WY2022 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 9, 2023

DISCLAIMER

Executive Summary

The WY2022 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 2022 (WY2022, 10/1/21 – 9/30/22). 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 WY2022 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).

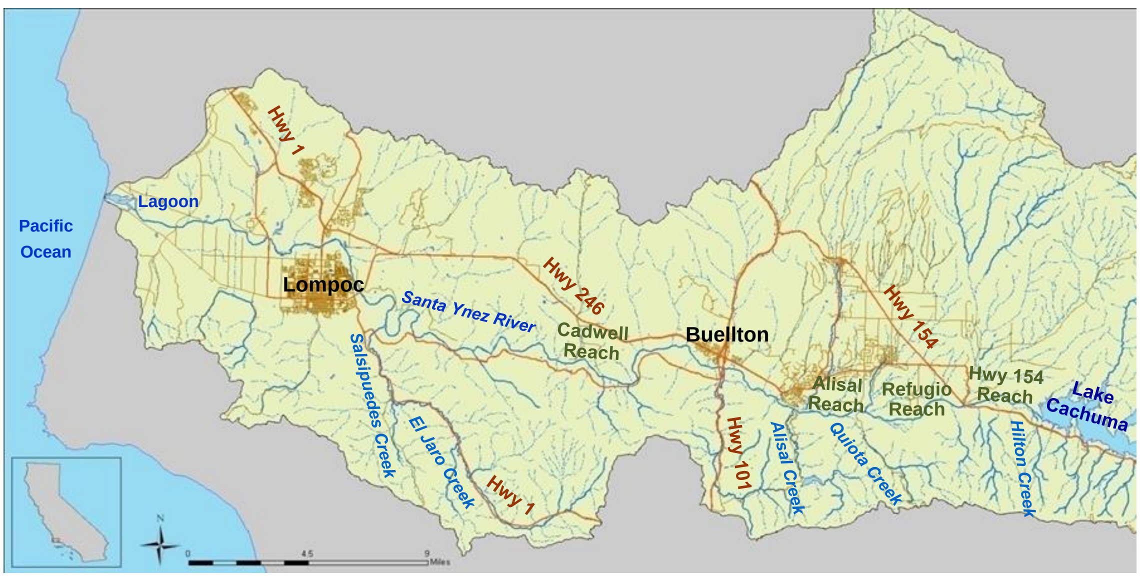

Figure ES-1: LSYR from Bradbury Dam and Lake Cachuma to the Pacific Ocean west of Lompoc, showing tributary creeks and management reaches of interest for the LSYR Fish Monitoring Program.

This report summarizes data gathered since the WY2021 Annual Monitoring Summary (COMB, 2022) and fulfills the annual 2022 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 WY2022, 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, a very dry water year, or program evolution from acquired field knowledge. A shortened version of this report, the WY2022 Annual Monitoring Report (AMR), is prepared by COMB-FD and provided by Reclamation to NMFS for compliance reporting established in the 2000 BiOp and Water Rights Order (WRO) 2019-0148.

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.

WY2022 was a dry year (13.13 inches of precipitation recorded at Bradbury Dam; long-term average, 1953-2022, is 19.70 inches) with the highest amount of rainfall occurring in December (8.33 inches) and March (2.10 inches). Of the 70-year long record, this was the 48th wettest, the 23rd driest year on record, and the 11th driest water year since the beginning of the BiOp in 2000 (3 normal and 8 wet years). The driest year on record occurred in 2007 with only 7.41 inches of rain and the wettest year on record was in 1998 with 53.65 inches of rain at Bradbury Dam. The largest storm of WY2022 (4.42 inches of rain) occurred on 12/14/21 followed by a storm on 12/23/21 (2.91 inches), and 12/28/21 (0.89 inches) that moved the watershed towards saturation but dried thereafter with only 3 minor storms (0.40 inches on 1/18/22, 2.03 inches on 3/28/22, and 0.23 inches on 4/22/22) during the rest of the water year. The lagoon remained closed throughout WY2022 due to insufficient river flow to open to the ocean. At the beginning of the water year (10/1/21), there were 95,586 acre-feet (af) of water stored in Lake Cachuma and 65,436 af at the end of the water year (9/30/22), with peak storage at the beginning and minimum storage at the end of the water year.

BiOp required target flows to the Highway (Hwy) 154 Bridge were maintained throughout the water year at a minimum of 2.5 cubic feet per second (cfs). Target flows to Hilton Creek were provided to the Upper Release Point (URP) and Lower Release Point (LRP) by gravity flow from either the Hilton Creek Watering System (HCWS), the Hilton Creek Emergency Backup System (HCEBS), or both, or HCWS pumped flow to the URP. The required 2000 BiOp Hilton Creek target flows of a minimum of 2 cfs were not being met going into the beginning of WY2022 as recorded on the Reclamation Daily Operations Report with flow deliveries of approximately 1.5 cfs on 10/1/21 dropping to approximately 0.8 cfs by the beginning of August, 2022. Reclamation and NMFS discussed the below target flow condition when it first occurred. Then Reclamation elected to turn on the HCWS pump on 8/2/22 to provide pump flow to the URP and the LRP at a minimum flow rate of 2 cfs as measured by Reclamation's in-pipe mag flow meter and reported in their Daily Operations Report. That night there was a PG&E unplanned power outage that stopped flow to the creek for approximately 2.5 hours. 32 *O. mykiss* were rescued/relocated and 9 *O. mykiss* mortalities were found. Reclamation responded the night of the outage and quickly ran the HCEBS pumps for several days before going to a parallel delivery system of HCEBS gravity flow to the LRP and HCWS pump flow to the URP. This configuration of flow delivery to Hilton Creek remained for the rest of the water year. There were 8 PG&E power outages during WY2022 (6 in Calendar Year 2022) that would have made continuous HCWS pump operation difficult.

There were three interruption of flow events to the URP during the first week of September when the region was experiencing a heat wave. On 9/2/22, there was an unexpected PG&E power outage that shut off the HCWS pumps for a short period but was restarted on generator power with no issues observed to the downstream fishery. On 9/3/22, Reclamation was switching from generator to grid power when the HCWS pump shut off. The interruption of flow to the URP continued for approximately 4 hours during which time there were 2 *O. mykiss* rescued/relocated and 6 *O. mykiss* mortalities found. On 9/5/22, the switch from generator to grid power caused the HCWS pump to shut off again but was immediately restarted with no issues observed to the downstream fishery.

During the migrant trapping effort, 182 *O. mykiss* (105 juveniles and 77 adults) were captured, all at Hilton Creek. There were 37 smolts observed. The Salsipuedes Creek and LSYR mainstem traps were not operated due to low flow conditions throughout the migration season. Forty-four redds were observed (23 in Hilton Creek, 16 in Salsipuedes Creek, two in El Jaro Creek, one in Quiota Creek and zero in the LSYR mainstem within the Refugio, Alisal and Narrows reaches.

There was a Water Rights (WR) 89-18 release in WY2022 that started on 8/8/22 and continued until 10/5/22 (a period of 58 days). This was a Below Narrows Account (BNA) release of 9,913 af from Lake Cachuma by Santa Ynez River Water Conservation District (SYRWCD) to recharge downstream aquifers.

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 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; target flow releases to the LSYR mainstem and Hilton Creek; 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, which were Reclamation projects) 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 15 fish passage projects restoring access to the upstream reaches of key tributaries in the LSYR Watershed for steelhead. The total number of stream restoration, fish passage, and flow enhancement projects completed since issuance of the 2000 BiOp is 22 projects, with the most recent completed last year at Quiota Creek Crossing 8, the South Side Erosion Control and Reforestation Project. Descriptions and photos of all habitat enhancement projects are presented in Section 4.

The following are recommendations to improve the monitoring program from WY2022 onward and are not listed by priority; some are subject to funding availability and permit acquisition:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000), BiOp (NMFS, 2000), and Order Water Rights (WR) 2019-0148 (SWRCB, 2019) to evaluate *O. mykiss* and their habitat within the LSYR for long-term trend analyses and improve consistency of the monitoring effort for better year-to-year comparisons.
- Continue to support Reclamation upon their request of information needed for their Reconsultation process with NMFS, in particular efforts to increase the ITS limits for both juvenile and adult *O. mykiss* to best cover the current and future population size.
- Continue to work closely with Reclamation on the implementation of the new WR 2019-0148 to conduct all required monitoring and reporting in a timely manner;
- Continue to expand upon monitoring efforts in the Narrows Reach; specifically during years with limited fish passage to conduct redd surveys, snorkel surveys, and water quality monitoring.
- 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 to develop a gravel augmentation plan for Hilton Creek and the Hwy 154 Reach of the LSYR mainstem to provide spawning gravels to habitats with limited spawning potential due to the makeup of the stream substrate. Pattern the effort on what was successfully completed in Hilton Creek on Reclamation property in WY2018 and WY2019. This will entail obtaining permits and identifying potential funding sources.
- Continue to work with Reclamation to maximize dry season releases to Hilton Creek versus the Outlet Works to the Stilling Basin to maximize support of the downstream fishery and minimize lake release stream temperatures entering the Long Pool and LSYR mainstem habitats downstream.
- Continue to work with the SYRWCD on further developing their ramp-up and ramp-down procedures for WR 89-18 releases to enhance the successful implementation of the release and minimize impacts to the downstream fishery; this collaboration was started in WY2020.
- Continue to evolve the collaborative relationship with CDFW regarding fish rescue within the LSYR basin. The effort was started in WY2021, should be continued, and should be initiated as soon as conditions warrant entering into the dry season.
- Initiate a PIT tag monitoring effort in the LSYR basin to identify current and future CDFW tagged fish. COMB obtained the PIT Monitoring Station for Hilton Creek and is working with Reclamation to deploy it during the next migration season.

- Investigate viable solutions to the sulfide problem observed predominantly at the LRP and to a lesser degree at the URP.
- Continue to remove non-native fish species and 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;
- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin;
- Continue to encourage Reclamation to improve and make reliable its system operation for delivering lake water to Hilton Creek;
- 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 with scale analyses going back in time to assure all scales have been read and documented that are currently in the LSYR *O. mykiss* scale inventory, specifically looking at growth rates, evidence of life-history strategies such as fresh versus marine water rearing, signs of spawning, integration of the findings with the results of the genetic analyses, etc. in support of ongoing fisheries investigations;
- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships;
- 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;
- Investigate with Reclamation Stilling Basin management actions specifically 1) a Stilling Basin bypass pipeline system at the tail of the pool to provide target flow releases without the potential for thermal heating and warm water fish species movement downstream; 2) limiting *O. mykiss* access to the Stilling Basin, 3) establishing a small road for access to the Stilling Basin, and 4) dewatering of the Stilling Basin for non-native fish removal;
- Look for interested parties to develop a Arundo and Tamarisk Eradication Plan and search for funding to implement the needed effort; and
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WY2022 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)*

Reclamation is also required under State of California State Water Resources Control Board Order WR 2019-0148 specifically Term and Condition 27 to submit an annual report by December 31 of each water year. This report complies with that requirement.

The objective of this WY2022 Annual Monitoring Summary (AMS) is to present the monitoring data collected in Water Year 2022 (WY2022, 10/1/21-9/30/22) 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) watershed below Bradbury Dam throughout WY2022 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 as well as WR 2019-0148 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), WY2013 Annual Monitoring Summary (COMB, 2017), WY2014 Annual Monitoring Summary (COMB, 2018a), WY2015 Annual Monitoring Summary (COMB, 2018b), WY2016 Annual Monitoring Summary (COMB, 2019a), WY2017 Annual Monitoring Summary

(COMB, 2019b), WY2018 Annual Monitoring Summary (COMB, 2020a), WY2019 Annual Monitoring Summary (COMB, 2020b), WY2020 Annual Monitoring Summary (COMB, 2021), and WY2021 Annual Monitoring Summary (COMB, 2022).

The data summarized in this report describe the habitat conditions and the fishery observations in the LSYR during WY2022. 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 to provide seasonal continuity of life-cycle observation and *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-0.51 is the Long Pool, which is 0.51 miles downstream from the dam; HC-0.14 is on Hilton Creek 0.14 miles upstream of its confluence with the mainstem).

WY2022 was classified as a dry year with 13.13 inches of precipitation recorded at Bradbury Dam (long-term average, 1953-2022, is 19.70 inches; 23rd driest year of 70 years over the period of record with WY2007 being the lowest at 7.41 inches and WY1998 being the highest at 53.65 inches. This was the 11th driest rainfall year since issuance of the 2000 BiOp, with 12 of 23 years classified as dry (WY2007, WY2013, WY2002, WY2018, WY2015, WY2014, WY2004, WY2016, WY2021, WY2012, WY2022 and WY2009; listed in order of severity), only 3 years as normal (WY2003, WY2020, and WY2000; listed in order of magnitude), and the rest (8 years) were wet years (WY2008. WY2019, WY2010, WY2006, WY2017, WY2011, WY2001, and WY2005; listed in order of magnitude). Wet years 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 have the potential to wash out redds. Following wildfires within the upper watersheds, wet years also have the potential to negatively impact the fishery via increased transport of loosely-held burn scar sediment into downstream habitats, filling pool habitats, and creating extreme short-term turbid conditions.

Migrant trapping was conducted in WY2022 in Hilton Creek only and all BiOp take limits were followed. No migrant trapping occurred in the LSYR mainstem or Salsipuedes Creek in WY2022 due to extreme dry conditions that precluded fish movement. Reproduction and population status were monitored through redd (spawner) surveys and snorkel surveys.

WY2022 was a dry year following another dry year in WY2021 (13.13 inches and 11.84 inches of rainfall, respectively, at Bradbury Dam). Entering into WY2022, the reservoir elevation at Lake Cachuma was at 49.4% capacity (95,586 af) and at 33.9 % capacity

(65,436 af) at the end of the water year, which was above critical drought conditions. Since the reservoir storage was less than 120,000 af throughout the water year, the 2000 BiOp required target flows were 2.5 cfs to the Highway (Hwy) 154 Bridge and a minimum of 2.0 cfs to Hilton Creek. There were only 8 storm events greater than 0.1 inches of rain recorded at Bradbury Dam; one moderate storm occurred in late October that created no storm flow, 2 major storms in mid and late December that created some short duration runoff and a moderate storm in late March. There were essentially no storms in January and February, which historically are the two wettest months of the year. Following the March storm event, dry conditions persisted for the remainder of the water year. The highest daily flow recorded by the USGS at H Street in Lompoc was 27.2 cfs on 12/26/21. In fact, stormflows from the December event only lasted for 10 consecutive days at H Street (12/23/21 - 1/1/22) before decreasing to zero flow for the remainder of the water year. It was highly unlikely that during those 10 days there was any opportunity for anadromous steelhead in the LSYR Lagoon to migrate into the Santa Ynez watershed. The LSYR Lagoon was closed to ocean connectivity throughout WY2022. For comparison, daily flows recorded by the USGS at Solvang peaked at 78.6 cfs on 12/26/21 before decreasing to less than 20 cfs three days later. Flows at Salsipuedes Creek peaked at 142 cfs on 12/23/21 before decreasing to less than 5 cfs 5 days later. Flows at the Narrows peaked at 86 cfs on 12/23/21 before decreasing to less than 20 cfs on 1/4/22. Baseflow conditions prevailed from January throughout the rest of the water year that greatly limited basin migration.

The following chronology is provided for reader orientation 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:

- Reclamation started the water year with HCEBS gravity flow to the LRP and URP. The release rate to Hilton Creek slowly diminished in association with the drop in lake elevation.
- On 8/2/22 during the day, Reclamation switched from HCEBS gravity flow to the LRP and URP to HCWS pump flow to the URP and the LRP, stopping gravity flow from the HCEBS.
- On 8/2/22 in the evening, an unplanned PG&E power outage occurred that caused a short duration interruption of flow incident to Hilton Creek when 32 *O. mykiss* were rescued/relocated and 9 *O. mykiss* mortalities were found. Reclamation then ran the HCEBS on pump flow to the URP and LRP until 8/11/22 when they switched to a parallel delivery system of HCEBS gravity flow to the LRP and HCWS pump flow to the URP. This configuration remained for the rest of the water year.
- There was a CDFW guided fish rescue and relocation effort within Reach 5 of Hilton Creek (LRP to the URP) on 8/8/22 through 8/10/22 when 446 *O. mykiss* were rescued/relocated and 8 *O. mykiss* mortalities were found. All fish were relocated downstream of the LRP and a blocking seine was installed just above the LRP to prohibit fish movement back upstream into Reach 5.
- On 9/2/22, there was a short duration interruption of flow incident to Hilton Creek due to an unplanned PG&E power outage during a heat wave. There were no issues observed to the downstream fishery.

- On 9/3/22, there was approximately a 4 hour interruption of flow incident to the URP of Hilton Creek when 2 *O. mykiss* were rescued/relocated and 6 *O. mykiss* mortalities were found within Reach 5 due to the HCWS pump shutting off when Reclamation switched from generator to grid power.
- On 9/5/23, the HCWS pump shut off again during the switch from generator to grid power but Reclamation was able to reactivate the pump in short order. There were no issues observed to the downstream fishery.
- State water deliveries to Lake Cachuma were conducted through the CCWA by-pass pipeline throughout the water year. No State Water was wheeled through the Outlet Works and Penstock. State water deliveries were relatively consistent through the water year with 6 relatively short-term stops in water deliveries.
- Peak storage for Lake Cachuma was recorded on 10/1/21 (95,586 af and 713.41 ft of elevation at 49.4% of capacity). Low storage for the water year was 9/30/22 (65,436 af and 695.65 ft of elevation at 33.9% of capacity).
- The 2022 WR 89-18 release was from 8/8/22 to 10/5/22 with a duration of 58 days and total of release of 9,913 af.
- Hydrogen sulfide odors were detected at the beginning of August, 2022 and it was noticed that sulfur fixing algae caused the stream bottom to go white. Hydrogen sulfide in solution is toxic to fish and most likely became an issue for the downstream fishery prior to that month. Upon lake turnover at the end of October, the sulfur issued ended.

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 for Reclamation in compliance with the 2000 BiOp and the WR 2019-0148. 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 13 Annual Monitoring Reports/Summaries completed for WY2009 (USBR, 2012), WY2010 (USBR, 2013), WY2011 (COMB, 2013), WY2012 (COMB, 2016), WY2013 (COMB, 2017), WY2014 (COMB, 2018a), WY2015 (COMB, 2018b), WY2016 (COMB, 2019a), WY2017 (COMB, 2019b), WY2018 (COMB, 2020a), WY2019 (COMB, 2020b), WY2020 (COMB, 2021), and WY2021 (COMB, 2022). All reports fulfilled the annual monitoring reporting requirements set forth in the 2000 BiOp (T&C 11.1) and WR 2019-0148 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 west of the City of Lompoc and north of Point Conception. 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, dry during the summer, 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, there is river connectivity with the LSYR lagoon, and the tributaries begin flowing. This typically occurs sometime after the first couple of major storms of the 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 than 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 water quality thresholds. Stressful and lethal stream temperatures and 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). All 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 WY2022 monitoring effort are organized by (1) hydrologic condition, (2) water quality, (3) habitat quality, (4) migration of *O. mykiss*, (5) Aging of *O. mykiss* migrant captures, (6) reproduction and rearing, (7) tributary enhancements project monitoring, and (8) 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 (e.g., precipitation) at Bradbury Dam is equal to or less than 15 inches, a normal (average) year when rainfall is 15 inches to 22 inches, and a wet year when 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/AMR reports, the SWRCB approach will not be used in this report, although the designation for WY2022 would have been a dry year with 4,908 af of computed inflow to Lake Cachuma.

WY2022 had 13.13 inches of rainfall recorded at Bradbury Dam and was therefore classified as a dry year (less than 15 inches) (Table 1). The long-term average (1953-2022) at the dam is 19.70 inches. With only 13.13 inches of rain recorded at Bradbury Dam, WY2022 ranked well below the 2-year recurrence interval in Santa Barbara County for total rainfall amount (2-year recurrence = 18.10 inches). There was some elevated stream runoff recorded within the LSYR mainstem and tributaries in WY2022 in association with the 12/14/21 (4.42 inches), 12/23/21 (2.92 inches), and 12/28/21 (0.89 inches) storms only. The streamflow during those three storms was sufficient to record river flow past H Street in Lompoc for a short period but insufficient to fill the lagoon and breach the sandbar. The LSYR lagoon remained closed throughout the water year. Peak instantaneous flow at H Street in Lompoc was 119 cfs on 12/26/21 (USGS) but river flows decreased to less than 5 cfs by the end of the evening that day and continued to decrease to zero on 12/27/21. At H Street, the river is wide and has a sandy bottom that can be impassable for migrating fish at low flows even though the lagoon is open to the ocean. For example, recorded flows at H Street greater than 25 cfs starting on 12/26/21 then decreasing to less than 25 cfs on 12/28/21 (with short duration dip in flow in between) and then to zero on 1/1/22 for the rest of the water year. There was only a 2 day period when river flows were in excess of 25 cfs and it was unclear whether flows ever reached the LSYR lagoon. It was highly unlikely that any lagoon *O. mykiss* migrated up into the LSYR mainstem.

The USGS Narrows gauge recorded an instantaneous peak flow rate of 592 cfs on 12/23/21 and decreased to less than 25 cfs on 1/1/22 for the rest of the water year. In Salsipuedes Creek, the highest recorded instantaneous peak discharge at the USGS gauging station at Jalama Road Bridge was 748 cfs recorded on 12/23/21 and decreased to less than 5 cfs on 1/1/22 onward. The USGS Solvang gauge at Alisal Bridge had a maximum instantaneous flow rate of 131 cfs on 12/26/21, decreased to less than 25 cfs on 12/28/21, and less than 10 cfs on 1/4/22 for the rest of the water year. Rainfall from the December storms was focused on the western portion of the Santa Ynez River watershed (Salsipuedes Creek watershed) and not so much in the mid- to upper-watershed towards the east. Historic minimum, maximum, and WY2022 rainfall data at 7 locations within the Santa Ynez River basin including at Bradbury Dam 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 8 precipitation events in WY2022 with rainfall equal to or greater than 0.1 inches at Bradbury (Table 3 and Figure 1). The majority of the recorded precipitation at Bradbury Dam fell during the months of December (8.33 inches 63.4%) and March (2.10 inches, 16.0%) combining for 79.4% of the total rainfall for the year. None of the triggers for the Fish Passage Supplementation Program were met. The lack of any meaningful rainfall after the large storm events in December and throughout the springtime eliminated the possibility of conducting Fish Passage Supplementation as flow conditions throughout the watershed quickly attenuated following the December storms. In addition, there are multiple sections in Reach 3 (Alisal Bridge to Robinson Bridge in Lompoc) that are so overgrown and choked with aquatic vegetation that a high magnitude flushing flow would be needed to clear out the river channel to facilitate fish passage. There was a BNA WR 89-18 water release that began on 8/8/22 and concluded on 10/5/22 with 9,913 af released in total over 58 days.

Annual daily mean discharge hydrographs for the LSYR basin at the H Street (USGS-11134000), Narrows (USGS-11133000), Salsipuedes Creek (USGS-11132500), Solvang (Alisal Bridge) (USGS-11128500), Hilton Creek (USGS-11125605), Bradbury Dam (Reclamation), and Los Laureles (USGS-11123500) (upstream of Lake Cachuma) gauges are shown in Figures 2 and 3. Those basin-wide annual hydrographs revealed anemic stormflow runoff conditions throughout the wet season except for the two events in the middle of December. The USGS Los Laureles gauge on the Santa Ynez River mainstem upstream of Lake Cachuma recorded continuous flow from 12/14/21 through 12/16/21 in association with the 12/14/21 storm and 12/23/21 through 4/13/22 in association with the 12/23/21 storm with a flow peak of 400 cfs on that initial day. It went to double-digit flows through December and single-digit flows from January to the end of the flow period (4/13/22) and did not flow again for the remainder of the year.

The Hilton Creek gauge (USGS-11125605) is a low flow gauge only (less than 50 cfs) and during the 12/14/21 stormflow event, stream discharge climbed to just under 50 cfs. During the 12/23/21 stormflow event, stream discharge went to just above 30 cfs then dropped shortly thereafter lake releases to the creek only. The peak release from Bradbury Dam (Outlet Works plus the HCWS+HCEBS to Hilton Creek) was approximately 164 cfs on 8/24/22 during the 2022 WR 89-18 release. None of these discharge rates were high enough to cause any changes to the channel or banks within the LSYR mainstem.

Ocean Connectivity: The Santa Ynez River lagoon remained close through the water year. Table 4 presents the lagoon status in WY2022 as well as conditions going back to WY2001. There may have been a brief period in WY2022 of LSYR mainstem connectivity to the lagoon in December but not at all during the rest of the water year. There was no ocean connectivity during the migration season. The USGS H Street gauge only recorded streamflow greater than 20 cfs for a brief couple of days during the third week of December and was at zero for the rest of the water year outside of WR 89-18 releases. The USGS gauge at the Narrows began to record streamflow on 12/23/21, peaked that day at 86 cfs and then tapered off for the rest of the migration season going to zero on 5/5/22 until the WR 89-18 release arrived in September.

Since WY2006, the presence of the lagoon sandbar has been monitored routinely 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.

Fish Passage Supplementation: No Fish Passage Supplementation occurred during WY2022 due to extreme dry conditions.

Adaptive Management Actions: There were no Adaptive Management Committee (AMC) meetings during WY2022. No flow allocations were made by the AMC from the Adaptive Management Account (AMA).

Target Flows: There were no spills from Bradbury Dam in WY2022. Reservoir storage remained below 120,000 af and above 30,000 af throughout the water year resulting in BiOp (2000) established target flows of 2.5 cfs at the Highway (Hwy) 154 Bridge for the LSYR mainstem and a minimum of 2 cfs for Hilton Creek. Historically, Hwy 154 Bridge target flow compliance documentation could not be done at that bridge due to the channel configuration and landowner access limitations. Reclamation and COMB established a low-flow river discharge monitoring location approximately 1 mile downstream of the bridge where access is available. Reclamation takes a discharge measurement approximately once a month and COMB-FD once a week plus maintains a pressure transducer which takes a stage measurement once every 15 minutes. The objective is to maintain a river discharge at that monitoring location of 2.5 cfs or greater if the lake storage is below 120,000 af and above 30,000 af. Based on the measurements at the monitoring location approximately one mile downstream of the bridge, target flows were met by Reclamation for WY2022 except for a brief period at the beginning of March when discharge measured was just less than 2.5 cfs. COMB was able to obtain landowner access in 2022 to in area upstream of Hwy 154 Bridge suitable for flow monitoring and worked with USGS in September 2022 to install a low-flow gauging station near the previous Hwy 154 Bridge stream gauge approximately 1,000 feet upstream. The gauging station record began in October 1, 2022 to provide documentation for flow compliance for the Hwy 154 Bridge for WY2023. The gauging station was not available for WY2022.

The required BiOp (2000) target flows for Hilton Creek on Reclamation property is a minimum of 2 cfs. Target flows to Hilton Creek were provided to the Upper Release Point (URP) and Lower Release Point (LRP) by gravity flow, pumped flow, or a combination of the two from either the Hilton Creek Watering System (HCWS), the Hilton Creek Emergency Backup System (HCEBS), or both. At the beginning of WY2022, Reclamation was providing lake discharge waters to Hilton Creek through the HCEBS by gravity to the URP and the LRP. The total discharge was less than 2 cfs that was discussed with NMFS prior to reaching that minimum target flow. As the lake level declined, the associated discharge decreased to the point when there was little discharge coming out at the URP but sufficient to sustain the fishery between the URP and LRP (Reach 5). After several discussions between Reclamation and NMFS, Reclamation decided to activate the HCWS pump on 8/2/22 to deliver water to Hilton Creek with the objective of setting the HCEBS to standby mode in the event that the pump turned off. Late that day the programmed linkages for that automated transfer of flow from the HCWS to the HCEBS were found to be inoperable, so Reclamation reconfigured part of the system for HCEBS gravity flow with HCWS pumped flow from the lake-based system. That night at approximately 8:00 PM an email alert from PG&E was received regarding an unplanned power outage in the area of Bradbury Dam and Lake Cachuma. The HCWS pumps shut off and HCEBS gravity flow to the creek did not occur, resulting in no water being delivered to Hilton Creek for approximately 2 hours. Both Reclamation and COMB-FD staff mobilized to the area. Reclamation attempted to activate the HCWS pumps without success and then started the HCEBS pumps which restored flow to the creek at the URP and LRP. COMB-FD staff conducted fish rescue and relocation efforts until flows were reestablished to the creek. There were 32 *O. mykiss* rescued/relocated downstream below the LRP and 9 *O. mykiss* mortalities found.

Multiple meetings were held after that incident with NMFS, USBR, and CDFW where it was concluded that the delivery system of water to Hilton Creek by HCWS pumped flow was not reliable, all fish should be relocated out of Reach 5 to sustainable habitats downstream of the LRP, and that reach should be blocked off to upstream fish movement. This would allow for HCEBS gravity flow to the LRP and HCWS pumped flow to the URP. If the HCWS pump turned off, then the fishery would be sustained by the HCEBS gravity flow to the LRP and downstream of the blocking seine. Fish rescue and relocation was conducted by CDFW with assistance from COMB-FD and approved by NMFS on 8/8/22 through 8/10/22. There were 446 *O. mykiss* rescued and successfully relocated with 8 *O. mykiss* mortalities. On 8/11/22, Reclamation turned off the HCEBS pump, reestablished HCEBS gravity flow to the LRP, and activated the HCWS pump to the URP. The parallel delivery systems (gravity and pump) functioned in that configuration for the rest of the water year.

There were 3 interruption of flow events to the URP during the first week of September when the region was experiencing an intensive heat wave. The first event occurred on 9/2/22 at approximately 7:45 AM that was associated with an unexpected PG&E power outage. Reclamation dam tenders were on site, started the onsite generator, and reestablished HCWS pump flow to the URP. The event duration was short and no strandings or mortalities were found within Reach 5. Reclamation was concerned about potential future power outages during the ongoing heat wave and opted to switch to a procedure of going to generator power at the end of the day when the dam tender staff would not be on site and back on grid power in the morning when staff were on site until the heat wave passed.

On 9/3/22 in the morning, Reclamation was in the process of switching from generator to grid power when the HCWS pump shut off. They were not able to reactivate the HCWS pump from the land-based controllers and had to boat to the pumping barge to start up the backup pump to reestablish flow to the URP. The interruption of flow to the URP continued for approximately 4 hours during which 2 *O. mykiss* were rescued/relocated and 6 *O. mykiss* mortalities were found.

Another short duration interruption of flow at the URP occurred on 9/5/22 in the morning at approximately 9:00 AM that was associated with Reclamation switching from generator to grid power. Reclamation was able to quickly restart the HCWS pump from the land-based controllers and reestablish flow to the URP, a duration of approximately15 to 30 minutes. Due to the brevity of the event, no COMB-FD staff were deployed to the creek.

For reference, COMB is aware of 8 PG&E power outages at Bradbury Dam during WY2022 (6 in Calendar Year 2022) that did make or would have made continuous HCWS pump operations difficult.

Water Rights Releases: Water Rights releases are non-discretionary releases called for by the Santa Ynez River Water Conservation District (SYRWCD, downstream Water Rights holders) as described in WR Order 89-18 (WR 89-18). There was a 2022 WR 89-18 Below Narrows Account (BNA) release that was initiated on 8/8/22 and ended on 10/5/22 that discharged 9,913 af of water from Lake Cachuma to recharge downstream aquifers over 58 days. A separate report was submitted after the release by COMB-FD to Reclamation that described the results of the monitoring effort associated with the release (COMB, 2023). Reclamation submitted that report to NMFS on 1/5/23.

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 (Outlet Works). 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 is delivered to Hilton Creek through the HCWS and/or HCEBS delivery systems and flows through Hilton Creek into the LSYR mainstem just upstream of 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 goes up and over the dam and eliminates having to use the Penstock (Outlet Works).

CCWA did not deliver SWP to the lake through the Penstock (Outlet Works) throughout the water year. Hence, the criterion was met for RPM 5.1 throughout WY2022 (Figure 4). All SWP deliveries to Lake Cachuma went through the bypass instead of through the Penstock. 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 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 was the sixth year that the sensors were operational and the data were recorded by Reclamation. No SWP water was delivered to Lake Cachuma through to Penstock, hence there were no issues with water temperatures from releases from the Outlet Works to the LSYR mainstem (Figure 4). Reclamation does not routinely record water temperatures going through the Penstock when there is no SWP water being delivered through the Outlet Works. Hence, monthly lake profile data from the bottom were used as a surrogate since the profile is taken near the intake to the Penstock at the bottom of the lake.

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 with thermographs (recording continuously at the beginning of every hour) and dissolved oxygen concentrations at select sites with multi-parameter units (Sondes and U-26s). 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 multi-parameter units) 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 warmest portion of the year (July through September). Several monitoring locations were added over the years starting in WY2013 to increase the understanding of the thermal regime in various LSYR mainstem and tributary habitats as they relate to fish assemblages, specifically *O. mykiss*.

Water Temperature: During WY2022, 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 (Figure 5 and 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 which 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 2000 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).

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 two locations; at the Upper Release Point (URP) and just upstream of the creek's confluence with the LSYR mainstem to monitor stream temperatures in the artificially watered sections of the creek on Reclamation property.

There were 30 thermograph units deployed at 15 sites on the LSYR mainstem which are listed below with the number of units in parentheses:

- Stilling Basin parapet wall (LSYR-0.01 (3));
- Downstream of Stilling Basin (LSYR-0.25 (1));
- Long Pool (LSYR-0.51 (3));
- LSYR directly downstream of Long Pool and upstream of Reclamation and Crawford-Hall property boundary (LSYR-0.68 (1));
- Grimm Property upstream (LSYR-1.09 (1));
- Grimm Property downstream (LSYR-1.54 (1));
- Grimm Property pool (LSYR-1.71 (3));
- Kaufman Property Run (LSYR-2.77 (1));
- Encantado Pool (LSYR-4.95 (3));
- LSYR Mainstem (WR 89-18) Trap Site (LSYR-6.08 (1));
- Double Canopy Pool (LSYR-7.65 (2));
- 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 units deployed at 12 sites which are listed below, all of which were single unit deployments:

- Hilton Creek (HC, 2 sites):
    - HC-lower (HC-0.12); and
    - HC-upper (HC-0.54);
- 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);
    - SC-Jalama Bridge (SC-3.5); and
    - SC-upper (SC-3.8).
- El Jaro Creek (EJC, 3 sites):
    - EJC-lower (EJC-3.81);
    - 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. Photos of each LSYR mainstem and tributary deployment location are presented in Figures 6-10 for general reference.

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

<u>Stilling Basin Parapet Wall – Pool (north) (LSYR-0.01)</u>

A 3-unit vertical array was deployed along the northeast parapet wall of the Stilling Basin from 5/2/22 through 11/1/22 (Figure 6 and Figures 11-13). 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 causing a rapid decrease in water temperatures.

Water temperatures within the Stilling Basin showed gradual seasonal warming and stratification starting in May before rapidly cooling on 8/8/22 following the start of WR 89-18 downstream releases. The thermal warming is most pronounced at the surface unit and diminishing going to depth with the development of stratification. Several temperature spikes greater than 22 °C were recorded coincident with hot days in June, July, and August at the surface unit. Maximum surface temperatures remained less than 22 °C except for the brief spikes mentioned above. The middle and bottom units nearly mimicked each other with both remaining essentially less than 20 °C prior to WR 89-18 releases. Following the start of WR 89-18 releases, water temperatures decreased to less than 17 °C at all three sites followed by gradual warming as releases decreased. Middle and bottom temperatures showed essentially the same trends and that the thermocline was established below 14-feet in depth both before and after the release.

No snorkel surveys were conducted in the Stilling Basin. Only adult carp and largemouth bass were observed from the parapet wall, no other fish species were observed. While no *O. mykiss* were observed in the Stilling Basin (bank surveys only), their presence cannot be ruled out, particularly following the WR 89-18 release, which provided cool water and a migration corridor to the Stilling Basin from portions of lower Hilton Creek and LSYR Long Pool where numerous *O. mykiss* were observed in WY2022.

Downstream of the Stilling Basin – Run (LSYR-0.25)

A single temperature unit was deployed in a 1.5 foot deep run habitat approximately 40-feet downstream of the Stilling Basin tailwater control point from 5/2/22 through 11/1/22 (Figure 6 and Figure 14). Maximum water temperatures remained less than 22 °C during the lead up to WR 89-18 downstream releases. Overall, maximum temperatures at this site ranged from 20 °C to 21 °C through the summer and slightly cooler than the Stilling Basin surface unit. Water temperatures decreased from a high of 21 °C to less than 17 °C following the start of WR 89-18 releases. *O. mykiss* were observed in and around this monitoring location during spring and fall snorkel surveys. It is likely some *O. mykiss* moved into the Stilling Basin as cold water from downstream releases created a linkage to the lower portions of Hilton Creek and the LSYR Long Pool where numerous YOY were observed prior to the release. In addition, a single redd site that produced YOY was located approximately 250 feet downstream of the thermograph location and there is the potential that some of these fish could have moved upstream into the Stilling Basin.

Long Pool – Pool (LSYR-0.51)

Prior to the Whittier Fire in 2017, the Long Pool habitat dimensions were approximately 100 feet wide at the widest point and 1,200 feet long with a maximum depth of over 9 feet. Since the Whittier Fire, the Long Pool has lost considerable length and depth due to extensive alluvial deposition from the Hilton Creek watershed specifically from the Whittier Fire that burned the upper third of the watershed. Currently, the Long Pool is approximately 900 feet long and has a maximum depth of just under 5.5-feet (Figure 6 and Figures 15-17). It can be fed by three water sources when there is no spill: the Outlet Works; the Chute Release Point (CRP) which is part of the HCWS that can release water directly into the Stilling Basin; and Hilton Creek proper (URP and LRP of the HCWS/HCEBS and natural upper basin creek flow). These water sources come together and mix in the channel that traverses the newly formed delta just upstream of the Long Pool. Though the Long Pool's overall length has decreased by 300-400 feet due to sedimentation, the length of Hilton Creek and where it confluences with the Long Pool has increased and appears to be a net benefit to rearing *O. mykiss* based on snorkel and redd survey data collected since 2017 given the increased stream channel length.

Over the last several decades, the Long Pool has been inhabited by various invasive species that can limit *O. mykiss* colonization due to predation, competition, and degradation of water quality. This conclusion was 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, primarily in the Stilling Basin in WY2022. Beaver activity has also been an issue in past years prior to WY2016. After WY2016, dry conditions within the Hwy 154 Reach extirpated beavers from this section of the river. However, beavers have returned to the Hwy 154 Reach and have moved into the Long Pool and lower portions of Hilton Creek in WY2022. As the Long Pool has decreased in depth due to siltation and the newly formed delta instream habitat as matured, there has been a change in the overall fish assemblage observed. Of note is a reduction in the numbers of invasive species and an increase in numbers of multi-age and size classes of *O. mykiss.*

A vertical array was deployed on 5/2/22 and removed 10/31/22 at the deepest portion of the pool habitat at 1-foot, 2.5 feet and 5.5 feet below the surface. Maximum surface water temperatures showed rapid warming starting in mid-May. Water level decreases exposed the surface unit to air from 6/11/22 – 7/20/22. Prior to the WR 89-18 release surface maximum temperatures varied between 22 °C to 23.6 °C before falling to less than 17 °C after the WR 89-18 releases started. As releases decreased there was a corresponding increase in surface temperatures during the latter portion of September through early October. Minimum surface water temperatures remained less than 19 °C during the entire deployment. Maximum water temperatures at the middle unit remained less than 22 °C and minimum temperatures were less than 19 °C for the majority of the deployment. The bottom unit showed little fluctuation and remained less than 19 °C for the entire deployment. Water quality conditions observed in Long Pool during WY2022 were favorable to rearing *O. mykiss*.

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 5/2/22 to 10/26/22 (Figure 6 and Figure 18). Temperatures at this location were slightly cooler compared to surface units upstream with maximum temperatures remaining less than 22 °C and minimum temperatures remaining less than 19 °C for the entire deployment period, particularly following the start of the WR 89-18 releases. Adult, juvenile, and YOY *O. mykiss* were observed throughout this section of the river downstream of the Long Pool indicating good rearing conditions throughout the year.

Grimm Property Upstream – Run (LSYR-1.09)

A single thermograph was deployed in a heavy canopy run habitat measuring approximately 100 feet long, 15 feet wide, and 1.5 feet deep from 5/2/22 to 10/25/22 (Figure 6 and Figure 19). This is the fifth year water temperature monitoring has occurred at this location. Water temperatures were nearly identical compared to LSYR-0.68 with maximum temperatures less than 22 °C and minimum temperatures less than 19 °C. Rapid cooling was observed following the start of the WR 89-18 downstream releases decreasing temperatures to less than 18 °C for the majority of the deployment. YOY, juvenile, and adult *O. mykiss* were observed throughout this area during spring and fall snorkel surveys.

Grimm Property Downstream – Run (LSYR-1.54)

A single thermograph was deployed in a run habitat measuring approximately 45 feet long, 15 feet wide, and 1.5 feet deep from 5/2/22 to 10/25/22 (Figure 6 and Figure 20). This is the fifth year water quality monitoring has occurred at this location. Water temperatures collected at this site showed gradual seasonal warming up to WR 89-18 releases and were nearly identical to those collected at LSYR-1.09 and LSYR-0.68. Maximum water temperatures generally remained less than 22 °C during the warmest portion of the year (the mid-July heatwave being the exception). Minimum temperatures generally remained less than 20 °C. The warming is most likely due to the absence of over story canopy and the presence of several large pool habitats between the two sites that allow for thermal heating, particularly during lower flow periods. YOY *O. mykiss* were observed both upstream and downstream of this location during spring snorkel surveys. Overall, *O. mykiss* numbers decreased during the fall snorkel surveys as the fish grew and possibly moved to occupy deeper habitats or were displaced and moved to other habitats during the WR 89-18 releases. Water temperatures decreased significantly following the start of the downstream water rights releases.

Grimm Property - Pool (LSYR-1.71)

A three unit vertical array was deployed for the fifth year in this pool habitat from 5/2/22 to 10/25/22 (Figure 7 and Figures 21-23). The habitat measured approximately 200 feet long, was 35 feet wide, and 6.5 feet deep. Surface water temperatures were nearly identical to those collected at SSYR-0.68, LSYR-1.09, and LSYR-1.54 with the same corresponding spike associated with the early July heatwave. Middle and bottom temperatures were slightly cooler with bottom maximum temperatures less than 22 °C and minimum temperatures less than 21 °C. Juvenile and adult *O. mykiss* were observed in this habitat during spring snorkel surveys with fewer numbers observed in the fall as the fish moved, were possibly displaced, or may have been predated upon. In addition, several size classes of largemouth bass were observed here in the spring and fall. Water temperatures showed a rapid decline following the start of WR 89-18 downstream releases, which provided cool water conditions after August and allowed a migratory pathway both upstream and downstream of this habitat.

Kaufman Property – Run (LSYR-2.77)

A single thermograph was deployed for the second time at this location at the head of a run habitat measuring 200 feet long, 20 feet wide, and 2 feet deep from 5/2/22 through 10/25/22 (Figure 7 and Figure 24). Maximum water temperatures were very similar compared to the Grimm property thermographs upstream with temperatures ranging from 22-23 °C during June through July. In the beginning of June, temperatures showed rapid warming up to the start of WR 89-18 releases. Maximum temperatures quickly decreased following the arrival of WR 89-18 releases. Minimum temperatures were less than 20 °C during the entire deployment. Juvenile and adult *O. mykiss* were observed in this habitat during spring and fall snorkel surveys as well as several adult largemouth bass. This location is just upstream of the new USGS stream gaging and water quality monitoring site (#11126400, Hwy 154 near Santa Ynez) that was activated on 10/1/22. The USGS recorded temperature data were very similar to the thermograph data.

Encantado Pool – Pool (LSYR-4.95)

When full, the Encantado Pool is approximately 400 feet long, an average of 30-feet in width, and has a maximum depth of 8 feet when residual pool depth is being maintained. A vertical array was deployed in this habitat from 5/2/22 to 11/2/22. (Figure 7 and Figures 25-27). The WR 89-18 release reached this habitat on 8/10/22. The middle unit was missing when the units were retrieved during early November and it is suspected a beaver may have removed the thermograph from the array as beavers recently moved into that habitat. Maximum surface water temperatures were among the highest along the LSYR mainstem monitoring locations, remaining greater than 22 °C during May through June. Coincidently during this timeframe was a rapid decrease in flow with the river going dry upstream and downstream of this habitat when residual pool depth was lost and briefly exposed the surface unit to air from 7/19/22 – 7/24/22. Middle maximum temperature spiked to 23 °C during this same time before decreasing following the arrival of WR 89-18 flow. Bottom maximum temperatures generally remained less than 20 °C except for a brief spike to 22 °C coincident with loss of inflow and residual pool depth. Overall, minimum water temperatures collected at the bottom remained less than 20 °C prior to WR 89-18 releases when minimum temperatures dropped to less than 16 °C during the height of the water release.

Adult and juvenile *O. mykiss* successfully oversummered in this habitat as bottom pool temperatures provided refuge habitat during the warmest portion of the summer. Once the WR 89-18 releases reached the habitat, general cooling was recorded while higher flow rates were being maintained. As the higher flow rates were decreased, there was a corresponding increase in water temperatures, but cooler than prior to the release with bottom temperatures decreasing further. *O. mykiss* were observed during snorkel surveys in the spring (21), summer (25) and fall (16). Summer *O. mykiss* observations occurred prior to WR 89-18 releases when residual pool depth was not being maintained and inflow into the pool was a trickle. Fall surveys were conducted following the peak of WR 89-18 releases. The reduction of *O. mykiss* numbers between the summer and fall suggest the likelihood of upstream or downstream fish movement. Snorkel surveys conducted in a pool habitat immediately upstream of the Encantado Pool show that one *O. mykiss* was observed in the summer and 13 in the fall after WR 89-18 releases providing further evidence that *O. mykiss* do move during water rights releases. No *O. mykiss* were observed downstream of the Encantado Pool during fall surveys. Invasive warm water species (adult and juvenile largemouth bass and sunfish) were also observed during snorkel surveys.

LSYR Mainstem (WR 89-18) Trap Site - Run (LSYR-6.08)

A single thermograph was attached to the trapping infrastructure from 8/14/22 through 9/15/22 to monitor water temperatures during trapping operations of the WR 89-18 release. The unit was attached to a sturdy section of the paneling (A-frame) approximately 1-foot from the bottom of the river. Water arrived at the site on 8/14/22 sometime around 20:00 hours (the unit was recording every hour). Water temperatures quickly increased the following day to nearly 26 °C before cooling each successive day as the full magnitude of the release reached the site. While releases were at their maximum thermal control was maintained. As flows were decreased, water temperatures increased.

Maximum water temperatures were lowest during the highest flow rates; specifically 8/22/20 through 9/3/22 and generally remained less than 20 °C (Figure 7 and Figure 28). As the release rates decreased there is a corresponding increase in water temperatures at LSYR-6.08. Maximum temperatures approached 26 °C on the first day after the flow arrival and on the last day of trapping. Warm water species were captured in both the upstream and downstream traps during the WR 89-18 releases. No *O. mykiss* were captured.

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 3.0 feet deep at its deepest point when the habitat is filled and flowing. There was a significant beaver dam in the habitat directly upstream and at the tail of the Double Canopy pool (150 feet upstream of the Refugio Bridge) (Figure 7). A two-unit vertical array was deployed at this site from 5/4/22 to 11/2/22 (Figures 29-30). Data collected showed relatively cool and stable water temperatures at the surface that remained between 18-22 °C prior to WR 89-18 releases reaching the site. Once release water arrived at the site on 8/17/22 at approximately 20:00 hours, there was a corresponding 23 °C temperature spike followed by cooler daily minimum water temperatures during the period of maximum release rate. Water temperatures were slightly cooler at the bottom but become uni-thermal once WR 89-18 releases reached the site and mimicked those collected at the surface. A single *O. mykiss* was observed at this monitoring location during the spring snorkel survey but was not observed during subsequent snorkel surveys in the summer and fall. Numerous adult largemouth bass, sunfish species, and carp were also observed during snorkel surveys.

Head of Beaver Pool (LSYR-8.7)

This habitat is located approximately ¼ mile downstream of the Quiota Creek confluence with the LSYR mainstem. The habitat is approximately 730 feet long, 50 feet wide, and 5.5 feet at the deepest point while residual pool depth is being maintained period (Figure 7 and Figures 31-33). A vertical array was deployed in this habitat from 5/4/22 to 11/2/22. The surface unit was exposed to air from 7/12/22 to 8/18/22 and the middle unit was exposed to air from 8/1/22 to 8/18/22 due to declining water levels and residual pool depth not being maintained. After WR 89-18 releases reached the site water temperatures became uni-thermal from the surface to the bottom. No *O. mykiss* were observed in this unit during snorkel surveys. WR 89-18 water reached this site on 8/18/22. Invasive warm water species were observed in this habitat during snorkel surveys in the spring and fall.

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 5/4/22 to 6/9/22 before it was removed due to the habitat drying out. The array was redeployed on 8/22/22 after WR 89-18 water reached the location and remained deployed until 11/2/22 (Figure 8 and Figures 34-36). Once WR 89-18 water reached the site, the surface and middle units became uni-thermal with the bottom unit recording slightly cooler water temperatures. Overall, maximum surface and middle temperature generally remained less than 22 °C for the majority of the deployment. Minimum temperatures remained between 17 °C- 20 °C for the entire deployment. No *O. mykiss* were observed during snorkel surveys. Invasive carp were observed in this habitat during the spring snorkel surveys.

Avenue of the Flags – Pool (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 5/4/22 to 11/4/22 one foot off the bottom (Figure 8 and Figure 37). Maximum water temperatures showed gradual seasonal warming through June and remained relatively stable through July and August at less than 21°C until WR 89-18 releases reached the site on 8/21/22 at approximately 17:00 hours. After flow reached the site, waters quickly warmed to nearly 22 °C followed by additional warming coincident with late season heat waves then general cooling into fall. Avenue of the Flags pool is generally fed by cooler underflow in the summer months and warmed surface flow from the Water Rights release results in increased temperatures in the pool. No *O. mykiss* or invasive warm water species were observed in this habitat during snorkel surveys.

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 5/5/22 to 11/4/22 (Figure 8 and Figures 38-40). The surface was exposed to air from 8/13/22 to 8/26/22 due to declining water levels. WR 89-18 releases reached the monitoring locations on 8/26/22. Water temperatures collected at the surface show general seasonal warming, with maximum temperatures reaching 24 °C several days prior to the arrival of the release. The middle and bottom units recorded noticeably cooler temperatures with the coldest temperatures recorded at the bottom unit. Once WR 89-18 releases reached the site, there was a several degree temperature spike followed by a several week stretch of warming before seasonal cooling began. Cadwell pool is generally fed by cooler underflow in the summer months and warmed surface flow from the water rights release results in increased temperatures in the pool. No *O. mykiss* were observed in this habitat, only invasive species including largemouth bass, sunfish species, and carp.

LSYR Mainstem Longitudinal Comparisons

Longitudinal LSYR mainstem (maximum daily) water temperature at the surface thermographs for LSYR-0.01, LSYR-0.25, LSYR-0.51, LSYR-0.68, LSYR-1.09, LSYR-1.54, LSYR-1.71, LSYR-2.77, LSYR-4.95, LSYR-7.65, LSYR-8.7, LSYR-10.2, LSYR-13.9, and LSYR-22.68 including USGS flows at Hilton Creek and Alisal Bridge in Solvang are presented in Figure 41. Longitudinal maximum surface temperature comparison is 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 the surface water temperature at all sites and does not look at bottom temperatures in pool habitats with vertical arrays (i.e., LSYR-0.01, LSYR-0.51, LSYR-1.71, LSYR-4.95, LSYR-7.65, LSYR-8.7, LSYR-10.2, and LSYR-22.68). Surface maximum temperatures, particularly in pool habitats does not reflect the general rearing potential throughout the water column of each habitat. For example, *O. mykiss* observed in pool habitats at LSYR-0.51, LSYR-1.71, LSYR-4.95 and LSYR-7.65 with elevated surface water temperatures do not inhibit fish survival and rearing specifically during the warmest portion of the year. Those fish are observed almost exclusively near the bottom or mid-water column of the habitats where cooler water quality conditions persisted due to stratification and/or groundwater upwelling. For a more complete presentation of each specific habitat, see above.

Factors influencing surface water temperatures along the longitudinal profile include: (1) thermally-warmed Stilling Basin surface water moving downstream resulting in an increase in stream temperature in the Hwy 154 Reach; (2) dry cobble bars with extensive exposure to the sun that warm the leading edge of any released waters moving downstream, which 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*. Particularly for pools closer to Bradbury Dam. Further downstream from Avenue of the Flags and onward the water rights releases appear to increase the temperature of the pools due to the continuous surface warming as the water travels down the river compared to the cooler river underflow feeding the pools in the summer months outside of the water rights releases.

WY2022 was a dry year type. The Hwy 154 target flows enabled flow to persist through the entire Hwy 154 Reach and portions of the upper Refugio Reach through late June. By July, portions of the Refugio Reach and Alisal Reach had completely dried, specifically a short riffle unit 0.1 mile upstream of LSYR-4.95 and from approximately LSYR-5.0 to LSYR-7.0 (known as the dry gap) as well as sections of the Alisal Reach upstream of the Alisal Bridge in Solvang and in areas upstream and downstream of the Narrows. All sites showed typical seasonal warming with an increase in ambient air temperatures and decreasing flow rates prior to the WR 89-18 release with lower temperatures recorded at all monitoring sites once the downstream release reached each site. Of note compared to previous years was the overall cooler water temperatures recorded at most of the LSYR mainstem monitoring locations.

Overall, maximum daily water temperatures generally increased going downstream and remained less than 24 °C during the warmest portion of the year prior to WR 89-18 releases reaching each site. The exception to the above observation was LSYR-4.95 which recorded noticeably higher surface water temperatures compared to the other locations.

