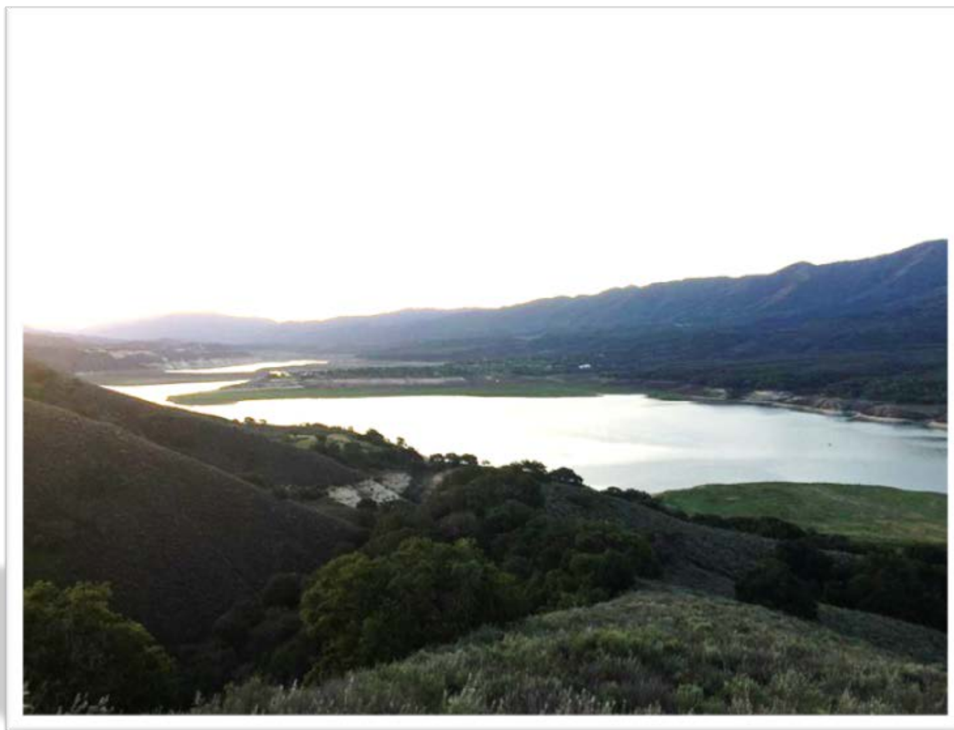
WY2017 ANNUAL MONITORING SUMMARY

for

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



Prepared by:

CACHUMA OPERATION AND MAINTENANCE BOARD

FISHERIES DIVISION

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

JUNE 22, 2019

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Executive Summary

The WY2017 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 2017 (WY2017, 10/1/16 – 9/30/17). Although the report was finalized in 2019, the monitoring data are from WY2017. 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 WY2017 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 WY2016 Annual Monitoring Summary (COMB, 2019) and fulfills the annual 2017 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 WY2017, 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 WY2017 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 for monitoring equipment, (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.

WY2017 was a wet year (25.48 inches of precipitation measured at Bradbury Dam; long-term average, 1953-2017, is 20.00 inches) with the highest amount of rainfall occurring in January and February. This was the first wet year after 5 consecutive years of dry conditions (from 2012 to 2016, the driest year on record occurring in 2007 with only 7.41 inches of rain at Bradbury Dam). The largest storm of WY2017 (8.14 inches of rain) occurred on 2/17/17. The LSYR lagoon opened to the ocean on 2/7/17 and closed on 4/4/17 for a duration of 57 days of continuous ocean connectivity. Since it was the sixth year after a spill (WY2011) and reservoir storage was well less than 30,000 acre-feet (af) at the beginning of the water year (14,202 af on 10/1/16), a critical drought determination was still in place and no target flows were provided for rearing in Hilton Creek (2 cubic feet per second (cfs) minimum) or to the Highway (Hwy) 154 Bridge (2.5 cfs minimum) until critical drought conditions were lifted on 3/23/17 when target flows were resumed. Prior to 3/23/17, Reclamation could only provide trickle flow (~0.03 cfs) to Hilton Creek at the Lower Release Point (LRP) which was less than 30 af of water per month as required in the 2000 BiOp. There was no fish passage supplementation due to critical drought conditions still in place throughout most of the migration season. A Water Rights (WR) 89-18 release was conducted from 8/21/17 until 11/8/17 during which 12,202 af of water was released over a period of 80 days.

There were 3 events in Hilton Creek that resulted in a rapid change in streamflow conditions. A large storm on 1/19/17 produced upper basin flow in Hilton Creek for the first time in over half a decade resulting in a rapid rise and then drop in streamflow that caused the mortality of 4 *O. mykiss*. The second event was initiated by Reclamation when it reinstalled a 30-inch valve at the Outlet Works of Bradbury Dam on 4/3/17 which required returning to trickle flow to Hilton Creek for several days during which time 2 *O. mykiss* were safely rescued and relocated. Finally, there was a power outage on 9/11/17 that caused an interruption of flow to Hilton Creek from the Hilton Creek Watering

System (HCWS) and 2 *O. mykiss* mortalities. Reports were produced for all events and submitted to Reclamation which then provided them to NMFS.

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 and the Hilton Creek Emergency Backup System (HCEBS); 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, HCEBS, and Cascade Chute Project in Hilton Creek) and was successful in acquiring grant funding for these projects 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 WY2017) restoring access to the upstream reaches of key tributaries in the lower Santa Ynez River Watershed for steelhead. Descriptions and photos of all habitat enhancement projects are presented in Section 4. Plans have moved forward for the completion of another 2 fish passage projects on Quiota Creek for Crossing 5 and Crossing 9 to be built in WY2018.

The following are recommendations to improve the monitoring program from WY2017 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;
- Collaborate with Reclamation on best management practices in Hilton Creek to address the potential for sediment-laden runoff from the Whittier Fire burn area;
- 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;
- Work with Reclamation and NMFS to develop a gravel augmentation program for Hilton Creek for spawning fish, given the long standing observation of a gravel starved system;
- Encourage Reclamation to improve its system operation for delivering lake water to Hilton Creek with one or a combination of the HCWS, HCEBS, Hilton Creek Water Tanks, and Stilling Basin submersible pumps to provide continuous flow to Hilton Creek without interruption;

- Continue to encourage Reclamation to gather continuous data on the water temperature discharged from the Outlet Works of Bradbury Dam to the LSYR to monitor BiOp compliance of a maximum of 18 ^{o}C of that discharge water;
- 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;
- 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 the collaboration with CDFW regarding operation of their Dual-Frequency Identification Sonar (DIDSON) in Salsipuedes Creek;
- 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;
- 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;
- 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;
- 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;
- 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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WY2017 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 WY2017 Annual Monitoring Summary (AMS) is to present the monitoring data collected in Water Year 2017 (WY2017, 10/1/16-9/30/17) 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 WY2017 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, 2016), the WY2013 Annual Monitoring Summary (COMB, 2017d), the WY2014 Annual Monitoring Summary (COMB, 2018a), the WY2015 Annual Monitoring Summary (COMB, 2018b), and the WY2016 Annual Monitoring Summary (COMB, 2019).

The data summarized in this report describe the habitat conditions and the fishery observations in the LSYR during WY2017. 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).

WY2017 was classified as a wet year with 25.48 inches of precipitation recorded at Bradbury Dam (long-term average, 1953-2017, is 20.00 inches; 13th wettest year of 65 years over the period of record with WY2007 being the lowest at 7.41 inches). This was the 4th highest rainfall year since issuance of the 2000 BiOp, with 9 of 17 years classified as dry (WY2007, WY2013, WY2002, WY2015, WY2014, WY2004, WY2016, WY2012, and WY2009 listed in order of severity). Wet years, in general, are often associated with an increase of the *O. mykiss* population due to higher stream flows, greater availability of habitat, and ocean connectivity for anadromous reproduction (Lake, 2003; COMB, 2013). However, wet years can result in high flows that create the potential for washing out redds.

Migrant trapping was conducted in WY2017 and all BiOp take limits were followed. Reproduction and population status was monitored through spawner (redd) surveys and snorkel surveys.

WY2016 was a very dry year and the fifth year of a long-standing drought. Entering into WY2017, the lowest reservoir elevation since the construction Bradbury Dam in 1953 was recorded on 10/15/16 at 646.42 feet above mean sea level with Lake Cachuma water storage at 14,057 acre-feet (af) or 7% of capacity. At that time, Reclamation could only provide trickle flow to Hilton Creek through submersible pumps in the Stilling Basin at a rate of approximately 0.03 cfs. A sequence of winter stormflow events resulted in upper basin stormflow events in the creek (1/19/17-1/24/17 and 2/17/17-2/27/17) and a sufficient rise in storage of Lake Cachuma for USBR to reactivate the Hilton Creek Emergency Backup System (HCEBS) on 3/23/17 and provide near or above target flows to Hilton Creek by gravity flow that continued through the rest of the water year.

There were 4 events in Hilton Creek that caused a sudden change in streamflow rate. The first big storm runoff event of the year occurred on 1/19/17 where upper basin flow in Hilton Creek produced a rapid climb then drop in the streamflow hydrograph throughout the wetted section of the creek resulting in 4 *O. mykiss* mortalities. The second large storm runoff event with upper basin flow started on 2/17/17 and ran for 10 days before returning to low baseflow rates. There were no *O. mykiss* mortalities found during this stormflow event. The third event was associated with USBR installing the 30-inch valve at the Outlet Works on 4/3/17 that required going off of HCEBS gravity flow to trickle flow from the Stilling Basin through 4/7/17 that resulted in dewatering of the lower section of Hilton Creek where 2 *O. mykiss* were rescued and relocated. The fourth and final event was a brief interruption of flow to Hilton Creek on 9/11/17 due to a power outage caused by an electrical storm where 2 *O. mykiss* mortalities were found. There was a period of elevated releases to Hilton Creek (8/11/17-9/10/17) when both the HCEBS gravity flow to the LRP and the HCWS to the URP by pumps were operational providing between 4.05 and 5.74 cfs to the creek. After the interruption of flow event, Reclamation provided HCEBS gravity flow to the creek for the rest of the water year.

To assist in understanding the hydrologic condition and specifically the origin of releases to Hilton Creek from Lake Cachuma, the following chronology is provided of events or milestones that directly influenced flow releases for the *O. mykiss* population downstream of Bradbury Dam (including Hilton Creek) throughout the water year:

- 10/1/16-3/22/17: Trickle flow (approximately 0.03 cfs) was provided to Hilton Creek at the LRP via submersible pumps in the Stilling Basin.
- Stormflow events: Upper Hilton Creek stormflow events occurred starting on 1/19/17 and 2/17/17 with durations of approximately 4 days and 10 days, respectively.
- 3/23/17-4/2/17: HCEBS gravity flow at greater than 2 cfs was provided to Hilton Creek at the LRP.
- 4/3/17-4/7/17: Reclamation installed the 30-inch valve at the Outlet Works during which time trickle flow from the Stilling Basin pumps was provided to Hilton Creek at the LRP.
- 4/8/17-8/10/17: HCEBS gravity flow was resumed to Hilton Creek at the LRP at approximately 1.3 cfs.
- 6/30/17-8/16/17: Dewatering and non-native fish removal of the Stilling Basin.
- 7/8/17-10/5/17: The Whittier Fire burned the southern slopes to the south of Lake Cachuma, specifically the upper section of the Hilton Creek watershed.
- 8/11/17-9/10/17: Reclamation provided both HCEBS gravity flow to the LRP and HCWS pumped flow to the URP for a cumulative release rate to Hilton Creek of 4-6 cfs.
- 8/21/17-11/8/17: The WR 89-18 release occurred.
- 9/11/17: There was a brief interruption of released water to Hilton Creek due to a power outage.
- 9/11/17-9/30/17: Only HCEBS gravity flow to the LRP was provided to Hilton Creek.

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, 2016), 2013 (COMB, 2017d), 2014 (COMB, 2018a), 2015 (COMB, 2018b), and 2016 (COMB, 2019). 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 higher tolerances for warmer stream temperatures and lower 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 WY2017 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 an above normal year at 87,485 af of computed inflow to Lake Cachuma.

WY2017 had 25.48 inches of rainfall at Bradbury Dam and was therefore classified as a wet year (greater than 22 inches) (Table 1). The long-term average (1953-2017) at the dam was 20.0 inches. There was elevated stream runoff recorded within the LSYR mainstem and tributaries in WY2017, and the mainstem flow was sufficient to breach the sand bar and open the LSYR lagoon to provide upstream migration opportunities from the lagoon and the ocean for 57 days. In Salsipuedes Creek, the highest recorded flow (peak discharge) at the USGS station at Jalama Bridge in WY2017 was 7,630 cfs on 2/17/17. Historic minimum, maximum, and WY2017 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 21 precipitation events in WY2017 with rainfall equal to or greater than 0.1 inches at Bradbury Dam (Table 3 and Figure 1). Recorded precipitation at Bradbury Dam was 25.48 inches in WY2017, with the majority of rain falling between the beginning of January and end of February (19.42 inches). There was over an inch of rainfall recorded in October, November and December (Table 3). The necessary triggers to implement a passage supplementation event were not met in WY2017. In addition, a WR 89-18 Water Rights release was conducted during the summer and fall period from 8/21/17 to 11/8/17.

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. To note, the Hilton Creek gauge (USGS-11125600) is a low flow gauge only (less than 50 cfs). The WR 89-18 release is visible from August through the beginning of November.

Peak daily mean discharge recorded by the USGS at the Narrows on the LSYR mainstem and Salsipuedes gauges occurred on 2/18/17 at 4,170 cfs and 2/17/17 at 2,310 cfs (stormflow), respectively. Peak daily discharge at the Solvang gauge of the LSYR mainstem was 3,000 cfs on 2/17/17 (peak WR 89-18 release was 164 cfs on 9/1/17). The USGS Los Laureles gauge on the Santa Ynez River mainstem upstream of Lake Cachuma recorded flow from 1/7/17 through 7/13/17 with peak daily discharge observed on 2/17/17 at 7,190 cfs. The Hilton Creek Gauge recorded flow throughout the water year with stormflow starting on 1/20/17 (Figure 3). The peak release from Bradbury Dam was approximately 176 cfs on 8/27/17 during the onset of the 2017 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 low spring runoff conditions throughout the basin (Figures 2 and 3). Baseflows (daily mean discharge) within Hilton Creek were between 0.03 cfs (trickle flow at the beginning of the water year) and 1.15 cfs on 8/9/17 prior to the start of WR 89-18 releases. During the installation of the 30-inch valve, Reclamation provided only trickle flow to the creek from 4/3/17-4/7/17 from the small submersible pumps installed in the Stilling Basin. The *O. mykiss* population in Hilton Creek survived throughout the Water Year but conditions were not ideal during trickle flow releases.

Instantaneous peak discharges across the Santa Ynez River basin occurred on 2/17/17 with values recorded at the Narrows, Salsipuedes, Solvang and Los Laureles USGS gauges of 8,580 cfs, 7,630 cfs, 8,200 cfs, and 19,300 cfs, respectively. Although higher stream discharge rates than observed over the last 5 years, only localized scour of vegetation within the wetted channel was observed.

Ocean Connectivity: The Santa Ynez River lagoon breached on 2/7/17 and remained open until 4/4/17 (Figures 2 and 3). During those 57 days of ocean connectivity to the Santa Ynez River basin, no anadromous *O. mykiss* were observed during migrant trapping efforts, redd surveys, or bank observations. Streamflow at the H Street USGS gauge went to zero on 4/4/17 and it remained dry throughout the rest of the water year.

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). From WY2001 to WY2005, the lagoon was monitored weekly and the flow at the USGS 13th Street gauge (approximately 1.2 mile upstream of the lagoon) was used to determine when the lagoon was open.

Passage Supplementation: There were no passage supplementation events in WY2017. Although the minimum criteria per BiOp RPM 3 were met for passage supplementation on 1/22/17, Reclamation still considered Lake Cachuma in critical drought conditions with no lake water available to supplement fish passage. It wasn't until the third week in March of WY2017 that there was enough lake storage to resume minimum target flows to Hilton Creek and end critical drought operations. At that point, it was too late in the season to augment any stormflow events for migratory fish as no spring storms were strong enough to trigger mandatory passage supplementation.

Adaptive Management Actions: There were no Adaptive Management Committee (AMC) meetings during WY2017. No flow allocations were made by the AMC from the Adaptive Management Account (AMA).

Target Flows: The water year started out under critical drought conditions (< 30,000 af of available storage in Lake Cachuma) with target flows of less than 30 af a month being delivered by Reclamation to Hilton Creek only. By 3/23/17, the lake level had risen enough for Reclamation to provide lake water to Hilton Creek through the HCEBS by gravity at a minimum of 2 cfs to the LRP. Reclamation returned to trickle flow to the LRP from the pumps installed in the Stilling Basin during the 30-inch valve installation from 4/3/17 to 4/7/17, after which HCEBS gravity flow was resumed to the creek but only at approximately 1.3 cfs. On 8/11/17, Reclamation operated in addition the HCWS pumps to deliver lake water to the URP until 9/10/17 with cumulative discharge rates of 4.05 to 5.72 cfs. After 9/10/17, Reclamation returned to HCEBS gravity flow only to the creek for the rest of the water year.

There were no spills from Bradbury Dam in WY2017, and reservoir storage remained under 120,000 AF, so long-term BiOp established target flows were required once the lake storage had increased beyond critical drought conditions, specifically 2.5 cfs at the Hwy 154 Bridge and a minimum of 2 cfs released into Hilton Creek.

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 WY2017, these releases began on 8/21/17 and ended on 11/6/17, with a total release amount of 12,202 af over 80 days (Figure 2). This was a Below Narrows Account (BNA) release that reached just downstream of the Robinson Bridge in Lompoc but did not go past the H Street Bridge. Monitoring for fish movement and water quality was conducted by the COMB-FD staff as stipulated in the BiOp RPM 6 and the 2017 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 2017 WR 89-18 release are provided in the RPM 6 Monitoring Report submitted by Reclamation to NMFS (USBR, 2018).

Mixing and Temperature of State Water Project Waters Released into 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 bypass system that eliminates having to use the penstock. The criterion was met for RPM 5.1 throughout WY2017 (Figures 4a). 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.

Outlet Works release water is now being monitored for temperature to assure BiOp compliance of 18 °C or less being released to the Stilling Basin of the LSYR. SWP water can arrive to the dam at higher temperatures than 18 °C at which point it would need to be mixed with cool lake water from the bottom of the lake through the Penstock. Reclamation has installed temperature sensors in the CCWA delivery pipe and the

Penstock to enable a volumetric calculation of the blended water temperature using the water temperature and the rate of flow from each source. This is the first year that the sensors were operational and the data were recorded by Reclamation from 8/23/17 to 10/23/17 once a day at approximately 8:00 AM. Temperatures exceeded 17 °C at the end of the first week in September then dropped abruptly to just above 14 °C for the rest of the monitoring period when CCWA switched their delivery pathway from the Penstock to the bypass system on 9/12/17 (Figure 4b).

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.

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 WY2017, 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 the 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 habitats, 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). Several mainstem legacy sites were not monitored during WY2017 due to the ongoing extreme drought which has dried the majority of the SYR prior to downstream water right releases with much of the LSYR drying soon after releases were stopped. Sites not monitored during WY2017 include: downstream of the Stilling Basin (LSYR-0.25) and Encantado Pool (LSYR-4.95).

In addition, several monitoring locations were discontinued due to the absence of observed fish over several years (Nojoqui Creek), or a sequence of impassable barriers prohibiting access for anadromous steelhead (San Miguelito Creek). 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 20 thermograph units (normally 24) deployed at 8 sites (normally 10) on the LSYR mainstem which are listed below with the number of units in parentheses:

- Stilling Basin parapet wall (LSYR-0.01 (3));
- 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));
- Double Canopy Pool (LSYR-7.65 (3));
- Head of Beaver Pool (LSYR-8.7 (3));
- Alisal Bedrock Pool (LSYR-10.2 (3));
- Avenue of the Flags (LSYR-13.9 (1)) and;
- Cadwell Pool (LSYR-22.68 (3))

In the tributaries, there were 12 thermograph unit deployed at 12 sites during WY2017, all of which were single unit deployments:

- Hilton Creek (HC, 2 sites):
  - HC-lower (HC-0.12); and
  - HC-upper (HC-0.54, legacy site but dry).
- Quiota Creek (QC, 1 site):
  - QC-Crossing 6 (QC-2.66).
- Salsipuedes Creek (SC, 5 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); and
  - SC-upper (SC-3.8).
- El Jaro Creek (EJC, 3 sites):
  - EJC-lower (EJC-3.81, legacy site but dry);
  - EJC-Palos Colorados (EJC-5.4); and
  - EJC-Rancho San Julian (EJC-10.82).
- 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 Parapet Wall (north) (LSYR-0.01)

A 3-unit vertical array was deployed along the northeast wall of the Stilling Basin from 6/6/17 through 11/21/17 (Figures 6-8). 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 at the surface prior to the dewatering effort to remove invasive non-native species (6/30/17-8/16/17) before the onset of WR 89-18 downstream releases on 8/21/17. Temperature monitoring was not conducted during the water drawdown and invasive species removal effort in the Stilling Basin. Overall, water temperature rapidly cooled from approximately 22 °C to just over 14 °C following the initiation of WR 89-18 releases at all three locations. There were two

O. mykiss captured from the Stilling Basin during invasive species removal that were relocated to Hilton Creek.

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*], 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 6/24/17 and removed on 11/21/17 at the deepest point of the pool at 6 feet (Figures 9-11,). From late June through early August, surface and middle water temperatures remained relatively high with maximum temperatures hovering between 22-26 °C and minimum temperatures between 18-21 °C. Bottom temperatures remained cool, generally less than 19 °C. During the first week of August, there was a rapid decrease in water temperatures observed at the surface and middle units. This is likely due to dewatering efforts that were conducted in the Stilling Basin that was contributing cooler water from down lower in that habitat. There was a brief spike in water temperatures associated with the beginning of the WR 89-18 release. No *O. mykiss* were observed in the Long Pool due to the inability of divers to accurately assess the fish assemblage due to elevated turbidity.

Downstream of Long Pool (LSYR-0.68)

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 5/9/17 to 11/20/17 (Figure 12). Temperatures at this location closely mimicked those collected in the Long Pool (surface and middle units). Maximum water temperatures were generally less than 24 °C and dropped to less than 18 °C following the start of WR 89-18 releases. No *O. mykiss* were observed at this habitat.

Double Canopy Pool (LSYR-7.65)

The Double Canopy Pool is located directly upstream of the Refugio Bridge. The pool was approximately 350 feet long, 40 feet wide, and 4.5 feet deep at its deepest point when the habitat is filled with water. A vertical array was deployed at this site from 6/6/17 to 11/20/17. Water temperatures showed stratification at this site prior to WR 89-18 releases with warmer temperatures recorded at the surface compared to the bottom. Once WR 89-18 releases reached the site, there was a short increase in overall maximum temperatures followed by a noticeable decrease in minimum water temperatures and minimal stratification evident at all three locations that were essentially recording the same values (Figures 13-15). No *O. mykiss* were observed at this habitat.

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 is approximately 730 feet long, 50 feet wide, and 7.1 feet at the deepest point while residual pool depth is being maintained. A vertical array was deployed in this habitat from 6/6/17 to 11/21/17. There was a malfunction with the surface unit and the data were lost and the unit was not replaced. The middle unit shows rapidly warming temperatures then no data from 8/5/17 – 8/23/17 as the unit was out of the water due to the habitat drying. The bottom unit remained wetted and showed water temperatures generally less than 20 °C prior to WR 89-18 release reaching the site. Once the water rights front arrived, there was a rapid warming to over 22 °C with increased variability between maximum and minimum water temperatures (Figures 16-17). No *O. mykiss* were observed at this habitat in WY2017 during WR 89-18 water rights releases.

Alisal Bedrock Pool (LSYR-10.2)

The Alisal Bedrock Pool is a corner scour pool habitat approximately 60 feet long and 40 feet wide with a maximum depth of 9 feet. A vertical array was deployed in the habitat from 6/6/17 to 11/20/17 (Figure 18 to Figure 20). The data showed that stratification developed as the dry season progressed and water flows diminished. The surface unit was exposed to air from 7/10/17 – 8/25/17 as the pool receded in the absence of flow contribution to the habitat. Upon arrival of WR 89-18 releases, maximum water temperatures increased slightly and minimum water temperatures decreased to less than 20 °C. No *O. mykiss* were observed at this habitat in WY2017.

Avenue of the Flags (LSYR-13.9)

The habitat was approximately 65 feet long and 20 feet wide at its widest point with a maximum depth of approximately 4 feet. A single unit was deployed in this habitat from 5/15/17 to 11/20/17. Overall, water temperatures in this habitat remained relatively cool prior to WR 89-18 releases with temperatures remaining less than 20 °C. When WR 89-18 releases reached the site, there was an abrupt increase in maximum temperatures from around 19 °C to approximately 24 °C (Figure 21). By mid-September, gradual seasonal cooling was observed throughout the rest of the monitoring period. No *O. mykiss* were observed in this habitat.

Cadwell Pool (LSYR-22.68)

The pool when full is approximately 490 feet long and 32 feet wide at the maximum point with a maximum depth of approximately 15 feet. A vertical array was deployed in this habitat from 6/1/17 to 11/17/17. The data showed stratified conditions developed with warmer water at the surface compared to the bottom of the habitat (Figures 22-24). These stratified conditions persisted until WR 89-18 releases reached that habitat causing the water to become essentially uni-thermal from surface to the bottom for the remainder of the monitoring period. No *O. mykiss* were observed at this location in WY2017.

LSYR Mainstem Longitudinal Comparisons

Longitudinal LSYR mainstem (maximum daily) water temperature at the surface thermographs for LSYR-0.01, LSYR-0.51, LSYR-0.68, LSYR-7.65, LSYR-8.7, LSYR-10.5, LSYR-13.9, and LSYR-22.68 are presented in Figure 25. 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.

Factors influencing surface water temperatures along the longitudinal profile presented can be: (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 August through October, 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.

There was 25.47 inches of rain measured at Lake Cachuma during WY2017. Even though that amount of rain is considered a wet year type, impacts from the previous 5 years of drought were still being observed throughout the LSYR mainstem habitats prior to WR 89-18 releases. This was primarily due to the existing low reservoir elevation (even after an above-average rain year) and target flows only extending down to the Highway 154 Bridge (LSYR-3.2) in WY2017. For example, the surface units at LSYR-8.7 and LSYR-10.5 were exposed to air in July and August due to declining surface water levels in the river. Zero flow was measured at Solvang starting on 5/20/17 and did not see flow until WR 89-18 release water reached the site on 8/24/17 (Figure 25).

Prior to WR 89-18 releases, observations show warm conditions typical of seasonal warming at nearly all the monitoring locations. The 2 exceptions being LSYR-8.7 and LSYR-10.2 which showed lower temperatures, likely due to the fact that declining water levels in each of those habitats were being influenced by cooler groundwater contribution in the absence of water flowing into the habitats. Additionally, monitoring sites close to the dam (LSYR-0.01, LSYR-0.51, and LSYR-0.68) showed cooling immediately prior to the onset of WR 89-18 releases. This was because Reclamation started a pre-release on 8/26/17 to refill the Stilling Basin which had been dewatered as part of the aquatic predator removal project. This release filled the Stilling Basin, spilled into the Long Pool and the river immediately downstream resulting in the cooler water temperatures observed. Following the start of the release on 8/22/17, maximum daily temperatures close to the dam remained less than 19 °C for the remainder of the deployment period.

At sites further downstream, particularly at LSYR-13.9, there was a noticeable increase in water temperatures coincident with the arrival of WR 89-18 water. This influence of WR 89-18 releases is more apparent when looking at vertical array deployment at the middle and bottom thermograph locations further downstream at LSYR-7.65, LSYR-8.7, LSYR-10.2 and LSYR-22.68.

O. mykiss and Water Temperature Criteria within the LSYR Mainstem

Due to the previous 5 years of drought conditions and the significant contraction of available oversummering rearing habitat throughout the LSYR mainstem and all of the tributaries within the lower watershed, 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.

A dewatering project was initiated in the Stilling Basin in July of 2017 in an attempt to remove the invasive aquatic warm water species which serve to continually recolonize the lower sections of the river during WR89-18 releases. During that effort, two *O. mykiss* were captured and were relocated into Hilton Creek.

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 single thermograph was deployed in a riffle habitat approximately 100 feet upstream of the confluence with the LSYR mainstem in approximately 1-foot of water from 5/9/17 to 11/20/17. Water temperatures remained less than 18 °C except for a brief period during the first part of September when temperatures rose to just over 18 ° (Figure 26). *O. mykiss* were observed inhabiting the creek at this monitoring location during the summer snorkel survey.

Hilton Creek at the LRP (HC-0.25)

A single thermograph was deployed immediately downstream of the LRP in a shallow run habitat from 5/9/17 to 9/11/17 when flows released into the creek from the URP were halted. Water temperatures remained less than 18 °C during the entire deployment time (Figure 27). *O. mykiss* were observed inhabiting the creek at this monitoring location during the summer snorkel survey.

Quiota Creek (QC-2.66)

A single thermograph was deployed approximately 20 feet upstream of Crossing 6 on Refugio Road from 5/9/17 through 9/25/17. The unit was placed at 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 observed over the years (up to WY2014) during routine snorkel surveys. The thermograph was removed on 9/25/17 due to the habitat being dry. Overall, maximum water temperatures reached 23 °C during several times in July and early August (Figure 28). Minimum temperatures remained less than 20 °C except for a day in early August and early September. No *O. mykiss* were observed at this location in WY2017.

Lower Salsipuedes Creek (SC-0.77)

A single thermograph was deployed on the bottom of the creek from 5/15/17 through 11/17/17. During the winter of 2017, storm flows changed the configuration of the habitat from a relatively shallow run with a maximum depth of 1 foot, to a pool habitat with a maximum depth of approximately 5 feet. This site is also immediately downstream of the Salsipuedes Creek migrant trapping location.

Water temperatures through early July showed maximum temperatures reaching 24 °C and minimum temperatures remaining less than 20 °C (Figure 29). As the season progressed and water flow into the habitat diminished, there was a corresponding reduction in the 24-hour fluctuation to less than 1 °C between the maximum and minimum water temperatures. Lower Salsipuedes Creek is generally one of the warmest monitoring locations within the watershed however, in 2017, it was the coldest. This could be due to stratification due to greater pool depth at the monitored location and/or potential groundwater contribution. This habitat dried out early in the fall in WY2016 but in WY2017 it remained wet throughout the year. 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 from 5/10/17 through 11/17/17. This is the fifth year a thermograph has been deployed at this location. It was done in order to better understand the water temperature regime in this reach and has become particularly important in identifying creek sections 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 habitat for oversummer 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 showed a similar seasonal pattern compared with the Lower Salsipuedes monitoring location (Figure 30). Overall, temperatures remained less than 23 °C throughout the monitoring period with greater 24-hour variation during the first month of deployment. As flows receded, water temperatures remained less than 22 °C with less than 1 °C variation for the remainder of the year. A sharp drop in temperatures was recorded in mid-September coincident with seasonal cooling in the fall. *O. mykiss* were observed at this location during WY2017.

Salsipuedes Creek – Highway 1 Bridge (SC-3.0)

A single thermograph was deployed in the pool habitat approximately 4 feet below the surface, directly downstream of the Hwy 1 fish ladder from 5/15/17 through 11/17/17. 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 WY2017 due to turbid conditions. This is the fifth year a thermograph has been deployed at this location and was done so to better understand the temperature regime throughout the creek, particularly in reaches that may have 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*.

Some of the warmest water temperatures were collected at this location, something that has not occurred in past years as this site has traditionally been one of the coolest. Temperatures gradually warmed through June, and were warmest from early July through early September before relatively rapid seasonal cooling started. During the warmest period, minimum water temperatures were generally greater than 20 °C with maximum temperatures remaining greater than 22 °C (Figure 31). No *O. mykiss* were observed at this location during WY2017.

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 5/10/17 through 11/17/17. The pool is approximately 30 feet long, 18 feet wide and 6 feet in depth. This area routinely holds oversummering *O. mykiss* and *O. mykiss* were observed in this habitat during snorkel surveys in WY2017.

Water temperatures showed a large 24-hour variation compared to other sites previously discussed. Maximum water temperatures fluctuated noticeably, generally going from 20 to 23 °C during the warmest time of the season. Minimum temperatures remained less than 20 °C except during a few hot days in early September when minimum water temperatures briefly approached 22 °C (Figure 32).

Upper Salsipuedes Creek (SC-3.8)

Although the past 3 years upper Salsipuedes Creek has been dry due to the prolonged drought, this site had flowing water throughout the monitoring period in WY2017. A single thermograph was deployed 0.5 feet from the bottom in a shallow run habitat 15 feet long, 4 feet wide, and approximately 1-foot deep from 5/10/17 through 11/30/17. No *O. mykiss* were observed at this site throughout the monitoring period although water temperatures were favorable for rearing in this section of the creek. Minimum temperatures generally remained less than 18 °C for the entire year except for a several day period in early September coincident with a heat wave (Figure 33). Maximum temperatures generally remained less than 23 °C except during certain warm days. Rapid seasonal cooling was observed during the middle of September onward.

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

A single thermograph was deployed at the bottom of a pool habitat immediately upstream of the El Jaro/Salsipuedes Creek confluence from 5/10/17 to 11/30/17. The habitat is roughly 50 feet long, 12 feet wide with a max depth of 3.5 feet. This location routinely held rearing *O. mykiss* prior to the drought but in WY2017 no *O. mykiss* were observed. This monitoring location was one of the coldest in the entire watershed. Water temperatures were warmest during the early portion of the deployment period and for a brief period during the beginning of September (Figure 34). Overall though, maximum temperatures remained less than 20 °C during the warmest portion of the year showing that this location still has good potential for rearing *O. mykiss* when they are present.

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 5/15/17 through 11/17/17. The habitat measured approximately 35 feet long, 7 feet wide and 3.5 feet deep. This the fifth year a thermograph was deployed in this section of the creek and was done to better understand potential oversummering rearing habitat for *O. mykiss* in El Jaro Creek. *O. mykiss*, including young of the year, juveniles and adults have been observed sporadically in the past. 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. Water contribution into El Jaro Creek (though at extreme minimal levels) has allowed this area to remain wetted throughout the drought and provided pool refuge habitat for any *O. mykiss* inhabiting this area.

Water temperatures at this location recorded some of the coolest temperatures during the deployment period with little 24-hour variation. Temperatures generally remained less than 20 °C except for a short period of time from mid-July to early August and the first part of September during warming trends (Figure 35). No *O. mykiss* were observed in this area in WY2017.

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, the drought has extirpated *O. mykiss* from large sections of upper El Jaro Creek including in and around the San Julian Ranch as large portions of the creek did not flow in the summer of 2013, 2014, and were completely dry in 2015 and 2016. A thermograph was deployed in the pool habitat immediately downstream of the bridge from 5/15/17 and removed on 8/21/17 due to the pool habitat drying out. During the deployment, water temperatures showed typical seasonal warming with maximum and minimum temperatures exceeding 20 °C starting in mid-July (Figure 37). No *O. mykiss* were observed in this area in WY2017.

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 5/15/17 through 11/17/17. 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 provides the sole source of water for that section of the creek. Maximum water temperatures in Los Amoles Creek were somewhat cooler compared to other monitoring stations in the watershed. Overall, maximum water temperatures remained less than 21°C for the majority of the deployment with minimum temperatures generally remaining less than 20 °C (Figure 37). No *O. mykiss* were observed at this monitoring location in WY2017.

Salsipuedes Creek Longitudinal Comparisons

Longitudinal maximum daily water temperatures for Salsipuedes Creek and El Jaro Creek are shown in Figure 38 for the thermographs at: Rancho San Julian (EJC-10.82), Palos Colorados (EJC-5.4), the confluence with El Jaro/Salsipuedes Creek EJC-(3.81), Upper Salsipuedes Creek upstream of the El Jaro confluence (SC-3.80), Salsipuedes Creek at Jalama Bridge (SC-3.5), Salsipuedes Creek at Highway 1 Bridge (SC-3.0), Salsipuedes Creek in the Reach 2 Bedrock Section (SC-2.20), and lower Salsipuedes Creek (SC-0.77). 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.

The entire watershed is still showing the impacts of the long-term drought. For example, while WY2017 was considered a wet year with 34.64 inches of rain recorded at Rancho San Julian, the thermograph monitoring location at Rancho San Julian was observed to be dry on 8/21/17, a phenomenon that has only occurred during the past few years of this recent drought. Flow values measured at the USGS gauging station at Salsipuedes Creek showed that the spring to fall pattern of extremely low flows has continued. Flow rates of 1.0 cfs were recorded in early May before declining to 0.1 cfs or less by the middle of June. Though low, the flow conditions observed in WY2017 are considered an improvement to the general habitat conditions compared to previous years as residual pool depths were being maintained throughout the creek system providing important pool habitat for any remaining *O. mykiss*. Comparing maximum daily water temperatures at thermograph sites within the watershed showed a broad range of results with the warmest sites in the lower portion of Salsipuedes Creek and the coolest site at the El

Jaro/Salsipuedes Creek confluence area (Figure 38). Water temperatures appeared suitable for rearing *O. mykiss* at all creek monitoring stations in WY2017.

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 influence the thermal regime within individual habitats in the watershed. In addition to the above listed variables, the previous five years of drought conditions have caused a significant negative impact to all tributary habitats throughout the watershed. The previous three years in particular have seen the majority of El Jaro and upper Salsipuedes Creek dry causing a large reduction in available habitat for oversummering and rearing. The wet year designation with nearly 35 inches of rain falling on the Salsipuedes/El Jaro Creek watershed offered a small reprieve to drought conditions by providing flow to the majority of the creek length during the critical summer period compared to previous years.

Temperature monitoring within the watershed highlighted the variability of individual habitats. Additional flow contributions to the Salsipuedes/El Jaro Creek in the summer after a wet year greatly improved overall habitat conditions throughout the watershed showing that the majority of the habitats monitored provided suitable water temperatures for rearing *O. mykiss* through portions of El Jaro and Salsipuedes Creeks.

Lake Cachuma Water Quality Profiles: Water quality profiles were collected at Bradbury Dam near the intake for the HCWS on 2/7/17, 4/20/17, 5/30/17, 8/3/17, 10/19/17 and 12/14/17 (Figure 39). 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 into Hilton Creek. In 2017, lake profile measurements were taken from a boat moored up to the HCWS intake pipe off the back of the boat so that the submerged monitoring equipment was 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. With reservoir elevation gains realized in WY2017, water temperatures being released into Hilton Creek remained below 18 °C throughout the year.

The first profile of the year was measured in February and showed cool temperatures from top to bottom, ranging from 10.9 °C – 12.5 °C (Figure 39). The second profile in April generally showed an increase in temperature at all depths with a bottom temperature of 12.3 °C and a surface temperature warming to 17.5 °C. The last spring profile in late May showed that the surface had warmed to 20.6 °C and lake stratification had developed. The summer profile in early August showed the widest variation in temperature with a bottom temperature of 13.8 °C and a surface temperature of 25.1 °C (a top to bottom difference of 11.3 °C). The thermocline depth in August sat in a zone of approximately 26-46 feet. With a diminishing photo period and cooler weather Lake Cachuma had cooled significantly in October with a surface temperature of 19.1 °C and a narrow thermocline located between 53-56 feet. The final profile in December showed the lake had experienced a turnover event with unithermal conditions with only a tenth of a degree difference from the top (14.1 °C) to the bottom (14.0 °C) of the lake.

DO concentrations were highest on the surface of the lake during the first lake profile in February, measuring 12.27 mg/l, and ranged between 7.45 mg/l – 8.92 mg/l for the remainder of the profiles (Figure 39). Anoxic conditions appeared in August with DO concentrations less than 1 mg/l found at 30 feet of depth and below. Anoxic conditions were also found in October at 56 feet and below. The final profile in December showed uniform DO conditions ranging from 6.75 mg/l at the bottom and 7.45 mg/l at the surface of the lake.

3.3. Habitat Quality within the LSYR Basin

Habitat quality monitoring during WY2017 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. Photographs were taken at designated locations (photo points) to track long-term and short-term changes that had occurred as a result of stormflows, 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 WY2017 LSYR photo points is provided in Appendix C (Table C-1)**.**

LSYR mainstem photo point locations include all bridges from the Highway 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, and San Miguelito creeks (Appendix C, Table C-2).

Photo point comparison between 2005 and 2017 shows an increase of LSYR mainstem riparian growth since the target flows were required to be met at the Alisal Bridge (2005), approximately 10.5 miles downstream from Bradbury Dam (Figures 40-44). Sections of the mainstem that were nearly devoid of vegetation in 2005 now show abundant new growth with willow, sycamore, and cottonwood trees in excess of 15 feet in height. However, trees in the riparian corridor throughout the mainstem are showing signs of stress and die off from the ongoing drought and lack of flowing water and the fact that target flows were no longer required at the Alisal Bridge due to no spill events. The last Bradbury Dam spill event occurred in 2011. Since 2011, the region has experienced 5 consecutive years of drought and decreased flows throughout the entire watershed.

Photo documentation within Hilton Creek continues to show a maturing riparian zone, particularly within the reach between the URP and LRP which was initially activated in 2005 (Figures 45-46). 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 WY2017 after five consecutive years of below average rainfall and an absence of channel changing flow events this year (Figures 47-49). In addition, the cattle exclusionary fencing installed in lower Salsipuedes Creek (completed in WY2015) has contributed to an increase in riparian growth in those reaches where cattle no longer eat, trample and damage emerging vegetation. 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.

WY2017 was the fourth 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 WY2017 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. Take was not exceeded during the 2017 trapping season.

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 LSYR mainstem (SC-0.7); and (3) in the LSYR mainstem LSYR 7.3 miles downstream of Bradbury Dam (LSYR-7.3).

WY2017 represented a wet year after 5 consecutive years of dry conditions (the drought was officially proclaimed by the County on 1/24/14) and had 21 storms with rainfall amounts greater than 0.1 inches recorded at Bradbury Dam. The wet year provided migration opportunities for *O. mykiss* throughout the LSYR basin although the LSYR mainstem had few days with sufficient streamflow for passage. The Hilton Creek and Salsipuedes Creek migrant traps were operated continuously from 2/12/17 to 4/21/17, at which point flows were too low for fish passage (Table 7). The LSYR mainstem traps were not operated due to limited fish passage potential with only 3 short periods of flow above 25 cfs at Solvang (determined critical riffle flow). Catch per unit effort (CPUE) for the WY2017 at the two tributary migrant traps showed 100% efficiency (Table 8).

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 9).

WY2017 ranked just below the 5 year recurrence interval in Santa Barbara County for total rainfall amount. Despite January receiving nearly 9 inches of rain, streamflow conditions in Salsipuedes Creek continued to show signs of an extended drought as peak flows of 3,890 cfs on 1/20/17 receded to 0.95 cfs on 1/30/17, providing poor migration opportunities. In February, peak flows of 7,630 cfs were recorded on 2/17/17 but receded to less than 5 cfs by 3/18/17. In the LSYR mainstem, flows greater than 25 cfs at the Solvang USGS gauge were recorded on 1/20/17, from 1/22/17 through 1/24/17, and from 2/17/17 through 3/3/17. By 5/3/17, flows were zero at that site. Base flows in Hilton Creek generally remained less than 1.3 cfs except during a few storm events that briefly generated modest upper basin stormflows. The highest average daily discharge recorded in Hilton Creek during the migration season was 8.32 cfs on 2/18/17. Instantaneous peak streamflow approached 50 cfs in association with the 1/19/17 storm event that brought down heavy turbidity.

Hilton Creek Migrant Traps: Both upstream and downstream migrant traps were installed from 2/12/17 through 4/21/17. Total captures by month and the average smolt size per month are shown in Figure 50. There was 1 upstream migrating *O. mykiss* captured on 3/4/17 measuring 152 mm (6.0 inches) that was classified as a pre-smolt (Figures 51-52). This fish was not recaptured and likely remained in the creek. There were 4 downstream migrating *O. mykiss* captured from 2/22/17 through 3/3/17 ranging in size from 141mm (5.6 inches) to 192 mm (7.6 inches) (Figures 51-52). Two of the 4 downstream migrating fish exhibited smolting characteristics with one captured in

February and one captured in March. All of the fish captured in Hilton Creek were juveniles and were observed following the peak stormflow event in February and March (Figure 53).

Both the upstream and downstream traps operated continuously for a period of 69 days with a trapping efficiency of 100% and a catch per unit effort (CPUE) of 0.01 for upstream migrating fish and 0.06 for downstream migrating fish (Table 8). The 5 migrant captures occurred over an 11 day period with 3 of the captures happening during the night time check and 2 of the captures happening during the first morning check (Table 9).

Salsipuedes Creek Migrant Traps: Trapping was conducted in Salsipuedes Creek from 2/12/17 through 4/21/17. No upstream or downstream migrating *O. mykiss* were captured (Figures 50, 51 and 53). This is the first time in monitoring history by COMB-FD that no migratory movement was documented in the creek when flow conditions allowed for potential migration and there was ocean connectivity (Figure 54). This was especially concerning when put into context of the back end of 5 year drought where large stretches of the Salsipuedes/El Jaro creek drainage dried up. When comparing trapping results since 1995, it is evident that the drought has caused a noticeable change in the overall population of *O. mykiss* (both resident and anadromous fish) inhabiting that watershed since the last anadromous adult was observed in WY2011.

A comparison of the trapping results between Salsipuedes Creek and Hilton Creek is provided in Table 10 and discussed in Section 4.2.

LSYR Mainstem Trap: No trapping was conducted at the mainstem trapping location in WY2017. Minimal passage flows greater than 25 cfs at Solvang only occurred 3 times, each for a brief period of time with rapid recessions to less than 5 cfs shortly after stormflow.

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, Alisal, and Hwy 154 reaches) and bi-monthly in the tributaries (Hilton, Quiota, Salsipuedes, and El Jaro [including Los Amoles and Ytias creeks]) in the winter and spring within the reaches where access is permitted. The previous 5 years of drought have been detrimental to spawning opportunities for resident *O. mykiss* throughout the watershed. Constricting habitats, beaver dams, and ponds that restrict water movement and submerge potential spawning grounds, and low flows essentially eliminated longitudinal *O. mykiss* movement within the LSYR mainstem and tributaries as fish could not navigate past critical riffles during those years. Spawning conditions were so poor that no spawning surveys were conducted in the LSYR mainstem in WY2016 due to dry conditions and the absence of any stormflow (except near the dam within the Highway 154 Reach) and the fact that the majority of the river downstream of Bradbury Dam completely dried out during the summer of 2016. While streamflow conditions were greatly improved in WY2017 compared to the previous 5 years and fish could navigate critical riffles and find each other, the low number of redd sites observed during the spawning surveys underscores the overall low population levels of adult *O. mykiss* inhabiting the Salsipuedes/El Jaro Creek, Quiota Creek and Hilton Creek watersheds.

Survey results are presented for the tributaries in Tables 11 and 12. Redd surveys within the LSYR tributaries began in mid-February and ended in April. Despite the watershed getting over 4 inches of rain between October-December 2016, and nearly 9 inches of rain January, flows fluctuated greatly as the watershed quickly absorbed the rainfall and minimized long-term runoff as described above. Spawning surveys started in February following several storm events which briefly elevated streamflow above baseflow, cleared the allochthonous material on spawning beds, and allowed a few fish to find each other. Three redd sites were identified in Salsipuedes Creek on 4/12/17 following the observation of young of the year (YOYs) along the margins of the creek.

There were two redd sites observed in Hilton Creek on 3/21/17. Creek flow was only 0.08 cfs when the spawning sites were documented which was just prior to Reclamation initiating gravity flow to the creek through the HCEBS. These low flow rates were not conducive to longitudinal fish movement and for fish to find suitable mates and spawning locations. The fact that a few fish did find a mate and a location to spawn was surprising at such low flow levels given the difficulty in moving from one habitat to another.

Survey results for WY2017 in Salsipuedes Creek (3 redds) are especially concerning considering that in WY2012 there were 50 redd sites identified within the Salsipuedes/El Jaro watershed. Since WY2012, there has been a decrease in the number of redds observed specifically WY2013 (11), WY2014 (2), WY2015 (3), and WY2016 (1) that illustrated the impact of the long-term drought on the *O. mykiss* population in that drainage.

There were no redds identified in the LSYR mainstem during WY2017 within the Hwy 154 Reach on Reclamation property immediately downstream of the Long Pool (Table 13). Spawning surveys were not conducted in either the Refugio Reach or Alisal Reach due to low to dry river conditions during the spawning season.

Snorkel Surveys: Snorkel surveys in WY2017 were conducted towards the end of the spring, summer, and fall within the LSYR mainstem (Figures 55-56 and Table 14). Standard and accepted single-pass snorkel survey protocols were followed (Hankin and Reeves, 1988). Spring snorkel surveys were completed in June 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 YOYs produced over the spawning season, as well as the standing crop of *O. mykiss* going into the over-summering period. Summer surveys were conducted in the LSYR mainstem in October, commensurate with the during-release phase of the WR 89-18 Release. Fall

LSYR mainstem snorkel surveys were conducted 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 snorkel 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 56 with all survey dates shown in Table 14 for the LSYR mainstem and Table 17 for 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 55). 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.

