinst Levelogger 3301	Annually	Spring	Factory calibrated
Atmospheric Pressure	Solinst Barologger 3301	Annually	Spring	Factory calibrated

Table B-2: Parameters and specifications for thermographs, sonde probes, and flow meters.

Instrument	Parameters Measured	Units	Detection Limit	Sensitivity	Accuracy/Precision
Marsh McBirney Flow-Mate Model 2000	Stream Velocity	ft/sec	0.01	±0.01	± 0.05
YSI 650 MDS Multi-Probe Model 6920	Temperature	°C	-5	±0.01	± 0.15
	Dissolved Oxygen	mg/l, % saturation	0, 0	±0.01, 0.1	0 to 20 mg/l or ± 0.2 mg/l, whichever is greater. ± 0.2 % of reading or 2 % air saturation, whichever is greater
	Salinity	ppt	0	±0.01	± 1 % of reading or 0.1 ppt, whichever is greater
	pH	none	0	±0.01	± 0.2
	ORP	mV	-999	±0.1	± 20
	Turbidity	NTU	0	±0.1	± 0.5 % of reading or 2 NTU, whichever is greater
	Specific Conductance @ 25°C	mS/cm	0	±0.001 to 0.1, range dependent	± 0.5 % of reading + 0.001 mS/cm
YSI Temperature/Dissolved Oxygen Probe Model 550A	Temperature	°C	-5	±0.1	± 0.3
	Dissolved Oxygen	mg/l, % saturation	0	±0.01, 0.1	± 0.3 mg/l or ± 2 % of reading, whichever is greater. ± 0.2 % air saturation or ± 2 % of reading, whichever is greater
YSI Temperature/Dissolved Oxygen Probe Model 57	Temperature	°C	0.1	±0.1 (manual readout, not digital)	± 0.5 °C plus probe which is ± 0.1 % °C
	Dissolved Oxygen	mg/l	0.1	±0.1 (manual readout, not digital)	± 0.1 mg/l or ± 1%, whichever is greater
ONSET U-26 Dissolved Oxygen Data Logger	Dissolved Oxygen	mg/l	0 to 20 mg/l	0.02	0.2 mg/l up to 8 mg/l, 0.5 mg/l from 8 to 20 mg/l
	Temperature	°C	-5 to 40	0.02	0.2
Optic Stow-Away (Thermographs)	Temperature	°C	-5	±0.01	0.01, calibration dependent
Solinst Levelogger 3301	Water Level	ft	0.002	.001 % Full Scale	±0.01 ft., 0.3 cm
Solinst Levelogger 3301	Temperature	°C	0.003	0.003	±0.05 °C
Solinst Barologger 3301	Atmospheric Pressure	ft	0.002	.002 % Full Scale	±0.003 ft., 0.1 cm

Thermographs

Steel cables with ¼ inch u-bolts are used to fasten thermographs to trees, rocks, and root masses when deployed. Single units are deployed in run habitats at the bottom half a foot above the substrate. Vertical arrays are deployed in pool habitats with the surface unit attached to a float (one foot below the surface), and the bottom unit deployed at the bottom. The instruments are downloaded monthly via a remote downloading shuttle and transferred to a computer back at the office where daily maximum, average, and minimum temperatures are calculated using a Visual Basic for Application (VBA) macro run in Excel and displayed in graphical form. If a thermograph shows any unexpected results or data anomalies when the data are reviewed, it is re-calibrated and tested before deployment back into the field. After thermographs are downloaded, each unit is wiped off to reduce algae and sediment buildup.

Sondes (6920 probes)

After calibration, the sonde is programmed on site to collect data for a specified amount of time and the calibration cap (attached when the sonde is in standby mode) is replaced by the slotted field cap that protects the water quality instruments from impact damage while allowing water to pass over the instruments. The sonde is then deployed in the lower third of the water column at the deepest point in the pool habitat, typically at the same location where rearing steelhead/rainbow trout are observed. The unit is deployed at a fixed elevation within the water column depending on the objective of the deployment. Precautionary measures are always taken to hide the sonde from the general public, especially in places that are easily accessible (i.e., close to road crossings). Once the specified time has elapsed, surveyors return to the deployment location and download the information in the field from the sonde to the YSI 650. The sonde is then reprogrammed and placed in another location or taken back for calibration. If a sonde shows any unexpected results or data anomalies when the data are reviewed, it is re-calibrated and tested before deployment back into the field.