O. mykiss and Water Temperature Criteria within the LSYR Mainstem

YOY, juvenile, and adult *O. mykiss* were observed at various locations in the spring, summer, and fall within the first 8.0 miles downstream of Bradbury Dam showing that habitat conditions remained favorable for rearing fish in this section (except for the dry gap from about LSYR-5.0 to LSYR 7.0), particularly in deeper pool habitats based on recorded water temperatures. The majority of the *O. mykiss* were in the Hwy 154 Reach and areas upstream of Encantado Pool (LSYR-4.95), with a few juveniles and adults scattered as far downstream as LSYR-7.8. Most of the YOYs observed upstream of LSYR-2.77 likely originated from successful spawning in Hilton Creek (23 redds documented) and localized areas within the Hwy 154 Reach where some suitable spawning habitats were available. Of note were the snorkel observations of numerous large adults in deeper pool habitats in the Hwy 154 Reach which likely points to the potential for another abundant spawning year in Hilton Creek during the next spawning season of WY2023. Spring snorkel survey results recorded juvenile and adult *O. mykiss*, with highest densities of fish observed in and around the Hwy 154 Reach, specifically within Reclamation and the Grimm property (see snorkel survey results). Most of these fish inhabited deeper pool habitats where stratification and groundwater inflow contributed to lower water temperatures in the summer and early fall before ambient temperatures began to decrease with the days getting shorter and the drop off of evapotranspiration. Monitored water temperatures showed cooler and more favorable rearing conditions compared to previous years possibly due to the timing and operation of the WR 89-18 releases as well as established riparian corridors that reduce thermal inputs into the water.

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

Lower Hilton Creek (HC-0.12)

A single thermograph was deployed in a run habitat approximately 250 feet upstream of the delta confluence of Hilton Creek and LSYR mainstem (Long Pool). The unit was deployed near the bottom in approximately 1.5-foot of water from 5/2/22 to 10/31/22. Maximum water temperatures remained at or less than 18.2 °C during the entire period of deployment (Figure 9 and Figure 42). There is a noticeable decrease in water temperature on 8/12/22 as flows from the Hilton Creek LRP were increased from 2 acre-feet to 4 acre-feet. YOY and juvenile *O. mykiss* were observed throughout this section of the creek during all of WY2022. No invasive species were observed in the lower section of Hilton Creek during spring and fall snorkel surveys.

Upper Hilton Creek (HC-0.54)

A single thermograph was deployed in a pool habitat adjacent to the URP release site from 5/2/22 to 11/1/22. The instrument was placed at the bottom of a pool habitat 20 feet long and 10 feet wide with a depth of approximately 1.5 feet. Water temperatures remained less than 17 °C for the majority of the deployment period (Figure 9 and Figure 43). *O. mykiss* were observed inhabiting the creek at this monitoring location through 8/10/22 when rescue and relocation were conducted with assistance from CDFW to remove *O. mykiss* from Reach 5 due to uncertainty of Reclamation flow deliveries to the

URP. Of note on the graph are two flow stoppage/dewatering incidents that occurred on 8/2/22 and 9/3/22. No invasive species were observed in the upper portion of Hilton Creek during spring and fall snorkel surveys.

In comparing water temperatures differences between the Upper and Lower Hilton Creek, data showed less than a 2.2 °C increase in water temperature from thermal heating between the upper and lower monitoring sites (slightly warmer compared to WY2021). The cool water releases coupled with the intact riparian canopy contributed to the continued low water temperatures readings from the URP downstream. Further discussion of lake water releases to Hilton Creek are provided in Section 4.

Quiota Creek (QC-2.66)

A single thermograph was deployed approximately 35 feet upstream of Crossing 6 on Refugio Road from 5/4/22 through 7/16/22 (Figure 9 and Figure 44). The unit was placed at the bottom of a pool habitat 30 feet long and 10 feet wide with a depth of approximately 2.75 feet. Maximum water temperatures fluctuated between 17 °C and 23 °C during the period of deployment. Declining water levels required the removal of the thermograph unit on 7/16/22 as the pool habitat was decreasing and residual pool depth was no longer being maintained. No *O. mykiss* were observed rearing in this habitat prior to it drying out.

Lower Salsipuedes Creek (SC-0.77)

A single thermograph was deployed in this habitat approximately 4.5 feet below the surface from 5/5/22 to 11/4/22. The habitat measured approximately 40 feet long, 15 feet wide with a maximum depth of 5.0 feet (Figure 9 and Figure 45). Habitats in the Lower Salsipuedes Creek area have undergone a transformation since the start of the drought. As riparian vegetation has become more established there has been a significant deepening of numerous instream habitats, which have contributed positively to the overall temperature regime and rearing conditions for *O. mykiss*. Water temperatures remained less than 19 °C during the entire deployment period with little daily variation. No *O. mykiss* were observed in this habitat though *O. mykiss* were observed in habitats upstream during WY2022 snorkel surveys. Invasive green sunfish were observed throughout this section of the creek.

Salsipuedes Creek-Reach 2-Bedrock Section (SC-2.2)

A single thermograph was deployed in a pool habitat approximately 4 feet below the surface from 5/5/22 through 11/4/22 within Reach 2. This 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 deep pools. The monitored habitat is approximately 40 feet long, 15 feet wide, and 9-10 feet deep at its deepest point (Figure 9 and Figure 46). *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 typical seasonal warming, peaking in July through early August with maximum temperatures reaching between 22-23 °C and minimum temperatures between 19-22 °C during the warmest portion of the year. One anomalous temperatures spike was recorded on 7/27/22 followed by a cooling trend then a late season heatwave during the first week of September. *O. mykiss* were observed throughout Reach 2 during spring snorkel surveys in WY2022. Numerous green sunfish were also observed.

Salsipuedes Creek – Highway 1 Bridge (SC-3.0)

A single thermograph was deployed in the pool habitat approximately 6 feet below the surface, 200 feet downstream of the Hwy 1 Bridge from 5/5/22 through 11/10/22. This deployment site is the deepest pool on Salsipuedes Creek measuring 175 feet long and 45 feet wide with a maximum depth of approximately 14 feet (Figure 9 and Figure 47). This thermograph location is near the top of Reach 4, the second significant bedrock influenced section of the creek. Reach 4 is similar to Reach 2 in that there are numerous deep pool habitats formed in the bedrock that offer excellent oversummering opportunities for rearing *O. mykiss*. Water temperatures were relatively cool with maximum temperatures remaining less than 22 °C during the warmest portion of the season. While no *O. mykiss* were observed in the pool habitat due to turbid conditions, *O. mykiss* were observed immediately upstream and downstream of this habitat which suggested they were likely rearing in the deeper sections of this large pool habitat. Green sunfish were also observed this habitat during spring snorkel surveys.

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 5/5/22 through 11/10/22. The pool was approximately 30 feet long, 18 feet wide, and 6 feet in depth (Figure 9 and Figure 48). The creek upstream and downstream of this monitoring location was one of the few stretches in the creek that provided minimal flow and rearing habitat during the recent drought. This area routinely has held oversummering *O. mykiss* and YOY, juvenile, and adult *O. mykiss* were observed in this habitat as well as in upstream and downstream habitats during the spring snorkel surveys in WY2022. Maximum water temperatures ranged from around 19 °C to over 23 °C during the warmest portion of the year with minimum temperatures generally remaining less than 20 °C except for several short periods coincident with heatwaves. These temperatures provided suitable rearing conditions for *O. mykiss* present in this and the surrounding habitats. Green sunfish adults and juveniles were observed in this habitat during the spring surveys.

Upper Salsipuedes Creek (SC-3.8)

Upper Salsipuedes was negatively impacted by the prolonged drought which dried the creek for an extended period of time and extirpated *O. mykiss* entirely from the portion of Salsipuedes Creek upstream of its confluence with El Jaro Creek. In the years before the drought, Upper Salsipuedes routinely held various age classes of *O. mykiss* as well as multiple spawning locations for both resident and anadromous steelhead. For the last 4 years running, Upper Salsipuedes Creek has completely dried during the early portions of summer.

A single thermograph was deployed on the bottom of the creek in a shallow run habitat 15 feet long, 3 feet wide, and approximately 0.5-foot deep from 5/5/22 through 6/9/22 (Figure 10 and Figure 49). Due to the dry year type with essentially no spring rain in WY2022, Lower Salsipuedes was dry on 6/9/22, several months earlier compared to WY2021. 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 when water was present. *O. mykiss* were observed in the confluence pool habitat approximately 35 feet downstream of the thermograph location as well as immediately upstream in El Jaro Creek. Unfortunately, the upper portions of Salsipuedes Creek dried out during the summer of WY2022 in and around the confluence area, including El Jaro Creek upstream of the confluence. When water was present, maximum water temperatures remained less than 19 °C during the entire deployment period. Minimum temperatures remained less than 14.4 °C for the entirety of the deployment period.

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 5/5/22 to 7/18/22. The habitat is roughly 50 feet long and 12 feet wide with a max depth of 1.5 feet (Figure 10 and Figure 50). This location routinely held rearing *O. mykiss* prior to the drought and numerous YOYs were observed during the spring snorkel surveys in this habitat and in multiple other upstream habitats. Water temperature data collected at this location were generally cooler compared to the other thermographs within the watershed. Maximum water temperatures generally remained less than 19 °C during the deployment with minimum temperatures less than 13 °C. As the season progressed, flow within the lower section of El Jaro Creek completely ceased drying large sections of lower El Jaro Creek. By 7/28/22, this section of El Jaro Creek was dry and dozens of YOY perished.

El Jaro Creek – Palos Colorados (EJC-5.4)

A single thermograph was deployed 0.5 feet from the bottom of a boulder-influenced pool habitat from 5/5/22 through 11/10/22. The habitat measured approximately 35 feet long, 7 feet wide and 3.5 feet deep (Figure 10 and Figure 51). *O. mykiss*, including YOY, juveniles and adults have been observed sporadically in past years in and around the monitored habitat. This area is influenced by Palos Colorados Creek where there is a spring that confluences with El Jaro Creek approximately 1/8 of a mile upstream of the monitoring pool. Water from the spring allowed this area of El Jaro Creek to remain wetted throughout the drought and provided a cool pool refuge habitat for any *O. mykiss* inhabiting this area. The remainder of El Jaro Creek upstream of Palos Colorados Creek essentially dried during the spring/summer months of 2013-2016 and 2021-2022 extirpating *O. mykiss* from this section of the creek. No *O. mykiss* were observed in this habitat in WY2022 though several were observed further downstream in deeper habitats as well as in an isolated pool directly upstream of the spring. During the warmest portion of the year, maximum water temperatures remained less than 22 °C and minimum temperatures less than 21 °C indicating good potential rearing habitat when fish were present. Upstream of Palos Colorados Creek, large portions of El Jaro Creek dried during 2022.

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

O. mykiss have regularly been observed within the plunge pool, the fish ladder, and in habitats upstream of the fish ladder in past years. The drought has extirpated *O. mykiss* from large sections of upper El Jaro Creek including in and around the San Julian Ranch Bridge as large portions of the creek did not flow in the summer of 2013, 2014, and were completely dry in 2015, 2016, 2022, and 2022. A thermograph was deployed in the pool habitat immediately downstream of the bridge from 5/5/22 and removed on 6/24/22 due to drying conditions (Figure 10 and Figure 52). During the deployment, water temperatures showed a steady increase coincident with seasonal warming, reaching a maximum of 22 °C near the end of the deployment. Minimum temperatures remained less than 18 °C when water was present. No *O. mykiss* or warm water species were observed in this habitat during snorkel surveys.

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 5/5/22 through 11/10/22. 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 (Figure 10 and Figure 53). Los Amoles Creek has regularly held various age classes of *O. mykiss* and spawning sites have been identified in the creek over the years. Recent drought conditions have negatively impacted the creek with vast sections of Los Amoles Creek drying several hundred feet upstream of the monitoring location. It is likely *O. mykiss* have been temporarily extirpated from the upper portions of this tributary since the prolonged drought. Conversations with the landowner in 2020, 2021 and 2022 indicated that the majority of the creek upstream of the monitoring location was completely dry during the summer months. Overall, maximum water temperatures remained less than 22 °C except for a several week period in August when maximum temperatures rose slightly over 22 °C and minimum temperatures generally remaining less than 20 °C. No *O. mykiss* were observed at this monitoring location in WY2022 though water temperatures remain favorable for oversummering.

Salsipuedes Creek Longitudinal Comparisons

Longitudinal maximum daily water temperatures for Salsipuedes Creek and El Jaro Creek are shown in Figure 54 for the thermographs at Rancho San Julian (EJC-10.82), Palos Colorados (EJC-5.4), Los Amoles Creek (LAC-7.0), 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 was 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. Drying conditions required the removal of thermographs at SC-3.81, EJC-3.8, and EJC 10.82. For the remaining thermographs, water temperatures collected in the Salsipuedes/El Jaro Creek watershed were noticeably cooler compared to previous years with the majority of maximum water temperatures remaining at or less than 22 °C during the entire year.

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, depth within individual habitats, groundwater upwelling, geomorphic features (bedrock for example), ambient air temperatures, drought, and presence/absence of riparian vegetation all influence the flow and thermal regime within individual habitats in the watershed. The recent drought caused much of the Salsipuedes/El Jaro Creek habitat to constrict down to a few fragmented and isolated flowing sections of creek. The wet water year of 2019 (33.99 inches at Rancho San Julian) and average water year of 2020 (21.0 inches at Rancho San Julian) have helped to some degree reconnect the creek system. Unfortunately, the consecutive dry water years in 2021 and 2022 again caused significant restriction in habitat extent, specifically in Lower Salsipuedes Creek downstream of Santa Rosa Bridge (dry) and portions of El Jaro Creek upstream of the Upper Salsipuedes confluence to Rancho San Julian (dry). As seen in WY2021, most of Los Amoles Creek, and all of Ytias Creek went dry in WY2022. Whether this was caused by the long-term drought conditions in the past or some other draw on the groundwater supply was not clear but the watershed has not entirely recovered to pre-drought dry season condition.

Spawning surveys identified 16 separate redd sites within Salsipuedes Creek and two in El Jaro Creek. Follow up snorkel surveys noted the presence of YOY in large numbers from SC-3.81 downstream to SC-3.0, with moderate numbers observed downstream of SC-2.2. Concentrations of YOY were closely associated to the proximity of spawning sites identified in February and March of 2022. Looking at the monitoring locations within the watershed, it is encouraging to see lower water temperatures during the critical summer period compared to previous years. Based on the data, water quality conditions improved throughout the watershed indicating there was a greater likelihood of YOY survival in the habitats they occupied.

Invasive species in the Salsipuedes/El Jaro Watershed

The entire Salsipuedes/El Jaro watershed has a number of invasive species inhabiting the watershed including green sunfish, largemouth bass, bullhead catfish, bullfrog, and carp. Of particular note is the population explosion of green sunfish seen the past several years. Multiple are classes have been observed throughout the watershed and spawning has been observed during spring snorkel surveys with multiple age classes captured during migrant trapping operations. Invasive fish are entering the creek at the confluence with the LSYR mainstem and traveling upstream into the creek when flows permit. Snorkel surveys conducted during WY2019, WY2020, WY2021, and WY2022 have raised concerns regarding the increased numbers, wider distribution, and observed high reproduction rate of green sunfish in the Salsipuedes and El Jaro creek drainage. The increased number of invasive species will be discussed in the Snorkel Survey section below.

Dissolved Oxygen and Temperature at LSYR-4.95: A single Onset U-26 dissolved oxygen/temperature logger was deployed to monitor water quality within the first 5 miles downstream of Bradbury Dam prior to and immediately following the WR 89-18 water rights releases.

Encantado Pool (LSYR-4.95)

A single U-26 temperature/dissolved oxygen unit was deployed in the mid-water column of the Encantado Pool from 6/13/22 – 11/23/22 to monitor water quality conditions for the *O. mykiss* present in the habitat prior to and immediately following WR 89-18 releases (release started on 8/8/22). Release water reached the site on 8/10/22. Two weeks prior to the release, inflow and outflow to the habitat had ceased creating an isolated pool habitat inhabited by approximately 25 adult and juvenile *O. mykiss* and numerous largemouth bass of various sizes. Prior to the release water temperatures showed little 24-hour variation, ranging from 18°C – 20.5°C. Dissolved oxygen showed a wide variation ranging from a high of around 13.0 mg/L to a low of nearly 2.0 mg/L. Once the release reached the site, dissolved oxygen concentrations improved and there was a slight increase in maximum water temperatures, which has been observed during past WR 89-18 releases (Figure 55).

Once the water reached the site there was a slight increase in water temperature which is expected as the water was flowing through a hot, dry river channel during the heat of the day before reaching the habitat. Once the water started to mix within the habitat, there was a general cooling to less than 18 °C followed by gradual warming through the end of the deployment. Dissolved oxygen concentration decreased from 6.45 mg/L at 16:00 hours to about 2.09 mg/L at 0:00 hours (most likely was due to mixing of stratified low DO waters towards the bottom) before gradually rising again. While dissolved oxygen concentrations regularly dipped into values that are considered stressful to rearing *O. mykiss* during portions of the instrument deployment, the short duration of the exposure did not appear to cause a long-term negative impact as the same fish were present in the habitat following the end of the releases in November. In addition, there were six juvenile *O. mykiss* observed following the release indicating that these fish moved into the habitat during the downstream water rights release.

Lake Cachuma Water Quality Profiles: Water quality profiles were collected at Bradbury Dam near the intake for the HCWS on 1/4/22, 2/1/22, 3/1/22, 4/5/22, 5/3/22, 6/7/22, 7/5/22, 8/9/22, 9/6/22, 10/26/22, 11/10/22, and 12/13/22 (Figure 56). Lake profiles are collected to assure the adjustable intake hose is at an optimal depth so that the HCWS is providing good conditions for *O. mykiss* in Hilton Creek, at or below 18 °C as stipulated in the BiOp. Lake profiles are collected from a boat tied up to the HCWS intake barge where water is typically being drawn in to feed Hilton Creek. This is not the deepest portion of the lake. COMB-FD staff sends instrumentation down from the back of the boat so that the monitoring equipment is not impacted (sucked in) by the snorkel hose of the HCWS.

The HCWS intake has been set at an approximate depth of 65 feet below the water surface, and temperatures of the released water are typically well below the thermocline and 18 °C. Although Lake Cachuma reservoir was less than 50% capacity through WY2022, water temperatures being released into Hilton Creek at both release points (URP and LRP) remained generally below 18 °C throughout the year.

The first lake profiles of the year (January through March) showed cold and uniform water temperatures to depth, ranging from 12.0 °C – 13.4 °C (Figure 57). Surveyors returned in April to find the lake beginning to stratify with a surface temperature of 15.8 °C and a bottom temperature of 12.5 °C. The upper layer of the lake continued to warm in spring with the May profile showing a surface temperature of 18.1 °C and a stratified profile (thermocline at a depth of about 39 feet). The late spring profile in June had a surface temperature of 21.1 °C and a well-defined thermocline beginning at 36 feet. Three summer surveys were conducted between July and September with the lake warming above the thermocline each successive month, ranging from 23.3 °C in July to a maximum of 26.3 °C in September. Summer profiles indicated the thermocline depth to range between 26 – 36 feet below the surface, extending down to approximately 58 feet in depth. Bottom of the lake temperatures ranged from 15.1°C – 15.6 °C during the peak heat of the summer. These measured temperatures, as expected, correlated with the temperatures observed at the lower Hilton Creek thermograph with the LRP providing HCEBS gravity flows from the bottom of the reservoir. When looking at the data from WY2021, when the reservoir was still above 50% capacity, bottom temperatures were running 1-2 °C cooler (13.5 °C – 13.8 °C) compared to WY2022 when the lake was less than 50% capacity. The profile in October revealed the surface of the lake had cooled down to 19.9 °C, a 6.4 °C decrease from the September measurement. The reservoir remained in a stratified condition with a sharp thermocline beginning at 52 feet below the surface. The November profile (2 weeks later) showed the lake had experienced a turnover event with near unithermal conditions from the surface (16.9 °C) down to the bottom (16.6 °C), with a difference surface to bottom of only 0.3 °C. A final profile was conducted in mid-December, which showed further cooling at all depths ranging between 13.4 °C and 13.8 °C.

DO concentrations at the surface of the lake steadily climbed from 8.47 mg/l in January to 9.11 mg/l in April (Figure 56). DO concentrations remained above 6.2 mg/l at all depths during the first four months of the year. The May profile continued to show elevated surface DO concentrations with all DO measurements remaining over 5.0 mg/l except for the final two measurements at the bottom of the reservoir. In June, anoxic conditions at depth were observed at 46 feet below the surface. In July and August, anoxic conditions less than 5.0 mg/l were measured at 33 feet below the surface with DO plunging to less than 1.0 mg/l towards the bottom of the lake. Anoxic conditions from the middle of the water column to the bottom continued in to September and October as the lake remained in a stratified condition. As soon as the lake turned over in early November, DO concentrations immediately recovered at all depths with relatively uniform oxygen levels at the surface (7.0 mg/l) and the bottom (6.1 mg/l). The final profile in December showed a continued increase in DO concentrations at all depths ranging between 7.8 mg/l to 8.0 mg/l.

3.3. Habitat Quality within the LSYR Basin

Habitat quality monitoring during WY2022 within the LSYR Basin was conducted 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 storm flows, spill events, phreatophyte growth, changes in canopy coverage and type, periods of drought, and the results of management activities in the drainage. Illustrative photo point locations are those that provide the best vantage point to show representative changes over time. A list of WY2022 LSYR mainstem photo points is provided in Appendix C (Figure C-1 and Tables C-1 and C-2)**.**

LSYR mainstem photo point locations include all bridges from the Highway 154 Bridge to the Highway 246 Robinson Bridge near Lompoc. Several other LSYR 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.

Photo point comparison between 2005 and 2022 showed 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 57-61). Sections of the LSYR mainstem that were nearly devoid of vegetation in 2005 now show abundant new growth with willow, sycamore, and cottonwood trees in excess of 40 feet in height in some locations. The recent drought caused significant die off of riparian vegetation throughout the LSYR mainstem with some areas being impacted harder than other areas. The last Bradbury Dam spill event occurred in 2011. Since 2011, the region has experienced 5 consecutive years of drought (2012-2016), two wet years (2017 and 2019), one average year (2020) with additional dry years in 2018, 2021 and 2022. The last several years (WY2017, WY2019, and WY2020) of average to above average rainfall has resulted in positive changes to the riparian vegetation with new growth observed in areas hit hard by the drought. WR 89-18 releases provide a water source for riparian plants during the latter part of the summer and the fall. In addition, the absence of spill events for the past 10 years has contributed to increased riparian encroachment creating more complex, densely vegetative and shaded habitats.

Photo documentation within Hilton Creek continues to show a maturing/drought recovering riparian zone, particularly within the reach between the URP and LRP which was initially activated in 2005 (Figures 62-63). Larger trees (willows, alders, sycamores, and cottonwoods) are replacing the smaller understory within the drainage. Salsipuedes and El Jaro Creeks showed recolonization of riparian vegetation after the 2005 flow events, the drought and two years of channel changing flow events in 2017 and 2019 (Figures 64-66). In addition, the cattle exclusionary fencing installed in lower Salsipuedes Creek (completed in WY2015) has contributed to a rapid 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 (specifically beaver dams) 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. Exceptions to trapping include 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 no trapping in WY2013 due to a misinterpretation of a NMFS incidental take request by Reclamation. Results from this year's migrant trapping effort remained below the 2000 BiOp established Incidental Take Statement (ITS) limits due to modified trapping operations that truncated migrant trapping efforts.

WY2022 was the ninth 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 prior to WY2013 and was reported to NMFS. In 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, recent trapping efforts have been starting in February (instead of January) to reduce numbers captured and remain within regulatory compliance. The trapping effort focuses on upstream migrating adults early in the season followed by a focus on out migrating smolts (often juveniles) during the second half of the migration season. Trapping typically ends before the completion of the smolting run as juvenile ITS number is usually reached by late March or early April and does not reflect actual total numbers of outmigrating smolts leaving both Hilton and Salsipuedes Creek watersheds. The downstream traps at Hilton Creek and Salsipuedes Creek can be modified with a pass-through pipe system that allows any fish entering the trap to move through the trap unencumbered. A 12-inch HDPE pipe approximately 15-feet long is secured to the back of the downstream traps below the water level to provide unhindered downstream movement when activated/open. The pipe outlet has a small drop at the downstream end to help prevent upstream fish from migrating up into the pipe and through the downstream trap. Historically the HDPE pipe has been installed at Hilton Creek only as the juvenile population has been significantly greater there compared to Salsipuedes Creek or the LSYR mainstem. Juvenile and adult ITS take limits were not exceeded in WY2022 with a total of 105 juvenile and 77 adult *O. mykiss* captures during the trapping season.

In WY2022, migrant traps were deployed only in Hilton Creek. The Salsipuedes Creek and LYSR mainstem traps were not deployed due to low flow conditions, the lack of spring rains, and no Passage Supplementation Releases. Two sets of paired upstream and downstream migrant traps were deployed at: (1) lower Hilton Creek (tributary farthest from the ocean) 0.14 miles upstream from the confluence with the mainstem LSYR (HC-0.14). Migrant traps were installed in Hilton Creek from 2/1/22 through 4/19/22 (Table 7). The downstream Hilton Creek trap pass through system was installed but not activated and the project stayed within regulatory take compliance.

As in WY2021, the weather pattern during WY2022 was not conducive in providing prolonged instream migratory conditions. Rainfall was inconsistent and sporadic with 1.79 inches in October 2021 (13.6% of yearly total), 8.33 inches in December 2021 (63.4% of yearly total) and 2.1 inches in March 2022 (16% of yearly total) (Table 3). November 2021, January 2022, February 2022 and April 2022 received a total of 0.89 inches of rain (6.8% of yearly total) compared to historic percentages (57.4%). The fact that essentially no rain fell during the January and February timeframe was especially problematic for migration and spawning as instream conditions were not conducive for movement past critical riffle bars. Since 2000, January and February typically receive 44% of the rainfall. In 2022, the two months combined for 4% of the total rainfall received, a 10-fold decrease from historic values. It is highly unlikely that any anadromous adults migrated into the Santa Ynez watershed during the brief window generated by the December storms. If any migration did occur, it would have only been from the lagoon and not from the ocean since the lagoon bar was closed). Flow recorded at the USGS gauging station at H Street in Lompoc registered flows for 10 consecutive days from 12/23/21 to 1/1/22 of which only three days had flow greater than 20 cfs (20.3 cfs on 12/24/22, 27.2 cfs on 12/26/22, and 24.4 cfs on 12/28/22). After January 1, flow at H Street remained at zero for the remainder of the water year.

During WY2022, there were five passage days (12/14/21, 12/24/21-12/27/21) with flows greater than 25 cfs at Solvang during the migration season, all from runoff from the December storms. Flows continued to decrease in the Santa Ynez River in the absence of spring rains and by 5/10/22, flows at Solvang were zero and remained at zero until WR 89-18 releases started in August. No Passage Supplementation Releases occurred due to not meeting the established criteria. Catch per unit effort (CPUE) for WY2022 at the Hilton Creek upstream and downstream migrant trap was 1.24 captures per day with the traps deployed the entire time (100% trapping efficiency) (Table 8). The Hilton Creek traps were removed on 4/19/22 due to reaching take levels with two smolts captured leaving the creek on 4/19/22. It is unknown how many additional smolts left Hilton Creek after the traps were removed but the fact that smolts were still being captured suggests that the smolt run had not ended.

Nighttime fish movement is a well-documented survival 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. WY2022 migrant trapping results suggested *O. mykiss* in general were more likely to move during the late night (2nd check) and early morning hours (1st check) (Table 9).

During the migration/trapping season, baseflows in Hilton Creek averaged 1.5 cfs (range 1.29 – 2.03 cfs) due to HCWS and HCEBS flow delivery limitations to the creek. Low stream flows hampered movement and spawning opportunities compared to WY2021 when the baseflow averaged approximately 5.0 cfs.

Hilton Creek Migrant Traps: Both upstream and downstream migrant traps were installed from 2/1/22 through 4/19/22 (Table 7). There were 97 upstream migrant captures ranging in size from 51 mm (2.0 inches) to 386 mm (15.2 inches) of which 4 were recaptures, all classified as parr or juvenile (Figure 67, Figure 68, and Table 10). Eight of the upstream migrants were classified as parr, 24 were classified as juveniles (<254 mm [10 inches]), and the remainder (61) were classified as adults (>= 254 mm [10 inches]). Upstream migrating fish were captured throughout the trap deployment with the last adult captured on 4/13/22 (Figure 69).

There were 85 downstream migrating fish captured ranging in size from 83 mm (3.3 inches) to 389 mm (15.3 inches) of which 19 were recaptures (Figures 67-69). Downstream migrating fish were captured throughout the trap deployment with no spring storm to generate any additional flow cues after December. There were 23 fish that were classified as parr, 6 were classified as juveniles (4 of which were recaptures), 37 classified as smolts or pre-smolts, and the remainder (16) were classified as adults. Of the 85 downstream migrating fish, 11 were classified as smolts and 26 classified as pre-smolts (43.5%) with three captured in February, 17 in March, and 17 in April (Figure 70). Average smolt size varied slightly by month (range 138.6 mm – 151.0 mm) with a cumulative average of 142.4 mm (5.6 inches) (Table 10). No anadromous *O. mykiss* were captured or observed.

During the 78 days of trapping operations, both the upstream and downstream traps operated for the entire period (100% trap efficiency). The catch per unit effort (CPUE) for upstream and downstream fish was 1.24 captures per day (Table 8). Of the 182 migrant captures, 165 (90%) occurred during the hours of darkness showing that the majority of migrating fish travel at night to reduce predation (Table 9).

Salsipuedes Creek Migrant Traps: No trapping was conducted in Salsipuedes Creek during the 2022 migrant season due to low flow conditions.

LSYR Mainstem Trap: No trapping was conducted in the LSYR mainstem during the 2022 migration season due to low flow conditions.

3.5. Aging of *O. mykiss* Migrant Captures plus Carcasses

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. The rate at which fish and their scales grow depends 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 or the lagoon, size at ocean entry, how long they spent at sea, when spawning occurred, and the approximate age they returned to the river. From a fisheries management perspective, it is important to know how long a fish lives, how big a fish can grow, how many offspring a fish can have, and how often they can reproduce. These various parameters make up the life history of the fish that can be studies through scale analysis. The determined age of a fish can show a broad range of results depending on the fluctuating environmental conditions that affect growth including habitat usage (pool, riffle, run), food availability (aquatic invertebrates, terrestrial drift) and hierarchical position in habitats (i.e., larger fish dominate the better feeding lanes within a given habitat). Smaller fish tend to eat smaller food items then transition to larger food items as the fish gets larger.

COMB-FD staff collects *O. mykiss* scales during migrant trapping efforts generally from fish that are greater than 120 mm (4.7 inches), opportunistically during any required fish rescue, or if a carcass or mortality are found. These scales are dried and stored in envelopes until they can be mounted on a microscope slide per fish 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 condition.

In WY2022, scales were collected and analyzed on 83 of 182 upstream and downstream migrants captured in Hilton Creek along with three Hilton Creek and three Quiota Creek carcasses, for a total of 89 (Table 11). The majority of the upstream fish whose scales were read were classified as adults while the majority of the downstream fish whose scales were read were classified as juvenile smolts/pre-smolts. There was a total of 107 fish where scales were collected but 18 could not be read due to scales undergoing regeneration (i.e., no circuli/annuli laid down) and were not legible. Scale samples could not be taken on 81 of a total of 182 migrant captures in WY2022 due to too small to sample, too much time in the measuring board and concerns of over stressing the fish, or the scales were imbedded and could not be collected (typically male *O. mykiss*). Minimum fish size for tissue/scale sampling was set at 120 mm and some fish were not sampled because the fell under the 120 mm size limit (32 fish total), although one fish measuring 115 mm was sampled and used in this analysis. The age range of analyzed scales was from 1+ to 4+ years with a size range from 115 mm (4.5 inches) to 386 mm (15.2 inches). Fish aged at 1+ ranged in size from 115 mm to 155 mm (6.1 inches), at 2 to 2+ ranged in size from 149 mm (5.9 inches) to 249 mm (9.8 inches), at 3 to 3+ ranged in size from 236 mm (9.3 inches) to 363 mm (14.3 inches) and at 4 to 4+ ranged in size from 315 mm (12.4 inches) to 386 mm (15.2 inches). Figure 71 provides examples of scales for a 178 mm 2+ year downstream migrating smolt and a 386 mm 4 year upstream migrating resident adult. Hilton Creek with continuous favorable rearing conditions from lake releases result in rapid and consistent growth (Figure 72). It is common to see smolt out-migration in Hilton Creek after just one (1+) age (Figure 73).

3.6. 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 and fall). The results are presented below.

Redd Surveys: Redd (spawning) surveys are typically conducted opportunistically once a month in the LSYR mainstem (Highway 154, Refugio, Alisal, and Narrows 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 winter of WY2022 delivered inconsistent and sporadic rainfall during the months that have historically delivered the most rainfall. Since 2000, December through March comprise on average approximately 80% of the total rainfall (18.1%, 23.8%, 20.3% and 17.3% respectively). In WY2022, this total was similar (83.4%) however; the majority of rain fell during this dry year in late December. For comparison during the same four months (December through March) in WY2022 rainfall was 63.4%, 3.4%, 0.6%, and 16.0%, respectively. Rainfall and subsequent runoff is important in several ways to migrating and spawning *O. mykiss*. Besides providing a pathway for movement, the first rains of the season with stream runoff are necessary to remove leaf debris, accumulated silt and other allochthonous material from spawning beds to make them accessible and usable for spawning fish. The late December rainfall was the first significant storm of the season that generated stormflows with a maximum daily flow of 142 cfs in Salsipuedes Creek on 12/23/22. Stream flow quickly attenuated to less than 2 cfs on 1/4/22 and was less than 1 cfs by the end of January. Flows did not increase again until the late March storm event that increased flows briefly to greater than 8 cfs for 2 days before decreasing to less than 1 cfs by the first week of April. While the December storms did prime migratory pathways and spawning beds, the lack of storm generating flows during the peak of the spawning season (January – April) hampered fish movement throughout the Salsipuedes/El Jaro watershed.

There were 43 redds sites documented in the tributaries in WY2022; 23 redds identified in Hilton Creek, 2 in Quiota Creek, 16 in Salsipuedes Creek, and 2 in El Jaro Creek (Tables 12 and 13). In Hilton, 7 redds were documented in January, 11 in February, and 5 in March. In Salsipuedes, 4 redds were observed in February and 12 in March. In Quiota, one redd was identified in January and one in April. All of the redd sites were created by resident *O. mykiss* based on the smaller size of the excavation sites compared to anadromous redd sites. No redd sites were identified after April as flow conditions had deteriorated to the point where movement between habitats was prohibited. Redd sites identified in Hilton Creek showed a significant reduction compared to WY2021 (48 to 23, a 48% reduction). For comparison, average baseflow during the migration season in Hilton Creek was reduced from 5.0 cfs (WY2021) to 1.5 cfs (WY2022). Lower baseflows hamper *O. mykiss* ability to successfully migrate past critical riffle bars.

There was only one redd identified in the LSYR mainstem in WY2022; a resident spawning site located in the Highway 154 Reach between the Stilling Basin and Long Pool on 3/12/22 (Table 14). Due to the general lack of spawning gravels and the prevalence of embedded cobbles in the LSYR mainstem immediately downstream of Bradbury Dam, the fish were forced to spawn in a location that was essentially a freshwater clam bed. Surveyors noted evidence of spawning activity and upon closer inspection, the majority of the substrate was a mixture of clams with some smaller gravel substrate. This site produced YOY in late April with COMB FD personnel confirming successful emergence.

Snorkel Surveys: Snorkel surveys in 2022 were conducted in the spring, summer, and fall within the LSYR mainstem (Figures 74-75 and Tables 15-17). Standard and accepted single-pass snorkel survey protocols were followed (Hankin and Reeves, 1988). Spring snorkel surveys were completed in mid-July in both the LSYR mainstem and tributaries. The first snorkel counts of the year capture baseline conditions after the spawning season had ended and prior to the critical summer rearing season. Spring snorkel surveys focus in on all dry season rearing habitats for *O. mykiss* after wet season runoff and spawning to document the number and location of YOY produced over the spawning season and the standing crop of *O. mykiss* going into the over-summering period. Summer snorkel surveys are conducted in August and give an indication of *O. mykiss* survival after the hottest months of the year. Fall snorkel surveys are typically completed between October and early November and are meant to evaluate the population of *O. mykiss* that survived the dry season as they go into the following water year.

After receiving heavy rains (8.33" at Bradbury Dam) in December in WY2022, only one moderate storm event occurred for the rest of the year that came in late March. With little to no runoff occurring in the spring, this manifested the need for early spring surveys in the LSYR mainstem, particularly in the areas that typically go dry first (i.e., the dry gap in the Refugio Reach).

There was a WR 89-18 release in WY2022 that started on 8/8/22 and ended on 10/5/22, 2000 BiOp Reasonable and Prudent Measure (RPM) 6 requires snorkel surveys be conducted just prior to, during, and after the WR 89-18 release to monitor possible movement of *O. mykiss* and other species within the Hwy 154, Reach 2 (Refugio and Alisal reaches) and Reach 3 (downstream of Alisal Bridge). These snorkel surveys are 3-pass surveys and are traditionally used for the summer and fall routine snorkel surveys within the LSYR mainstem and are reported as such below. Compliance reporting for RPM 6 occurs in a separate document.

The COMB-FD staff applied the same level of effort for snorkel surveys and covered the same spatial area during the spring, summer, and fall surveys (except for 3-pass surveys required for RPM 6 snorkel surveys in specific LSYR mainstem habitats). However, factors such as turbidity, beaver activity, and lack of water influenced some of those objectives and diminished the spatial extent of the three surveys as conditions changed throughout the year in the LSYR mainstem and its tributaries. 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* have reared in previous years 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 75 with all survey dates shown in Table 15 for the LSYR mainstem and Table 18 for its tributaries.

LSYR Mainstem: LSYR mainstem snorkel surveys were conducted during the spring, summer, and fall within the Hwy 154, Refugio, and Alisal reaches (Figure 73 and Tables 16-17). Other reaches downstream such as the Avenue of the Flags and Cadwell reach were surveyed during RPM 6 monitoring in the summer and fall only.

Hwy 154 Reach

The Hwy 154 Reach extends from the Stilling Basin (LSYR-0.01) to the Hwy 154 Bridge (LSYR-3.2); the Stilling Basin was not snorkeled due to continuous poor water clarity. The Long Pool water clarity remained poor throughout the season with no official count possible. Snorkel survey results for the Hwy 154 Reach are shown in Figure 76 and Tables 16-17.

Divers conducted the spring snorkel survey within the Hwy 154 Reach in mid-July and counted a total of 262 *O. mykiss*; 190 of which were observed below the Long Pool to the Reclamation property boundary and 72 which were observed above the Long Pool to the tail-out of the Stilling Basin. The Long Pool and the Stilling Basin contained poor visibility during the spring survey which prevented COMB-FD staff from enumerating fish in those large pool habitats. Of the 262 *O. mykiss* observed during the spring survey, 133 (50.8%) fell into the 0-3 inch size category, 90 (34.4%) were 3-6 inches, 25 (9.5%) were 6-9 inches, 8 (3.1%) were 9-12 inches, 4 (1.5%) were 12-15 inches and 2 (0.8%) were 15-18 inches. With so many YOY in the 0-3 inch size class observed, it was likely these fish were produced in the winter and spring in Hilton Creek and traversed through the Long Pool downstream into the Hwy 154 Reach. This spring survey was also used for the pre-release RPM 6 snorkel counts since the survey was conducted so close to the start of the release.

The fall survey within the Hwy 154 Reach corresponded to the post-release survey just after completion of the 2022 WR 89-18 Release in late October. A total of 97 *O. mykiss* were counted; 1 (1.0%) were 0-3, 39 (40.2%) were 3-6 inches, 52 (53.6%) were 6-9 inches, 4 (4.1%) were 9-12, and 1 (1.0%) was 15-18 inches. With only one *O. mykiss* under 3 inches observed, this was yet another indication of the Hwy 154 Reach being an optimal rearing habitat for YOYs oversummering in this section of the river as YOY showed rapid growth.

Refugio Reach

The Refugio Reach streches 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. Location and results are presented in Figure 75, Figure 77, and Tables 16-17. Spring snorkel surveys were conducted in June with 23 *O. mykiss* observed within the Refugio Reach. The size class distribution were as follows; 1 (4.3%) 3-6 inches, 5 (21.7%) 6-9 inches, 9 (39.1%) 9-12 inches, 6 (26.1%) 12-15 inches, 1 (4.3%) 15-18 inches, and 1 (4.3%) 18-21 inches.

COMB-FD staff conducted the summer snorkel survey in the Refugio Reach corresponding with the pre-release phase of RPM 6 WR 89-18 Release requirements. A total of 26 *O. mykiss* were observed; 3 (11.5%) were 6-9 inches, 6 (23.1%) were 9-12 inches, 7 (26.9%) were 12-15 inches, 6 (23.1%) were 15-18 inches, 3 (11.5%) were 18-21 inches, and 1 (3.8%) were 21-24 inches. All but one 12-15 inch *O. mykiss* was observed in the Encantado Pool (LSYR-4.95). These were some of the largest trout oversummering in the LSYR mainstem ever observed, and likely some of the same fish occupying this large pool in WY2020 and WY2021. Looking back at the data from WY2020, surveyors enumerated 3 9-12 inch, 12 12-15 inch and 4 15-18 inch *O. mykiss* on 12/2/20 in this habitat unit. In the absence of sustained high flows or spill events during the winter and spring in recent years, it's likely some of the same trout have been residing (and growing) in the Encantado Pool for several years.

The final fall survey (post-release RPM 6 survey) was conducted in October. A total of 29 *O. mykiss* were observed; 6 (20.7%) were 9-12 inches, 17 (58.6%) were 12-15 inches, 5 (17.2%) were 15-18 inches, and 1 (3.4%) was 18-21 inches. All of the trout observed in the Refugio Reach were located in furthest 2 upstream habitats, with 16 *O. mykiss* observed in the Encantado Pool (LSYR-4.95) and 13 *O. mykiss* observed in the pool located approximately 200 yards upstream.

Alisal Reach

The Alisal Reach extends from Refugio Bridge (LSYR-7.8) downstream to the Alisal Bridge (LSYR-10.5) (Figure 74). Snorkel survey results are presented in Figure 75, Figure 78, and Tables 16-17. The spring snorkel survey was conducted early June with 2 *O. mykiss* observed in 2 separate habitat units. One was estimated to be 12-15 inches and the other estimated to be 15-18 inches. Much of the lower half of the reach down to Alisal Bridge (LSYR-10.5) was dry or barely wetted during the survey.

The summer survey was conducted in mid-August as part of the pre-release surveys for WR 89-18 Release RPM 6. No *O. mykiss* were observed in the designated Alisal Reach habitat units during this survey. It should be noted that the amount of water remaining in this reach had retracted significantly since the spring effort, with only the upper third of the reach wetted prior to the summer release from Bradbury Dam.

Divers returned in the fall in October (post-release RPM 6 surveys) where they visited the same habitats as in the spring snorkel survey. One large 15-18 inch *O. mykiss* was observed in a large pool habitat approximately 0.25 mile downstream of Refugio Bridge (LSYR-7.8). This was likely the same fish observed four months earlier in the spring. Of particular note is that a single, large *O. mykiss* was seen by divers in all three snorkel surveys in WY2021 in this habitat unit, marking two full years that this fish occupied the same pool.

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 74). Results of all snorkel surveys for this reach are presented Figure 79 and Tables 16-17. The upper half of the reach below

Alisal Bridge is influenced by Buellflat, Granite, and other flood plain mining companies that have historically altered the river bottom. The bottom (or downstream) half of the Avenue of the Flags Reach consists of a mature, unaltered riparian canopy with better complexity and overhead vegetative cover.

With very little runoff and dry conditions in the spring of WY2022, much of the Avenue of the Flags Reach had gone dry by May and June. Spring snorkel surveys were not conducted in this reach. Ten designated RPM 6 habitat units were snorkeled in the summer and fall (commensurate with during and post-release RPM 6 surveys) with no *O. mykiss* observed.

Cadwell Reach

The LSYR mainstem downstream of the Avenue of Flags Bridge is mostly comprised of private property that has been subdivided into sub-reaches (i.e., going downstream: Sanford, Cadwell, Cargasacchi, etc.) where the COMB-FD staff has been granted access. Since WY2011, the Cadwell sub-reach (LSYR-22.0-23.0) has been used as permanent monitoring location for both snorkel surveys and water quality monitoring (LSYR-22.68) (Figure 74). Results for all 2022 snorkel surveys are presented in Tables 16-17.

The Cadwell sub-reach 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 this reach during the summer or fall snorkel surveys with only invasive species observed. Surveys were conducted as part of RPM 6 in the pre-, during-, and post-release stages in August, September, and October.

Tributaries: Tributary snorkel surveys were conducted in the spring and fall in 2022 at all of the long-term monitoring locations within Hilton, Quiota, Salsipuedes, and El Jaro creeks. The location and results are presented in Figure 74, Tables 18-20, and Figures 80-84. Summer snorkel surveys were not conducted in the tributaries this year as agreed to by NMFS through Reclamation beginning in WY2020 due to concerns of adverse impacts on the fishery by divers in refuge habitats during the time of the year when water quality conditions are often the most stressful for *O. mykiss*. In addition, summer snorkel surveys within the tributaries are often problematic due to poor visibility and decreased water levels.

Hilton Creek

Hilton Creek snorkel surveys are conducted on Reclamation property from the confluence of the LSYR mainstem 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 (Figure 74). 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 Lake Cachuma from the HCWS and HCEBS 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.

During WY2022, target flows into Hilton Creek were not able to be sustained above the 2 cfs minimum throughout most of the season (February through August) as set forth in the 2000 BiOp (NMFS, 2000) due to low lake elevation and HCWS/HCEBS pipeline delivery constraints as described above. There was a long period in WY2022 when cumulative flows dropped below the minimum 2 cfs criteria. Hilton Creek is typically one of the last snorkel survey efforts in the spring to allow YOY the ability to grow and occupy habitats that are deep enough for divers to enumerate.

The spring snorkel survey was conducted in early July with a total of 1,076 *O. mykiss* observed (Figure 80 and Tables 19-20). Of the fish observed, 922 (85.7%) were 0-3 inches, 113 (10.5%) were 3-6 inches, 32 (3.0%) were 6-9 inches, 8 (0.7%) were 9-12 inches and 1 (0.09%) was 15-18 inches. The two smaller size classes of observed *O. mykiss* were likely produced during the winter and spring spawning season when a total of 23 redd sites were documented from January to March. The lack of bigger (>12 inch) *O. mykiss* during the spring snorkel survey was indicative of Whittier Fire sediment/material continuing to fill most of the deeper pool refuge habitats within Hilton Creek, as well as lower cumulative flow releases into the creek in WY2022 via the HCWS and HCEBS.

Between 8/8/22 and 8/10/22, CDFW with assistance from COMB-FD conducted a fish rescue and relocation effort (all species specifically O. mykiss and prickly sculpin [*Cottus asper*]) within Reach 5 of Hilton Creek. The action was deemed necessary due streamflow interruptions and the inability of the HCWS and the HCEBS to reliably deliver water to the upper portion of Hilton Creek. Electrofishing was performed in Reach 5 between the LRP and URP across approximately 1,275 ft of the stream channel. A total of 446 *O. mykiss* and 40 *C. asper* were successfully relocated from Reach 5 to habitats downstream of the LRP. A total of 222 *O. mykiss* were counted in Reach 5 during the spring snorkel survey which was approximately 50 percent of the total *O. mykiss* relocated from that reach in August. This was attributed to the amount of aquatic vegetation that provided excellent hiding locations in that reach and the efficiency of an electrofisher for fish capture for relocation.

No summer Hilton Creek snorkel surveys were conducted in WY2022. The fall snorkel survey was conducted in late October, just prior to Lake Cachuma turning over which has historically lowered water clarity and reduced the ability to count fish for several weeks. In some cases, the visibility within Hilton Creek (after lake turnover) has been impacted for the remainder of the calendar year, preventing COMB-FD from completing the fall snorkel survey. A total of 228 *O. mykiss* were observed; 17 (7.5%) at 0-3 inches, 176 (77.2%) at 3-6 inches, 30 (13.2%) at 6-9 inches, and 5 (2.2%) at 9-12 inches (Figure 80 and Tables 19-20).

A 78.8% reduction in fish observed occurred between the spring and fall snorkel survey. With that being said, the size class differential between the spring and fall was still notable with 85.7% of the total *O. mykiss* observed in the spring in the 0-3 inch size class and 7.5% of the total in the 0-3 inch size class in the fall. Despite a significant reduction in overall population, the fish inhabiting the drainage showed positive growth.

Quiota Creek

A historic section of Quiota Creek, located between Crossing 5 and Crossing 7, usually contains perennial flow and has been a standard monitoring reach for COMB-FD staff. The location and results of all snorkel surveys are presented in Figure 74, Figure 81, and Tables 19-20. In a dry or below average rainfall season, Quiota Creek has one of the highest surface water retraction and habitat loss rates observed in the Santa Ynez River basin. Surveyors conducted the spring snorkel survey in mid-July and found limited surface flows with the bottom of the historical snorkel reach (Crossing 5) already dry. Surface water began approximately 100 feet upstream of the crossing and continued through Crossing 7. No *O. mykiss* were observed during the spring snorkel survey. Divers returned in early November (fall survey) and found limited surface water with only a few wetted habitats remaining just above Crossing 6. No *O. mykiss* were observed during the fall survey.

Salsipuedes Creek

Lower Salsipuedes Creek is separated into 5 different reaches based on geomorphic profile differences of the stream channel. Several sections of exposed bedrock help to differentiate the reaches, rather than having one long, continuous reach that extends multiple miles. Reaches 1 through 4 are located from the confluence of Salsipuedes Creek with the LSYR mainstem upstream to the Jalama Road Bridge, a distance of approximately 3.5 stream miles (Figure 74). Reach 5 of Lower Salsipuedes Creek is from Jalama Road Bridge to the confluence with El Jaro Creek, a distance of approximately 0.45 miles. Reach 5 has been a historic monitoring location because of reliable surface flows and good visibility (compared to reaches further downstream), as well as the consistent presence of *O. mykiss* within the reach.

Despite WY2022 being a dry year with below average rainfall, COMB-FD staff found flowing and mostly clear water quality conditions in Salsipuedes Creek during the spring snorkel survey (except for the bottom of Reach 1 and a short section of Reach 3 which were turbid). These areas were noted as having fresh beaver activity, which was the likely cause of the poor water clarity. The spring snorkel survey in Reach 1 through Reach 4 was conducted over a 2-day period in early June (Figures 82-85 and Tables 19-20). A total of 493 *O. mykiss* were observed; 400 (81.1%) at 0-3 inches, 76 (15.4%) at 3-6 inches, 15 (3.0%) at 6-9 inches, and 2 (0.4%) at 9-12 inches. Such a high percentage of YOY observed in all reaches indicated a successful spawning season throughout the drainage.

Reach 5 was snorkeled in mid-June with surveyors noting good water clarity and flowing conditions throughout the reach. A total of 215 *O. mykiss* were observed with 165 (76.7%) falling into the 0-3 inch size class, 15 (7.0%) in the 3-6 inch size class, 33 (15.3%) in the 6-9 inch size class, and 2 (0.9%) in the 9-12 inch size class. With more than three-quarters of the spring fish observed being YOY, this was yet another indication of the high spawning success rate *O. mykiss* had within the basin in WY2022, despite below average rainfall and runoff conditions in the winter and spring.

Summer surveys in tributaries of the LSYR were discontinued several years ago. Divers returned (several times) in the fall to conduct snorkel surveys in Salsipuedes Creek and were met with poor visibility throughout the entire drainage. A large storm had already impacted the basin as early as 9/19/22 when 4 inches of rain fell at the Rancho San Julian gauge (the storms did not impact the Lake Cachuma area). This, coupled with beaver activity, hindered the ability for divers to get any *O. mykiss* counts in before the end of the calendar year.

El Jaro Creek

El Jaro Creek is the main tributary to Salsipuedes Creek and provides the majority of runoff within the basin during the rainy season. 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 staff each year. Location and snorkel survey results are presented in Figure 74, Figure 84, and Tables 19-20.

Staff surveyed El Jaro Creek in mid-June and this section of the drainage appeared to already be losing surface water connectivity. Several of the habitat units near the confluence were isolated with the upper portion of the reach still flowing. A total of 39 *O. mykiss* were observed; 36 (92.3%) were 0-3 inches, 2 (5.1%) were 3-6 inches, and 1 (2.6%) was 6-9 inches in length. The majority of *O. mykiss* observed were YOY, continuing the trend of successful reproduction in WY2022 as was observed further downstream in Salsipuedes Creek.

As mentioned above, summer surveys were not conducted within the tributaries in 2022. The El Jaro Creek thermograph was removed in late July due to that habitat unit being barely wetted and the unit already exposed to air. Divers returned for the fall survey in November but were met with few habitats containing water as most of the lower part of El Jaro Creek had gone dry by the middle of summer. Surveyors attempted to count fish in the few remaining pools but encountered pool visibility.

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. Results are presented in Figures 85-86. 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 (*Ictalurus punctatus*) catfish. It is thought that these fish travel downstream during spill events from the Lake Cachuma to the LSYR mainstem 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 were not observed in any of the three tributary drainages (Salsipuedes, Quiota, and Hilton creeks) that the COMB-FD staff monitors. However, snorkel survey results within Salsipuedes Creek and El Jaro Creek did contain warm-water fish in 2022. Divers did not encounter any warm-water species occupying Hilton Creek during the annual spring or fall snorkel surveys.

<u>LSYR mainstem</u>

Largemouth Bass: The largemouth bass population within the LSYR mainstem was slightly lower in WY2022 compared to recent years (Figure 85). For reference, the Stilling Basin de-watering and non-native fish removal effort is now 6 years removed (July 2017); the Stilling Basin is a known source population for largemouth bass residing in the LSYR mainstem.