<u>*Hwy 154 Reach*</u>

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 downstream of 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 Figures 56 and 57 as well as Tables 15-16. No *O. mykiss* were observed in the reach below the Long Pool to the Reclamation property boundary during the early spring survey (LSYR-0.5 to LSYR-0.7). As mentioned above, a WR 89-18 release was conducted in WY2017, which called for pre- and post-release surveys within the Hwy 154 Reach. Divers snorkeled the Hwy 154 Reach in August and November and no *O. mykiss* were observed.

<u>*Refugio Reach*</u>

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 55 and Figure 57). Spring snorkel surveys were conducted in late May. Summer and fall snorkel surveys were conducted in relation to the timing of the 2017 WR 89-18 Release, as well as the predetermined number and location of habitats snorkeled. A total of 7 habitat units were visited during the WR 89-18

Release surveys; 6 pool habitats and 1 run habitat (Tables 15-16). A single *O. mykiss* (9-12 inches) was observed in a pool habitat just below the Lower Gainey Crossing (LSYR-6.4) during the spring snorkel survey. No *O. mykiss* were observed within any habitat during the summer and fall snorkel surveys within the Refugio Reach.

Alisal Reach

The Alisal Reach extends from Refugio Bridge (LSYR-7.8) downstream to the Alisal Bridge (LSYR-10.5) (Figure 55 and Figure 58). Spring snorkel surveys were conducted in late May. Summer and fall snorkel surveys were conducted in relation to the timing of the 2017 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 (Tables 15-16). A single *O. mykiss* (9-12 inches) was observed in a run habitat downstream of Refugio Bridge (LSYR-7.6) during the spring snorkel survey. No *O. mykiss* were observed within any habitat during the summer and fall snorkel surveys within the Alisal Reach.

Avenue of the Flags Reach

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 55 and Tables 15-16). The river towards the upper half of the reach has noticeably changed by anthropogenic means, insofar as where Buellflat, Granite and other flood plain mining companies have been historically altering the river bottom. The downstream half of the reach consists of a mature, unaltered riparian canopy. The COMB-FD staff conducted a spring snorkel survey in the Avenue of the Flags Reach at the end of May with no *O. mykiss* observed. 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 5 pools and 4 runs. No *O. mykiss* were observed within the Avenue of the Flags Reach during the summer and fall snorkel surveys.

Cadwell Reach

The LSYR 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 WY2011 (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 survey activities and water quality monitoring (Figure 55 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 3 WY2017 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 WY2017 at most of the long-term monitoring locations within Hilton, Quiota, Salsipuedes, and El Jaro creeks (Figure 55 and Tables 17-19). With higher rainfall and sustained flows observed in WY2017, more summer and fall surveys were possible than in the previous years of drought where limited water and turbidity prevented snorkeling.

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 (Tables 17-19 and Figure 59). 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 along 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.

With continued low reservoir elevation and coming off of critical drought conditions, flows into Hilton Creek were being provided at the start of the water year by Stilling Basin pumped flows (approximately 0.03 cfs) to the LRP in the fall and winter of WY2017 until March. Rainfall and runoff led to an increase in reservoir elevation in February and March with Reclamation activating the HCEBS by gravity flows to the LRP starting on 3/23/17. HCEBS gravity flows were shut off between 4/4/17 to 4/7/17 for the installation of the 30-inch valve at the Outlet Works during which time trickle flow from the Stilling Basin pumps was once again provided to the LRP. Given the low flow conditions and clear visibility of discharged Stilling Basin waters, staff quickly conducted an early spring snorkel survey on 4/7/17 to assess the current *O. mykiss* population. Habitats in lower Hilton Creek (Reach 1) were dry from the confluence of the LSYR mainstem up to just past the Ford Crossing. Habitats above the LRP (Reach 5) were also dry, so surveyors focused their efforts from the middle of Reach 1 up through Reach 4 where water was present. A total of 31 *O. mykiss* were observed during the 4/7/17 survey (Figure 59 and Tables 18-19). Of the 31 *O. mykiss* observed, there were no 0-3 inch fish (indicating no YOY emergence yet), and 3 (9.7%) juvenile fish in the 3-6 inch size category. The larger size classes of *O. mykiss* consisted of 25 (80.6%) 6-9 inch, and 3 (9.7%) 9-12 inch fish. There were no *O. mykiss* over 12 inches observed during the survey.

The COMB-FD conducted a summer snorkel survey within Hilton Creek between 9/6/17-9/7/17 (Figure 59 and Tables 18-19). At the time of the survey, the HCWS was providing pumped flow to the URP and the visibility within the creek was clear enough to conduct a survey from the confluence to the LRP. A blocking seine just above the LRP had been installed and was being maintained for several months leading up to the summer survey, preventing *O. mykiss* from moving into Reach 5. A total of 256 *O. mykiss* were observed during the summer survey, which was an upward trend in abundance compared to the spring survey. It was apparent that successful spawning had occurred with 149 (58.2%) 0-3 inch YOYs observed. The remaining size classes and percentage of the total number of *O. mykiss* observed were as follows; 73 (28.5%) 3-6 inch, 13 (5.1%) 6-9 inch, 16 (6.3%) 9-12 and 5 (2.0%) 12-15 inch fish.

Divers made several site visits to Hilton Creek for a final fall survey but were unable to snorkel due to poor visibility (1.0-2.0 feet maximum water clarity). At the time, flows were being delivered via the HCEBS from the bottom of the reservoir which appeared to be laden with suspended sediment as water being delivered to Hilton Creek was in a constant state of elevated turbidity.

<u>*Quiota Creek*</u>

A historic section of Quiota Creek, located between Crossing 5 and Crossing 7, typically contains perennial flow and habitat of which staff routinely snorkels (Figure 55 and Tables 18-19). WY2017 was a wet year with flowing conditions being sustained into the beginning of the dry season, with the regular survey reach flowing into early June. Spring snorkel surveys were conducted on 5/9/17 with no *O. mykiss* observed. Summer (9/11/17) and fall (11/29/17) surveys occurred but the area of wetted habitat to snorkel had shrunk and once again no *O. mykiss* were observed.

<u>*Salsipuedes Creek*</u>

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 55). 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 flow, and presence of *O. mykiss*. Flow conditions and water clarity were notably improved during WY2017 snorkel surveys compared to WY2016, although several reaches (Reaches 3-4) contained poor visibility during the final fall survey (Figures 60-61 and Tables 18-19).

Spring surveys within Reaches 1 through 4 were completed between 4/11/17-4/13/17 and COMB-FD staff encountered higher baseflows and clear water conditions since it was the beginning of spring after an above-average rain year. Only 3 *O. mykiss* were encountered during the survey, all resident adults with 2 measuring 9-12 inch and 1 measuring 12-15 inches. It’s important to note that this early spring survey was likely conducted prior to any fry emergence from redds in those reaches. Several weeks later (5/10/17) staff visited Reach 5 in Salsipuedes Creek and counted 6 *O. mykiss*, 4 of which were YOYs indicating successful spawning and emergence in that reach.

Summer surveys within Reaches 1 through 4 were conducted from 9/12/17 to 9/14/17, resulting in a marked increase in *O. mykiss* observed since the spring survey with 83 individuals counted. Successful spawning and emergence was evident as 77 of the 83 *O. mykiss* observed fell into the smaller size classes (30 at 0-3 inches and 47 at 3-6 inches). As noted above, no fish under 9 inches were observed during the spring survey under clear conditions, so this was strong evidence of recent spawning success and rapid growth within the lower reaches of the drainage. The summer survey within Reach 5 also yielded higher numbers compared to the spring with 13 *O. mykiss* observed. Size classes included 3 0-3 inch (23.1%), 6 3-6 inch (46.2%), 2 6-9 inch (15.4%), 1 9-12 inch (7.7%) and 1 12-15 inch (7.7%) fish, the 2 largest fish being observed at the pool below and within the Jalama fish ladder (SC-3.5).

Reaches 1 through 4 fall surveys in Salsipuedes Creek were conducted between 11/28/17-11/30/17 and a total of 47 *O. mykiss* were observed. This was a 43% reduction in fish observed since the summer survey, although the visibility for divers was noted as being fair to poor through the top of Reach 3 and the bottom of Reach 4. Of the 47 fish observed, there was an expected upward shift in size classes with only 8 0-3 inch (17%) counted and 32 3-6 inch (68.1%) and 6 6-9 inch (12.8%) fish observed. One larger 15-18 inch *O. mykiss* was observed in the same Reach 2 pool habitat that was seen in the previous summer survey. Divers counted 6 *O. mykiss* in Reach 5 during the final fall snorkel survey; 4 3-6 inch, 1 12-15 inch and 1 15-18 inch fish. Both of the larger fish were located within the deep pool directly downstream of the Jalama fish ladder.

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 55, Tables 18-19). Divers arrived in early May to conduct spring snorkel surveys and encountered good flow conditions and water clarity during the survey. Although conditions were favorable, no *O. mykiss* were observed. Most of lower El Jaro Creek near the confluence with Salsipuedes Creek was dry by September, 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 55 and Figures 62-63). 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 events 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 and Salsipuedes Creek did contain warm-water fish in WY2017, especially in the lower reaches of each tributary.

Hilton Creek

No warm-water species were observed within Hilton Creek during the spring snorkel survey. In the summer, the COMB-FD staff observed 13 green sunfish (0-3 inch) within Reach 1 in lower Hilton Creek. Water clarity made conditions unsuitable for snorkeling in the fall, so the number of warm-water fish inhabiting Hilton Creek could not be enumerated accurately. Prior to WY2015, it was uncommon to observe any non-native fish species in Hilton Creek.

Salsipuedes Creek

In the spring survey, COMB-FD staff counted 6 green sunfish (4 3-6 inch and 2 6-9 inch). The summer survey within Salsipuedes Creek unfortunately revealed a population explosion of green sunfish within the basin, primarily confined to the top of Reach 1 through the bottom of Reach 3. A total of 1,632 green sunfish were counted; 1,545 0-3 inch, 81 3-6 inch, and 6 6-9 inch fish. The majority of sunfish were fry, which indicated successful spawning and emergence between the spring and summer surveys. Personnel returned in the fall and observed a dramatic decrease in green sunfish numbers (a total of 65), but the visibility was marginal in many of the habitats that contained large numbers of green sunfish during the summer survey, so the total number of sunfish observed in the fall was likely a low estimate.

LSYR mainstem

Largemouth Bass: Largemouth bass were observed within the LSYR mainstem in WY2017 in relatively low numbers compared to recent years (Figure 62). This could be partly due to the Stilling Basin de-watering and non-native fish removal activities that occurred in July of 2017 when 139 largemouth bass and hundreds of juvenile largemouth bass fry were removed during that effort. Spring snorkel surveys within the Refugio and Alisal reaches resulted in 0 largemouth bass and 2 largemouth bass being observed within each reach, respectively. Coincident with WR 89-18 releases, largemouth bass observations slightly increased during the summer with 7 observed in Refugio Reach and 4 observed in the Alisal Reach. A steady increase (but not nearly the numbers observed during recent fall surveys) in largemouth bass numbers came during the fall snorkel survey with 19 observed in the Refugio Reach and 32 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. A handful of sunfish were observed within the Refugio and Alisal reaches during the spring survey with 6 observed in the Refugio Reach and 1 observed in the Alisal Reach in the spring (Figure 62). In the summer (or during WR 89-18 Release) survey, no sunfish were observed within the Refugio and Alisal Reaches. The fall (post WR 89-18 Release) survey resulted in zero sunfish in the Refugio Reach and 1 sunfish in the Alisal Reach. With 1,239 sunfish over 3 inches in length and many thousands of sunfish fry removed during the Stilling Basin de-watering and fish removal effort in July, these fish were removed from the system prior to potentially moving downstream and appearing in the summer and fall surveys.

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 WY2017, no catfish were observed during any of the spring, summer and fall surveys within the LSYR mainstem (Figure 63).

Carp: During the Stilling Basin (LSYR-0.1) de-watering and non-native fish removal effort in July, 556 large adult carp were removed during that management activity. The spring snorkel survey resulted in 3 carp observed in the Refugio Reach and 1 carp in the Alisal Reach (Figure 63) in WY2017. In the summer period, personnel counted 18 carp in the Refugio Reach and none in the Alisal Reach. The final fall snorkel survey resulted in 12 carp in the Refugio Reach and none in the Alisal Reach.

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 WY2017, no tributary projects were conducted but all preparations were done to construct 2 projects the following year (Quiota Creek Crossing 5 and Crossing 9). All of the completed projects along Quiota Creek removed a fish passage barrier and replaced it with a bridge that allowed complete juvenile and adult fish passage across all determined fish passage flows.

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, mulching), and photo documentation were all conducted in accordance with the post-project monitoring requirements at each location.

3.7. Additional Investigations

Scale Analysis: *O. mykiss* have fish scales (cycloid scales) that grow out of the skin and protect the body. They add rings (circuli) to their scales as they grow, depending upon food availability, water quality, and environmental stressors. Seasonal variations in conditions create annuli, which can be used to estimate the age of the fish. Other information that can be estimated from scale analysis include growth rate, when an individual migrated to the ocean, how long they spent at sea, when spawning occurred, and the approximate age they returned to the river.

COMB-FD staff collects eligible *O. mykiss* scales during migrant trapping efforts. These scales are stored in envelopes and transferred to microscope slides and added to the *O. mykiss* scale library at the COMB-FD office for analysis as time permits. The scale library is a valuable resource for documenting patterns in migration, growth rate, spawning, and environmental stress.

Genetic Analysis: Tissue samples from all of the migrant captures during WY2017 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 WY2017, beavers continue to inhabit the Salsipuedes/El Jaro Creek watershed (Figure 64). 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 WY2017, the COMB-FD completed the LSYR mainstem beaver dam survey from the dam (LSYR-0.0) to 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 mainstem survey 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 which beavers 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 state 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 4 years, the number, extent, and size of beaver dams has decreased in both the LSYR mainstem and its tributaries. In 2011, Bradbury Dam spilled, removing many beaver dams and displacing 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 WY2011 (Table 20). The highest total of dams identified in the mainstem (132) occurred in WY2013 and tributaries (36) occurred in WY2014.

Mainstem dams identified in WY2017 (66) represent a slight increase in the number of dams observed during the previous year (45) (Figure 64). Of note is the number of active dams versus the number of inactive dams. Of the 45 dams identified in WY2016, only 16 of those were classified as active dams, the remainder dams were relic or recently abandoned dams (due to lack of water). In WY2017, of the 66 dams identified, only 14 were classified as active with most (12) documented downstream of the Avenue of the Flags in Buellton including one active dam downstream of the Floradale Bridge near Vandenberg Airforce Base. There was one active dam in the Refugio Reach and one in the Alisal Reach and 17 non-active dams (relic or abandoned).

The number and extent of beaver dams identified in WY2017 serves to illustrate the extent of habitat fragmentation caused by the dams within the LSYR with 26 identified as barriers and 9 as impediments (Table 20).

There were 8 beaver dams identified in the Salsipuedes/El Jaro watershed; 8 in Salsipuedes Creek and 0 in El Jaro Creek. Of note was that in WY2016, there were also 8 dams identified with one being active. In WY2017, none of the beaver dams were active and it appears that the past drought conditions removed beavers from the entire watershed. Three of the relic dams were classified as barriers and one as an impediment with the remainder being passable. Five of the dams were between 1.1-2.0 feet with the other dams smaller in height. Following the large flow event in February of WY2017, it appears that all relic dams were removed by the storm flows providing unimpeded movement of fish within the system that will be documented in next year's beaver dam survey.

4. Discussion

This section provides (4.1) additional historical context for the WY2017 results presented above, specifically since the issuance of the 2000 BiOp, (4.2-4.9) discussion as needed on specific topics of interest or concern, and (4.10) the status of last year's Annual Monitoring Summary 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, 2016), 2013 (COMB, 2017d), 2014 (COMB, 2018a), 2015 (COMB, 2018b), and 2016 (COMB, 2019).

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 65) are presented since WY2000.

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

Salsipuedes Creek and Hilton Creek are very different tributaries in terms of their size (Salsipuedes is an order of magnitude larger than Hilton), hydrology (rainfall and flow patterns, hydrologic regime, and artificial watering system), land use (chaparral, agriculture, and cattle ranching), and biology (*O. mykiss* migration and population characteristics). Both creeks have hydrologic regimes typical of a Mediterranean-type climate with flashy streams and high inter/intra-year runoff variability. The watershed area for Salsipuedes Creek is larger than that of Hilton Creek and at times can receive more rainfall during any given rainfall event due to its westerly location. Typically, smaller watersheds like Hilton Creek can have sharper recessional storm hydrographs however Hilton Creek has an artificially sustained baseflow greater than 2 cfs year around, whereas in the upper reaches of Salsipuedes Creek and its largest tributary, El Jaro Creek, baseflows typically approach 0.5 cfs during the dry season. Out-migrant *O. mykiss* smolts in both creeks attempt to migrate to the ocean/lagoon when flow opportunities present themselves.

The *O. mykiss* populations between the two creeks exhibit differences in spawning time, rearing habitat, and over-summering characteristics (i.e., water quality, flow, and habitat complexity). Hilton Creek has good habitat quality (refuge pools with structure and a mature riparian canopy) and flows into the Long Pool just downstream of the confluence with the LSYR mainstem, but has limited stream length and sparse spawning gravel. The Salsipuedes Creek system has extensive stream mileage but only fair habitat quality due to low dry season flows, limited pool habitat with acceptable water quality for over-summering, a predominance of fine sediment substrate, and high water temperatures in the lower portion of the creek (AMC, 2009). One result of these differences is earlier resident *O. mykiss* upstream migration in Hilton Creek due to greater availability of water in the mainstem immediately below the dam where resident *O. mykiss* have been documented to oversummer. Hilton Creek also has a longer migration time for smolts to make it to the ocean given the additional distance, and a potentially longer smolting period due to favorable water quality conditions near the dam which can diminish some environmental cues for out migration (for example low water temperature and continuous baseflow greater than 2 cfs). Returning ocean run adults also have a longer travel distance to Hilton Creek than Salsipuedes Creek.

Regardless of the differences in the watersheds described above, the drought of WY2012-WY2016 has negatively impacted both watersheds as evident by the extremely low captures in Hilton Creek (5) and zero captures in Salsipuedes Creek in WY2017 (Table 10). The fact that only two potential smolts were captured during the entire migratory season shows how difficult rearing conditions have been overall during the drought and (based on Annual Reports since 2011) highlights the fact that essentially no smolting fish have made it to the ocean since 2011.

4.3. Tributary Passage Enhancement Projects

By the end of WY2017, 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 66-69). 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 45-46). 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 69) and releases from the URP provided for extensive riparian vegetation growth that has shaded and cooled the stream water. 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, which has resulted in some thermal heating in that upper reach (Figure 70).

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.

The 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 WY2017 as cattle have been excluded from the stream corridor.

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 over the course of 3 years within that section of the river channel. Staff surveyed that section of river in WY2017 (last known occurrence was 12/8/16) 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. Hilton Creek January Storm Events

A series of 3 large storms impacted Hilton Creek watershed on 1/7/17 (1.65 inches, as recorded at Bradbury Dam), 1/11/17 (1.64 inches), and 1/19/17 (5.15 inches) (Table 3) with natural upper basin flow beginning during the third event as recorded by the USGS gauge (1125600) just downstream of the URP (Figure 3). Prior to the storms, discharge into Hilton Creek was approximately 0.03 cfs of trickle flow being pumped from the Stilling Basin to the LRP due to critical drought conditions. Traps had been installed and left blocked prior to the storm series to prevent fish from moving downstream to the end of the wetted front during trickle flows. During the third storm event, streamflow went from 0 to over 50 cfs (USGS gauge 1125600 is a low flow gauge that is not calibrated above 50 cfs) between 10:15 AM and 10:45 AM on 1/20/17, with an instantaneous peak flow of 51 cfs (Figures 71-72).

COMB-FD staff was on site at Hilton Creek during each day, once upper basin flow started, to conduct fish rescues as needed, remove equipment in the stream, and provide information to Reclamation as needed. Due to the sudden rise of high stormflows and the lack of continuity and sustaining flows between Hilton Creek and the Long Pool (LSYR-0.5) after the storm event, some mortalities were found by COMB-FD staff (Figure 73). Three *O. mykiss* mortalities were recovered in lower Hilton Creek near the confluence with the Long Pool (LSYR-0.5) on 1/21/17. On the same day a total of 27 live sculpin were found in dewatered habitat and moved upstream into Reach 3 of Hilton Creek. One dead sculpin was also found. On 1/24/17, COMB-FD staff arrived early and Hilton Creek flows to Long Pool were barely sustaining. Two live sculpin were found in a dewatered habitat and moved upstream. At 9:00 AM, the California Department of Fish and Wildlife (CDFW) arrived with a 3 person electrofishing team to assist with fish rescue activities (Figure 74). The COMB-FD and CDFW teams worked together to electrofish lower Hilton Creek up to approximately 200 feet downstream of the Hilton Creek trap site. One sculpin was rescued from this section and moved to Reach 3. Electrofishing was then conducted throughout all wetted habitats between the LRP and URP of Hilton Creek. No fish were observed throughout all of the remaining wetted portions of Reach 5. At the end of the day, COMB-FD staff found an additional *O. mykiss* mortality in the lower section of the creek that appeared to have been dead for several days. Mortalities could have been caused by strandings, high sediment load from upstream, or other unknown reasons.

The rapid rise and subsequent drop in Hilton Creek stormflows were indications of the magnitude of the 1/19/17 event and how dry the watershed was, with extremely low antecedent soil moisture content prior to the rainfall event that resulted in a steep recessional limb to the storm hydrograph. A full report was written and provided to Reclamation and NMFS that described the changes in stream discharge, stream survey results, mortalities found, and fish rescued and relocated (COMB, 2017b).

4.6. Outlet Works 30-inch Valve Reinstallation

With a higher reservoir elevation from winter rainfall and runoff, Reclamation initiated gravity flows at an approximate flow rate of 3.6 cfs to Hilton Creek from the HCEBS on 3/23/17 after months of trickle flows while in critical drought. The HCEBS connects to the penstock at the base of Bradbury Dam through a 10-inch valve at the Bradbury Dam Outlet Works. Associated with the penstock are 2 other valves, each 30-inch cone valves. One of those 30-inch valves had been previously removed and repaired. Reclamation scheduled installation of that repaired 30-inch valve during the week of 4/3/17-4/7/17, which required closing the guard gate (lake-ward most valve) of the penstock on Monday 4/3/17, draining the penstock, and shutting off flows through the HCEBS to Hilton Creek. Discharge into Hilton Creek during the planned outage was provided to Hilton Creek by returning to trickle flow as was done during critical drought conditions. Reclamation provided continuous minimum flow of 0.03 cfs to Hilton Creek by pumping water from the Stilling Basin and later with additional flow from the Hilton Creek Water Tanks at approximately 0.03 cfs for a total of 0.06 cfs throughout the operation.

The COMB-FD was on site throughout the operation to conduct fish rescues as needed, in case aquatic species were stranded, until the HCEBS was back online on Friday 4/7/17. Reclamation conducted the ramp-down of the HCEBS over the course of several days following established protocols in the 2000 Biological Opinion (NMFS, 2000). COMB-FD staff rescued and relocated 2 *O. mykiss*, 1 prickly sculpin, and 3 southwestern pond turtles during HCEBS ramp-down, all within the lower most section of the creek that dewaters with only trickle flow (Figure 75). The rescue and relocation of the 2 *O. mykiss* occurred on the final flow cut in the afternoon of 4/3/17. At 12:30 PM that day, HCEBS releases were down to 1.3 cfs (after several days of incremental HCEBS flow cuts). Reclamation attempted to make another flow cut which resulted in the HCEBS shutting down completely with no flow being released. The Stilling Basin pump was immediately turned on which began providing approximately 0.03 cfs to the LRP of Hilton Creek with no interruption of flow. COMB-FD staff quickly spread out downstream and found an *O. mykiss* in the lower section of the creek that needed to be moved into a deeper pool habitat further upstream. Later that evening, Reclamation opened up the Hilton Creek Storage Tanks valve to provide additional water at an approximate cumulative total release of 0.06 cfs.

During the course of the week and associated ramp-downs, there were no interruptions of flow to Hilton Creek and no *O. mykiss* redds were dewatered. On 4/7/17, Reclamation finished its work on the 30-inch valve at the Outlet Works and the HCEBS by gravity was slowly ramped up to not overwhelm the remaining fish occupying Hilton Creek and to meet BiOp target flows of a minimum of 2 cfs. A full report was provided to Reclamation and NMFS (COMB, 2017a).

4.7. Stilling Basin Dewatering and Non-Native Fish Removal

The objective of this adaptive management effort was to reduce the most likely primary seeding source of warm-water non-native fish species (i.e., carp, bass, catfish and sunfish) that came from Lake Cachuma via the Bradbury Dam spillway and inhabit the Stilling Basin just downstream of the dam. Those species are known to spawn, move downstream with higher flows, and some predate upon and compete with *O. mykiss* downstream of Bradbury Dam. The proposed action was to dewater the Stilling Basin to a depth suitable to seining and remove non-native fish from that body of water through a systematic seining operation, with a secondary goal of completely dewatering the Stilling Basin to ensure complete removal of non-native species. Dewatering of the Stilling Basin occurred utilizing multiple pumps over multiple weeks to draw down the habitat to a suitable seining depth of approximately 2 feet. One or more seines were hand-pulled through the habitat multiple times over multiple days where the captured non-native fish were removed, dispatched and disposed of away from the site. Any native fish (*O. mykiss* or sculpin) were carefully and immediately relocated to nearby Hilton Creek. This was a collaborative effort between COMB, Reclamation, and NMFS.

COMB contracted Rain-4-Rent to assist in the pumping operation and on 6/23/17 they mobilized to the Stilling Basin near the Outlet Works where they installed two electric 6-inch submersible pumps with a diesel generator along with an aluminum transmission pipeline to convey water from the Stilling Basin to the discharge point well downstream of the tailwater control of that habitat (Figures 76-77). In addition to the rented pumps, COMB deployed 2 3-inch and 1 4-inch gas powered trash pumps placed along the western margin of the Stilling Basin that again discharged downstream of the tailwater control . Once the Stilling Basin had been drawn down to a depth suitable for seining (less than 3 feet), a 100-foot long, 6-foot tall, weighted 1/8-inch mesh pocket seine was used for all seining efforts. Seine pulls were conducted using a 5-7 person team and an additional 1-2 people lifting the lead line over obstacles in the water (i.e., rocks and woody debris). The seine was pulled anywhere from 1/3 to 1/2 of the total width of the Stilling Basin during each pull. Seines were hauled onto the concrete batting of the spillway where the caught fish were rinsed off and inspected for the presence of *O. mykiss*. All invasive species were placed in a fish basket (or bucket) to be hauled up to the road way near the Outlet Works via a crane truck where they were separated by species then size class for enumeration and loaded into a pickup truck for disposal offsite within Reclamation property.

Dewatering took well over a month to achieve a depth for effective seining. Over the 7 day seining effort, there was a total of 2,150 fish captured over 3 inches long. Specifically, there were 556 carp (25.9 %), 1,239 sunfish (57.6%), 201 catfish (9.4%), 139 bass (6.5%), 13 crappie (0.6%), and *2 O. mykiss* (0.1%) captured (Figure 77). The 2 *O. mykiss* captured during seining activities were quickly moved via bucket with aerators into refuge habitats within Hilton Creek. Additionally, there were approximately 72 gallons of fry and young of the year of multiple fish species (threadfin shad, sunfish, bass and catfish) less than 3 inches in length that were also dispatched.

On 8/3/17, the Rain-4-Rent and COMB pumps were turned off and the Stilling Basin began to refill on its own (spring and seep flow). Staff estimated that the majority (roughly over 90%) of warm-water fish previously occupying the Stilling Basin had been captured, enumerated, and removed. This was the first time the Stilling Basin had been dewatered and fish removed in 20 years. The previous (and only) drawdown and fish removal operation occurred in April of 1997.

As previously stated, the goal of this management effort was to bring the Stilling Basin down to a manageable depth in order to seine the majority of fish out of the pool, with the secondary goal of completely dewatering the habitat to ensure 100% sterilization of non-native fish species. The operation was highly successful in removing the majority of fish. However, seepage and spring flow coming into the Stilling Basin and the configuration of the pumping system prevented the habitat from being completely drawn down and fish totally removed from the Stilling Basin. A full report was submitted by COMB-FD to Reclamation and NMFS (COMB, 2017c).

To further substantiate the positive results of the fish removal effort, on 8/21/17 a WR 89-18 Release commenced and COMB-FD staff deployed a seine at the tail-out of the

Stilling Basin to capture any fish species potentially moving downstream during the onset of the release (a common occurrence during past releases). No fish were observed or captured during the onset of the WY2017 release, indicating a noticeable difference in the warm-water fish population and dispersal coming from the Stilling Basin.

4.8. WR 89-18 Release Trapping

A single trapping location at the tail-out of the Long Pool was operated during the first 3 weeks of the 2017 WR 89-18 release, from 8/21/17 to 9/15/17 (Figure 78). The trap functioned over the full range of release flows (with maximum flow of 182 cfs), in order to capture non-native species and to prevent *O. mykiss* from moving out of the Long Pool habitat. Traps were checked every 4-6 hours throughout the entire deployment period when traps were open, commensurate with the standard routine wintertime trapping program in the LSYR basin. After consultation with NMFS and Reclamation, the traps were blocked on 9/15/17 due to no fish being captured during the initial three week trapping operation. Leaving the traps blocked kept any potential *O. mykiss* from moving downstream throughout the remainder of the release. Although no fish species were captured, 26 bullfrog tadpoles and 4 pond turtles were captured in the downstream trap. In the upstream trap, 10 bullfrog tadpoles were captured. Since bullfrogs are a known invasive species, all the captured tadpoles were dispatched on site. COMB-FD staff cleaned and maintained the block traps throughout the entire WR 89-18 release. Debris loads were cleared during each site visit and all paneling and traps were inspected for holes or gaps that could have allowed fish passage. One day after the 2017 WR 89-18 release ended, the COMB-FD removed the traps and all associated paneling from the Long Pool. Further detail of the 2017 WR 89-18, see the full report for RPM 6 (USBR, 2018).

The fact that no invasive fish species were captured the first 3 weeks of the 2017 WR 89-18 release is an indication that the Stilling Basin dewatering and non-native fish removal effort was successful and is helping to control the number of non-native fish in the LSYR, both within the Stilling Basin and downstream. The end result has been and will be beneficial for *O. mykiss* within the LSYR watershed.

4.9. Whittier Fire July 2017

The Whittier Fire was started on 7/8/17 by a vehicle driving through tall grass near Camp Whittier and was fully contained on 10/5/17. The fire burned approximately 18,430 acres in and around Lake Cachuma including 40% (819 acres) of the 2,010 acre Hilton Creek watershed (Figures 79-80). Of those 819 acres burnt in Hilton Creek, 166 acres (8%) were classified as high intensity burn severity, 461 acres (23%) classified as moderate intensity, and 192 acres (10%) classified as low intensity (USDA-Forest Service, 2017). Characteristic of chaparral vegetation communities, soils in the burned area are naturally hydrophobic. Fire-enhanced hydrophobic strength, in the form of thickening and deepening of the hydrophobic layer was observed in approximately 70% of the observed fire area. Soils that burned with moderate and high burn severity resulted in near complete vegetation canopy removal, leaving surface rock as the only effective ground cover. Of particular concern to *O. mykiss* inhabiting Hilton Creek is the fact that the majority of the burn scar is focused along the upper portions of the Hilton Creek watershed, meaning that there is an increased potential for significant debris flows and sediment movement from future storm events due to the very steep nature of the upper watershed. Storm events during the fall of 2017 and winter/spring of 2018 bear watching as moderate to high intensity storms may result in poor water quality, high stream sediment loads, and habitat alterations for *O. mykiss* in Hilton Creek and locations in the LSYR mainstem immediately downstream of the confluence.

4.10. Status of WY2016 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 WY2016 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 whenever possible.

- Encourage Reclamation to improve its system operation for delivering lake water to Hilton Creek with one or a combination of the HCWS, HCEBS, Hilton Creek Water Tanks, and Stilling Basin submersible pumps to provide continuous flow to Hilton Creek without interruption.
    - Status: This recommendation is being followed and is ongoing.

- 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.

- 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.
    - 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 with 2 fish passage projects tentatively scheduled for next fall.

- 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.
    - Status: This recommendation is being followed but further attention is needed specifically in analysis of individual scales and comparison to the trapping results.

- Continue working with the USGS, 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 recommendation is being followed and is ongoing.

- 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.
    - Status: This recommendation is being followed and is ongoing.

- 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;.
    - Status: This recommendation was completed and executed by COMB with approval from Reclamation, NMFS and CDFW.

- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin.
    - Status: This continues to be a good recommendation and has not been addressed.

- 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.

- o Status: Collaborative relationships continue to be developed between COMB-FD staff and fisheries biologists working on the Ventura River, Santa Clara River, Carpinteria Creek, Topanga Creek, and Malibu Creek.

5. Conclusions and Recommendations

WY2017 was the first wet year after 5 consecutive years of dry conditions with 25.48 inches of rainfall recorded at Bradbury Dam. Lake Cachuma did not spill but it did go from 7.35% to 42.81% of capacity from the beginning to the end of the water year. The higher lake level took the lake operations out of critical drought and allowed for gravity flow through the HCEBS at a minimum of 2 cfs to Hilton Creek at the LRP from 3/23/17 onward. BiOp target flows were also resumed to the Hwy 154 Bridge of 2.5 cfs. The lagoon did breach providing ocean connectivity but no anadromous fish were observed entering or within the Santa Ynez River basin.

Limited spawning was observed with only 6 redds documented across the entire LSYR basin. Spring, summer, and fall snorkel surveys did not record many *O. mykiss* in the basin, which provided further evidence of the toll on the basin's *O. mykiss* population from the previous 5 years of drought and very low flow conditions. The passage potential for migrating fish and dry season rearing water quality conditions during WY2017 were influenced by depleted groundwater storage causing rapid decay of stormflow hydrographs and limited baseflow conditions between storms and during the following dry season. Several years of wet conditions are needed for the basin to fully recover and sustain streamflow over extended periods of time.

Monitoring tributary and LSYR mainstem *O. mykiss* populations has resulted in observations that fluctuate by water year type, instream flows, spawning success, and oversummer rearing 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 WY2016 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 WY2017 onward:

- ontinue 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;
- Collaborate with Reclamation on best management practices in Hilton Creek to address the potential for sediment-laden runoff from the Whittier Fire burn area;

- 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;
- Work with Reclamation and NMFS to develop a gravel augmentation program for Hilton Creek for spawning fish, given the long standing observation of a gravel starved system;
- Encourage Reclamation to improve its system operation for delivering lake water to Hilton Creek with one or a combination of the HCWS, HCEBS, Hilton Creek Water Tanks, and Stilling Basin submersible pumps to provide continuous flow to Hilton Creek without interruption;
- Continue to encourage Reclamation to gather continuous data on the water temperature discharged from the Outlet Works of Bradbury Dam to the LSYR to monitor BiOp compliance of a maximum of 18 ^{o}C of that discharge water;
- 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;
- 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 the collaboration with CDFW regarding operation of their Dual-Frequency Identification Sonar (DIDSON) in Salsipuedes Creek;
- 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;
- 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;
- 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;
- 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;
- 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.

6. References

AMC, 2008. Upper Basin Study - Habitat Synthesis. Adaptive Management Committee (AMC).

AMC, 2009. Summary and analysis of annual fishery monitoring in the Lower Santa Ynez River, 1993-2004. Prepared for the National Marine Fisheries Service by the Santa Ynez River Adaptive Management Committee (AMC).

Baker, B. W. and E. P. Hill, 2003. Beaver (*Castor canadensis*), The Johns Hopkins University Press, Baltimore, Maryland, USA.

Brege, B. A., R. F. Absolon and R. J. Graves, 1996. Seasonal and diel passage of juvenile salmonids at John Day Dam on the Columbia River. North American Journal of Fisheries Management, 16 (3): 659-665.

CDFG, 2005. M112 American Beaver (*Castor canadensis*). California Wildlife Habitat Relationships (CWHR) System Version 8.1, California Department of Fish and Game, California Interagency Wildlife Task Group, Sacramento, CA.

COMB, 2013. 2011 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, 2016. 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, 2017a. Biological Report Associated with the 30-inch Valve Reinstallation. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017b. Hilton Creek January Storm Events Report. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017c. Stilling Basin Dewatering and Fish Removal below Bradbury Dam on the Lower Santa Ynez River. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017d. 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.

COMB, 2019. WY2016 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.

DeVries, P., 2013a. Evaluation of water temperature and dissolved oxygen impacts of water rights releases and habitat flows on steelhead trout in the Santa Ynez River. R2 Resource Consultants, Inc.

DeVries, P., 2013b. Identification of water temperature and dissolved oxygen criteria applicable to assessing effects of water rights and habitat flow releases on steelhead trout in the Santa Ynez River. R2 Resource Consultants, Inc.

Dolloff, C. A., D. G. Hankin and G. H. Reeves, 1993. Basinwide estimation of habitat and fish populations in streams. U.S. Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina.

Gregory, R. S. and C. D. Levings, 1998. Turbidity reduces predation on migrating juvenile pacific salmon. Transactions of the American Fisheries Society, 127: 275-285.

Hankin, D. G. and G. H. Reeves, 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences, 45: 834-844.

Hensley, A. L., 1946. A progress report on beaver management in California. California Fish and Game, 32 (2): 87-99.

Knutsen, C. J. and D. L. Ward, 1991. Behavior of juvenile salmonids migrating through the Willamette River near Portland, Oregon. Oregon Department of Fish and Wildlife, Portland, Oregon, 1-16.

Krcma, R. R. and R. F. Raleigh, 1970. Migration of juvenile salmon and trout into Brownlee Reservoir 1962-1965. Fishery Bulletin, 68: 203-217.

Lake, P. S., 2003. Ecological effects of perturbation by drought in flowing waterings. Freshwater Biology, 48: 1161-1172.

Mains, E. M. and J. M. Smith, 1964. The distribution, size, time and current preferences of seaward migrant chinook salmon in the Columbia and Snake rivers. Fisheries Research Papers, Washington Department of Fisheries, 2: 5-43.

Matthews, K. and N. Berg, 1997. Rainbow trout responses to water temperature and dissolved oxygen stress in two southern Californa stream pools. Journal of Fish Biology, 50: 40-67.

Meehan, W. R. and T. C. Bjornn, 1991. Salmonid distributions and life histories. Influences of forest and rangeland management on salmonid fishes and their habitats, American Fisheries Society Special Publication. 19**:** 47-82.

Molony, B., 2001. Environmental requirements and tolerances of rainbow trout (Oncorhynchus mykiss)
and brown trout (Salmo trutta) with special reference to Western Australia: a review. 130.

Moyle, P. B., 2002. Inland fishes of California, revised and expanded, University of California Press, Berkeley, CA.

Nielson, L. J., E. T. Lisle and V. Ozaki, 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society, 123: 613-626.

NMFS, 1997. Code of Federal Regulations, listing of Southern Steelhead 62 FR 43937, National Marine Fisheries Service.

NMFS, 2000. Cachuma Project Biological Opinion, U.S. Bureau of Reclamation operation and maintenance of the Cachuma Project on the Santa Ynez River in Santa Barbara County, California. National Marine Fisheries Service, Southwest Region.

NMFS, 2012. Final Southern California Steelhead Recovery Plan. National Marine Fisheries Service.

NOAA, 2005. Endangered and threatened species: designation of critical habitat for seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. Federal Register 70FR52488 - 52627, Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), http://www.nwr.noaa.gov/Publications/FR-Notices/2005/loader.cfm?csModule=security/getfile&pageid=33713.

SWRCB, 2011. Cachuma Project final environmental impact report on consideration of modifications to the U.S. Bureau of Reclamation's Water Rights Permits 11308 and 11310 (Applications 11331 and 11332) to protect public trust values and downstream Water Rights on the Santa Ynez River below Bradbury Dam (Final EIR). State Water Resources Control Board (SWRCB).

SYRCC and SYRTAC, 1997. Synthesis and analysis of information collected on the fishery resources and habitat conditions of the Lower Santa Ynez River: 1993-1996. Prepared in compliance with Provision 2.C of the 1996 Memorandum of Understanding for cooperation in research and fish maintenance - Santa Ynez River, Santa Ynez River Consensus Committee and Santa Ynez River Technical Advisory Committee.

SYRTAC, 2000. Lower Santa Ynez River Fish Management Plan. Santa Ynez River Technical Advisory Committee, prepared for the Santa Ynez River Consensus Committee, Santa Barbara, CA.

USBR, 1999. Biological assessment for Cachuma Project operations and the Lower Santa Ynez River. Prepared for the National Marine Fisheries Service, U.S. Bureau of Reclamation (USBR), Fresno, CA.

USBR, 2000. Revised Section 3 (Proposed Project) of the Biological Assessment for Cachuma Project Operations and the Lower Santa Ynez River. Prepared for the National Marine Fisheries Service, U.S. Bureau of Reclamation, Fresno, CA.

USBR, 2011. 2008 Annual monitoring report and trend analysis for 2005-2008. Prepared for the National Marine Fisheries Service by the Cachuma Operation and Maintenance Board for USBR, U.S. Bureau of Reclamation.

USBR, 2012. 2009 Annual monitoring report and trend analysis. Prepared for the National Marine Fisheries Service by the Cachuma Operation and Maintenance Board for USBR, U.S. Bureau of Reclamation.

USBR, 2013. 2010 Annual monitoring report and trend analysis. Prepared for the National Marine Fisheries Service by the Cachuma Operation and Maintenance Board for USBR, U. S. Bureau of Reclamation (USBR).

USBR, 2018. 2000 Cachuma Biological Opinion Reasonable and Prudent Measure 6 Monitoring Report Submittal on 2017 State Water Right 89-18 Releases - Cachuma Project. United States Bureau of Reclamation (USBR), prepared in collaboration with the Cachuma Operation and Maintenance Board Fisheries Division.

USDA-Forest Service, 2017. Draft Whittier Burned Area Report. US Department of Agriculture, https://www.countyofsb.org/ceo/asset.c/3417.

Villamagna, A. and B. Murphy, 2010. Ecological and socio-economic impacts of invasive water hyacinth (Eichhornia crassipes). Freshwater Biology.

WY2017 Annual Monitoring Summary
Results
Figures and Tables

3. Monitoring Results

Table 1: WY2000 to WY2017 rainfall at Bradbury Dam, reservoir conditions, passage supplementation, and water rights releases.

Water Year	Rainfall Bradbury* (in)	Year Type**	Spill	# of Spill Days	Reservoir Condition Storage (max) (af)	Elevation (max) (ft)	Passage Supplementation	Water Right Release
2000	21.50	Normal	Yes	26	192,948	750.83	No	Yes
2001	31.80	Wet	Yes	131	194,519	751.34	No	No
2002	8.80	Dry	No	0	173,308	744.99	No	Yes
2003	19.80	Normal	No	0	130,784	728.39	No	No
2004	10.60	Dry	No	0	115,342	721.47	No	Yes
2005	44.41	Wet	Yes	131	197,649	753.11	No	No
2006	24.50	Wet	Yes	54	197,775	753.15	Yes	No
2007	7.40	Dry	No	0	180,115	747.35	No	Yes
2008	22.59	Wet	Yes	53	196,365	752.70	No	No
2009	13.66	Dry	No	0	168,902	743.81	No	No
2010	23.92	Wet	No	0	178,075	747.05	Yes	Yes
2011	31.09	Wet	Yes	53	195,763	753.06	No	No
2012	12.69	Dry	No	0	180,986	748.06	No	No
2013	7.57	Dry	No	0	142,970	733.92	No	Yes
2014	9.96	Dry	No	0	91,681	710.00	No	Yes
2015	9.38	Dry	No	0	61,107	691.17	No	Yes
2016	11.45	Dry	No	0	32,989	669.66	No	Yes
2017	25.48	Wet	No	0	99,152	715.25	No	Yes

* Bradbury Dam rainfall (Cachuma) period of record = 65 years (1953-2017) with an average rainfall of 20.0 inches.

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

Table 2: WY2017 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 (WY2017)
	(#)	(date)	(years)	(in)	(in)	(WY)	(in)	(WY)	(in)
Lompoc	439	1955	63	14.59	5.31	2007	34.42	1983	22.19
Buellton	233	1955	63	16.76	5.87	2014	41.56	1998	20.16
Solvang	393	1965	53	18.45	6.47	2007	43.87	1998	21.55
Santa Ynez	218	1951	67	15.80	6.58	2007	36.36	1998	20.61
Cachuma*	USBR	1953	65	20.00	7.33	2007	53.37	1998	25.48
Gibraltar	230	1920	98	26.36	8.50	2013	73.12	1998	31.15
Jameson	232	1926	92	28.85	8.50	2007	79.52	1969	30.31

* Bradbury Dam USBR rainfall.

Table 3: (a) Storm events greater than 0.1 inches with associated flow conditions (> 10 cfs) at Salsipuedes Creek (SC) and the Los Laureles (Los L) gauging stations and (b) monthly rainfall totals at Bradbury Dam during WY2017. 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	10/16/2016	0.31	No	No
2	10/28/2016	0.77	No	No
3	11/21/2016	0.54	No	No
4	11/27/2016	0.67	No	No
5	12/9/2016	0.17	No	No
6	12/16/2016	0.66	No	No
7	12/24/2016	1.01	No	No
8	1/1/2017	0.17	No	No
9	1/5/2017	0.25	No	No
10	1/7/2017	1.65	No	Yes
11	1/11/2017	1.64	No	Yes
12	1/19/2017	5.15	Yes	Yes
13	2/3/2017	0.23	No	Yes
14	2/6/2017	1.12	Yes	Yes
15	2/10/2017	0.88	Yes	Yes
16	2/17/2017	8.14	Yes	Yes
17	2/26/2017	0.13	Yes	Yes
18	3/6/2017	0.21	Yes	Yes
19	3/21/2017	0.60	No	Yes
20	5/7/2017	0.30	No	No
21	9/11/2017	0.45	No	No

(b)

Month	Rain (in.)
Oct-16	1.13
Nov-16	1.21
Dec-16	1.92
Jan-17	8.81
Feb-17	10.61
Mar-17	0.83
Apr-17	0.20
May-17	0.32
Jun-17	0.00
Jul-17	0.00
Aug-17	0.00
Sep-17	0.45
Total:	**25.48**

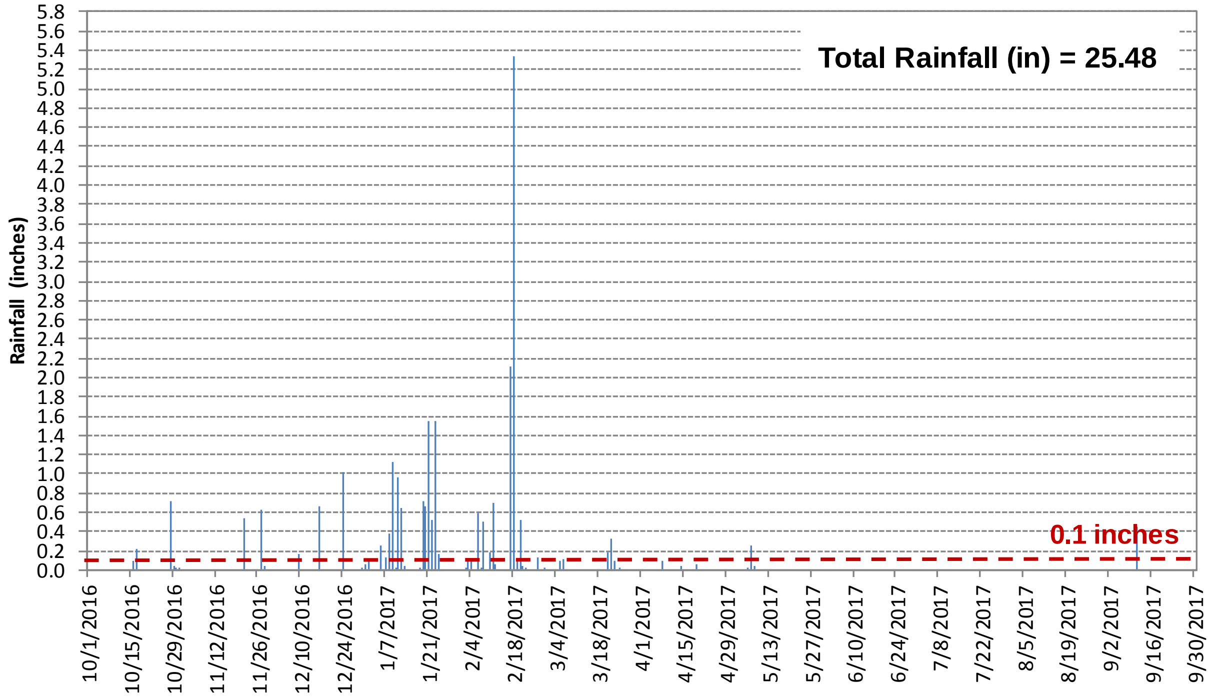


Figure 1: Rainfall in WY2017 recorded at Bradbury Dam (USBR).