Electromagnetic Flow-Meter

Flows are measured using a Marsh McBirney Flow Mate (model 2000) and a top setting rod. When a transect has been established the flow meter is activated and uses a filter value of 15 seconds which averages the flow rate over a 15 second period and displays the result in the instrument display. Surveyors are careful to note the readings from the instrument with respect to the visual flow rate, making sure that the values being displayed are within the expected range of flow. Surveyors keep a constant eye on the electromagnetic probe so that no algae or debris moving downstream is blocking the field or getting caught on the probe. Once each station is measured, the recorder calculates flow by multiplying width (x) depth (x) velocity to determine flow in cubic feet/second at each station. The recorded values are calculated two to three times in the field to insure a correct flow value has been obtained.

ONSET (U-26) DO/Temp Data Logger

These units were added in WY-2013 to accompany other DO measuring devices (sondes) in order to measure additional monitoring locations. Steel cables with ¼ inch u-bolts are used to fasten U-26 loggers to trees, rocks, and root masses when deployed. Single units are deployed in run habitats at the bottom half a foot above the substrate. Vertical arrays are deployed in pool habitats with the surface unit attached to a float (one foot below the surface), and the bottom unit deployed at the bottom. These data loggers require HOBOware software (USB interface cable) and a communication device for downloading. Units are factory calibrated and once initialized, can record DO/temperature for a period of 6 months before being returned to the factory for a new sensor cap.

Levelogger/Barologger

The levelogger measures surface water levels by recording changes in absolute pressure (water column pressure and barometric pressure). The levelogger also records temperature. The barologger functions and communicates similarly to the levelogger, but is used above the water level to record ambient barometric pressure in order to

barometrically correct data recorded by the leveloggers. These units are deployed within Hilton Creek, the LSYR mainstem at vertical array locations, the Cross Creek Ranch Fish Passage Improvement Project, and within the Rancho San Julian Fish Ladder. The main purpose of the levelogger and barologger is to establish rating curves at fish passage projects and to record water levels within the LSYR mainstem. The leveloggers are also used to verify water temperatures with respect to thermograph deployments within the basin. Both of these units have a lifetime factory calibration and do not require recalibration if used in the specified range. Each unit is tested in the spring (prior to deployment) to verify that each unit is functioning properly.

Data QA/QC and Database Storage

There were no unusual conditions, unexplainable outliers, logistical problems, vandalism, or operator error of note except for some minor tampering of the deployment cable by recreational visitors at the Encantado habitat site only.

Optic thermograph data transferred to a shuttle in the field are downloaded to the Boxcar program, converted to a text file, and then exported to Microsoft Excel. Once the data have been transferred to Excel, outliers and anomalous data are easily seen when put into graphical form.

Sonde data that have been transferred to a field pc (650 MDS) are then downloaded to an EcoWatch program. The data are then exported into Microsoft Excel. Once the data have been transferred to Excel, outliers and anomalous data are easily seen when put into graphical form.

ONSET data are transferred to a communication device through a USB interface cable and then downloaded to a HOBOware software program. Once the data have been transferred, the material is converted to a CSV file and then exported to Microsoft Excel. Once the data have been transferred to Excel, outliers and anomalous data are easily seen when put into graphical form.

Spot flow data obtained from flow meters are put directly into Microsoft Excel from the data sheets used in the field.

Outlier resolution

Water quality instruments that are deployed in the field and retrieved at a later date oftentimes have anomalous readings at the very start and end of deployment. This is caused by a unit being out of water just prior to deployment, which occurs right after a unit has been programmed for deployment and is taken down to a specific habitat. The same situation occurs at the end of deployment when a unit is removed from the water and downloaded. The other situation causing poor data occurs when a wetted habitat becomes dry. This usually takes place in the summer in locations downstream of Bradbury Dam, below target flow areas. When the water quality data are ultimately transferred to a computer, outliers are easily identified and removed.

C. Photo Points/Documentation

Photo points were taken regularly from 2002-2016 in the spring, summer, and fall. After 2005 and continuing through 2010, photo points were scaled down and taken at irregular intervals. All photo points taken in WY2016 are listed in Tables C-1 and C-2 and were taken at more regular intervals as recommended in the 2010 Annual Monitoring Report. The reason for discontinuing some photo point locations was that many sites were not depicting long-term changes. Furthermore, some locations had either become so overgrown with vegetation or were no longer showing any visible change.