The total number of largemouth bass observed in the spring within the Refugio Reach and Alisal Reach was 29 and 42, respectively. Bass observations in the summer increased within the Refugio Reach to 31 and decreased within the Alisal Reach to 7. Fall snorkel surveys contained 42 bass in the Refugio Reach and 25 bass in the Alisal Reach. It should be noted that although divers enumerate all warm-water species encountered, much of the focus is dedicated to accurately counting and sizing *O. mykiss* when snorkeling, hence slight discrepancies from one survey to the next can be expected. This is particularly true in the "during-release" phase of RPM 6 Water Right Release surveys, when LSYR mainstem flows are high and habitats are much larger in extent. Invasive species tend to hide and seek refuge in the margins and go deeper into cover when flows are up, making detection and accurate counts more difficult. Conversely, *O. mykiss* tend to occupy open feeding lanes and deep water (out in the open) during periods of elevated summer flows when water quality conditions are favorable for rearing.

Sunfish Species: There are several types of sunfish species (green, red-ear, and bluegill) found within the LSYR mainstem, most of which are especially difficult to distinguish at smaller size classes. The COMB-FD staff attempted to categorize the different species of sunfish during snorkel surveys when possible, but all three species were grouped into a single category when reported.

When comparing WY2021 snorkel surveys, a lower number of sunfish were observed in the spring, summer and fall within the management reaches of the LSYR mainstem in WY2022 (Figure 85). COMB-FD staff counted 16 and 6 sunfish in the Refugio and Alisal Reaches during the spring survey, respectively. Summer sunfish totals were 8 in the Refugio Reach and none in the Alisal Reach. No sunfish were observed in either the Refugio or Alisal Reaches of the LSYR mainstem in the fall.

Catfish Species: The two types of catfish found in the LYSR mainstem are easier to differentiate (compared to sunfish) based on their tail morphology (forked for channel and flat for bullhead), but they are lumped into a single catfish category for the purposes of this report. In 2022, no catfish were observed during the spring, summer, or fall snorkel surveys within the LSYR mainstem management reaches (Figure 86). Although no catfish were observed within designated snorkel sites, it should be noted that 19 bullhead catfish (13 upstream and 6 downstream) were captured during WR 89-18 Release trapping activities at the LSYR mainstem.

Carp: Carp continue to be abundant within the Hwy 154 Reach, in particular within the Stilling Basin (LSYR-0.01). COMB-FD staff observed many adult carp on the surface of the Stilling Basin on every site visit throughout the year, typically around the HCEBS pipe going across the pool or up against the concrete dam spillway eating algae.

Carp totals in the Refugio Reach and Alisal Reach of the LSYR mainstem in the spring were 4 and 40, respectively (Figure 86). Of the 40 carp observed in the Alisal Reach, one quarter of them (10 carp) were found in a single pool habitat located 0.5 mile upstream of Alisal Bridge that was barely wetted. The habitat was approximately 20 feet by 5 feet with a maximum depth of 1 foot. This unit went dry several months prior to WR 89-18 Release flow arrival and the invasive species living there perished.

Divers returned to the management reaches in the summer and counted 7 carp in the Refugio Reach and 12 carp in the Alisal Reach. In the final fall survey 11 carp were observed in each the Refugio and Alisal Reaches of the LSYR mainstem. When reviewing the data from WY2021 snorkel surveys, carp numbers were lower in WY2022 which was likely due to earlier season de-watering and habitat retraction prior to the summer aquifer recharge releases.

Salsipuedes Creek

COMB-FD staff counted a total of 271 green sunfish within Reaches 1 through 4 during the annual spring survey (132 0-3 inches, 125 3-6 inches, and 14 6-9 inches). This was a decrease in sunfish numbers observed in the spring of 2021 which totaled 1,516. Green sunfish were found throughout all the lower reaches of Salsipuedes Creek with Reach 4 having the highest concentration of this invasive species. COMB-FD staff encountered many green sunfish redds during the spring snorkel survey, efforts were made to smother (by hand) any nests that were encountered.

As previously mentioned, divers returned several times in the fall but encountered poor visibility throughout all of the lower reaches of the drainage due to early season rainfall and beaver activity.

Since *O. mykiss* are tracked separately within the historic section of Reach 5 of Salsipuedes Creek, warm-water species are treated in the same fashion for the purposes of this report. The green sunfish total within Reach 5 in the spring was 80; 36 at 0-3 inches, 36 at 3-6 inches and 8 at 6-9 inches.

El Jaro Creek

The 0.40 mile regular survey reach of El Jaro Creek (just upstream of its confluence with Salsipuedes Creek) also contained warm-water species during the annual spring snorkel survey with 14 green sunfish observed. This was a significant reduction in green sunfish numbers from the previous spring snorkel survey in 2021, likely due to early habitat losses from the lack of spring rainfall. Three size classes of sunfish were observed: 1 measuring 0-3 inches, 8 measuring 3-6 inches, and 5 measuring 6-9 inches. Two bullhead catfish (1 at 9-12 inches and 1 at 12-15 inches) were observed in a single pool habitat in lower El Jaro Creek near the confluence with Salsipuedes Creek.

Surveyors returned in the fall but turbid conditions were observed in the few remaining wetted habitats on lower El Jaro Creek.

Hilton Creek

No warm water non-native fish were observed in Hilton Creek during the spring or fall snorkel survey in WY2022. This was the third season in a row that non-native fish were not detected in the drainage.

3.7. 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 or other aquatic species 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. COMB-FD did not conduct any tributary enhancement projects in WY2022.

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

3.8 Additional Investigations

Genetic Analysis: Tissue samples from all of the migrant captures during WY2022 were sent to Dr. Carlos Garza of NOAA Southwest Science Center at UC Santa Cruz. A total of 132 *O. mykiss* tissue samples were sent to the NMFS Southwest Fisheries Science Center mostly from the WY2021 migrant trapping efforts; 87 Hilton Creek upstream captures, 41 Hilton Creek downstream captures, and 4 sampled carcasses that were found in Hilton Creek. We are still awaiting the results of those genetic analyses.

Past results of captured and sampled migrating *O. mykiss* showed a strong genetic correlation to their streams of origin. In addition, the vast majority of the fish sampled during trapping activities indicate that these fish are genetic descendants of native coastal steelhead.

Beaver Activity: Beaver dams and the associated ponds often change riffles and runs into pools that can lead to greater thermal heating of stream water, can fragment habitats and inhibit movement of juvenile and adult *O. mykiss* during the spawning season, increase siltation, change benthic macroinvertebrate assemblages, and create favorable pool habitat for invasive aquatic species (i.e., bass, sunfish, catfish, and carp). Beaver regularly build their dams at the control points of pool habitats, a prime spawning location for *O. mykiss* and have been observed to reduce spawning locations/opportunities during normal and drier years in the El Jaro/Salsipuedes Creek watershed as well as the LSYR mainstem. Also, beaver dams can affect operational flows of the Fish Passage Supplementation Program, target flow releases, and downstream water right releases. As a result of increased beaver activity in the watershed, 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. Beaver dam abundance is a simple way to annually track the beaver population (an active single beaver dam could mean multiple beavers in the area) and spatial distribution within the LSYR basin. This survey is conducted each year prior to the steelhead migration season, typically from November through January.

During December of 2021 and January of 2022, the COMB-FD staff completed the LSYR mainstem beaver dam survey from Bradbury Dam (LSYR-0.0) to downstream of the Narrows where the river goes dry out on the Lompoc plain downstream of the Salsipuedes Creek confluence with the LSYR mainstem (approximately LSYR-34.4). A small section of the Hwy 154 Reach on the San Lucas Ranch was not surveyed due to lack of access (LSYR-0.68 to LSYR-4.0). The survey also looked at the wetted section of the river downstream of the Lompoc Waste Water Treatment Plant (approximately LSYR-42.0) to the 13th Street Bridge on Vandenberg Air Force Base and the start of the lagoon. All of Salsipuedes Creek and a significant portion of El Jaro Creek containing perennial flow and habitat are also surveyed for beaver dams.

Dams were classified as barriers, impediments, or passable utilizing CDFW passage criteria. In order for migrating *O. mykiss* to pass over barriers, CDFW criteria states that 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 each dam height then measured 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. All beaver dams are typically built at pool control points (i.e., tail out of pool habitats) and hence create an immediate barrier to movement as no pool habitat exists downstream of a beaver dam to allow fish to jump over. Barrier dams were large in height resulting in minimal depth downstream to allow fish to jump over the dams. Barrier dams spanned the river channel with no flanking flows around the dam. Impediment dams represent a greater challenge for *O. mykiss* to traverse and are categorized at the discretion of the surveyor based on severity. Compared to a barrier dam, 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 that would allow fish to swim around the impediment. Passable dams were all small in height with deeper habitats immediately downstream of the dam with some measure of flanking occurring, or in some cases were in the process of being built and small in stature.

The results of the WY2022 beaver dam surveys showed that the number of beaver dams stayed essentially the same in the LSYR mainstem and decreased in the tributaries compared to the previous year (Figure 87 and Table 21). There were 80 LSYR mainstem beaver dams documented in WY2021 and 79 documented in WY2022. Of the 79 beaver dams identified, 58 were classified as barriers, 11 as impediments, and 10 as passable at the survey flow rate with 76 of the 79 dams determined to be active. There were two dams in the Hwy 154 Reach, two in the Refugio Reach, 9 in the Alisal Reach and 63 in Reach 3 (Alisal Bridge downstream to the Narrows). The lowermost active dam was located approximately 2 miles upstream of the Narrows. No dams were identified downstream of the Floradale Bridge (Wastewater Treatment Plant) or around 13th Street (Vandenberg Air Force Base).

Active beaver dams in the Salsipuedes/El Jaro Creek watershed decreased from 11 in WY2021 to four in WY2022. The dry water year type during WY2022 likely contributed to the decrease in observed beaver dams. Dry year types reduce the surface water connection between the mainstem Santa Ynez River and the confluence with Salsipuedes Creek, limiting beaver expansion from the mainstem. Similarly, low flow conditions in Salsipuedes including long reaches of dry creek in the El Jaro portion of the watershed further reduced beaver expansion in the watershed. No beaver dams were observed in either Quiota Creek or Hilton Creek.

4. Discussion

The Discussion section provides additional historical context for the WY2022 results presented above specifically since the issuance of the 2000 BiOp (4.1-4.2), discussion of specific topics of interest or concern (4.3-4.15), and the status of last year's Annual Monitoring Summary recommendations (4.16). 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, 2017), 2014 (COMB, 2018a), 2015 (COMB, 2018b), 2016 (COMB, 2019a), 2017 (COMB, 2019b), 2018 (COMB, 2020a), 2019 (COMB, 2020b), 2020 (COMB, 2021), and 2021 (COMB, 2022).

4.1. Water Year Type since WY2000

The monthly rainfall (Table 22), monthly average runoff at Solvang and the Narrows (Table 23), and water year type with the years that Lake Cachuma spilled (Table 1 and Figure 88) are presented from WY2000-WY2022. Since WY2000, there have been 6 spill events, 8 wet years, 3 normal (average) years, and 12 dry years.

4.2. WY2022 – Another Dry Water Year

WY2022 was the twelfth dry water year (defined as < 15 inches of rainfall recorded at Bradbury Dam) since issuance of the 2000 BiOp but was particularly severe with only one large rainfall event in December 2021 and a minor storm in March 2022 with little rain in January, February, and April (Table 3). Storm flows during December were insufficient to breach the lagoon in WY2022 with no migration opportunities for anadromous *O. mykiss*. The lack of spring rains resulted in a long dry season although summer temperatures were generally mild with few prolonged heat waves. Habitat loss from streams drying up was particularly evident in sections of Quiota, Upper Salsipuedes, El Jaro, Los Amoles, and Ytias creeks.

4.3. Target Flow Compliance to Hilton Creek and the Highway 154 Bridge

Monitoring for the required 2000 BiOp and WR 2019-0148 target flows are conducted by USGS and USBR for Hilton Creek, and COMB-FD and USBR for the LSYR at the Hwy 154 Bridge. Documenting target flow compliance at the Highway 154 Bridge (2.5 cfs) historically could not be done at that specific location due to the channel configuration and landowner access limitations. USBR established a low-flow river discharge monitoring location approximately 1 mile downstream of the Highway154 Bridge where access is available. USBR has been taking a discharge measurement approximately once a month and the COMB-FD staff was taking a discharge measurement once a week as well as maintaining a pressure transducer at that location to record river stage every 15 minutes to enable development of a rating curve (stage vs discharge) (Figure 89). The figure clearly shows the December stormflow events, 2022 WR 89-18 releases, and the beginning of the WY2023 storms. This is part of a compliance measure within WR 2019-0148, specifically the Plan required in Term 18 and Term 25. The objective is to maintain a river discharge at that monitoring location of 2.5 cfs or greater (at the current lake elevation) which follows Reclamations established operational protocols for meeting required target flows at the Highway 154 Bridge upstream. The objective was challenging to meet at all times with two incidents of the discharge being a bit below 2.5 cfs at the end of February and the end of July due to many factors influencing streamflow between the release point at Bradbury Dam and the monitoring location (i.e., weather changes, varying riparian corridor vegetation and substrate composition, land use practices, alluvial groundwater extraction, etc.). USBR has been operating within acceptable discharge parameters to meet Highway 154 Bridge target flows throughout the year. The Hwy 154 Reach and upper Refugio Reach fishery has certainly benefitted from any additional flow releases.

COMB obtain landowner access in 2022 to in area upstream of Hwy 154 Bridge with a suitable site for measuring river discharge and worked with USGS in September 2022 to install a low-flow gauging station approximately 1,100 feet upstream of the Hwy 154 Bridge. The gauging station became operational on 10/1/22 and has been documenting flow compliance at that site for WY2023. The gauging station was not available in WY2022.

The 2000 BiOp and WR 2019-0148 target flows to Hilton Creek are a minimum of 2 cfs. That minimum flow rate was a challenge to meet during most of WY2022 due to a dropping lake level and delivery constraints (Figure 90). USBR has discussed the situation with NMFS and it was agreed to continue with gravity flow instead of going to pumps which have proven multiple times to be problematic in sustaining the Hilton Creek fishery. Reasons for those limitations were described above and below. The USGS data taken just downstream of the LRP were consistently higher than the USBR data partly because that is only lake water delivered to the creek and does not include upper basin flow and bank drainage and USBR uses an in-pipe mag flow meter verses an instream transect measurement that is traditionally done by USGS. The USGS data clearly shows the December stormflow events, the decrease in gravity flow to the creek, the switch to the lake-based pumping system, the PG&E power outage on 8/2/22 and the parallel deliveries of HCEBS gravity flow to the LRP and the HCWS pumped flow to the URP.

4.4. Hilton Creek and Long Pool Sediment Deposition from the Whittier Fire

The Whittier Fire in WY2017 completely burned the upper third of the Hilton Creek watershed. That combined with the high runoff events in WY2019 generated significant bed load transport and channel changing conditions within the drainage and downstream. All pool habitats were filled in with sediments and a large delta formed at the creek's confluence with the LSYR mainstem and specifically out into the Long Pool where half the depth and a third of the length of that habitat were filled in. Although turbid conditions and heavy silt loads were observed in WY2018, it was not until the above average rainfall in WY2019 that the Whittier Fire burn scar truly impacted the lower reaches of Hilton Creek on Reclamation property when all pool habitats filled in and a large delta was formed.

At the end of the runoff season in WY2022, Hilton Creek pool habitats on Reclamation property continued to be full of deposited sediment with very small scour pockets at the head of each habitat. Between WY2021 and WY2022, deposited upstream alluvial sediment bars are still being scoured during higher flow events and translating down into the watered section of Hilton Creek resulting in approximately a net neutral situation between degradation and aggregation of sediments in pool habitats. These sediment bars have provided gravels at multiple locations that have benefitted spawning *O. mykiss* (Figures 91 and 92). There continues to be an abundance of great spawning gravels in the creek but very limited amount of pool refuge habitat for rearing and oversummering, particularly for larger size classes of *O. mykiss*. This will be an ongoing issue until the upper watershed vegetation recovers, depositional bars get locked in with riparian corridor plant growth, and a wet water year produces enough streamflow to scour and reform pool habitats. The reduction of HCWS/HCEBS releases to the creek in WY2022 furthered the loss of habitat extent. Water was mostly delivered to the creek by gravity flow and flows declined as the lake level dropped through the dry season.

4.5. Recovery of the *O. mykiss* Population in Hilton Creek and the Hwy 154 Reach after the Drought and Whittier Fire

Between the drought that occurred between WY2012-WY2016 and impacts from the Whittier Fire and subsequent sediment deposition/distribution between WY2017 and WY2022, the *O. mykiss* population and associated stream habitat (filled in refuge pool habitats) has been in a state of recovery the past few years including WY2022. Although the sediment load from the fire is diminishing with upper basin and riparian corridor vegetation growth, much of the deeper pool habitats within Hilton Creek remain gravel filled and shallow through WY2022 (Figure 89). The lack of deep water may be precluding larger *O. mykiss* from oversummering within Hilton Creek, as reflected by the absence of larger size classes of fish observed during snorkel surveys the past several years. The larger fish appear to be oversummering in the Hwy 154 Reach and entering Hilton Creek to spawn then returning downstream after spawning. No redds were observed in the Hwy 154 Reach downstream of the Long Pool due to a general lack of suitable sized spawning material and embedded cobble substrate immediately downstream of the dam on Reclamation property.

The abundance of new gravel distributed throughout Hilton Creek from the upper watershed (specifically from the burn scar area following the wet year of WY2019) has enhanced the spawning material from the URP to the confluence with the LSYR mainstem, distributing additional spawning sized material over multiple locations providing greater opportunity for *O. mykiss* to successfully reproduce. This is especially evident when looking at the overall number of identified redd sites from WY2012-WY2022 (Table 24). Prior to the Whittier Fire in 2017, Hilton Creek was a relatively sediment starved system with a few consistent locations providing the requisite habitat for successful redd construction and YOY production (i.e., the Spawning Pool and just upstream of the Ford Crossing within Reach 1). Several site-specific gravel augmentation efforts (two year project starting in WY2018) showed immediate usage by spawning *O. mykiss* illustrating that more gravel in the creek resulted in more spawning and more overall *O. mykiss* production. Following the wet winter of WY2019 there was significant gravel distribution throughout the creek from the upper watershed. The additional gravel combined with the localized recovery of the *O. mykiss* population in the Hwy154 Reach following the drought showed a remarkable increase in the number of redds documented in Hilton Creek. Between WY2017 and WY2021 there was a twenty-four fold increase (2 to 48) in the number of redds documented in Hilton Creek on Reclamation property specifically due to an *O. mykiss* population recovery and many more habitats with suitable spawning substrate. Documented redd sites decreased in half in WY2022 compared to WY2021, most likely due to lower flows in the creek which prevented larger adults from migrating through critical riffles and steep habitats to areas upstream.

4.6. Details on the Multiple Hilton Creek Incidents/Events

During the day on 8/2/22, Reclamation initiated a change in lake water delivery to Hilton Creek from HCEBS gravity flow to HCWS (lake-based system) pump flow to both the URP and the LRP due to the drop in lake elevation and the reduction of flow being delivered to the URP by gravity. COMB-FD staff was on site that day to assist Reclamation as requested. Once HCWS pump flow was established, Reclamation shut off the HCEBS gravity flow and tried to reconfigure the HCEBS to standby mode with the objective of it activating automatically if the lake based pump shut off and provide water to Hilton Creek. Problems were discovered with the system programming and the automation was found to be inoperable. Reclamation then returned the HCEBS to a gravity flow configuration with HCWS pump flow dominating the two and providing lake water to Hilton Creek. This delivery configuration continued until the commercial power went out shortly after 8:00 PM that night and the HCWS pump shut off. Unfortunately, the HCEBS gravity flow releases did not occur at either the LRP or the URP as planned resulting in no water being delivered to the creek at either of the release points, and Hilton Creek's Reach 5 was left without releases for approximately 2.5 hours.

There were 3 interruption of flow events to the URP during the first week of September when the region was experiencing an intensive heat wave. The first event occurred on 9/2/22 at approximately 7:45 AM that was associated with an unexpected PG&E power outage. USBR dam tenders were on site, started the onsite generator, and reestablished HCWS pump flow to the URP. The event duration was short and no fisheries issues were found within Reach 5. USBR was concerned about potential future power outages during the ongoing heat wave and opted to switch to a procedure of going to generator power at the end of the day when the dam tender staff would not be on site and back on grid power in the morning when staff were on site until the heat wave passed.

On 9/3/22 in the morning, USBR was in the process of switching from generator to grid power when the HCWS pump shut off. They were not able to reactivate the HCWS pump from the land-based controllers and had to boat to the pumping barge to start up the backup pump to reestablish flow to the URP. The interruption of flow to the URP continued for approximately 4 hours during which time two *O. mykiss* were rescued/relocated and six *O. mykiss* mortalities were found.

Another short duration interruption of flow at the URP occurred on 9/5/22 in the morning at approximately 9:00 AM that was associated with USBR switching from generator to grid power. USBR was able to quickly restart the HCWS pump from the land-based controllers and reestablish flow to the URP, a duration of approximately15 to 30 minutes. Due to the brevity of the event, no COMB-FD staff were deployed to the creek.

4.7. Comparison Trends 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 drainage 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 storm event due to its westerly location, which was the case in WY2022. Typically, smaller watersheds like Hilton Creek can have sharper recessional storm hydrographs. However, Hilton Creek has an artificially sustained baseflow normally greater than 2 cfs year round from Lake Cachuma that provides a higher sustainable flow rate and cooler water temperatures. The Salsipuedes/El Jaro watershed on the other hand has significantly higher winter flows due to a larger watershed with baseflows typically approaching 0.05 cfs during the height of the dry season with extensive areas completely drying out particularly during drought years. Out-migrating *O. mykiss* smolts in both creeks have been documented when flow opportunities present themselves, hence not always at the same time with the Hilton Creek smolt run starting a little earlier and lasting longer into the spring compared with Salsipuedes Creek (Figure 93). Travel distance from the confluence of each creek within the LSYR mainstem to the ocean is approximately 15 river miles for Salsipuedes Creek and 49 river miles for Hilton Creek fish.

The *O. mykiss* populations between the two creeks exhibit differences in upstream and downstream migration timing, spawning time, rearing habitat, and over-summering characteristics (i.e., water quality, flow, and habitat complexity). Hilton Creek normally has excellent habitat quality (refuge pools with structure and a mature riparian canopy) but has limited stream length. Many of the Hilton Creek refuge pools have filled in since the Whittier Fire and pool habitats have yet to reform. The Salsipuedes Creek system has extensive stream mileage but only fair habitat quality due to low dry season baseflows, a predominance of fine sediment substrate, a greater prevalence of invasive species (mainly green sunfish) and sometimes high water temperatures in portions of the lower creek (AMC, 2009; COMB, 2021; COMB, 2022). One result of these differences is earlier resident *O. mykiss* upstream migration in Hilton Creek due to greater availability of water in the LSYR mainstem immediately downstream of the dam where resident *O. mykiss* have been documented to oversummer (Hwy 154 Reach). Hilton Creek also has a longer migration time for smolts to make it to the ocean given the additional distance, numerous beaver dams to negotiate, and lots of aquatic vegetation especially during dry water years. Smolts may be inclined to linger in areas within the Hwy 154 Reach as favorable conditions near the dam can diminish some environmental cues for out migration especially later in the water year as flows decrease and water temperatures increase. This phenomenon has been observed with tissue/scale analyses of smolts captured moving downstream but then are recaptured the following year (or several years later) as adults migrating into Hilton Creek to spawn suggesting some smolts residualized to a resident life-history strategy after oversummering in the Hwy 154 Reach. From scale analyses, Hilton Creek fish tend to grow larger faster than Salsipuedes Creek fish due to favorable year round conditions and as a result may out migrate as smolts at an earlier age and larger than Salsipuedes Creek smolts (Figure 94). Returning ocean run adults also have a much longer travel distance to Hilton Creek compared to Salsipuedes Creek and must navigate a significant number of obstacles along the way.

Regardless of the differences in the watersheds described above, the drought of WY2012-WY2016 has negatively impacted both watersheds, but Salsipuedes to a much greater extent as recent trapping trend data indicate low numbers of observed *O. mykiss* during trapping operations. Since the end of five consecutive dry years (drought), the LSYR watershed has experienced two wet years (WY2017 and WY2019), three dry years (WY2018, WY2021 and WY2022), and one normal (average) year (WY2020) (Figure 86).

Starting in WY2017, Hilton Creek has shown an increase in the numbers of both upstream migrants captured (one in WY2017, 49 in WY2020, 86 in WY2021, and 97 in WY2022) and downstream migrants (4 in WY2017, 90 in WY2020, 101 in WY2021 and 85 in WY2022) (Table 25). The number of smolt (including pre-smolt) captured leaving the creek has also increased from two in WY2017 to 32 in WY2020, 28 in WY2021 and 37 in WY2022. The first smolt was captured on 2/22/22 and the last was captured on 4/19/22 (the last day of trapping due to reaching the ITS take limit). The ability to keep *O. mykiss* alive in Hilton Creek during the extended drought (trickle tank flow for example) was instrumental in keeping a viable seed population alive to repopulate Hilton Creek, the Highway 154 Reach, and locations further downstream.

The fact that smolts were being captured leaving the creek every year since the drought showed that the *O. mykiss* population that survived in Hilton Creek possessed the anadromous genes that encourage smolting behavior under the right environmental conditions. It also illustrates the importance of keeping the HCWS/HCEBS functional and reliable while expanding upon its operational capacity and reliability to assist recovery efforts of the species.

The contrast between Salsipuedes Creek and Hilton Creek is stark. Since WY2017, only three upstream migrating *O. mykiss* were captured during Salsipuedes Creek trapping efforts (only one in WY2021 at 153 mm [6 inches]) (Table 26). These three fish were classified as residents. Similarly, downstream captures have also decreased (prior to WY2021) with none captured in WY2017, three in WY2018, two in WY2019, and one in WY2020. Of the downstream migrants captured during those years, only three of those fish were classified as smolts with no smolts captured in WY2020. WY2021 showed the largest increase in downstream migrants (primarily smolts) with 17 downstream migrants, 15 identified as smolts or pre-smolts. Unfortunately, no trapping was conducted in Salsipuedes Creek in WY2022 due to extreme low flow conditions and no comparisons can be made between Hilton Creek and Salsipuedes Creek migrant trapping results for that year. As river discharge at H Street only flowed for 10 consecutive days at the end of December 2021 through January 2022 it is probable that no smolts migrated from Salsipuedes Creek to the LSYR Lagoon due to the absence of migratory cues. If any smolting did occur in the Salsipuedes Creek watershed, there was no way for them to reach the lagoon/ocean following January 2022, as H Street was dry for the remainder of the year. For Hilton Creek, no smolts were able to exit the watershed as all of the identified smolts were captured when flows at H Street were zero. Until and unless the watershed receives spring rains, (absent in WY2021 and WY2022) capable of generating flows to the lagoon and ocean, this trend will continue.

4.8. Trends in Migrant Trapping since WY2001

Trend analyses of migrant captures through the longstanding trapping effort can provide insights into the dynamics of the *O. mykiss* population within the LSYR basin. The migrant trapping results have been complicated by a long-term drought (WY2012-WY2016) and the limited amount of take provided by the 2000 Incidental Take Statement (ITS), specifically only 110 juveniles and 150 adults. Since the issuance of the 2000 BiOp, it has been evident that those take limits (specifically for juveniles) are insufficient for the size of the *O. mykiss* population within the LSYR basin, particularly Hilton Creek where the majority of the juveniles are captured. As of WY2012, the ITS limits were adhered to resulting in a truncated trapping effort and incomplete dataset for each migration season. Nonetheless, valuable insights can be gained by conducting a trend analyses from the migrant trapping effort.

The LSYR basin *O. mykiss* population was trending upward within the Hwy 154 Reach of the LSYR mainstem, Hilton Creek, Quiota Creek, and Salsipuedes/El Jaro Creek until the onset of the drought in WY2012 where the observed number of fish and available habitat decreased annually through WY2016. Nearly the entire LSYR dried in WY2016 with only the Stilling Basin, a few reaches in Hilton Creek, and small portions of Quiota and Salsipuedes Creek remaining wetted. WY2017 was the low point and thereafter began an increase in the population that has continued through the current water year (WY2022). Although annually the number of captured juvenile *O. mykiss* throughout the LSYR basin at all trapping locations was over the 2000 BiOp established juvenile take limit (and at or below the adult take limit) from WY2001 through WY2011, NMFS required enforcement of the ITS limits from WY2012 onward. This resulted in implementing a truncated trapping plan (February – April) that did not fully capture the environmental conditions and subsequent population response throughout the migration season (January – May). The annual Migrant Trapping Plan (started in WY2012) prioritizes first capture of upstream migrating resident/anadromous adults and second downstream migrating juvenile/smolts. Unfortunately, the current Migrant Trapping Plan misses the start of the adult migration season and the end of the smolting run hence captures do not accurately reflect actual population totals and dynamics but is the best that can be done given the imposed ITS limits. Since WY2012, take limits have not been exceeded for juveniles and adults (Figure 95), with take limits typically being met (for juveniles) and trapping ending by early April.

From WY2001 to WY2022, the maximum number of migrant *O. mykiss* captures across all trapping locations was in WY2007 with 665 captured and a minimum of 5 in WY2017 that reflected the basin wide impact of the long-term drought (Table 27). Anadromous fish captured over that time had a high in WY2008 of 16 with the next highest of nine in WY2011 (one being a recapture at Hilton Creek that was initially captured in Salsipuedes Creek) (Tables 28 and 29). Since the issuance of the 2000 BiOp, there have been 7 years with one or more anadromous steelhead observed, primarily in Salsipuedes Creek (WY2001, WY2003, WY2005, WY2006, WY2008, WY2009, WY2010, and WY2011) all corresponding to wet or average rain year types. Only during 2 years have anadromous steelhead been observed in Hilton Creek (WY2008 and WY2011), most likely from the WY2005/WY2006 and WY2008 (all spill years) cohorts. The number of returning anadromous adults has been low since monitoring began, but WY2008 and WY2011 (wet years) were slight signs of the potential viability of the LSYR watershed for maintaining the Southern California steelhead population. An increase in the number of anadromous returns during those 2 years was also observed in other watersheds where monitoring has taken place across the Monte Arido Highlands Biogeographic Population Group (NMFS, 2012; Dagit et al., 2020). Unfortunately, the drought and inconsistent rain years after WY2016 have hampered a positive overall population response within the LSYR watershed, specifically of anadromous fish. In Hilton Creek, the number of resident adults migrating upstream to spawn have shown a positive trend with a low of one captured in WY2017 (most likely due to the long-term drought plus Whittier Fire impacts) and a high of 86 captured in WY2021 that resulted in the construction of 48 individual redd sites, the highest yearly total recorded in the creek. Smolt captures had a maximum of 445 in WY2006 at all trapping locations (Hilton Creek [213], Salsipuedes Creek [218], and the mainstem [14]) and a low of two in WY2017, again reflective of the impact of the drought (Table 30). Downstream migrants in Hilton Creek have also shown an encouraging population response since WY2016 with a low of four captured in WY2017 (two smolts) and a high of 101 captured in WY2021 (28 smolts). Compared to WY2022, there were 85 downstream migrants captured, 37 of which were smolts. Downstream migrants, especially smolts, are likely undercounted due to the truncated trapping season so the number of smolts moving downstream in WY2022 (and likely other truncated trapping seasons) is likely higher (Figure 96).

Before the drought, Salsipuedes Creek routinely produced the most smolts compared to all trapping sites and is highly correlated to the amount of rainfall received in the watershed. This behavior is not observed in Hilton Creek due to the artificial flow from Lake Cachuma and the low water temperature regime from reservoir releases to the creek that is not reflected in the rest of the LSYR watershed. For example, wet and average year types produced the most number of smolts in Salsipuedes Creek whereas during dry year types, the number of smolts captured was significantly reduced (WY2002, WY2004, WY2007, and WY2009) highlighting the importance of environmental ques in relation to the smolt migration in this watershed. Since WY2016, the effects of the drought to the smolt population in Salsipuedes is most pronounced and a stark reminder of long-term drought impacts to the overall population in the creek. There was no migrant trapping in WY2022 due to extreme low flows. (Figure 97).

The last years that anadromous steelhead were captured in the LSYR were in WY2008 and WY2011 in Salsipuedes and Hilton Creeks with several fish captured between 480-701 mm (19-27.5 inches) including a few smaller fish that were speculated to have originated from the lagoon based on their general appearance (robust with silvery coloration) (Figure 98).

The total number of large *O. mykiss* fish captures, defined as equal to or greater than 400 mm (15.7 inches) follows a similar trend as discussed above with the highest total observed in WY2008 (prior to the drought) (Figure 99). No fish larger than 400 mm have been captured in Salsipuedes Creek since WY2011. In Hilton Creek, only two large migrants were captured in WY2014 with none captured in WY2012, WY2015, WY2016, and WY2017. There was a steady uptick in larger fish captured in the creek since WY2018 with one captured in WY2018, three in WY2019, eight captured in WY2020, and three captured in WY2021 however, no adults over 400 mm were captured in WY2022. Tracking the abundance of larger fish is an important metric due to the higher fecundity rate of larger versus smaller spawning fish. This also reflects the positive results of Highway 154 Bridge target flows that have been enhancing the rearing habitats within the Hwy 154 Reach.

4.9. Aging *O. mykiss* through Scales Analyses

Each year, COMB-FD staff looks back several years to catch up on reading and analyzing scales from previous water years. Scale analyses are valuable and insightful regarding growth patterns, environmental changes, and differences between one stream and another. The following describes findings from WY2017, WY2016 and WY2015.

WY2017: Scale collection of captured migrants in WY2017 in Hilton Creek followed several years of extreme drought and represent the lowest capture totals for migrant trapping efforts since the inception of the migrant trapping program. The low total coincides with observed low *O. mykiss* survivability during extreme low flow conditions observed during the summer through fall in 2016 where trickle tank flows and minimal pump flows from the Stilling Basin kept a short portion of Hilton Creek instream habitat viable for the remaining small population of *O. mykiss*. During this timeframe, the entirety of the Hwy 154 Reach was dry with habitat available in the short section of Hilton Creek and the Stilling Basin only. A total of 5 fish were captured in WY2017; one upstream migrant and 4 downstream migrants. Scales were read on one 152 mm (6.0 inches) upstream migrant and one 141 mm (5.6 inch) downstream migrant. Both fish were aged at 1+ (Table 31).

WY2016: A total of 92 scales were analyzed during the WY2016 trapping season; five upstream migrants and 87 downstream migrants (Table 32). The five upstream migrants were aged at 2+ (3 fish) and 3+ (2 fish) with three of the five fish greater than 10 inches. No anadromous adults were captured in WY2016. Of the downstream migrants, four were identified as residents (age 0+ [1], 1+ [2] and 2+ [1]) with the remainder (83) identified as smolts or pre-smolts that comprised approximately 93% of the downstream migrating fish analyzed. The majority of the smolts and pre-smolts fell within age 1+ (42 or 45.7%) followed by age 2+ fish (37 at 43.5%) with age 2 fish comprising 4.3% of the total supporting further evidence that smolts are trying to exit to the ocean between 1+ and 2+ years after being hatched. The majority of the smolt scales analyzed were between 130 mm and 179 mm (5.1-7.0 inches) with the greatest number in the 150-159 mm range. Figure 101 highlights the differences in growth patterns between two Hilton Creek downstream migrating smolts, a 151 mm 1+ fish and a 206 mm 2+ fish.

WY2015: A total of 86 scales were analyzed during the 2015 trapping season; 13 upstream migrants and 73 downstream migrants (Table 33). The upstream migrants were ages at 1+ (2), 2+ (2), 3 (2), 3+ (6), and 4 (1) with 9 of the 13 fish greater than 10 inches in length. No anadromous adults were captured in WY2015. Of the 73 downstream migrants, 55 were identified as smolts and pre-smolts that comprised 75.3% of the downstream migrating fish analyzed with the remaining fish identified as residents. The majority of the smolts and pre-smolts fell within age 1+ (19 at 34.5%) and age 2+ (33 at 60.0%). Compared to WY2016 captures, the average smolt size was about the same with the exception of several older and larger age 3 and 3+ smolts attempting to leave the watershed. The majority of the smolts scales analyzed were between 140 mm-and 220 mm (5.5-8.7 inches) with the greatest number in the 150-159 mm size range. Figure 102 highlights the differences in growth patterns between two Hilton Creek downstream migrating smolts, a 155 mm 1+ fish and a 173 mm 2+ fish.

4.10. Sulfur and *O. mykiss* Issues

Sulfur (sulfides, hydrogen sulfide [H_2S]) is toxic to salmonids (0.002 mg/L or greater), in this case *O. mykiss* (Smith et al., 1976). In the summer and fall of 2022, water releases from Lake Cachuma in support of the downstream fishery (specifically from the Outlet Works and the Hilton Creek LRP) exhibited strong sulfur odors, presumed to be H_2S, that registered over 20 ppm in the LRP energy diffuser box with gas monitors (over 10 ppm is a concern for human safety). The odors were so strong downstream of the dam that complaints from a nearby small community were called in to the County of Santa Barbara. Conditions worsened as the summer continued in association with the further development of lake stratification and an anoxic zone on the bottom of the lake (Figure 103).

There are three pathways for releases from Bradbury Dam at Lake Cachuma to the downstream fishery: the spillway (only used during high flow events), the Outlet Works (OW) release to the LSYR and to Hilton Creek through the Watering System (HCWS) and Hilton Creek Emergency Backup System (HCEBS) (Figure 104). The HCWS and HCEBS release to Hilton Creek at the Upper Release Point (URP) and Lower Release Point (LRP), each with an energy diffuser box and cascade to increase the dissolved oxygen concentrations (Figure 105). Hilton Creek confluences with the LSYR just downstream of the Stilling Basin. The intake for the HCWS is set at 65 feet of depth (below the thermocline) whereas the intake for the HCEBS is the bottom of the lake.

Lake Cachuma is a monomictic lake that annually stratifies, develops a thermocline in the metalimnion during the warmer months of the year between 35 and 55 feet of depth and then turns over in the fall. In 2022, the lake turned over at the end of October and the effect of sulfur immediately ended (Figure 106). The depth and timing of lake stratification and turnover varies by atmospheric conditions (temperature and wind) and lake depth.

The most likely sources of sulfur are (1) bottom sediments and (2) low points in the HCWS pipeline that accumulate sediments over time and release sulfur into solution during reducing environment (anoxic) formation. A vertical profile of sulfide (H_2S) sampling was taken in the fall (10/26/22) prior to lake turnover that supports this observation (Figure 106). Prior to lake turnover, sulfur reducing bacteria (genus desulfovibrio) (Smith et al., 1976) on the stream bottom pulled sulfur out of solution and turned the stream bottom white (Figure 105), the effect and concentration diminished moving downstream (Figure 107). Avoidance behavior of *O. mykiss* was observed in Hilton Creek in Reach 4 just downstream of the LRP (Figure 108).

These observations have brought up multiple concerns. Lake bottom sediments are now at (or above) the intake at the bottom of the lake for the Outlet Works which was not the case in previous years (significant additional sedimentation occurred during WY2023 winter storms). This allows for sulfides to readily flow into the intake for the Outlet Works and HCEBS when an anoxic zone (reducing environment) has developed. The HCWS intake is set at 65 feet and well above bottom sediments. Sediments in the HCWS pipeline are limited and have a much lower potential for sulfide delivery to Hilton Creek. The Outlet Works releases disperse waters into the air and effectively volatilize sulfur by producing H_2S gas (the odor detected by the local community). Any level of dissolved sulfides in release waters to Hilton Creek or the LSYR mainstem poses a direct threat to the downstream *O. mykiss* population. Phosphorous (P) can also be released into the water column from bottom sediments through reduction that can cause algae blooms and increased and total organic carbon (TOC) concentrations which is problematic for water treatment facilities.

There are various potential solutions. The release waters at the LRP and URP could be blown into the air to better volatilize sulfides, while considering air quality impacts. USBR could maximize releases from the HCWS (65 feet of depth) and minimize releases from the HCEBS (bottom of the lake). An aeration system could be installed to elevate the dissolved oxygen concentration to eliminate the anoxic (reducing) zone at the lake bottom sediment surface, possibly using a Speece Cone (Horne, 2019). This is an expensive and continuous course of action. Lastly, the intake at the bottom of the lake could be raised well above the current sediment level, which would alleviate intake waters coming from the reducing zone.

4. 11. Water Quality Impacts from Ramping up of the 2022 WR 89-18 Releases

In 2021, SYRWCD changed their long-standing request for conducting a WR 89-18 release by doing a relatively slow ramp-up of the release (2 days). This reduced the amount of thermally heated surface Stilling Basin water going down the LSYR mainstem at the start of the release, which had favorable results for the downstream fishery. Previously that slug of warm surface water caused a 2-4 °C temperature spike above ambient stream water temperatures. In 2022, SYRWCD continued with this new procedure but over a longer period (11 days) for ramping up the 2022 WR 89-18 release. The longer period of 11 days for ramping up was mostly related to initiating an ANA release prior to starting the BNA release. Again, positive results were observed for the downstream fishery.

This allowed for gradual mixing of cool water from the bottom of the lake with the surface water in the Stilling Basin, preventing rapid warm water displacement. This also allowed for more night time cooling. Stream water temperature data at various downstream locations showed a gradual cooling from released waters with no temperature spikes (Figure 109). It is recommended to continue with a slow ramp-up procedure in support of the downstream fishery.

4.12. LSYR Beaver Dams

History: The North American Beaver (*Castor canadensis*) according to scientific literature was introduced into the Santa Ynez River and has sustained active populations in the watershed since the late 1940s (Hensley, 1946; Baker and Hill, 2003; CDFG, 2005). The value of beavers in Southern California watersheds is debatable (Richmond et al., 2021). In the mid 1990s, their distribution within the lower watershed was spotty, localized to areas downstream of Buellton with a few scattered dams in the Salsipuedes Creek watershed. From 1995 to 2011, the hydrological regime was in a wetter cycle and the lake spilled on average about every three years (1995, 1998, 2001, 2005, 2006, 2008, and 2011) creating migration opportunities throughout the lower watershed (AMC, 2009). In addition, prior to 2005 when summer target flows were implemented for rearing *O. mykiss*, the river was managed much differently. Prior to the listing of the endangered Southern California steelhead in 1997, the river was largely used as a water delivery corridor to quickly and efficiently recharge the various groundwater basins both upstream and downstream of the Narrows. Once natural flows ceased from the tributaries (typically April-June), no releases occurred from Bradbury Dam unless a WR 89-18 downstream water rights release was called for to recharge the groundwater basins, usually every three years or so (now annually since the drought). This resulted in large sections of the LSYR mainstem going dry with the riparian corridor vegetation largely absent from the associated floodplain, particularly in the Alisal, Refugio, and Avenue Reaches as well as large sections of the river in Reach 3 downstream of Buellton (LSYR-13.9) to the Narrows (LSYR-36.0).

Since 2005, Hilton Creek releases and target flows were required to improve summertime *O. mykiss* rearing conditions in the LSYR mainstem in the year of and year after a spill when *O. mykiss* were present in the Refugio and Alisal reaches. Target flows are required to the Highway 154 Bridge (Hwy 154 Reach) for all other years until Lake Cachuma storage drops below 30,000 af. This coupled with consecutive downstream water rights releases during the drought has provided water in the river during June through September that has resulted in an explosion of riparian corridor vegetation growth (willows, cottonwoods, sycamores, mulefat, etc.) and in some places the surrounding floodplain due to the additional water. An average of 6,967 af of water (range 2,468 to 13,333 af) has been provided to the LSYR mainstem each year target flows were required during the summertime period (June-September) (Table 34). This has translated to more surface water down into Reach 3 downstream of Buellton due to groundwater flow that emerges and creates surface streamflow at various locations due to basin geology that forces groundwater to the surface. The increase in surface water in the LYSR mainstem has increased the extent of suitable conditions for beavers as well as the lack of Lake Cachuma spill that can cause channel changing and clearing events.

Over time and with the increased amount of flow in the river since 2005 as a result of the target flow requirements of the 2000 BiOp and WR89-18 releases, the number and spatial distribution of beavers and their dams have increased substantially throughout the LSYR mainstem and select tributaries. Once Lake Cachuma surcharged for the first time and the long-term target flows were initiated in 2005, beaver dams have been observed in the wetted reaches during the dry season from the Bradbury Dam to the Narrows as well as portions of the LSYR mainstem downstream of the Lompoc Waste Water Treatment Plant upstream of the Santa Ynez River lagoon. In addition, beavers now have successfully colonized the Salsipuedes/El Jaro Creek watershed despite their numbers and distribution being reduced during the 2012-2016 drought. Well established beaver dams can be of sufficient strength and breadth to remain in place during stormflows, and create passage impediments and/or barriers for migrating fish during low to moderate flows as well as submerging suitable areas to spawn.

Beaver Dams - Documentation and Potential Migration Barriers: Beaver dams have been observed to act as migration barriers on the LSYR especially during low to moderate flows, forcing *O. mykiss* to spawn in suboptimal locations, as they are unable to negotiate past large well-established dams. This was evident in WY2021 when two large anadromous steelhead redds were identified 1.5 miles upstream of the Salsipuedes Creek confluence and 0.9 miles downstream of a significant beaver dam. The steelhead spawned in the only area available that consequently went dry before most of the eggs hatched. Without the presence of beaver dams (80 recorded in the LYSR mainstem in WY2021), it is likely those fish could have moved up through the Management Reaches to Hilton Creek where optimal spawning and rearing habitat were available. Barrier beaver dams are forcing anadromous steelhead to spawn in sub-optimal locations that are prone to drying before fry can emerge and navigate to refuge and rearing habitats, especially in the lower river, as illustrated in WY2021 within the Narrows Reach.

WY2021 was the first year since WY2011 that anadromous steelhead redds were identified in the LSYR mainstem and their entry into the LSYR basin was documented most likely by CDFW's DIDSON video camera near the Lompoc Airport. Looking at the USGS Narrows and H Street flows, it appeared that anadromous steelhead had a small window of opportunity to enter the watershed following the late January storm before decreasing flow began to impede movement. At H Street, flows in excess of 25 cfs were present for only 17 days (1/28/21 – 2/13/21) and were present for 26 days at the Narrows (1/27/21 – 2/21/21). It is estimated that about 45 cfs (25 cfs at Solvang) is the minimum flow rate needed to allow for steelhead to pass through critical riffles (SYRTAC, 1999). For a point of reference, the steelhead redds were found approximately three miles upstream of the Narrows USGS gauging station. The closest barrier beaver dam is located approximately 0.9 miles upstream from both steelhead redd sites. Upon inspection of the beaver dam following the discovery of the steelhead redds, it was clear that the dam was a complete barrier to any upstream migrating fish due to the absence of a jump pool below the beaver dam, the height of the dam (2.7 feet) and no observable flow paths to enable fish to swim through the dam. The Narrows area was not surveyed during WY2022 due to extreme low flow conditions that prevented resident and anadromous *O. mykiss* from moving to and spawning in that location.

From 2005 to 2010, COMB-FD biologists noted an increase in the number of beaver dams observed in the Management Reaches (Alisal, Refugio, and Hwy 154 reaches), which called into question the efficacy of conducting Fish Passage Supplementation Releases and how successful the releases were regarding anadromous steelhead and outmigrating smolt passage with many LYSR mainstem beaver dams of varying size. In order to evaluate the number and distribution of beaver dams in the LSYR and to better understand movement challenges by *O. mykiss* in regards to Fish Passage releases from Bradbury Dam, yearly beaver dam surveys have been conducted along the entire LSYR and the Salsipuedes/El Jaro watershed since 2010. Prior to the 2012-2016 drought, regular spill events acted to remove beaver dams or provide enough flanking flows to allow for both upstream and downstream *O. mykiss* passage as evident in anadromous steelhead captures in both Hilton and Salsipuedes Creeks. While the drought did contribute to a significant reduction in both the number and geographic distribution of beavers, there has been a noticeable uptick in the number and distribution of beaver dams since 2016. The fewest number of LSYR mainstem dams identified was in 2016 with 45 dams documented. That number has increased to 80 in WY2021 and 79 in WY2022. Beaver dams in the tributaries declined to 0 in WY2019 then increased to 11 in WY2021 and decreased to 4 in WY2022.

Beaver Activities Transforming the Riparian Corridor: Beavers are classified as ecosystem engineers by changing their habitat to suit their needs (Jones et al., 1997). In the absence of significant spill and/or stormflow events during the past 12 years to remove beaver dams, the overall beaver population and associated dams/pools have increased and contributed to a transformation of the riparian corridor throughout the LSYR watershed where beavers have been active. In the past, biologists have been able to negotiate pathways through the LSYR riparian corridor while conducting the beaver dam survey. That was not the case in the WY2021 or the WY2022 surveys. Spatial distribution of dams has changed over time from scattered individual impoundments to contiguous complexes or impoundments along extensive sections of the river. What was once a relatively confined channel (especially in Reach 3) has transformed into a marsh/reed/willow forest that in many places has extended well out into the floodplain and widened the riparian vegetation corridor. The dense vegetation can obscure or eliminate the active channel with no apparent migration pathway available for upstream and downstream migrating *O. mykiss*. Any new channel with flowing water has the potential for beaver dam building that with time further extends the inundation zone and expansion of vegetation contributing to additional suitable habitat and food sources for beavers. Reed and willow growth in their present state have a high resilience to disturbance, slowing water velocities and reducing erosional characteristics of high flow events and creating obscure migratory pathways in the absence of higher stormflows (Naiman et al., 1994). The extensive ponding and marsh habitat has also reduced and in some locations eliminated all spawning habitat. Introduced species, such as the American beaver into the Santa Ynez River watershed, can extensively alter the historical ecosystem and negatively disrupt the balance of sustainability for native flora and fauna (Richmond et al., 2021). These beaver dam complexes often attract and favor non-native species (i.e., Centrarchids vs. *O. mykiss*, bull frogs vs. red-legged frogs, arundo donax, tamarisk, etc.). These invasive species all occur in the LSYR basin. Until a beaver management plan is developed and implemented, beavers will continue to impact endangered steelhead habitat and spawning opportunities through dam building activities that impede passage, especially in dry and average years, and favor non-native species competition. With climate change already influencing weather patterns and shifting rainfall to later in the year, beaver dams will continue to have the potential to negatively influence spawning and recruitment of *O. mykiss* within the LSYR basin in the foreseeable future.

4.13. Tributary Fish Passage Enhancement and Stream Restoration Projects

By the end of calendar year 2020, 15 tributary fish passage enhancement and 6 stream restoration projects for a total of 21 projects have been completed within the LSYR basin in support of the LSYR basin *O. mykiss* population (Table 35). Many of the fish passage projects, but not all, were listed in the 2000 BiOp (Tables 36-37 and Figures 110-115). All documented anthropogenic passage impediments within the Salsipuedes/El Jaro Creek and Quiota Creek (except for Crossing 0B which is a partial migration barrier that has been mandated by the Santa Barbara District Attorney to be removed) 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 these fish passage facilities, and in cases where fish ladders were installed, fish often use the ladders for refuge and oversummering habitats.

The deliveries from the HCWS/HCEBS have 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 62-63). In 2005, completion of the Hilton Creek Cascade Chute Project doubled the available habitat for *O. mykiss* in the watered section of Hilton Creek and releases from the URP provided for extensive riparian vegetation growth that has shaded and cooled the stream water (Figure 116). Channel changes and the redistribution of optimal sized spawning gravels throughout Hilton Creek from the Whittier Fire, coupled with continuous Lake Cachuma water deliveries to the URP since WY2019, and gravel augmentation (2017-2018) have greatly enhanced instream spawning and rearing conditions throughout the creek.

All these tributary fish passage enhancement projects removed potential passage barriers for adult and juvenile *O. mykiss*, reduced sediment supply to the stream, and/or provided for passage, spawning (gravel augmentation), 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.

4.14. Invasive Plant Species – Monitoring and Status

Water Hyacinth: 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, specifically in the Sacramento-San Joaquin River Delta where it has heavily impacted the river ecology and fisheries (Villamagna and Murphy, 2010). 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 with assistance from the California Conservation Corps over the course of 3 years within that section of the river channel. Staff surveyed that section of river in WY2022 during beaver dam surveys and did not observe any water hyacinth (last known occurrence was 12/8/16). This has become a routine field monitoring activity during beaver dam surveys.

Arundo: Arundo (*Arundo donax*, giant reed) is a noxious weed and a significant problem in many watersheds in central and southern California due to being a very thirsty plant, propagates quickly and easily through several means, out competes native plants and reduces biodiversity, and tends to narrow stream channels resulting in increased flood risks. If left unchecked, Arundo can evolve to be the dominant species in the riparian corridor. Arundo was first discovered along the Santa Ynez River several decades ago and was first mapped in 2008 by the County of Santa Barbara Agricultural Commissioner's Office and was observed below and above Lake Cachuma in isolated locations. A weed removal program was conducted for a couple of years (2012-2013) that helped but did not eradicate Arundo. Currently it is found most prominently in the lower watershed west of Lompoc and continues to be a major threat to the wellbeing of the watershed. A comprehensive eradication program should be reinitiated.

Tamarisk: Tamarisk (*Tamarix ramosissima*, Salt Cedar) is also a noxious weed found along the banks of the Santa Ynez River. It was discovered in the watershed about the same time as Arundo and has a similar distribution (above and below Lake Cachuma). Its distribution was mapped at the same time as Arundo in 2008 but never was treated. Its impacts on the watershed are similar to Arundo and needs to be treated before it gets out of control as observed in other Southern California watersheds. It is prominently found upstream of Lake Cachuma particularly on the dry lake bed.

4.15. Update on the Lake Cachuma Oak Tree Mitigation Project

The annual oak tree inventory was completed on 7/1/22 with the objective of determining the status and success rate of the trees planted since the beginning of the program with 13 years of plantings. At the end of the 2022 planting season, 5,734 oak trees have been planted and 4,711 are alive and thriving (an 81.4 % survival rate) (Figure 117). The number of mitigation trees still to be planted is 9 trees (mitigation number minus total alive trees). Staff is on track to complete the remaining plantings during WY2023.

There were 384 trees planted at Live Oak Camp in the Lake Cachuma County Park that are referenced as Year 13 trees. We have found that trees planted inside Cachuma County Park as opposed to outside the park have a higher success rate due to easier access for maintenance, less brush that would otherwise provide habitat for herbivores that eat oak trees (e.g., woodrats, rabbits, etc.), a water source inside the park to ease the process of filling the water truck and trailer, and clean mulch piles on site that can be utilized as needed. The lessons learned by the COMB-FD staff from 10 years of conducting the Oak Tree Program have been put into practice and are recommended for future work. These lessons include annual mulching, deer cage maintenance, exposing buried gopher wire baskets, planting trees above ground when planting new trees, and planting larger trees.