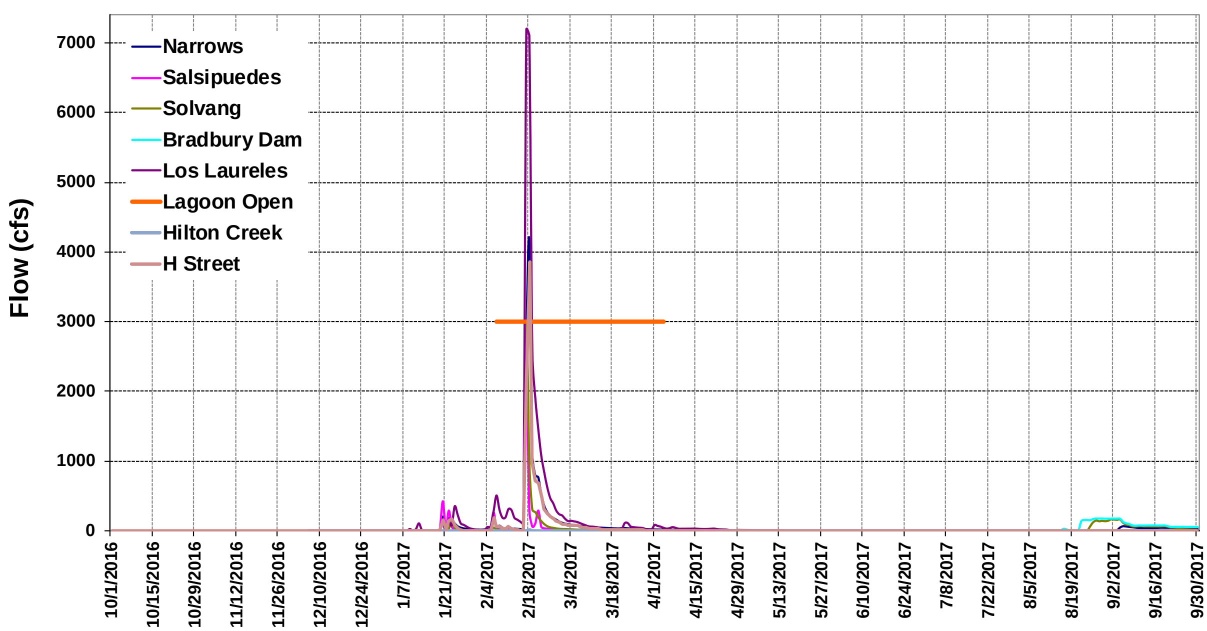


Figure 2: Santa Ynez River discharge and the period when the Santa Ynez River lagoon was open in WY2017.

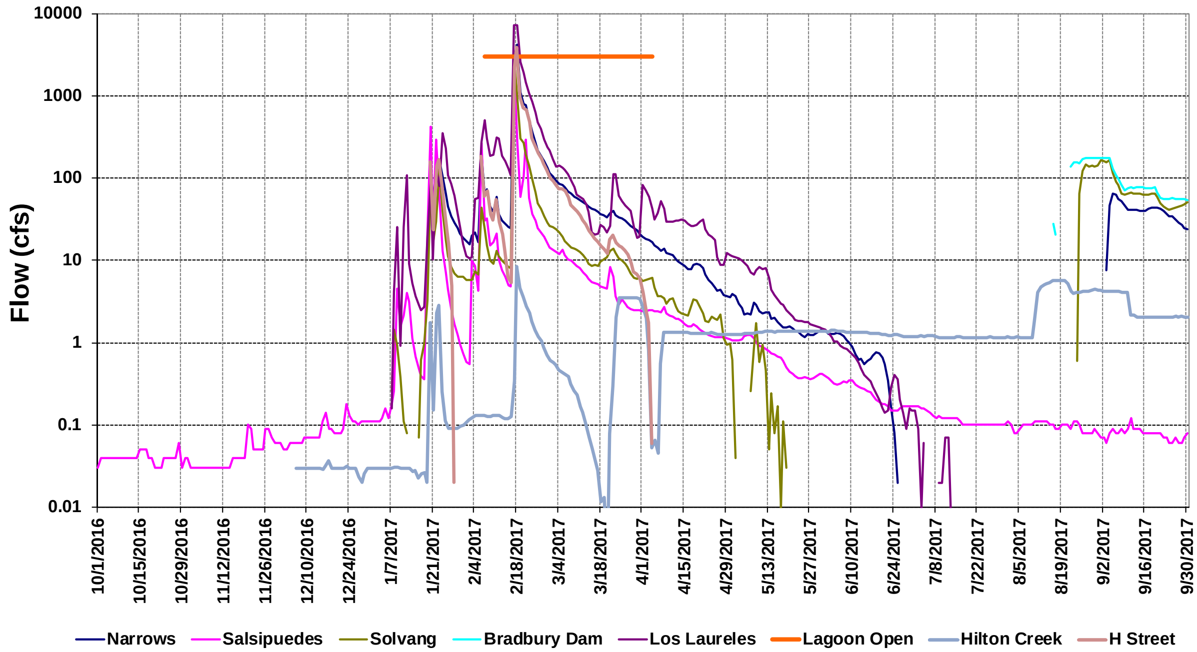
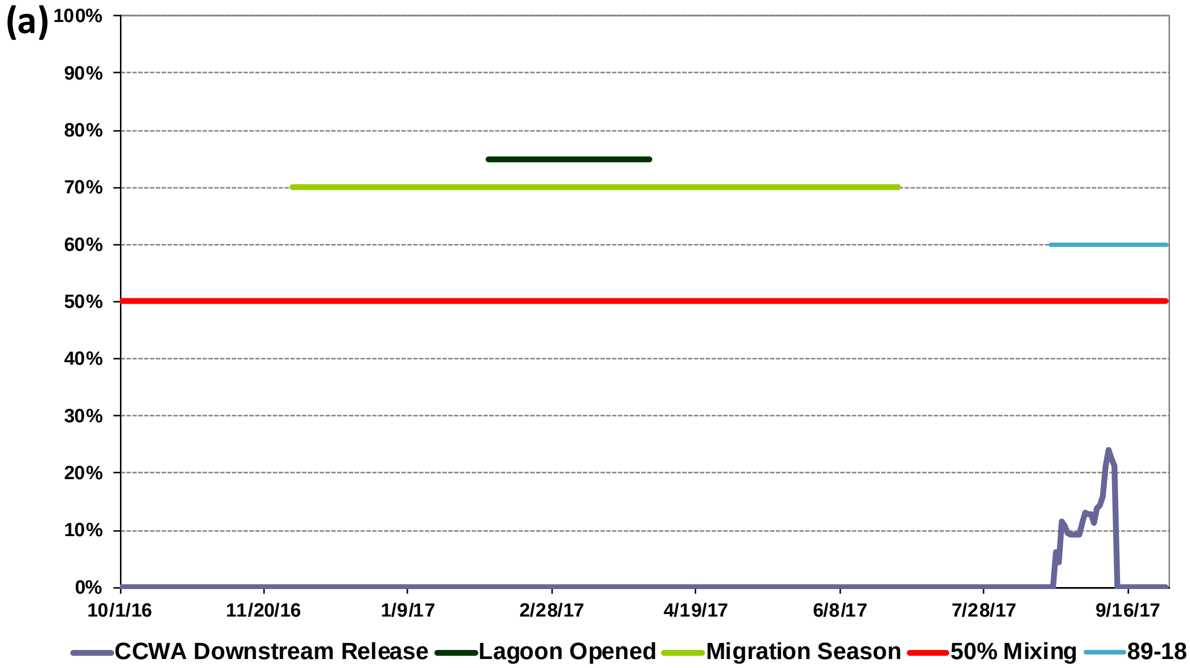


Figure 3: USGS average daily discharge at the LSYR mainstem USGS gauging stations at Los Laureles, Bradbury Dam, Alisal Bridge (Solvang), Salsipuedes Creek, the Narrows and H Street (Lompoc) during WY2017.

Table 4: Ocean connectivity, lagoon status and number of days during the migration season from WY2001 to WY2017.

Water	Year	Ocean	Lagoon Status			# of Days Open in
Year	**Type**	**Connectivity**	**Open**	**Closed**	**# of Days**	**Migration Season***
2001	Wet	Yes	1/11/01	6/5/01	146	141
2002	Dry	No	-	-	0	0
2003	Normal	Yes	12/20/02	5/14/03	146	134
2004	Dry	Yes	2/25/04	2/29/04	5	5
2005	Wet	Yes	12/27/04	7/21/05	207	151
2006	Wet	Yes	3/1/06	-	214	92
2007	Dry	Yes	-	11/21/06	52	0
2008	Wet	Yes	1/6/08	5/19/08	135	135
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	12/20/10	-	285	151
2012	Dry	Yes	-	5/17/12**	80	34
2013	Dry	No	-	-	0	0
2014	Dry	No	-	-	0	0
2015	Dry	No	-	-	0	0
2016	Dry	No	-	-	0	0
2017	Wet	Yes	2/7/17	4/4/17	57	57

*Migration Season is January through May.
**Lagoon opened and closed several times during the water year.



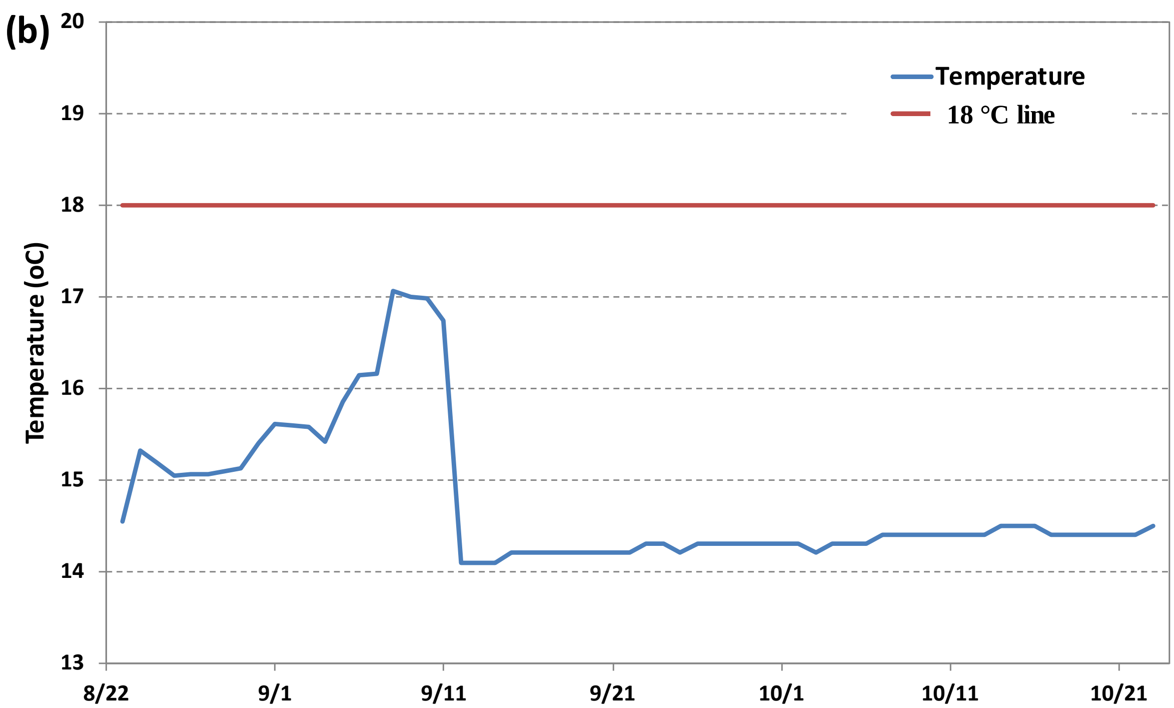


Figure 4: SWP releases into the LSYR regarding BiOp compliance with (a) the 50-50 mix rule showing the percentage of CCWA water being released from Bradbury Dam downstream to the Long Pool and (b) the 18 ^{o}C rule for the water temperature being released from the Outlet Works.

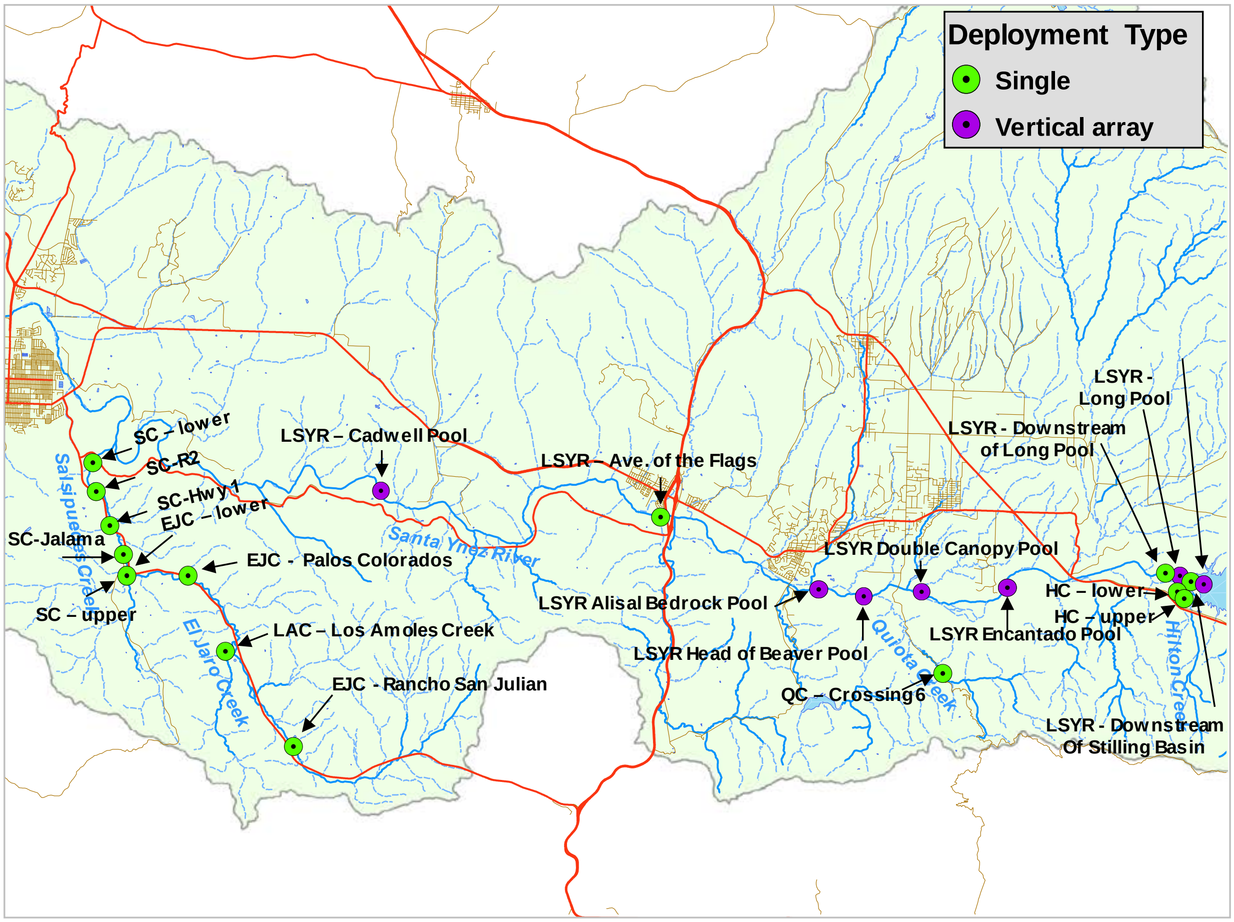


Figure 5: Thermograph single and vertical array deployment locations in WY2017 within the LSYR and its tributaries (HC – Hilton Creek, QC – Quiota Creek, SC – Salsipuedes Creek, and EJC – El Jaro Creek); the El Jaro Creek site and upper Salsipuedes Creek sites are very close together with overlapping symbols.

Table 5: 2017 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)
Mainstem	Stilling Basin Wall	LSYR-0.01	Vertical Array	6/6/17	11/21/2017	165
	LSYR - D/s of Stilling Basin	LSYR-0.25	Single	Not Deployed - habitat dry prior to WR89-18		
	LSYR - Long Pool	LSYR-0.51	Vertical Array	6/24/17	11/21/2017	147
	LSYR - D/s of Long Pool	LSYR-0.68	Single	5/9/17	11/20/2017	191
	LSYR - Encantado Pool	LSYR-4.95	Vertical Array	Not Deployed - habitat dry prior to WR89-18		
	LSYR - Double Canopy	LSYR-7.65	Vertical Array	6/6/2017	11/20/2017	164
	LSYR - Head of Beaver	LSYR-8.7	Vertical Array	6/6/2017	11/21/2017	165
	LSYR - Alisal Bedrock Pool	LSYR-10.2	Vertical Array	6/6/2017	11/20/2017	164
	LSYR - Avenue of the Flags	LSYR-13.9	Single	5/15/2017	11/20/2017	185
	LSYR - Cadwell Pool	LSYR-22.68	Vertical Array	6/1/2017	11/17/2017	166
Tributaries	Hilton Creek (HC)-lower	HC-0.12	Single	5/9/2017	11/20/2017	191
	HC-upper	HC-0.54	Single	5/9/2017	9/11/2017	122
	Quiota Creek (QC)-Crossing 6	QC-2.66	Single	5/9/2017	9/25/2017	136
	Salsipuedes Creek (SC)-lower-Reach 1	SC-0.77	Single	5/15/2017	11/17/2017	182
	SC-Reach 2-Bedrock Section	SC-2.2	Single	5/10/2017	11/17/2017	187
	SC-Reach 4-Hwy 1 Bridge	SC-3.0	Single	5/15/2017	11/17/2017	182
	SC-Reach 5-Jalama Bridge	SC-3.5	Single	5/10/2017	11/17/2017	187
	SC-upper at El Jaro confluence	SC-3.8	Single	5/10/2017	11/30/2017	200
	El Jaro Creek (EJC)-Lower-Confluence	EJC-3.81	Single	5/10/2017	11/30/2017	200
	EJC-Palos Colorados	EJC-5.4	Single	5/15/2017	11/17/2017	182
	EJC-Rancho San Julian Bridge	EJC-10.82	Single	5/15/2017	8/21/2017	96
	Los Amoles Creek (LAC)-Creek Crossing	LAC-7.0	Single	5/15/2017	11/17/2017	182

*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 Fish Species*: Spring	Summer	Fall
LSYR Mainstem:						
Reach 1	Hwy 154	Stilling Basin	LSYR-0.2	B, C	O, B, S, C	C
		Long Pool	LSYR-0.51		n/s	n/s
		Downstream of Long Pool	LSYR-0.62		n/s	B
Reach 2	Refugio	Encantado	LSYR-4.95	dry		
		Corner Scour	LSYR-5.9	dry	B	B
		Double Canopy Pool	LSYR-7.65	C	C	B, C
	Alisal	Car Pool	LSYR-7.8	B	B	B
		Quiota Confluence Pool	LSYR-8.2			
		Head of Beaver Pool	LSYR-8.7			
		Rip-Rap Pool	LSYR-10.49	S	B	B, S
Reach 3	Ave. of the Flags	Ave. of the Flags (HWY 101)	LSYR-13.9			
	State Pipeline	Canoe Pool	LSYR-16.66	B, S, C	B, C	B, C
	Cadwell	Cadwell Pool	LSYR-22.68	B, C	B, C	B, C
Tributaries:						
Hilton	Reaches 1-5			O	O	ns
Quiota	Crossings 1-9					
	Upstream of Crossing 9			O	O	O
Salsipuedes	Reaches 1-4			O	O, S	O, S
	Reach 5					
El Jaro	Upstream of Confluence				Dry	

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

n/s - not snorkeled due to turbid conditions or low water level.

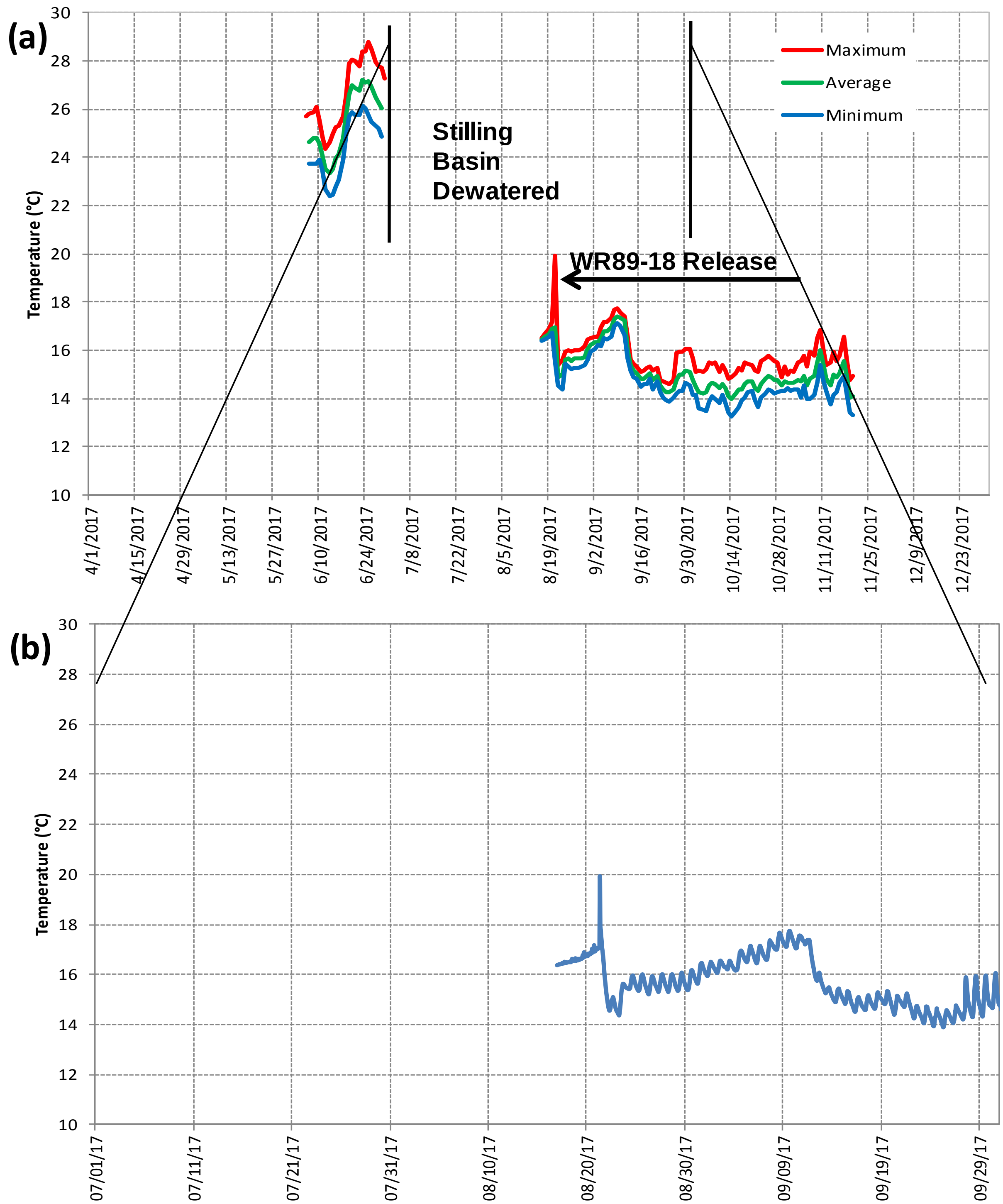


Figure 6: 2017 LSYR-0.01 (Stilling Basin parapet wall) surface (1 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of 7/1/17-10/1/17; the Stilling Basin was dewatered from 6/30/17 to 8/16/17 and the WR 89-18 release began on 8/21/17.

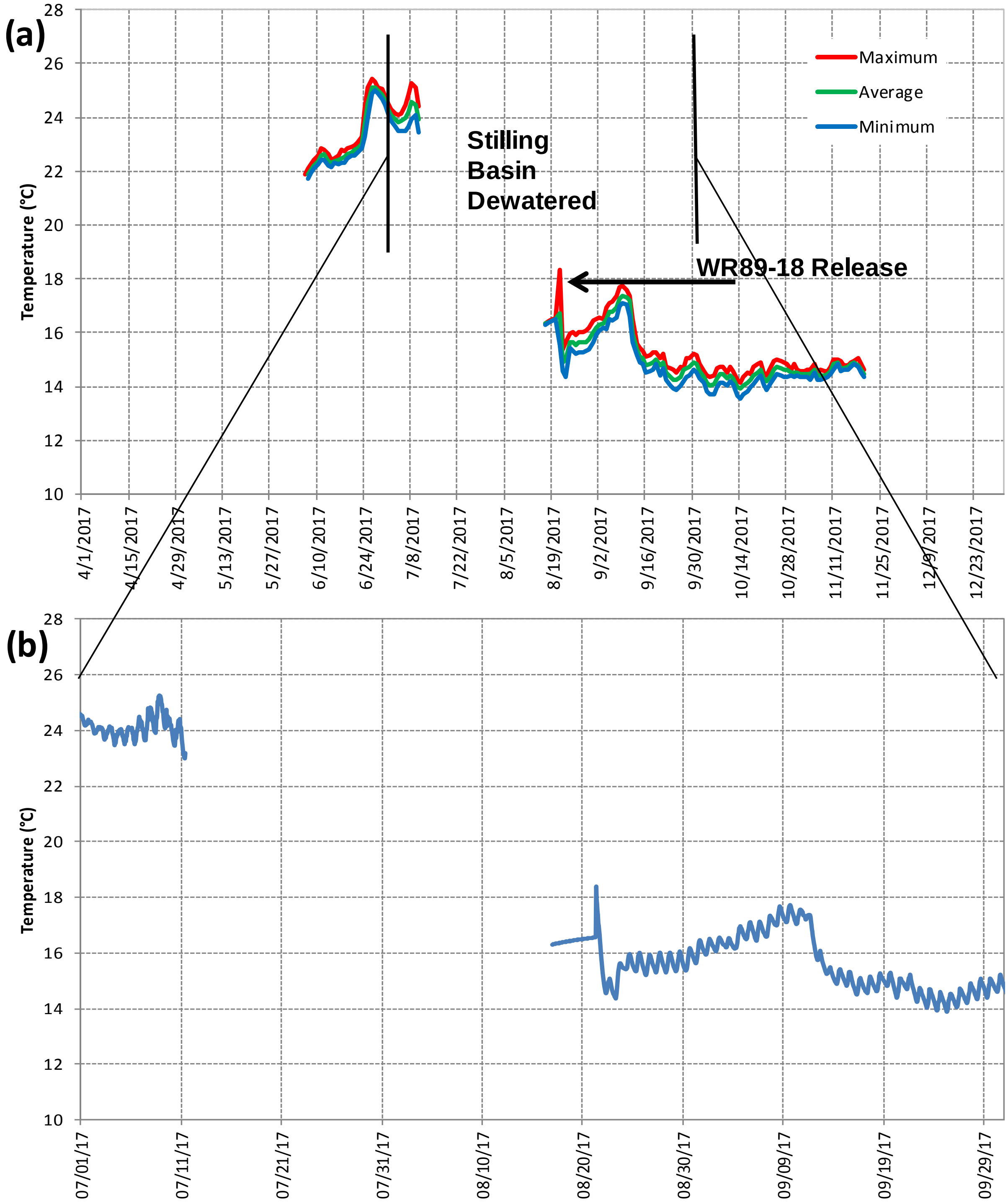


Figure 7: 2017 LSYR-0.01 (Stilling Basin parapet wall) middle (14 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of 7/1/17-10/1/17; the Stilling Basin was dewatered from 6/30/17 to 8/16/17 and the WR 89-18 release began on 8/21/17.

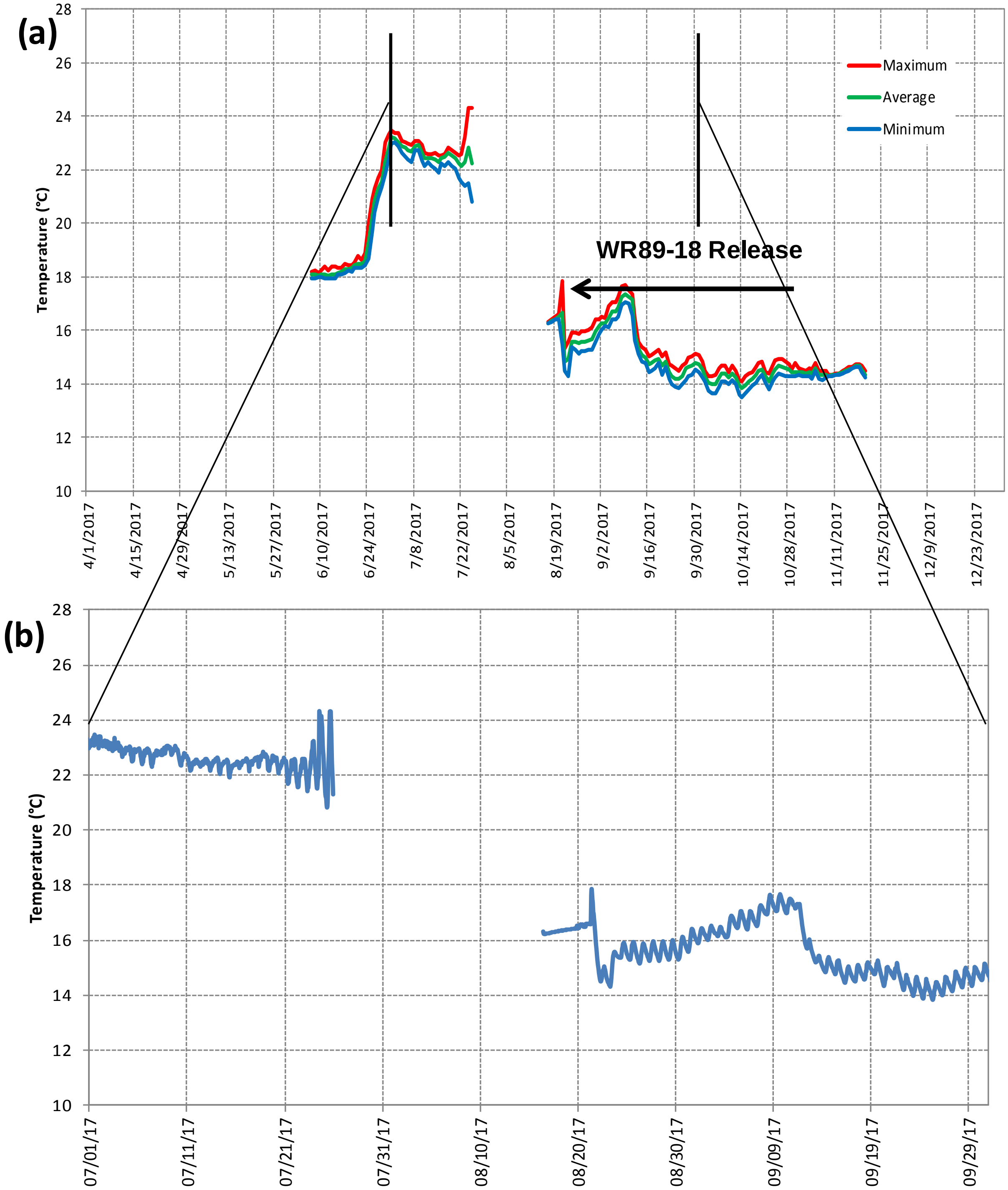


Figure 8: 2017 LSYR-0.01 (Stilling Basin parapet wall) bottom (28 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period of 7/1/17-10/1/17; the Stilling Basin was dewatered from 6/30/17 to 8/16/17 and the WR 89-18 release began on 8/21/17.

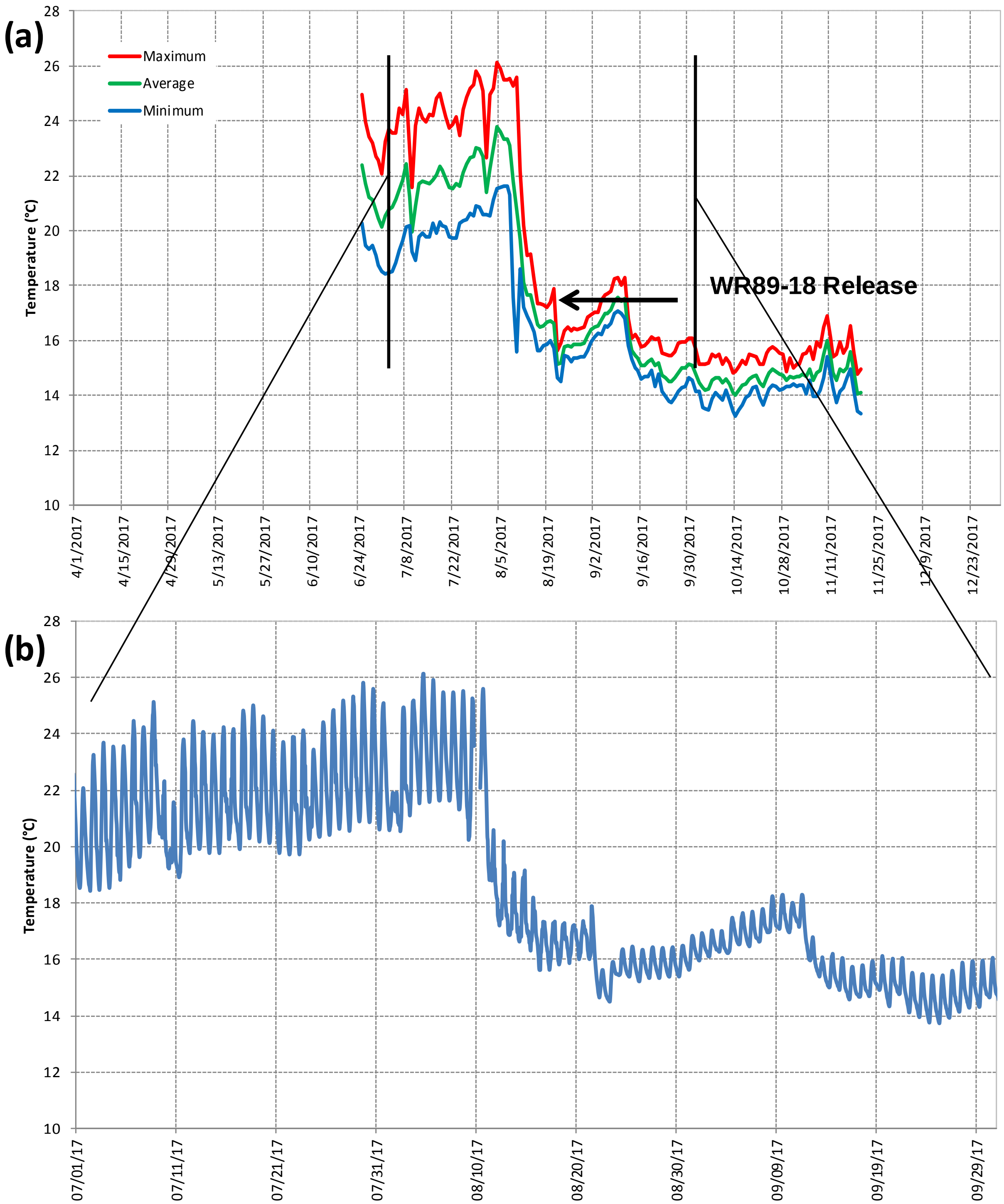


Figure 9: 2017 LSYR-0.51 (Long Pool) surface (1 foot) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/17–10/1/17.

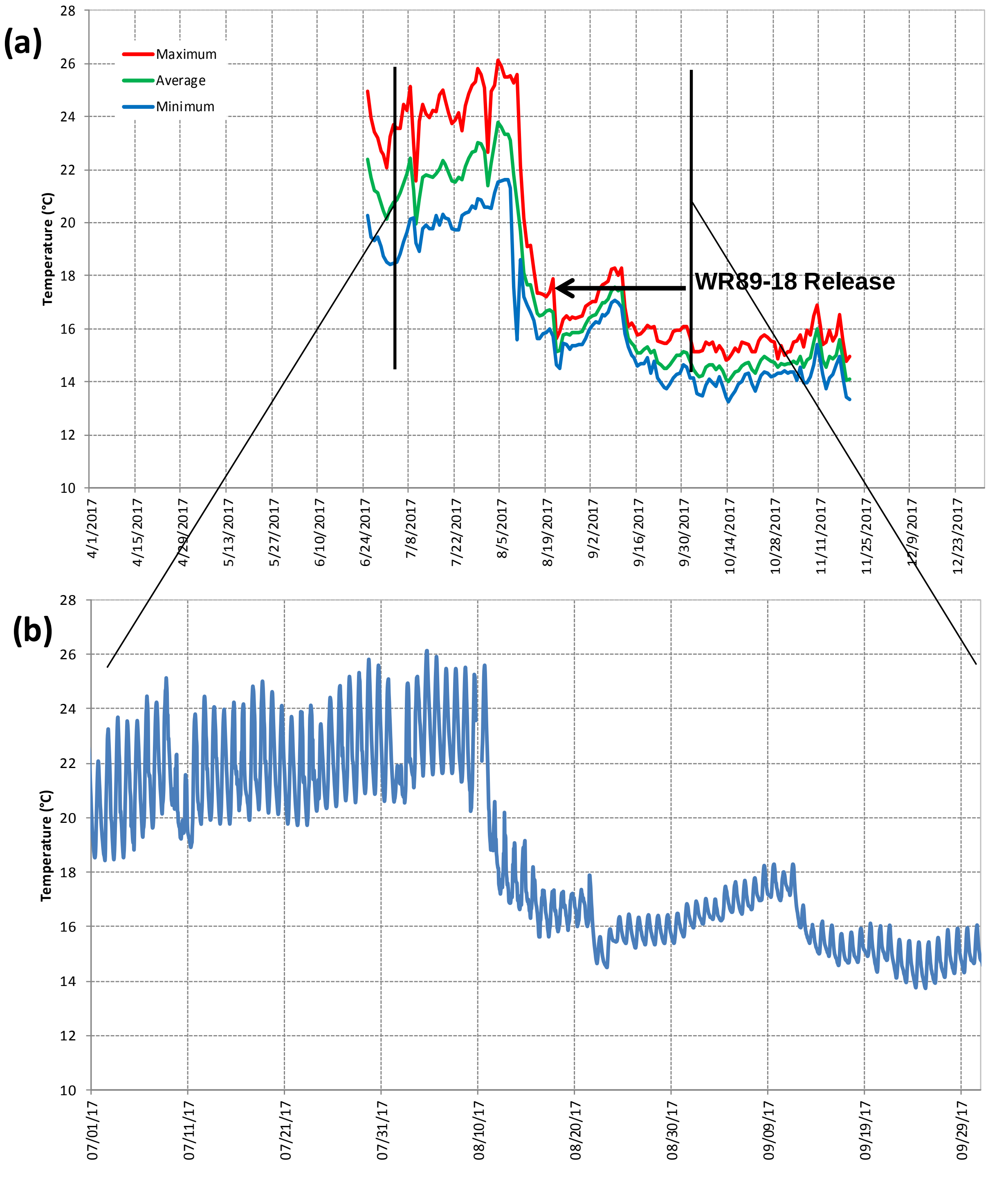


Figure 10: 2017 LSYR-0.51 (Long Pool) middle (4.5 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/17-10/1/17.

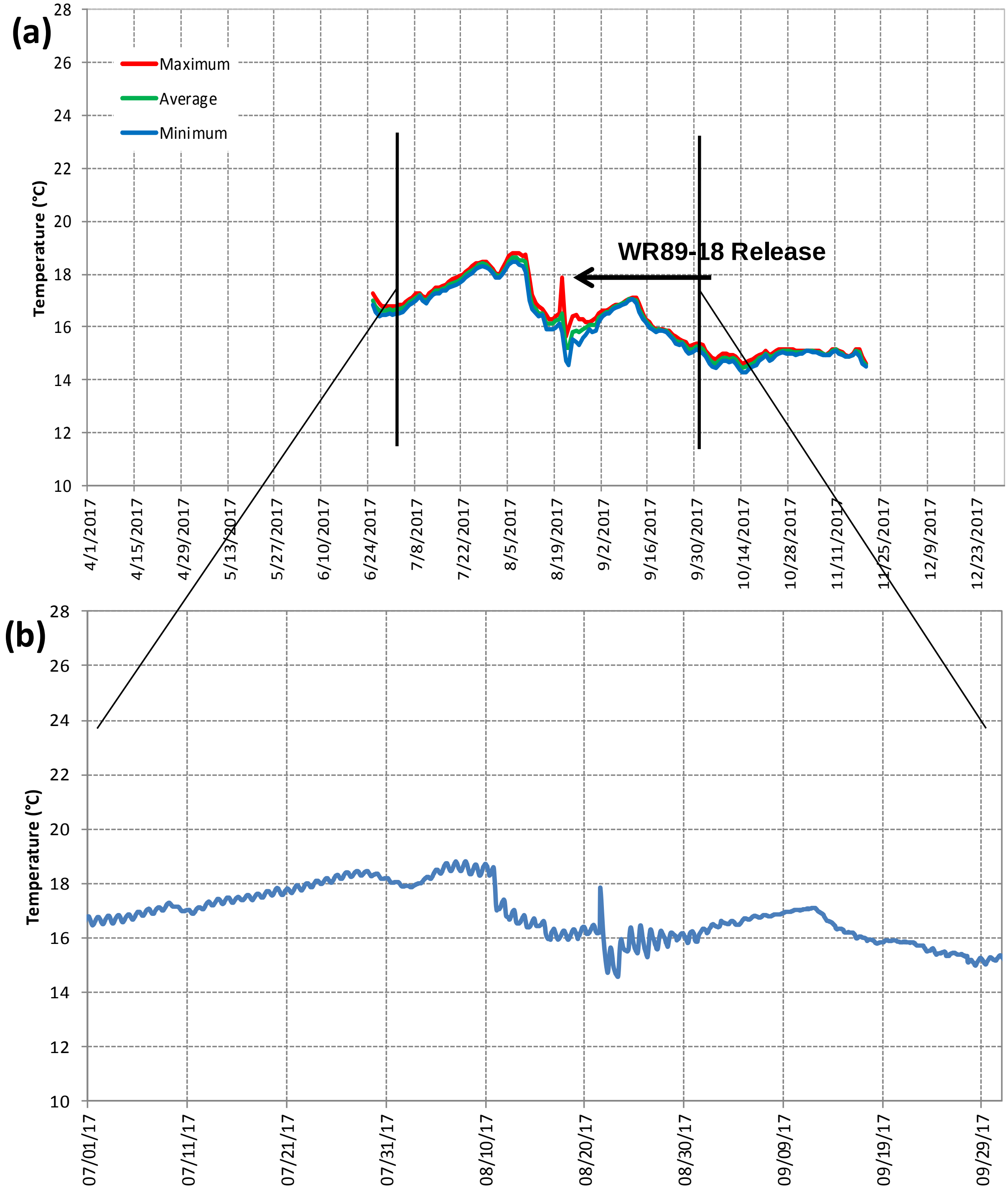


Figure 11: 2017 LSYR-0.51 (Long Pool) bottom (9 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/17-10/1/17.

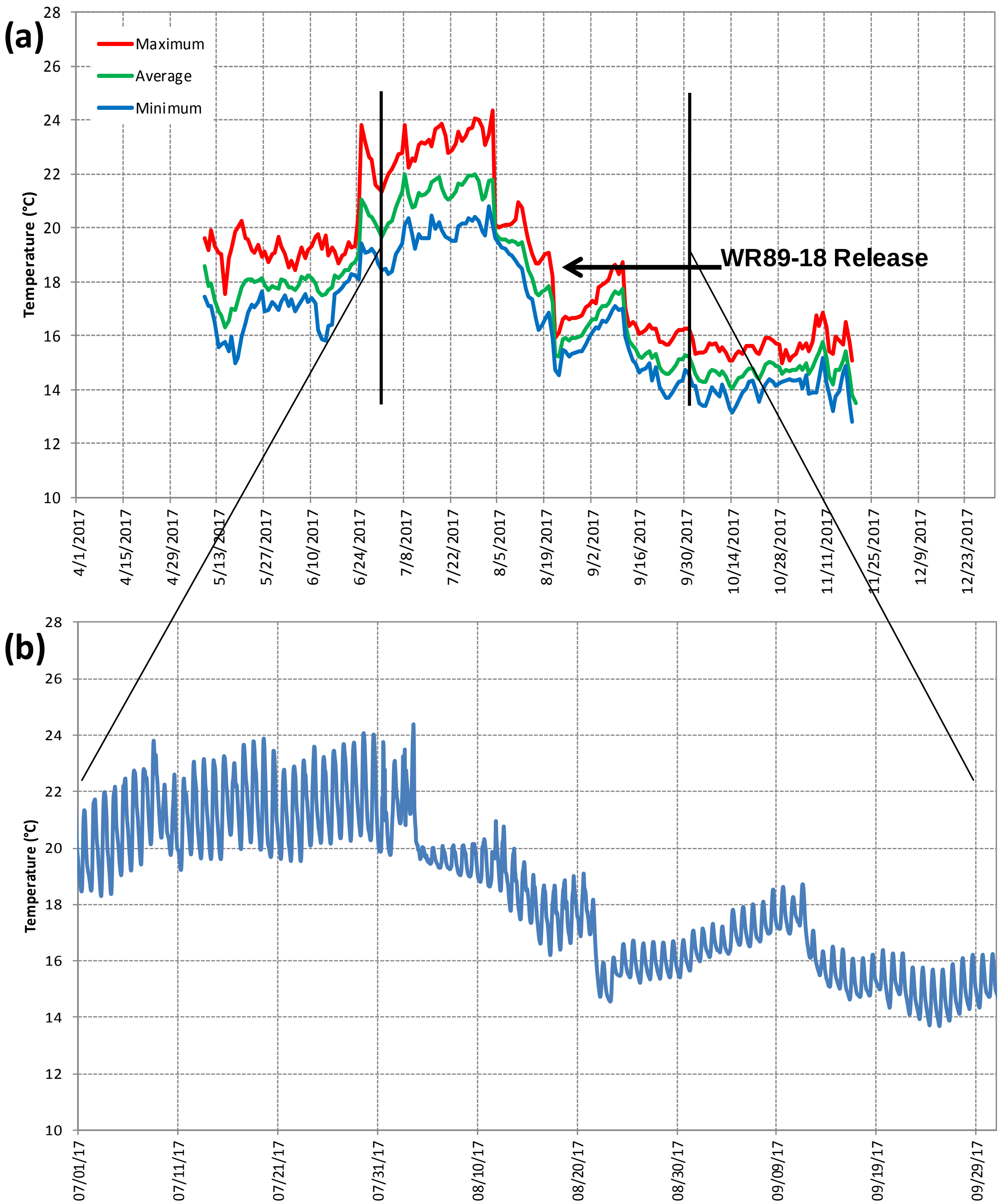


Figure 12: 2017 Reclamation property boundary at LSYR-0.68 (downstream of the Long Pool) bottom (2 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/17-10/1/17.