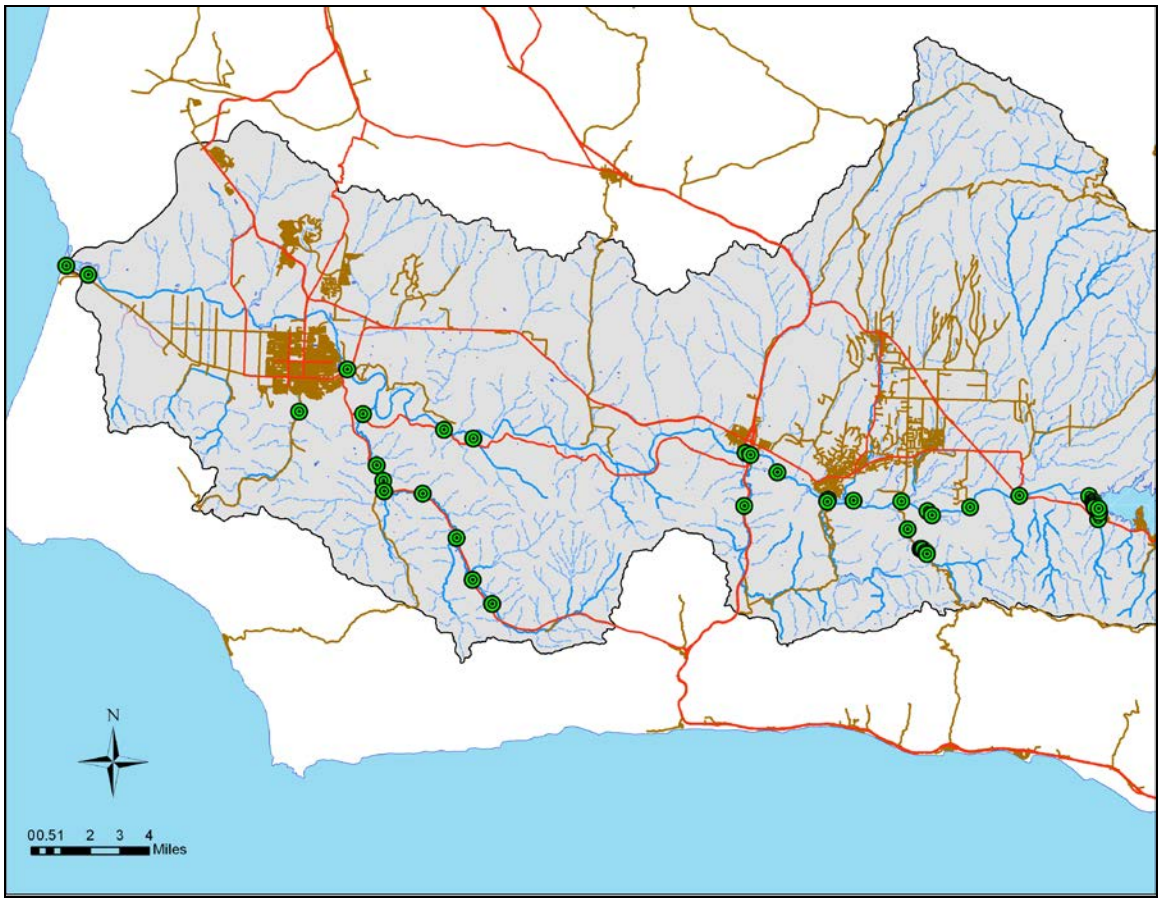


Figure C-1: WY2016 photo point locations.

Table C-1: WY2016 photo points on the LSYR mainstem. "X's" denote photos taken, downstream (d/s) and upstream (u/s).