4.16 Status of WY2021 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 WY2021 Annual Monitoring Summary to improve the monitoring program pending available funding:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000), BiOp (NMFS, 2000), and Order Water Rights (WR) 2019-0148 (SWRCB, 2019) 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.

- Incorporate the Narrows Reach into routine monitoring efforts specifically redd surveys, snorkel surveys, and water quality.
    - Status: This recommendation is being followed and is ongoing.

- Continue to support Reclamation upon their request of information needed for their Reconsultation process with NMFS, in particular efforts to increase the ITS limits for both juvenile and adult *O. mykiss* to best cover the current and future population size.
    - Status: This recommendation is being followed and is ongoing.

- Continue to work closely with Reclamation on the implementation of the new WR 2019-0148 to conduct all required monitoring and reporting in a timely manner;
    - 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.

- Work with Onset to improve functionality and reliability of their Hobo Shuttles for thermograph data downloads.
    - Status: This recommendation is being followed and is ongoing.

- Develop a gravel augmentation plan for the Hwy 154 Reach of the LSYR mainstem to provide spawning gravels to habitats with limited spawning potential due to the makeup of the stream substrate. Pattern the effort on what was successful completed in Hilton Creek on Reclamation property. Work with Reclamation on developing the plan, environmental coverage, and identifying potential funding sources.
    - Status: A draft Gravel Augmentation Plan was submitted on 4/3/23 to Reclamation and they are in the process of reviewing the Plan with the objective of implementation in WY2024.

- Continue to work with Reclamation to maximize dry season releases to Hilton Creek versus the Outlet Works to maximize support of the downstream fishery and minimize lake release stream temperatures entering the Long Pool and LSYR mainstem habitats downstream.
    - Status: This recommendation is being followed and is ongoing.

- Work with the Santa Ynez River Conservation District on further developing their ramp-up and ramp-down procedures for WR 89-18 releases to enhance the successful implementation of the release that was started in WY2020.
    - Status: This recommendation is being followed and is ongoing.

- Continue to evolve the collaborative relationship with CDFW regarding fish rescue within the LSYR basin. The effort was started in WY2020 it has been exemplary, and should be continued. Coordinate and prepare early as conditions warrant entering into the dry season.
    - Status: This recommendation is being followed and is ongoing.

- Initiate a PIT tag monitoring effort in the LSYR basin to document current and future CDFW tagged fish. This will require obtaining the equipment and conducting the required monitoring effort.
  - Status: The equipment has been obtained and Reclamation is considering our proposal for installing the PIT tag monitoring station.

- Continue to remove non-native fish species and conduct basic stomach content analyses of non-native piscivorous fish whenever possible (during migrant trapping, fish rescue, and stranding surveys), specifically in habitats known to support *O. mykiss* and non-native fish;
  - Status: This recommendation is being followed and is ongoing.

- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin;
  - Status: This continues to be a good recommendation and is being considered in the Reconsultation effort between Reclamation and NMFS.

- Continue to encourage Reclamation to improve and make reliable its system operation for delivering lake water to Hilton Creek;
  - Status: This recommendation is being followed and is ongoing.

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

- Continue with scale analyses going back in time to assure all scales have been read and documented that are currently in the LSYR *O. mykiss* scale inventory, specifically looking at growth rates, evidence of life-history strategies such as fresh versus marine water rearing, signs of spawning, integration of the findings with the results of the genetic analyses, etc. in support of ongoing fisheries investigations;
  - Status: This recommendation is being followed and is ongoing.

- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships;
  - Status: This recommendation is being followed and is ongoing. The USGS installed a low flow stream gauging station just upstream of the Hwy 154 Bridge in 2022, which should be used for compliance monitoring in future water years.

- 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.

- Investigate with Reclamation Stilling Basin management specifically 1) a Stilling Basin bypass pipeline system to provide target flow releases without the potential for thermal heating and warm water fish species movement downstream; 2) limiting *O. mykiss* access to the Stilling Basin, 3) establishing a small road for access to the Stilling Basin, and 4) dewatering of the Stilling Basin for non-native fish removal; and
    - Status: This recommendation is being followed and is ongoing.

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

5. Conclusions and Recommendations

WY2022 was the 12th dry year since the 2000 BiOp was issued. Bradbury Dam recorded only 13.13 inches of rain with the highest rainfall occurring in December and March. Lake Cachuma did not spill and the highest lake level was on the first day of the water year (10/1/21) at 713.41 ft above mean sea level (95,586 af, or 49.4% of capacity). A minimum of 1.0 cfs was delivered to Hilton Creek at the URP and LRP, and target flows to the Hwy 154 Bridge were met. The lagoon was closed throughout the water year. It was highly unlikely that any LSYR Lagoon fish migrated upstream or downstream.

There were 44 redds documented across the LSYR basin that were observed in Hilton Creek (23), Salsipuedes Creek (16), El Jaro Creek (2), and Quiota Creek (2) along with one redd site documented in the Hwy 154 Reach. Spring and fall snorkel surveys showed spawning success with many YOYs observed in Hilton and Salsipuedes/El Jaro creeks.

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 WY2021 AMS 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 WY2022 onward:

- Continue to implement the monitoring program described in the revised BA (USBR, 2000), BiOp (NMFS, 2000), and Order Water Rights (WR) 2019-0148 (SWRCB, 2019) to evaluate *O. mykiss* and their habitat within the LSYR for long-term trend analyses and improve consistency of the monitoring effort for better year-to-year comparisons.

- Continue to support Reclamation upon their request of information needed for their Reconsultation process with NMFS, in particular efforts to increase the ITS limits for both juvenile and adult *O. mykiss* to best cover the current and future population size.
- Continue to work closely with Reclamation on the implementation of the new WR 2019-0148 to conduct all required monitoring and reporting in a timely manner;
- Continue to expand upon monitoring efforts in the Narrows Reach; specifically during years with limited fish passage to conduct redd surveys, snorkel surveys, and water quality monitoring.
- 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 to develop a gravel augmentation plan for Hilton Creek and the Hwy 154 Reach of the LSYR mainstem to provide spawning gravels to habitats with limited spawning potential due to the makeup of the stream substrate. Pattern the effort on what was successfully completed in Hilton Creek on Reclamation property in WY2018 and WY2019. This will entail obtaining permits and identifying potential funding sources.
- Continue to work with Reclamation to maximize dry season releases to Hilton Creek versus the Outlet Works to the Stilling Basin to maximize support of the downstream fishery and minimize lake release stream temperatures entering the Long Pool and LSYR mainstem habitats downstream.
- Continue to work with the SYRWCD on further developing their ramp-up and ramp-down procedures for WR 89-18 releases to enhance the successful implementation of the release and minimize impacts to the downstream fishery; this collaboration was started in WY2020.
- Continue to evolve the collaborative relationship with CDFW regarding fish rescue within the LSYR basin. The effort was started in WY2021, should be continued, and should be initiated as soon as conditions warrant entering into the dry season.
- Initiate a PIT tag monitoring effort in the LSYR basin to identify current and future CDFW tagged fish. COMB obtained the PIT Monitoring Station for Hilton Creek and is working with Reclamation to deploy it during the next migration season.
- Investigate viable solutions to the sulfide problem observed predominantly at the LRP and to a lesser degree at the URP.
- Continue to remove non-native fish species and 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;
- Develop a Beaver Management Plan and an Invasive Species Management Plan for the LSYR basin;
- Continue to encourage Reclamation to improve and make reliable its system operation for delivering lake water to Hilton Creek;

- 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 with scale analyses going back in time to assure all scales have been read and documented that are currently in the LSYR *O. mykiss* scale inventory, specifically looking at growth rates, evidence of life-history strategies such as fresh versus marine water rearing, signs of spawning, integration of the findings with the results of the genetic analyses, etc. in support of ongoing fisheries investigations;
- Continue working with the US Geological Survey, specifically at all LSYR basin gauges, to obtain accurate real-time measurements and to identify appropriate transect locations for stage-discharge relationships;
- 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;
- Investigate with Reclamation Stilling Basin management actions specifically 1) a Stilling Basin bypass pipeline system at the tail of the pool to provide target flow releases without the potential for thermal heating and warm water fish species movement downstream; 2) limiting *O. mykiss* access to the Stilling Basin, 3) establishing a small road for access to the Stilling Basin, and 4) dewatering of the Stilling Basin for non-native fish removal;
- Look for interested parties to develop a Arundo and Tamarisk Eradication Plan and search for funding to implement the needed effort; 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, 2017. 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, 2019a. 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.

COMB, 2019b. WY2017 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, 2020a. WY2018 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, 2020b. WY2019 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, 2021. WY2020 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, 2022. WY2021 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, 2023. RPM 6 Monitoring Report for the 2022 WR 89-18 Releases. Compliance Report, Cachuma Operation and Maintenance Board (COMB).

Dagit, R., M. T. Booth, M. Gomez, T. Hovey, S. Howard, S. D. Lewis, S. Jacobson, M. Larson, D. McCanne and T. H. Robinson, 2020. Occurrences of Steelhead Trout (*Oncorhynchus mykiss*) in southern California, 1994-2018. California Fish and Wildlife Journal, 106 (1): 39-58.

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.

Horne, A. J., 2019. Hypolimnetic oxygenation 1: win-win solution for massive salmonid mortalities in a reservoir tailwater hatchery on the Mokelumne River, California. Lake and Reservoir Management, 35 (3): 308-322.

Jones, C. G., J. H. Lamton and M. Shachak, 1997. Positive and negative effects of organisms as physical ecosystem engineers. Ecology, 78: 1946-1957.

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.

Naiman, R. J., G. Penay, C. A. Johnston and J. Pastor, 1994. Beaver influences on the long-term biogeochemical characteristics of boreal forest drainage networks. Ecology, 75: 905-921.

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 (NMFS), 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.

Richmond, J. Q., C. S. C. Shift, T. A. Wake, C. S. Brehme, K. L. Preston, B. E. Kus, E. L. Erwin, S. Tremor, T. Matsuda and R. N. Fisher, 2021. Impacts of a Non-indigenous Ecosystem Engineer, the American Beaver (Castor candadensis), in a Biodiversity Hotspot. Frontiers in Conservation Science, 2 (752400): 1-14.

Smith, L. L. J., D. M. Oseid, I. R. Adelman and S. J. Broderius, 1976. Effect of Hydrogen Sulfide on Fish and Invertebrates, Part I - Acute and Chronic Toxicity Studies. US Environmental Protection Agency (US-EPA).

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).

SWRCB, 2019. State of California State Water Resources Control Board Order WR 2019-0148. S. o. C. S. W. R. C. B. (SWRCB). Sacramento. 9/17/19.

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, 1999. Adult steelhead passage flow analysis for the Santa Ynez River. Memo prepared for the Santa Ynez River Consensus 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, California.

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).

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

3. Monitoring Results

Table 1: WY2000 to WY2022 rainfall (precipitation) 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)	Reservoir Condition 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	60,992	691.09	No	Yes
2016	11.45	Dry	No	0	32,900	669.57	No	Yes
2017	25.48	Wet	No	0	99,152	715.25	No	Yes
2018	9.32	Dry	No	0	82,580	706.27	No	Yes
2019	23.79	Wet	No	0	156,374	740.23	Yes	No
2020	21.03	Normal	No	0	156,960	740.45	Yes	Yes
2021	11.84	Dry	No	0	135,402	731.94	No	Yes
2022	13.13	Dry	No	0	95,586	713.41	No	Yes

* Bradbury Dam rainfall (Cachuma) period of record = 70 years (1953-2022) with an average rainfall of 19.70 inches.

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

Table 2: WY2022 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 (WY2022)
	(#)	(date)	(years)	(in)	(in)	(WY)	(in)	(WY)	(in)
Lompoc	439	1955	68	14.44	5.31	2007	34.42	1983	10.19
Buellton	233	1955	68	16.42	5.87	2014	41.56	1998	9.31
Solvang	393	1965	58	18.00	6.47	2007	43.87	1998	11.04
Santa Ynez	218	1951	72	15.56	6.58	2007	36.36	1998	10.13
Cachuma*	USBR	1953	70	19.79	7.33	2007	53.37	1998	13.13
Gibraltar	230	1920	103	28.36	8.50	2013	73.12	1998	17.70
Jameson	232	1926	97	28.36	8.50	2007	79.52	1969	16.91

* Bradbury Dam USBR rainfall.

Table 3: (a) Storm events greater than 0.1 inches of rainfall at Bradbury Dam 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 WY2022; dates reflect the starting day of the storm and not the storm duration.

(a)

#	Date	Rainfall (in.)	SC 10 cfs	Los L 10 cfs
1	10/25/2021	1.60	No	No
2	11/9/2021	0.11	No	No
3	12/14/2021	4.42	Yes	Yes
4	12/23/2021	2.91	Yes	Yes
5	12/28/2021	0.89	Yes	Yes
6	1/18/2022	0.40	No	No
7	3/28/2022	2.03	No	No
8	4/22/2022	0.23	No	No

(b)

Month	Rainfall (in.)	%
Oct-21	1.79	13.6
Nov-21	0.12	0.9
Dec-21	8.33	63.4
Jan-22	0.44	3.4
Feb-22	0.08	0.6
Mar-22	2.10	16.0
Apr-22	0.25	1.9
May-22	0.00	0.0
June-22	0.00	0.0
July-22	0.00	0.0
Aug-22	0.00	0.0
Sept-22	0.02	0.2
Total:	**13.13**	100

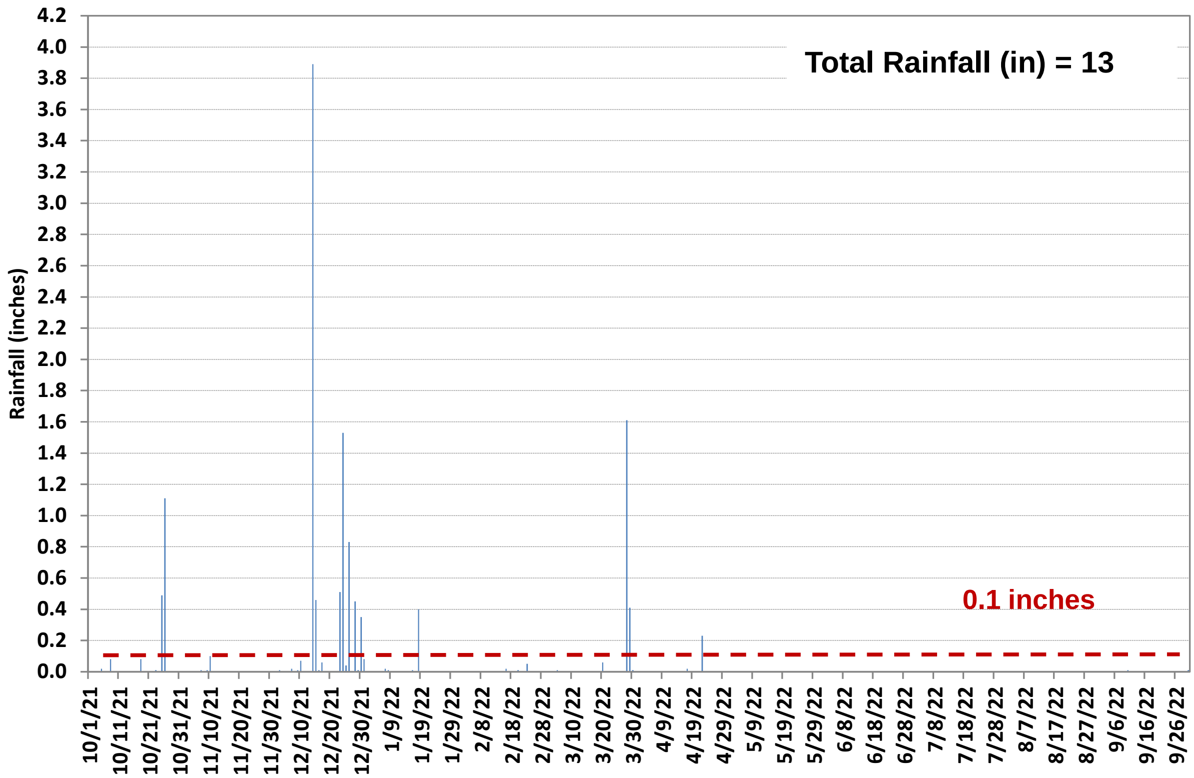


Figure 1: Daily rainfall in WY2022 as recorded at Bradbury Dam (USBR).

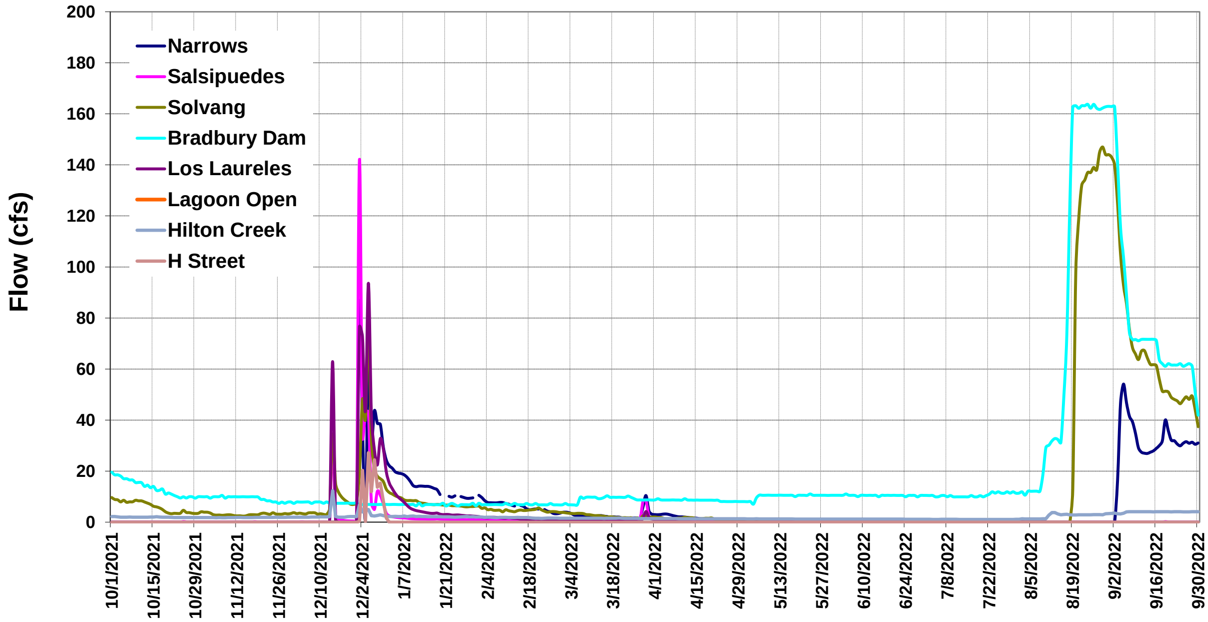


Figure 2: Santa Ynez River discharge and the period when the Santa Ynez River lagoon was open to the ocean (0 days) in WY2022.

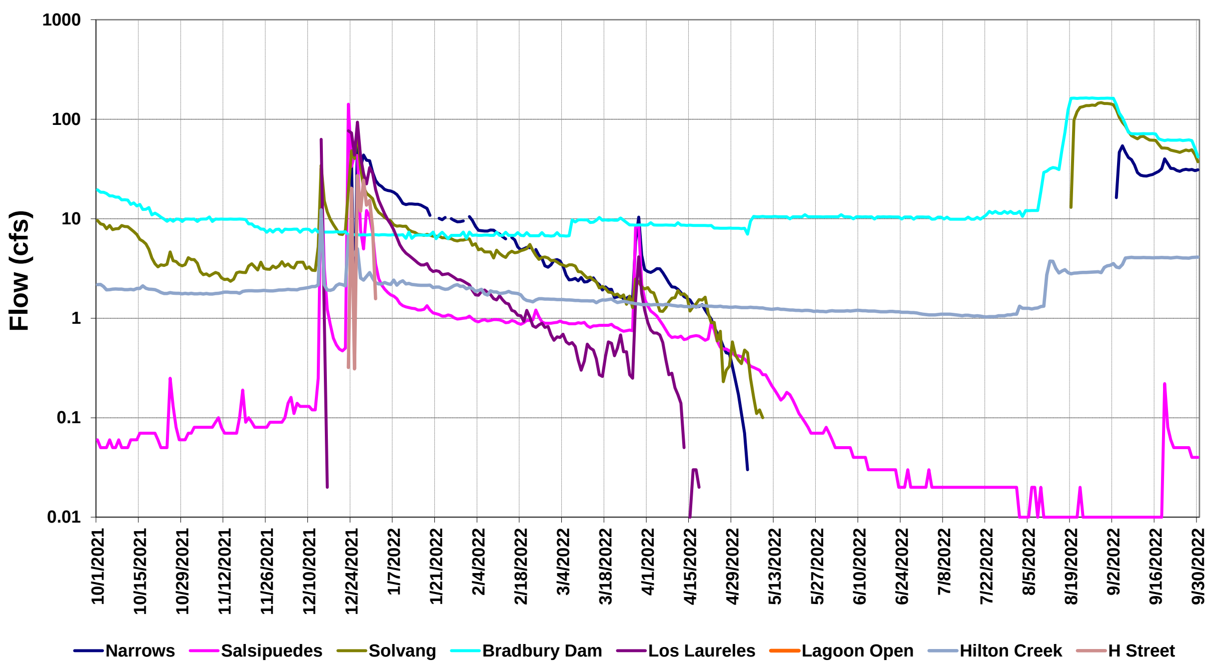


Figure 3: USGS average daily discharge at the LSYR mainstem USGS gauging stations at Los Laureles, Bradbury Dam (USBR), Hilton Creek (USBR), Alisal Bridge (Solvang), Salsipuedes Creek, the Narrows and H Street (Lompoc) during WY2022.

Table 4: Ocean connectivity, lagoon status and number of days during the *O. mykiss* migration season from WY2001 to WY2022.

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	5/19/03	151	139
2004	Dry	Yes	2/26/04	3/22/04	26	26
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	33
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
2018	Dry	No	-	-	0	0
2019	Wet	Yes	1/18/19	5/6/19	107	107
2020	Normal	Yes	4/7/20	-	177	55
2021**	Dry	Yes	-	12/7/20	55	0
			1/28/21	3/10/21	30	30
2022	Dry	No	-	-	0	0

*Migration Season is January through May.

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

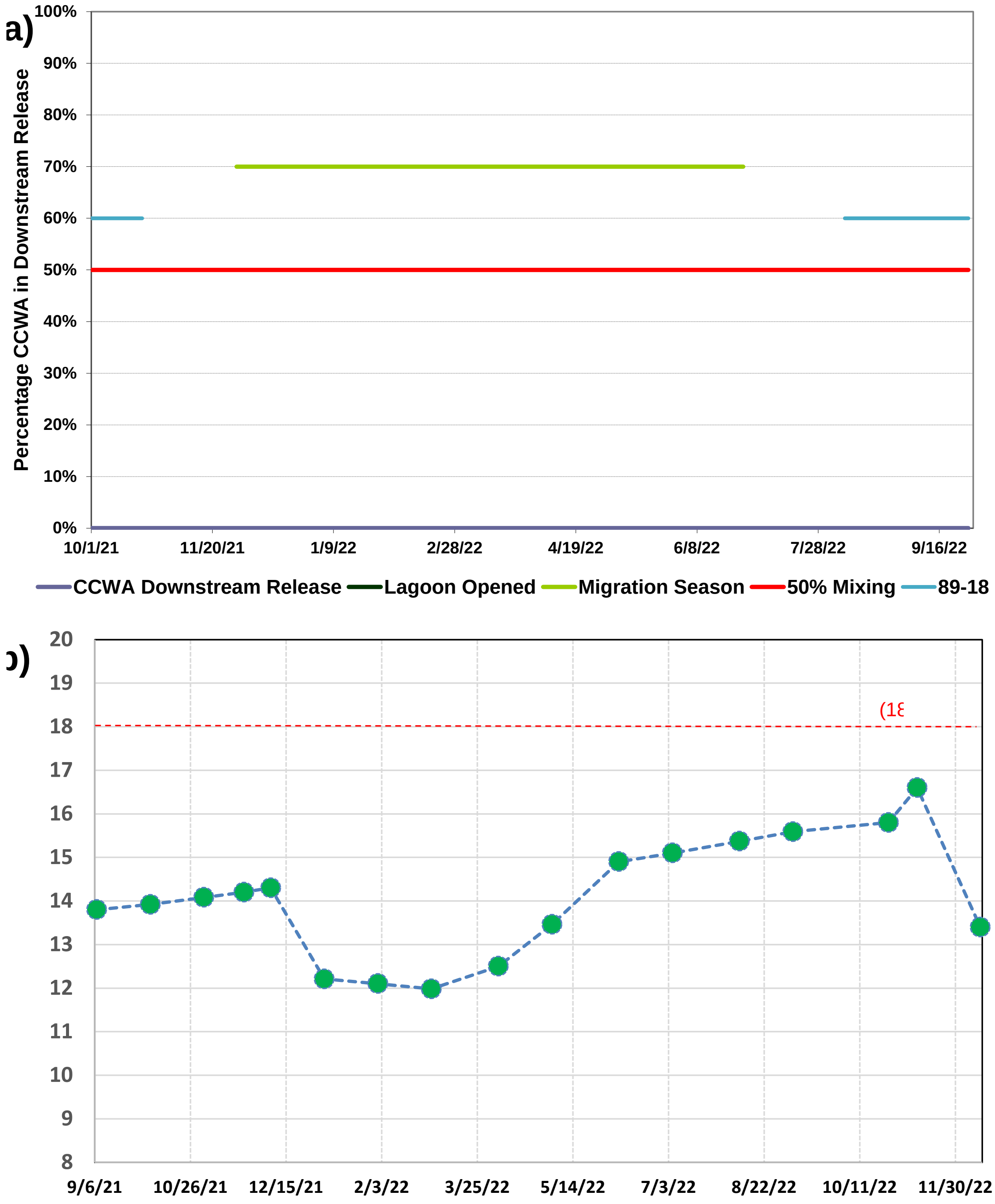


Figure 4: State Water Project (SWP) release into the LSYR regarding BiOp compliance with (a) the 50-50 mix rule showing the percentage of CCWA water being released from Bradbury Dam downstream to the Long Pool and (b) the 18 °C rule for the water temperature being released from the Outlet Works; there were no SWP deliveries through the Bradbury Dam Outlet Works (penstock) in WY2022 hence bottom lake profile data were used for this graph.

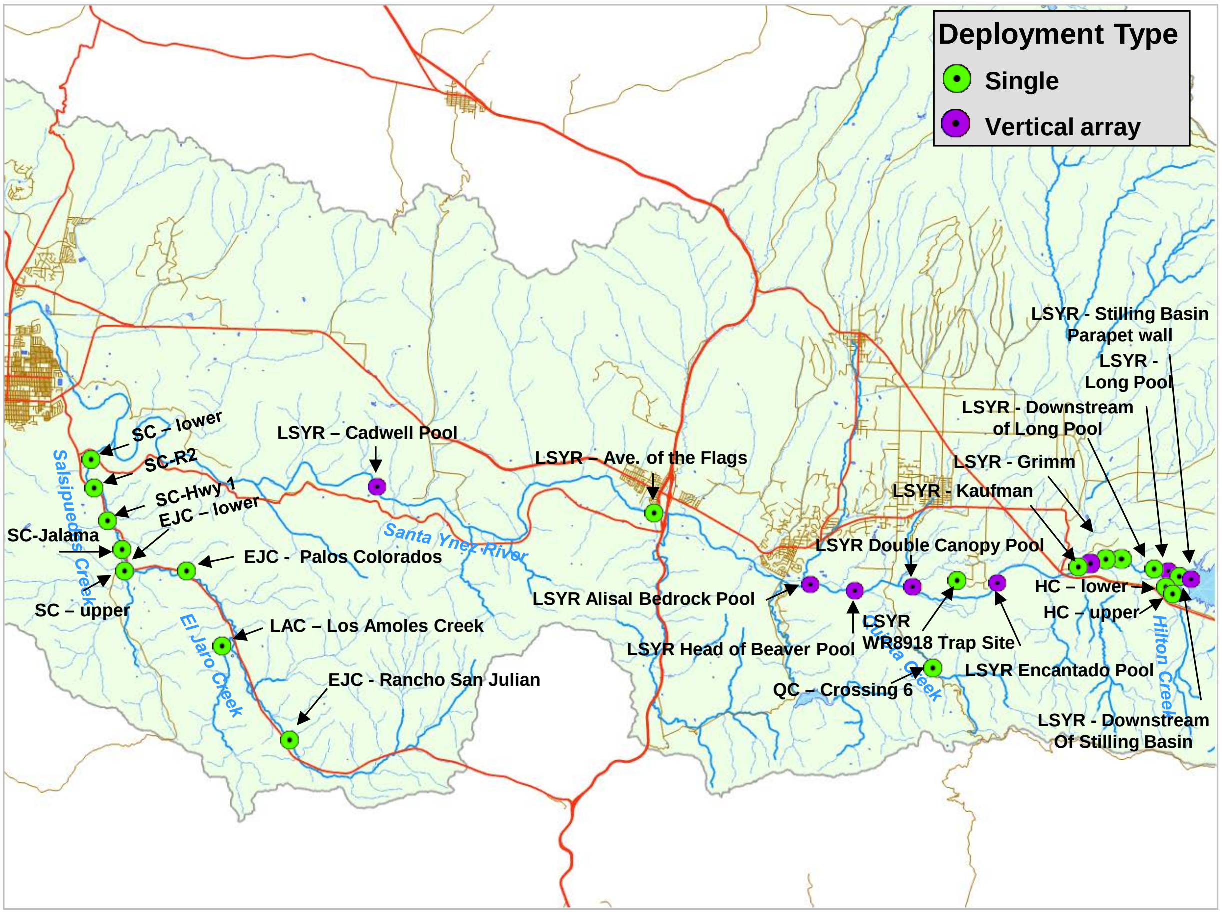


Figure 5: Thermograph single and vertical array deployment locations in WY2022 within the LSYR and its tributaries (HC – Hilton Creek, QC – Quiota Creek, SC – Salsipuedes Creek, and EJC – El Jaro Creek); the El Jaro Creek site and upper Salsipuedes Creek sites are close together with overlapping symbols.

Table 5: 2022 thermograph network locations and period of record listed from upstream to downstream.

	Location Name	Stream ID	Type	Latitude	Longitude	Deployment Date	Retrieval Date	Period of Record (Days)	# of units (#)
Mainstem	LSYR - Stilling Basin Wall	LSYR-0.01	Vertical Array	34.585472	-119.98316	5/2/2022	11/1/2022	179	3
	LSYR - D/s of Stilling Basin	LSYR-0.25	Single	34.586502	-119.985333	5/2/2022	11/1/2022	179	1
	LSYR - Long Pool	LSYR-0.51	Vertical Array	34.588545	-119.987998	5/2/2022	10/31/2022	178	3
	LSYR - D/s of Long Pool	LSYR-0.68	Single	34.590550	-119.991317	5/2/2022	10/26/2022	174	1
	LSYR-Grimm Property-Upstream	LSYR-1.09	Single	34.590097	-119.999322	5/2/2022	10/25/2022	173	1
	LSYR-Grimm Property-Downstream	LSYR-1.54	Single	34.59423	-120.00537	5/2/2022	10/25/2022	173	1
	LSYR-Grimm Property Pool	LSYR-1.71	Vertical Array	34.594533	-120.008004	5/2/2022	10/25/2022	173	3
	LSYR-Kaufman Property Pool	LSYR-2.77	Single	34.589631	-120.025523	5/2/2022	10/25/2022	173	1
	LSYR - Encantado Pool	LSYR-4.95	Vertical Array	34.583817	-120.058500	5/2/2022	11/2/2022	180	3
	LSYR - Mainstem (WR 89-18) Trap Site	LSYR-6.08	Single	34.579611	-120.077804	8/14/2022	9/15/2022	31	1
	LSYR - Double Canopy	LSYR-7.65	Vertical Array	34.583998	-120.096764	5/4/2022	11/2/2022	178	2
	LSYR - Head of Beaver	LSYR-8.7	Vertical Array	34.581116	-120.114454	5/4/2022	11/2/2022	178	3
	LSYR - Alisal Bedrock Pool**	LSYR-10.2	Vertical Array	34.583267	-120.141369	5/4/2022	11/2/2022	178	3
	LSYR - Avenue of the Flags	LSYR-13.9	Single	34.606734	-120.195150	5/4/2022	11/4/2022	180	1
	LSYR - Cadwell Pool	LSYR-22.68	Vertical Array	34.610143	-120.306920	5/5/2022	11/4/2022	179	3
Tributaries	Hilton Creek (HC)-lower	HC-0.12	Single	34.587132	-119.986255	5/2/2022	10/31/2022	178	1
	HC at URP	HC-0.54	Single	34.581522	-119.982846	5/2/2022	11/1/2022	179	1
	Quiota Creek (QC)-Crossing 6	QC-2.66	Single	34.559525	-120.084834	5/4/2022	7/16/2022	72	1
	Salsipuedes Creek (SC)-lower-Reach 1	SC-0.77	Single	34.620473	-120.423552	5/5/2022	11/4/2022	179	1
	SC-Reach 2-Bedrock Section	SC-2.2	Single	34.61168	-120.42191	5/5/2022	11/4/2022	179	1
	SC-Reach 4-Hwy 1 Bridge	SC-3.0	Single	34.597429	-120.413034	5/5/2022	11/10/2022	185	1
	SC-Reach 5-Jalama Bridge	SC-3.5	Single	34.589551	-120.408944	5/5/2022	11/10/2022	185	1
	SC-upper at El Jaro confluence	SC-3.8	Single	34.583953	-120.408199	5/5/2022	6/9/2022	34	1
	El Jaro Creek (EJC)-Lower-Confluence	EJC-3.81	Single	34.584167	-120.407983	5/5/2022	7/18/2022	73	1
	EJC-Palos Colorados	EJC-5.4	Single	34.574767	-120.371795	5/5/2022	11/10/2022	185	1
	EJC-Rancho San Julian Bridge	EJC-10.82	Single	34.530013	-120.342545	5/5/2022	6/24/2022	49	1
	Los Amoles Creek (LAC)-Creek Crossing	LAC-7.0	Single	34.558216	-120.369581	5/5/2022	11/10/2022	185	1
*Stream distance for El Jaro Creek (a tributary of Salsipuedes Creek) are to the confluence with the LSYR mainstem.									42
**The Alisal Bedrock Pool units were not deployed from 6/9/22 through 8/22/22.									

Table 6: 2022 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-0.01	C, B, S	C	C
		Downstream of Stilling Basin	LSYR-0.25	O , B	n/s	O
		Long Pool	LSYR-0.51	O	n/s	n/s
		Downstream of Long Pool	LSYR-0.68	O	O	O
		LSYR-Grimm Property Upstream	LSYR-1.09	O	n/s	O
		LSYR-Grim Property Downstream	LSYR-1.54	O	n/s	O
		LSYR-Grimm Property Pool	LSYR-1.71	O, B	n/s	O
		LSYR-Kaufman Property Run	LSYR-2.77	O, B	n/s	O, B
Reach 2	Refugio	Encantado	LSYR-4.95	O, B, S	O, B, S	O, B
		LSYR Mainstem Trap	LSYR-6.08	n/s	B, S, C	n/s
		Double Canopy Pool	LSYR-7.65	O, B, C	O, B, S, C	B, C
	Alisal	Head of Beaver Pool	LSYR-8.7	S	n/s	B
		Bedrock Pool	LSYR-10.2	C	n/s	
Reach 3	Ave. of the Flags	Ave. of the Flags (HWY 101)	LSYR-13.9	n/a		
	Cadwell	Cadwell Pool	LSYR-22.68	B, S, C	B, S, C	B, C
Tributaries:						
Hilton	Upper Hilton	Hilton Creek URP Pool	HC-0.12	O	n/s	O
	Lower Hilton	Lower Hilton Creek near Conf.	HC-0.54	O	n/s	O
Quiota	Crossing 6	Crossing 6 Pool	QC-2.66		n/s	n/s
Salsipuedes	Reach 1	Salsipuedes Creek at Trap Site	SC-0.77	n/s	n/s	n/s
	Reach 2	Salsipuedes Creek Reach 2 Bedrock Section	SC-2.2	O, S	n/s	n/s
	Reach 4	Salsipuedes Creek at Highway 1 Bridge	SC-3.0	O	n/s	n/s
	Reach 5	Salsipuedes Creek at Jalama Bridge	SC-3.5	O, S	n/s	
	Upper Salsipuedes	Salsipuedes Creek upstream of El Jaro Conf.	SC-3.8		n/s	n/s
El Jaro	Lower El Jaro	El Jaro upstream of Conf. with Salsipuedes	EJC-3.81		n/s	
	Palos Colorados	Palos Colorados Pool	EJC-5.4		n/s	n/s
	Rancho San Julian	EL Jaro at Rancho San Julian Bridge	EJC-10.82		n/s	n/s
Los Amoles	Lower Los Amoles	Lower Los Amoles Creek Crossing	LAC-7.0		n/s	n/s
* O - *O. mykiss* , B - bass, S - sunfish, C - carp, Ca - catfish, blank means zero observed.						
n/s - not snorkeled due to turbidity or had gone dry.						

Figure 6: 2022 LSYR mainstem temperature unit deployment locations at: (a) LSYR-0.01, (b) LSYR-0.25, (c) LSYR-0.51, (d) LSYR-0.68, (e) LSYR-1.09, and (f) LSYR-1.54.

Figure 7: 2022 LSYR mainstem temperature unit deployment locations at: (a) LSYR-1.71, (b) LSYR-2.77, (c) LSYR-4.95, (d) LSYR-6.08, (e) LSYR-7.65, and (f) LSYR-8.7.

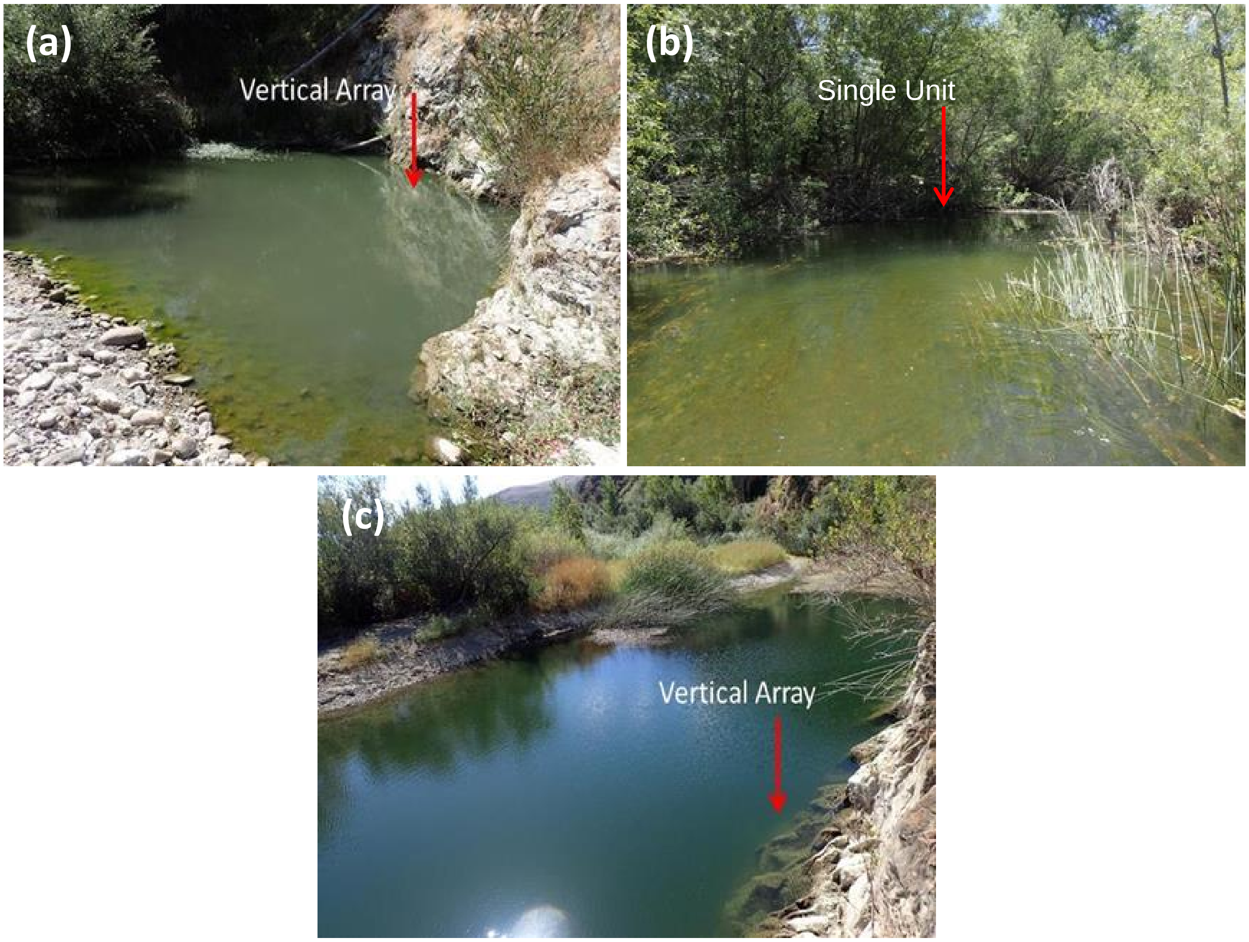


Figure 8: 2022 LSYR mainstem temperature unit deployment locations at: (a) LSYR-10.2, (b) LSYR-13.9, and (c) LSYR-22.68.

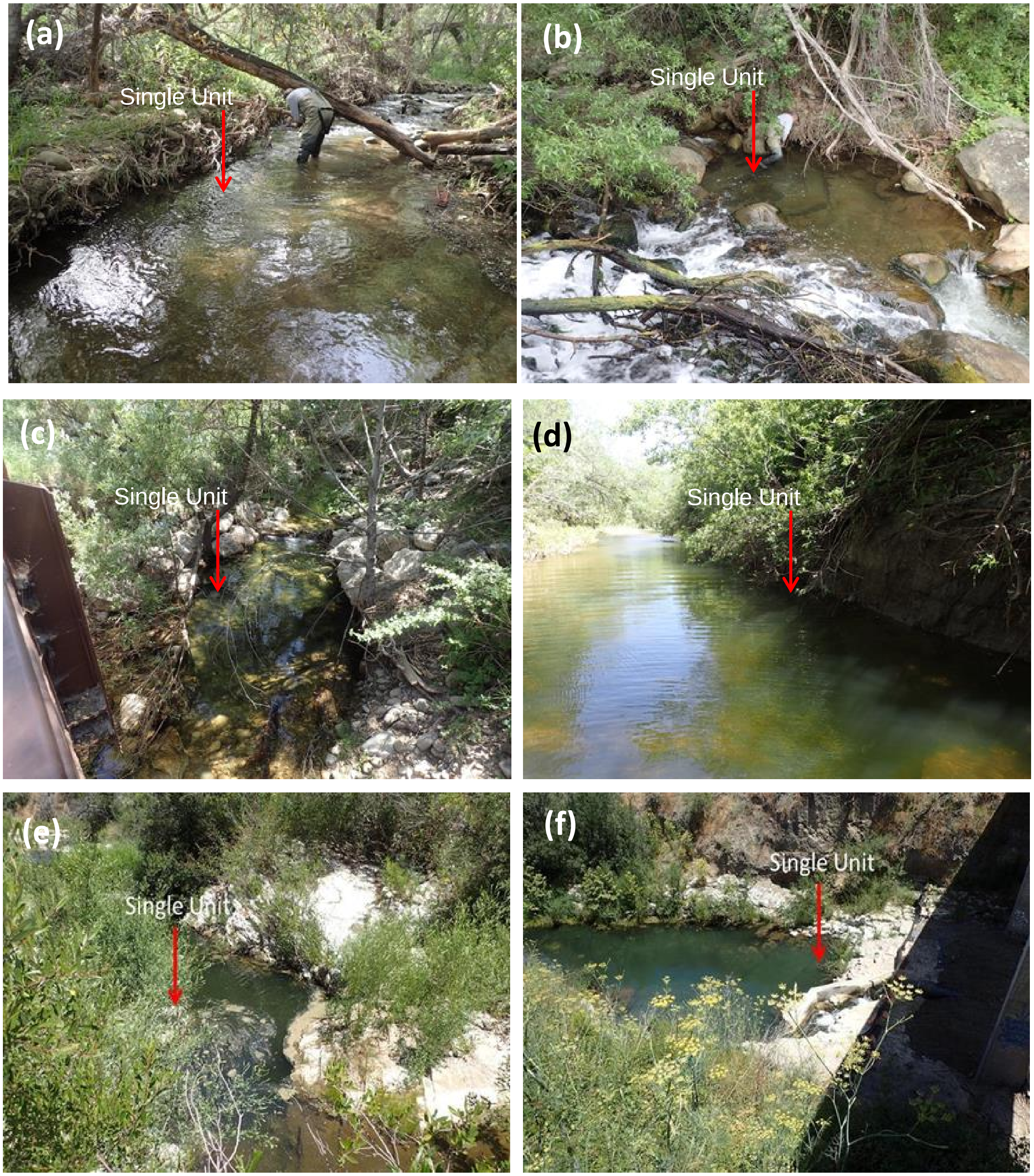


Figure 9: 2022 tributary temperature unit deployment location at: (a) HC-0.12, (b) HC-0.54, (c) QC-2.66, (d) SC-0.77, (e) SC-2.2, and (f) SC-3.0.

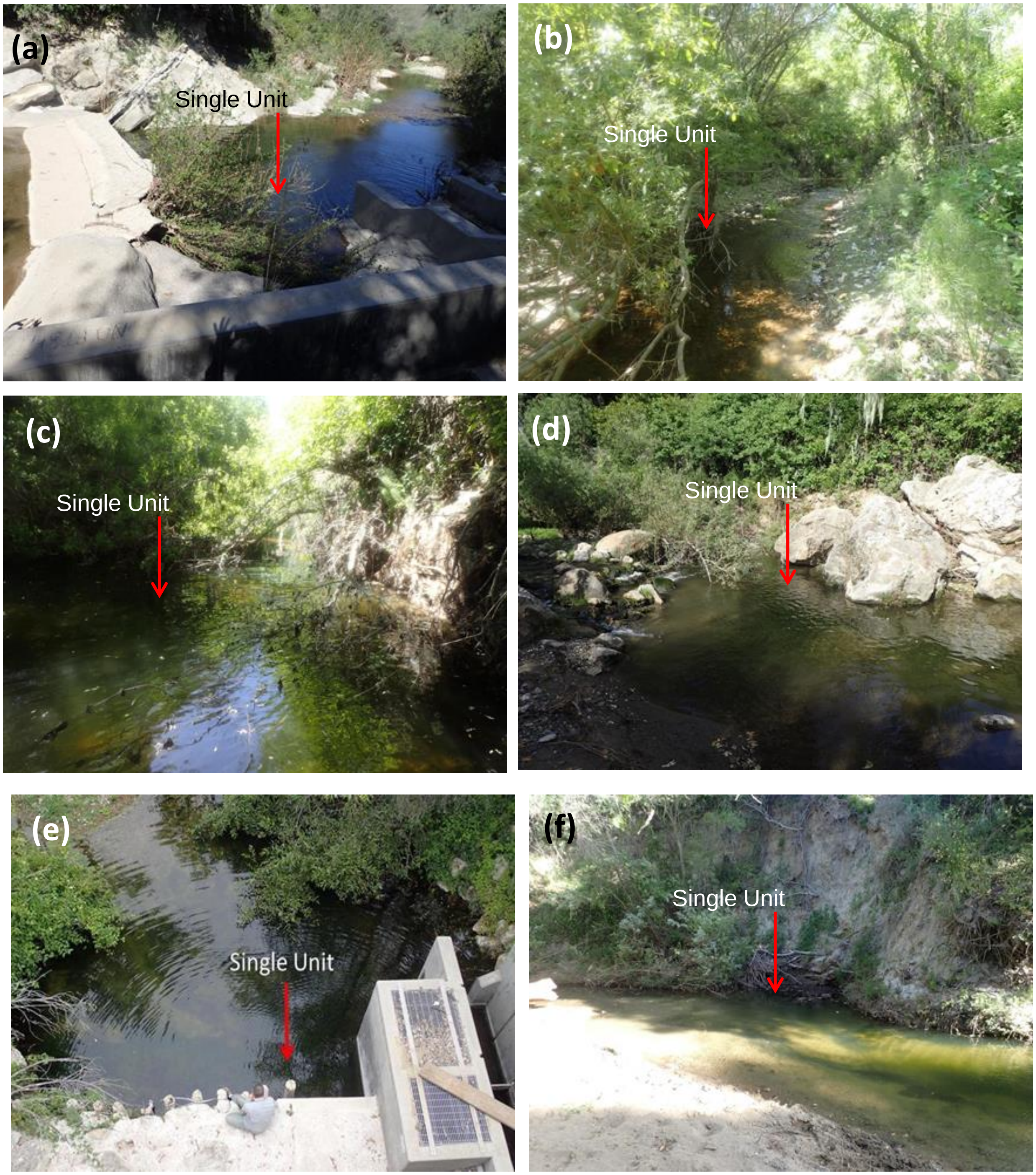


Figure 10: 2022 Tributary thermograph deployment locations at: (a) SC-3.5, (b) SC-3.8, (c) EJC-3.81, (d) EJC-5.4, (e) EJC-10.82, and (f) LAC-7.0.

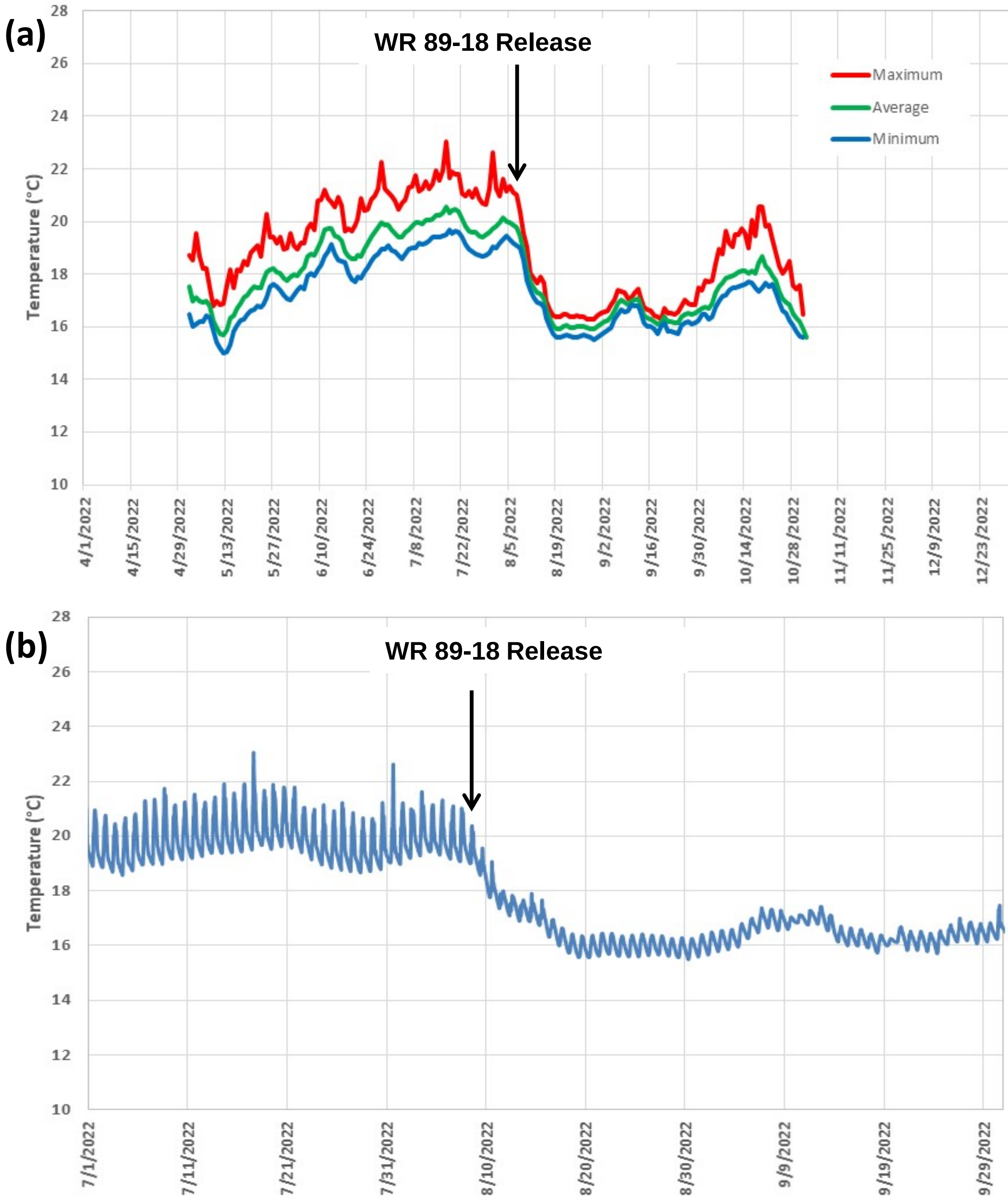


Figure 11: 2022 LSYR-0.01 (Stilling Basin parapet wall) surface (1.0-foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; the WR 89-18 releases started on 8/8/22.