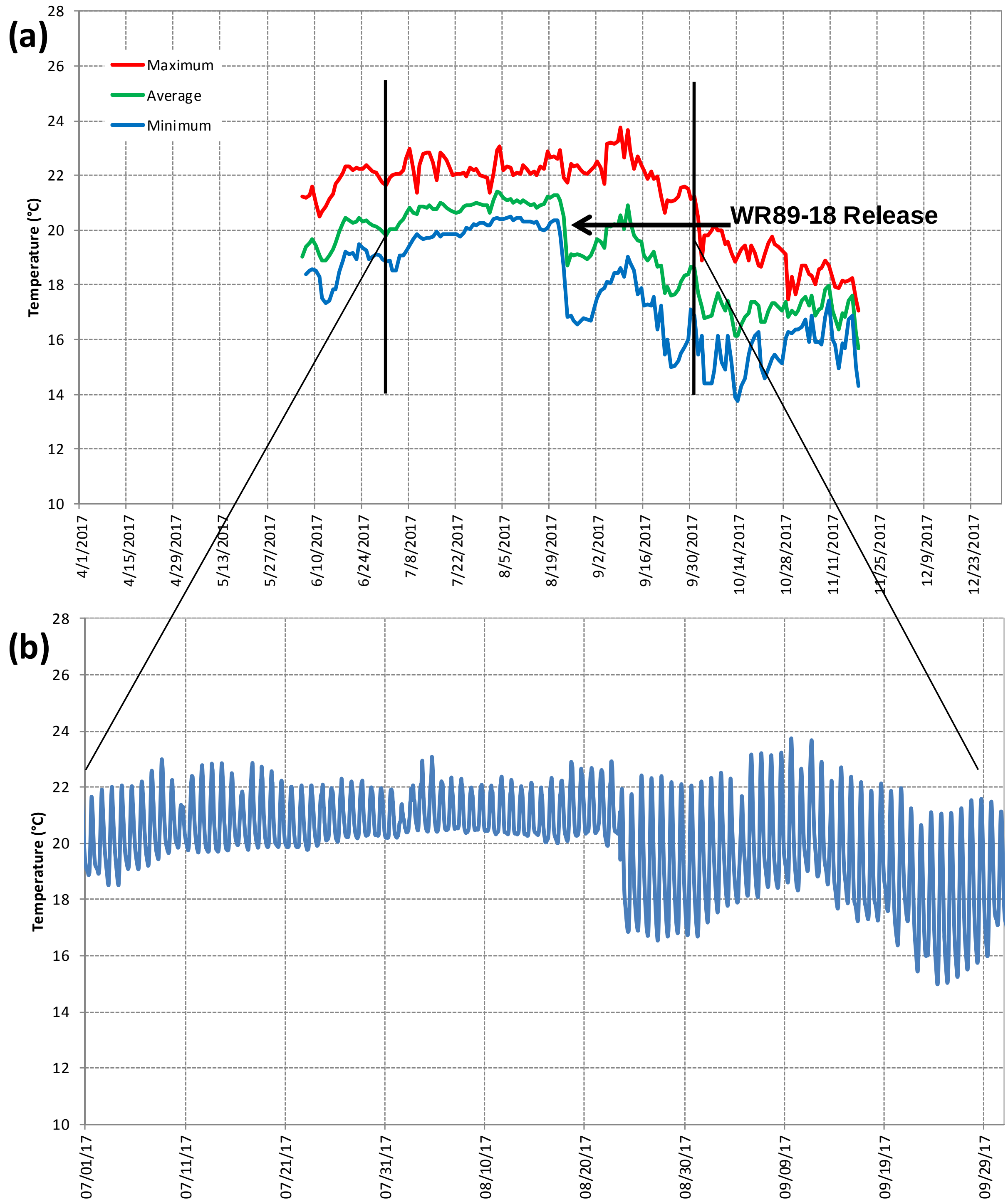


Figure 13: 2017 LSYR-7.65 (Double Canopy Pool) surface (1.0 foot) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

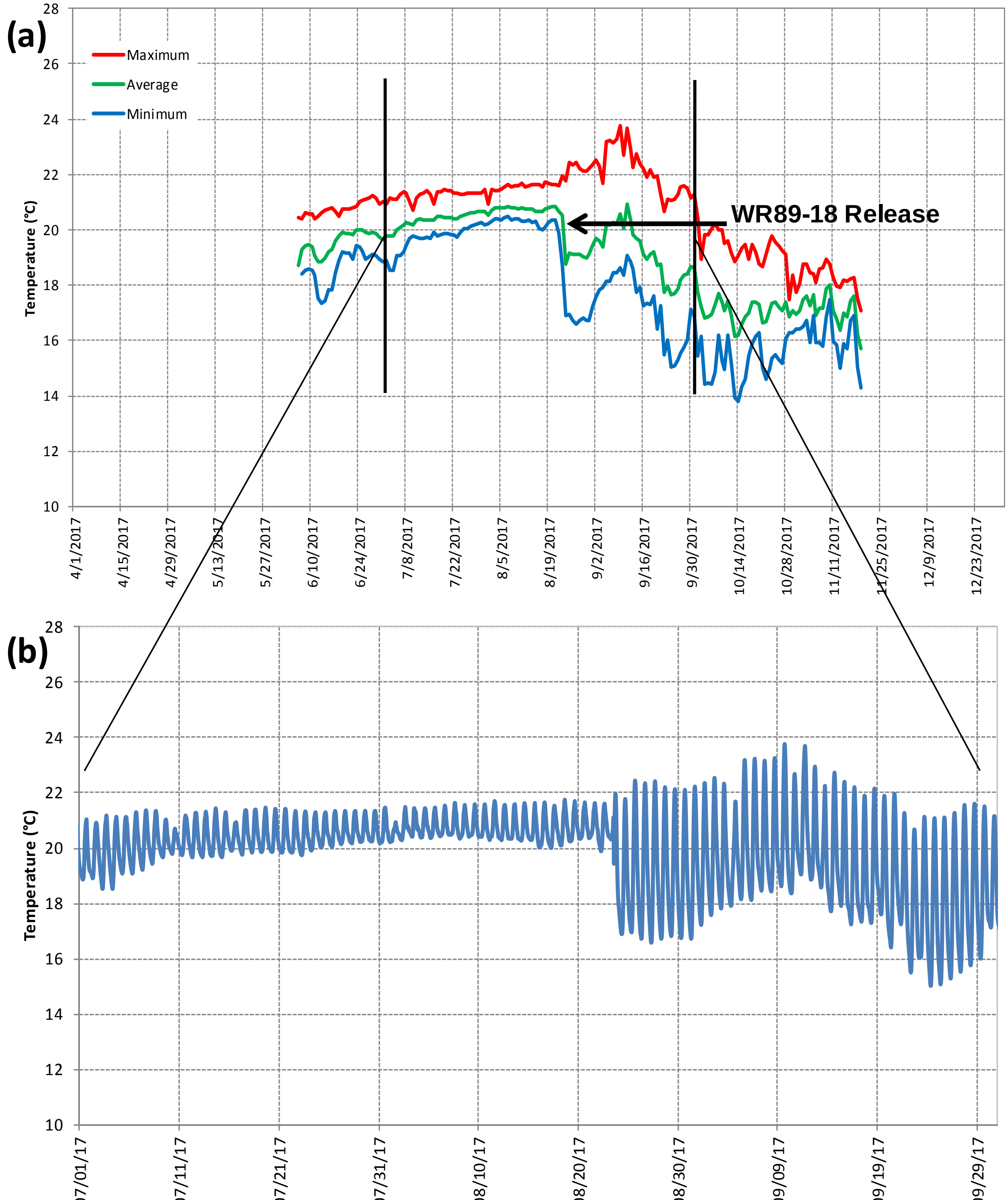


Figure 14: 2017 LSYR-7.65 (Double Canopy Pool) middle (2.0 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

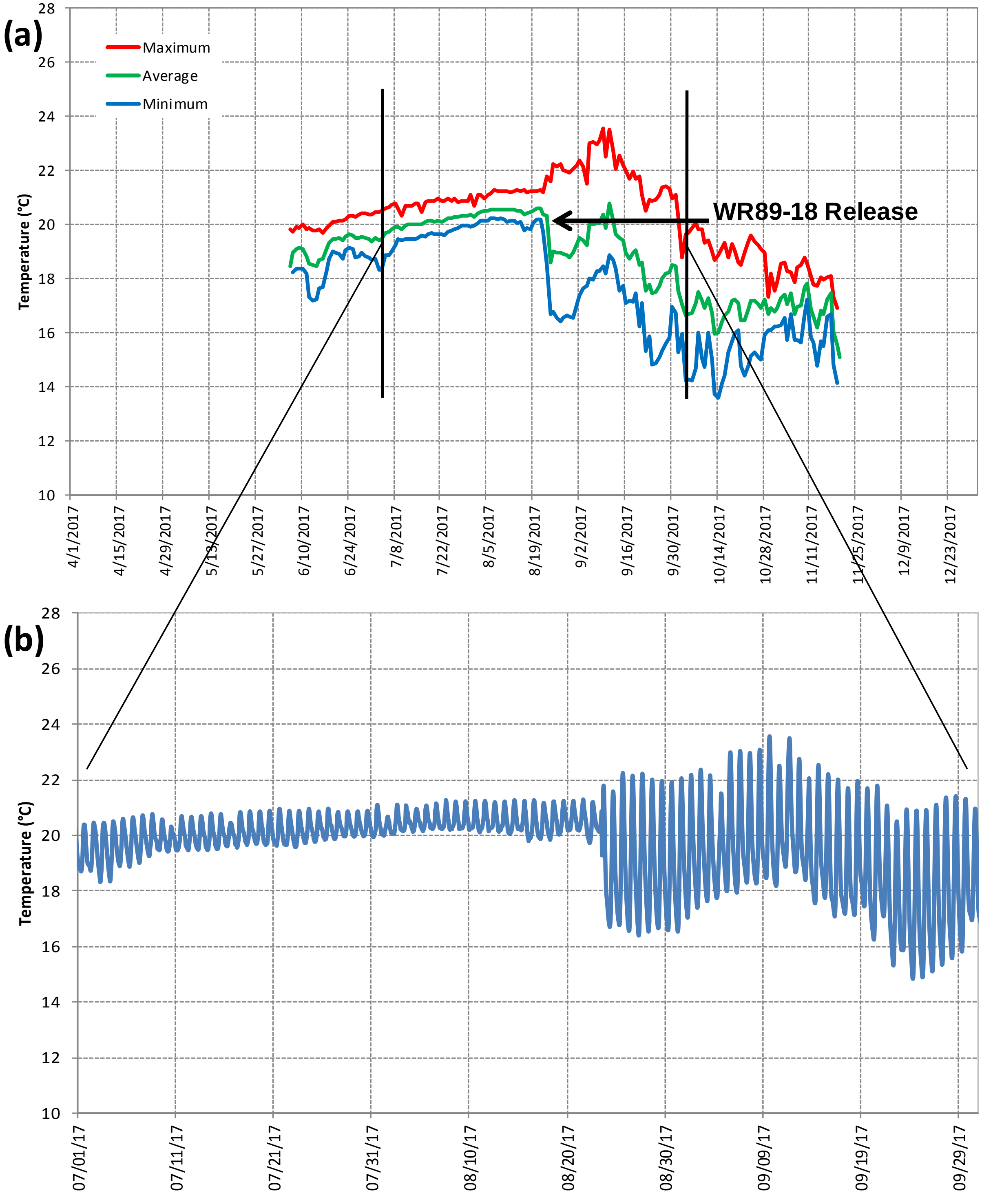


Figure 15: 2017 LSYR-7.65 (Double Canopy Pool) bottom (3.0 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

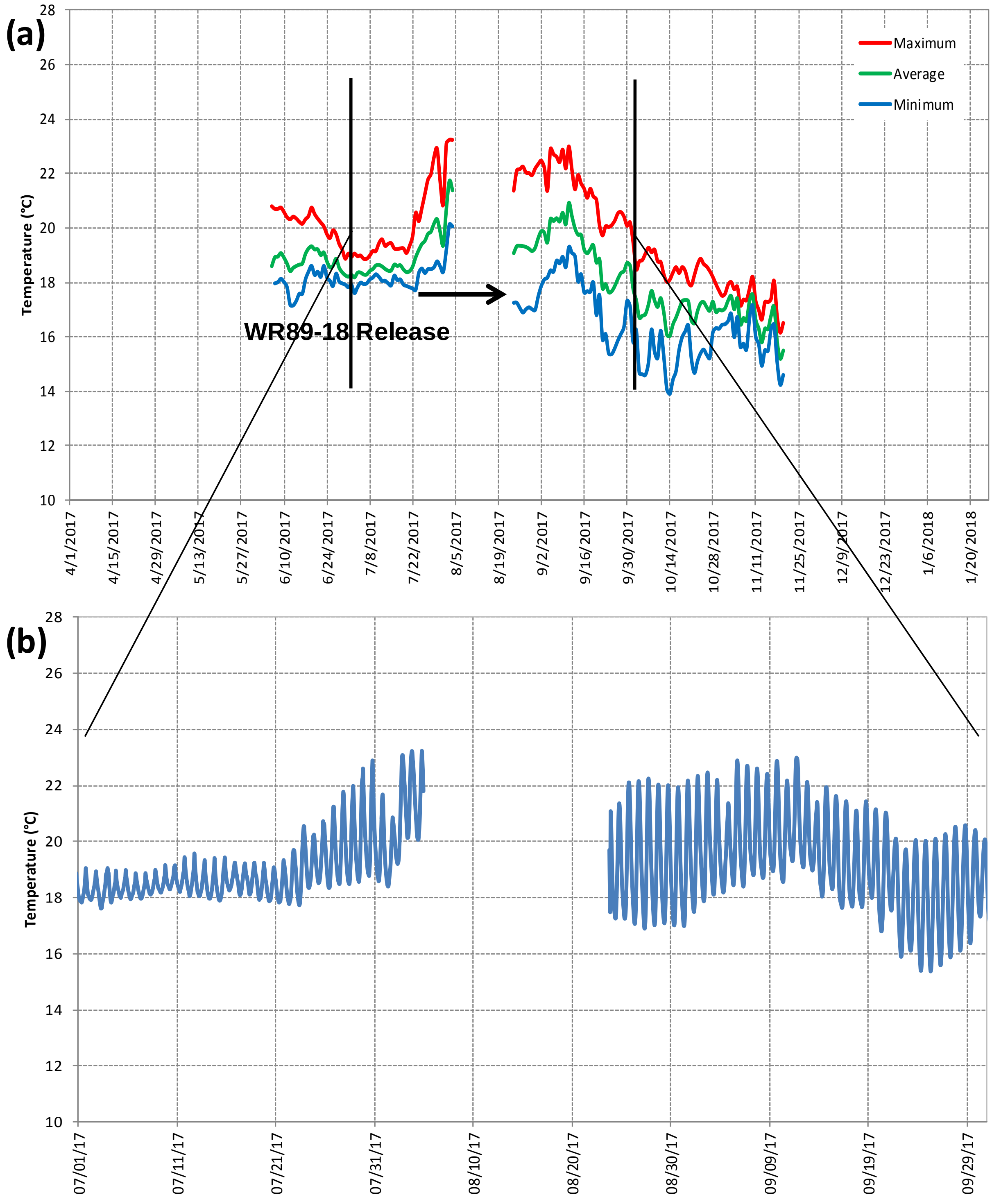


Figure 16: 2017 LSYR-8.7 (Head of Beaver Pool) middle (2.5 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17. The middle unit was out of the water due to drying conditions from 8/5/17-8/23/17.

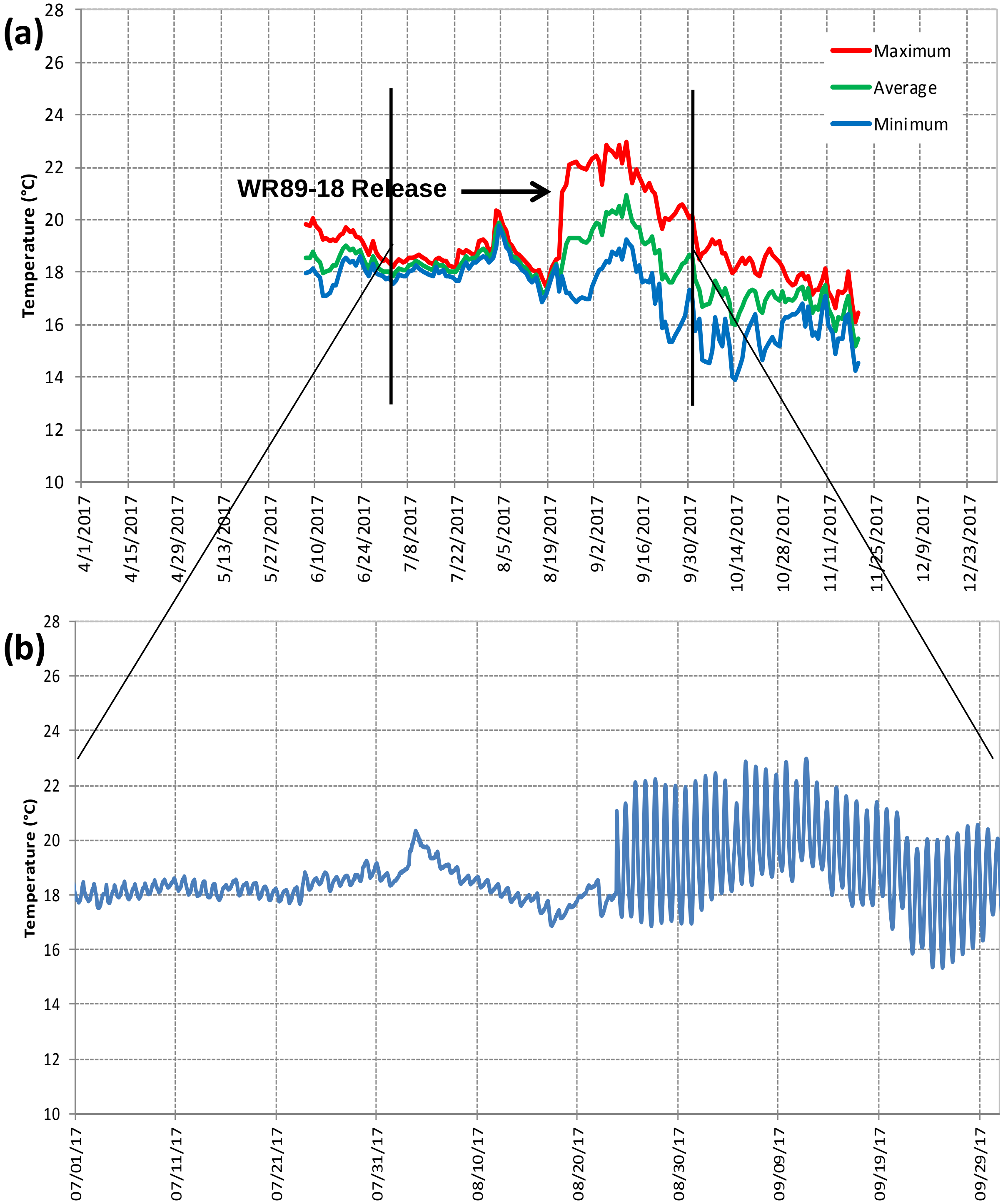


Figure 17: 2017 LSYR-8.7 (Head of Beaver Pool) bottom (5.0 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

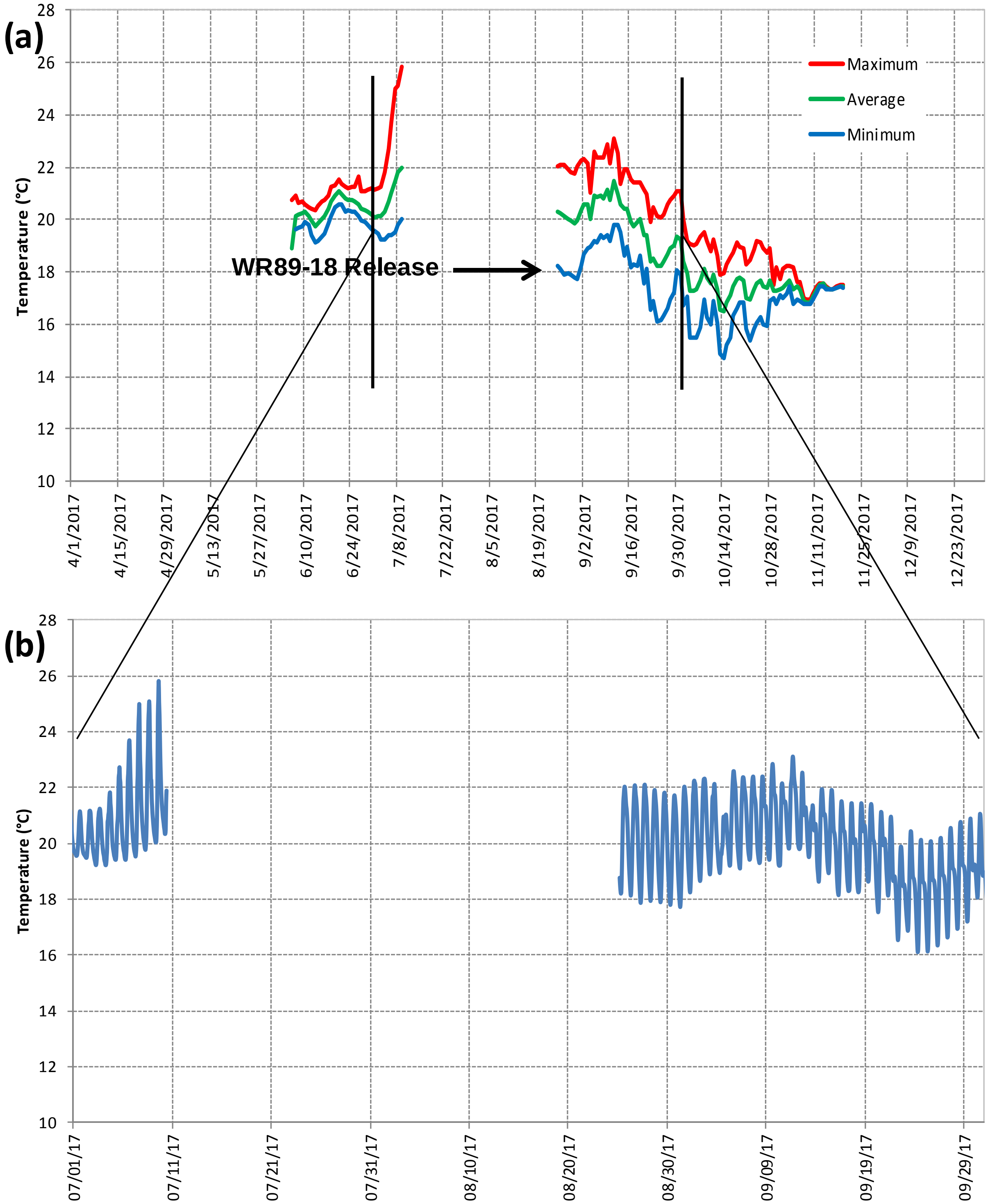


Figure 18: 2017 LSYR-10.2 (Alisal Bedrock Pool) surface (1.0 foot) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17; the surface unit was out of the water from 7/10/17-8/25/17 due to drying conditions.

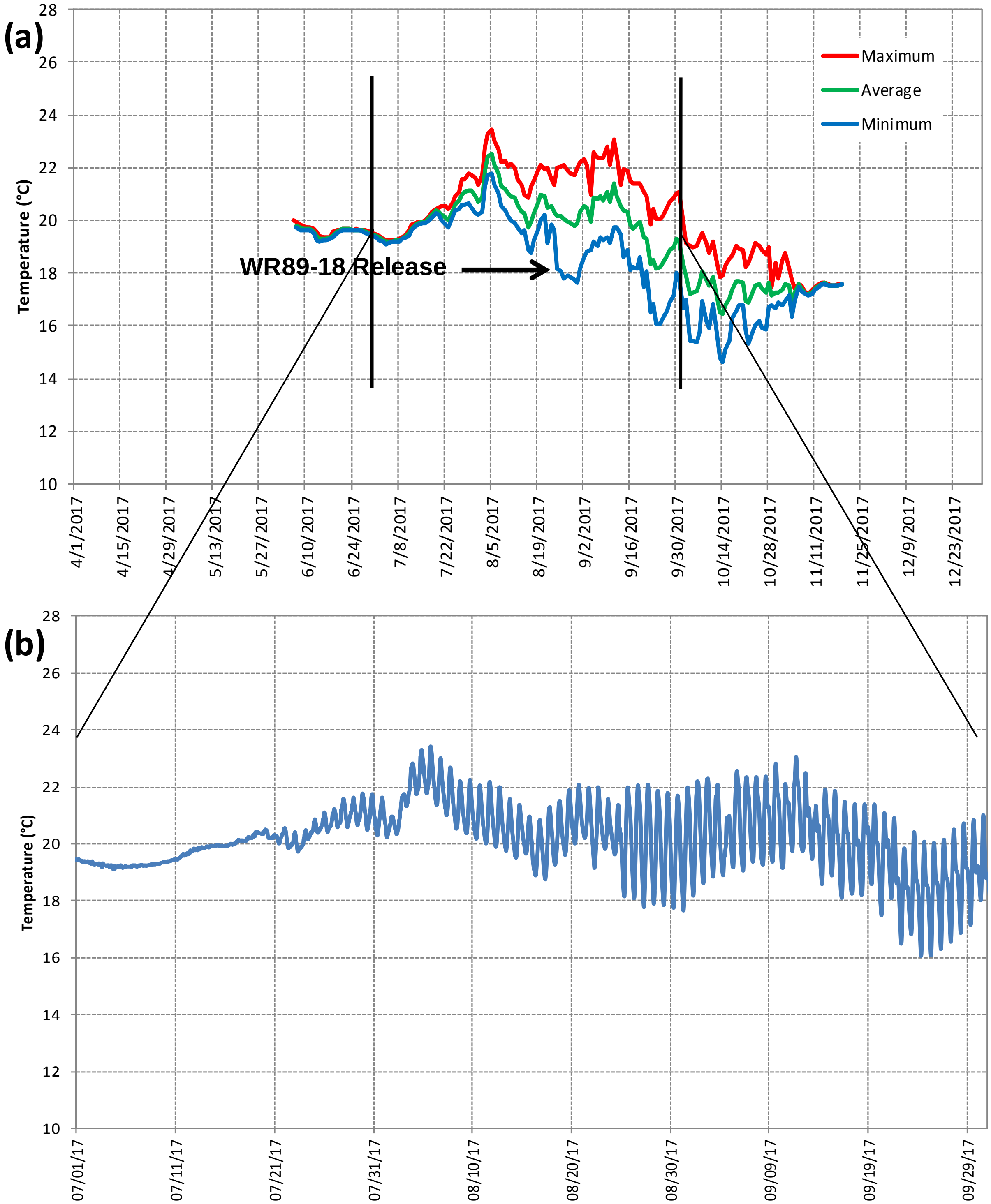


Figure 19: 2017 LSYR-10.2 (Alisal Bedrock Pool) middle (4.5 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

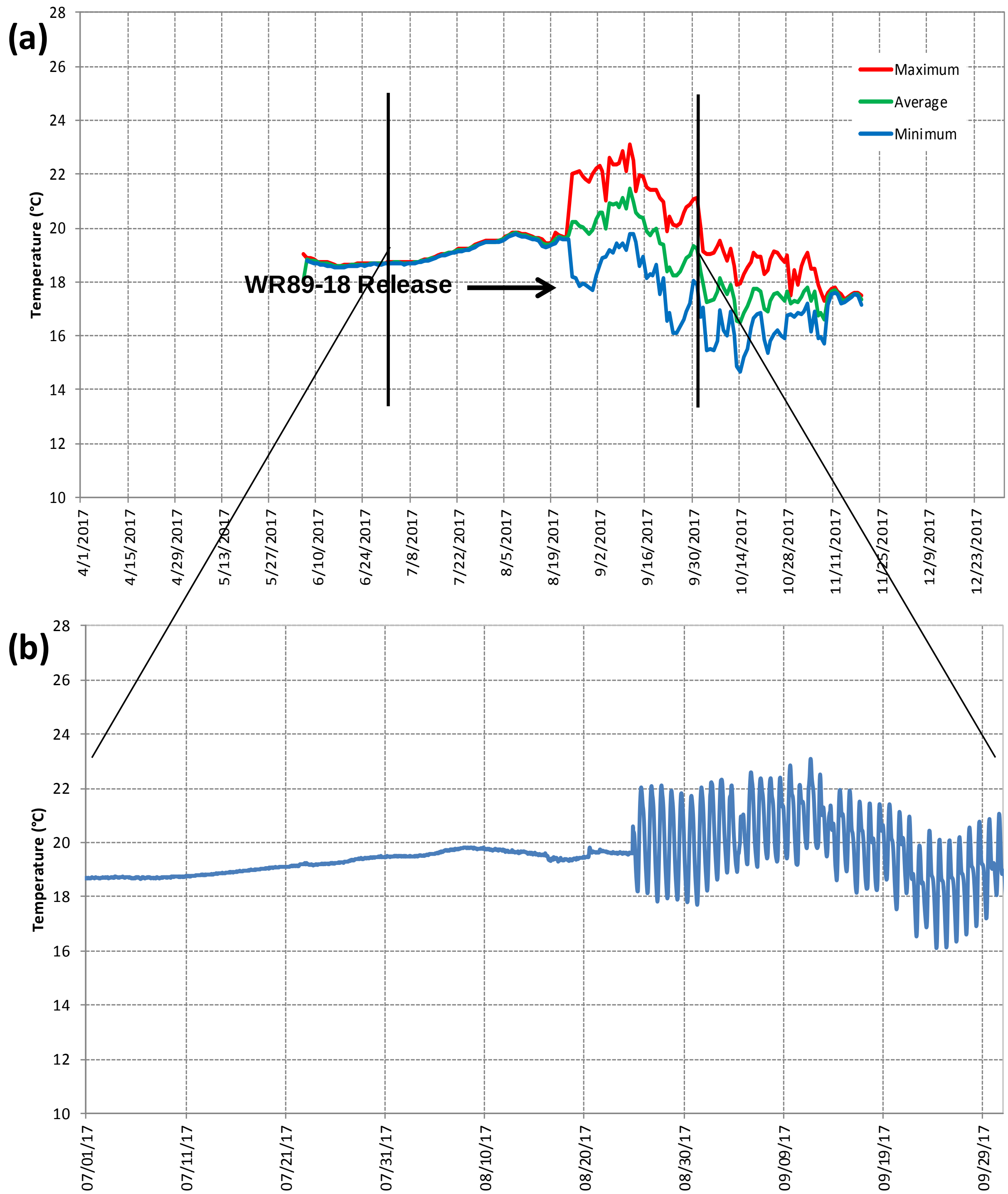


Figure 20: 2017 LSYR-10.2 (Alisal Bedrock Pool) bottom (9.0 feet) water temperatures for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

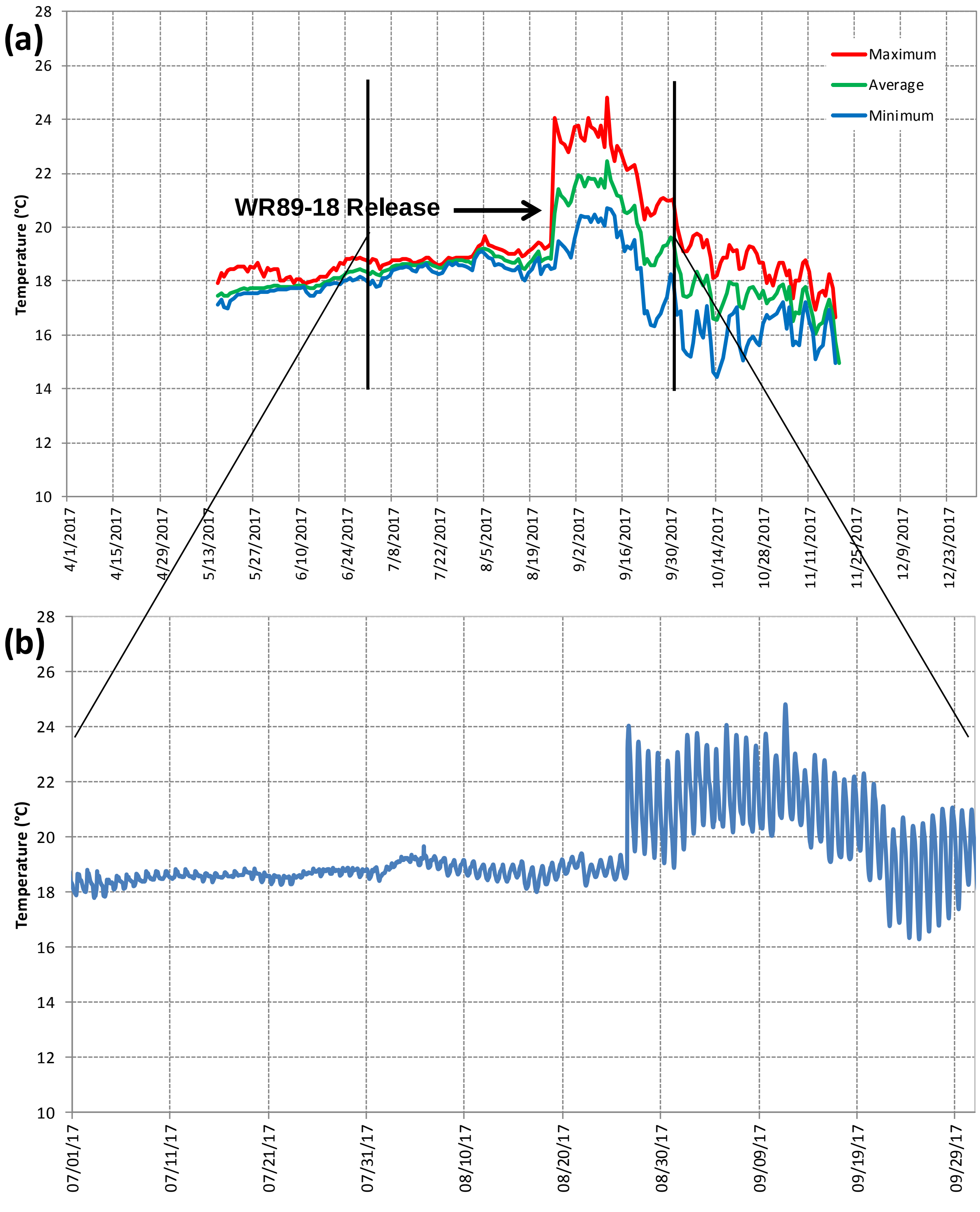


Figure 21: 2017 LSYR-13.9 (Avenue of the Flags) bottom (3.0 feet) water temperatures for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

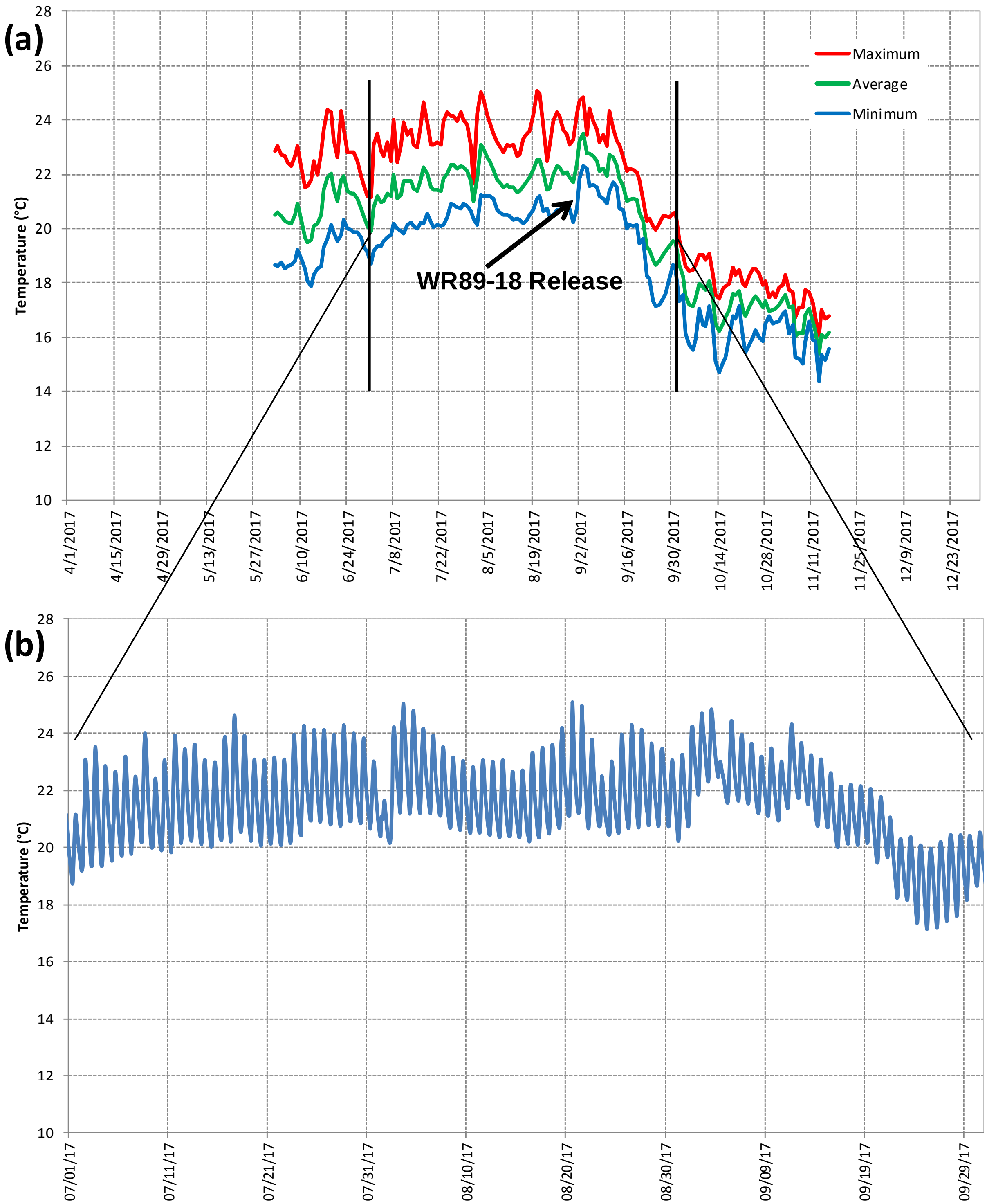


Figure 22: 2017 LSYR-22.68 (Cadwell Pool) surface (1.0 foot) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

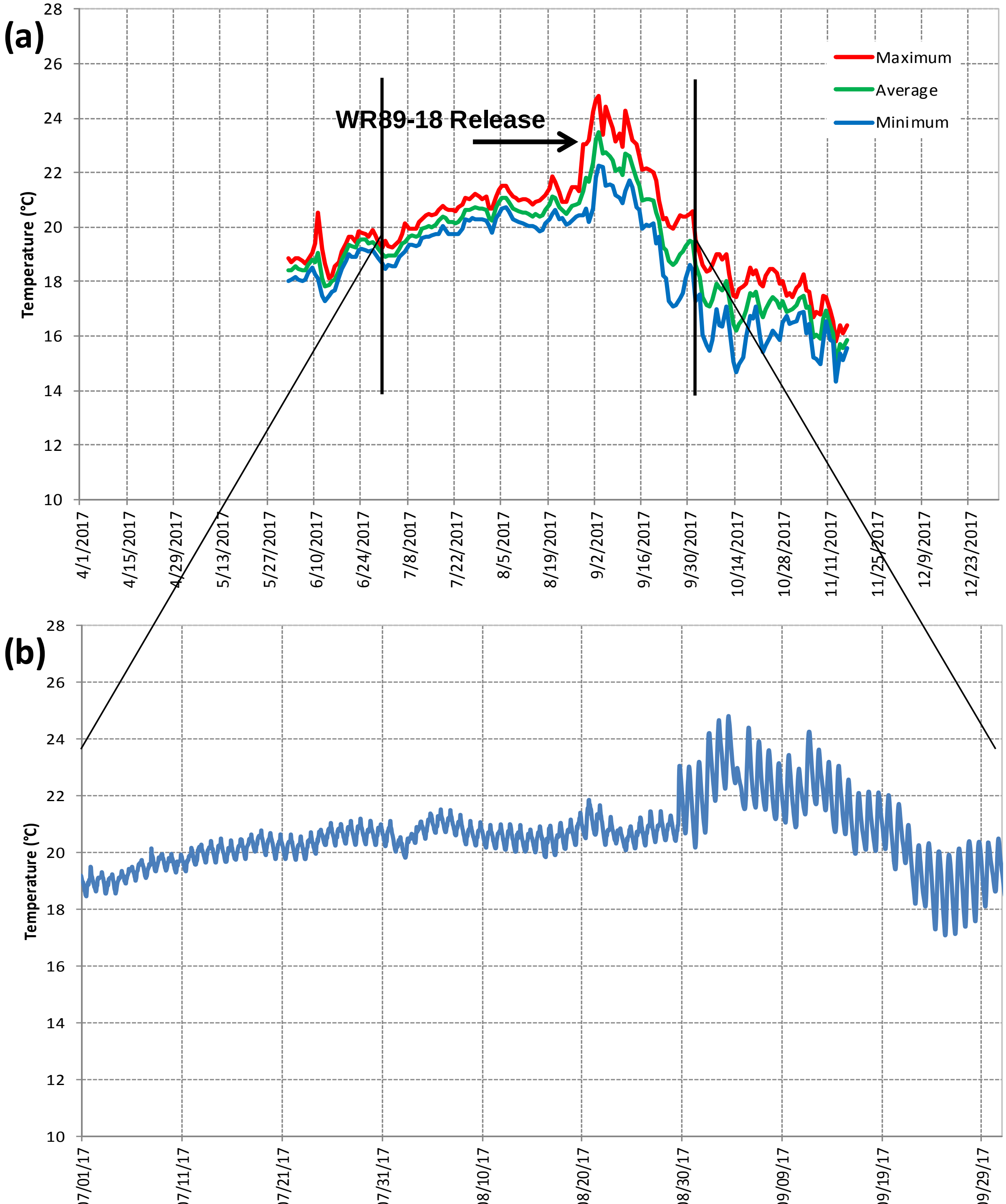


Figure 23: 2017 LSYR-22.68 (Cadwell Pool) middle (7.0 feet) water temperature for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

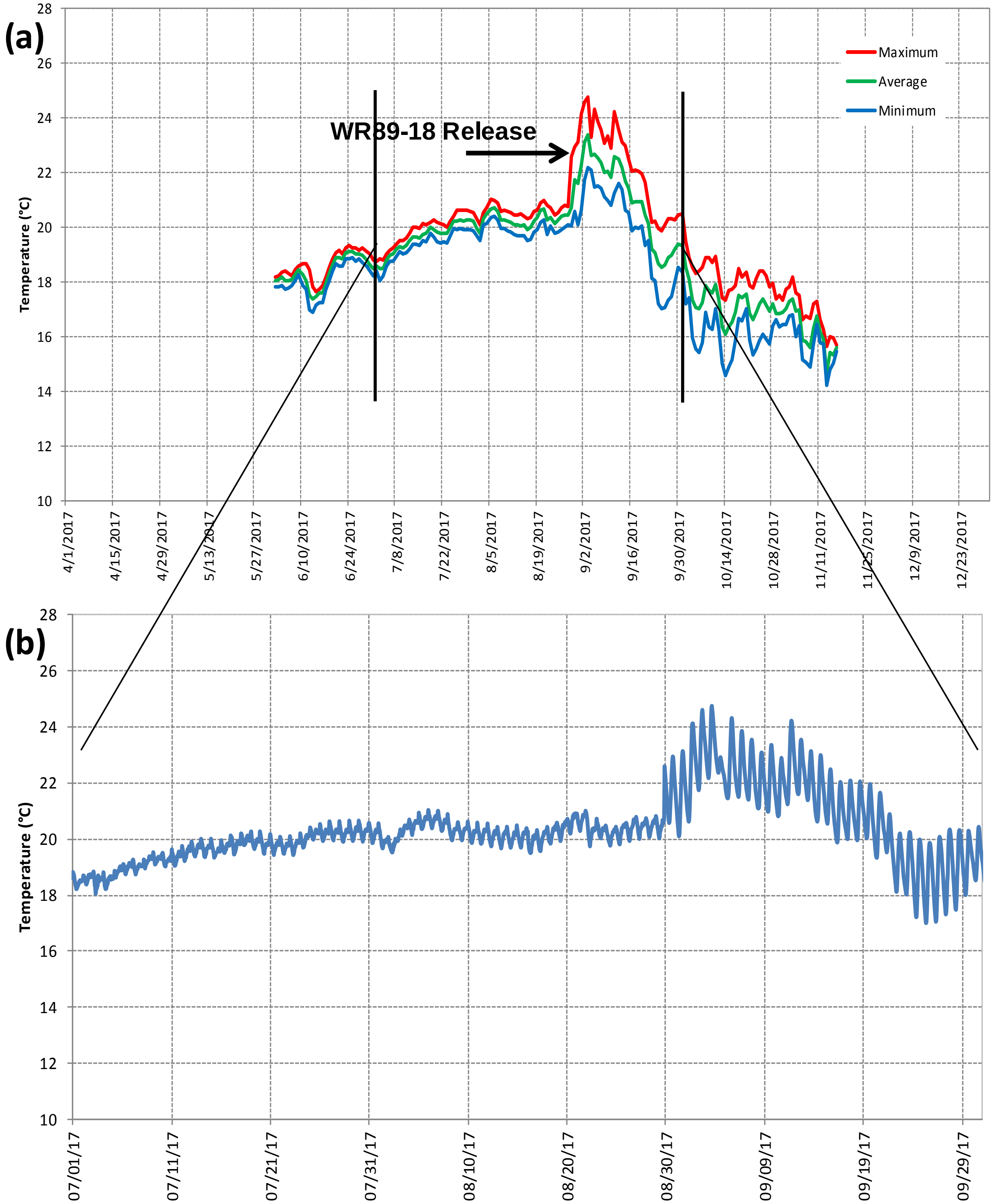


Figure 24: 2017 LSYR-22.68 (Cadwell Pool) bottom (14.0 feet) water temperatures for a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/17-10/1/17.

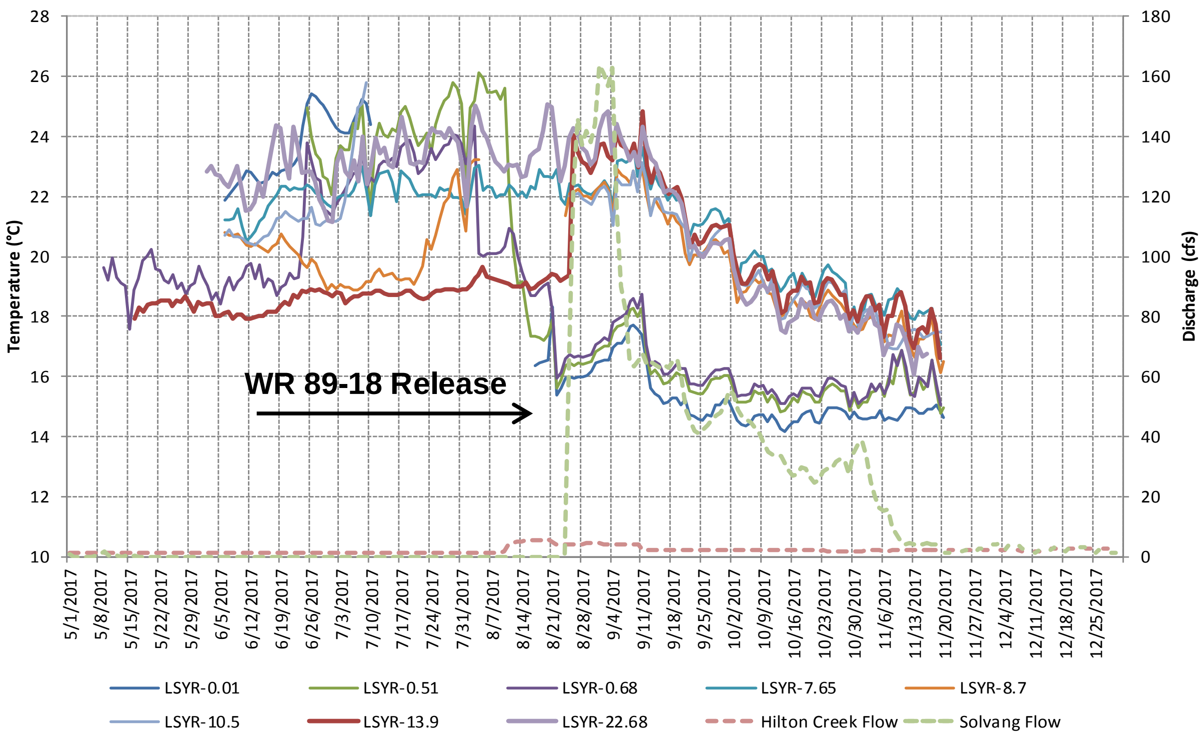


Figure 25: 2017 Longitudinal maximum surface water temperatures at: LSYR-0.01 (parapet wall), LSYR-0.51 (Long Pool), LSYR-0.68 (downstream of Long Pool), LSYR-7.65 (Double Canopy), LSYR-8.7 (Head of Beaver), LSYR-10.5 (Alisal Bedrock Pool), LSYR-13.9 (Avenue of the Flags), and LSYR-22.68 (Cadwell Pool) with daily flow (discharge) at the Hilton Creek and Solvang (at the Alisal Bridge) USGS gauges; no water quality monitoring was conducted at LSYR-0.25 and LSYR-4.95 because the river was dry prior to WR 89-18 releases.