LSYR Mainstem Photo Point ID	Location/Description	March 2016	Sept 2016
M1	Lower Hilton Creek, photo d/s at ford crossing	X	
M2a	Bluffs overlooking long pool, photo u/s	X	
M2b	Bluffs overlooking long pool, photo d/s	X	
M3	Highway 154 culvert on Hilton Creek, photo u/s		
M4	Highway 154 culvert on Hilton Creek, photo d/s		
M5	Highway 154 Bridge, photo u/s	X	
M6	Highway 154 Bridge, photo d/s	X	
M7	Meadowlark crossing, photo u/s	X	X
M8	Meadowlark crossing, photo d/s	X	X
M9	Lower Gainey crossing, beaver dam, photo u/s		
M10	Lower Gainey crossing, beaver dam, photo d/s		
M11a	Lower Gainey crossing, photo u/s		
M11b	Lower Gainey crossing, photo d/s		
M12	Refugio Bridge, photo u/s	X	X
M13	Refugio Bridge, photo d/s	X	X
M14	Alisal Bridge, photo u/s	X	X
M15	Alisal Bridge, photo d/s	X	X
M17	Mid-Alisal Reach, photo u/s		
M18	Mid-Alisal Reach, photo d/s		
M19	Avenue of the Flags Bridge, photo u/s	X	X
M20	Avenue of the Flags Bridge, photo d/s	X	X
M21	Sweeney Road crossing, photo u/s	X	
M22	Sweeney Road crossing, photo d/s	X	
M23	Highway 246 (Robinson) Bridge, photo u/s	X	X
M24	Highway 246 (Robinson) Bridge, photo d/s	X	X
M25	LSYR Lagoon on railroad bridge, photo u/s	X	X
M26	LSYR Lagoon on railroad bridge, photo d/s	X	X
M27	LSYR at 35th St. Bridge, photo d/s	X	
M28	LSYR at 35th St. Bridge, photo u/s	X	
M29	LSYR Lagoon upper reach, photo d/s		X
M30	LSYR Lagoon upper reach, photo u/s		X
M31	Slick Gardener, looking across towards highway		X
M32	Slick Gardener, looking d/s through culvert	X	X
M33	Slick Gardener, looking u/s through culvert	X	X

Table C-2: WY2016 photo points on the LSYR tributaries. "X's" denote photos taken.

Tributary Photo Point ID	Location/Description	March 2016	Sept 2016
T1	Hilton trap site, photo u/s	X	
T2	Hilton start Reach #2, pt site, photo d/s	X	
T3	Hilton at ridge trail, photo d/s	X	
T4	Hilton at ridge trail, photo u/s	X	
T5	Hilton at telephone pole, photo d/s	X	
T6	Hilton at telephone pole, photo u/s	X	
T7	Hilton at tail of spawning pool, photo u/s	X	
T8	Hilton impediment/tributary, photo d/s	X	
T9	Hilton impediment/tributary, photo u/s	X	
T10	Hilton just u/s of URP, photo d/s	X	
T11	Hilton road above URP, photo d/s	X	
T12	Hilton road above URP, photo u/s	X	
T14	Hilton from hard rock toe, photo d/s		
T15	Hilton from hard rock toe, photo u/s		
TX1a	Quiota Creek at 1st crossing, photo u/s	X	
TX1b	Quiota Creek at 1st crossing, photo d/s	X	
TX2a	Quiota Creek at 2nd crossing, photo u/s	X	
TX2b	Quiota Creek at 2nd crossing, photo d/s	X	
TX3a	Quiota Creek at 3rd crossing, photo u/s	X	
TX3b	Quiota Creek at 3rd crossing, photo d/s	X	
TX4a	Quiota Creek at 4th crossing, photo u/s	X	X
TX4b	Quiota Creek at 4th crossing, photo d/s	X	X
T16	Quiota Creek at 5th crossing, photo d/s	X	
T17	Quiota Creek at 5th crossing, photo u/s	X	
T18	Quiota Creek at 6th crossing, photo d/s	X	
T19	Quiota Creek at 6th crossing, photo u/s	X	
T20	Quiota Creek at 7th crossing, photo d/s	X	
T21	Quiota Creek at 7th crossing, photo u/s	X	
T22	Quiota Creek below 1st crossing, photo d/s	X	
T23	Alisal Creek from Alisal Bridge, photo u/s	X	X
T24a	Alisal Creek from Alisal Bridge, photo u/s	X	X
T24b	Alisal Creek from Alisal Bridge, photo d/s	X	X
T25	Nojoqui Creek at 4th Hwy 101 Bridge, photo u/s	X	
T26	Nojoqui Creek at 4th Hwy 101 Bridge, photo d/s	X	
T27	Nojoqui/LSYR confluence, photo u/s	X	
T28	Salsipuedes Creek at Santa Rosa Bridge, photo u/s	X	X
T29	Salsipuedes Creek at Santa Rosa Bridge, photo d/s	X	X
T39	Salsipuedes Creek at Hwy 1 Bridge, photo d/s	X	X
T40	Salsipuedes Creek at Hwy 1 Bridge, photo u/s	X	X
T41	Salsipuedes Creek at Jalama Bridge, photo d/s	X	X
T42a	Salsipuedes Creek at Jalama Bridge, photo u/s	X	X
T42b	Pool at Jalama Bridge	X	X
T43	El Jaro/Upper Salsipuedes confluence, photo u/s	X	
T44	Upper Salsipuedes/El Jaro confluence, photo u/s		
T45	Upper Salsipuedes/El Jaro confluence, photo d/s		
T48	El Jaro Creek above El Jaro confluence, photo u/s		
T49	El Jaro Creek above El Jaro confluence, photo d/s		
T52	Ytias Creek Bridge, photo d/s	X	
T53	Ytias Creek Bridge, photo u/s	X	
T54	El Jaro Creek 1st Hwy 1 Bridge, photo d/s	X	X
T55	El Jaro Creek 1st Hwy 1 Bridge, photo u/s	X	X
T56	El Jaro Creek 2nd Hwy 1 Bridge, photo d/s	X	X
T57	El Jaro Creek 2nd Hwy 1 Bridge, photo u/s	X	X
T58	El Jaro Creek 3rd Hwy 1 Bridge, photo d/s	X	X
T59	El Jaro Creek 3rd Hwy 1 Bridge, photo u/s	X	X
T60	San Miguelito Creek at crossing, photo d/s	X	X
T61	San Miguelito Creek at Stillman, photo u/s	X	X
T62	Rancho San Julian Bridge, photo d/s	X	X
T63	Rancho San Julian Bridge, photo u/s	X	X