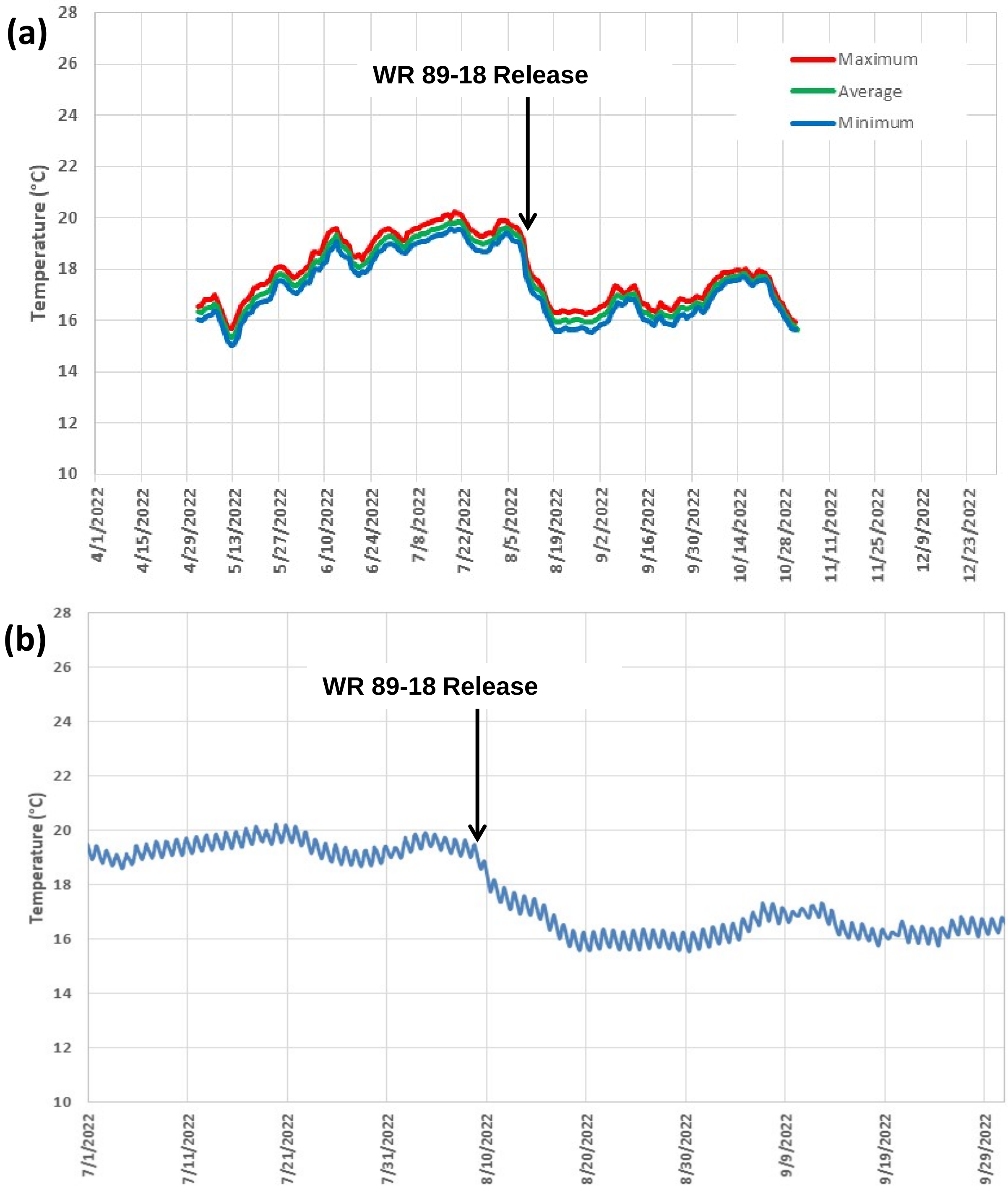


Figure 12: 2022 LSYR-0.01 (Stilling Basin parapet wall) middle (14 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22.

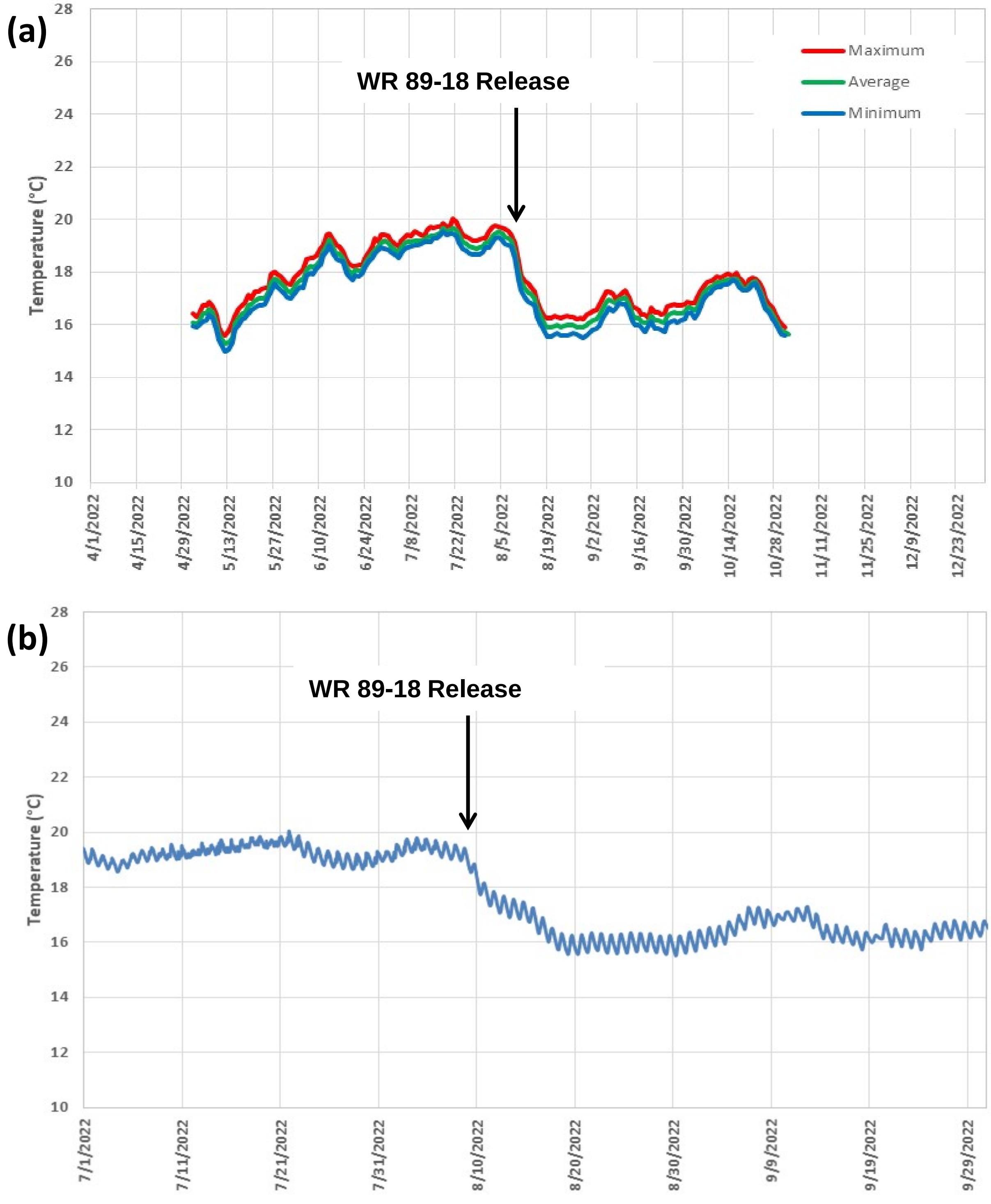


Figure 13: 2022 LSYR-0.01 (Stilling Basin parapet wall) bottom (28 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22.

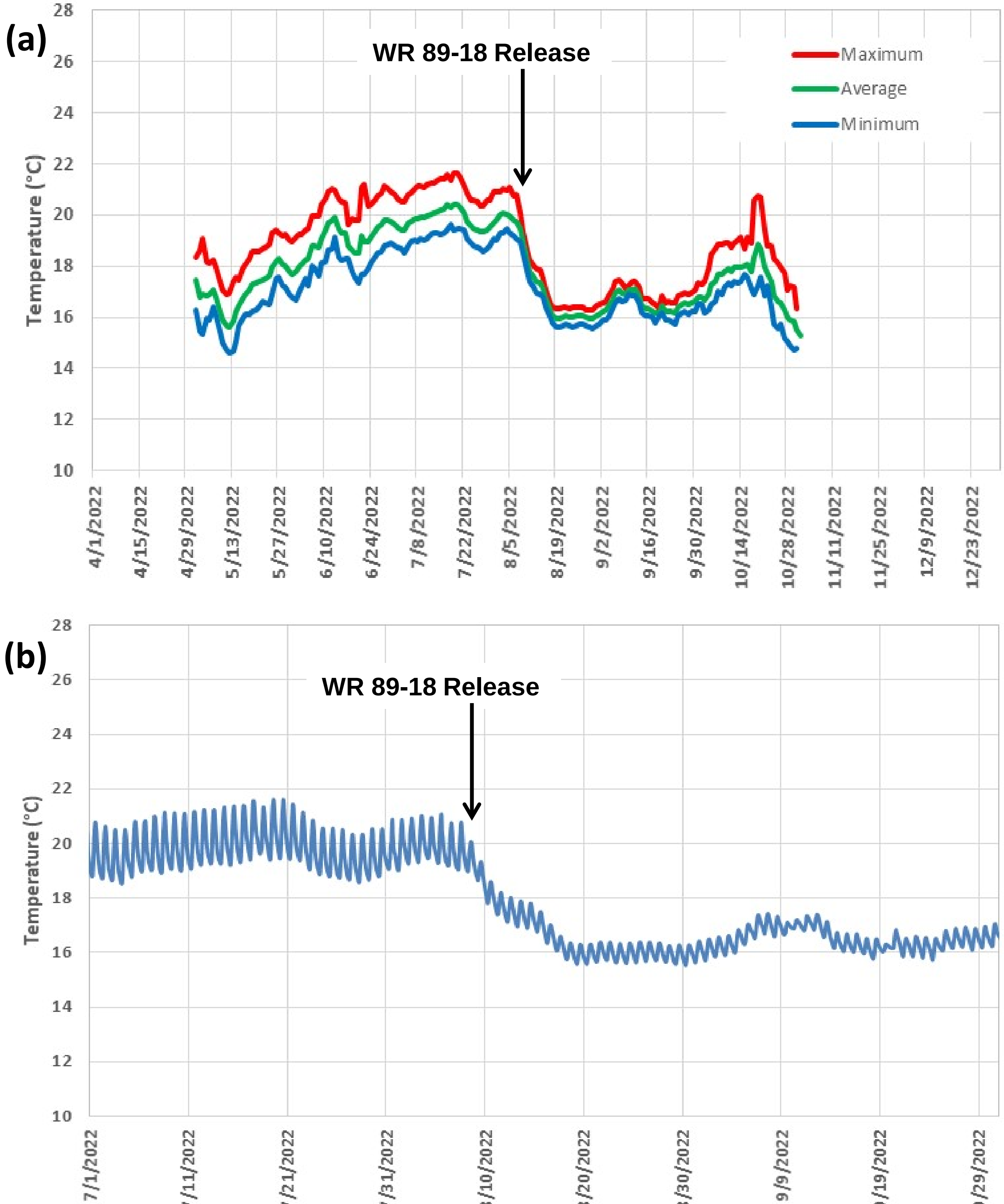
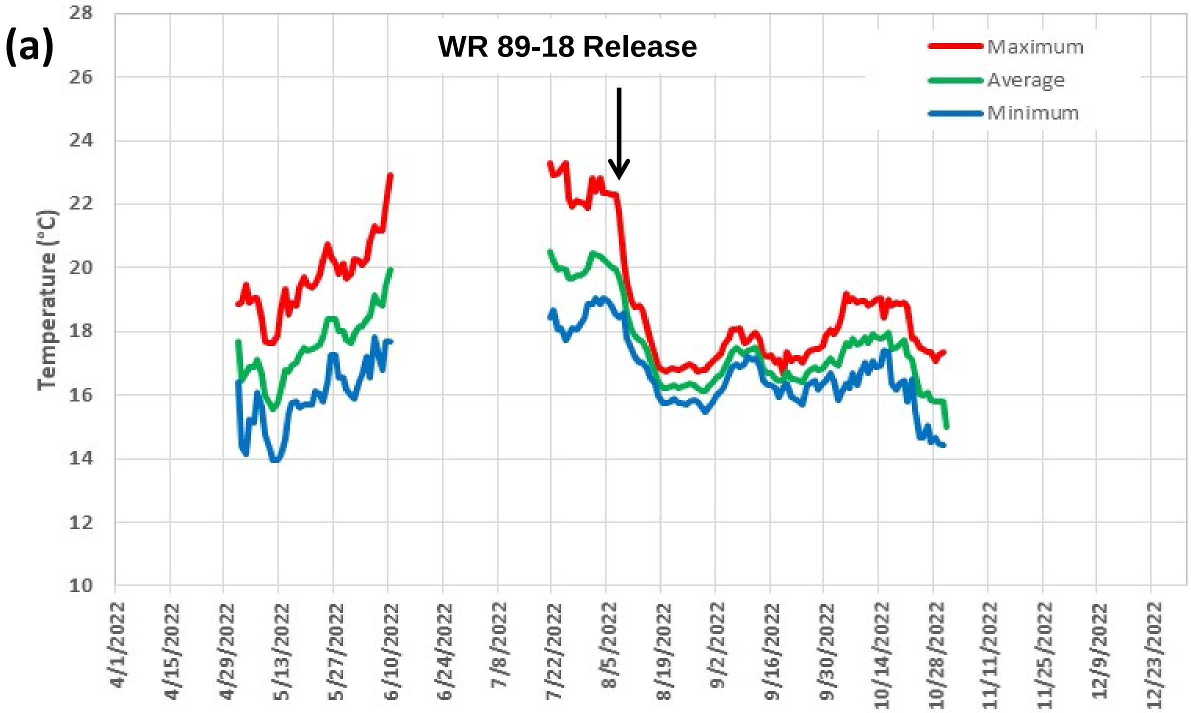


Figure 14: 2022 LSYR-0.25 (Downstream of Stilling Basin) bottom (1.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements 7/1/22 through 10/1/22.



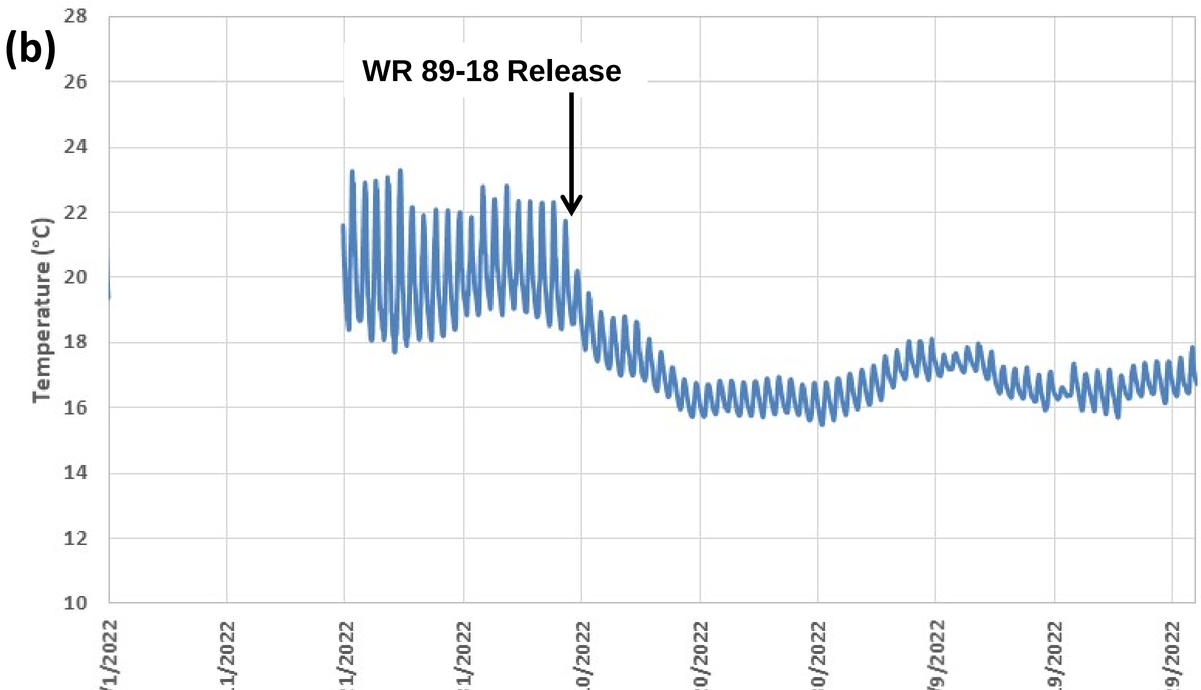


Figure 15: 2022 LSYR-0.51 (Long Pool) surface (1.0 foot) thermograph for (a) daily maximum, average, and minimum values for the entire period of deployment and (b) hourly data from 7/1/22 through 10/1/22; surface unit was exposed to air from 6/11/22 through 7/20/22.

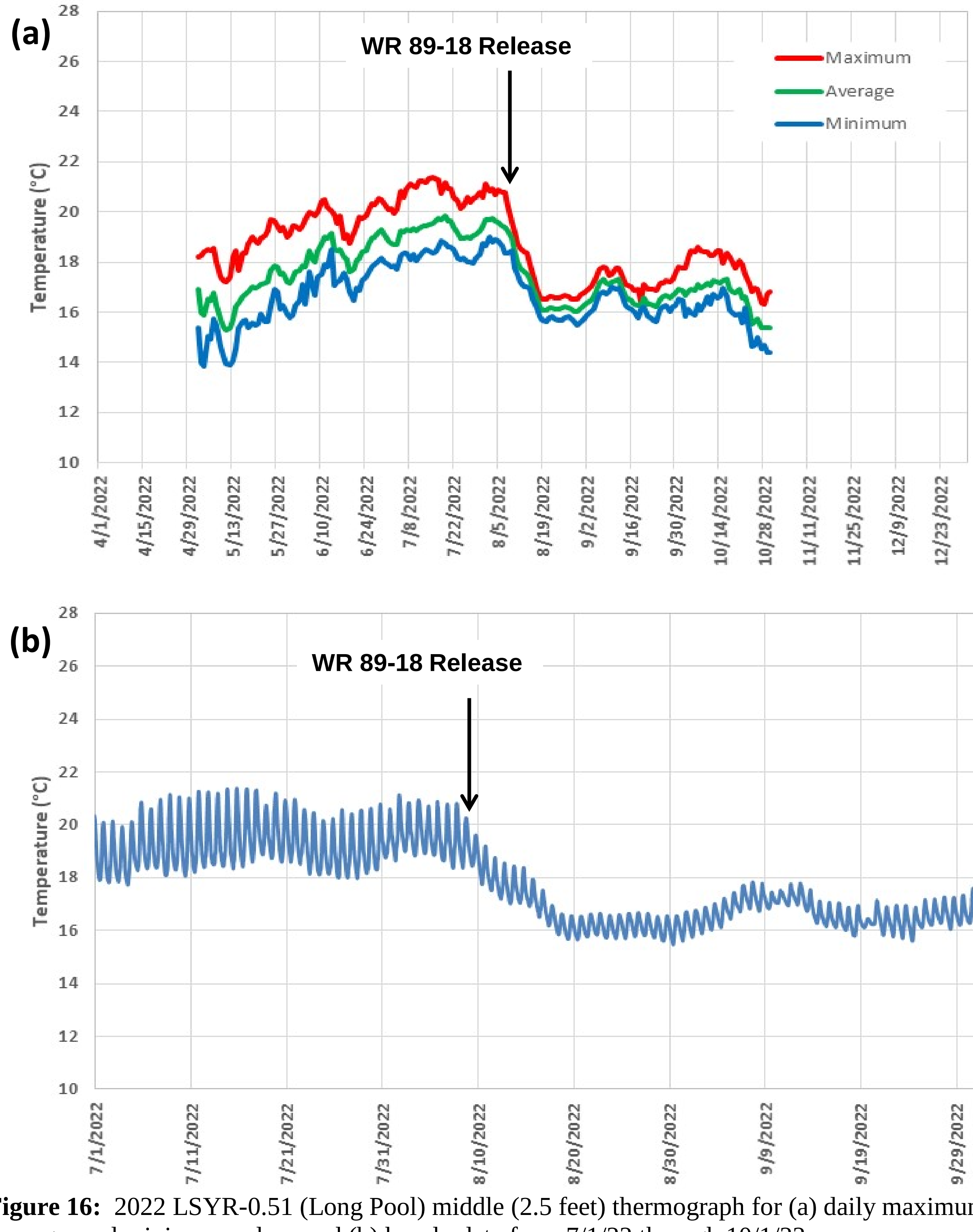


Figure 16: 2022 LSYR-0.51 (Long Pool) middle (2.5 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/22 through 10/1/22.

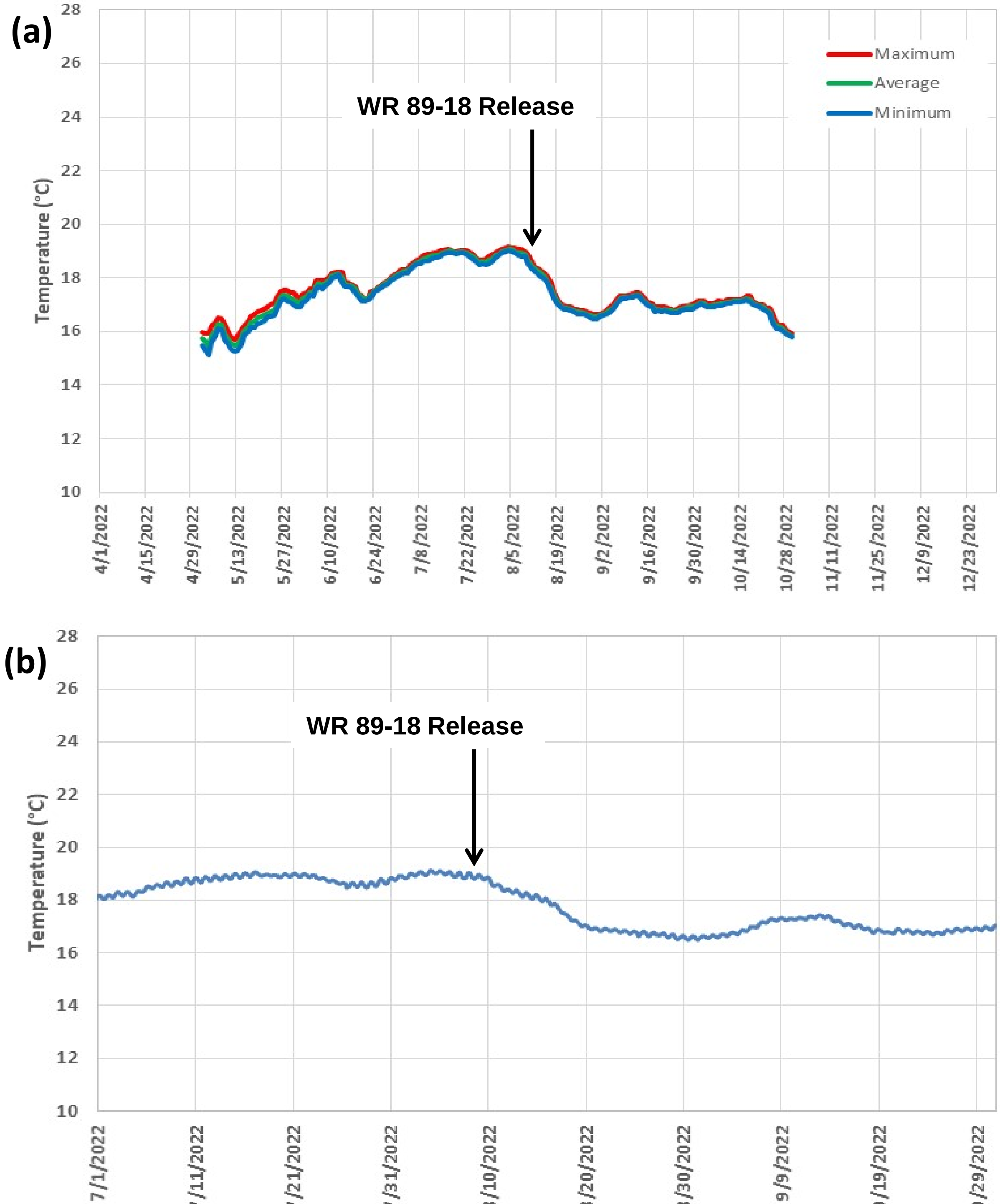


Figure 17: 2022 LSYR-0.51 (Long Pool) bottom (5.5 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/22 through 10/1/22.

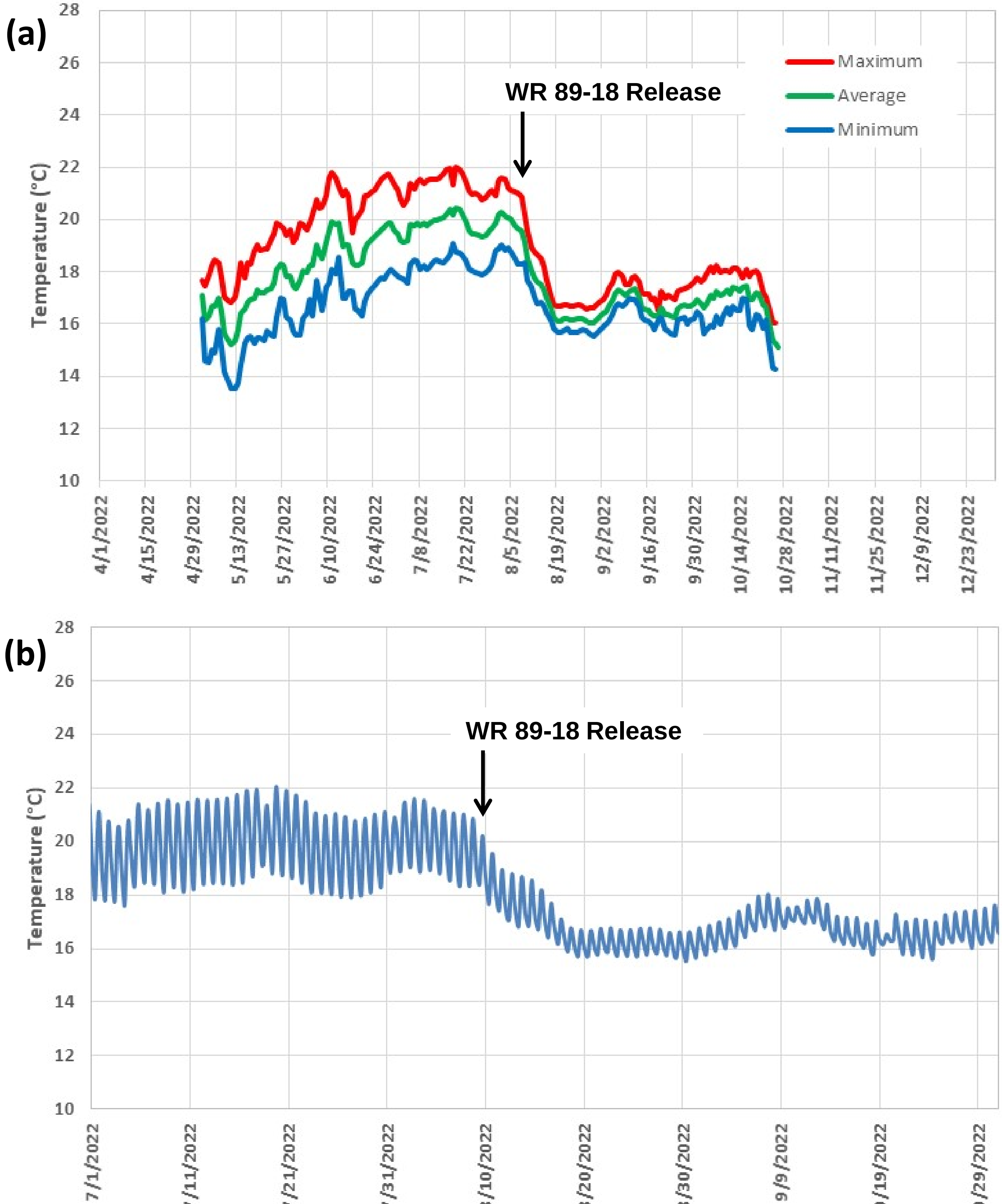


Figure 18: 2022 Reclamation property boundary at LSYR-0.68 (downstream of the Long Pool) bottom (2 feet) thermograph for (a) daily maximum, average, and minimum values and (b) hourly data from 7/1/22 through 10/1/22.

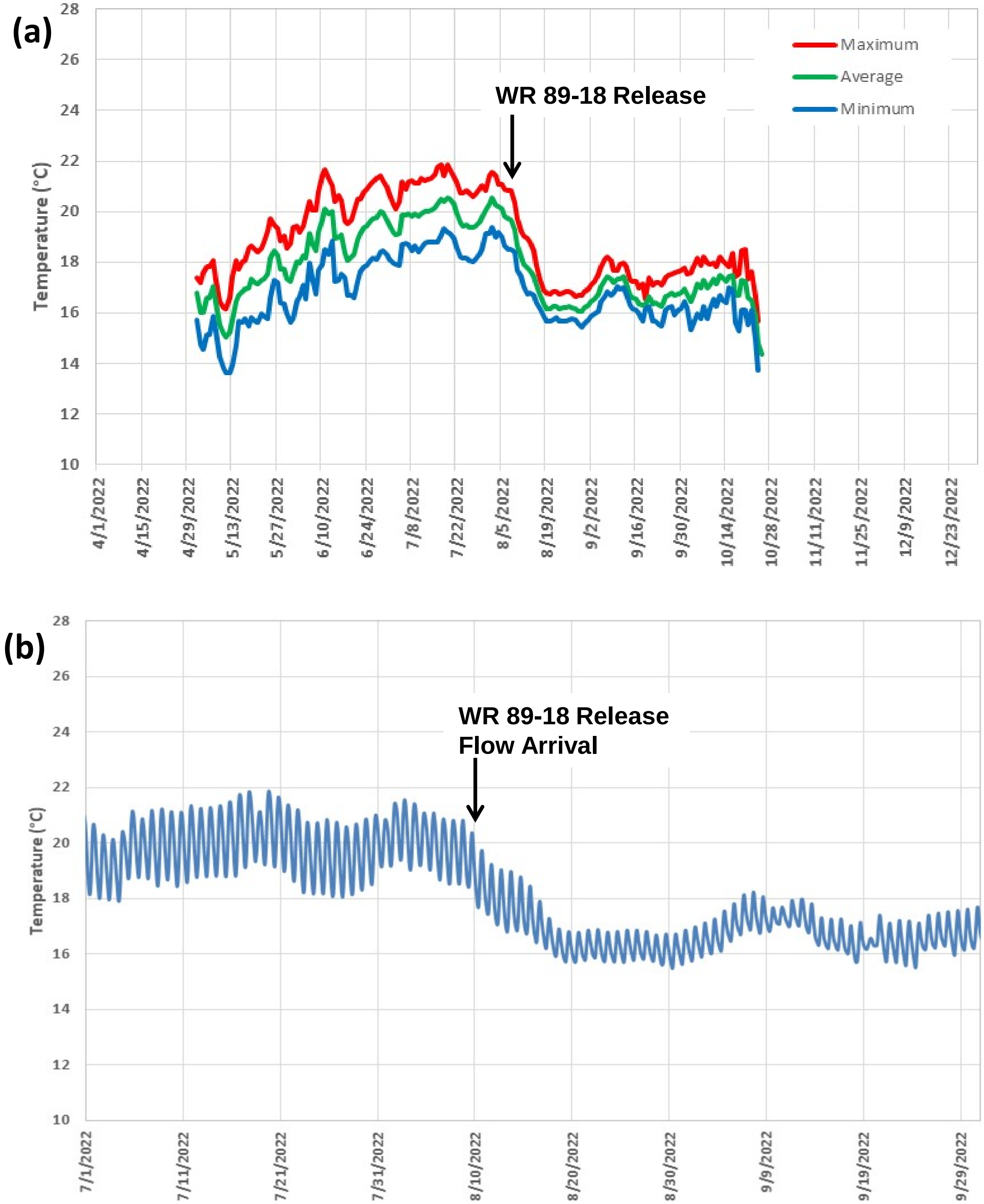
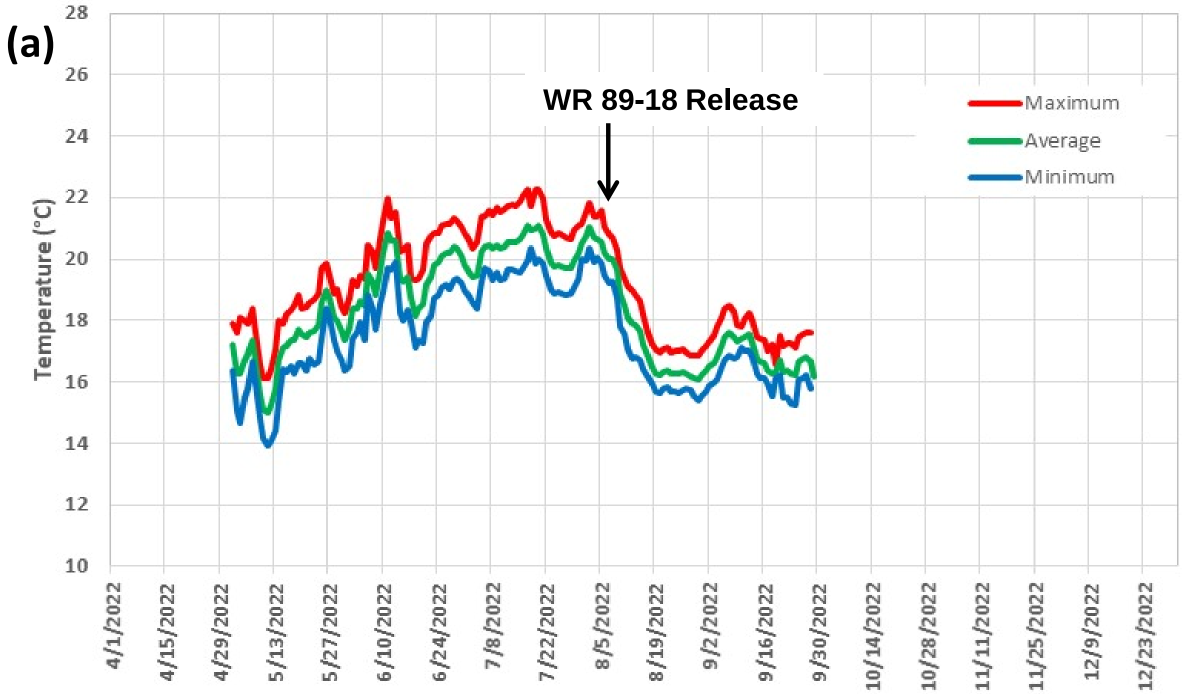


Figure 19: 2022 LSYR-1.09 (Grimm Property upstream-run) bottom (1.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.



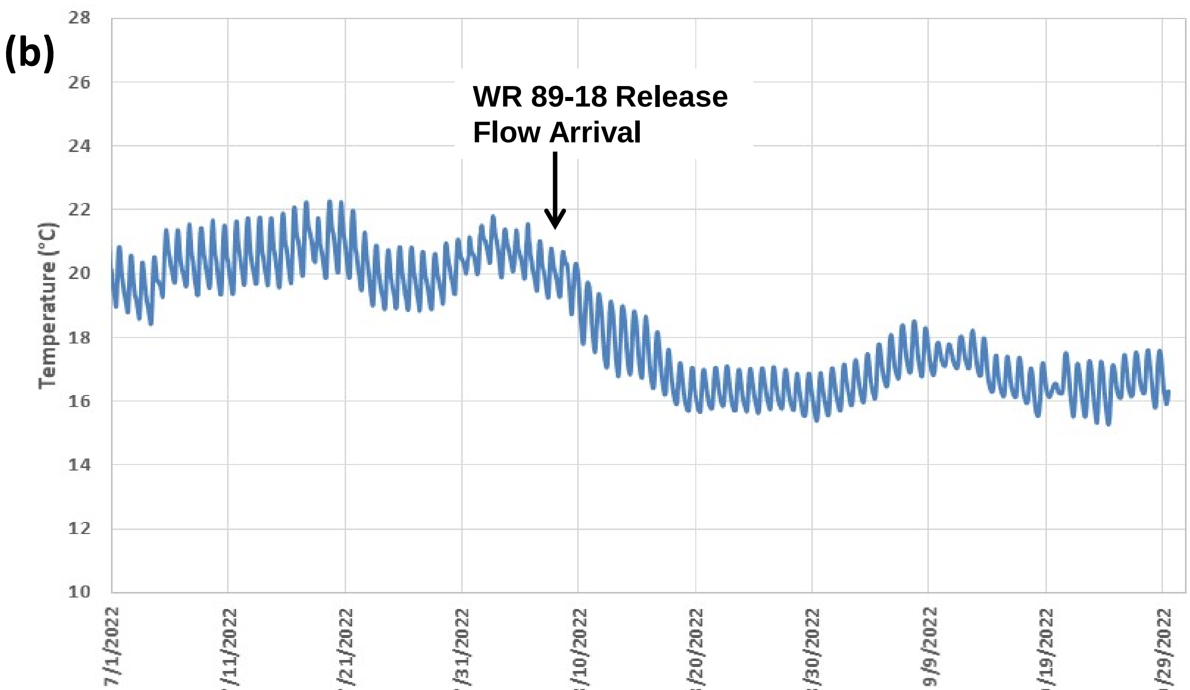


Figure 20: 2022 LSYR-1.54 (Grimm Property downstream-run) bottom (1.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 9/30/22.

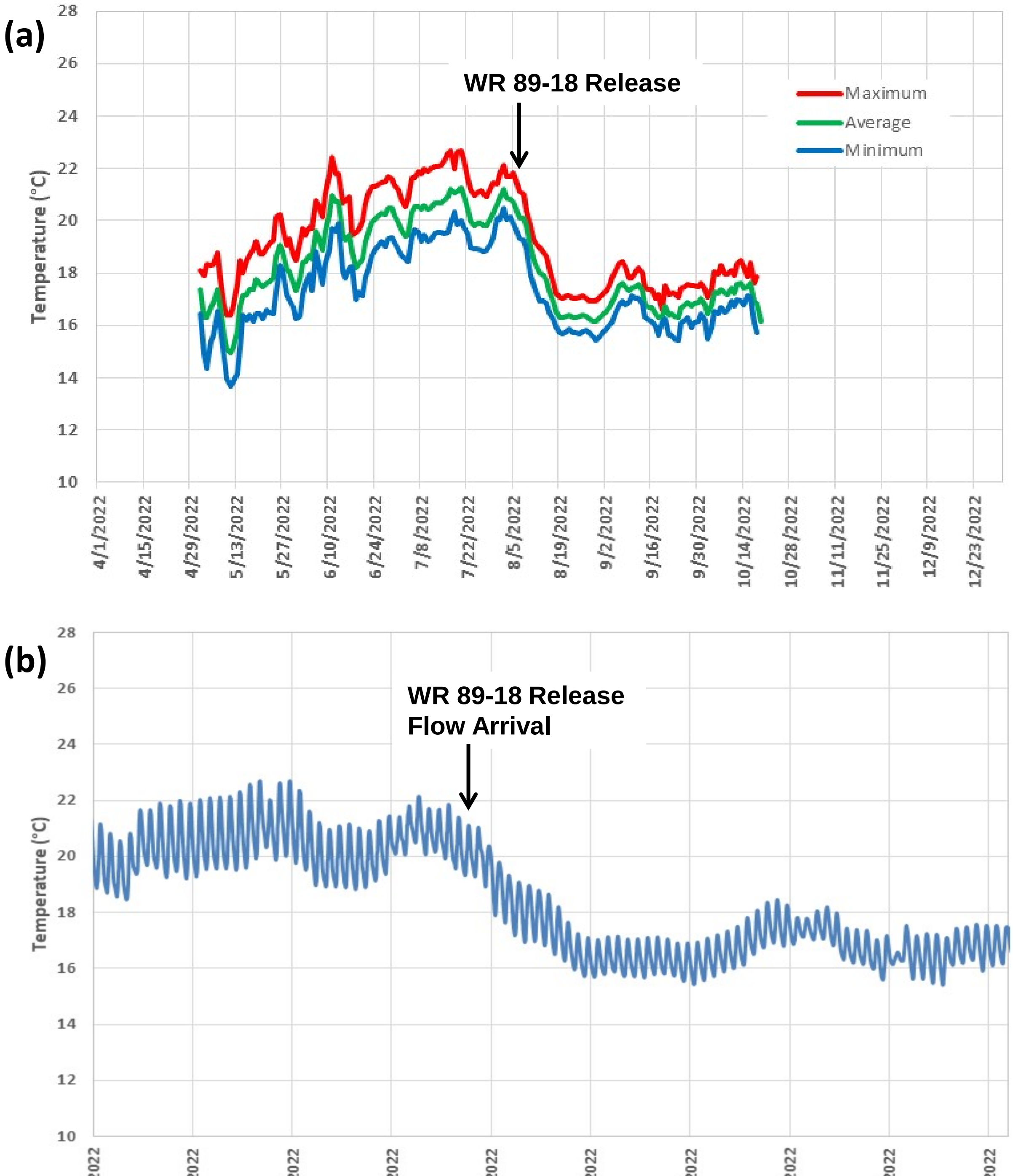


Figure 21: 2022 LSYR-1.71 (Grimm Property pool) surface (1.0-foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.

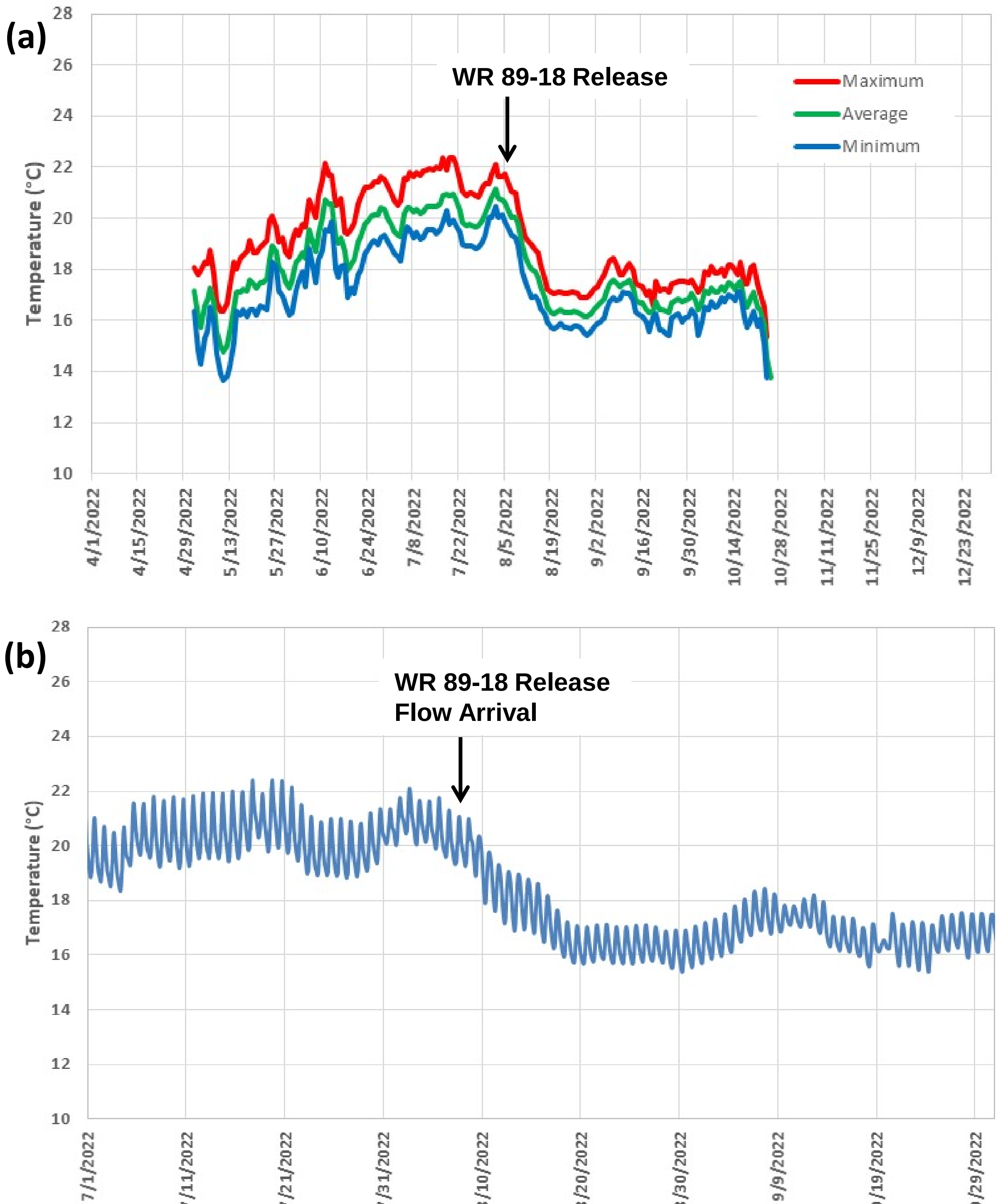


Figure 22: 2022 LSYR-1.71 (Grimm Property pool) middle (3.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.

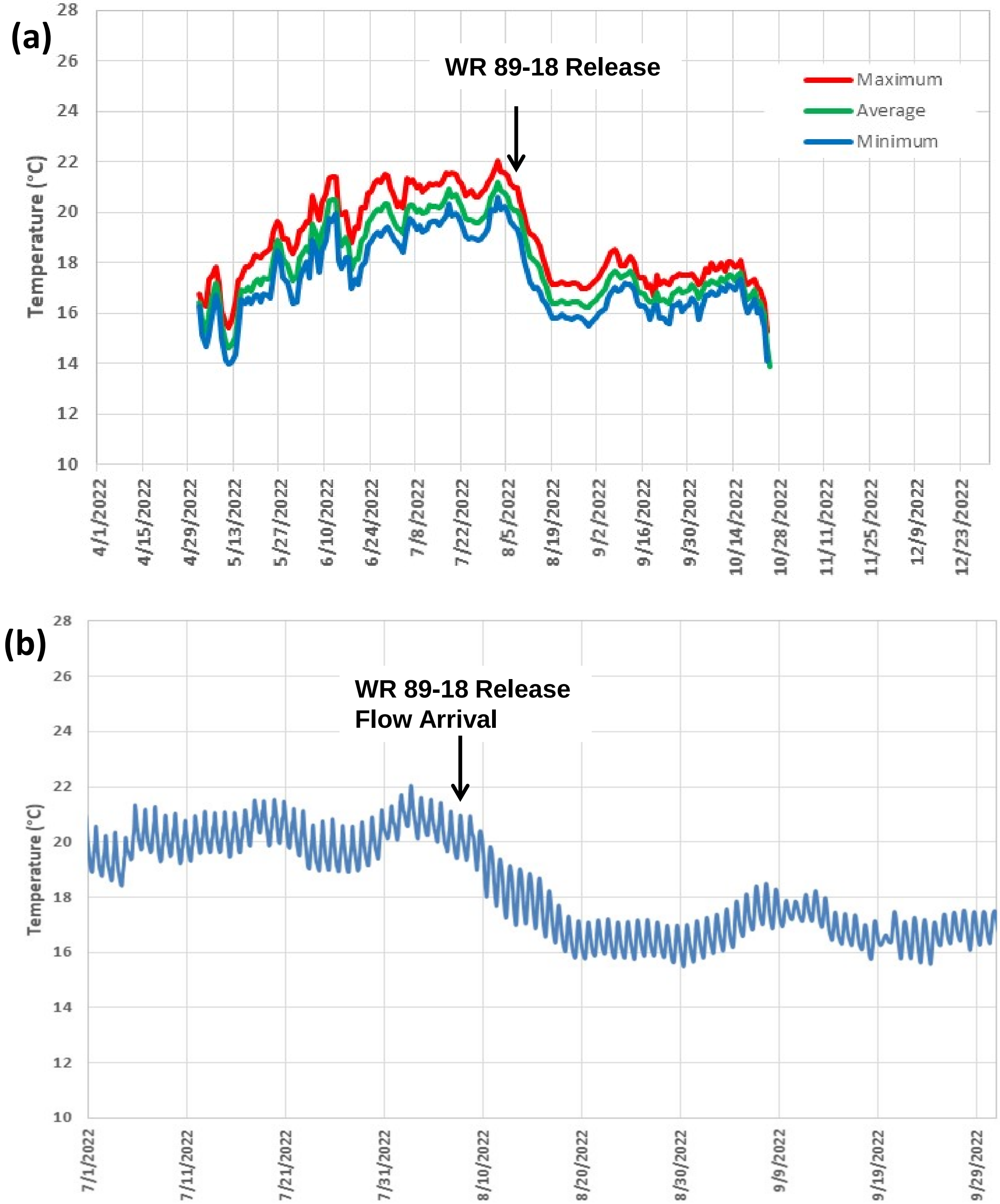
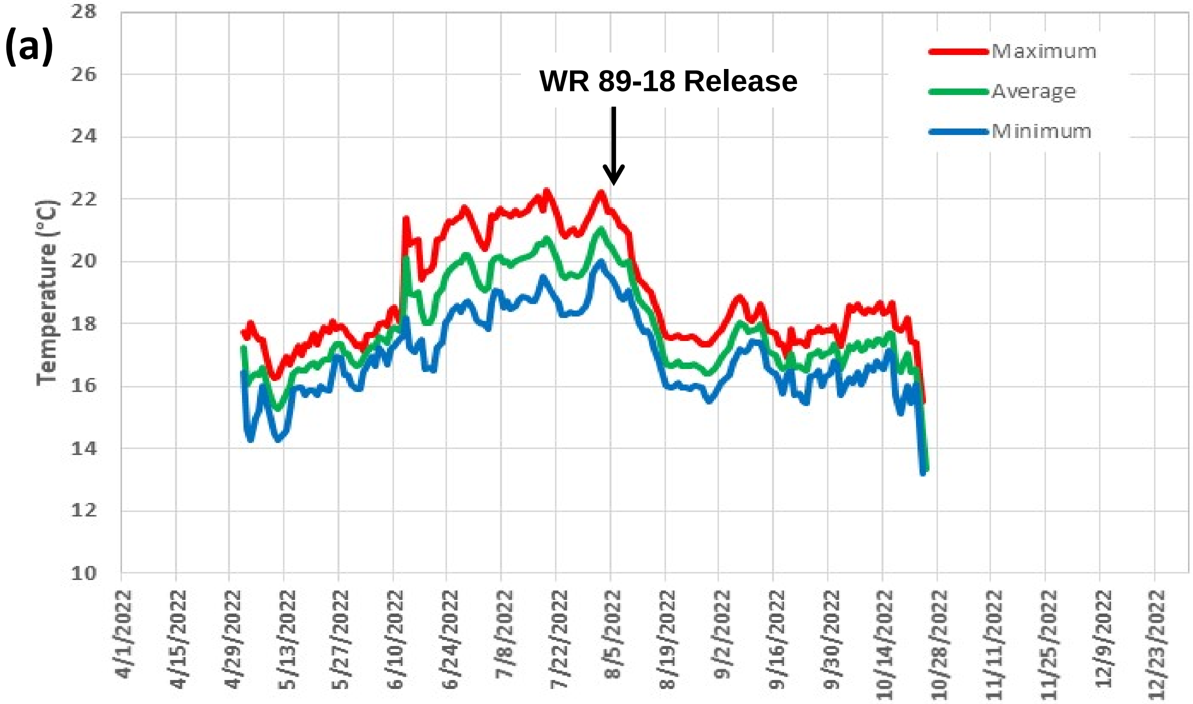


Figure 23: 2022 LSYR-1.71 (Grimm Property pool) bottom (6.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.



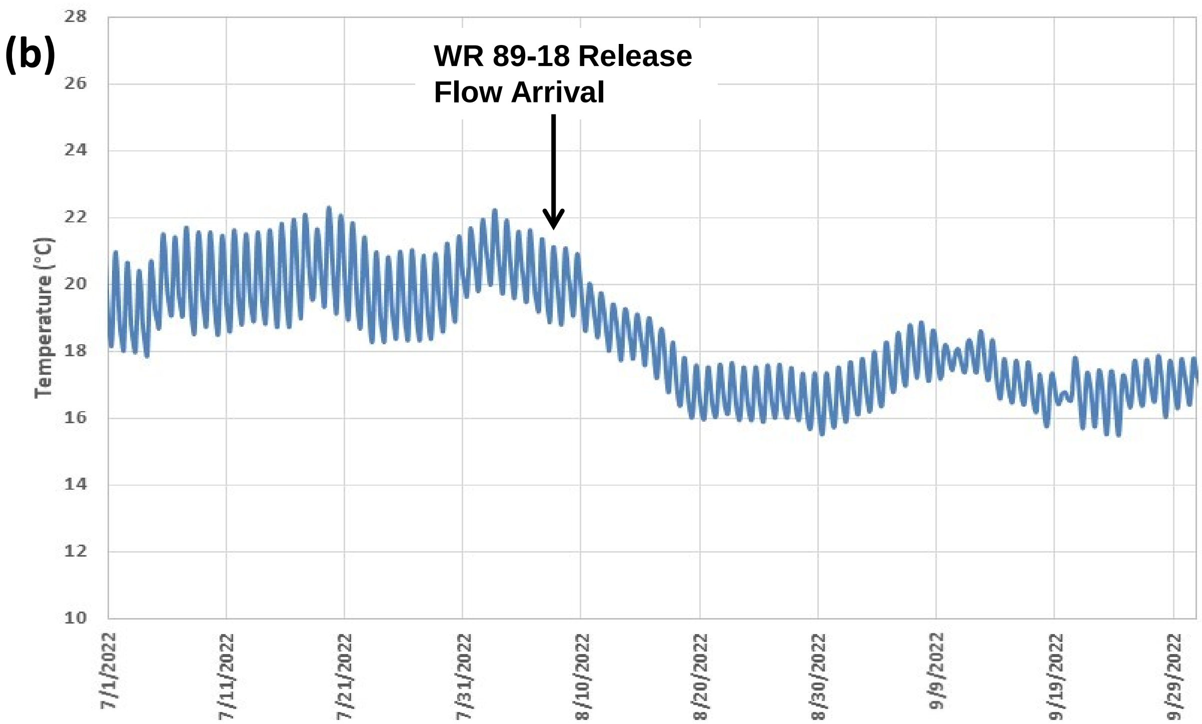
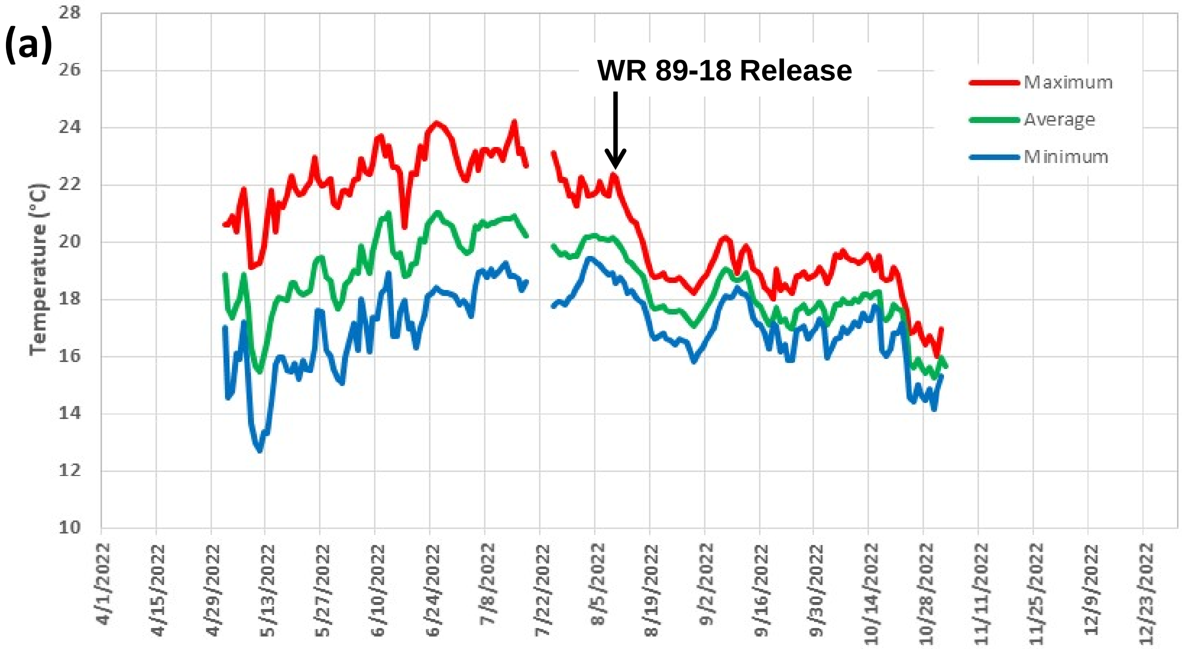


Figure 24: 2022 LSYR-2.77 (Kaufman run) bottom (1.0-feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.