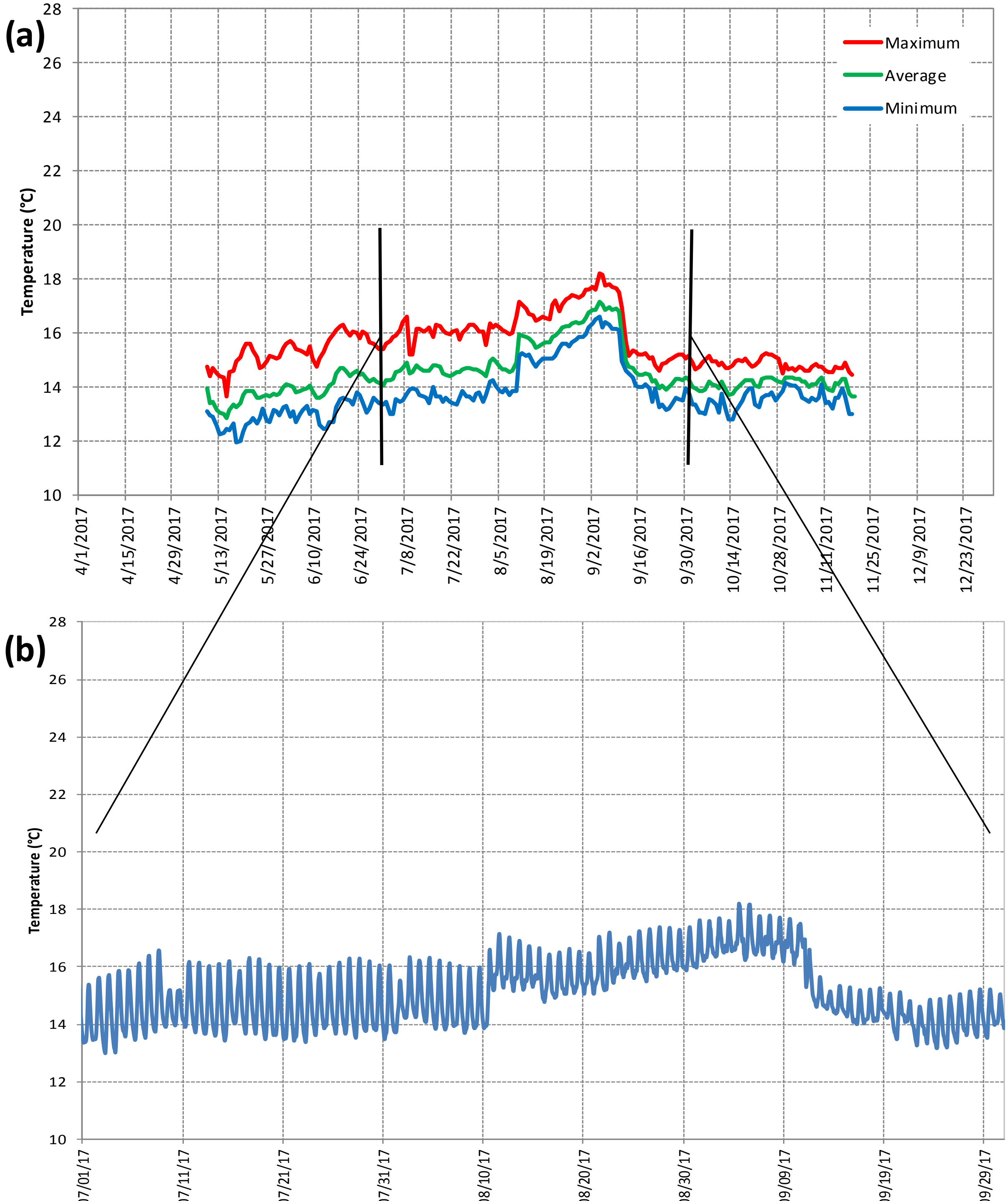


Figure 26: 2017 Lower Hilton Creek (HC-0.12) bottom (0.5 feet) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data from 7/1/17-10/1/17.

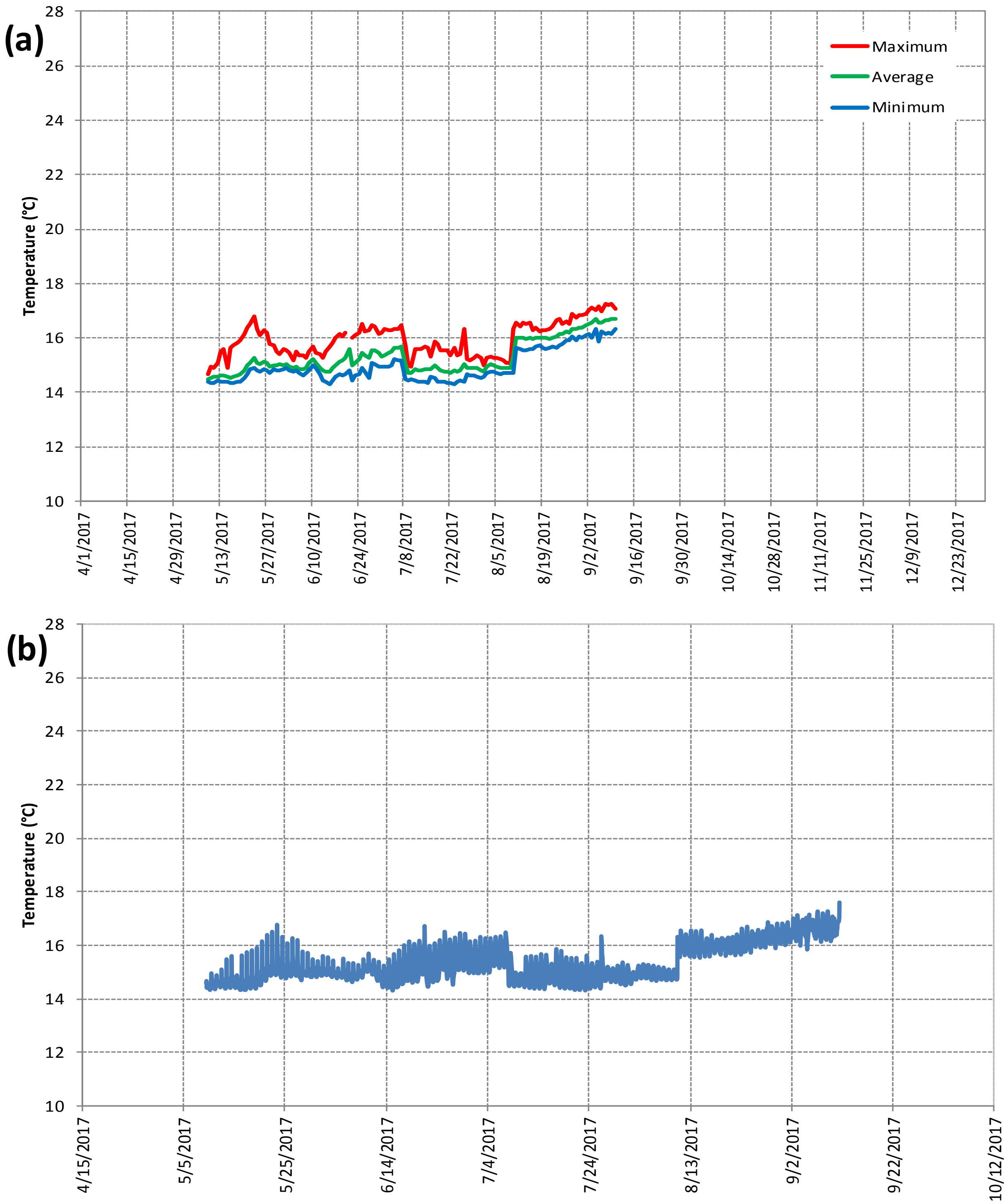
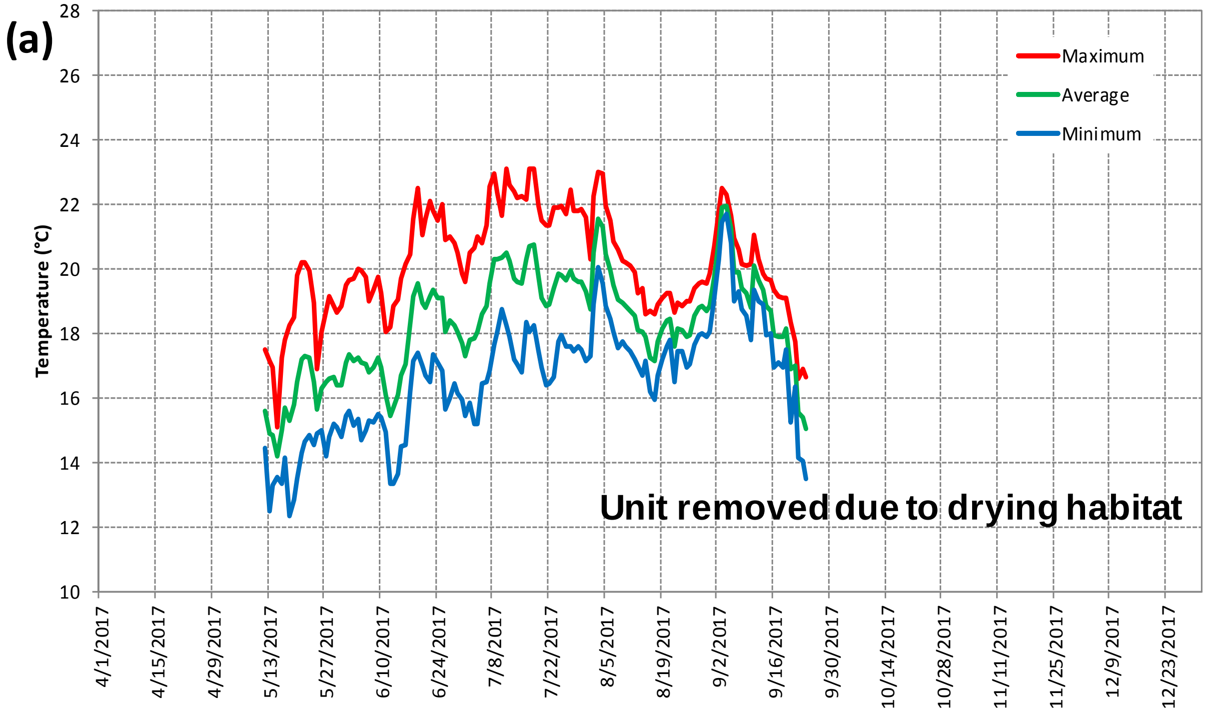


Figure 27: 2017 Hilton Creek at the Upper Release Point (HC-0.25) bottom (2.5 feet) water temperatures for: (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of deployment; releases from the URP ran from 8/11/17-9/11/17.



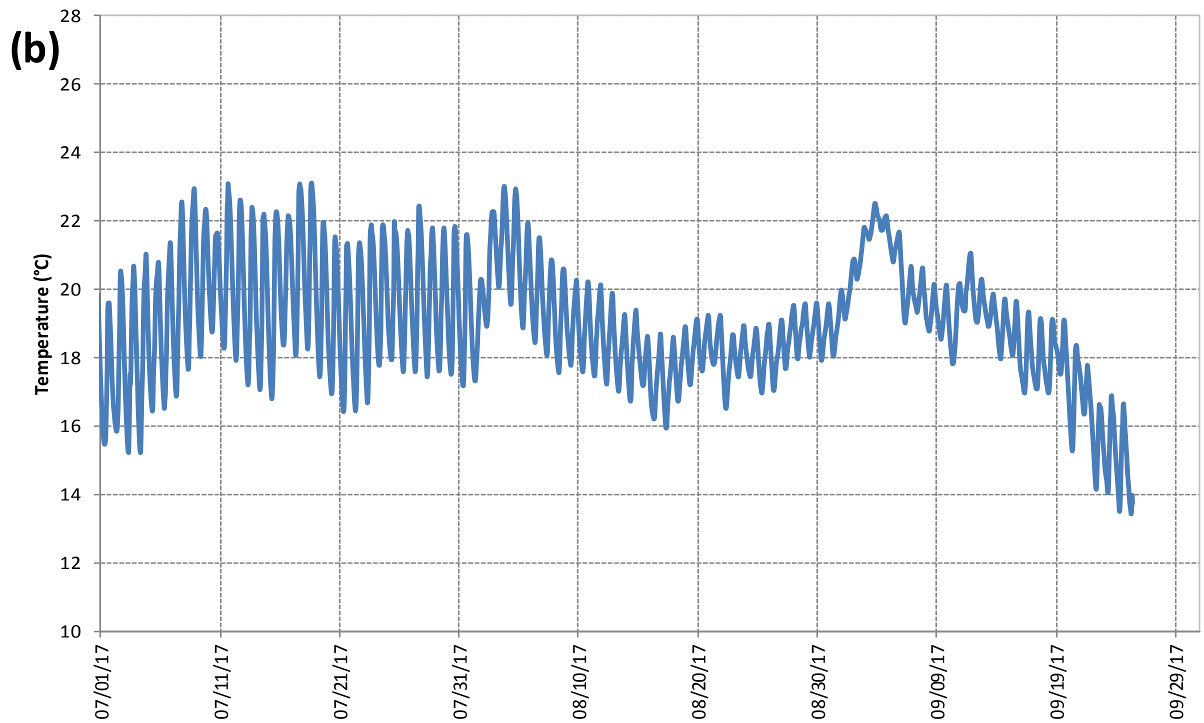


Figure 28: 2017 Quiota Creek (QC-2.66) bottom (2.5 feet) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data for the entire period of deployment; unit removed due to drying habitat.

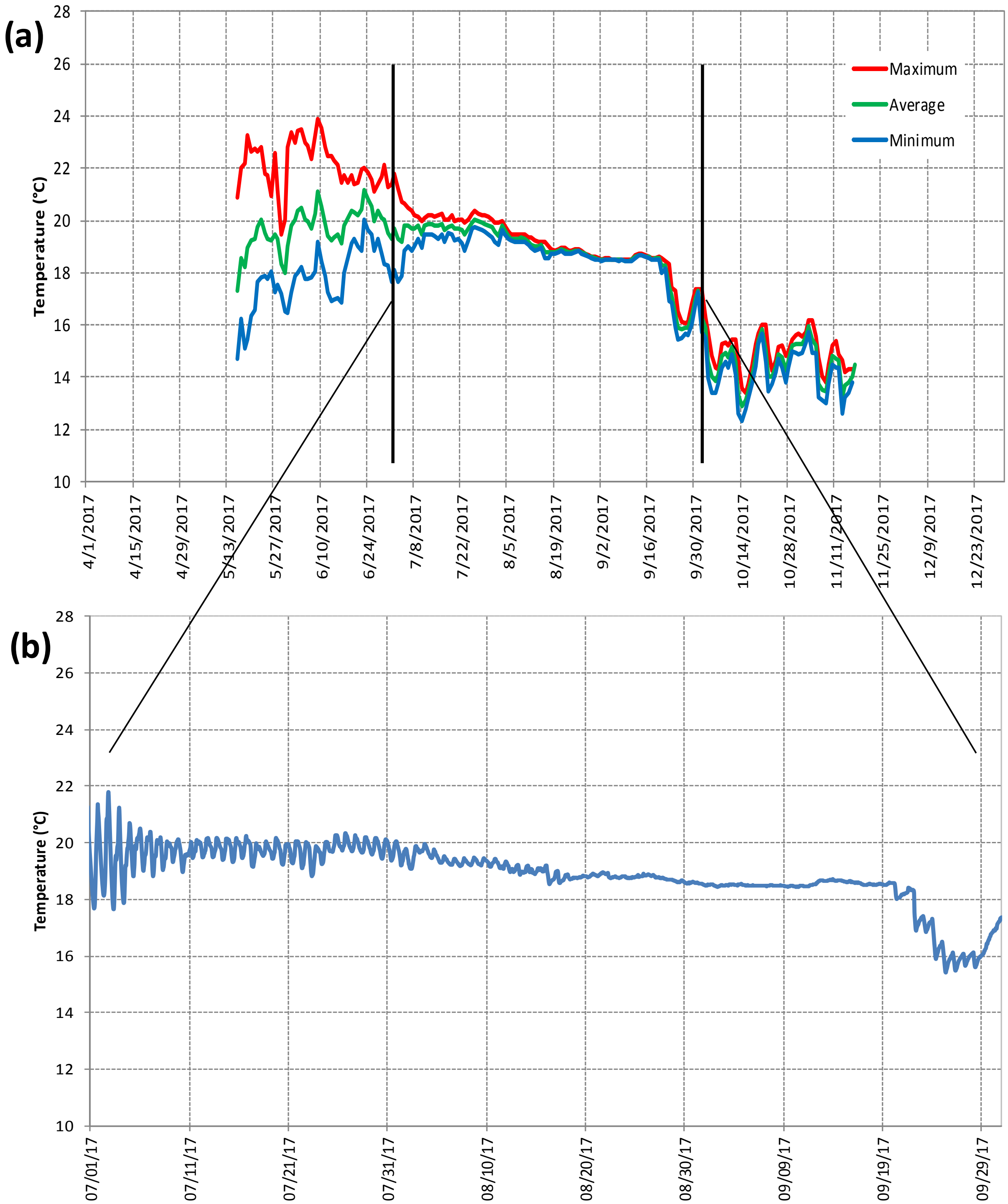


Figure 29: 2017 Lower Salsipuedes Creek (SC-0.77) bottom (0.5 feet) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data from 7/1/17-10/1/17.

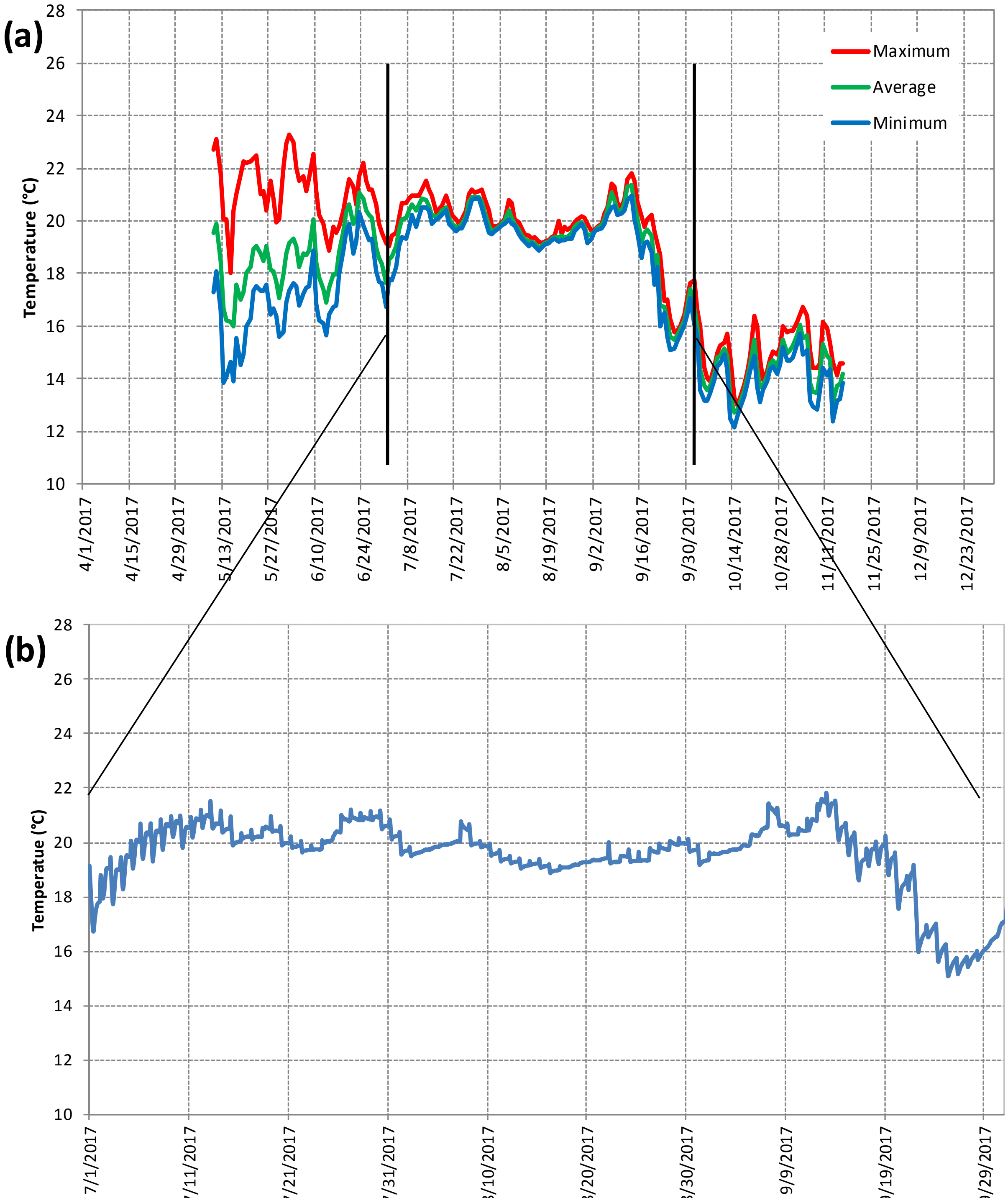


Figure 30: 2017 SC-2.20 (Reach 2 Bedrock Section) bottom (4.0 feet) water temperatures for (a) daily maximum, average, and minimum temperatures for the entire period of deployment and (b) hourly measurements for the period from 7/1/17-10/1/17.

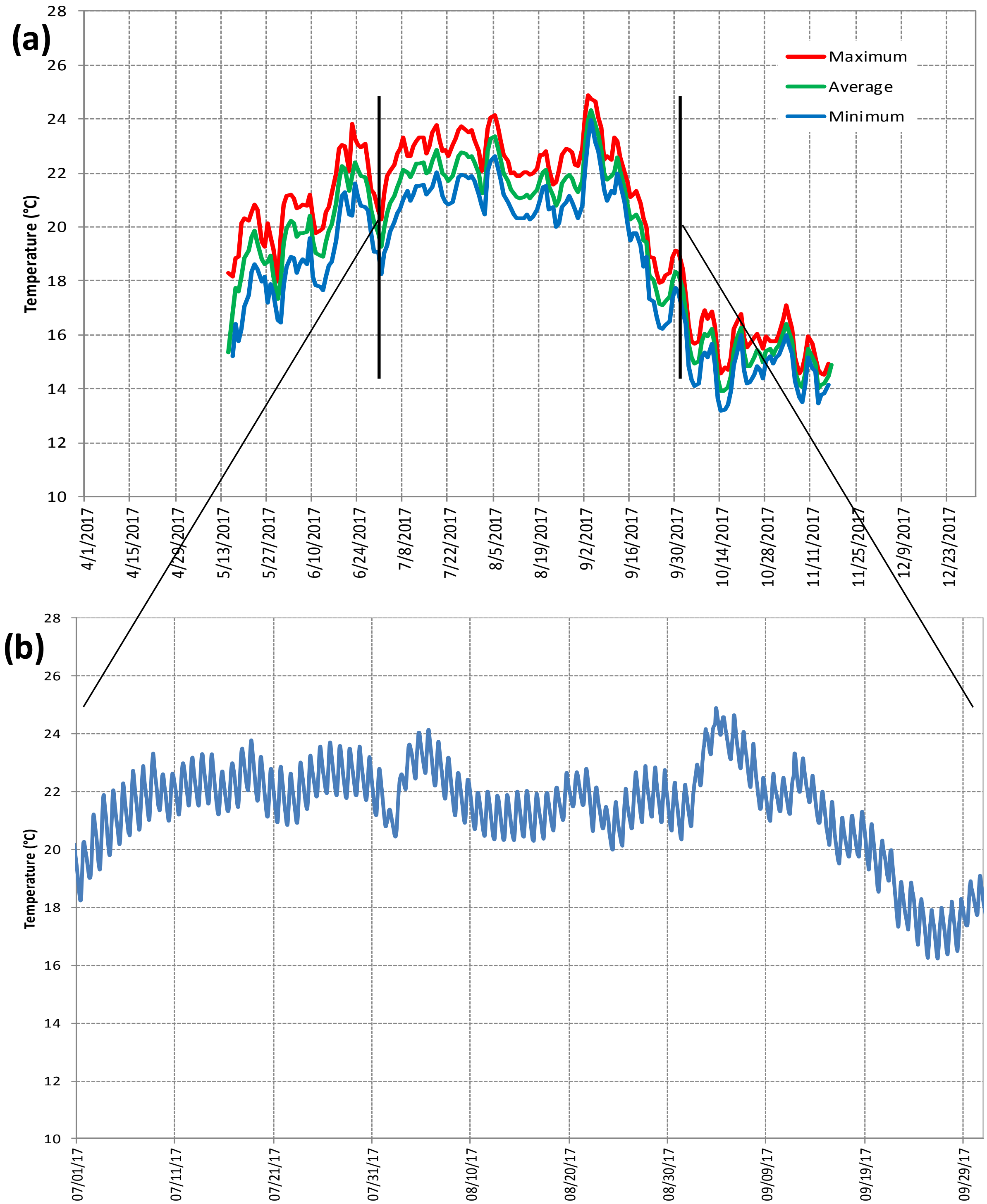
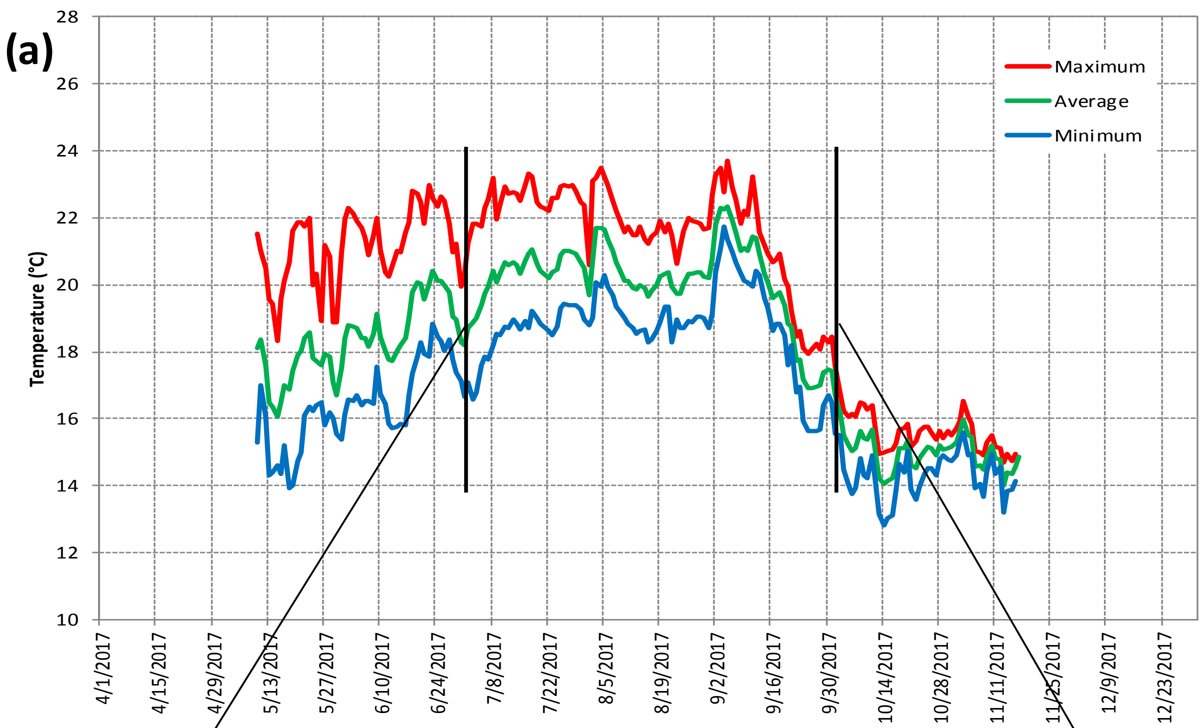


Figure 31: 2017 SC-3.0 (Highway 1 Bridge Pool Habitat) bottom (4.0 feet) water temperature for (a) maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/17-10/1/17.



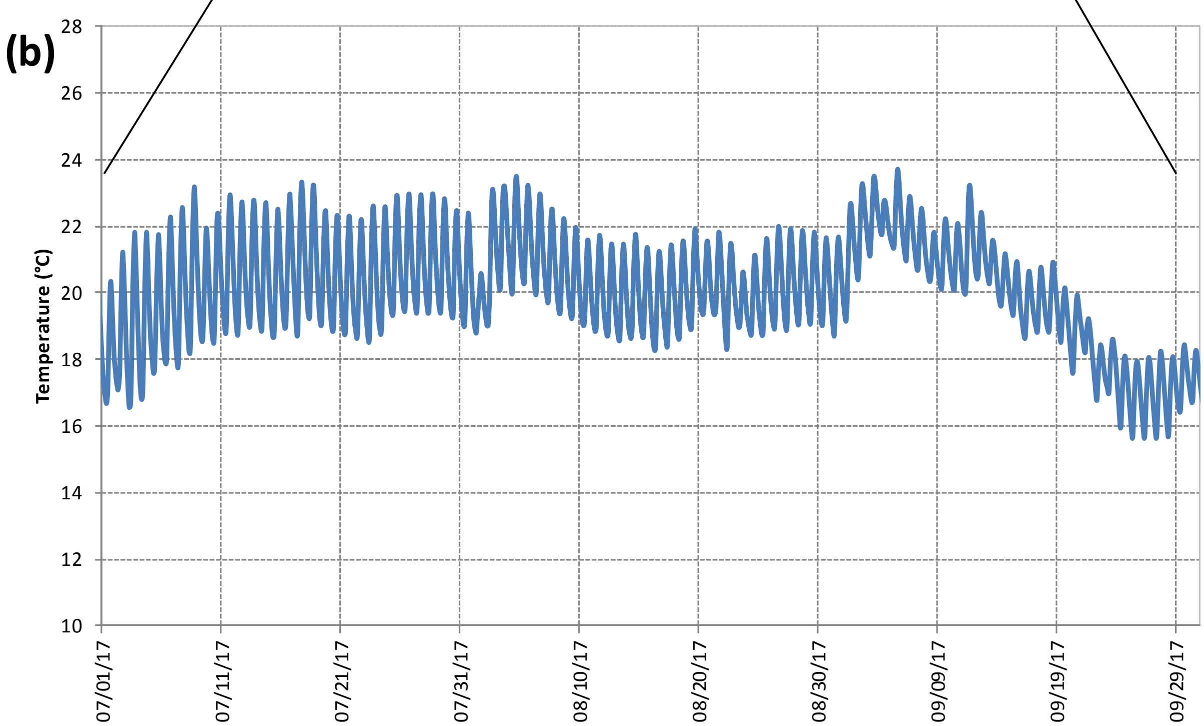


Figure 32: 2017 SC-3.5 (Jalama Bridge Pool Habitat) bottom (4.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/17-10/1/17.

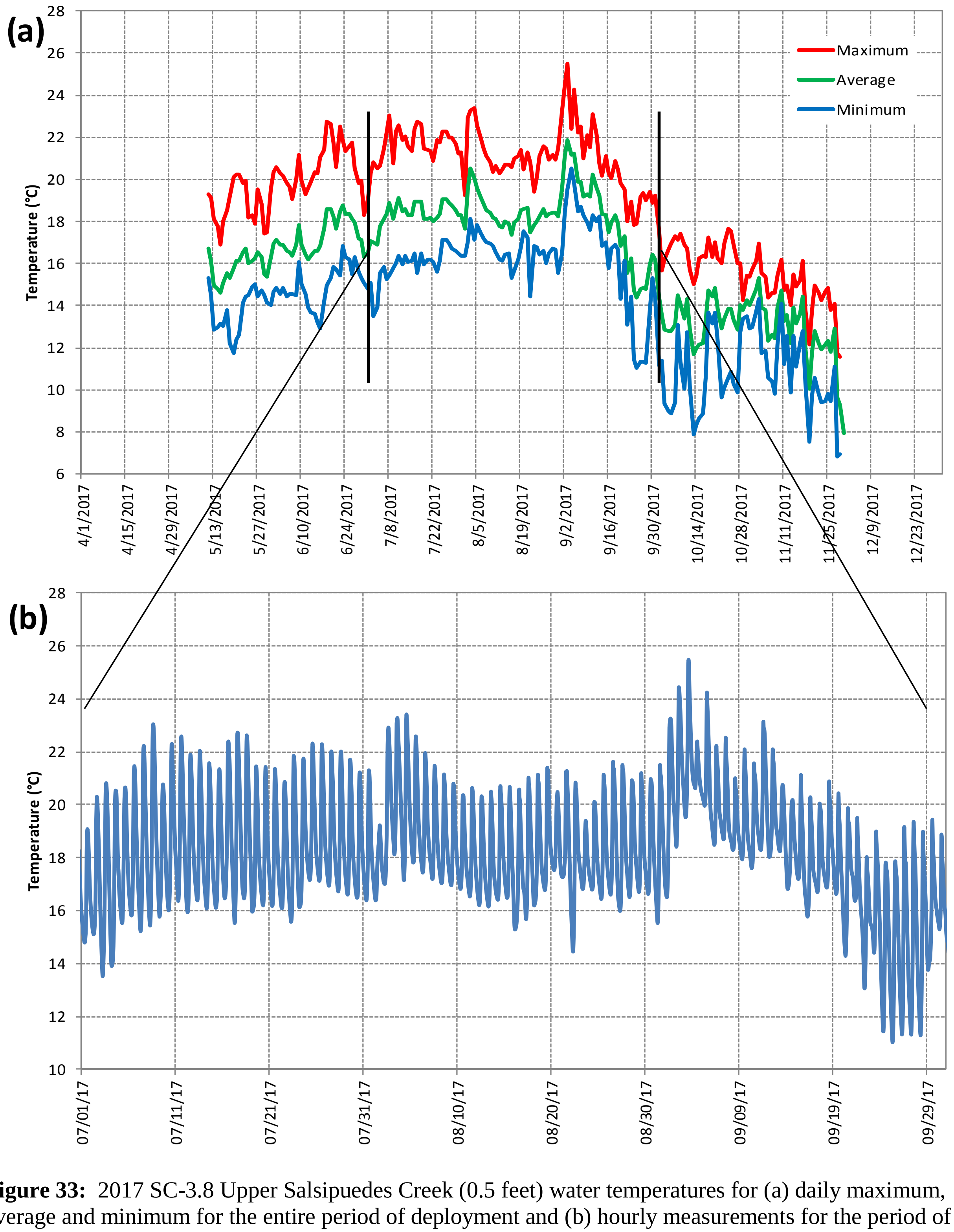


Figure 33: 2017 SC-3.8 Upper Salsipuedes Creek (0.5 feet) water temperatures for (a) daily maximum, average and minimum for the entire period of deployment and (b) hourly measurements for the period of record from 7/1/17-10/1/17.

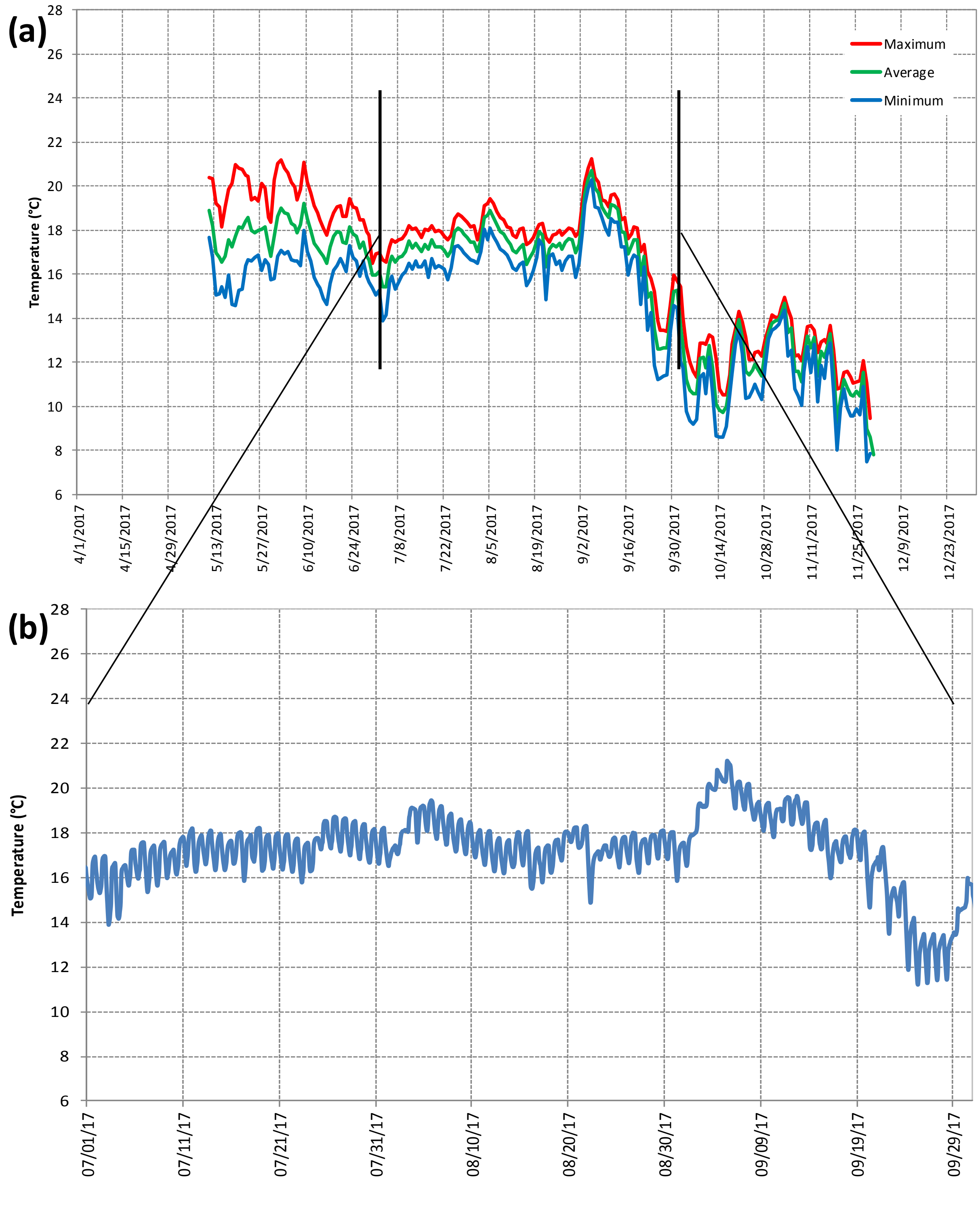


Figure 34: 2017 EJC-3.81 – Directly upstream of the Upper Salsipuedes Creek confluence – bottom (3.5 feet) water temperatures for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/17-10/1/17.

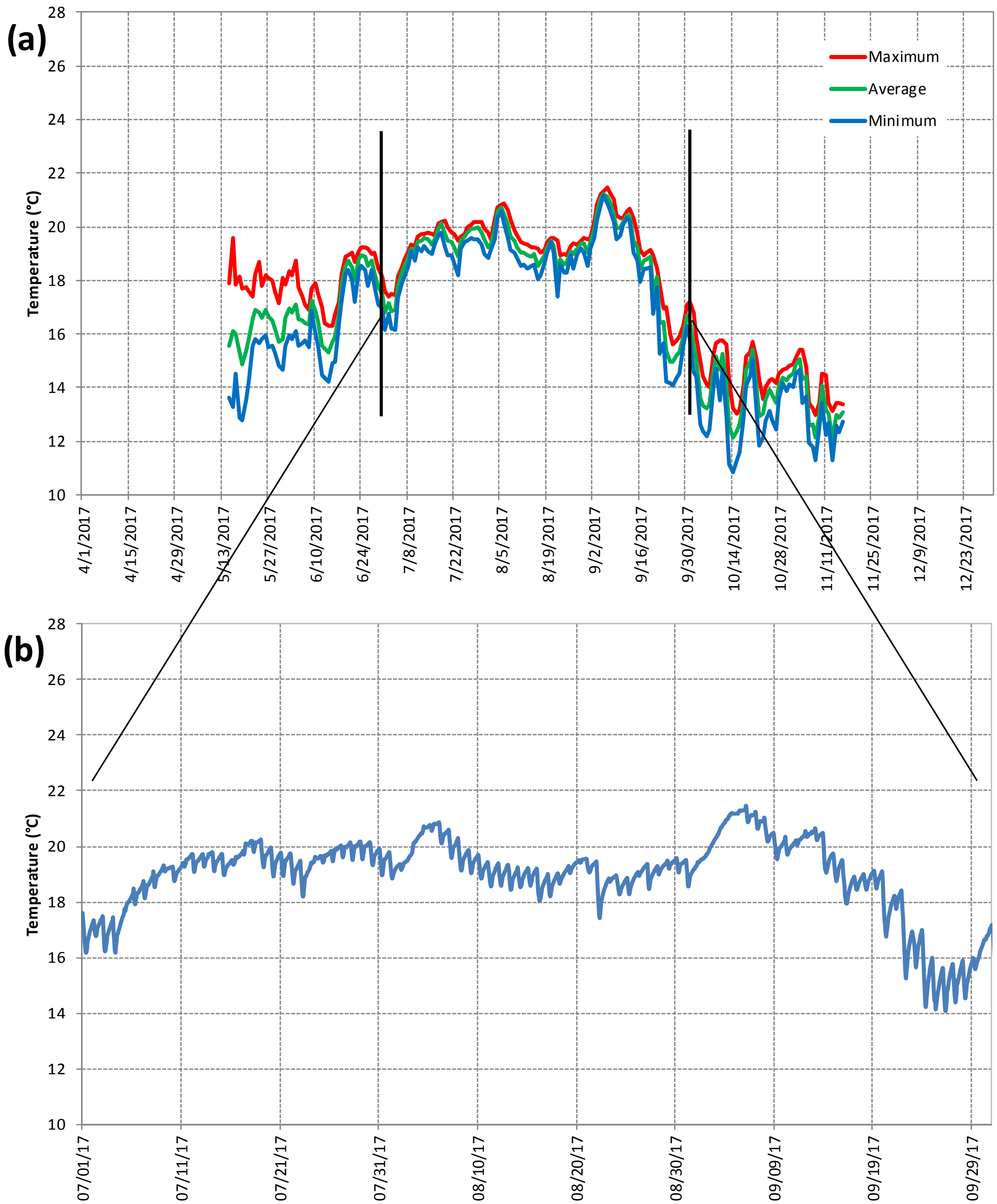


Figure 35: 2017 EJC-5.4 (Palos Colorados Pool Habitat) bottom (3.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/17-10/1/17.

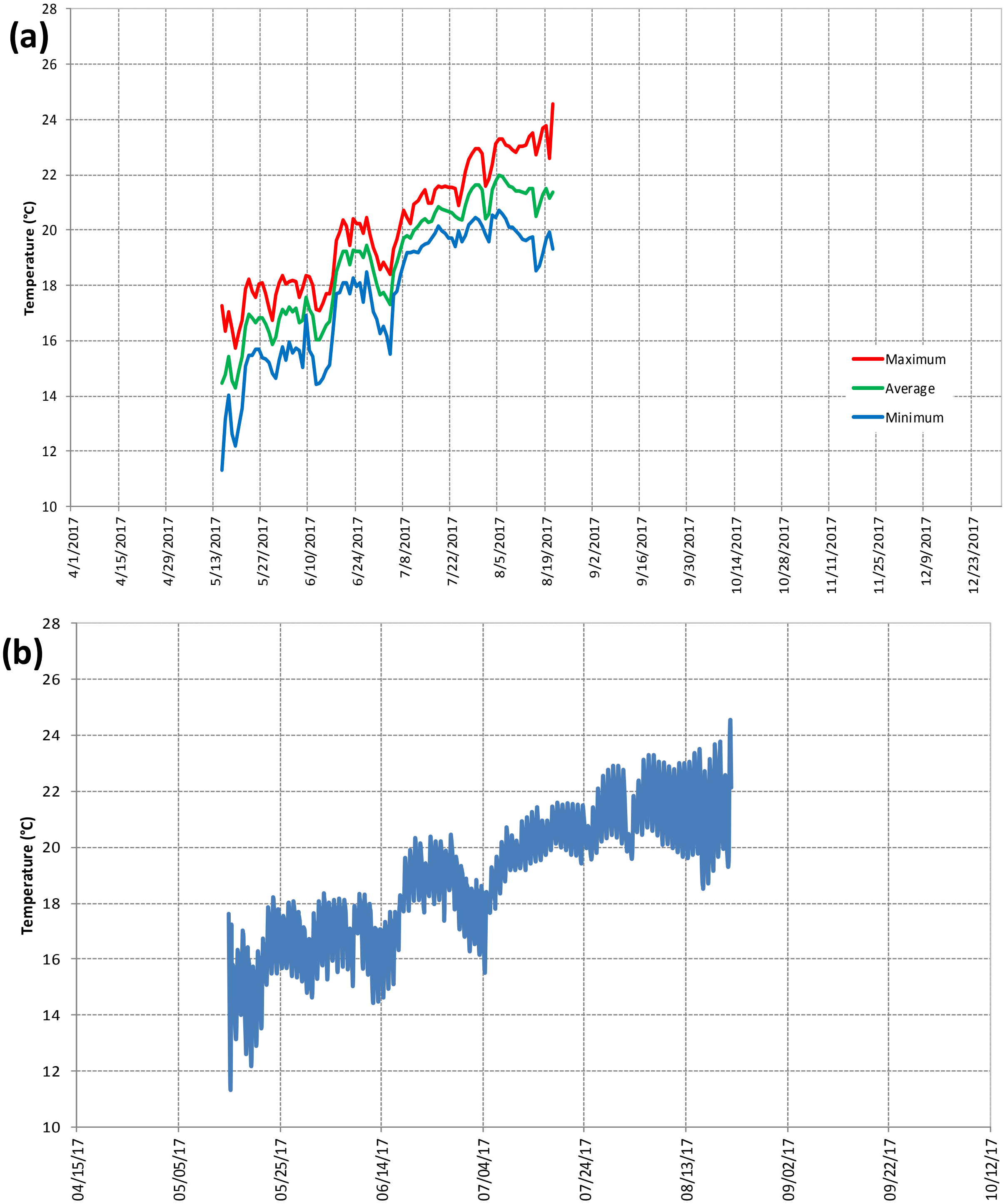


Figure 36: 2017 EJC-10.82 – water temperature at Rancho San Julian Fish Ladder bottom (3.5feet) for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of deployment. The thermograph was removed on 8/21/17 due to dry conditions.

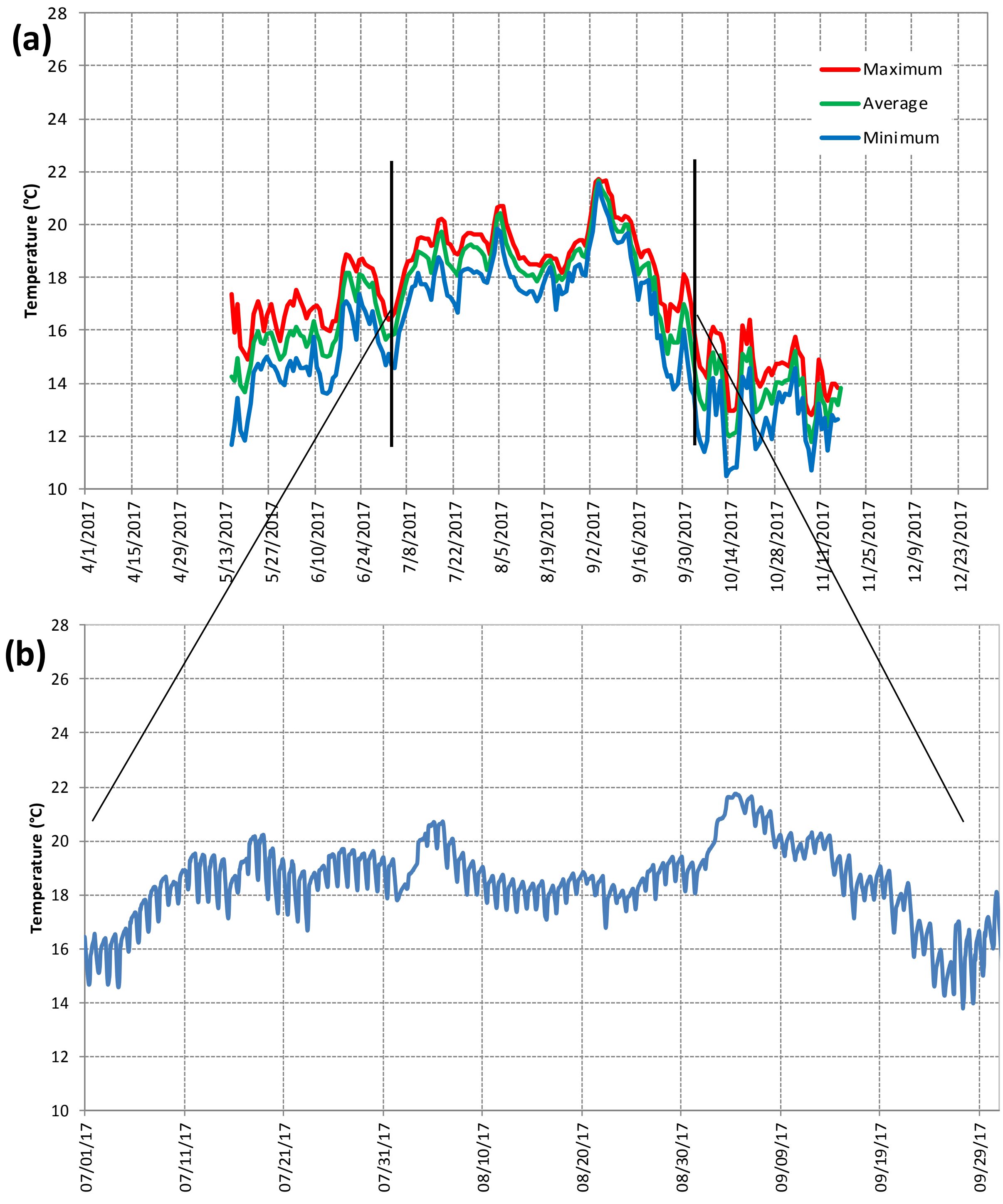


Figure 37: 2017 LAC-7.0 (Los Amoles Creek at Ford Crossing) bottom (3.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/17-10/1/17.