D. List of Supplemental Reports Created During WY2016

- WY2012 Annual Monitoring Summary with Trend Analyses (COMB, 2016a).
- WY2013 Annual Monitoring Report with Trend Analysis (COMB, 2017c).
- WY2014 Annual Monitoring Summary (COMB, 2018a)
- WY2015 Annual Monitoring Summary (COMB, 2018b)
- Quiota Creek Crossing 0A End of Project Report (COMB, 2017a).
- Quiota Creek Crossing 4 End of Project Report (COMB, 2017b).
- CDFW-FRGP Grant Proposal for Quiota Creek Crossing 5 Project.
- WY2016 Migrant Trapping Plan.
- 2016 WR 89-18 Release Study Plan.
- 2016 WR 89-18 Release Monitoring Report for RPM 6 (COMB, 2016b).
- Hilton Creek Watering System to Hilton Creek Emergency Backup System Transfer and Fish Relocation Report (COMB-FD and CDFW, 2015).
- Lower Hilton Creek fish Rescue-Relocation Report Prior to WR 89-18 Releases (COMB, 2016d).
- Fisheries Activities Associated with the End of the 2016 WR 89-18 Releases (COMB, 2016b).
- Long Pool Fish Rescue/Removal Report (COMB, 2016c).

E. Appendices References

COMB-FD and CDFW, 2015. Hilton Creek Watering System to Hilton Creek Emergency Backup System Transfer and Fish Relocation Report. Operations Report, Cachuma Operation and Maintenenance Board Fisheries Division (COMB-FD) and California Department of Fish and Wildlife (CDFW).

COMB, 2016a. 2012 Annual Monitoring Summary and Trend Analysis. Prepared for the Bureau of Reclamation and the National Marine Fisheries Service, Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2016b. Fisheries Activities Associated with the End of the 2016 WR 89-18 Releases.

COMB, 2016c. Long Pool Fish Rescue/Removal Report. Cachuma Operation and Maintenance Board (COMB) Fisheries Division.

COMB, 2016d. Lower Hilton Creek Fish Rescue-Relocation Report Prior to WR 89-18 Releases. Cachuma Operation and Maintenance Board (COMB) Fisheries Division

COMB, 2017a. End of Project Compliance Report, Fish Passage Improvement on Crossing 0A, Quiota Creek. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017b. End of Project Compliance Report, Fish Passage Improvement on Crossing 4, Quiota Creek. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017c. WY2013 Annual Monitoring Summary and Trend Analysis. Prepared to be consistent with requireemnts set forth in the 2000 Cachuma Project Biological Opinion, Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2018a. WY2014 Annual Monitoring Summary, Prepared by the Cachuma Operation and Maintenance Board (COMB), Fisheries Division. Prepared to be consistent with requirements set forth in the 2000 Cachuma Project Biological Opinion.

COMB, 2018b. WY2015 Annual Monitoring Summary, Prepared by the Cachuma Operation and Maintenance Board (COMB), Fisheries Division. Prepared to be consistent with requirements set forth in the 2000 Cachuma Project Biological Opinion.