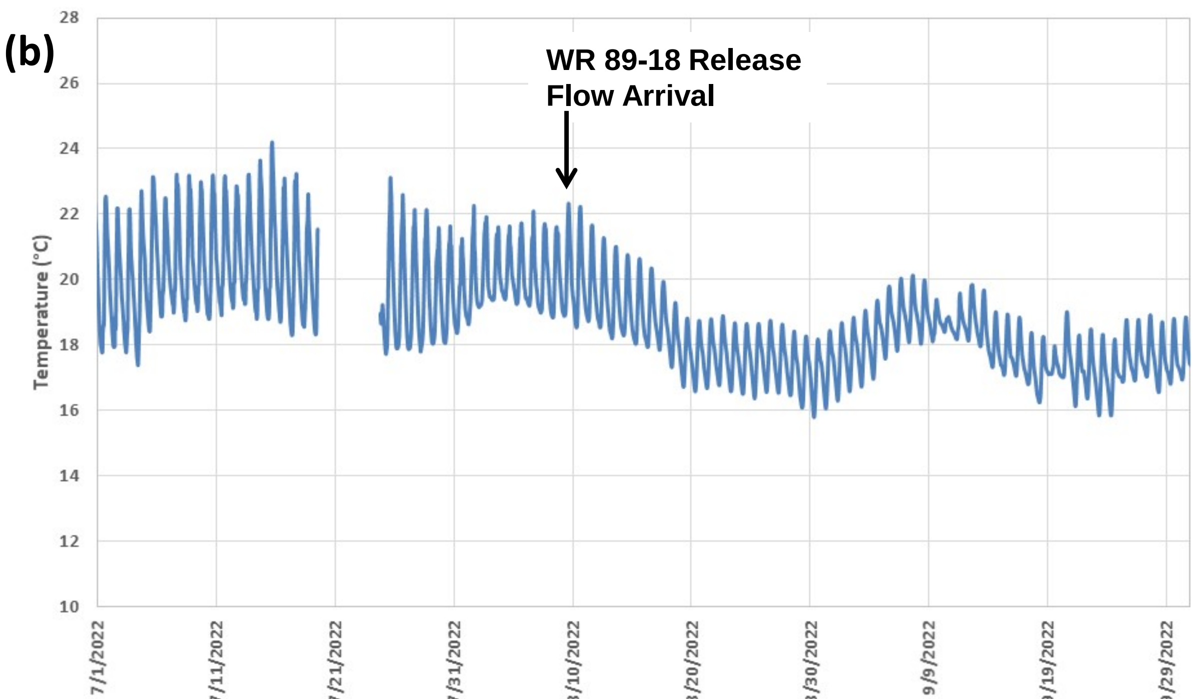


Figure 25: 2022 LSYR 4.95 (Encantado Pool) surface (1.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; the surface unit was exposed to air due to decreasing water levels during a brief period in July.

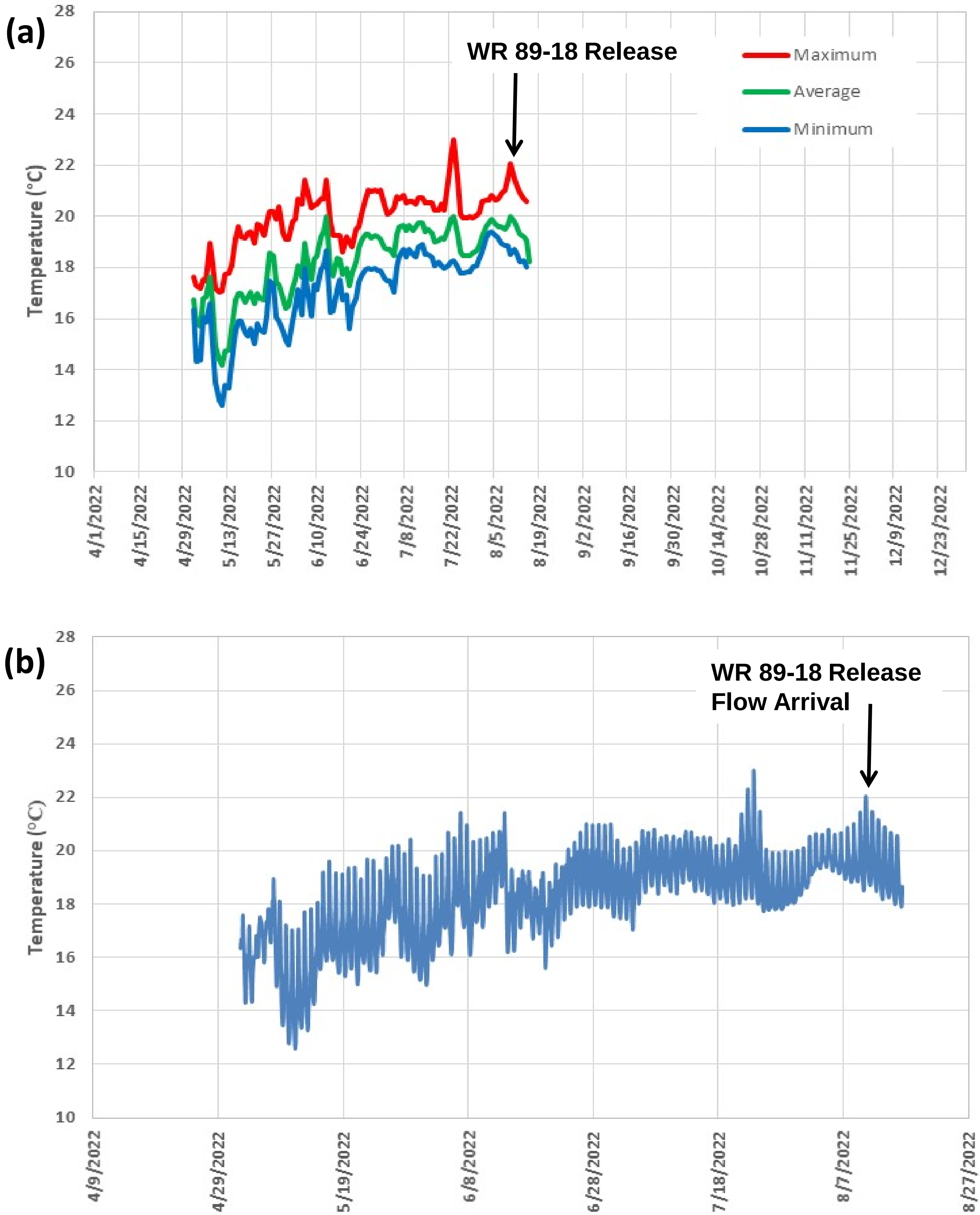


Figure 26: 2022 LSYR-4.95 (Encantado Pool) middle (4.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of record; suspected that a beaver removed the middle unit sometime after 8/16/22.

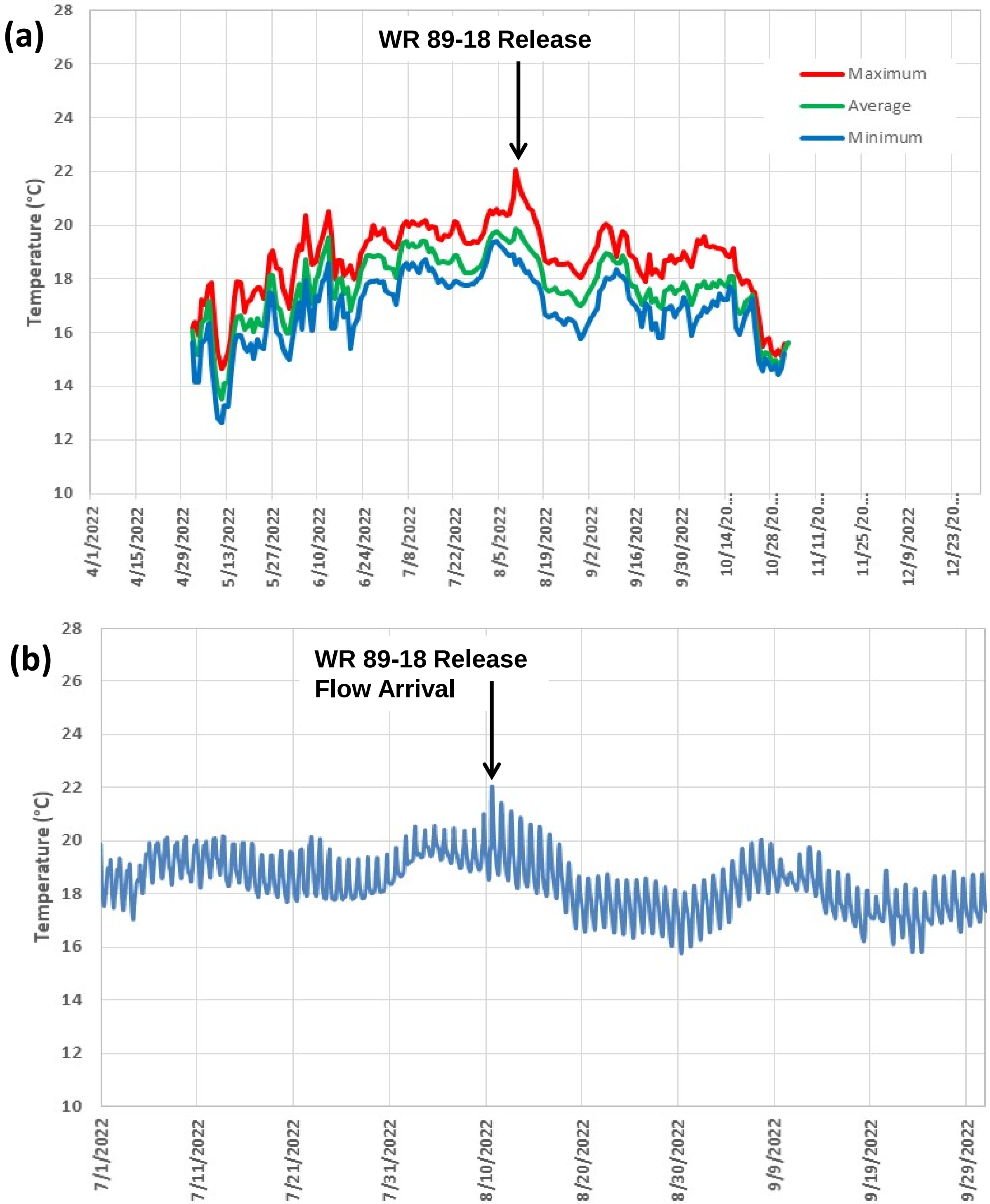


Figure 27: 2022 LSYR-4.95 (Encantado Pool) bottom (8.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22.

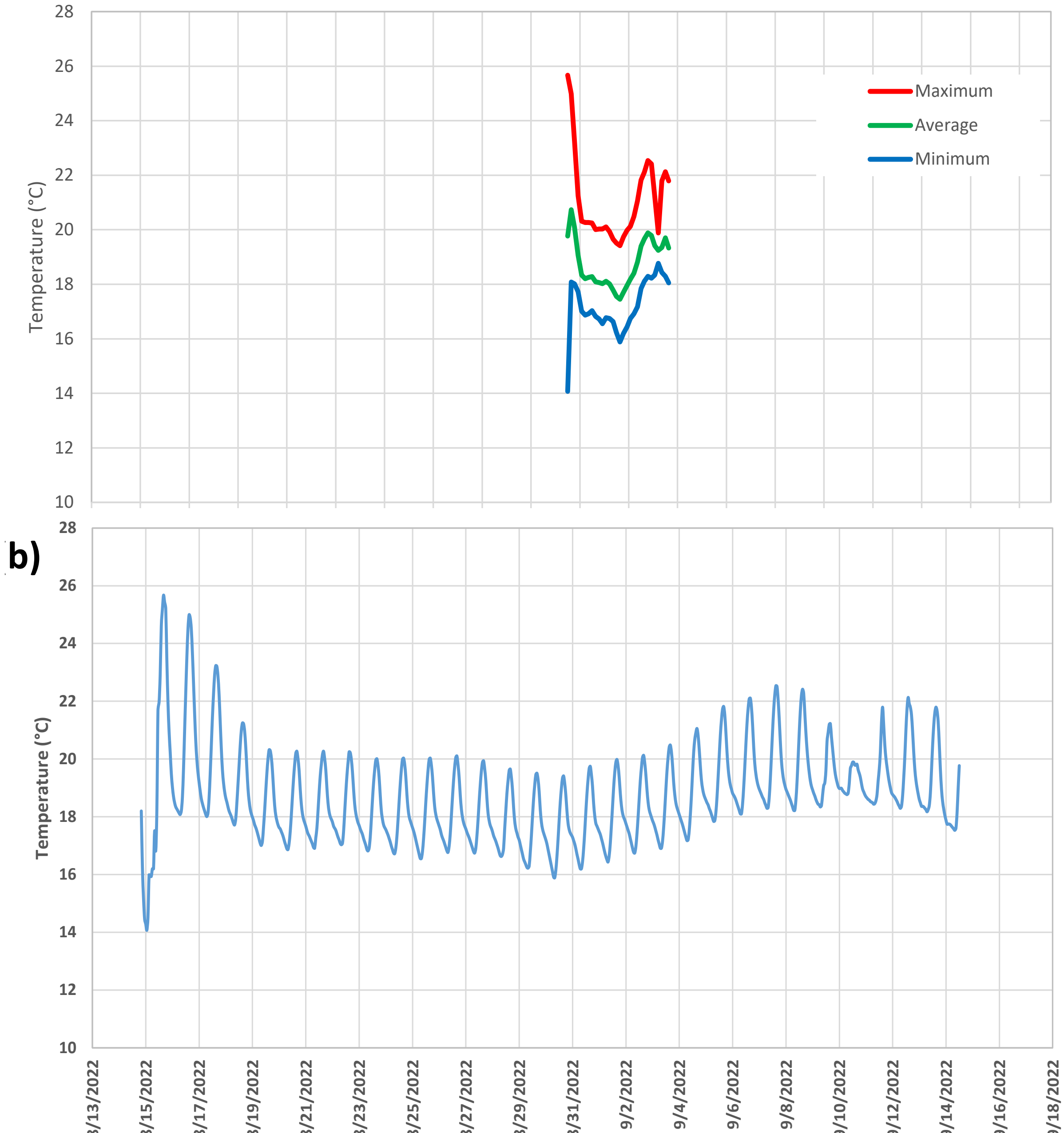


Figure 28: 2022 LSYR-6.08 (LSYR Mainstem Trap Site) bottom (3.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements for the entire period of record; unit deployed to monitor water temperature conditions during trapping of the WR 89-18 releases; the release arrived on 8/14/22 and the traps and thermograph were removed on 9/15/22.

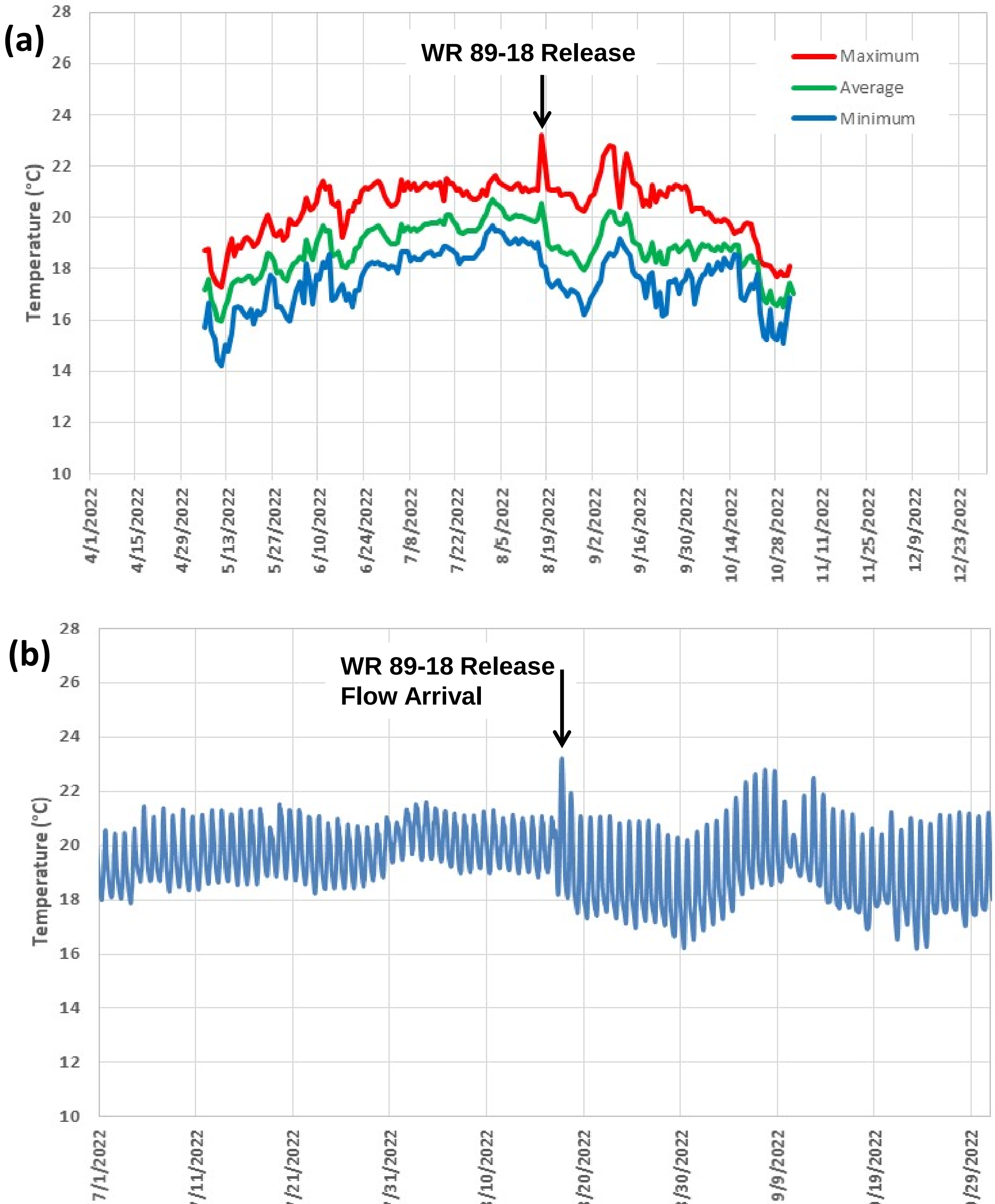


Figure 29: 2022 LSYR-7.65 (Double Canopy Pool) surface (1.0-foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.

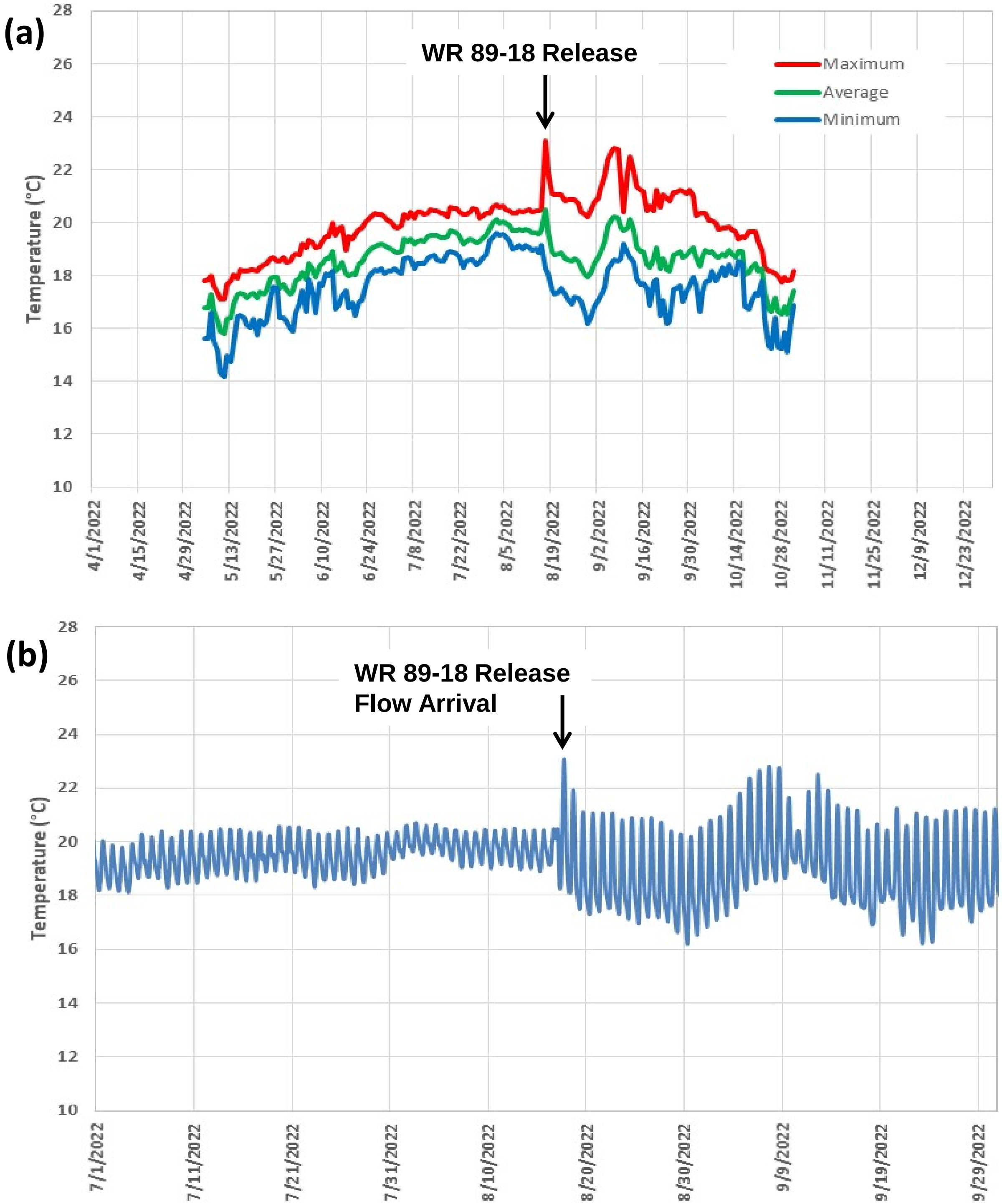


Figure 30: 2022 LSYR-7.65 (Double Canopy Pool) bottom (3.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22; the WR 89-18 releases arrived on 8/17/22 at approximately 20:00 hours.

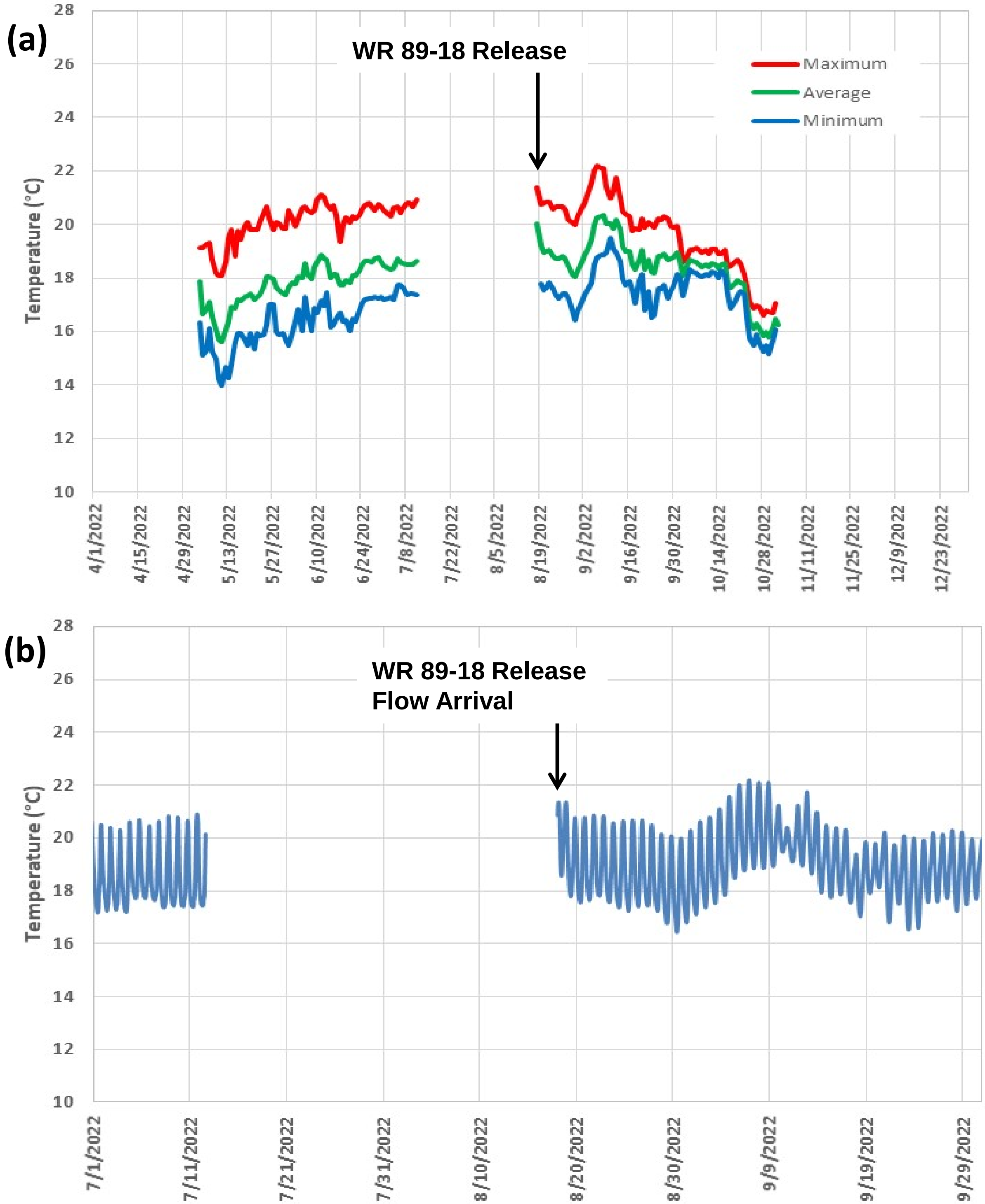
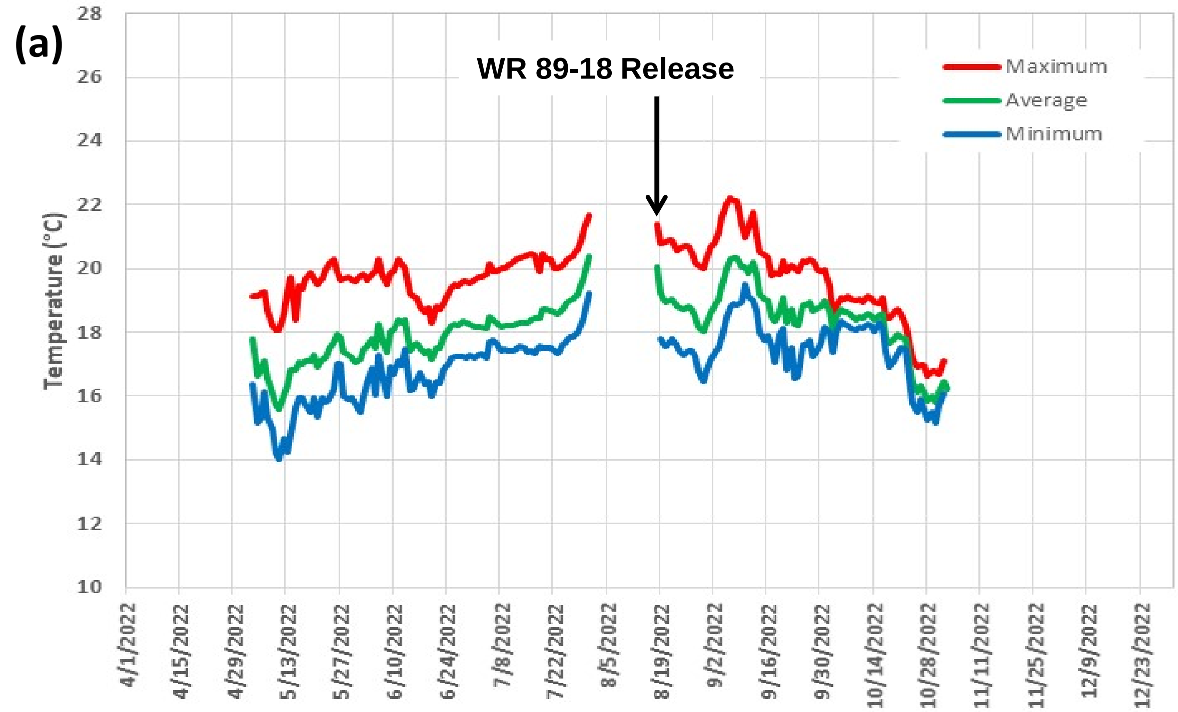


Figure 31: 2022 LSYR-8.7 (Head of Beaver Pool) surface (1.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22. Surface unit out of the water from 7/12/22 through 8/18/22 due to declining water levels; the WR 89-18 releases arrived 8/18/22.



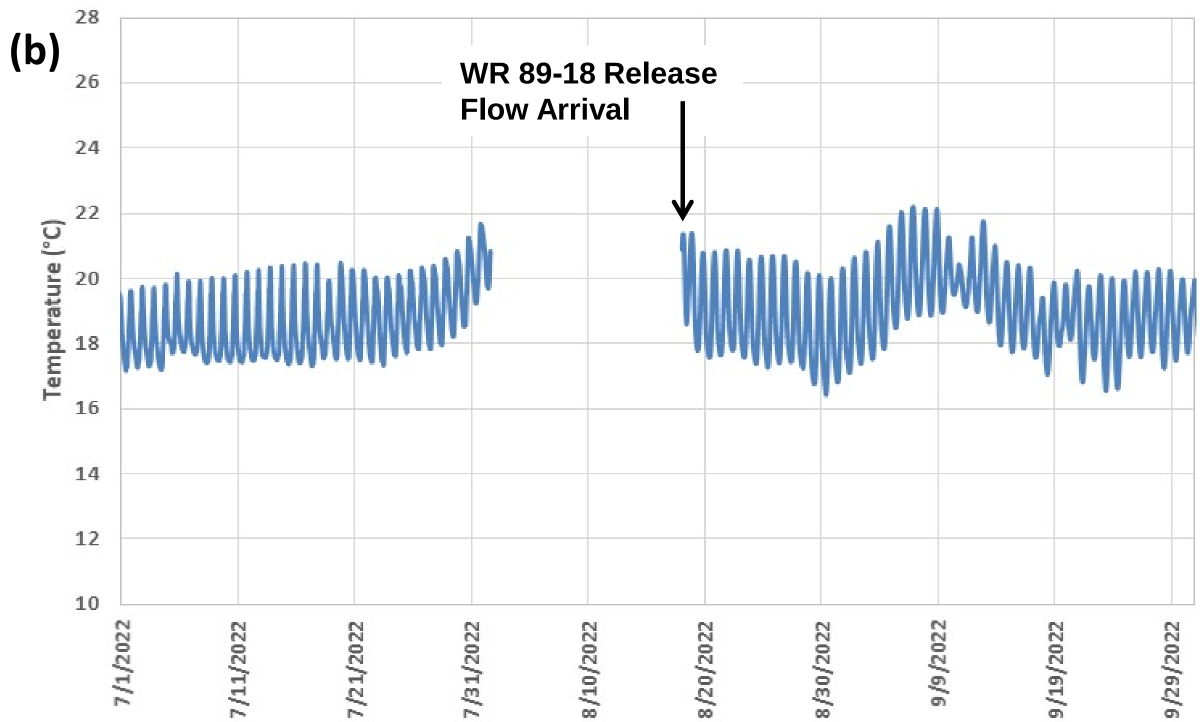


Figure 32: 2022 LSYR-8.7 (Head of Beaver Pool) middle (2.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22. Middle unit out of the water from 8/1/22 through 8/18/22 due to declining water levels; the WR 89-18 releases arrived 8/18/22.

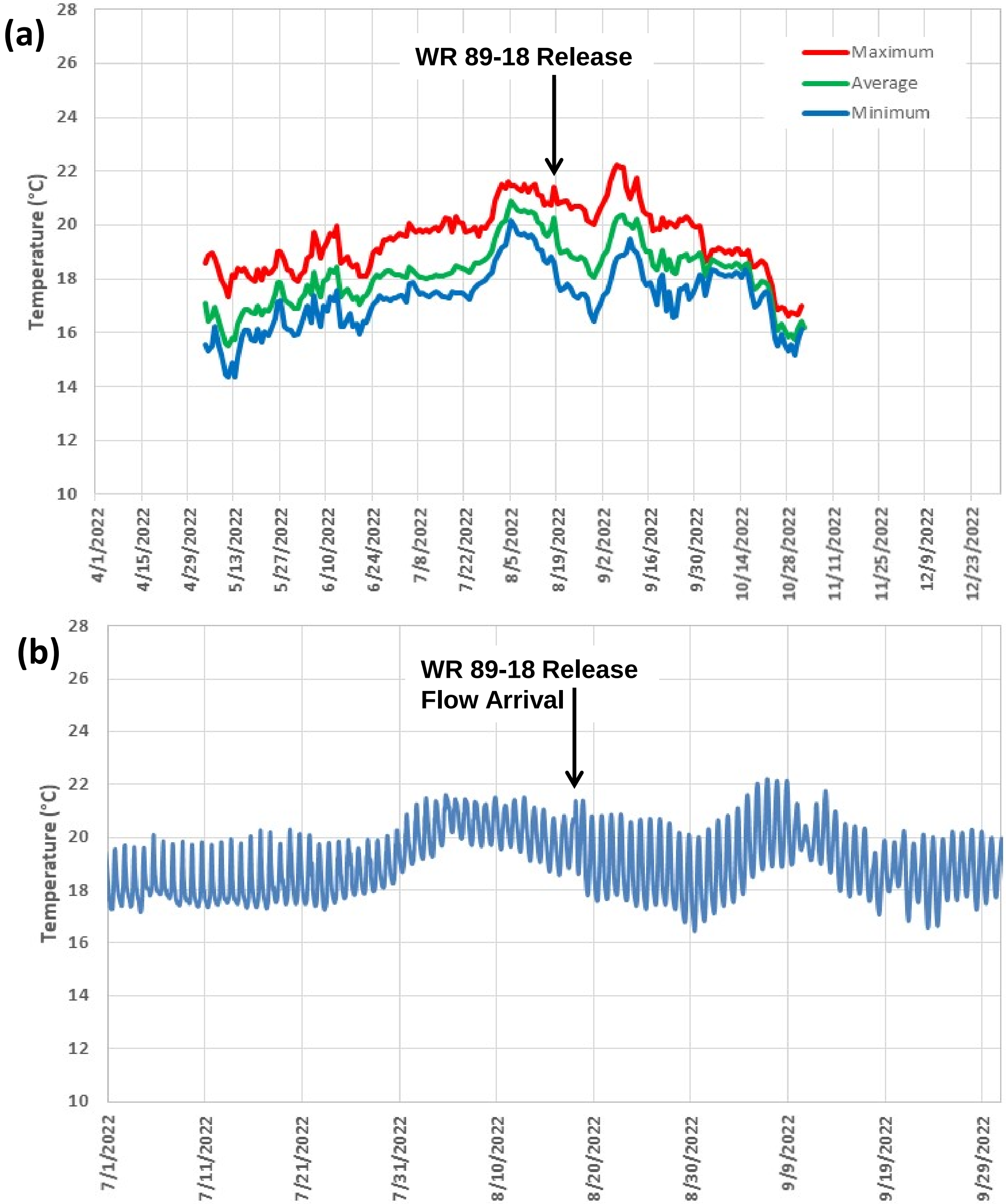


Figure 33: 2022 LSYR-8.7 (Head of Beaver Pool) bottom (5.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22.

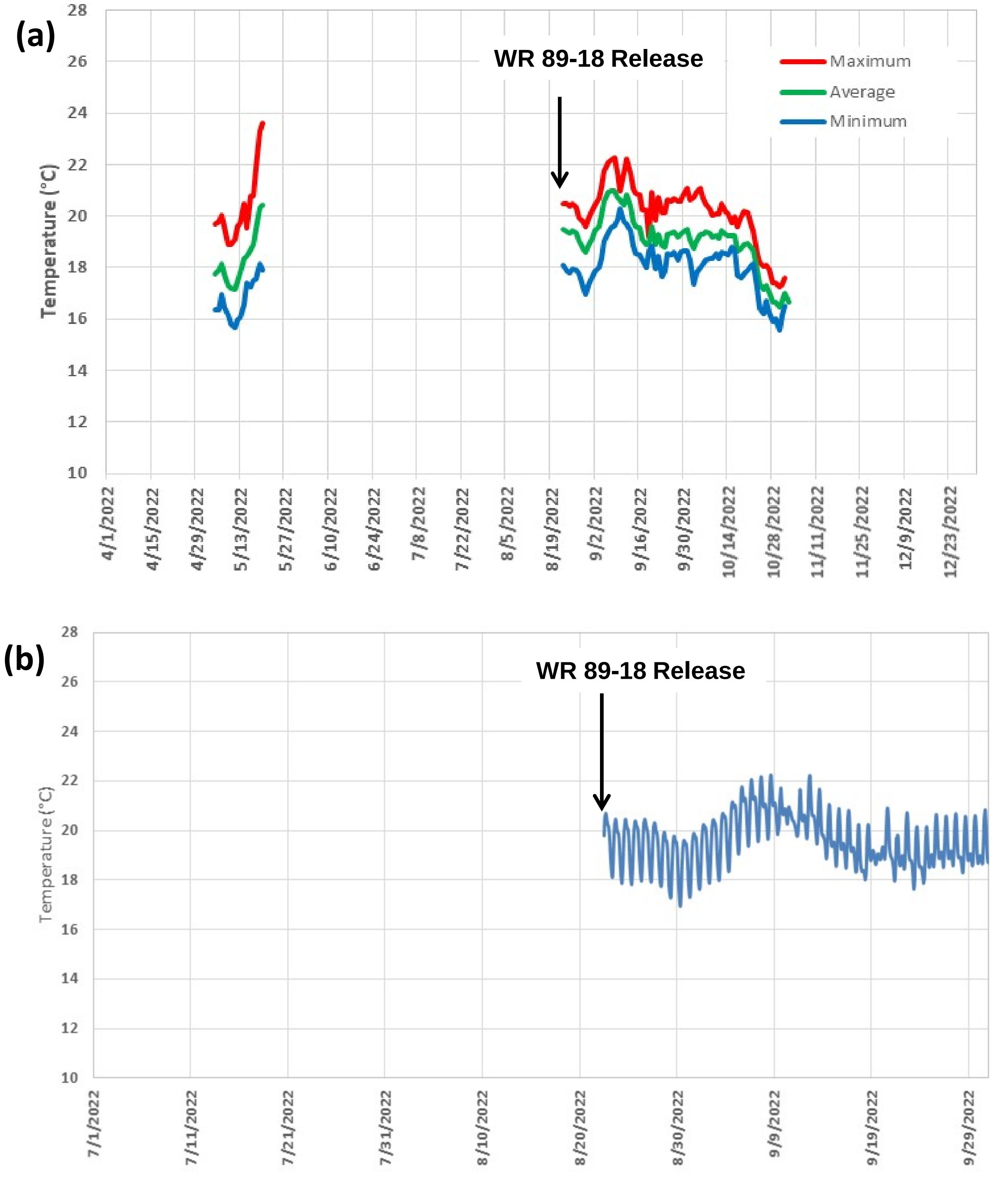


Figure 34: 2022 LSYR-10.2 (Bedrock Pool) surface (1.0-foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; the array was removed on 6/9/22 due to drying conditions, then redeployed on 8/22/22 after the WR 89-18 releases reached the site on 8/21/22.

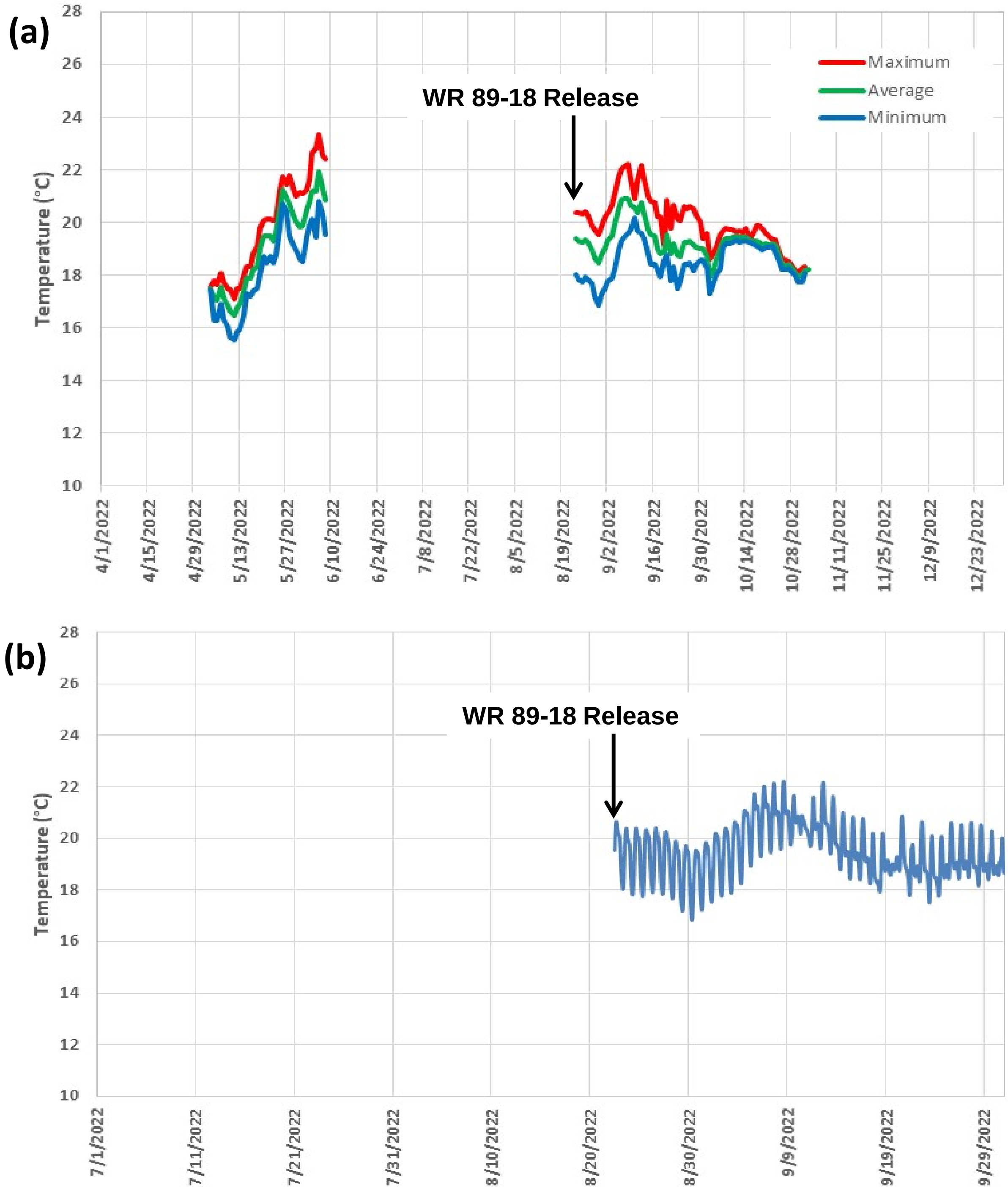


Figure 35: 2022 LSYR-10.2 (Bedrock Pool) middle (4.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; the array was removed on 6/9/22 due to drying conditions, then redeployed on 8/22/22 after the WR 89-18 releases reached the site on 8/21/22.

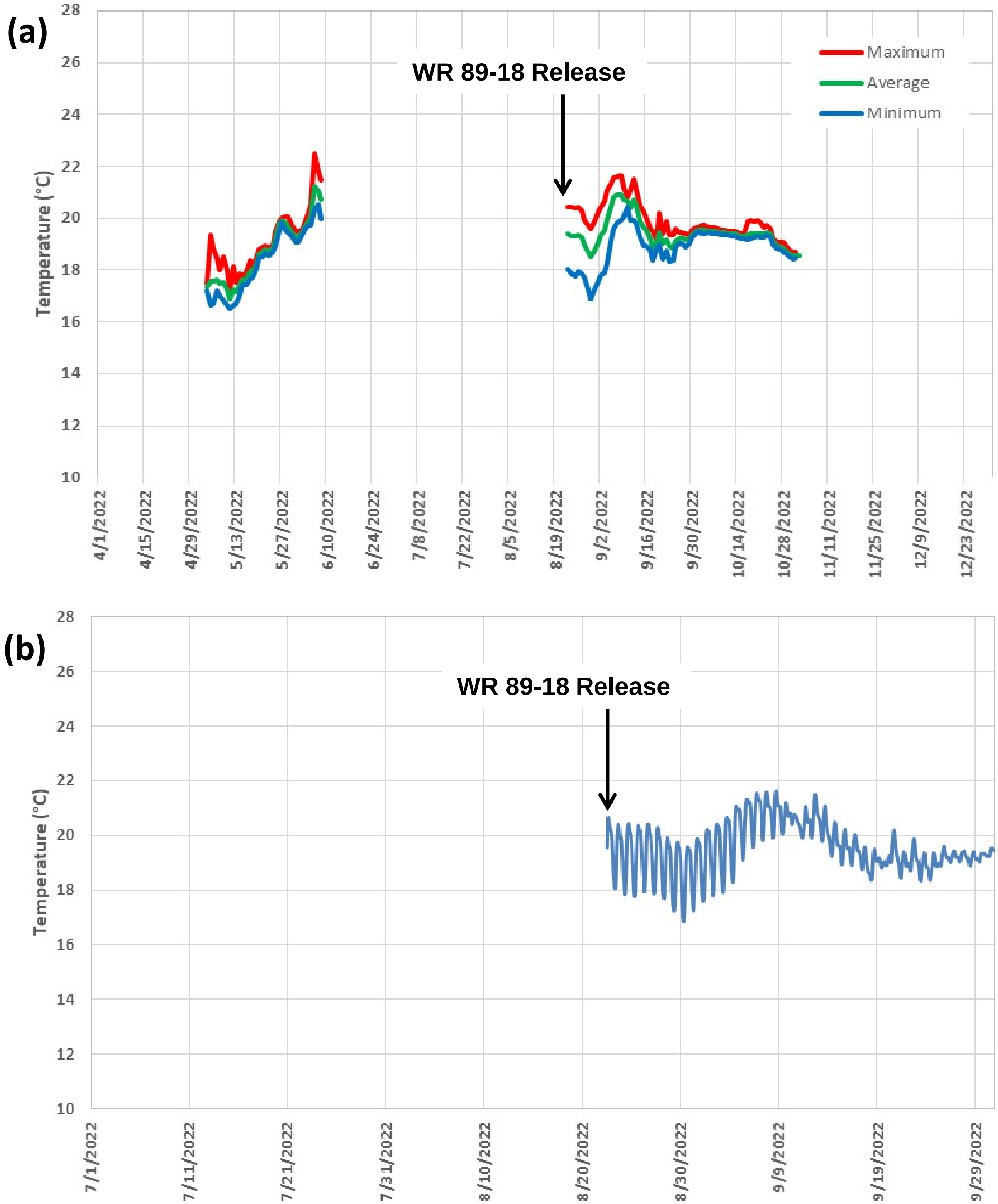


Figure 36: 2022 LSYR-10.2 (Bedrock Pool) bottom (9.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 to 10/1/22; the array was removed on 6/9/22 due to drying conditions, then redeployed on 8/22/22 after the WR 89-18 releases reached the site on 8/21/22.

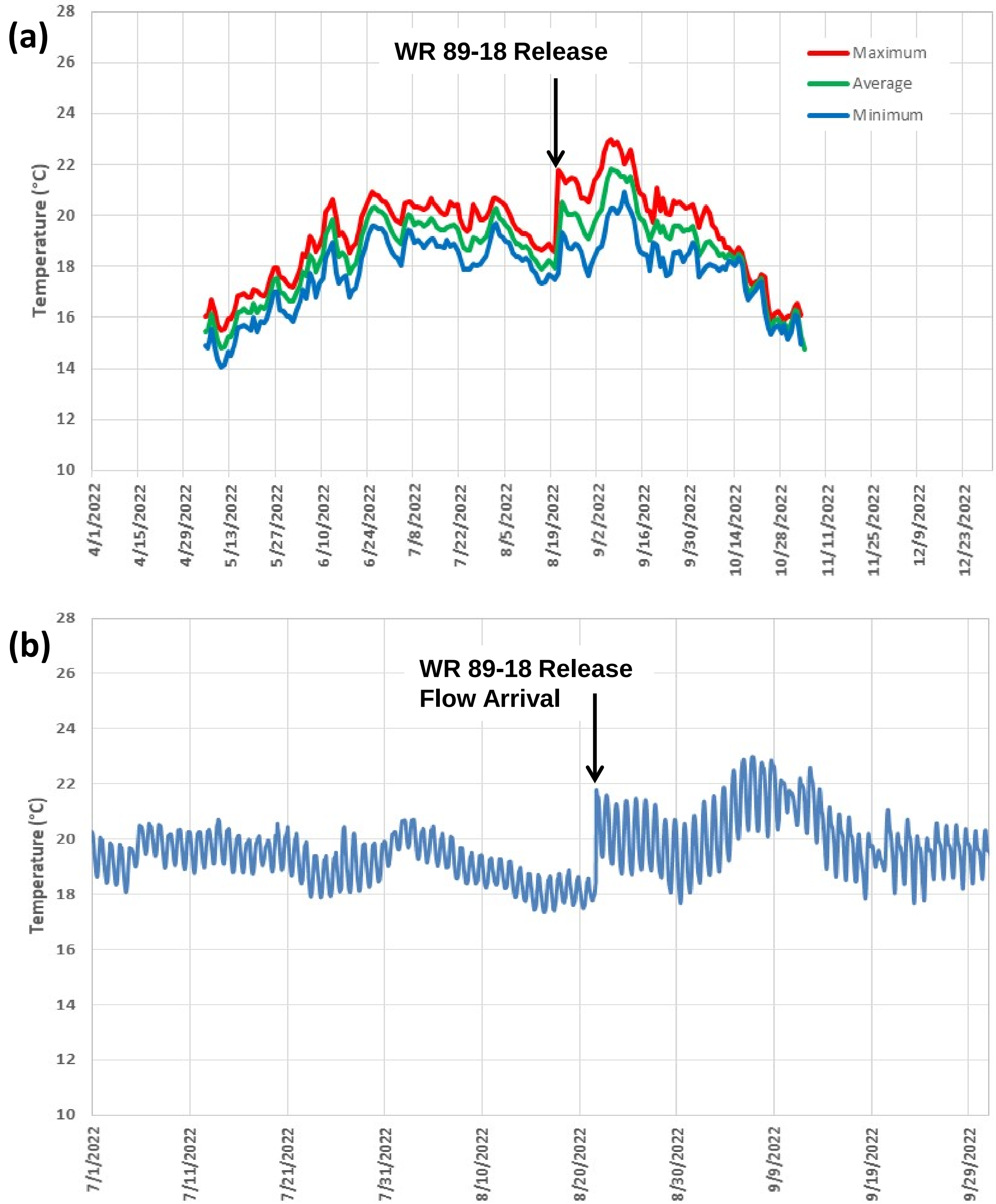


Figure 37: 2022 LSYR-13.9 (Avenue of the Flags) bottom (3.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; the WR 89-18 releases arrived at the monitoring location on 8/21/22 at approximately 17:00 hours.