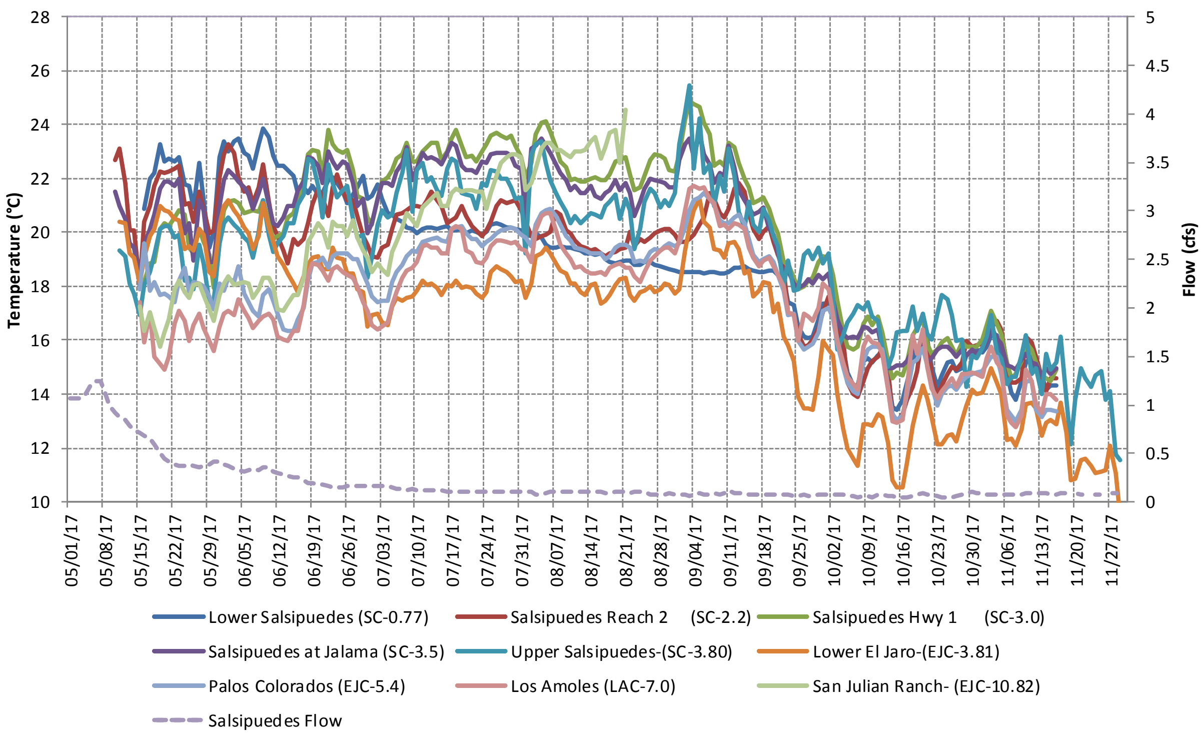


Figure 38: 2017 Longitudinal maximum daily water temperatures within the Salsipuedes Creek watershed which included El Jaro Creek at Rancho San Julian (dry on 8/21/17) (EJC-10.82), at Palos Colorados (EJC-5.4), at lower El Jaro Creek (EJC-3.81), at upper Salsipuedes Creek (SC-3.8), at Jalama Bridge (SC-3.5), at Highway 1 (SC-3.0), at Bedrock Section (SC-2.2), and at lower Salsipuedes Creek (SC-0.77) versus flow (cfs) at the USGS gauging station at Salsipuedes Creek.

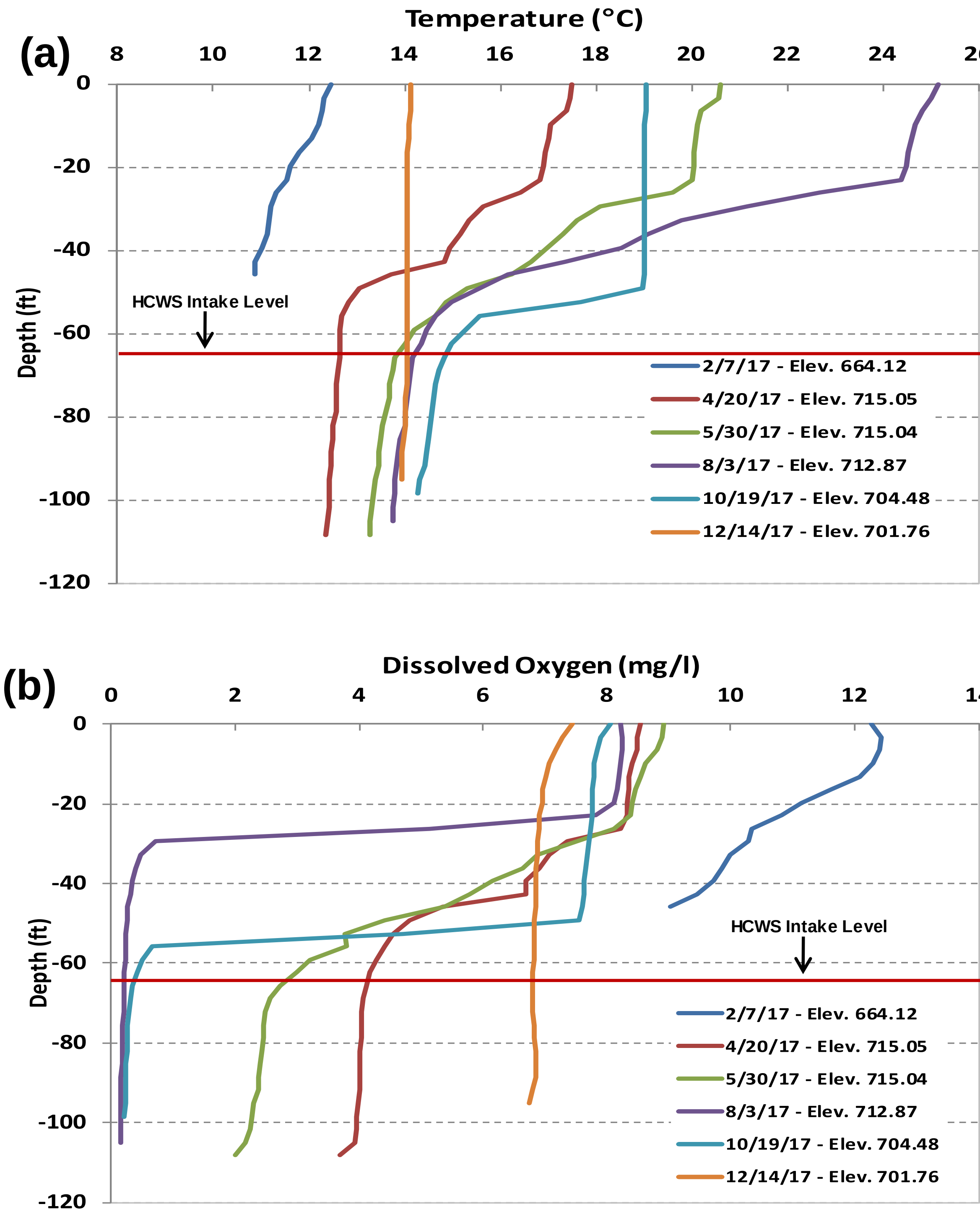


Figure 39: Lake Cachuma 2017 water quality profiles for (a) temperature and (b) dissolved oxygen concentrations at the intake barge for the HCWS; the HCWS intake hose level was set at 65 feet of depth throughout the monitoring period.

3.3. Habitat Quality within the LYSR Basin

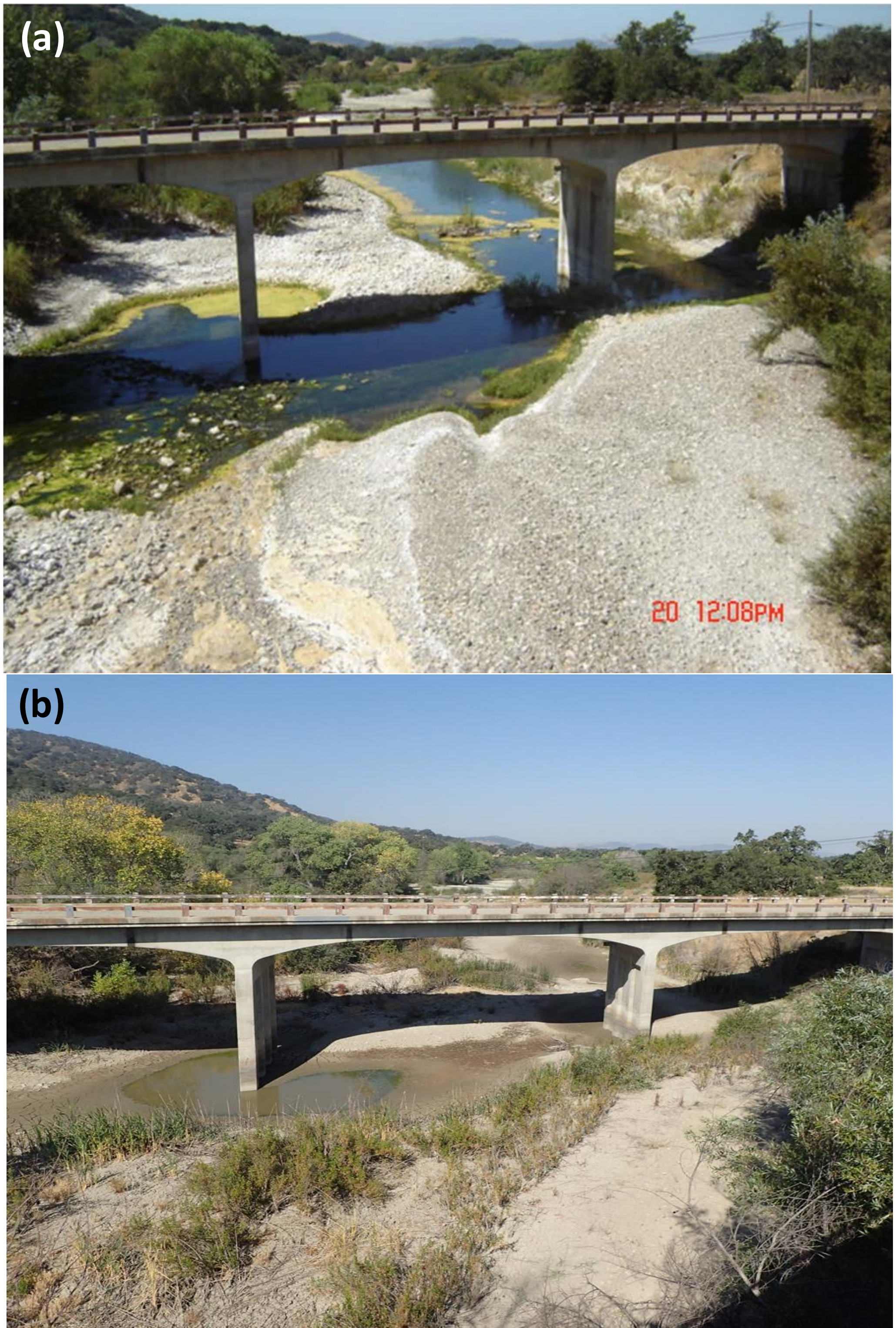


Figure 40: Photo points (M-6) collected at Highway 154 Bridge looking downstream in (a) September 2005 and (b) July 2017.

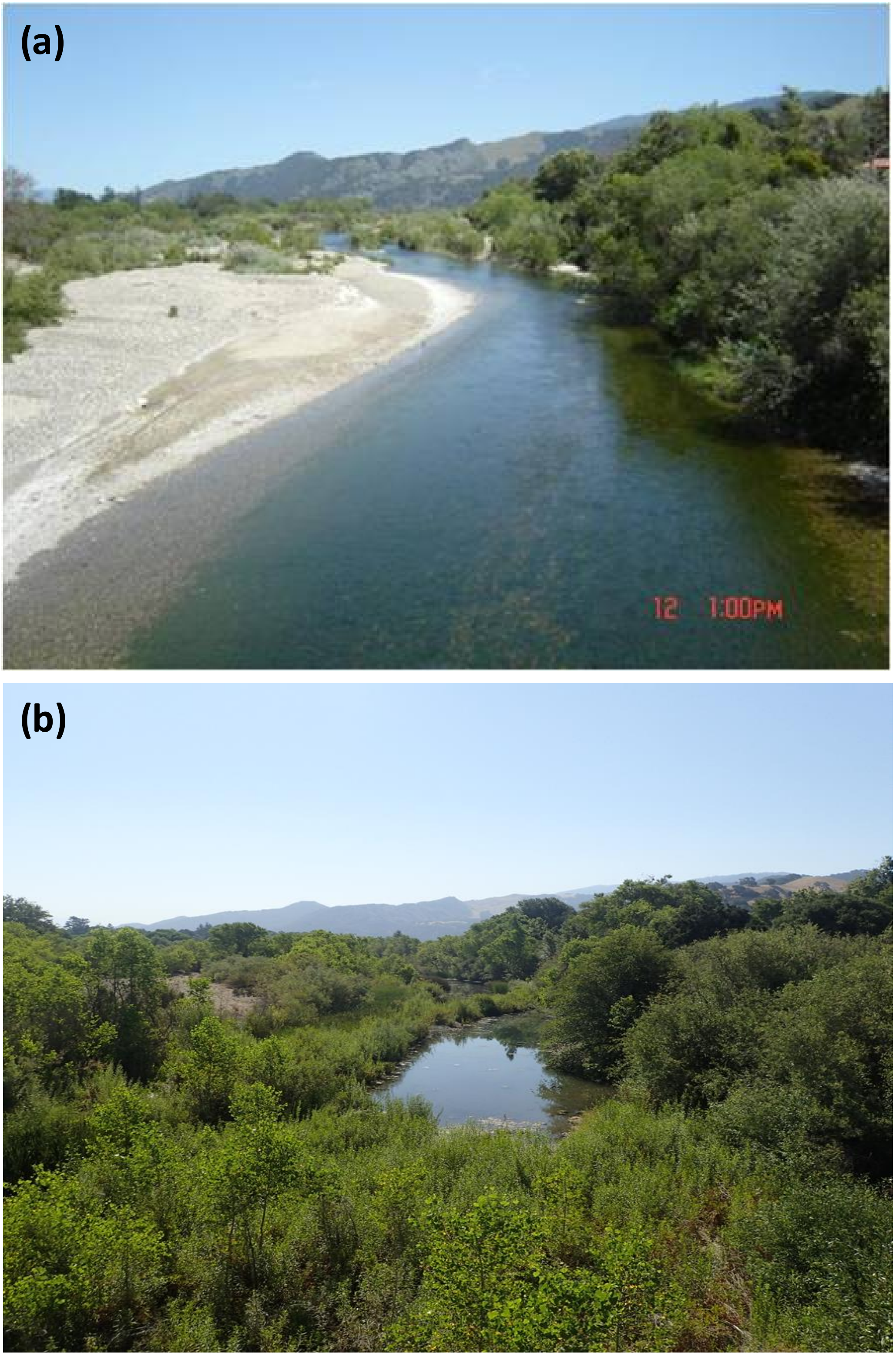


Figure 41: Photo point (M-12) collected at Refugio Bridge looking upstream in (a) May 2005, and (b) July 2017.

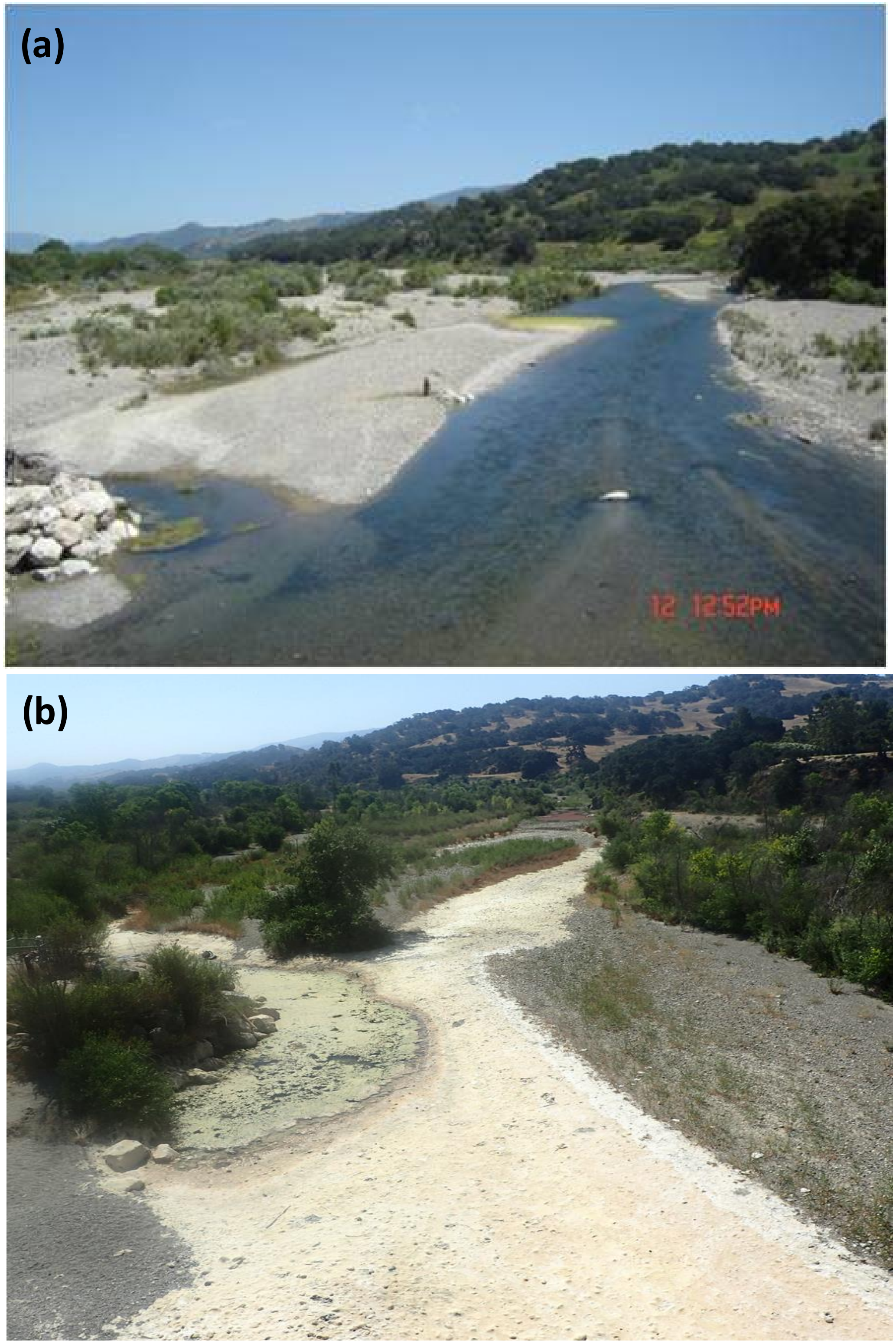


Figure 42: Photo point (M-14) collected at Alisal Bridge looking upstream in a) May 2005, and b) July 2017.

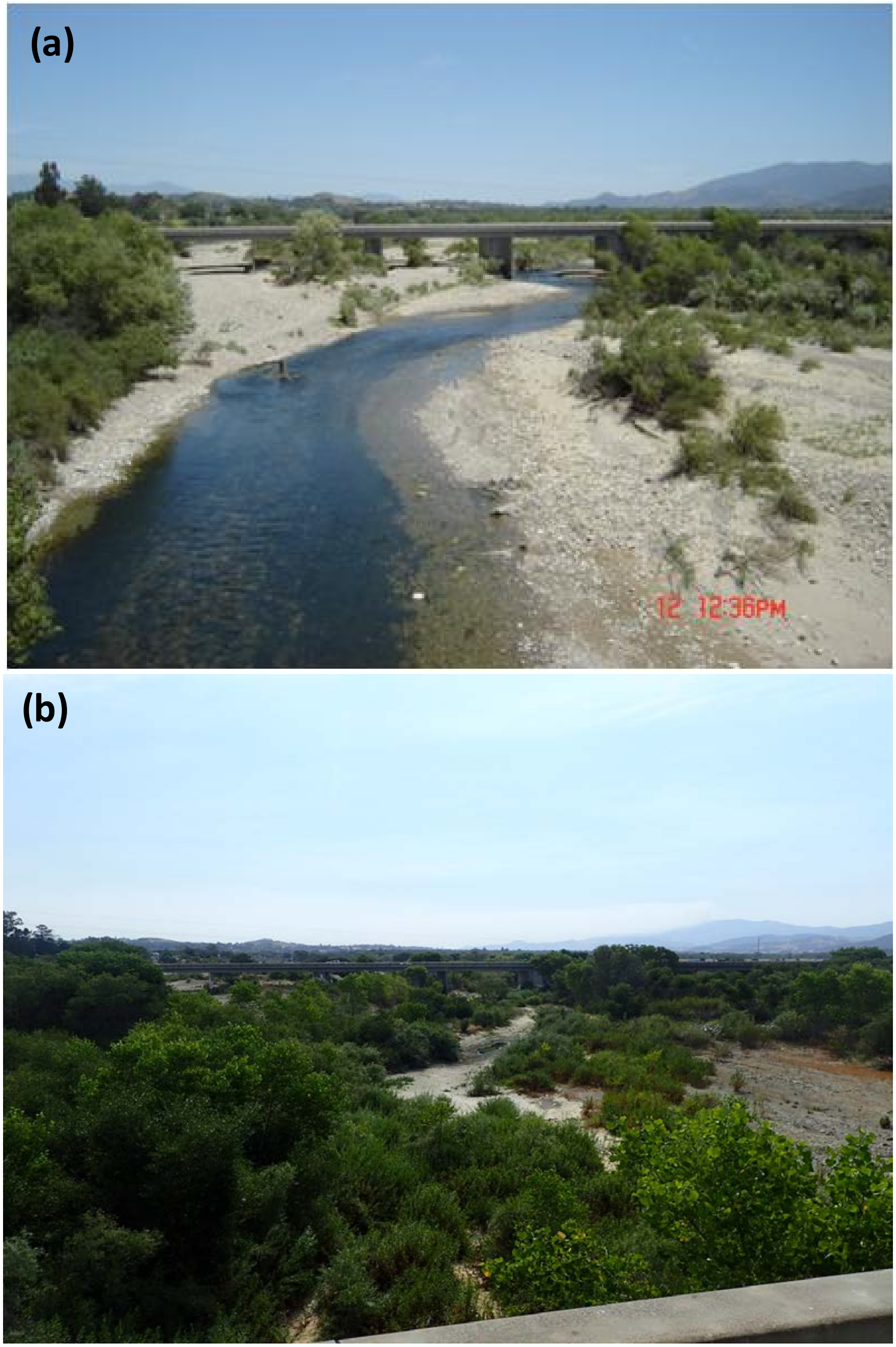


Figure 43: Photo point (M-19) collected at Avenue of the Flags Bridge looking upstream in (a) May 2005, and (b) July 2017.

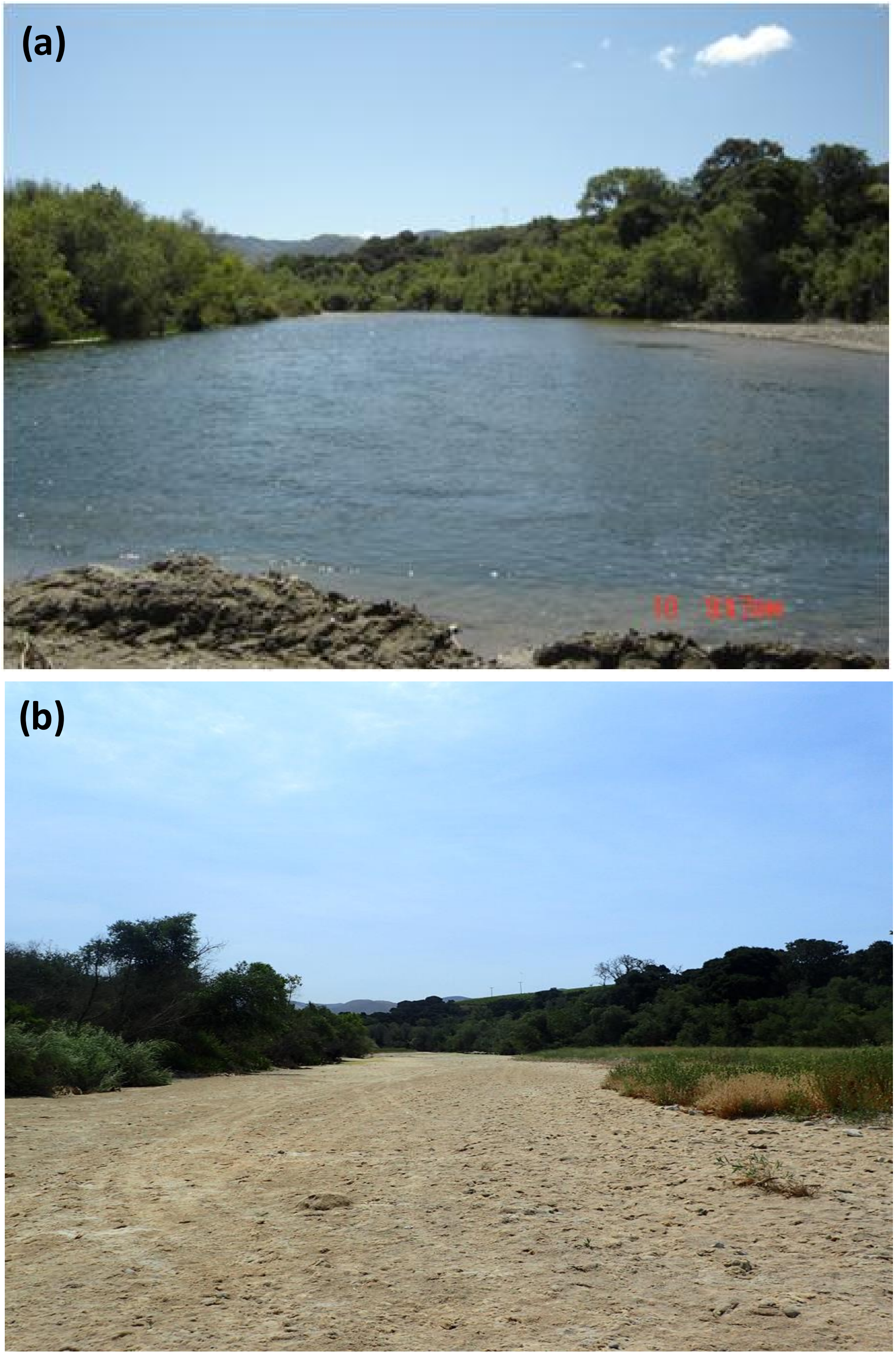


Figure 44: Photo point (M-21) collected at Sweeney Road Crossing looking upstream in (a) May 2005, and (b) July 2017.

Figure 45: Photo point (T-1) collected at Hilton Creek looking upstream towards the trap site on (a) May 2005, and (b) July 2017.

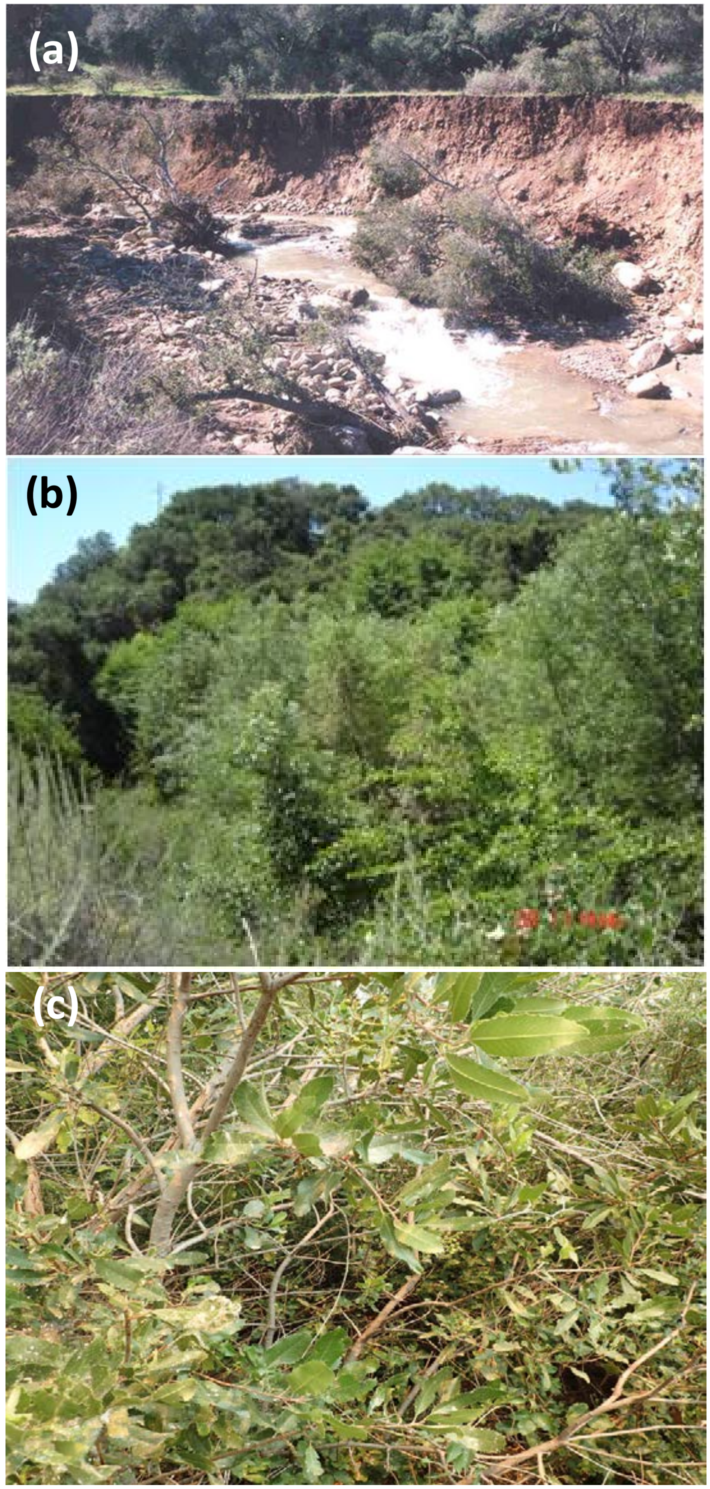


Figure 46: Photo point (T-6) collected at the Hilton Creek ridge trail looking upstream in (a) March 1999, (b) May 2005, and (c) July 2017. The creek is nearly invisible now from this vantage point.

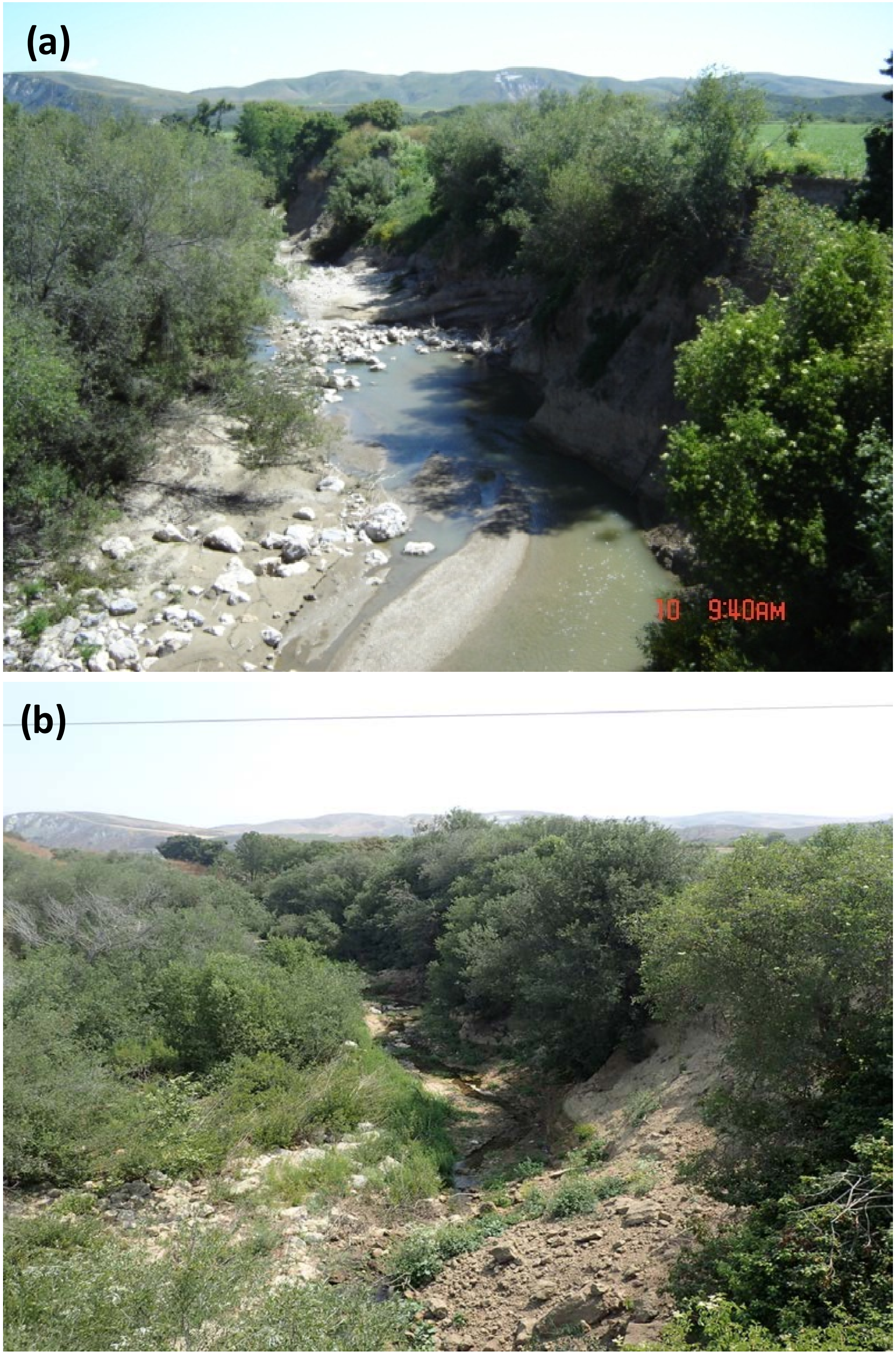


Figure 47: Photo point (T-28) collected at Salsipuedes Creek at Santa Rosa Bridge in (a) May 2005 and (b) July 2017.

Figure 48: Photo point (T-39) collected at Salsipuedes Creek at Hwy 1 Bridge in May 2005 and (b) July 2017.

Figure 49: Photo point (T-42) collected at Salsipuedes Creek at Jalama Road Bridge in May 2005 and (b) July 2017.

3.4 Migrant Trapping

Table 7: WY2017 migrant trap deployments.

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 Creek	2/12/2017	4/21/2017					
	Total:	69		**Total:**	0	69	100%
Salsipuedes Creek	2/12/2017	4/21/2017					
	Total:	69		**Total:**	0	69	100%
LSYR Mainstem	No trapping conducted						
	Total:			**Total:**	0		

Table 8: WY2017 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	1	~	69	69	100%	0.01	0	0.01	1.3	0.88
Hilton DN	~	4	69	69	100%	0	0.06	0.06	1.3	0.88
Salsipuedes	0	0	69	69	100%	0.00	0.00	0.00	51.5	5.0
Mainstem	0	0	0	0	0%	0.00	0.00	0.00	83.1	9.6

~ Not applicable.

Table 9: 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 WY2017.

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

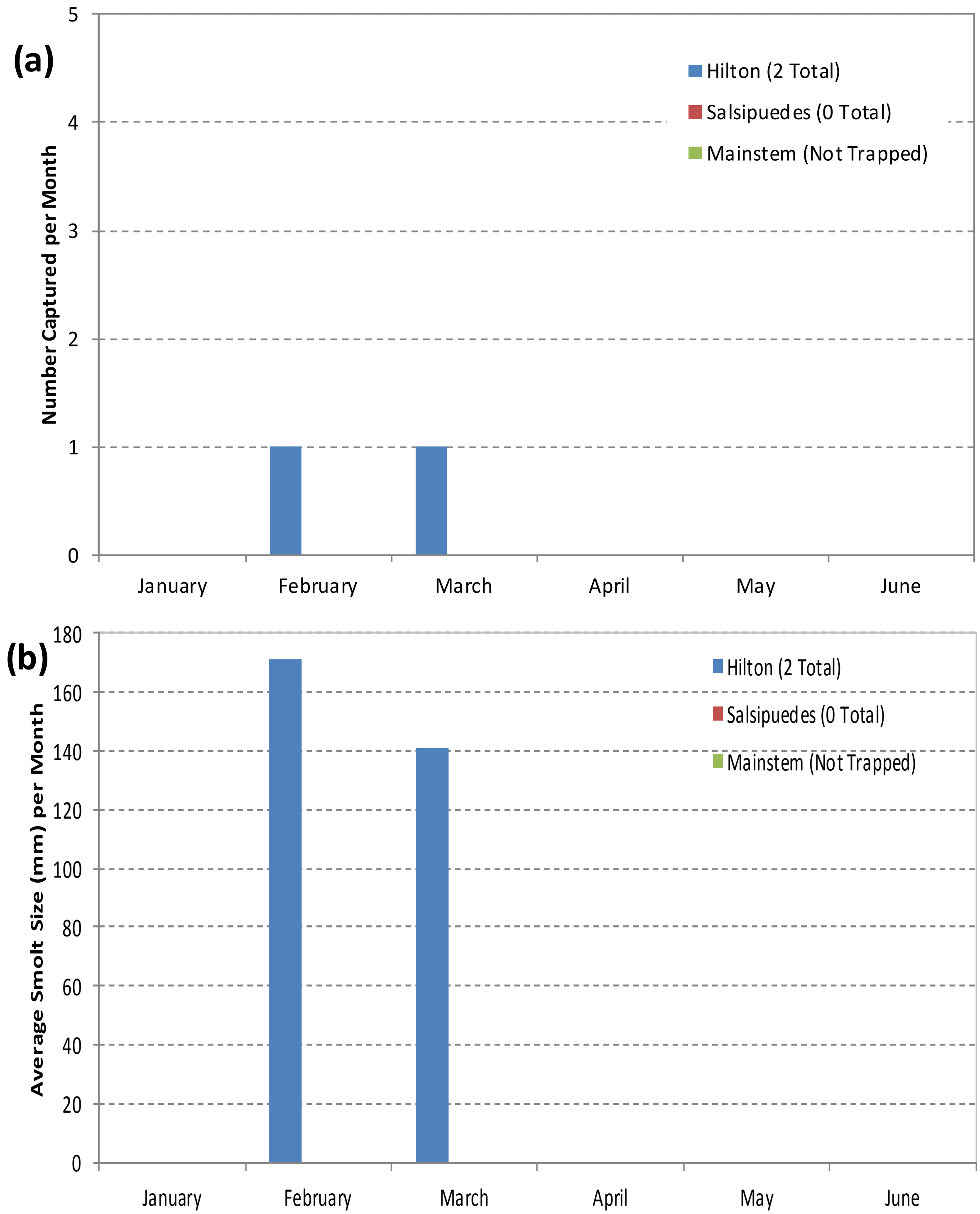


Figure 50: Monthly smolt captures observed at the Hilton Creek, Salsipuedes Creek, and LSYR mainstem traps in WY2017 showing: (a) number captured at each site and (b) average size of smolts captured by month; trapping period was 2/12/17 to 4/21/17.

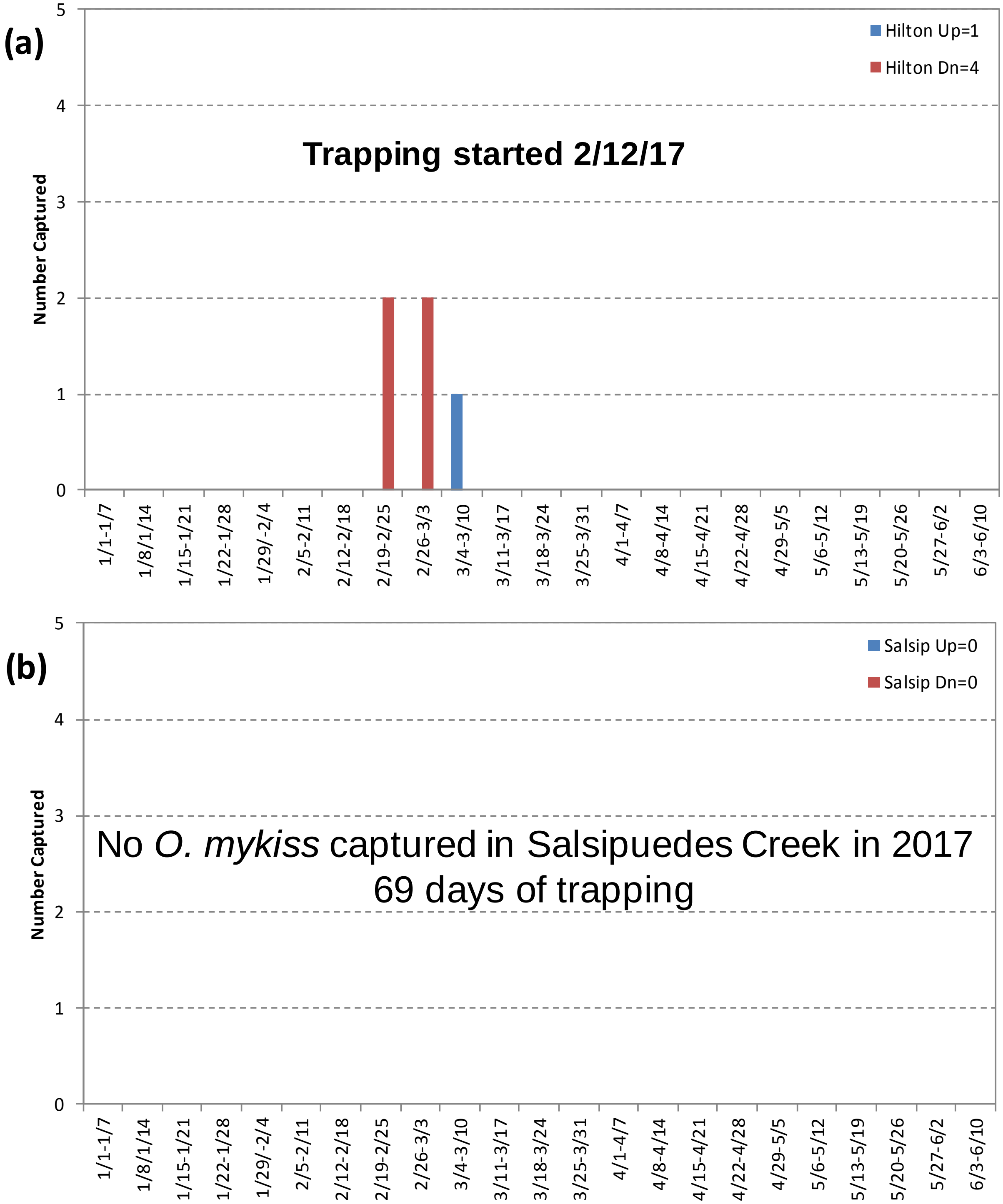


Figure 51: WY2017 paired histogram of weekly upstream and downstream captures by trap site for: (a) Hilton Creek and (b) Salsipuedes Creek.

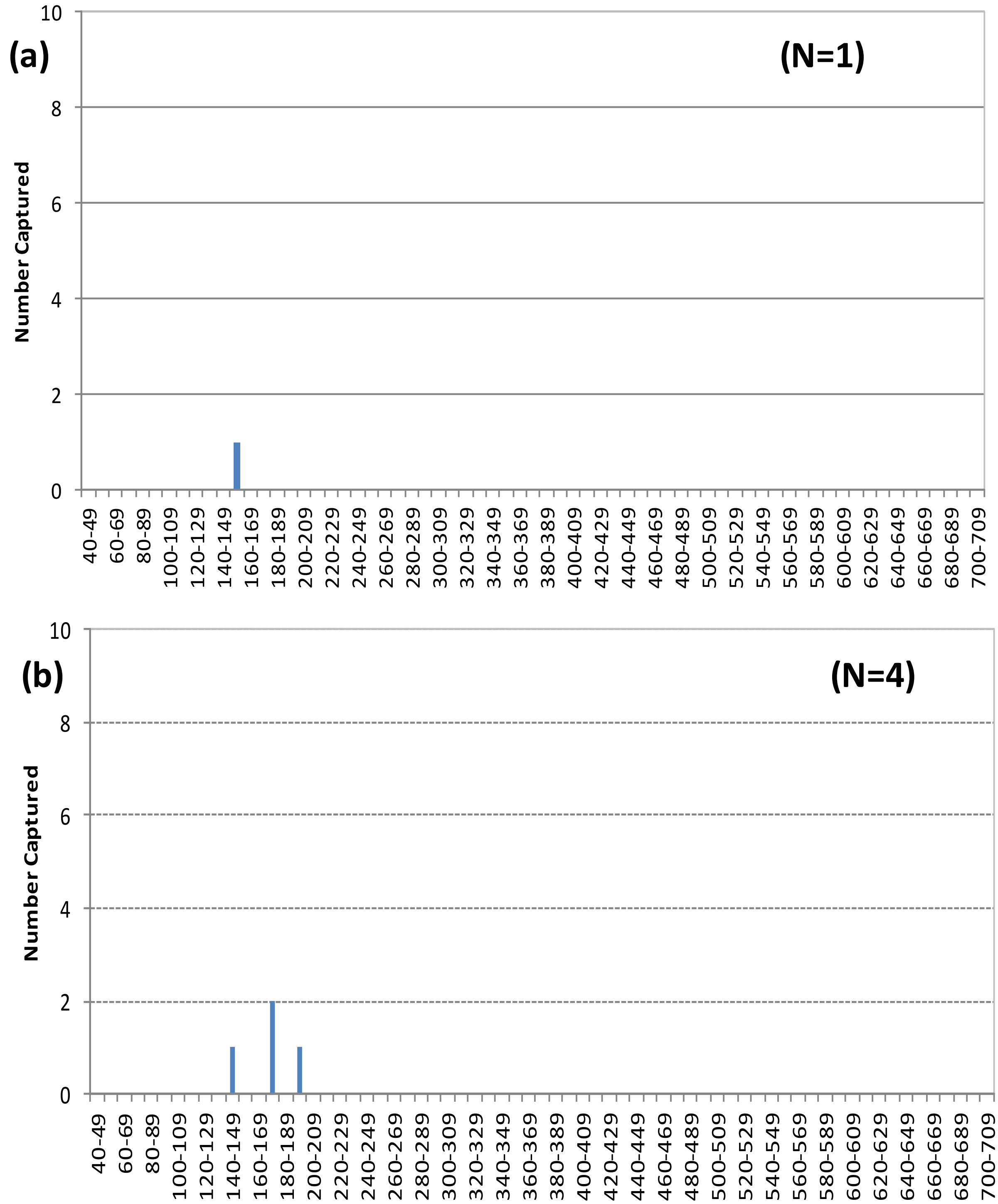


Figure 52: WY2017 Hilton Creek trap length-frequency histogram in 10-millimeter intervals for (a) upstream and (b) downstream migrant captures.