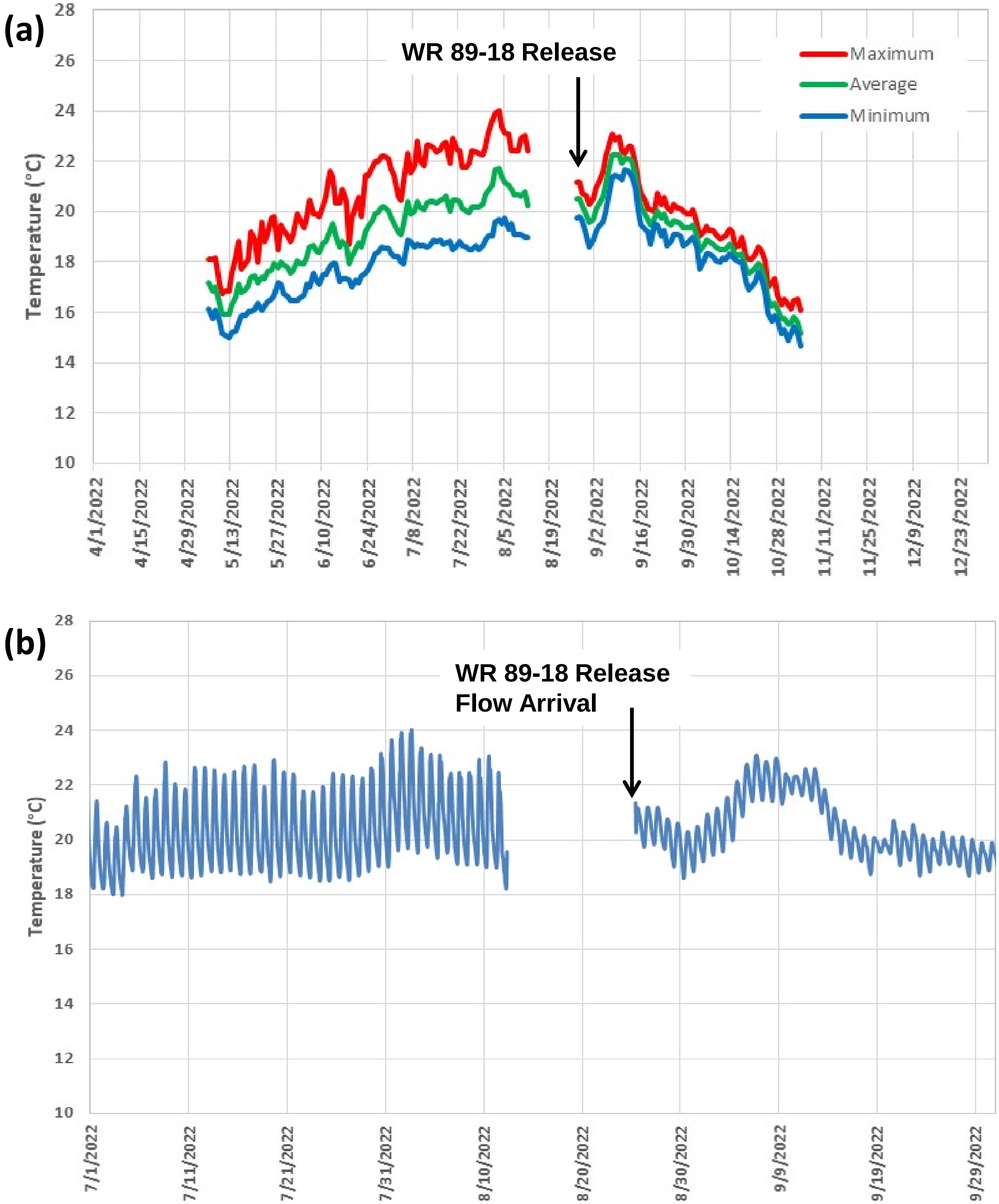
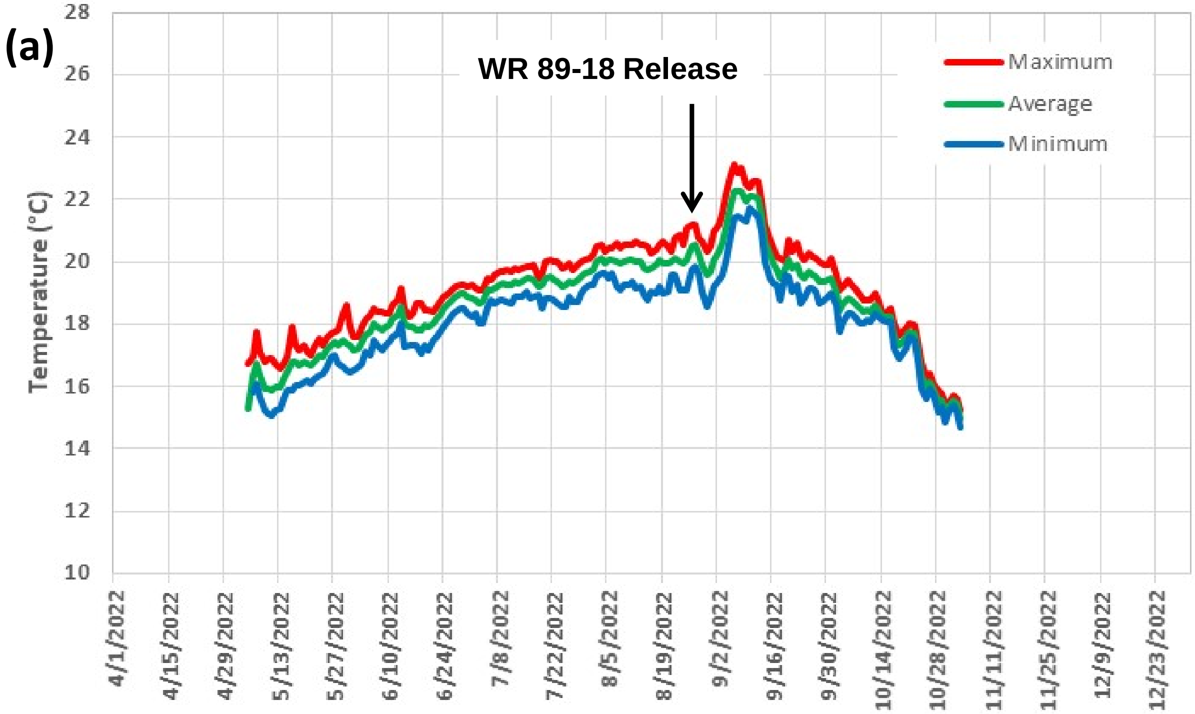


Figure 38: 2022 LSYR-22.68 (Cadwell Pool) surface (1.0-foot) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22; the surface unit was exposed to air from 8/12/22 through 8/25/22 due to declining water levels and WR 89-18 releases arrived at the monitoring location 8/25/22 at approximately 19:00 hours.



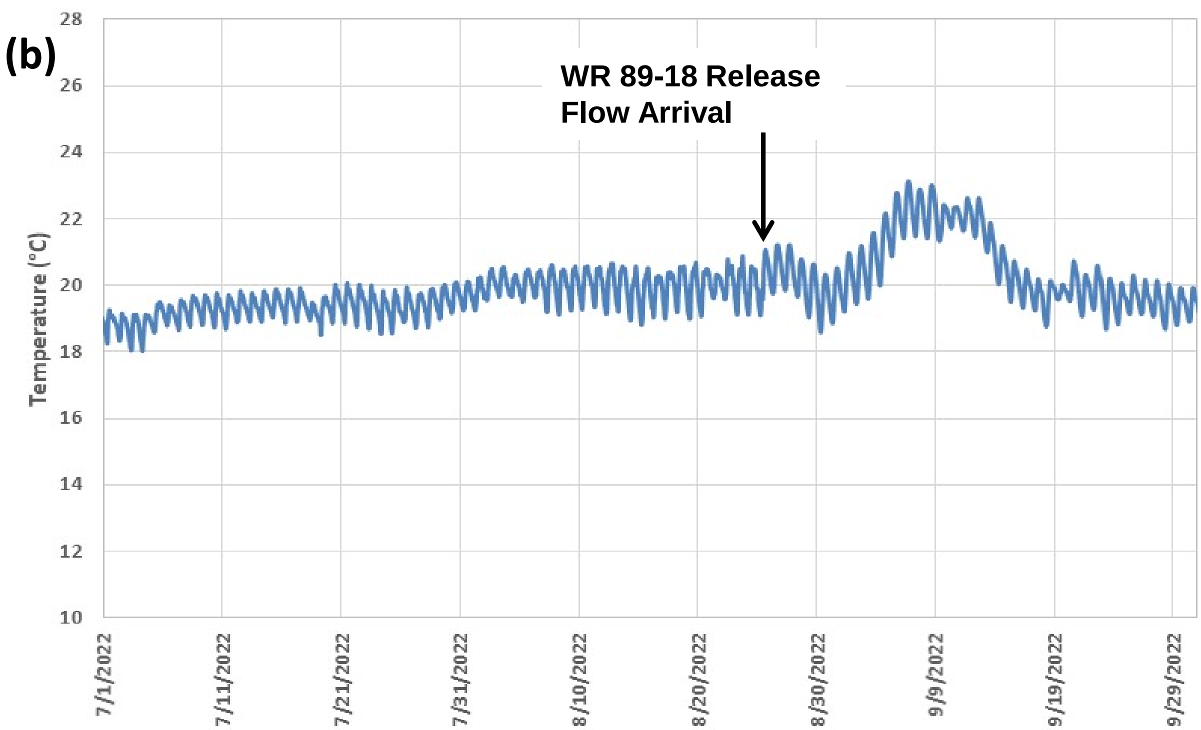


Figure 39: 2022 LSYR-22.68 (Cadwell Pool) middle (7.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22; the WR 89-18 releases arrived at the monitoring location on 8/25/22 at approximately 19:00 hours.

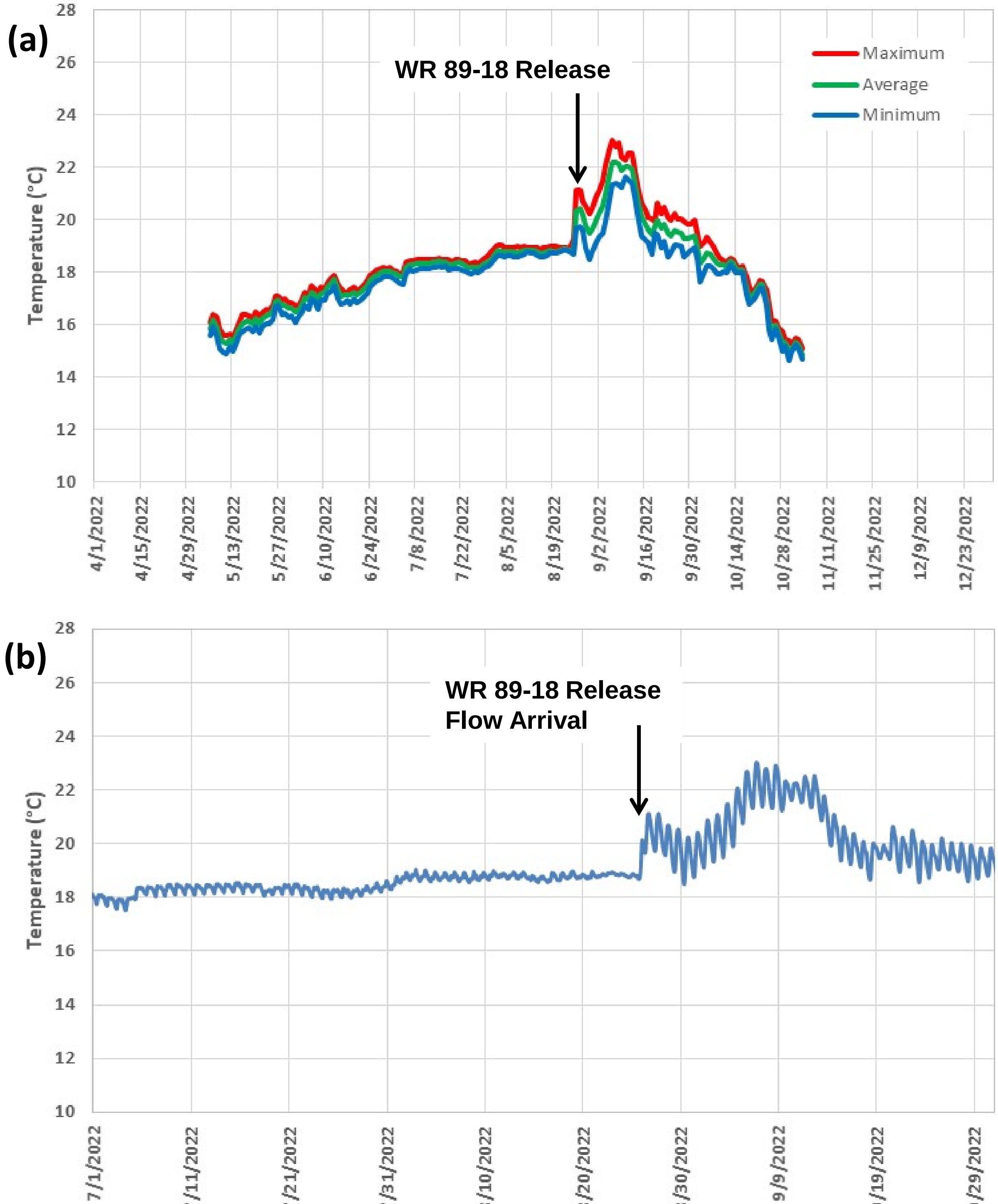


Figure 40: 2022 LSYR-22.68 (Cadwell Pool) bottom (14.0 feet) water temperatures for (a) daily maximum, average, and minimum for the entire period of record and (b) hourly measurements from 7/1/22 through 10/1/22; the WR 89-18 releases arrived at the monitoring location on 8/25/22 at approximately 19:00 hours.

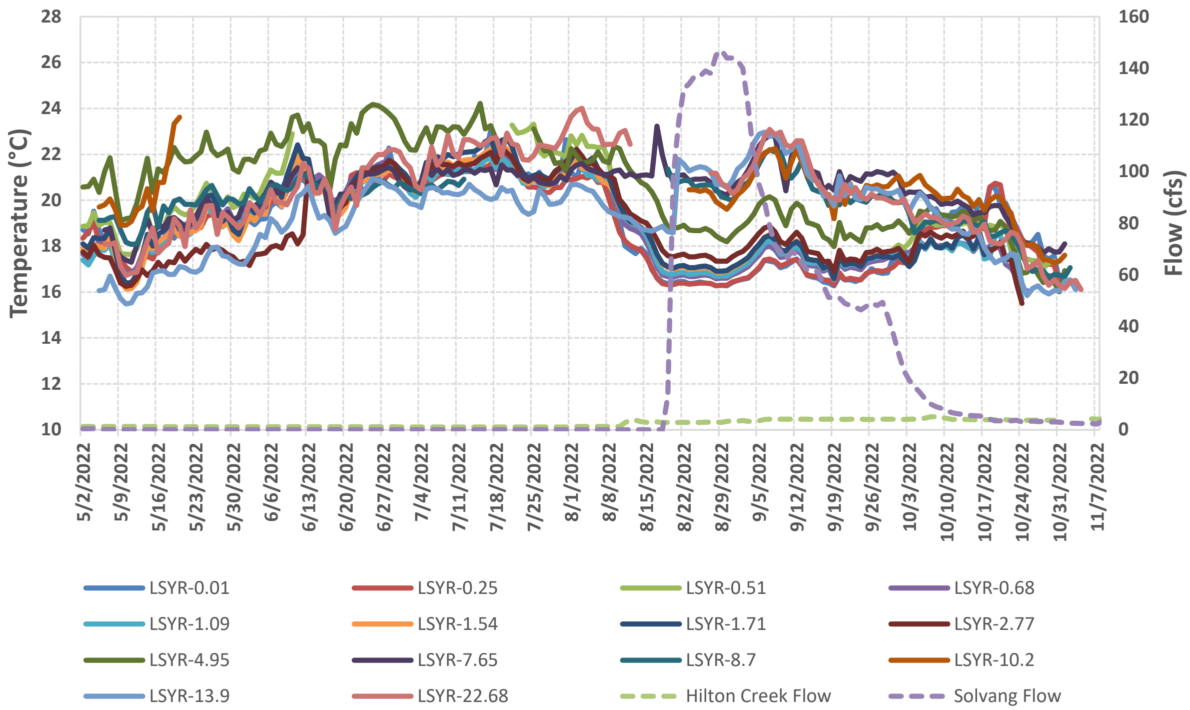


Figure 41: 2022 Longitudinal maximum daily surface water temperatures at: LSYR-0.01 (parapet wall), LSYR-0.25 (downstream of Stilling Basin), LSYR-0.51 (Long Pool), LSYR-0.68 (downstream of Long Pool), LSYR-1.09 (Grimm u/s), LSYR-1.54 (Grimm d/s), LSYR-1.71 (Grimm Pool), LSYR-2.77 (Kaufman), LSYR-4.95 (Encantado Pool), LSYR-7.65 (Double Canopy), LSYR-8.7 (Head of Beaver), LSYR-10.2 (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.

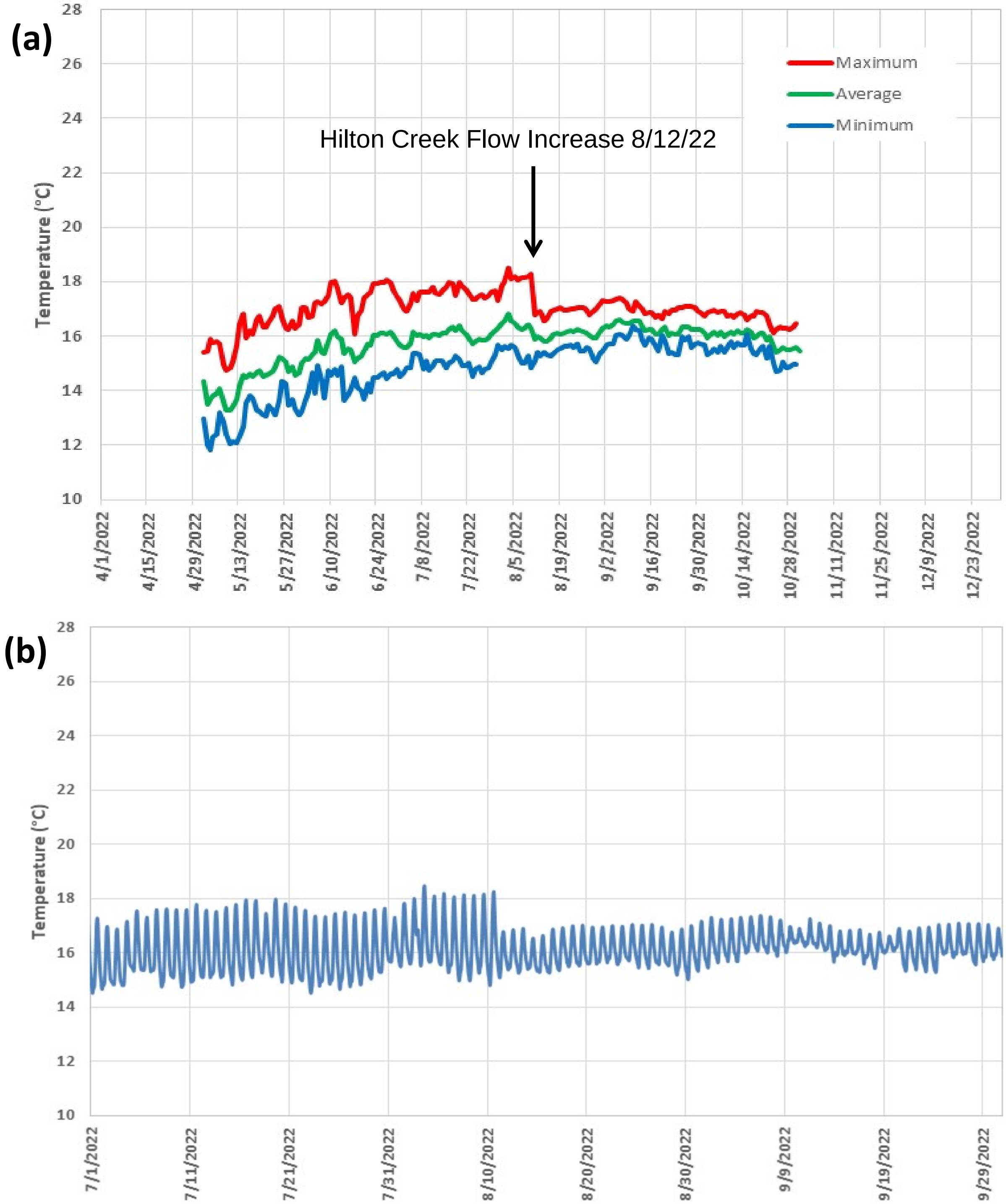


Figure 42: 2022 Lower Hilton Creek (HC-0.12) bottom (1.5 feet) thermograph for (a) daily maximum, average, and minimum daily values and (b) hourly data from 7/1/22 through 10/1/22; flow increase on 8/12/22 from the Lower Release Point resulted in cooler water quality conditions.

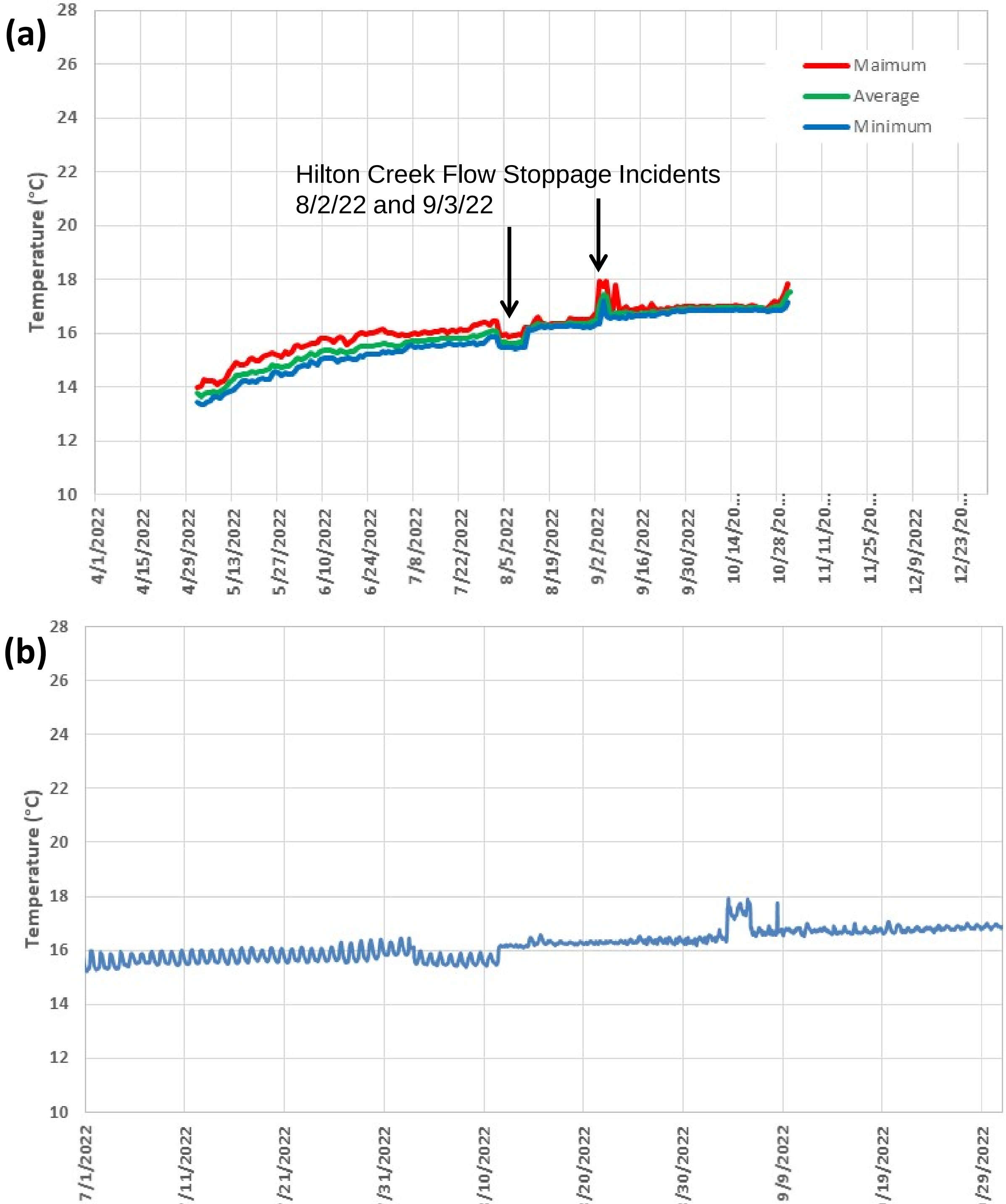


Figure 43: 2022 Hilton Creek at the Upper Release Point (HC-0.54) bottom (2.5 feet) water temperatures for: (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22; two separate flow interruptions from the URP on 8/2/22 and 9/3/22 are highlighted in (a).

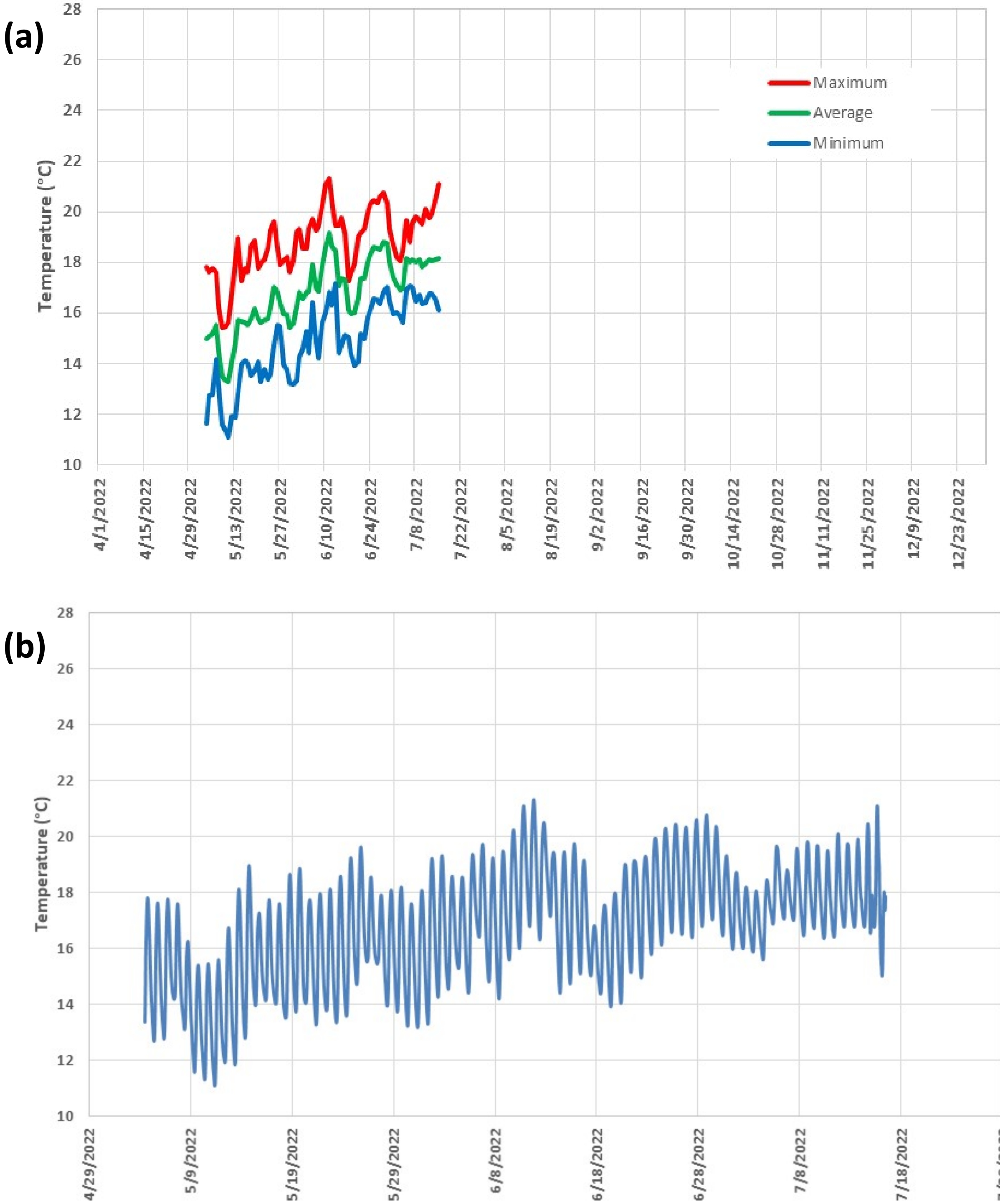


Figure 44: 2022 Quiota Creek (QC-2.66) bottom (2.5 feet) thermograph for (a) daily maximum, average, and minimum daily values for the entire period of record and (b) hourly data for the entire period of record 5/4/22 through 7/16/22; the habitat was nearly dry when the thermograph was removed.

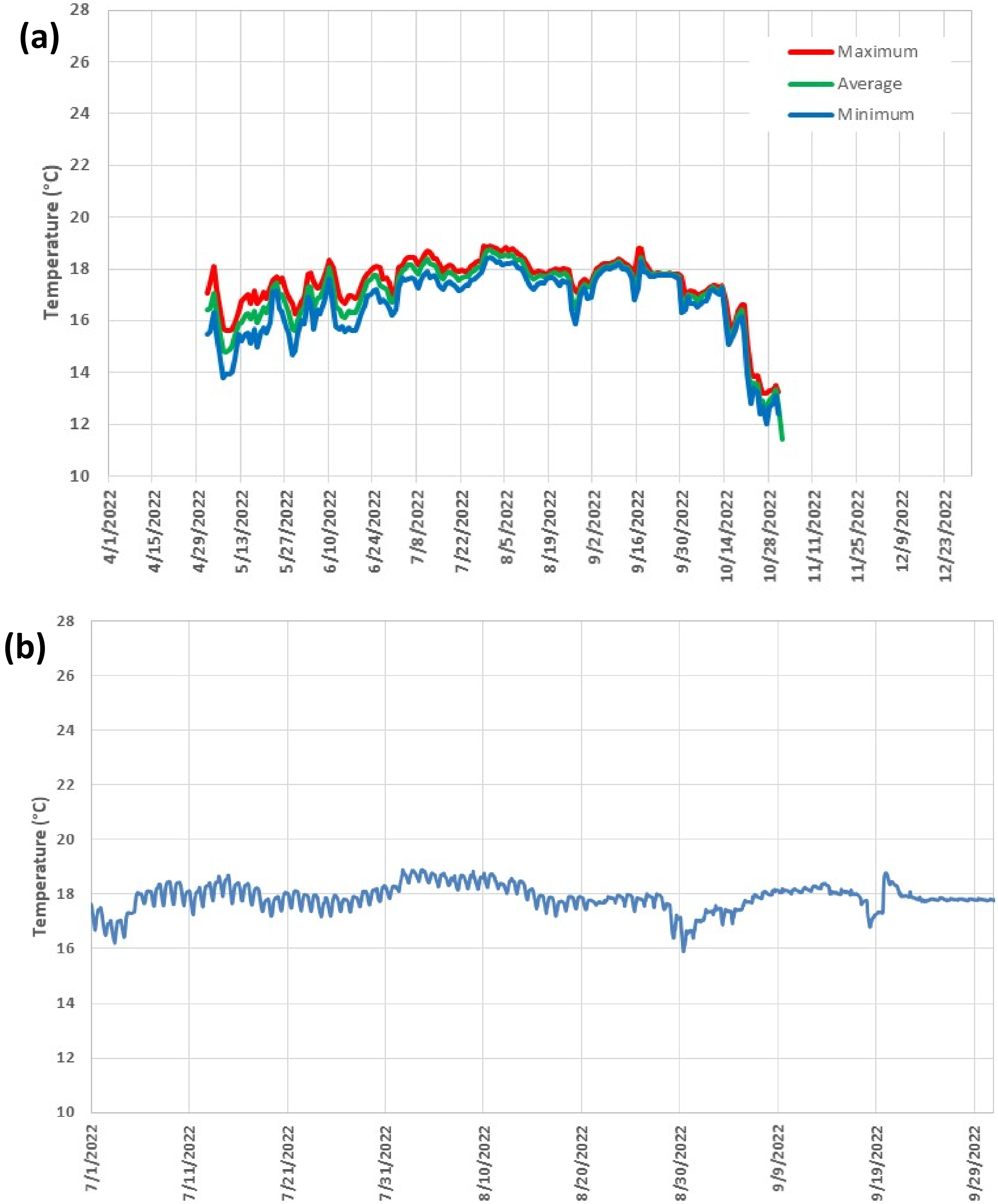


Figure 45: 2022 SC-0.77 bottom (5.0 foot) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements from 7/1/22 through 10/1/22.

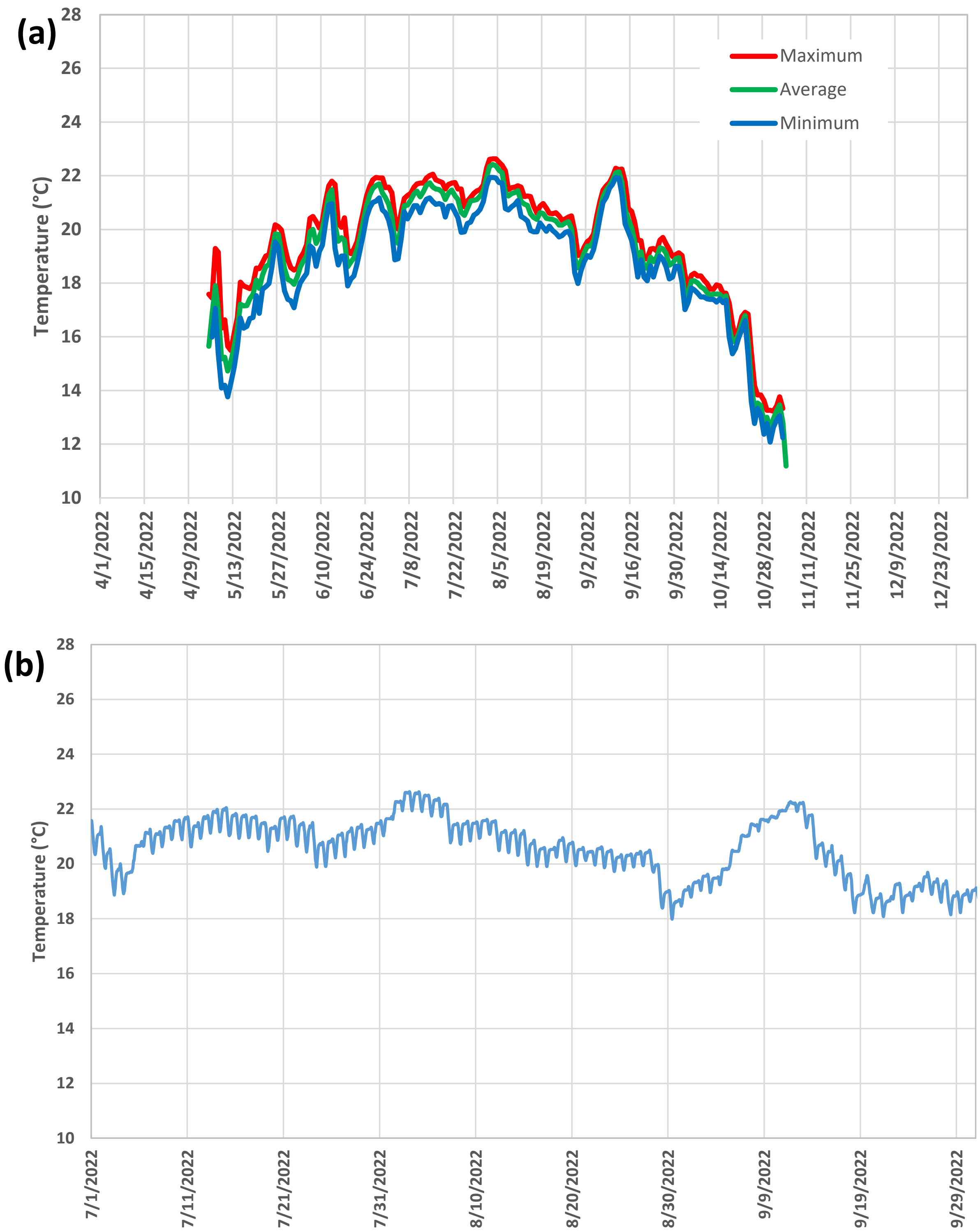


Figure 46: 2022 SC-2.2 (Reach 2 Bedrock Section) middle (4.0 feet) water temperatures for (a) daily maximum, average, and minimum temperatures for the entire period of deployment and (b) hourly measurements for the period from 7/1/22 through 10/1/22.

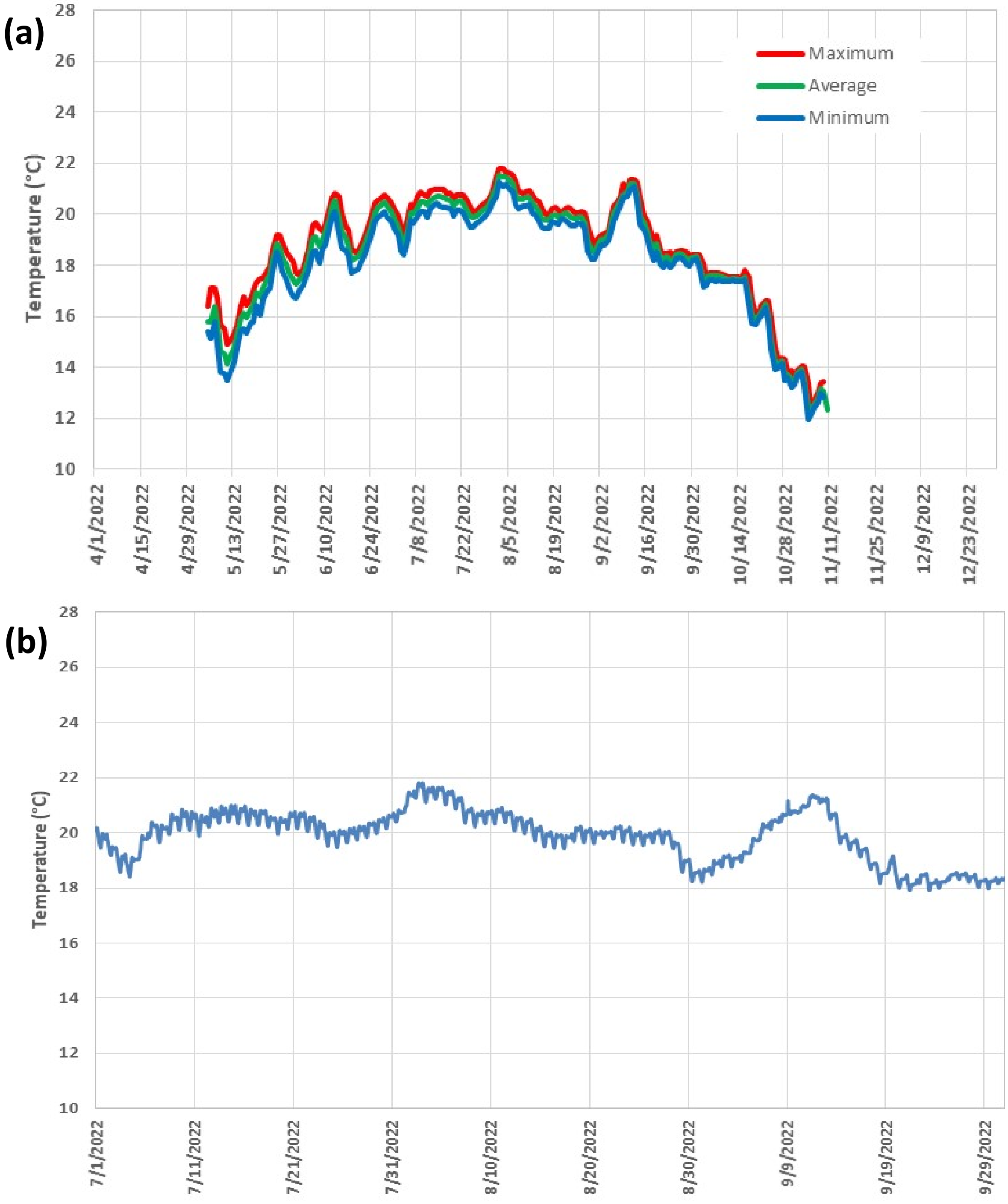


Figure 47: 2022 SC-3.0 (250 downstream of Highway 1 Bridge) middle (6 feet) water temperature for (a) maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/22 through 10/1/22.

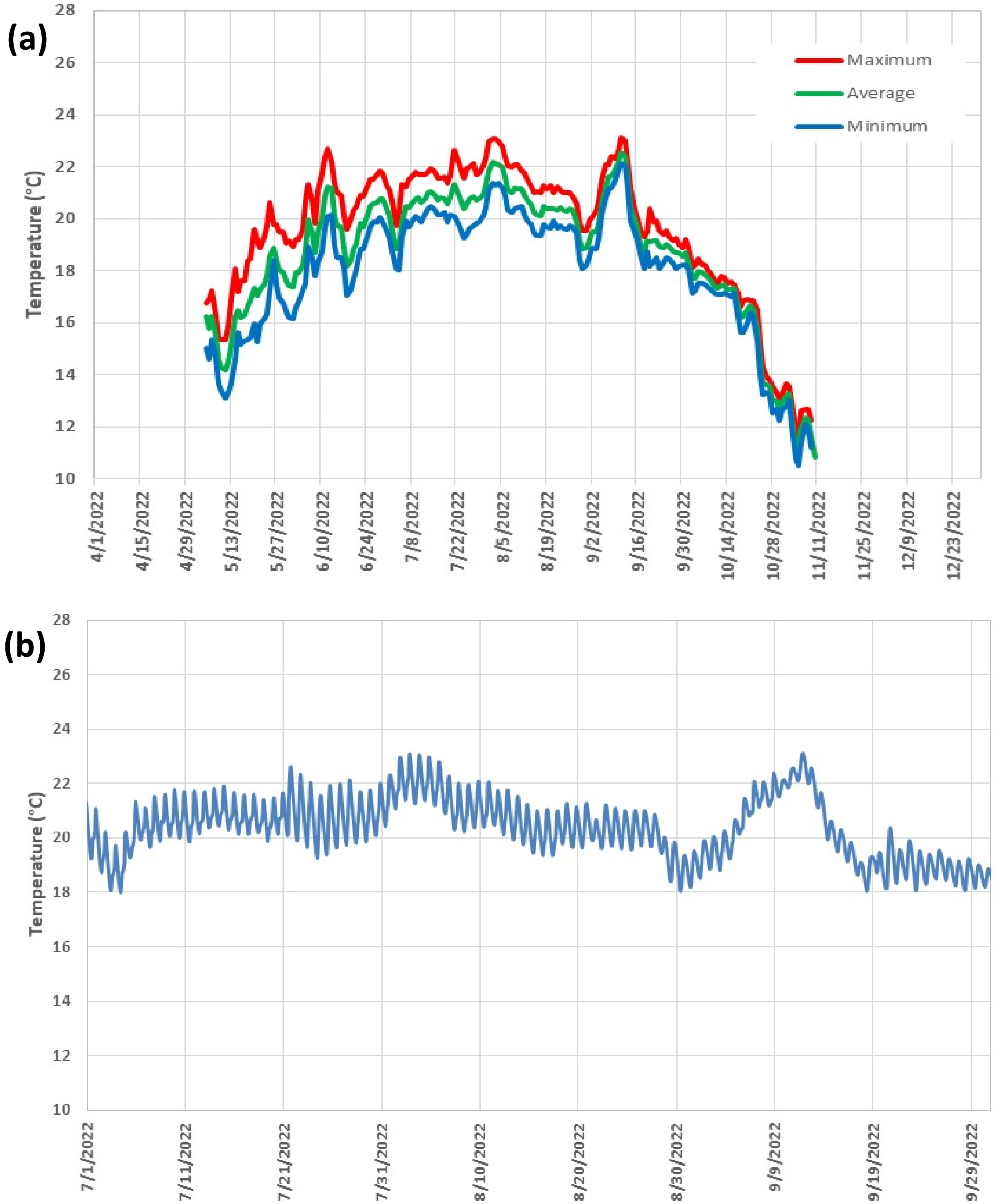


Figure 48: 2022 SC-3.5 (Jalama Bridge Pool habitat) bottom (4.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/22 through 10/1/22.

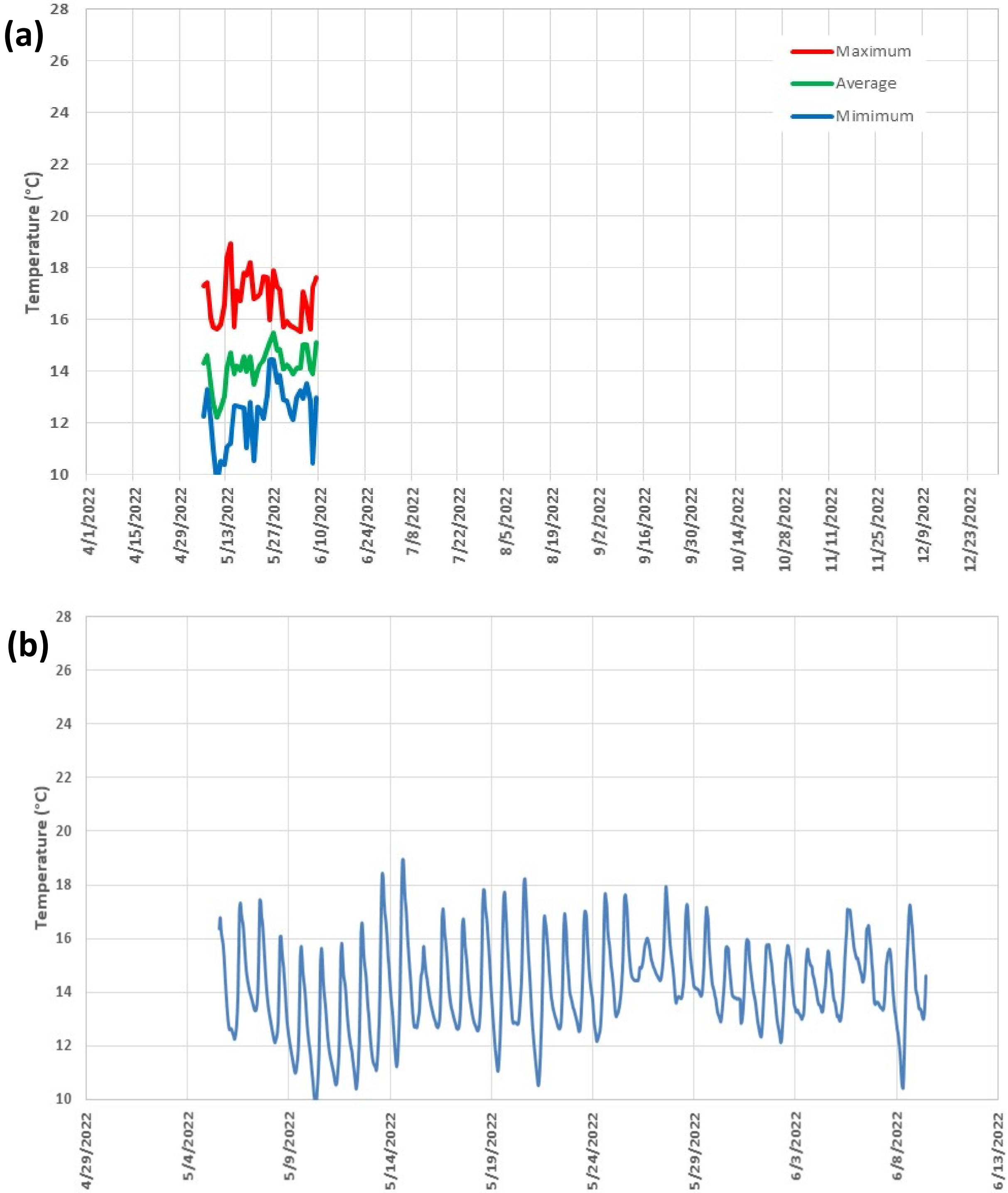


Figure 49: 2022 SC-3.8 Upper Salsipuedes Creek (0.5 feet) water temperatures for (a) daily maximum, average and minimum for the entire period of deployment and (b) hourly measurements for the entire period of record 5/5/22 through 6/9/22 (creek was dry on 6/14/22).

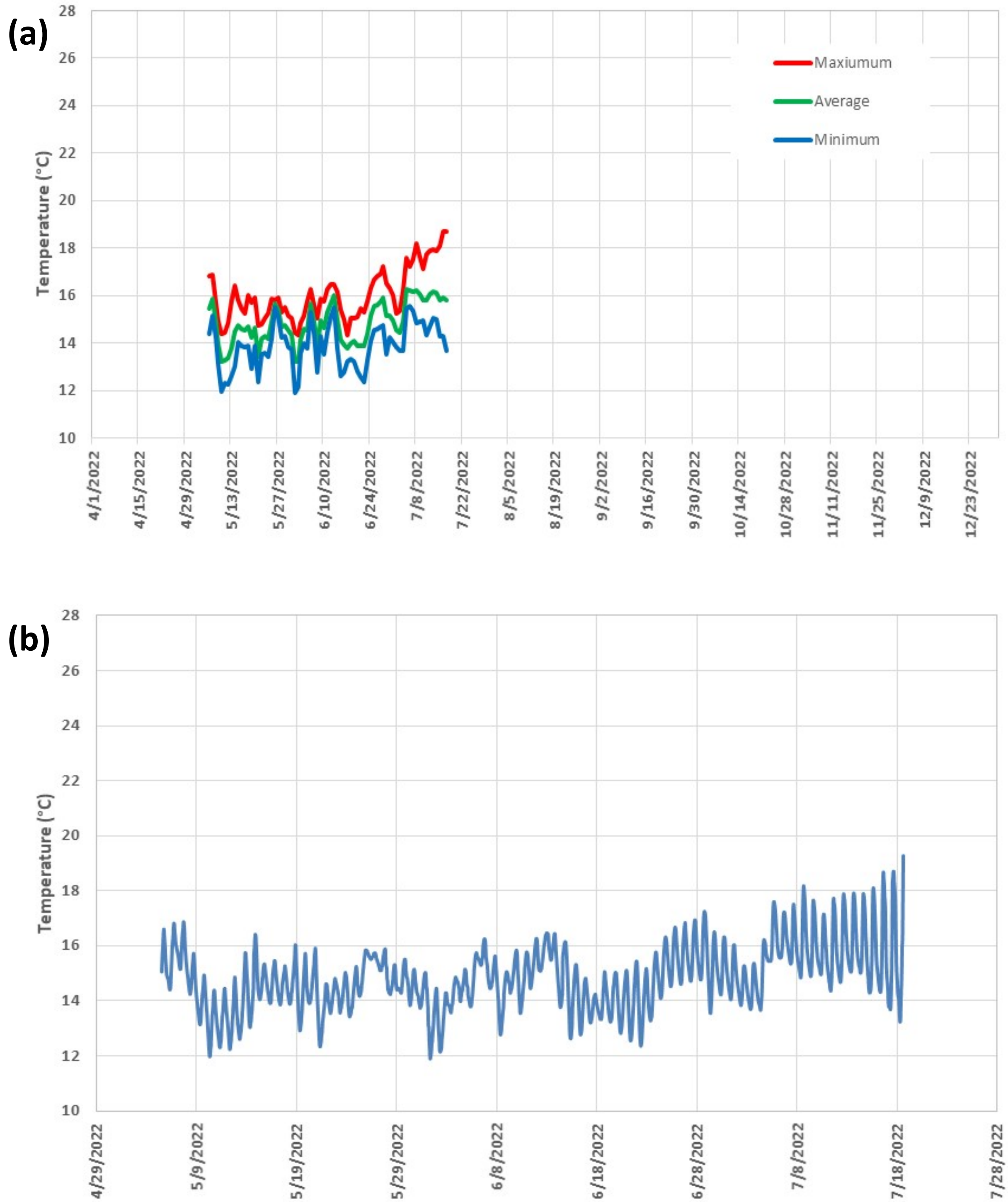


Figure 50: 2022 EJC-3.81 directly upstream of the Upper Salsipuedes Creek confluence – bottom (3.0 -feet) water temperatures for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of record (5/5/22 through 7/17/22).

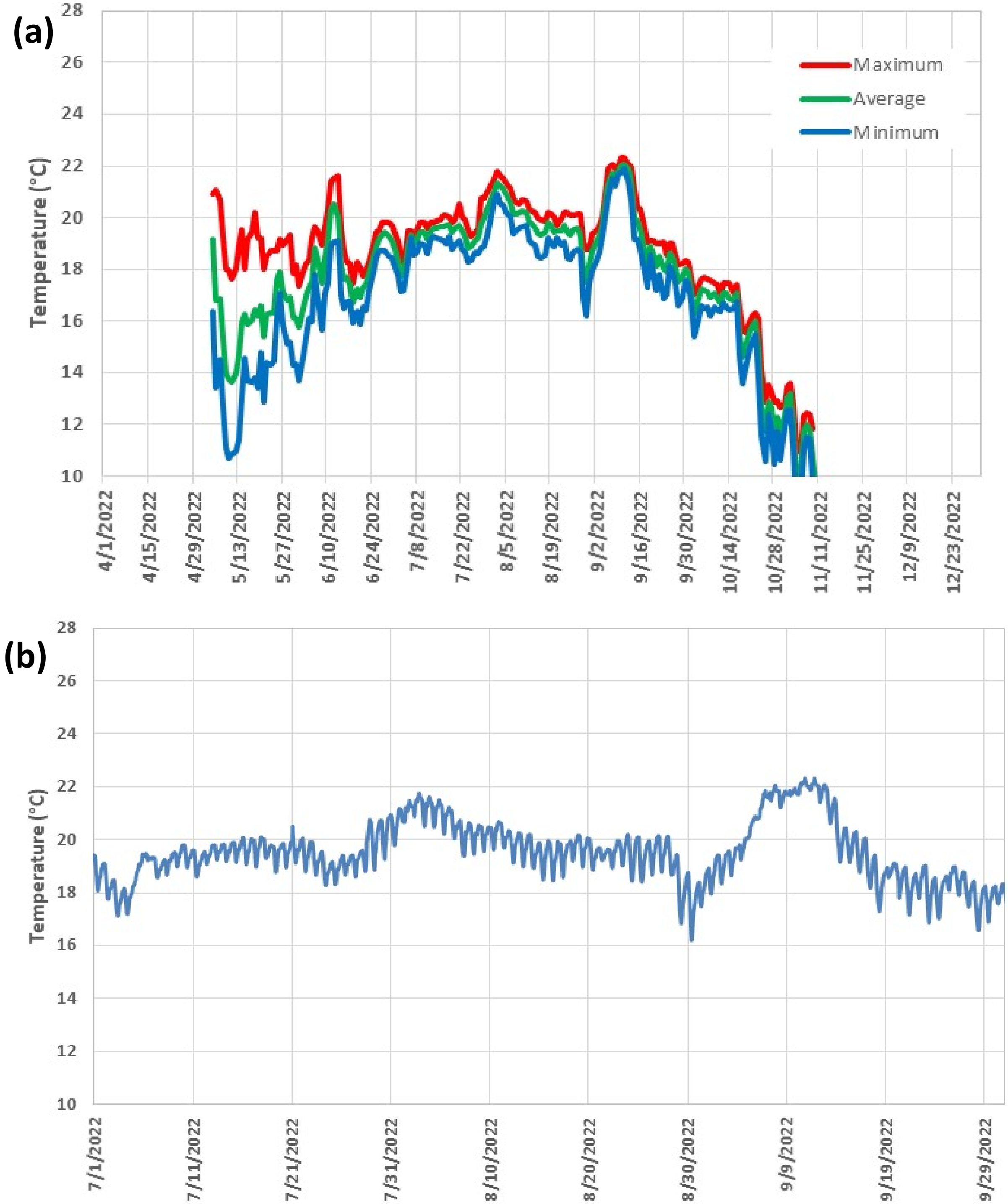


Figure 51: 2022 EJC-5.4 (Palos Colorados Pool habitat) bottom (3.0 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/22 through 10/1/22.