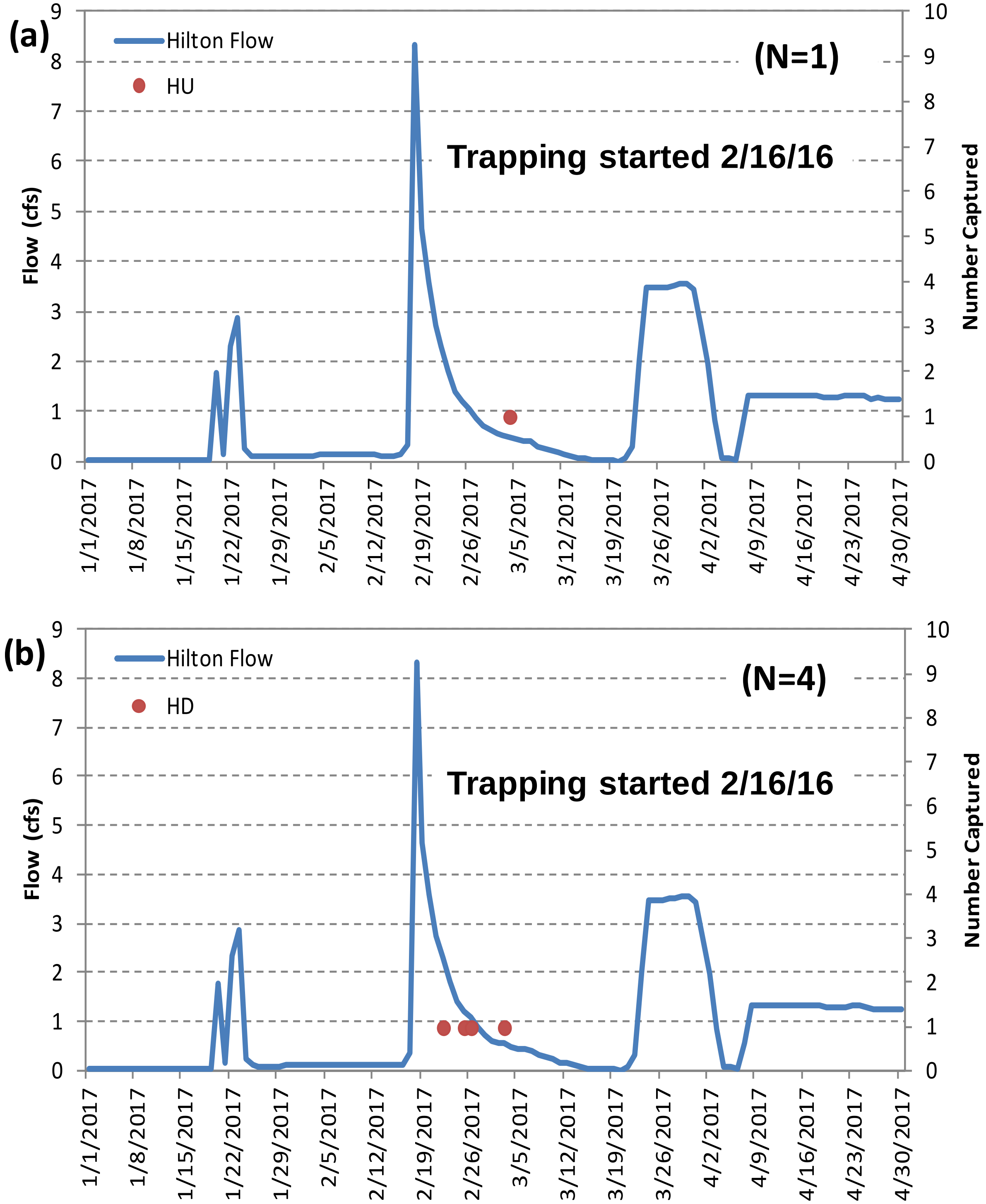


Figure 53: WY2017 Hilton Creek migrant captures (red dots) vs. flow: (a) upstream migrant captures and (b) downstream migrant captures.

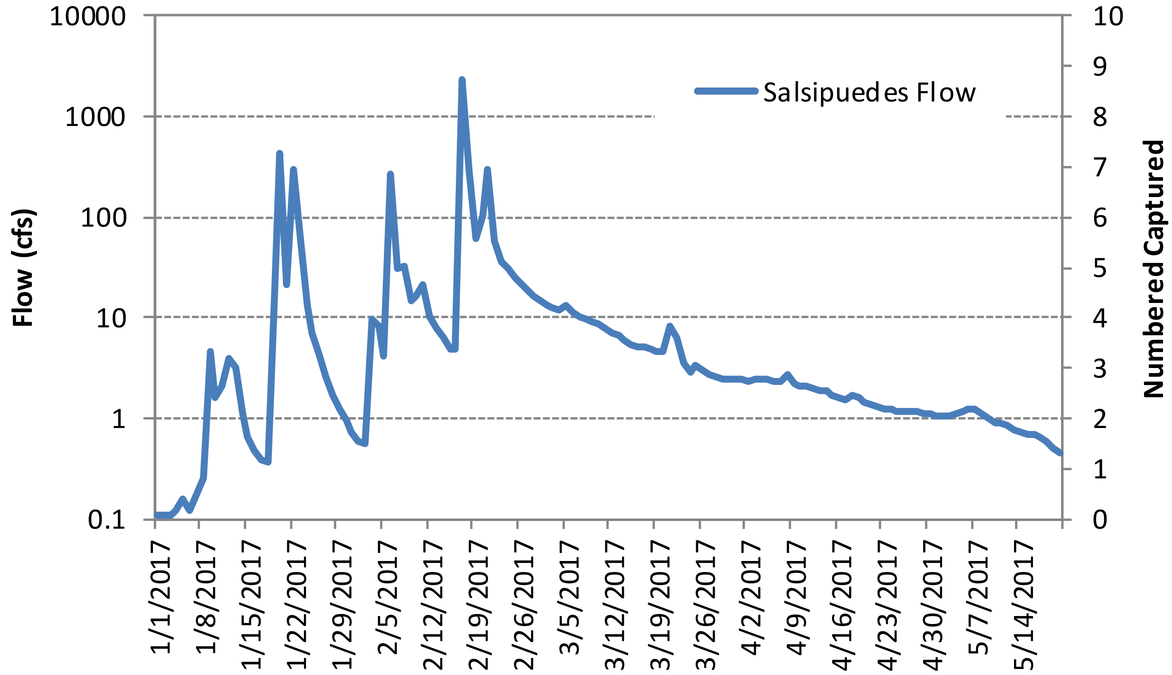


Figure 54: WY2017 Salsipuedes Creek migrant captures (red dots) vs. flow for (a) upstream and (b) downstream migrants. No *O. mykiss* were captured in Salsipuedes Creek in 69 days of trapping in 2017.

Table 10: Tributary upstream and downstream migrant captures for Hilton Creek and Salsipuedes Creek in WY2017; blue lettering represents breakdown of smolts, pre-smolts, and resident trout for each size category.

Hilton Captures (#)		Size (mm)	Salsipuedes Captures (#)
		Upstream Traps	
0		>700	0
0		650-699	0
0		600-649	0
0		550-599	0
0		500-549	0
0		450-499	0
0		400-449	0
0		300-399	0
0		200-299	0
1		100-199	0
0		<99	0
1		**Total**	**0**
		Downstream Traps	
0		>700	0
0		650-699	0
0		600-649	0
0		550-599	0
0		500-549	0
0		450-499	0
0		400-449	0
0		300-399	0
0		200-299	0
	0	***Smolts***	
	0	***Pre-Smolt***	
	0	***Res***	
4		100-199	0
	0	***Smolts***	
	2	***Pre-Smolt***	
	2	***Res***	
0		<99	0
	0	***Smolts***	
	0	***Pre-Smolt***	
	0	***Res***	
4		**Total**	**0**

Table 11: WY2017 tributary redd survey results; lengths and widths are given in feet.

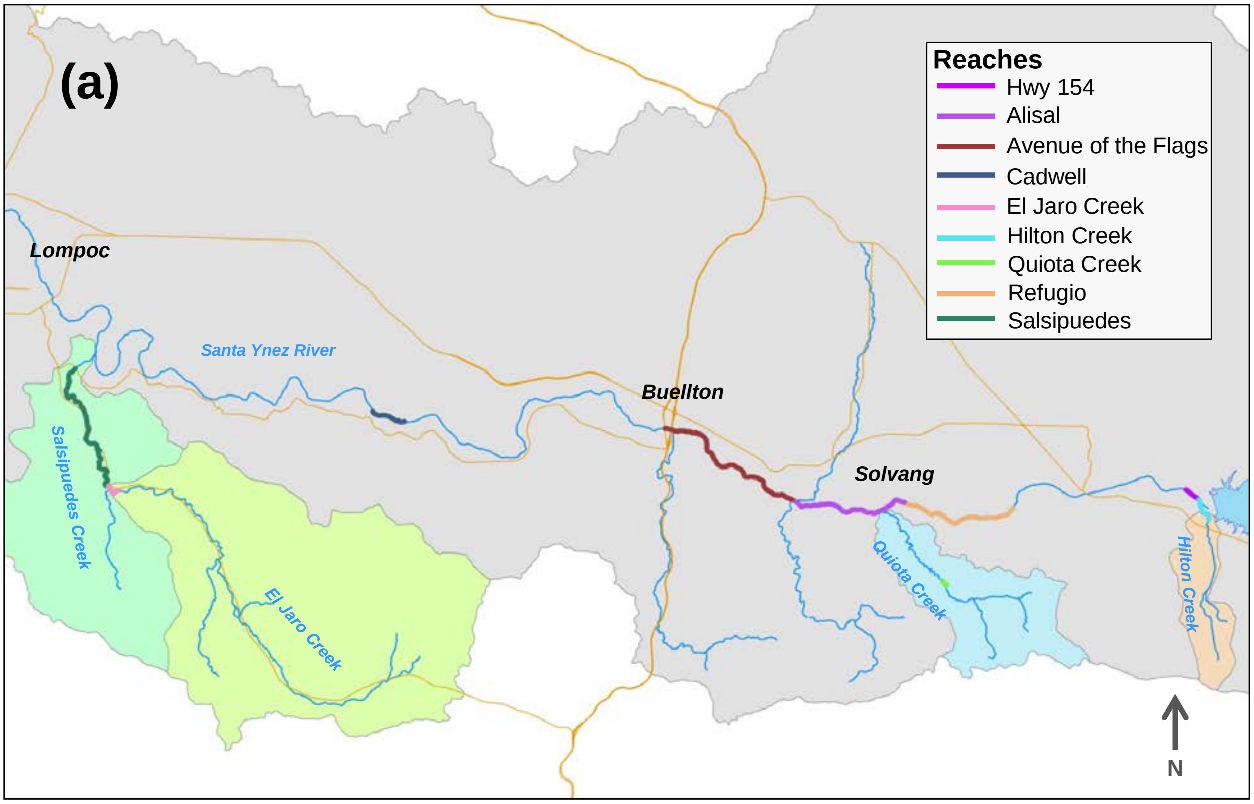
Location	Date	Redd#	Length*	Width**
Tributary Redds				
Hilton Ck	3/21/2017	1	1.40	0.7
	3/21/2017	2	1.30	0.6
Salsipuedes Ck	4/12/2017	3	5.40	1.7
	4/12/2017	4	4.60	2.2
	4/12/2017	5	6.40	3.3
Quiota Ck	6/7/2017	6	1.80	1.0
* Pit length plus tail spill length.				
** Average of all width measurements.				

Table 12: WY2017 tributary redd observations by month for each creek surveyed.

	January	February	March	April	May	Total
Hilton Ck	n/s	0	2	0	n/s	2
Quiota Ck	n/s	0	0	1	n/s	1
Salsipuedes Ck	n/s	0	0	3	n/s	3
El Jaro Ck	n/s	0	0	0	n/s	0
Los Amoles CK	n/s	0	0	0	n/s	0
Ytias Ck	n/s	0	0	0	n/s	0
Total:	**n/s**	**0**	**2**	**4**	**n/s**	**6**
n/s - not surveyed due to turbid conditions or low water level.						

Table 13: WY2017 LSYR mainstem redd survey results within the management reaches (Refugio and Alisal reaches) by month.

	January	February	March	April	May	Total
Highway 154	n/s	0	n/s	n/s	n/s	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
n/s - not surveyed due to turbid conditions or low water level.						



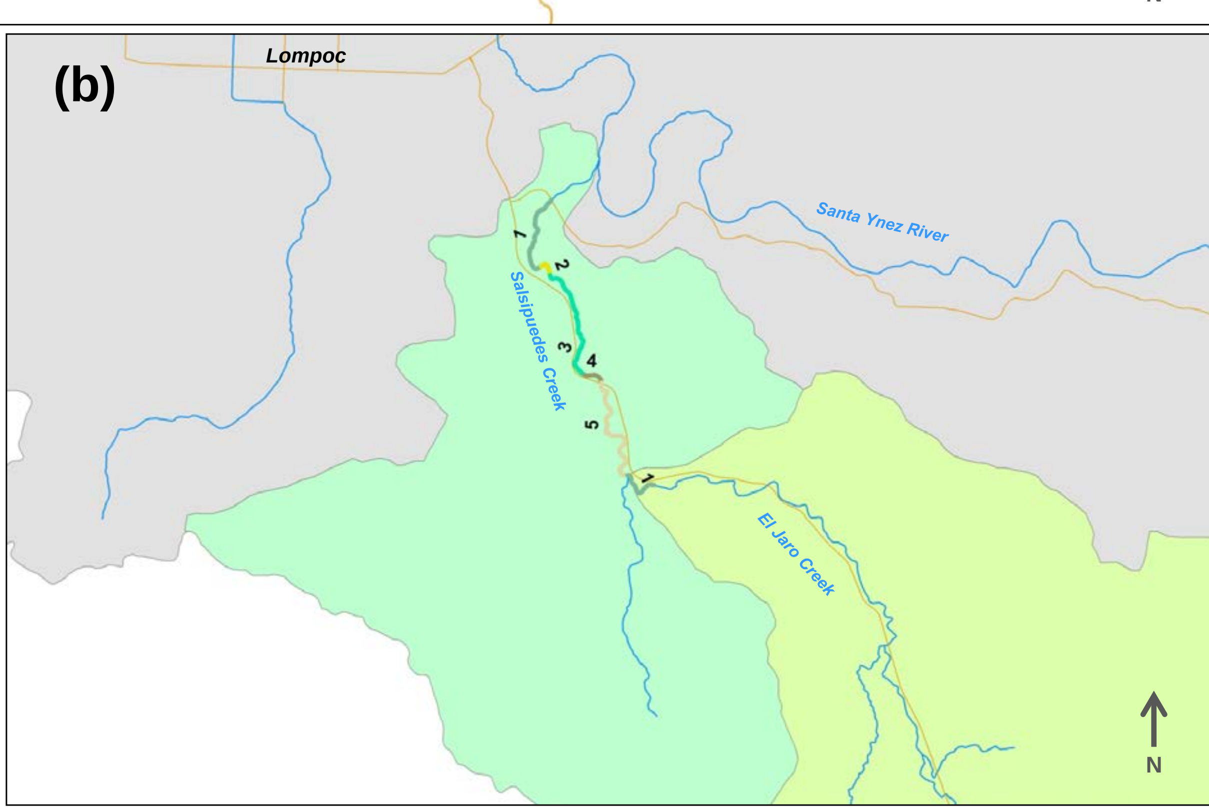


Figure 55: Stream reaches snorkel surveyed in 2017 with suitable habitat and where access was granted within the (a) LSYR mainstem and its tributaries, and (b) Salsipuedes Creek.

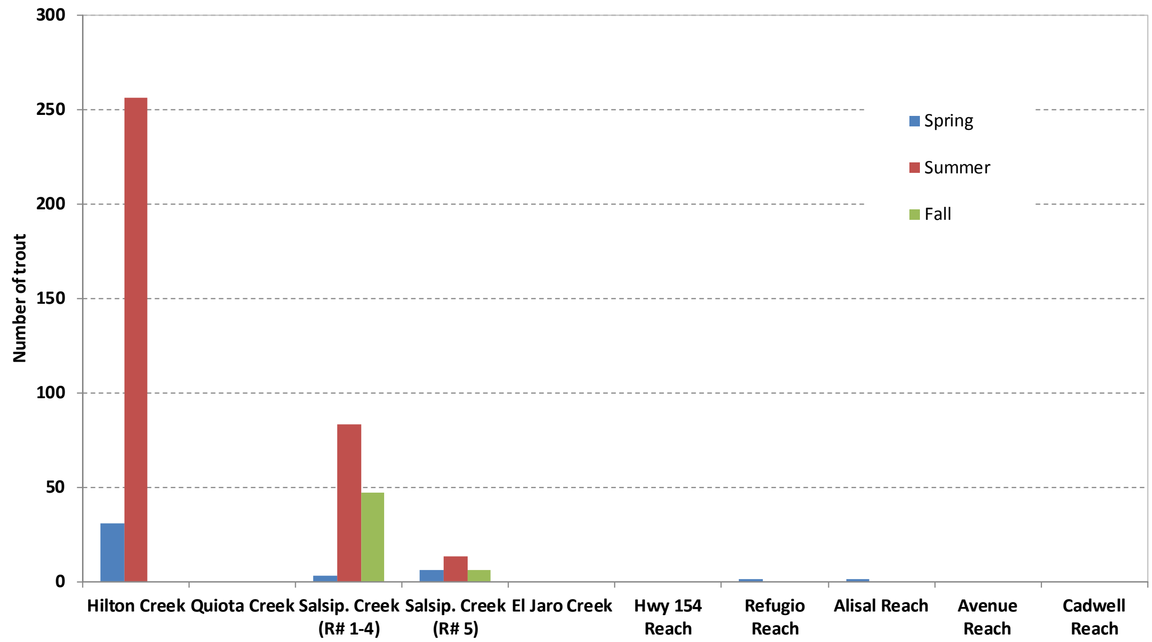


Figure 56: 2017 LSYR steelhead/rainbow trout observed during spring, summer and fall snorkel surveys.

Table 14: 2017 LSYR mainstem snorkel survey schedule.

Mainstem/Stream Miles	Season	Survey Date
Hwy 154 Reach	Spring	6/21/2017
(LSYR-0.2 to LSYR-0.7)	Summer	n/s
	Fall	11/20/2017
Refugio Reach	Spring	5/24/2017
(LSYR-4.9 to LSYR-7.8)	Summer	10/2/17 - 10/3/17
	Fall	11/9/17 - 11/10/17
Alisal Reach	Spring	5/24/17-5/30/17
(LSYR-7.8 to LSYR-10.5)	Summer	10/3/17 - 10/4/17
	Fall	11/10/17 - 11/13/17
Avenue Reach	Spring	6/5/2017
(LSYR-10.5 to LSYR-13.9)	Summer	10/4/17 - 10/12/17
	Fall	11/14/17 - 11/15/17
Reach 3 Downstream of Avenue	Spring	5/31/2017
(LSYR-13.9 to LSYR-25.0)	Summer	10/12/17 - 10/17/17
	Fall	11/15/17 - 11/17/17
n/s - not surveyed.		

Table 15: LSYR mainstem spring, summer, and fall snorkel survey results in 2017 with the miles surveyed; the level of effort was the same for each snorkel survey.

Mainstem	Spring (# of trout)	Summer (# of trout)	Fall (# of trout)	Survey Distance (miles)
Hwy 154 Reach	0	0	0	0.26
Refugio Reach	1	0	0	2.95
Alisal Reach	1	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 2017 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	Hwy 154	0	0	0	0	0	0	0	0	0	0
	Refugio	0	0	0	1	0	0	0	0	0	1
	Alisal	0	0	0	1	0	0	0	0	0	1
	Avenue	0	0	0	0	0	0	0	0	0	0
	Cadwell	0	0	0	0	0	0	0	0	0	0
Summer	Hwy 154										n/s
	Refugio	0	0	0	0	0	0	0	0	0	0
	Alisal	0	0	0	0	0	0	0	0	0	0
	Avenue	0	0	0	0	0	0	0	0	0	0
	Cadwell	0	0	0	0	0	0	0	0	0	0
Fall	Hwy 154	0	0	0	0	0	0	0	0	0	0
	Refugio	0	0	0	0	0	0	0	0	0	0
	Alisal	0	0	0	0	0	0	0	0	0	0
	Avenue	0	0	0	0	0	0	0	0	0	0
	Cadwell	0	0	0	0	0	0	0	0	0	0

n/s - not surveyed.

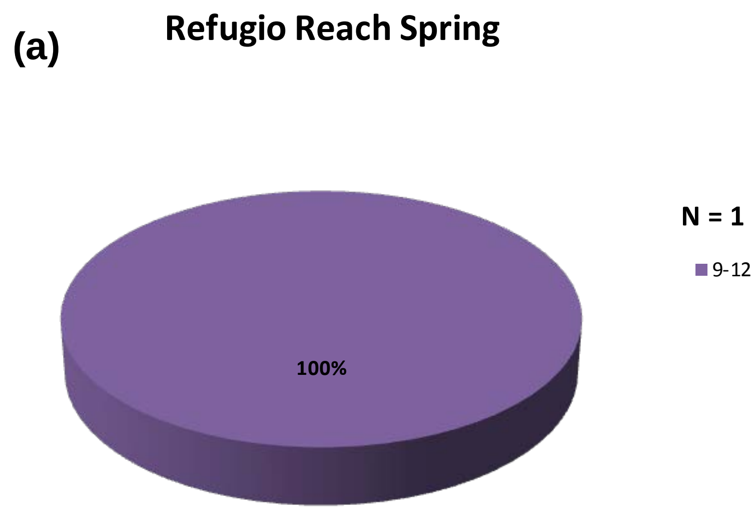


Figure 57: 2017 Refugio Reach fall snorkel survey with size classes (range) of fish observed in inches.

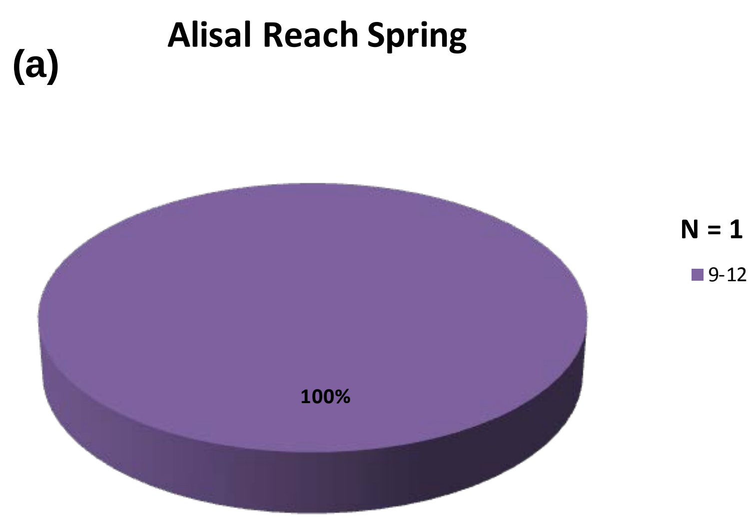


Figure 58: 2017 Alisal Reach fall snorkel survey with size classes (range) of fish observed in inches.

Table 17: 2017 tributary snorkel survey schedule.

Tributaries/Stream Miles	Season	Survey Date
Hilton Creek	Spring	4/7/2017
(HC-0.0 to HC-0.54)	Summer	9/6/17-9/7/17
	Fall	n/s
Quiota Creek	Spring	5/9/2017
(QC-2.58 to QC-2.73)	Summer	9/11/2017
	Fall	11/29/2017
Salsipuedes Creek	Spring	4/11/17 - 4/13/17
(Reach 1-4)	Summer	9/12/17-9/14/17
	Fall	11/28/17 - 11/30/17
Salsipuedes Creek	Spring	5/10/2017
(Reach 5)	Summer	9/14/17-9/26/17
	Fall	11/30/2017
El Jaro Creek	Spring	5/10/2017
(ELC-0.0 to ELC-0.4)	Summer	dry
	Fall	dry
n/s - not surveyed due to turbid conditions or low water level.		

Table 18: *O. mykiss* observed and miles surveyed during all tributary snorkel surveys in WY2017; the level of effort was the same for each survey.

Tributaries	Spring (# of trout)*	Summer (# of trout)	Fall (# of trout)	Survey Distance (miles)
Hilton Creek				
Reach 1	0	34	n/s	0.133
Reach 2	3	73	n/s	0.050
Reach 3	1	55	n/s	0.040
Reach 4	27	93	n/s	0.075
Reach 5	n/s	1	n/s	0.242
Reach 6	n/s	n/s	n/s	0.014
Total:	***31***	***256***	***n/s***	***0.554***
Quiota Creek	0	0	0	0.11
Salsipuedes Creek (Reach 1-4)	3	81	47	2.85
Salsipuedes Creek (Reach 5)	6	13	6	0.45
El Jaro Creek	0	dry	dry	0.35
n/s - not surveyed due to turbid conditions or low water level.				

Table 19: WY2017 tributary spring, summer and fall snorkel survey results 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	0	3	25	3	0	0	0	0	0	31
	Quiota	0	0	0	0	0	0	0	0	0	0
	Salsipuedes (R 1-4)	0	0	0	0	2	1	0	0	0	3
	Salsipuedes (R-5)	4	0	0	0	1	1	0	0	0	6
	El Jaro	0	0	0	0	0	0	0	0	0	0
Summer	Hilton	149	73	13	16	5	0	0	0	0	256
	Quiota	0	0	0	0	0	0	0	0	0	0
	Salsipuedes (R 1-4)	30	47	2	0	1	1	0	0	0	81
	Salsipuedes (R-5)	3	6	2	1	1	0	0	0	0	13
	El Jaro	0	0	0	0	0	0	0	0	0	dry
Fall	Hilton	0	0	0	0	0	0	0	0	0	n/s
	Quiota	0	0	0	0	0	0	0	0	0	0
	Salsipuedes (R 1-4)	8	32	6	0	0	1	0	0	0	47
	Salsipuedes (R-5)	0	4	0	0	1	1	0	0	0	6
	El Jaro										dry
n/s - not surveyed due turbid conditions or low water level.											

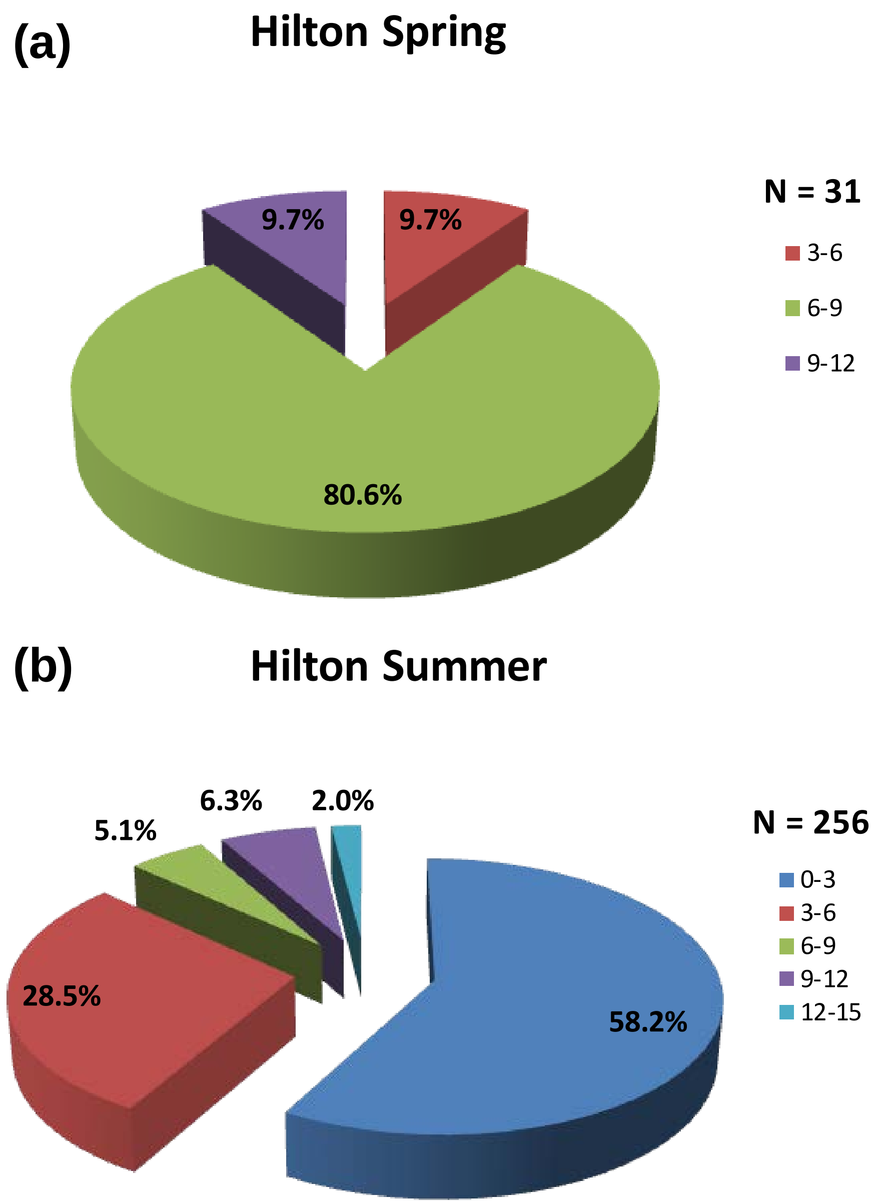


Figure 59: WY2017 Hilton Creek snorkel survey with size classes (range) of fish observed in inches.

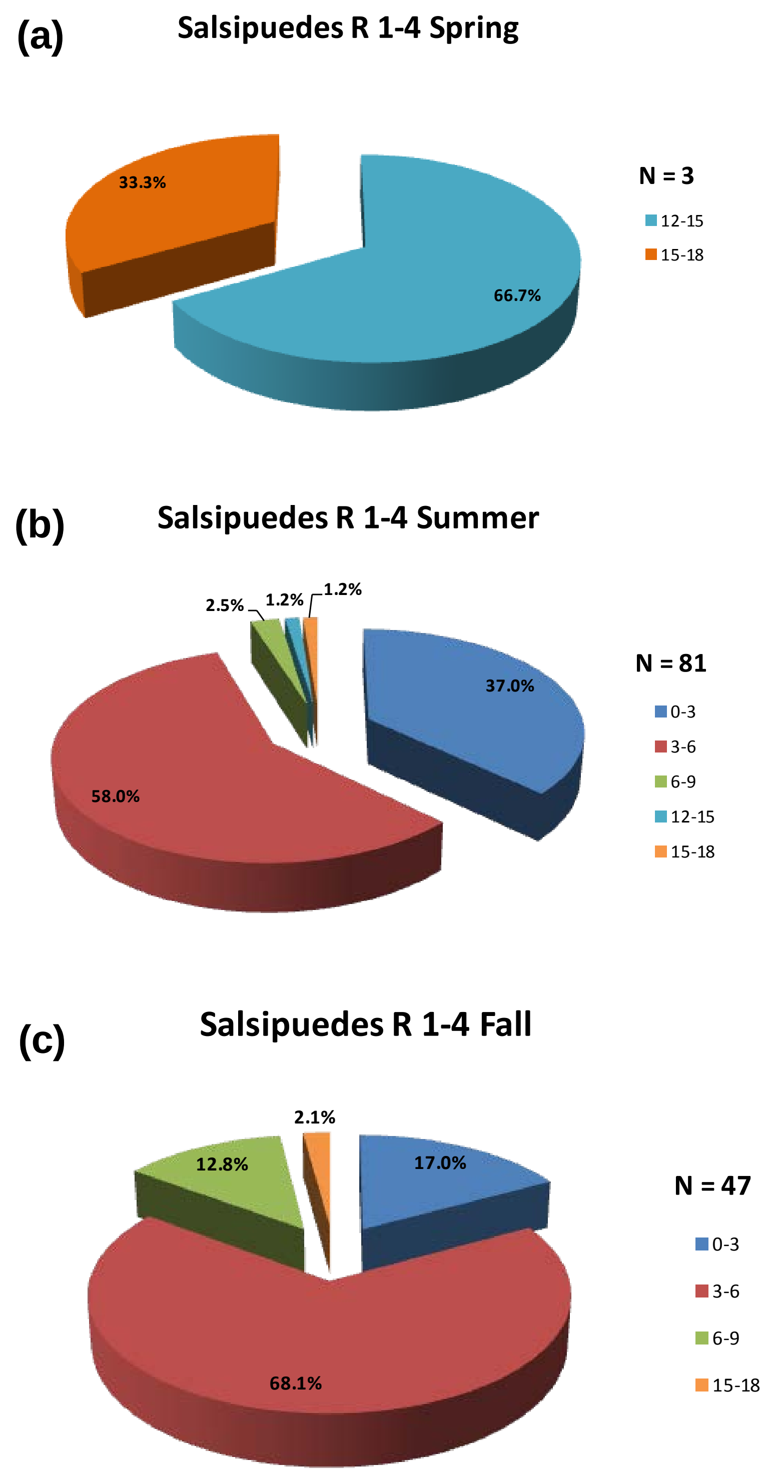


Figure 60: WY2017 Salsipuedes Creek Reach 1-4 snorkel survey with size classes (range) of fish observed in inches.

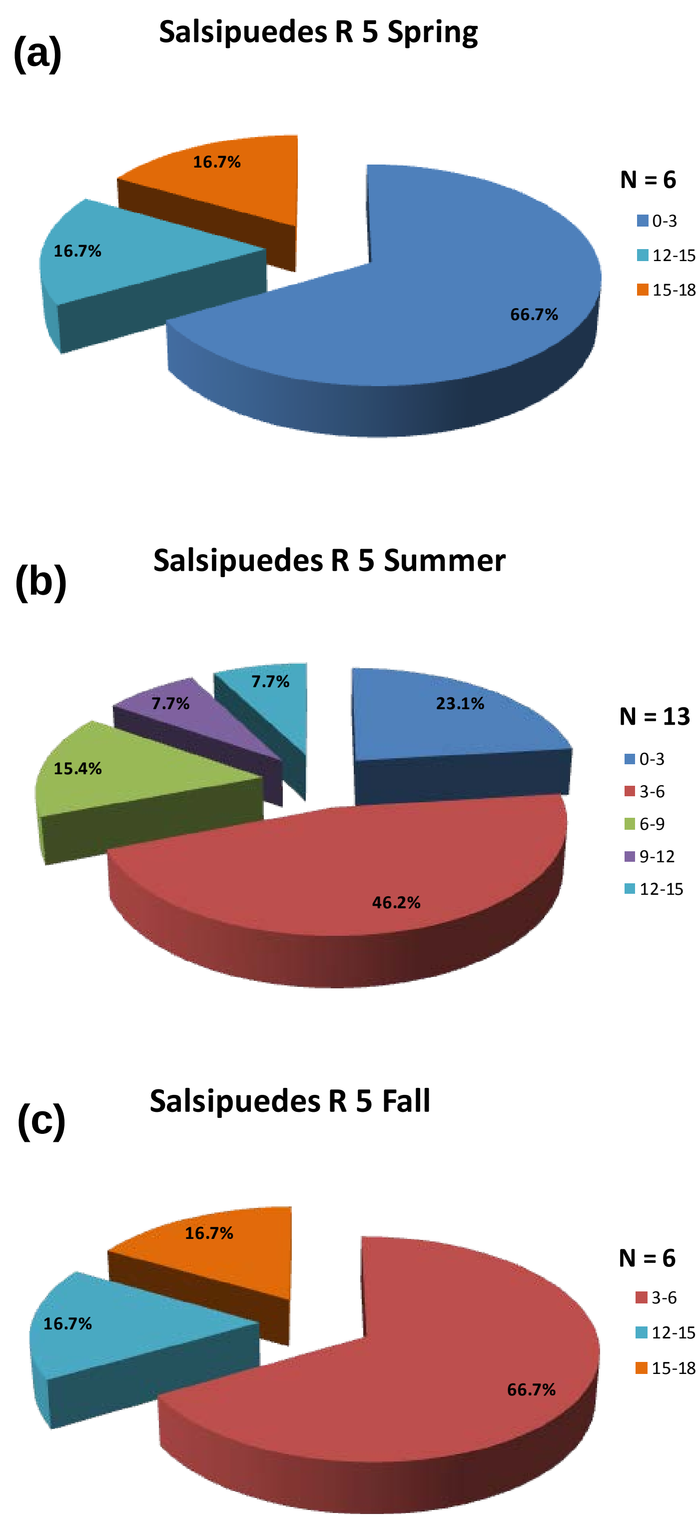


Figure 61: WY2017 Salsipuedes Creek Reach 5 snorkel survey with size classes (range) of fish observed in inches.

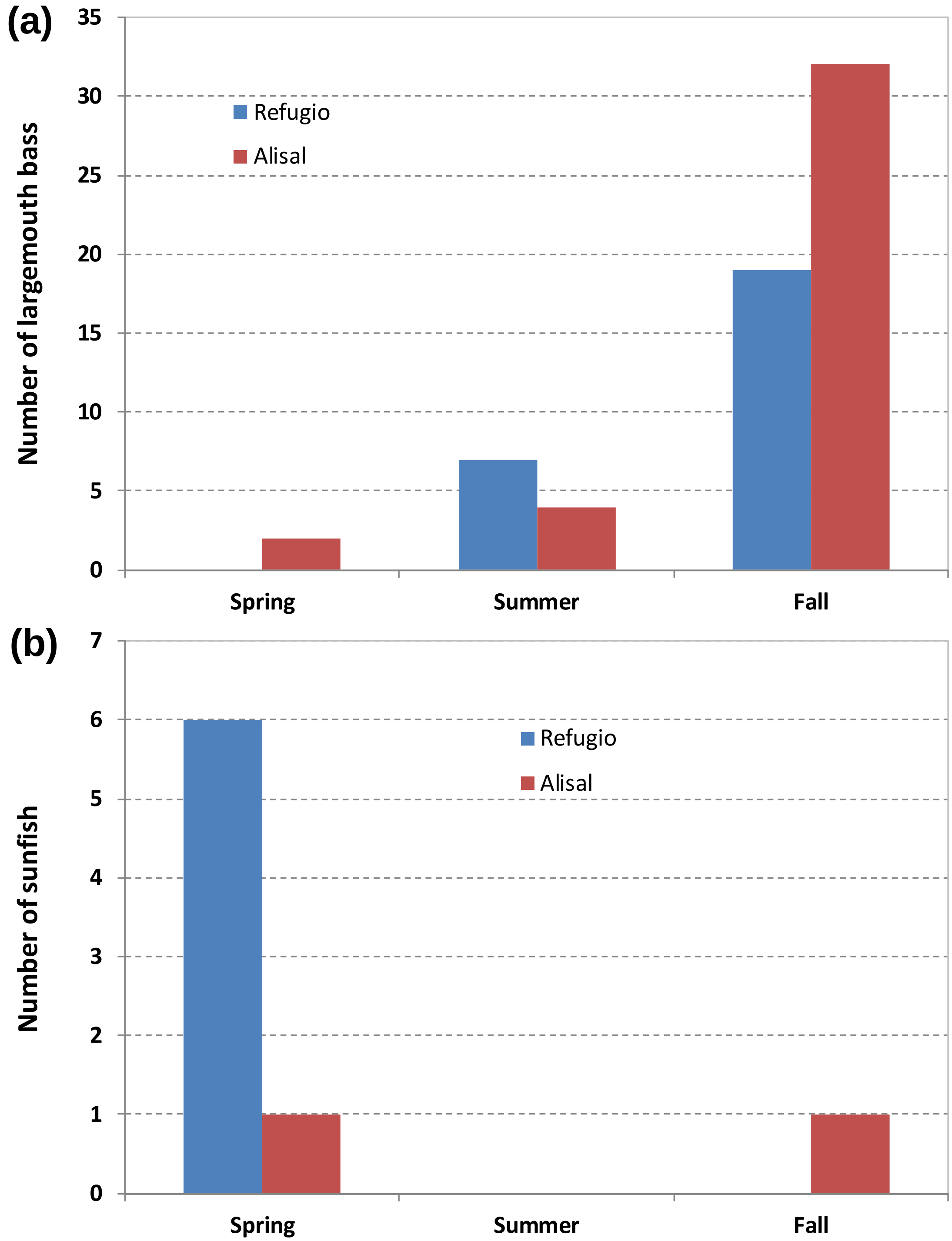
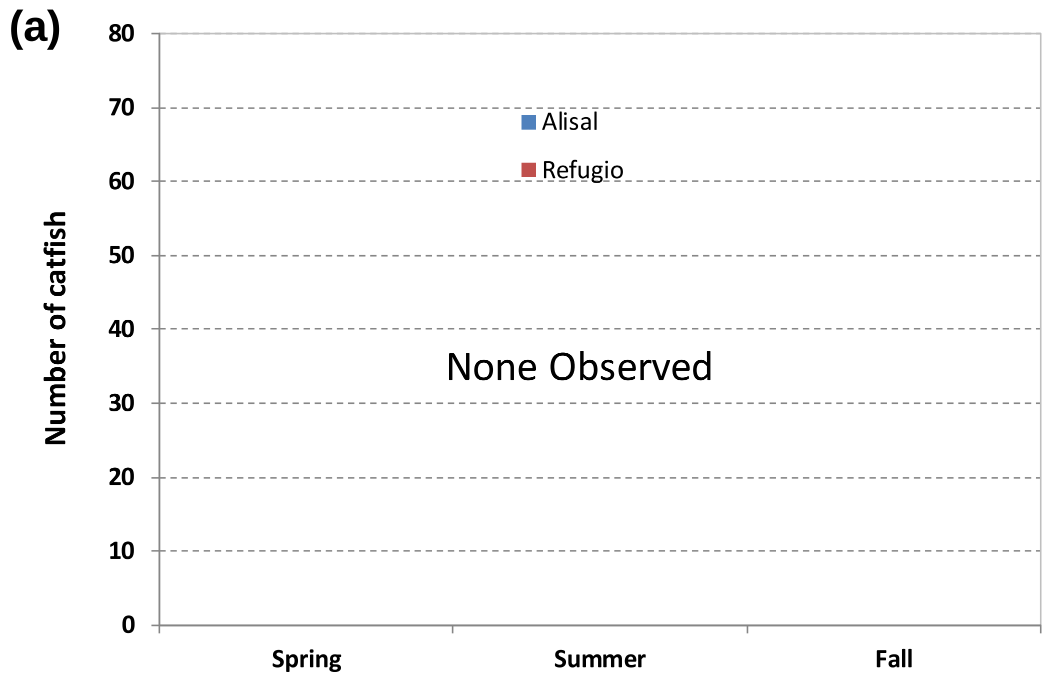


Figure 62: Observed warm water predators during the spring, summer and fall snorkel surveys in WY2017 within the Refugio and Alisal reaches: (a) largemouth bass and (b) sunfish.



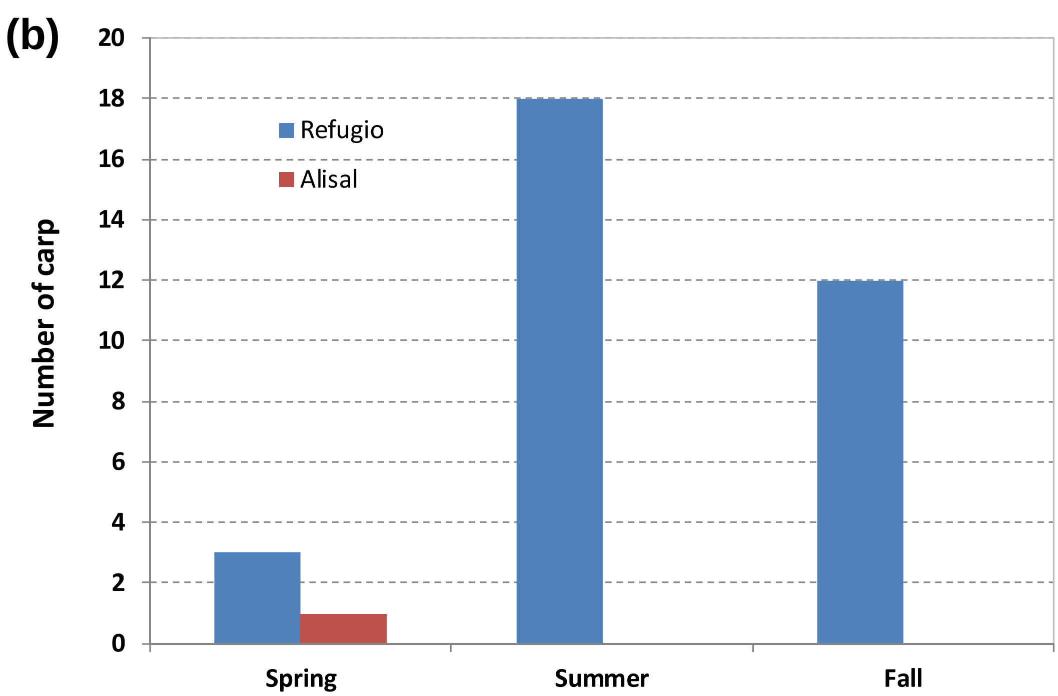
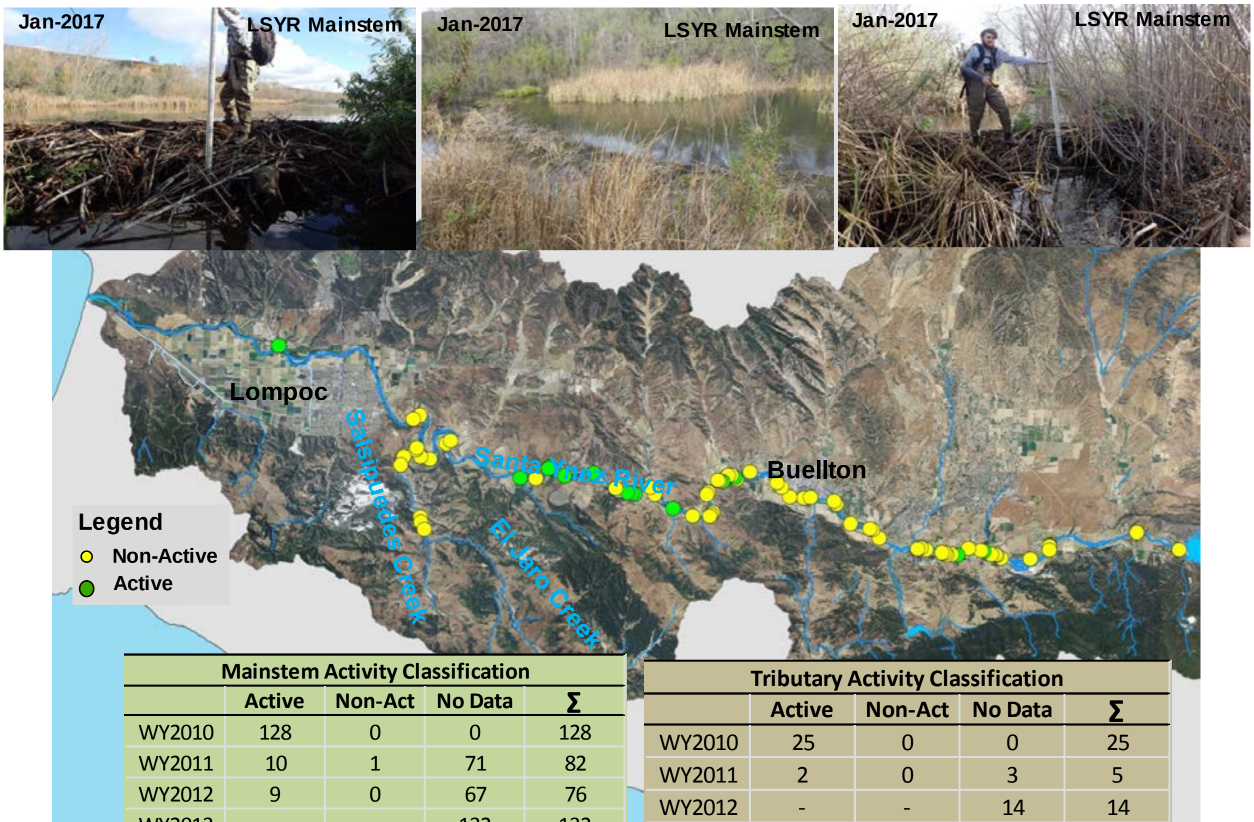


Figure 63: Observed warm water predators during the spring, summer and fall snorkel surveys in WY2017 within the Refugio and Alisal reaches: (a) catfish, and (b) carp.



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
WY2017*	14	52	0	66

* Additional reaches surveyed from previous year.

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
WY2017	0	8	0	8

Figure 64: Spatial extent of beaver dams from the WY2017 survey within the LSYR drainage where 66 dams (14 active) were observed in the LSYR mainstem and 8 dams (0 active) observed in the Salsipuedes Creek watershed.

Table 20: WY2010-WY2017 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
WY2017	8	29	28	1	0	66	1	5	2	0	0	8

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

4. Discussion

Table 21: Monthly rainfall totals at Bradbury Dam from WY2000-WY2017.

Month	Water Years:																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
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	1.13
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	1.21
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	1.92
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	8.81
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	10.61
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	3.01	0.83
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	0.20
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	0.32
Jun	0.04	0	0	0.02	0	0.04	0	0	0	0.16	0	0.34	0	0	0	0.42	0	0
Jul	0	0.06	0	0.01	0	0	0	0	0	0	0	0.00	0	0	0	0.03	0	0
Aug	0	0	0	0	0	0	0	0	0	0.03	0	0.00	0	0	0	0	0	0
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	0.45
Totals:	*21.47*	*31.75*	*8.78*	*19.76*	*10.55*	*44.41*	*24.49*	*7.41*	*22.59*	*13.66*	*23.92*	*31.09*	*12.69*	*7.57*	*9.96*	*9.38*	*10.84*	*25.48*

Table 22: Monthly average stream discharge at the USGS Solvang and Narrows gauges during WY2001-WY2017.

Month	WY2001		WY2002		WY2003		WY2004		WY2005		WY2006	
	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (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	6.1	9.4
Nov	n/d	14.8	n/d	12.3	8.11	15.2	0	0	6.4	14.2	6.9	16.0
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	37.3	24.6	10.7	26.7	1.6	1.54	2556.0	2765.0	40.0	79.4
Feb	n/d	321	n/d	21.6	12.7	27	8.96	38.4	2296.0	2555.0	12.2	28.0
Mar	n/d	3378	n/d	13.4	24.0	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	0.29	1.46	206.8	300.8	1317.0	1053.0
May	n/d	57.5	n/d	1.44	9.83	19.5	0	0.1	104.3	150.7	131.9	139.6
Jun	n/d	13.6	n/d	0.52	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	14.0	7.8	4.8
Aug	n/d	2.53	64.8	24.2	0	0.11	59.4	30.9	6.35	2.9	4.7	1.0
Sep	n/d	2.15	37.2	28.9	0	0	39.3	24.0	6.02	4.2	5.7	1.0

Month	WY2007		WY2008		WY2009		WY2010		WY2011		WY2012	
	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	7.3	1.0	25.0	17.5	3.0	0.0	6.8	0.0	19.8	18.3	7.6	4.3
Nov	5.8	1.0	7.4	8.5	5.8	0.0	1.6	0.0	6.9	12.8	8.3	11.1
Dec	7.7	10.0	6.6	13.2	7.0	1.0	6.9	0.0	53.1	203.3	7.9	14.6
Jan	9.4	15.3	265.0	496.3	6.1	5.1	72.8	183.6	27.6	85.8	8.0	16.9
Feb	10.4	18.6	401.1	490.1	17.7	33.4	72.1	180.7	24.0	100.3	7.5	14.1
Mar	8.8	10.7	93.9	158.4	12.1	19.6	26.4	67.8	1441.0	1267.0	6.0	11.7
Apr	4.5	1.4	8.5	18.9	4.4	5.2	34.9	50.9	321.5	422.0	8.8	14.7
May	1.5	0.5	6.3	6.8	5.1	0.6	6.1	12.6	39.0	70.8	5.6	5.5
Jun	1.9	0.1	5.1	2.5	7.1	0.3	1.3	1.9	13.9	29.4	4.7	0.5
Jul	35.8	1.4	7.1	0.4	3.5	0.0	0.3	0.4	9.3	10.7	4.6	0.0
Aug	55.2	30.8	3.7	0.1	3.7	0.0	52.7	21.6	7.8	3.1	4.9	0.0
Sep	31.0	23.4	3.8	0.0	4.1	0.0	29.8	19.2	8.5	2.2	6.6	0.0

Month	WY2013		WY2014		WY2015		WY2016		WY2017	
	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrow (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	4.5	0.0	42.6	28.8	13.2	0.0	0.6	0.0	0.002	0
Nov	2.7	0.0	22.4	17.1	5.2	0.0	0.0	0.0	0.01	0
Dec	5.8	0.0	8.8	8.1	7.1	0.0	0.0	0.0	0.069	0
Jan	6.3	0.0	4.4	2.2	5.1	0.0	0.2	0.0	12.4	29.9
Feb	6.0	3.6	5.9	3.6	4.0	0.0	2.1	0.0	193.2	432.4
Mar	4.7	4.5	10.7	12.3	1.5	0.0	2.4	0.0	12.7	50.5
Apr	1.7	0.5	3.0	1.8	0.0	0.0	0.1	0.0	2.98	9.83
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.99
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.66
Jul	51.0	3.0	0.0	0.0	0.0	0.0	54.8	0.0	0	0
Aug	59.0	27.0	0.0	0.0	78.7	0.0	69.4	35.0	28.9	0
Sep	48.0	28.0	2.6	0.0	41.9	0.77	0.7	2.9	74.1	37.2

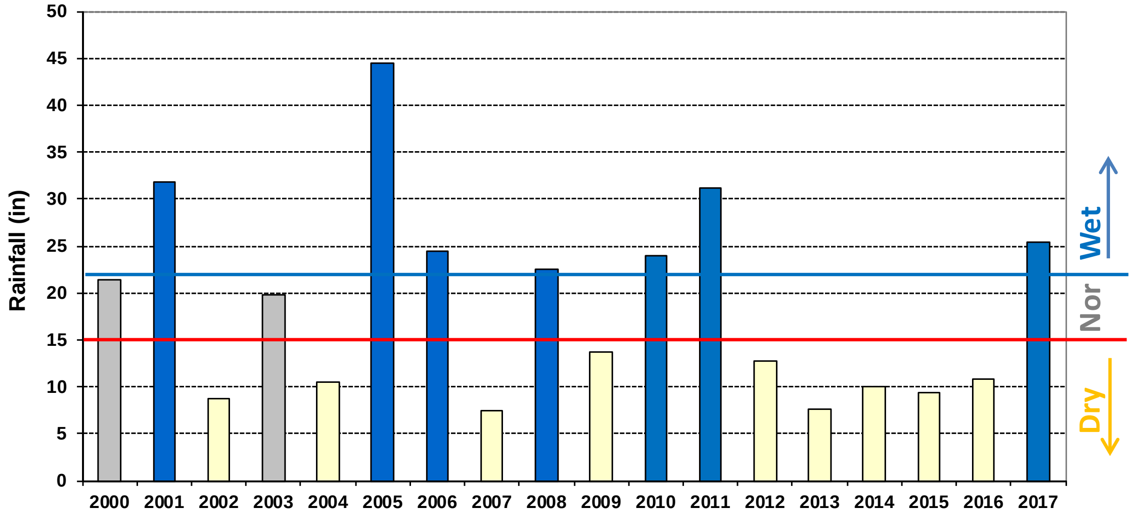


Figure 65: Water year type (wet, normal and dry) and spill years since the issuance of the BO in 2000. Year types are defined as Dry (< 15 inches), Normal (15 to 22 inches) and Wet (> 22 inches) at Bradbury Dam.

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.		
2. Grants have been submitted for funding.		

Table 24: Non-BO 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.	
2. Grants have been submitted for funding.	

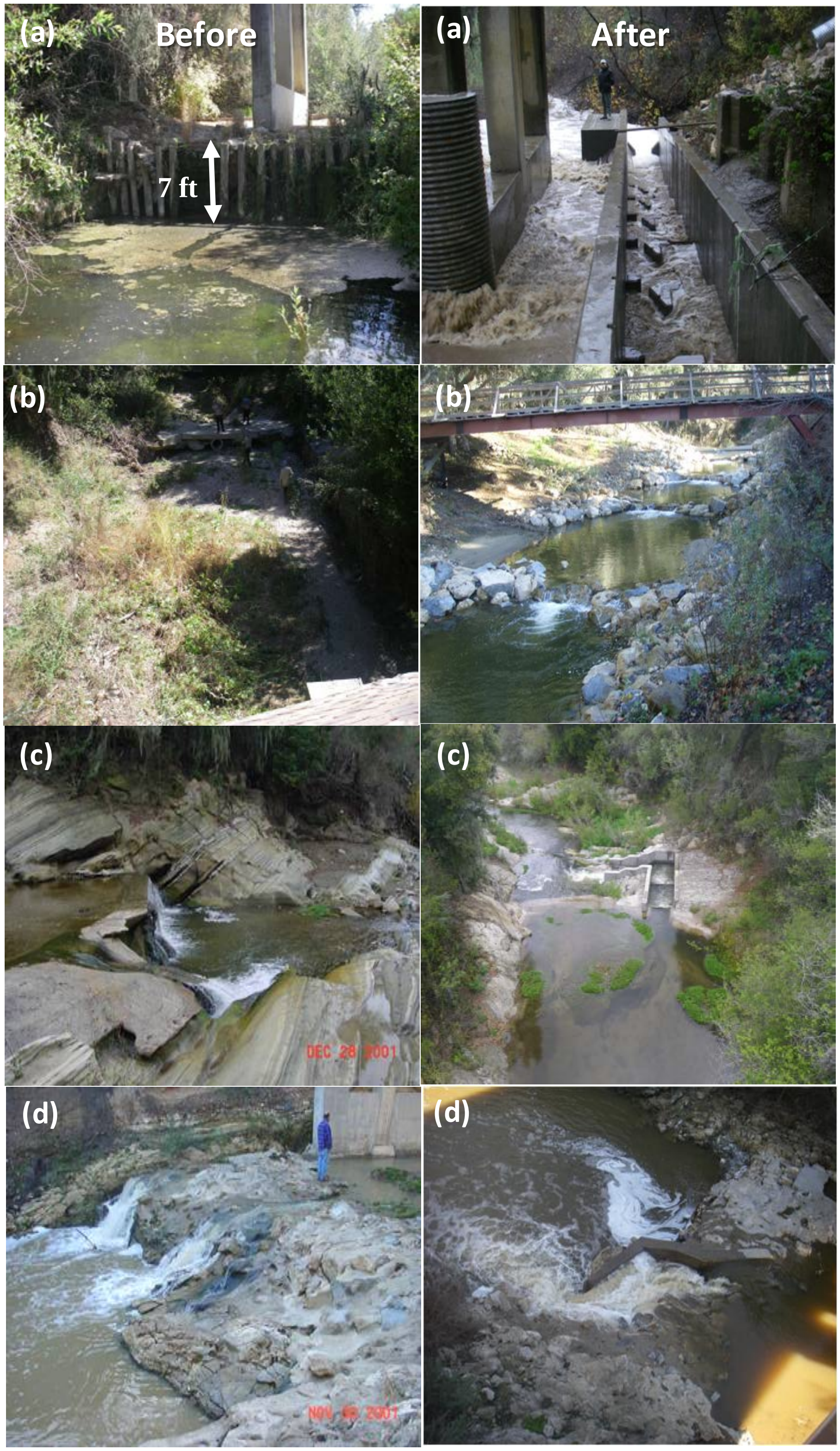


Figure 66: Fish passage and habitat restoration at: at (a) Rancho San Julian Bridge on El Jaro Creek (2008), (b) Cross Creek Ranch on El Jaro Creek (2009), (c) Jalama Road Bridge on Salsipuedes Creek (2004), and (d) Highway 1 Bridge on Salsipuedes Creek (2002).

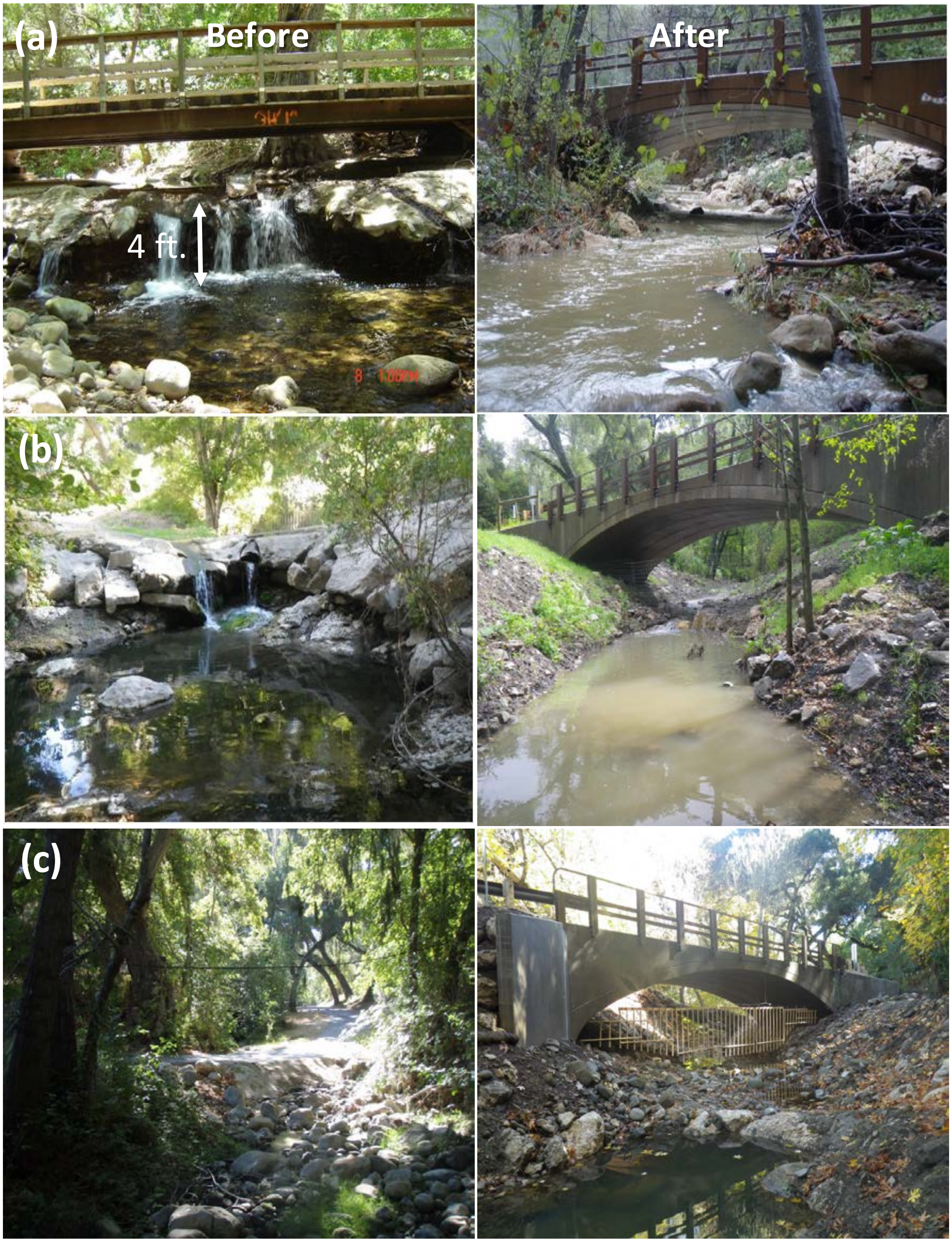


Figure 67: Fish passage and habitat restoration at a) Quiota Creek Crossing 6 (2008), (b) Quiota Creek Crossing 2 (2011), and Quiota Creek Crossing 7 (2013).

Figure 68: Fish passage and habitat restoration at (a) Quiota Creek Crossing 1 (in 2014) and (b) Quiota Creek Crossing 3 (in 2015).

Figure 69: Fish passage and habitat restoration at Hilton Creek at the Cascade Chute Project that was completed in 2005.

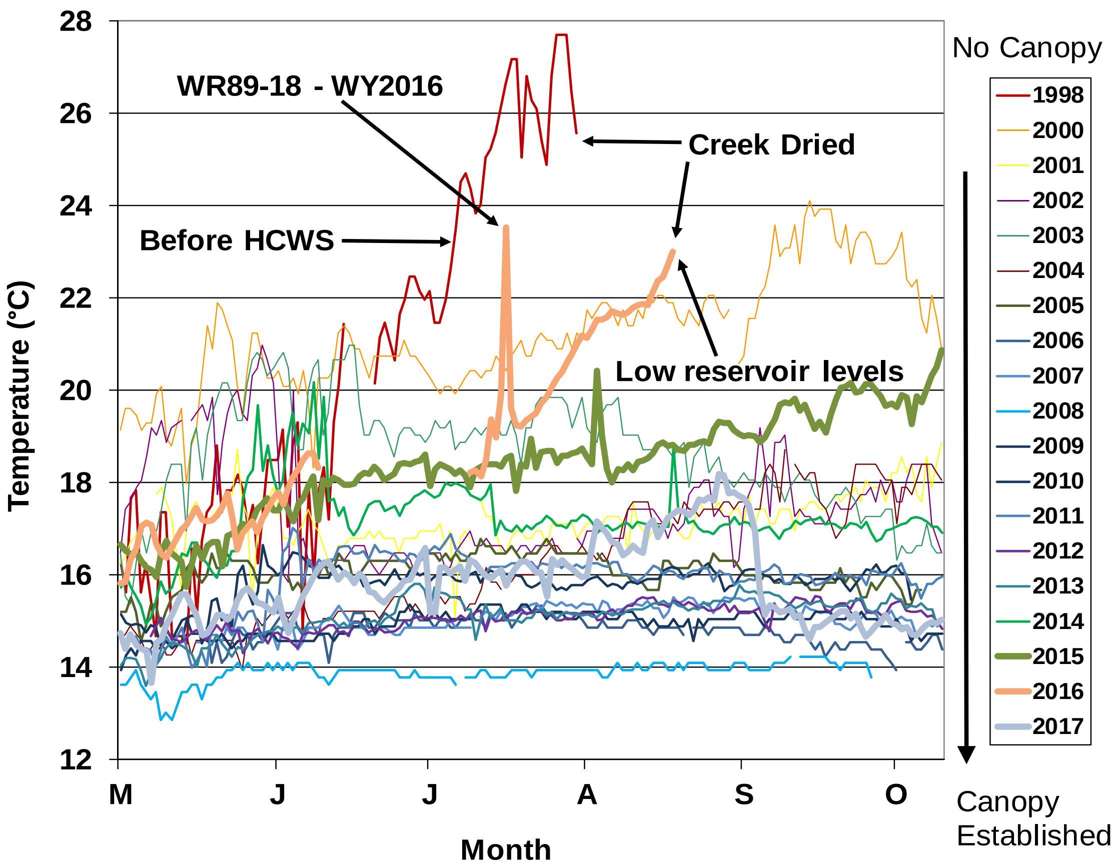


Figure 70: Lower Hilton Creek thermograph maximum water temperature data from 1998 to 2017, the last three years are shown with a wider curve.

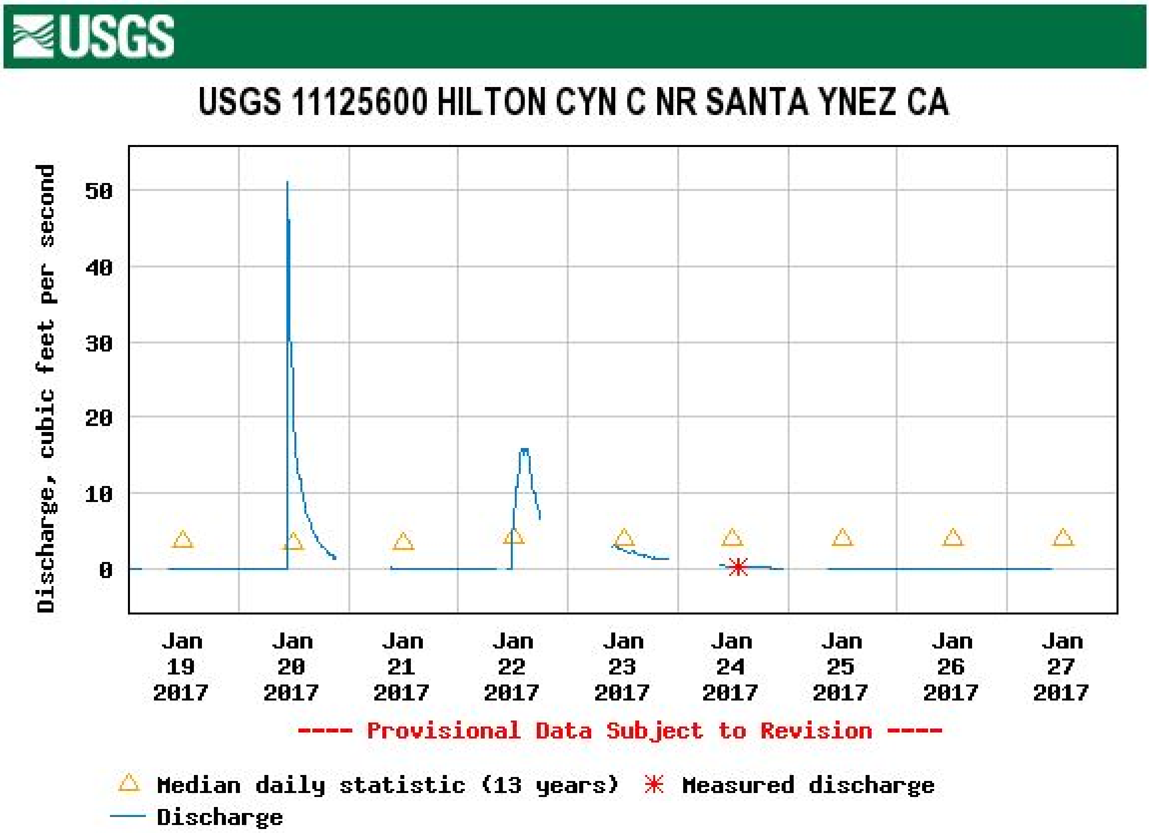


Figure 71: Hilton Creek USGS gauge 11125600 hydrograph for the 1/19/17 storm event.

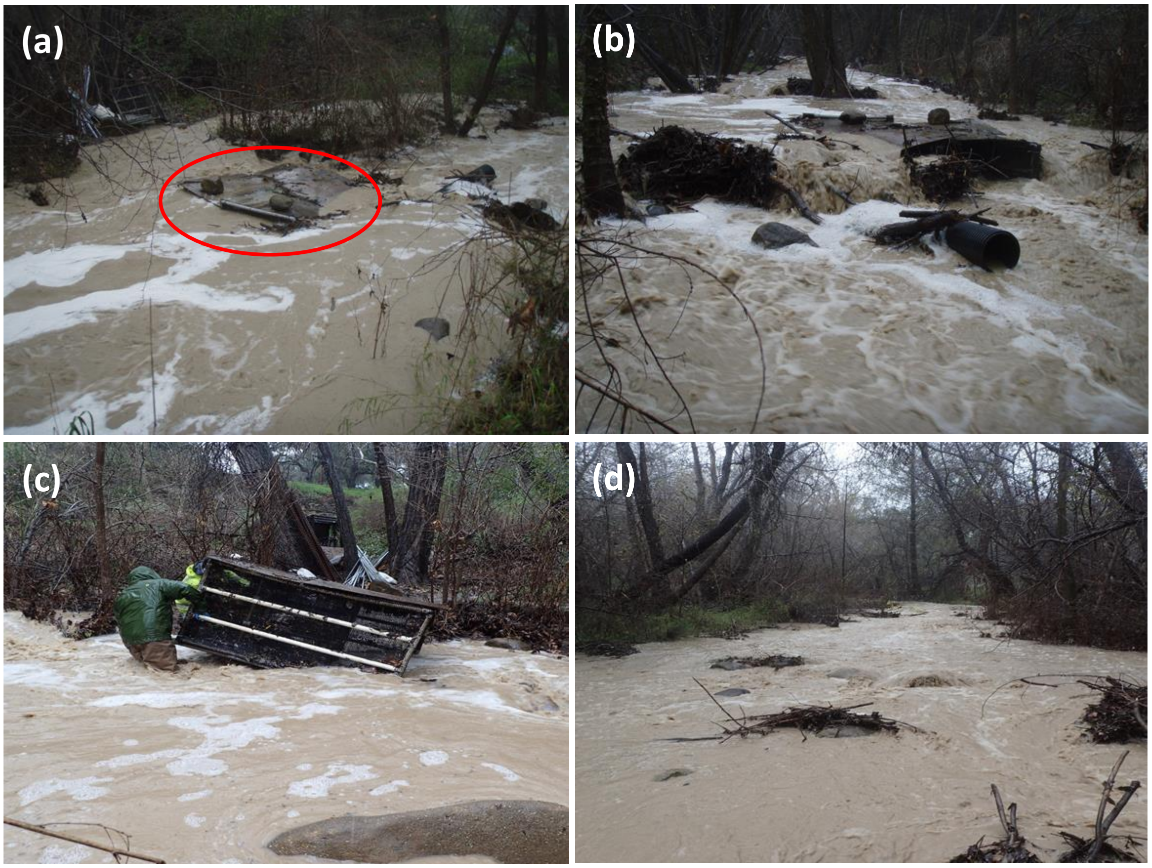


Figure 72: Rapid rise of Hilton Creek from upper basin flows during the 1/19/17 storm event at the migrant trapping site (installed to block migration during trickle flow) in the lower reach of the creek near the confluence with the LSYR: (a + b) inundated trap, (c) trap removal, and the creek just upstream of the trap location.

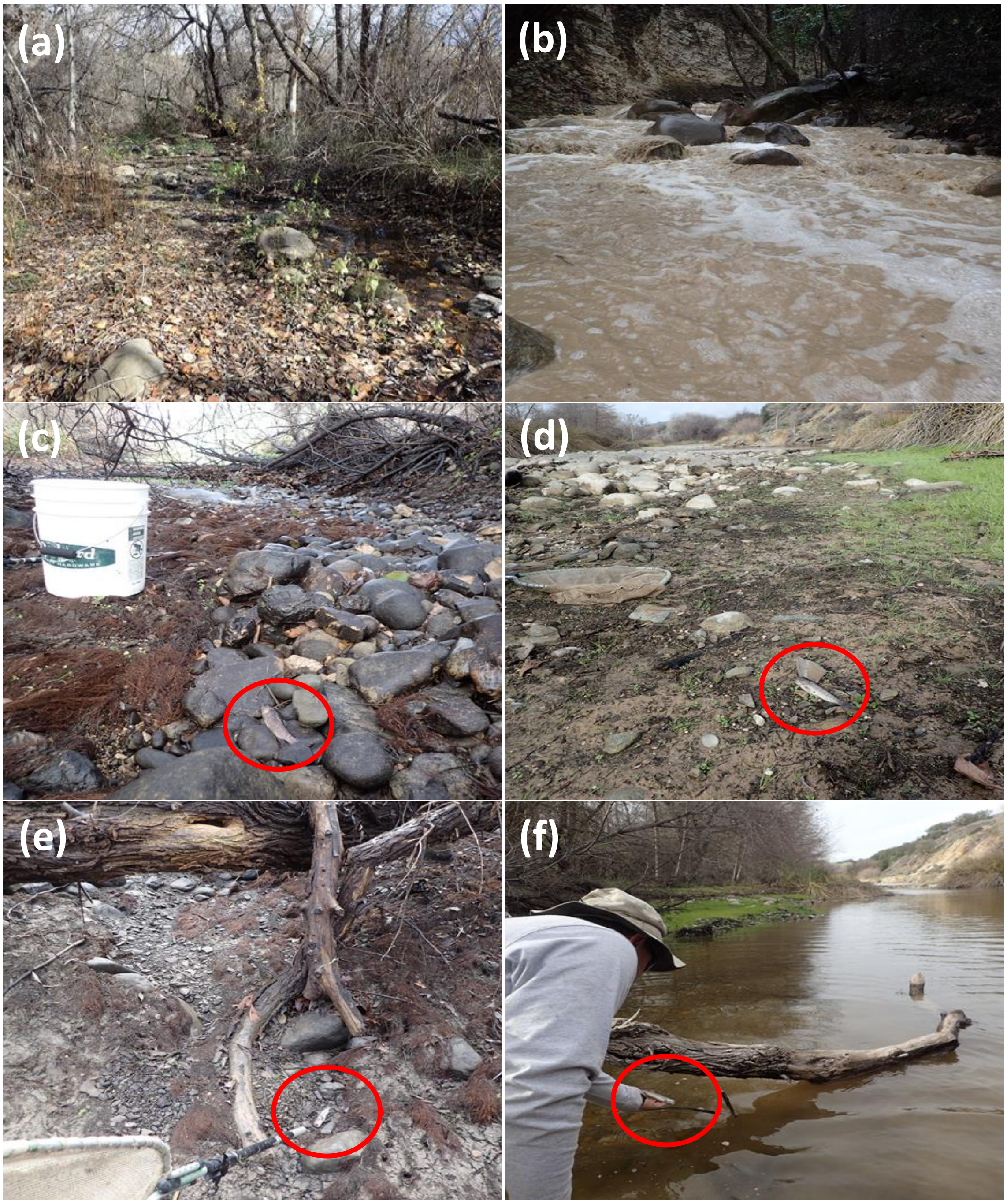


Figure 73: Hilton Creek condition and stream surveys associated with the 1/19/17 stormflow event showing (a) the pre-storm condition in the lower section of the creek, (b) during-storm condition in that same reach, and (c-f) post-storm condition showing the location of *O. mykiss* mortalities (circled in red) found on 1/21/17, 1/21/17, 1/21/17, and 1/24/17, respectively.

Figure 74: Electrofishing on lower Hilton Creek on 1/24/17 with CDFW and COMB-FD staff.

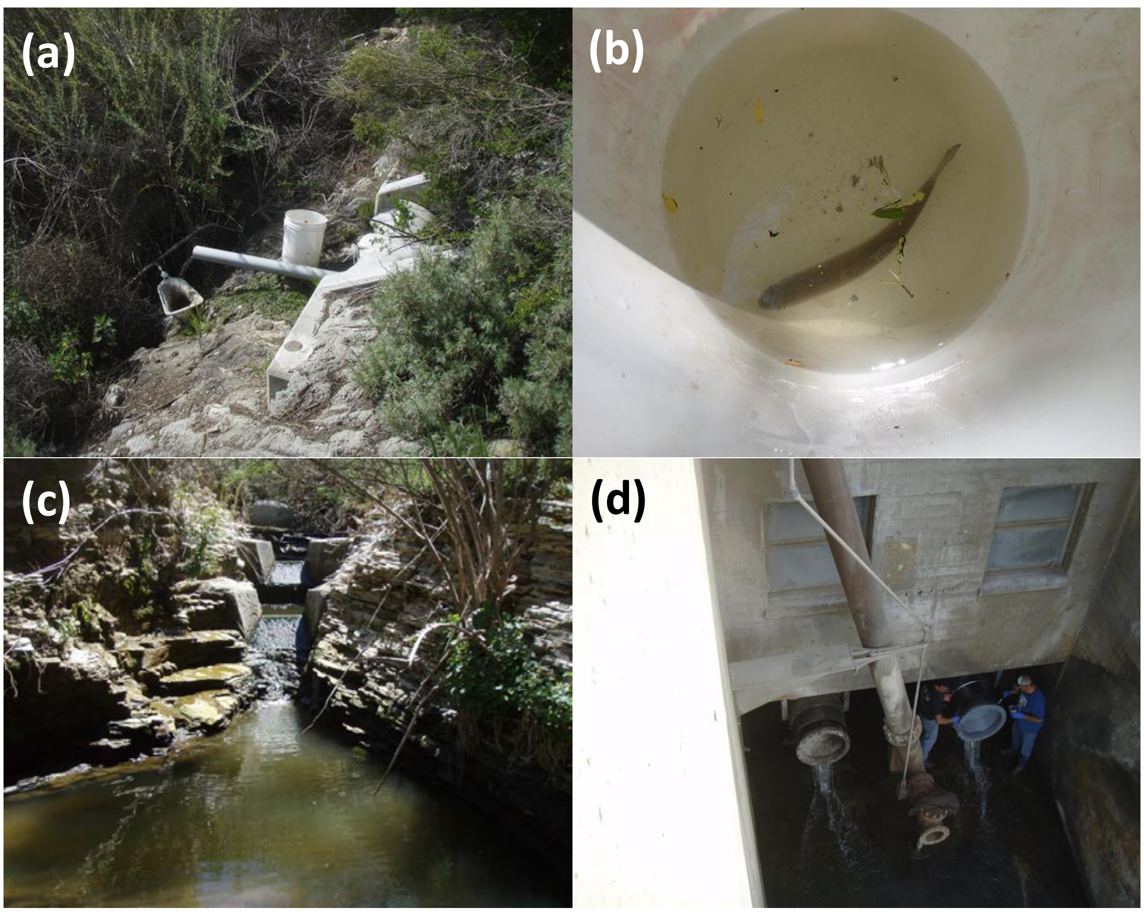


Figure 75: 30-inch valve installation at the Outlet Works, (a) trickle flow being provided to the LRP, (b) *O. mykiss* rescue ready for relocation, (c) trickle flow at the Cascade Chute project, and (d) reinstalled 30-inch cone valve at the Outlet Works.

Figure 76: Stilling Basin dewatering and non-native fish removal efforts showing (a) 2 electric submersible pumps in a screened container to eliminate the potential for fish impingement, (b) delivery pipeline from the 2 pumps to the main transmission line to the discharge point downstream of the tailwater control, (c) 3 trash pumps also used in the dewatering effort, and (d) seining operations west of the spillway of the dam.

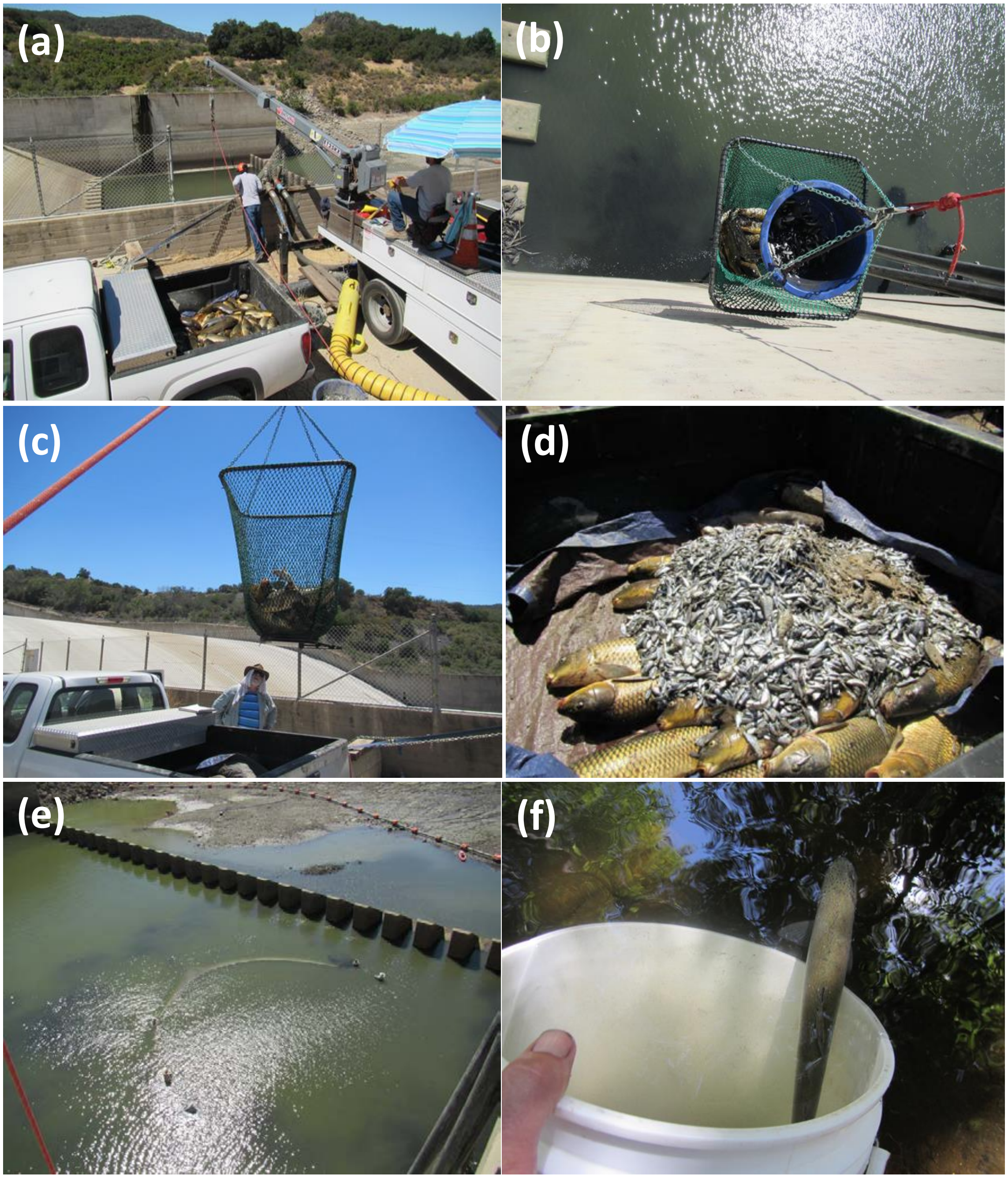


Figure 77: Non-native fish removal operations in the Stilling Basin with (a-d) a crane truck hoisting up captured fish to a truck for counting and removal offsite, (e) seining within the spillway, and (f) 1 of the 2 *O. mykiss* captured being safely released in Hilton Creek.

Figure 78: Trapping operations during the WY2017 WR 89-18 releases at (a) the tail out of the Long Pool which required routine cleaning of the traps throughout the installation period put particularly during the first day.

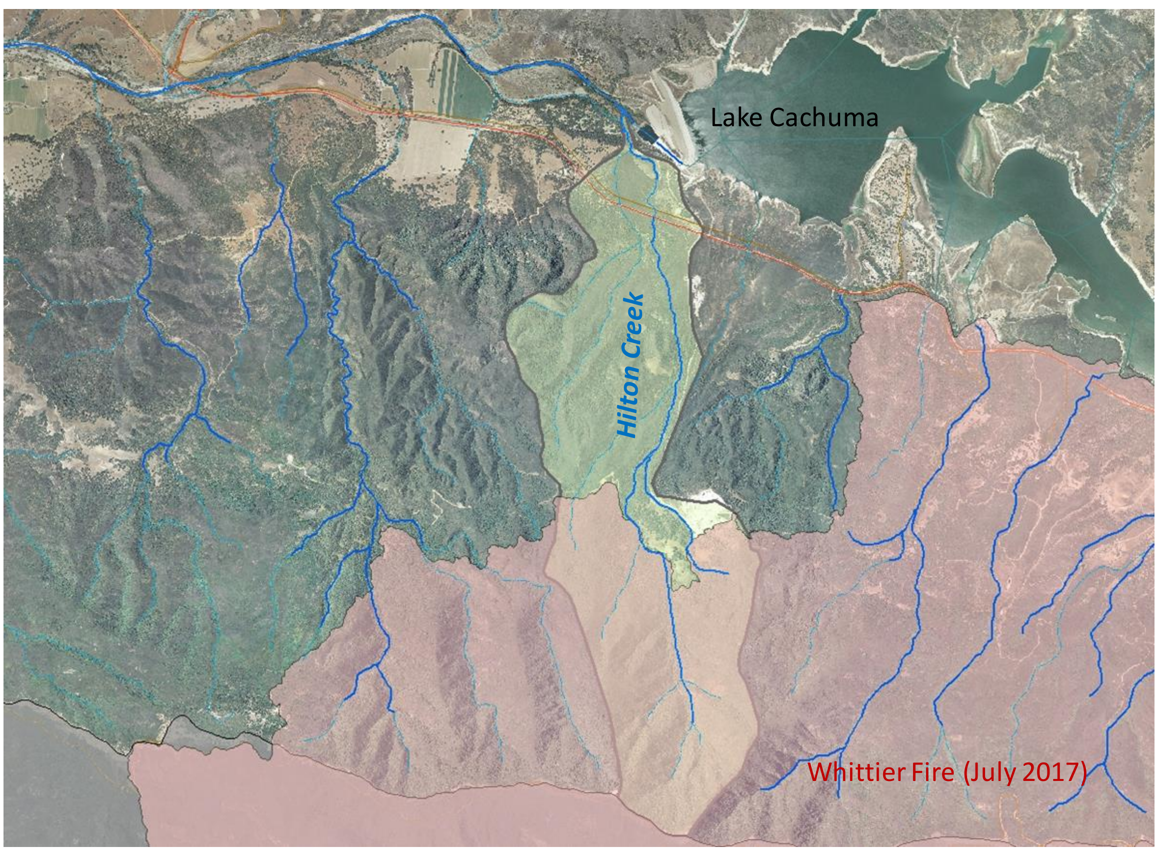


Figure 79: Whittier Fire burn area (in red) in relation to the Hilton Creek watershed downstream of Lake Cachuma.

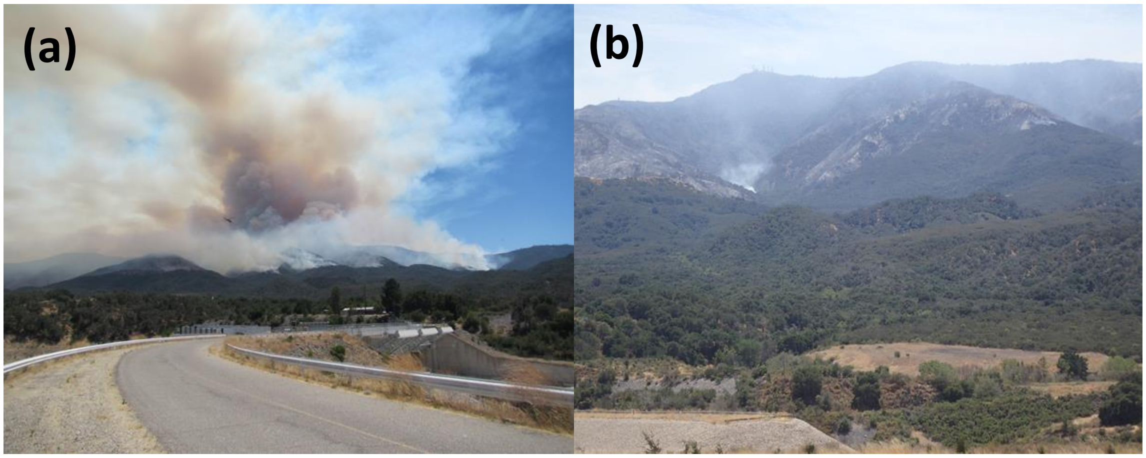


Figure 80: Photos of the Whittier Fire on 7/13/17 looking (a) across the crest of Bradbury Dam to the south and (b) the burnt upper watershed of Hilton Creek.

WY2017 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

COMB-FD: COMB Fisheries Division (previously 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 Operation and Maintenance Board – Fisheries Division (COMB-FD)staff 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 COMB-FD 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.

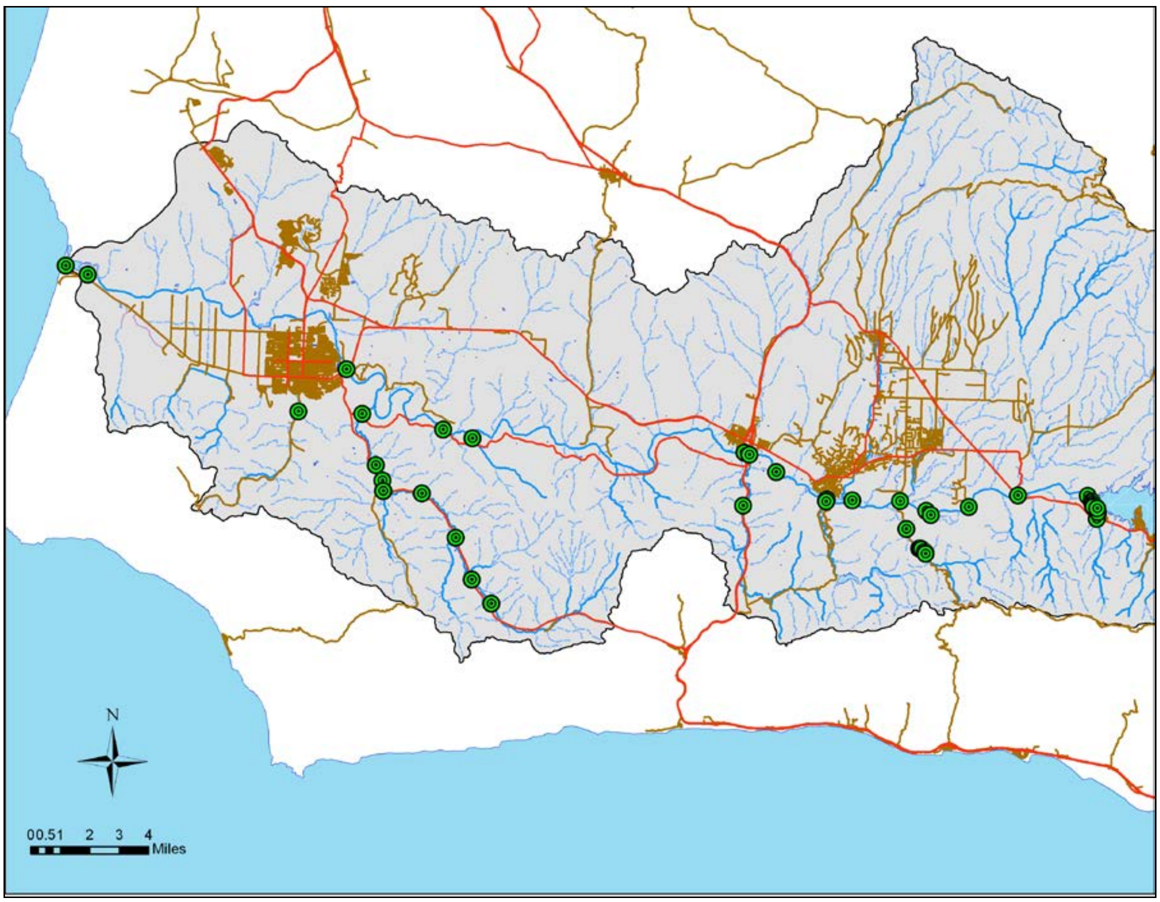


Figure C-1: WY2017 photo point locations.

Table C-1: WY2017 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	July 2017
M1	Lower Hilton Creek, photo d/s at ford crossing	
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	X
M4	Highway 154 culvert on Hilton Creek, photo d/s	X
M5	Highway 154 Bridge, photo u/s	X
M6	Highway 154 Bridge, photo d/s	X
M7	Meadowlark crossing, photo u/s	X
M8	Meadowlark crossing, photo d/s	X
M9	Lower Gainey crossing, beaver dam, photo u/s	X
M10	Lower Gainey crossing, beaver dam, photo d/s	X
M11a	Lower Gainey crossing, photo u/s	X
M11b	Lower Gainey crossing, photo d/s	X
M12	Refugio Bridge, photo u/s	X
M13	Refugio Bridge, photo d/s	X
M14	Alisal Bridge, photo u/s	X
M15	Alisal Bridge, photo d/s	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
M20	Avenue of the Flags Bridge, photo d/s	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
M24	Highway 246 (Robinson) Bridge, photo d/s	X
M25	LSYR Lagoon on railroad bridge, photo u/s	X
M26	LSYR Lagoon on railroad bridge, photo d/s	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	
M30	LSYR Lagoon upper reach, photo u/s	
M31	Slick Gardener, looking across towards highway	
M32	Slick Gardener, looking d/s through culvert	X
M33	Slick Gardener, looking u/s through culvert	X

Table C-2: WY2017 photo points on the LSYR tributaries. "X's" denote photos taken.

Tributary Photo Point ID	Location/Description	July 2017
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	X
T15	Hilton from hard rock toe, photo u/s	X
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
TX4b	Quiota Creek at 4th crossing, photo d/s	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	
T24a	Alisal Creek from Alisal Bridge, photo u/s	X
T24b	Alisal Creek from Alisal Bridge, photo d/s	X
T25	Nojoqui Creek at 4th Hwy 101 Bridge, photo u/s	
T26	Nojoqui Creek at 4th Hwy 101 Bridge, photo d/s	
T27	Nojoqui/LSYR confluence, photo u/s	X
T28	Salsipuedes Creek at Santa Rosa Bridge, photo u/s	X
T29	Salsipuedes Creek at Santa Rosa Bridge, photo d/s	X
T39	Salsipuedes Creek at Hwy 1 Bridge, photo d/s	X
T40	Salsipuedes Creek at Hwy 1 Bridge, photo u/s	X
T41	Salsipuedes Creek at Jalama Bridge, photo d/s	X
T42a	Salsipuedes Creek at Jalama Bridge, photo u/s	X
T42b	Pool at Jalama Bridge	X
T43	El Jaro/Upper Salsipuedes confluence, photo u/s	
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
T55	El Jaro Creek 1st Hwy 1 Bridge, photo u/s	X
T56	El Jaro Creek 2nd Hwy 1 Bridge, photo d/s	X
T57	El Jaro Creek 2nd Hwy 1 Bridge, photo u/s	X
T58	El Jaro Creek 3rd Hwy 1 Bridge, photo d/s	X
T59	El Jaro Creek 3rd Hwy 1 Bridge, photo u/s	X
T60	San Miguelito Creek at crossing, photo d/s	X
T61	San Miguelito Creek at Stillman, photo u/s	X
T62	Rancho San Julian Bridge, photo d/s	X
T63	Rancho San Julian Bridge, photo u/s	X

D. List of Supplemental Reports Created During WY2017

- WY2014 Annual Monitoring Summary (COMB, 2018b)
- WY2015 Annual Monitoring Summary (COMB, 2018c)
- Quiota Creek Crossing 0A End of Project Report (COMB, 2017b).
- Quiota Creek Crossing 4 End of Project Report (COMB, 2017c).
- CDFW-FRGP Grant Proposal for Quiota Creek Crossing 9 Project (April, 2017).
- WY2017 Migrant Trapping Plan (March, 2017).
- Biological Report Associated with the 30-inch Valve Reinstallation (COMB, 2017a).
- 2017 WR 89-18 Release Study Plan (August, 2017).
- 2017 WR 89-18 Release Monitoring Report for RPM 6 (USBR, 2017).
- Stilling Basin Dewatering and Fish Removal below Bradbury Dam on the Lower Santa Ynez River (Report) (COMB, 2017e).
- Hilton Creek January Storm Events Report (COMB, 2017d).
- Interruption of Flow to Hilton Creek on 9/11/17 Incident Report (COMB, 2018a).

E. Appendices References

COMB, 2017a. Biological Report Associated with the 30-inch Valve Reinstallation. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

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

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

COMB, 2017d. Hilton Creek January Storm Events Report. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2017e. Stilling Basin Dewatering and Fish Removal below Bradbury Dam on the Lower Santa Ynez River. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2018a. Interruption of Flow to Hilton Creek on 9/11/17 Incident Report. Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2018b. 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, 2018c. 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.

USBR, 2017. 2000 Cachuma Biological Opinion Reasonable and Prudent Measure 6 Monitoring Report Submittal on 2016 State Water Right 89-18 Releases - Cachuma Project. United States Bureau of Reclamation (USBR), prepared in collaboration with the Cachuma Operation and Maintenance Board Fisheries Division.