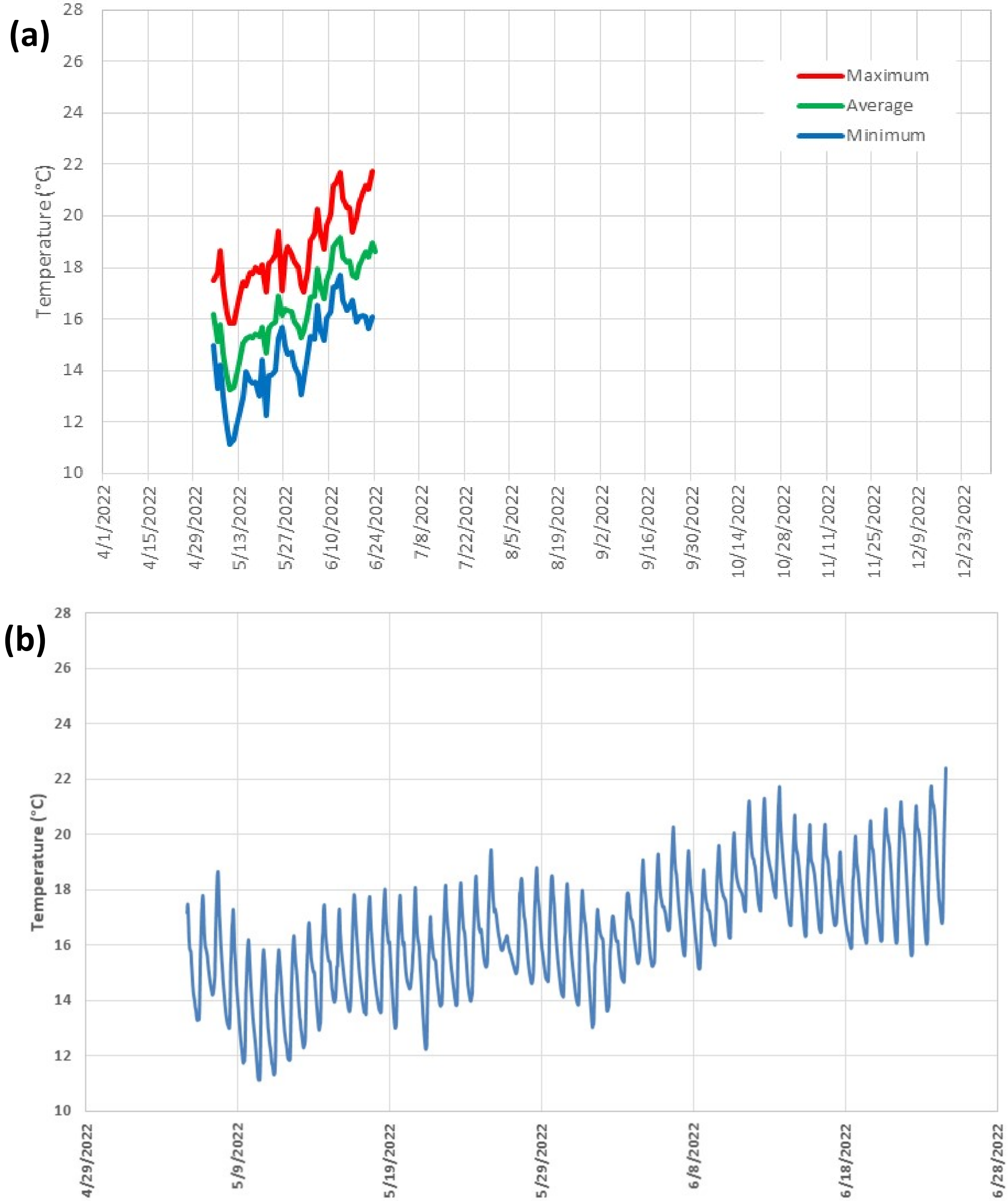
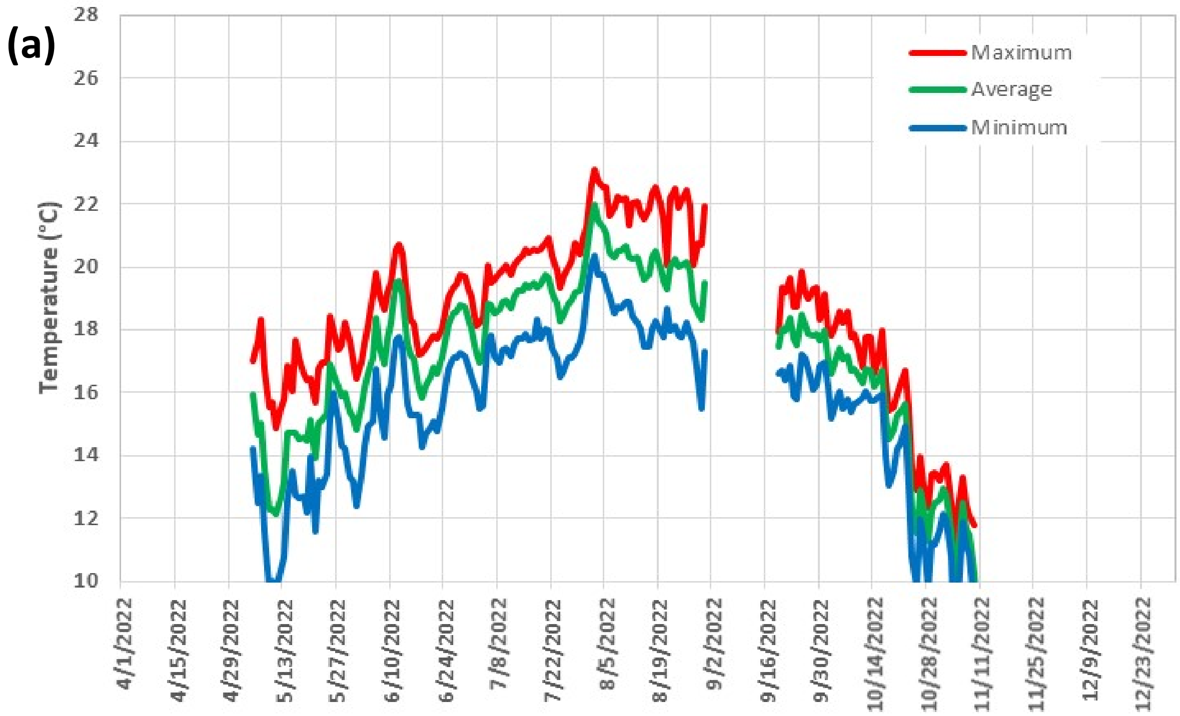


Figure 52: 2022 EJC-10.82 water temperature at Rancho San Julian Fish Ladder bottom (3.5-feet) for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the entire period of deployment 5/5/22 – 6/24/22; the unit was removed from drying and isolated habitat.



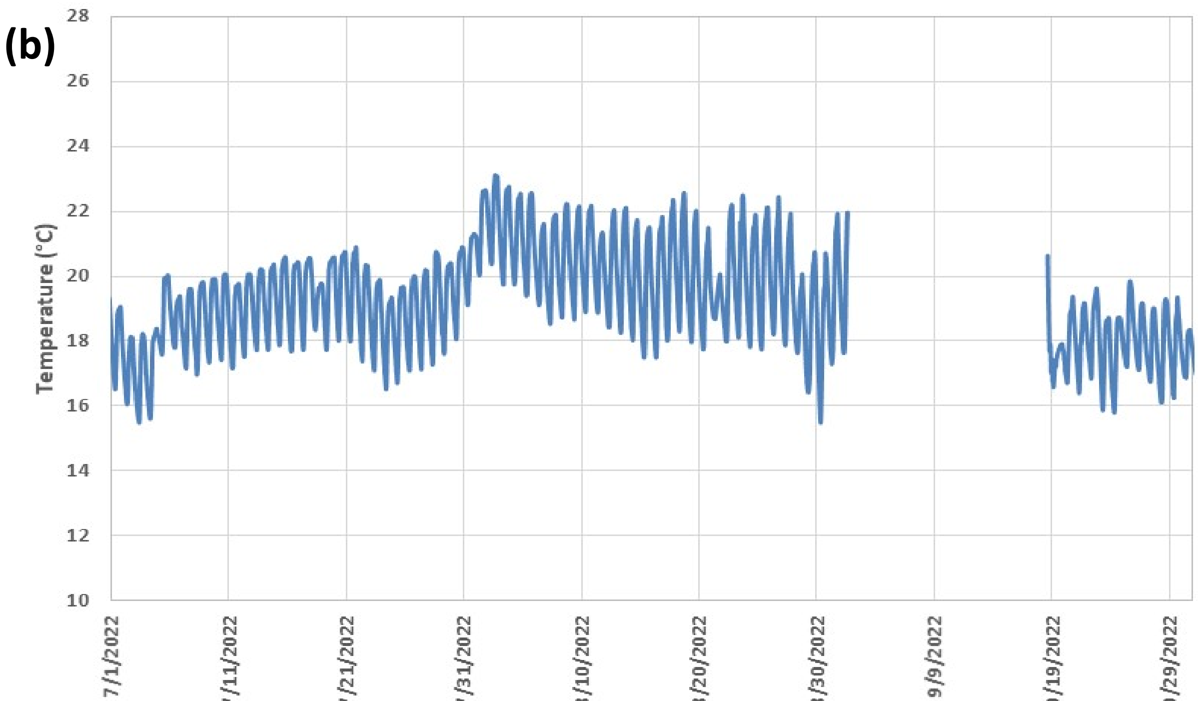


Figure 53: 2022 LAC-7.0 (Los Amoles Creek at Ford Crossing) bottom (2.5 feet) water temperature for (a) daily maximum, average, and minimum for the entire period of deployment and (b) hourly measurements for the period from 7/1/22 through 10/1/22; the surface unit was out of the water from 9/1/22 through 9/18/22 due to declining water levels.

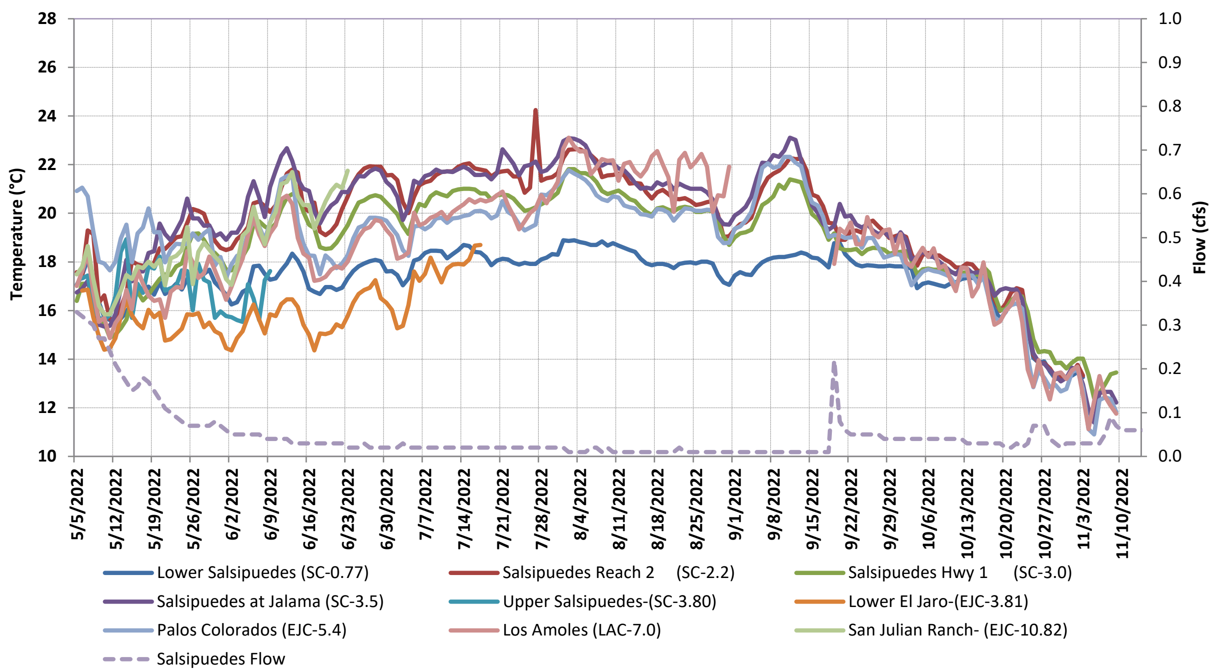


Figure 54: 2022 longitudinal surface daily maximum at 9 tributary locations within Salsipuedes/El Jaro watershed and flow at the USGS gauging station at Salsipuedes Creek.

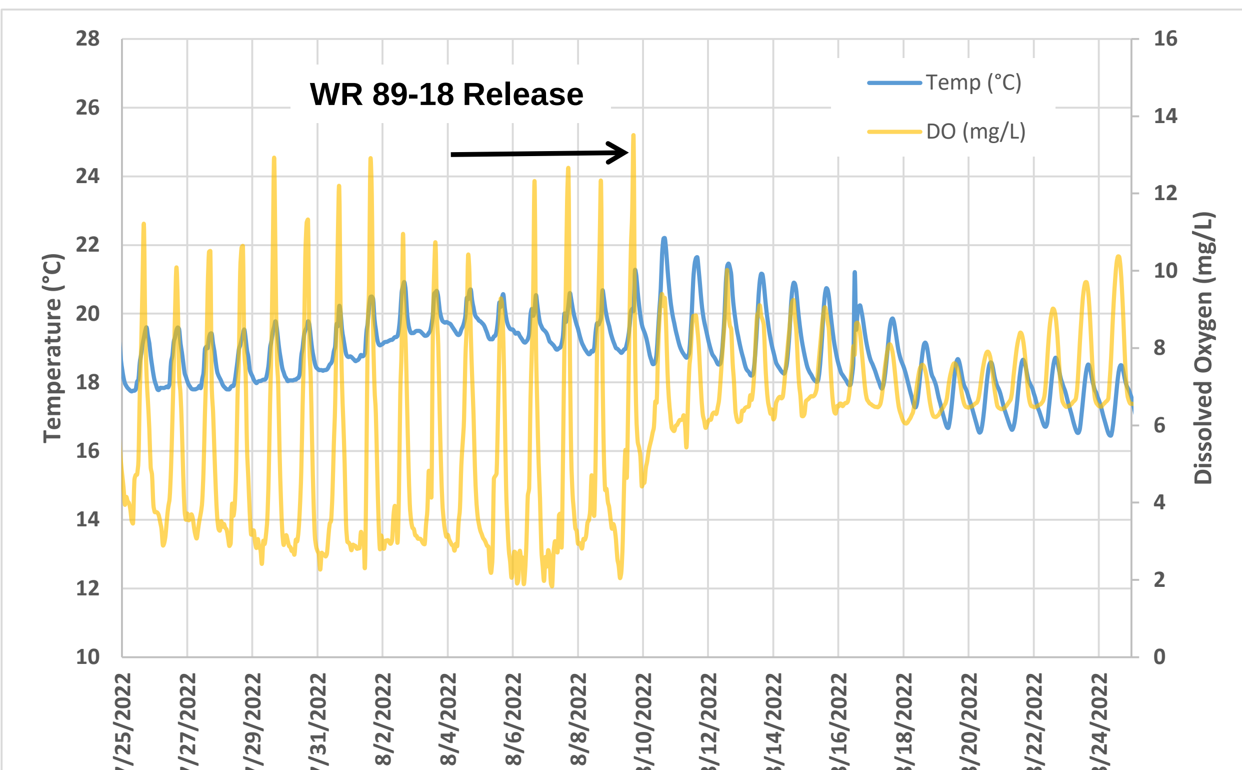


Figure 55: Temperature and dissolved oxygen at LSYR-4.95 4-feet below the surface (mid-water) from 7/25/22-8/25/22; water from the WR 89-18 release reached the site on 8/10/22.

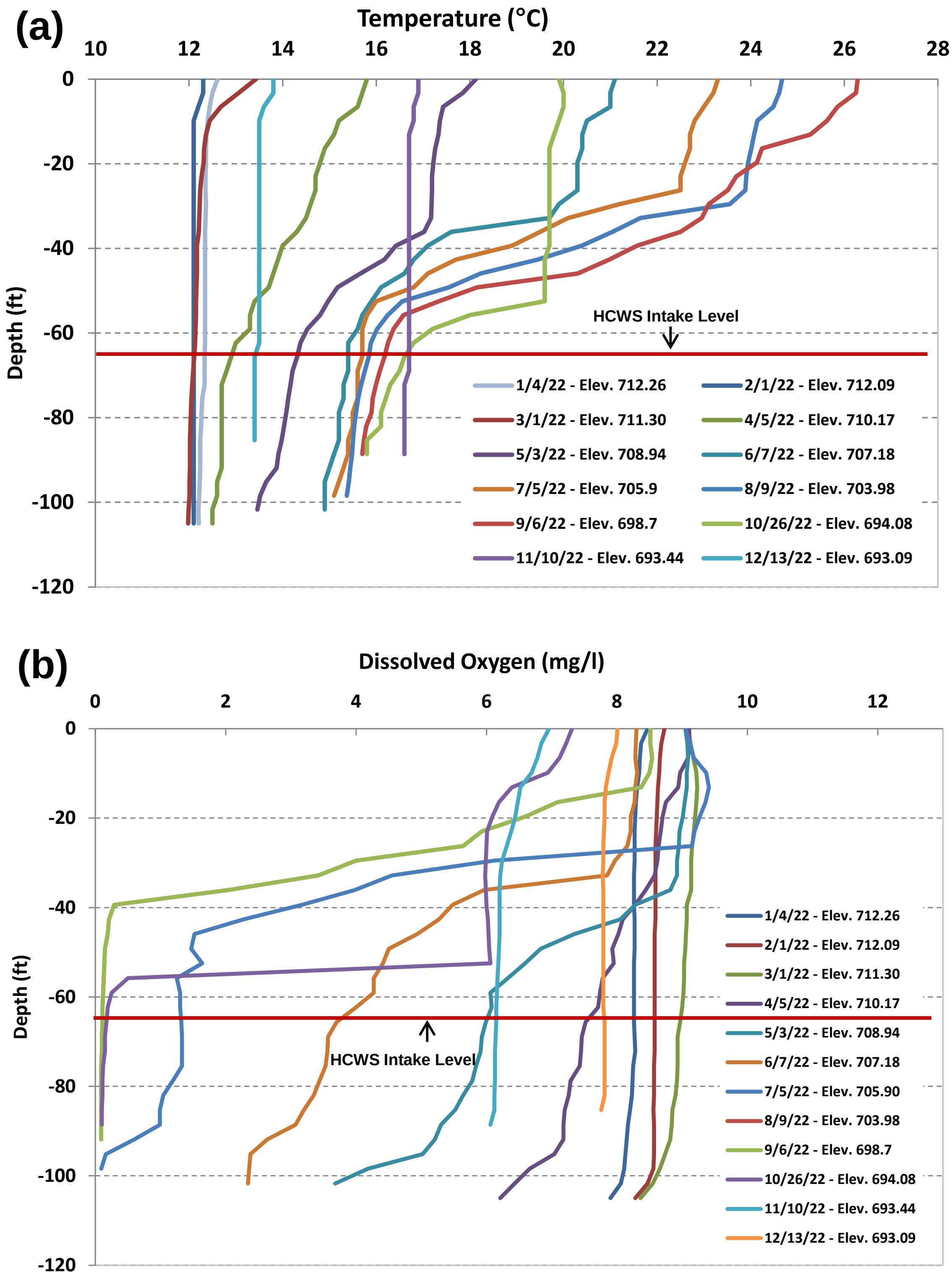


Figure 56: Lake Cachuma 2022 water quality profiles for (a) temperature and (b) dissolved oxygen concentrations at the intake barge for the HCWS; the target depth of HCWS intake hose is 65 feet of depth throughout the monitoring period.

3.3. Habitat Quality within the LYSR Basin

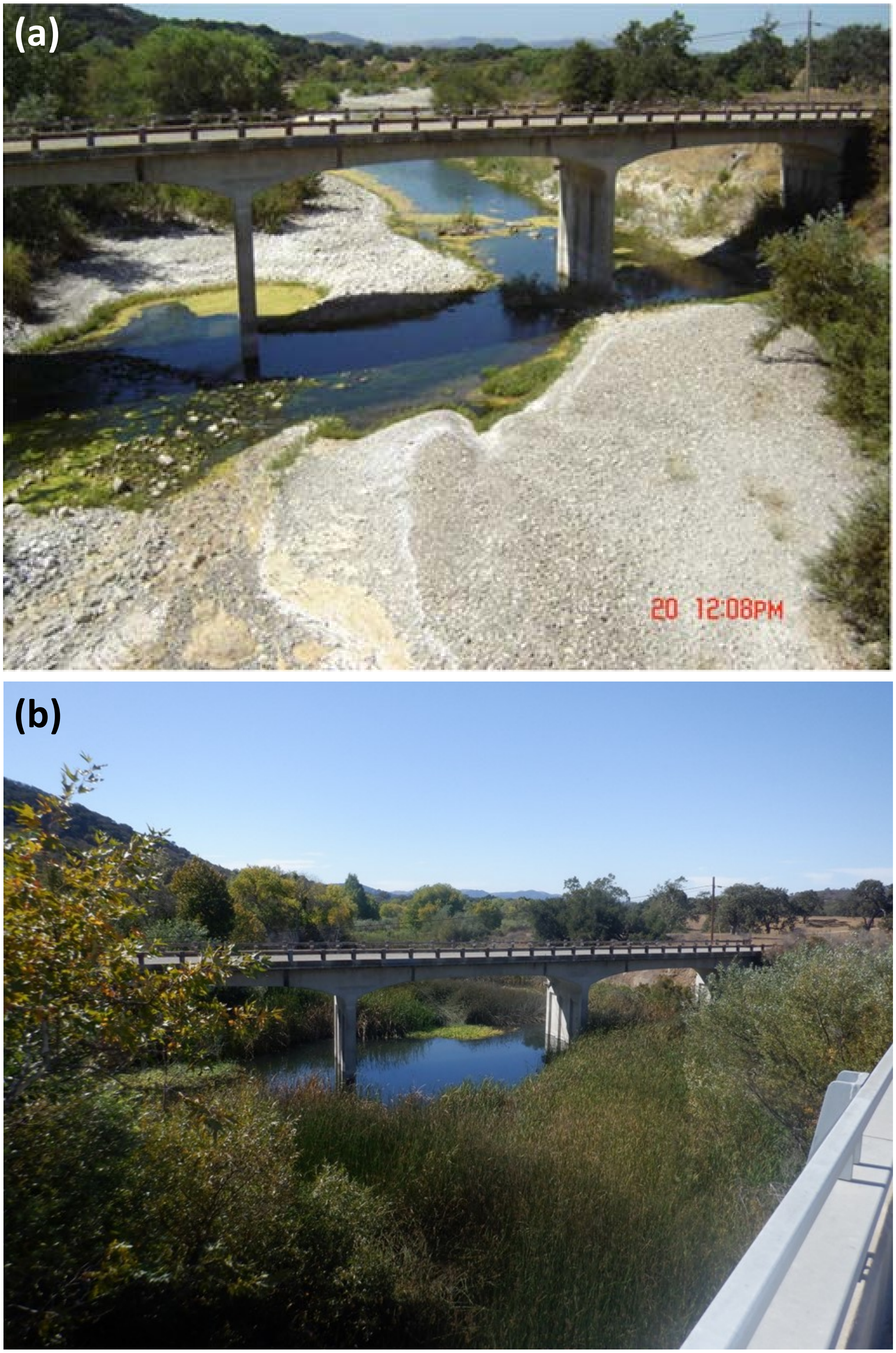


Figure 57: Photo points (M-6) collected at Highway 154 Bridge looking downstream in (a) September 2005 and (b) October 2022.

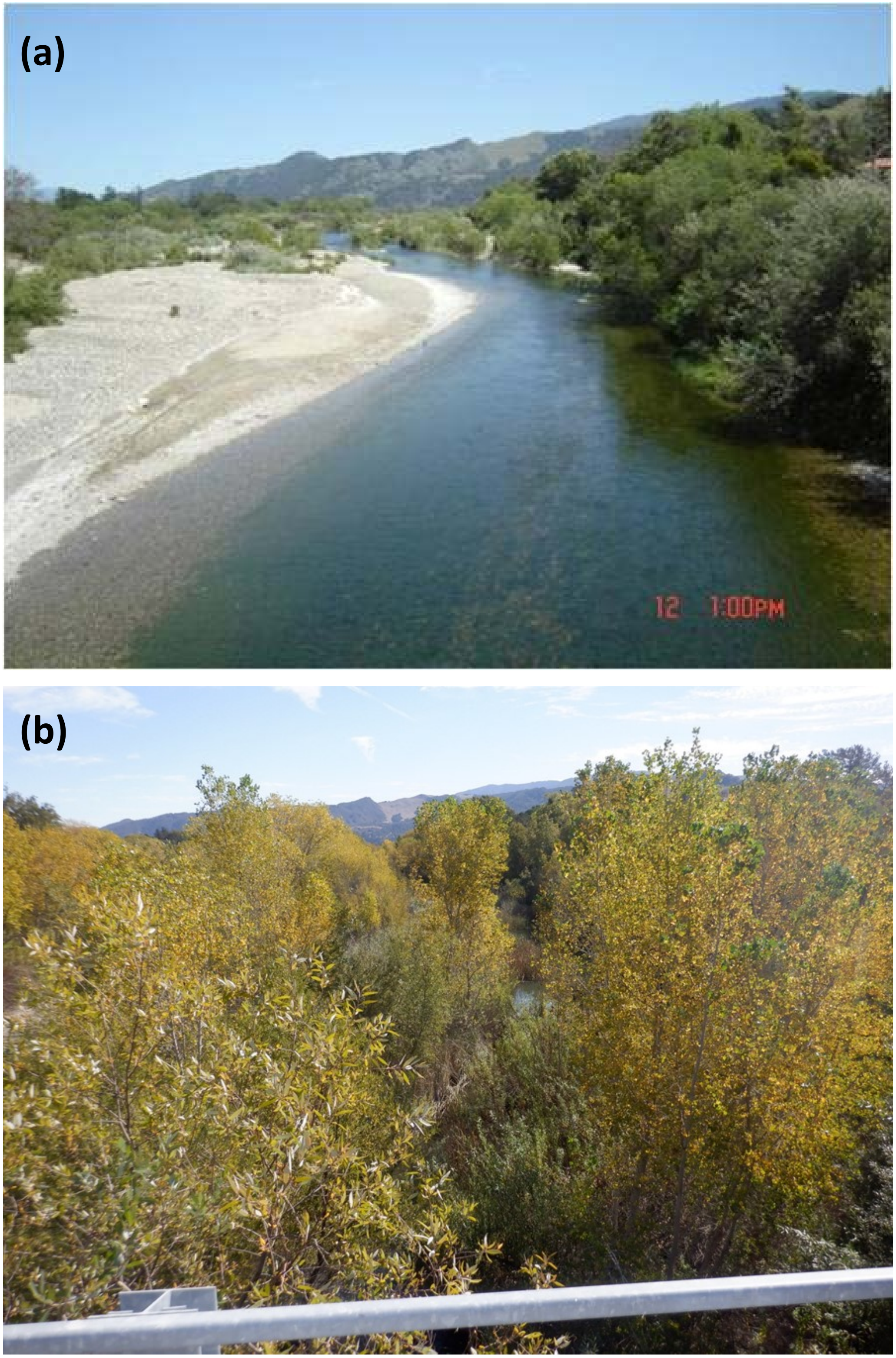


Figure 58: Photo point (M-12) collected at Refugio Bridge looking upstream in (a) May 2005, and (b) October 2022.

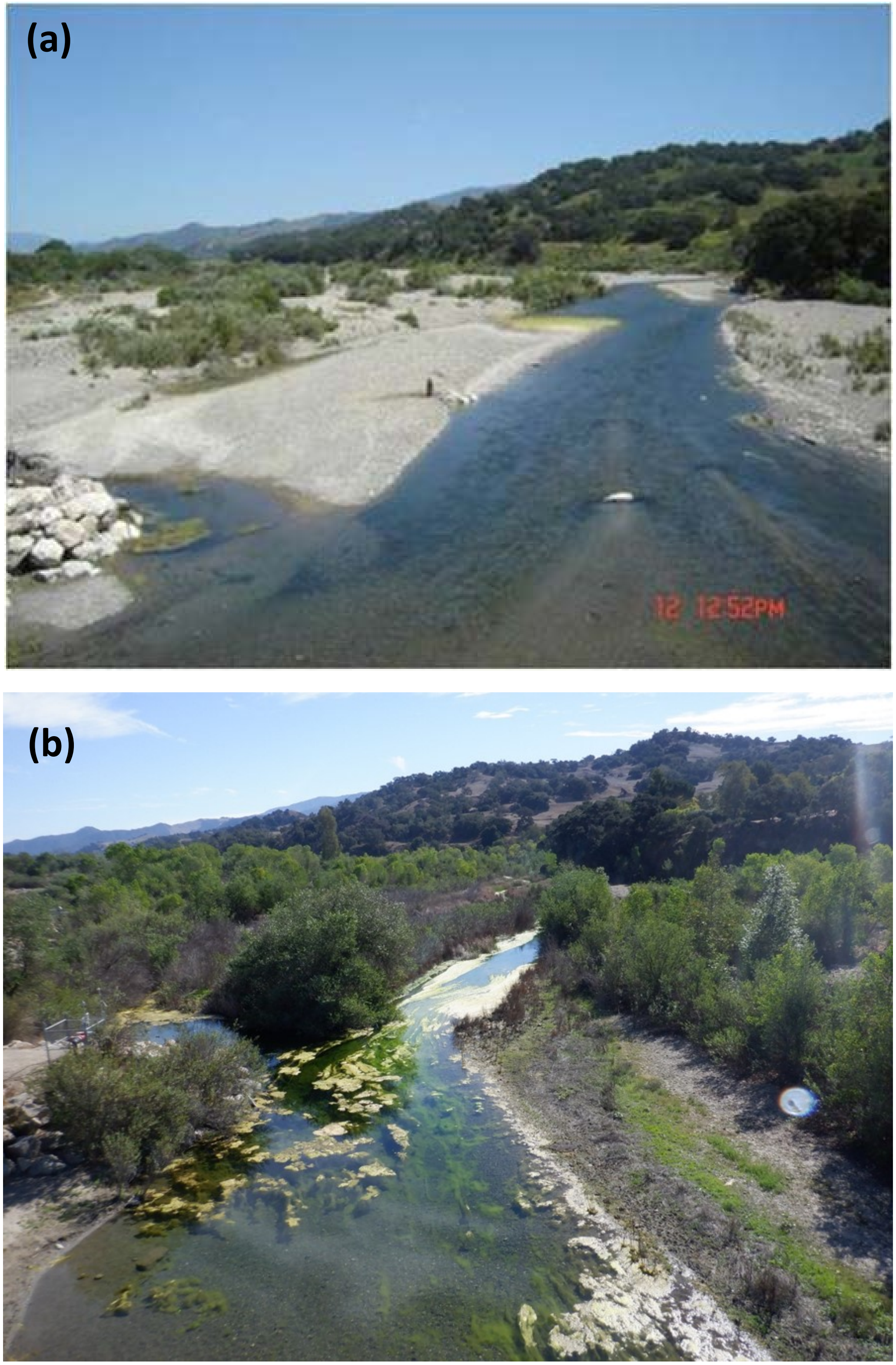


Figure 59: Photo point (M-14) collected at Alisal Bridge looking upstream in a) May 2005, and b) October 2022.

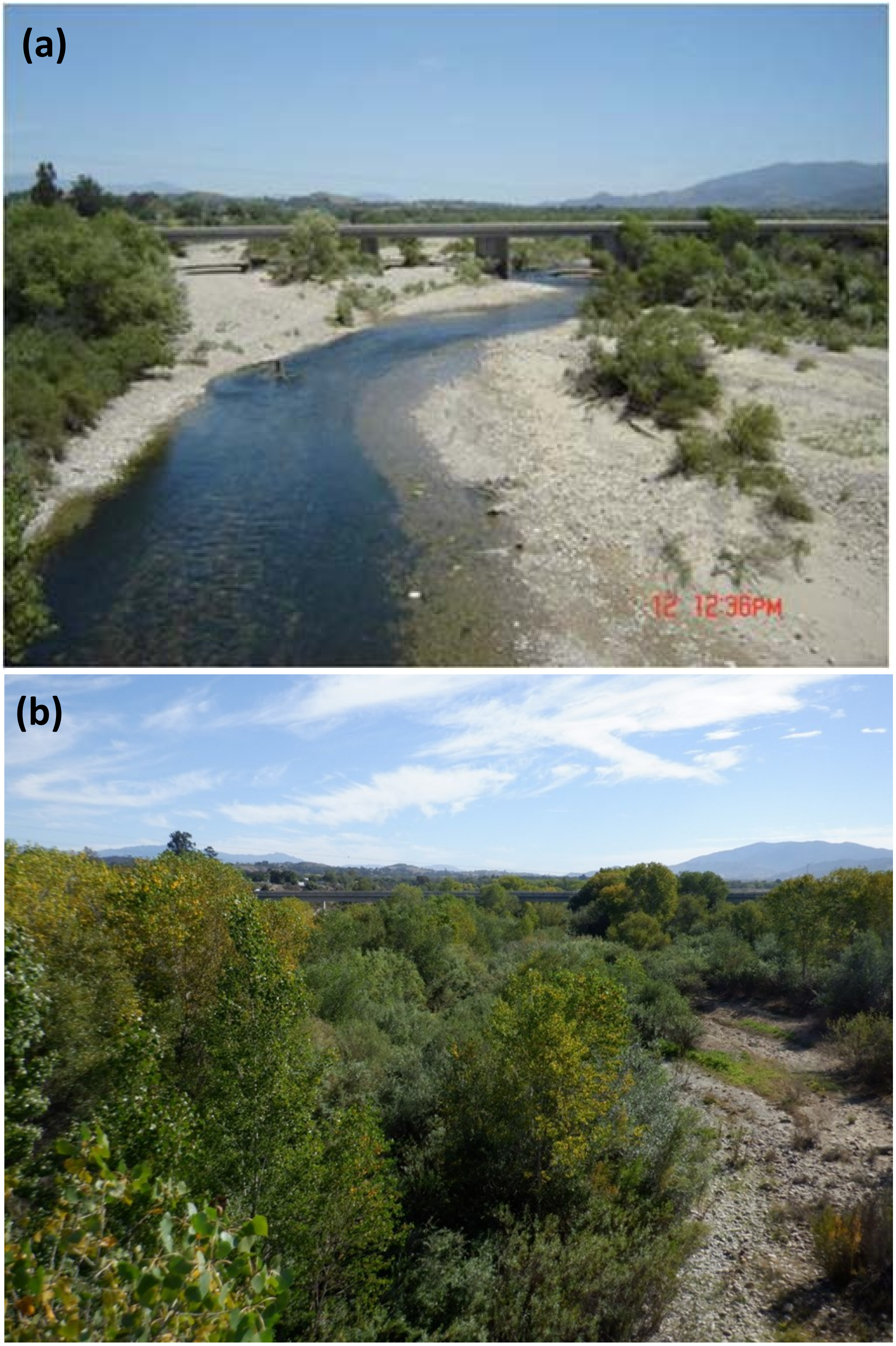


Figure 60: Photo point (M-19) collected at Avenue of the Flags Bridge looking upstream in (a) May 2005, and (b) October 2022.

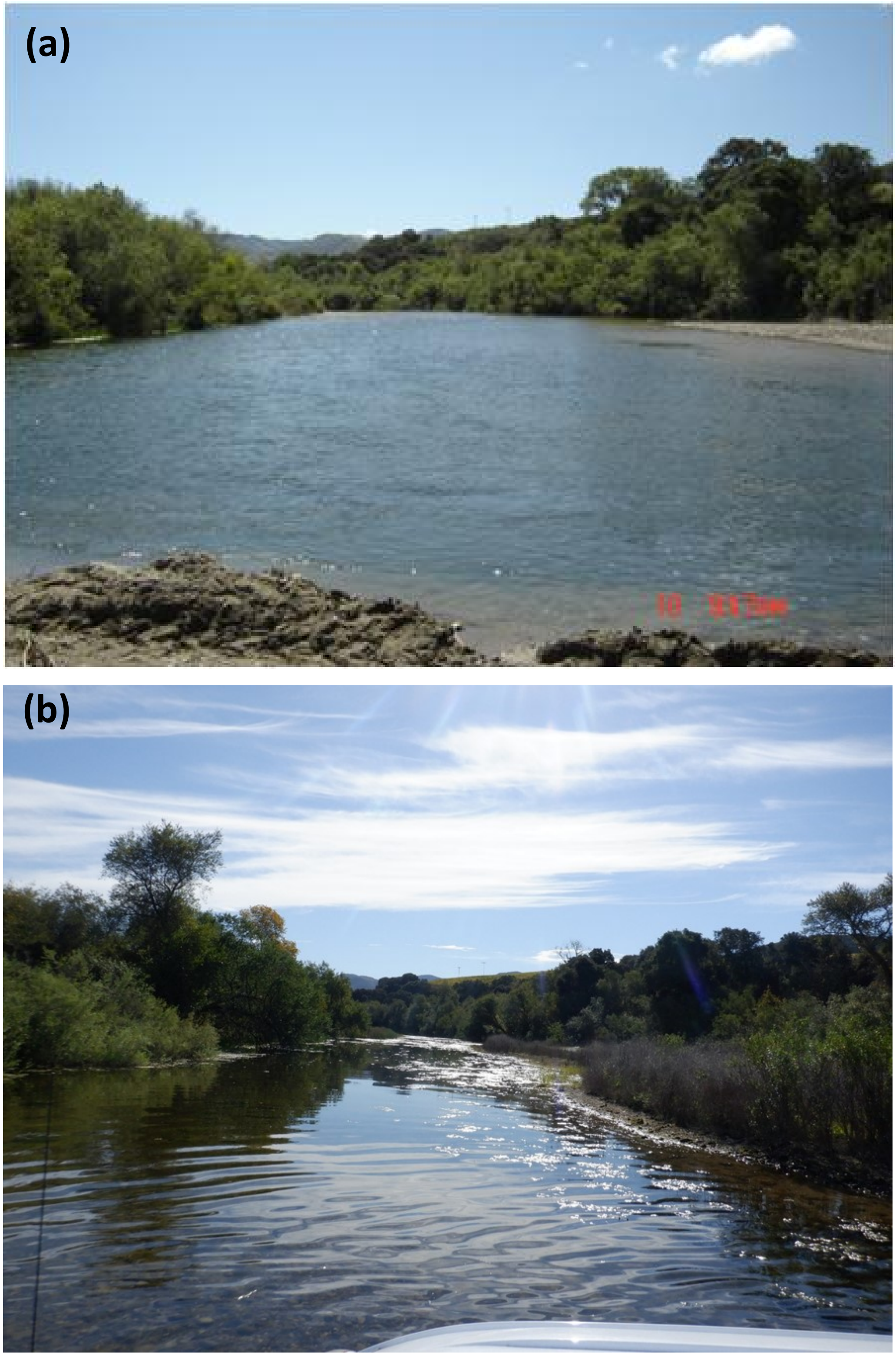


Figure 61: Photo point (M-21) collected at Sweeney Road Crossing looking upstream in (a) May 2005, and (b) October 2022.

Figure 62: Photo point (T-1) collected at Hilton Creek looking upstream towards the trap site on (a) May 2005, and (b) May 2022.

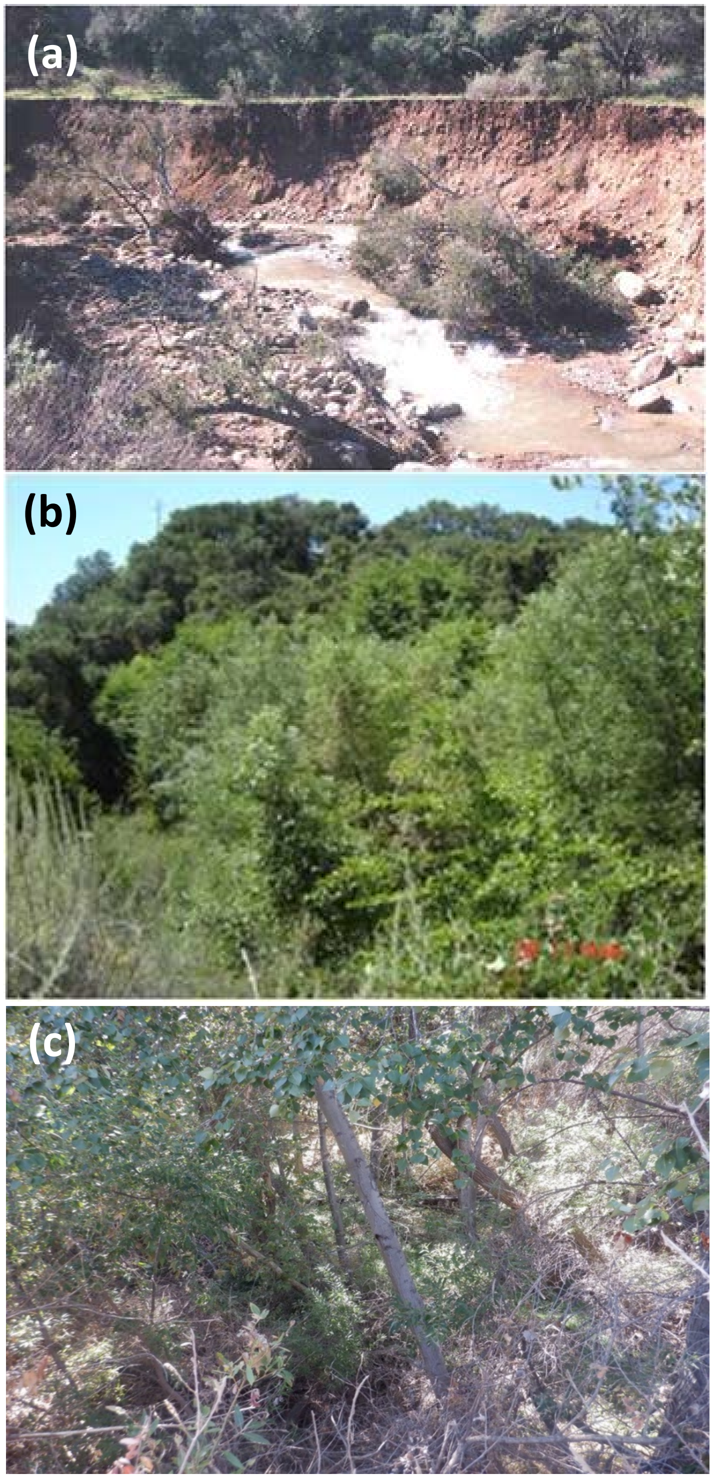


Figure 63: Photo point (T-6) collected at the Hilton Creek ridge trail looking upstream in (a) March 1999, (b) May 2005, and (c) October 2022; the creek is nearly invisible now from this vantage point.

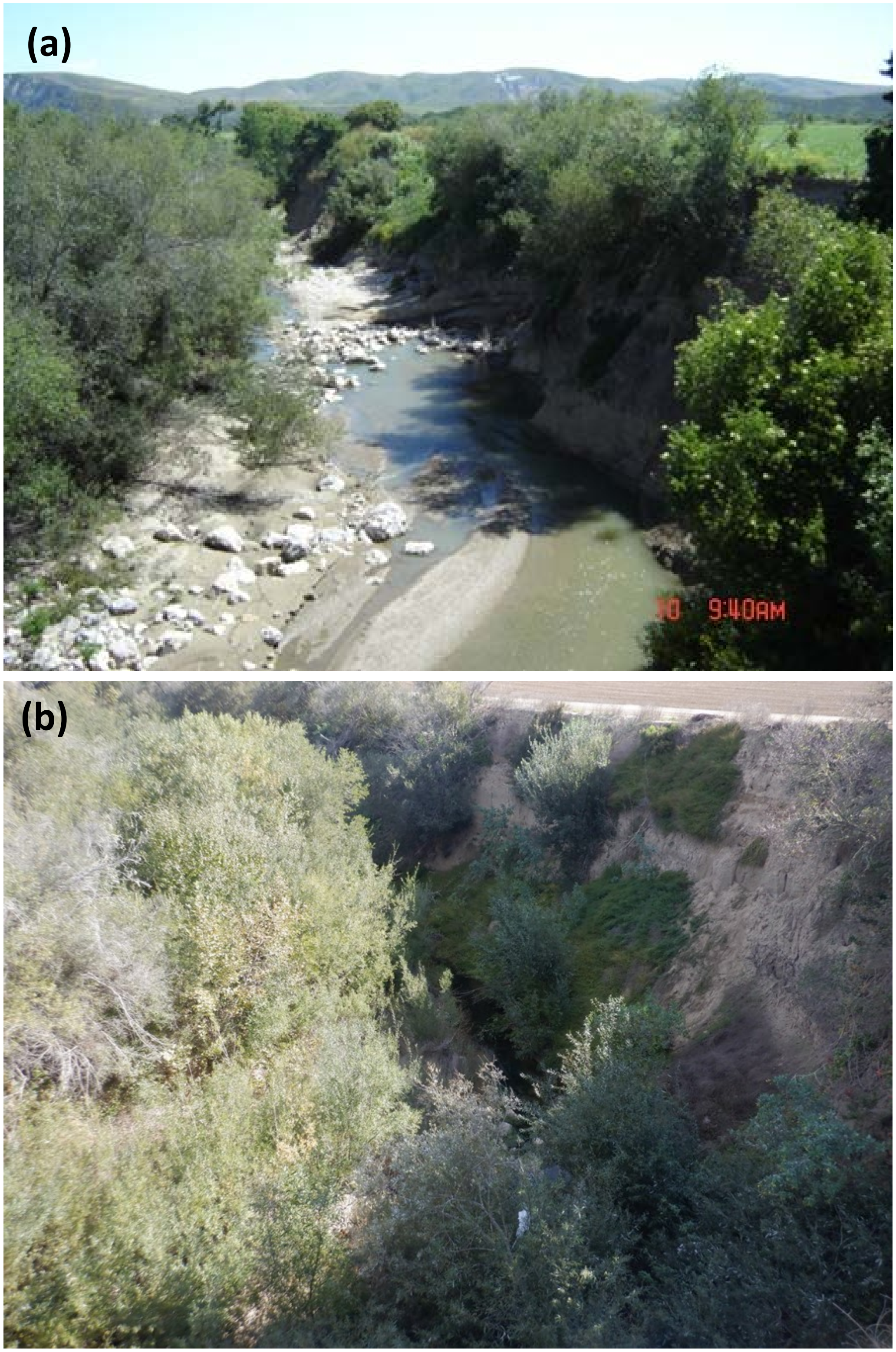


Figure 64: Photo point (T-28) collected at Salsipuedes Creek at Santa Rosa Bridge in (a) May 2005 and (b) October 2022.

Figure 65: Photo point (T-39) collected at Salsipuedes Creek at Hwy 1 Bridge in May 2005 and (b) October 2022 (Post CalTrans Hwy 1 Bridge Replacement Project).

Figure 66: Photo point (T-42) collected at Salsipuedes Creek at Jalama Road Bridge in May 2005 and (b) October 2022.

3.4 Migrant Trapping

Table 7: WY2022 migrant trap deployments.

Location	Date Traps Deployed	Date Trap Removed	Date Traps Removed (take limit)	Date Traps Installed (take limit)	# of Days Not Trapping	Functional Trapping Days	Functional Trapping %
	(dates)	(dates)	(dates)	(dates)	(days)	(days)	(days)
Hilton	2/1/2022	4/19/2022					
	Total:	78		**Total:**	0	78	100%
Salsipuedes	No trapping conducted						
	Total:			**Total:**	0	0	
Mainstem	No trapping conducted						
	Total:			**Total:**	0	0	

Table 8: WY2022 *O. mykiss* 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	97	~	78	78	100.0	1.24	~	1.24	1.5	1.5
Hilton DN	~	85	78	78	100.0	~	1.09	1.09	1.5	1.5
Salsipuedes	ND									
LSYR Mainstem	ND									

ND: No data, traps not deployed.

Table 9: Number of *O. mykiss* migrant captures, including recaptures but not young-of-the-year, associated with each trap check at each trapping location over 24-hours in WY2022.

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	39	7	5	46		97
	Downstream	17	4	1	63		85
	Total:	56	11	6	109		182
Salsipuedes	Upstream	No Trapping Conducted					
	Downstream						
	Total:						
Mainstem	Upstream	No Trapping Conducted					
	Downstream						
	Total:						

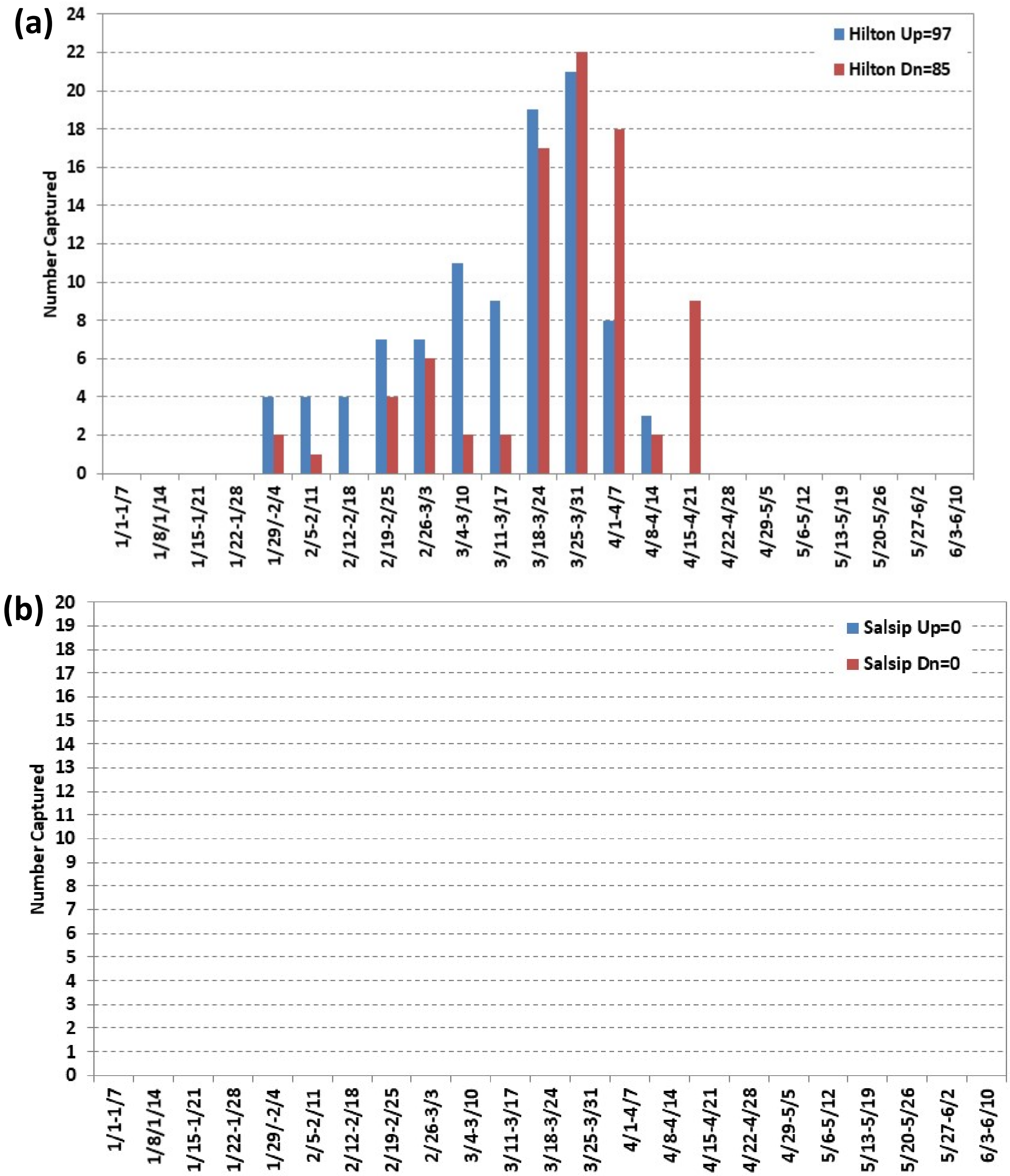


Figure 67: WY2022 paired histogram of weekly upstream and downstream *O. mykiss* captures by trap site for (a) Hilton Creek and (b) Salsipuedes Creek; no trapping was conducted in Salsipuedes Creek due to low flow conditions.

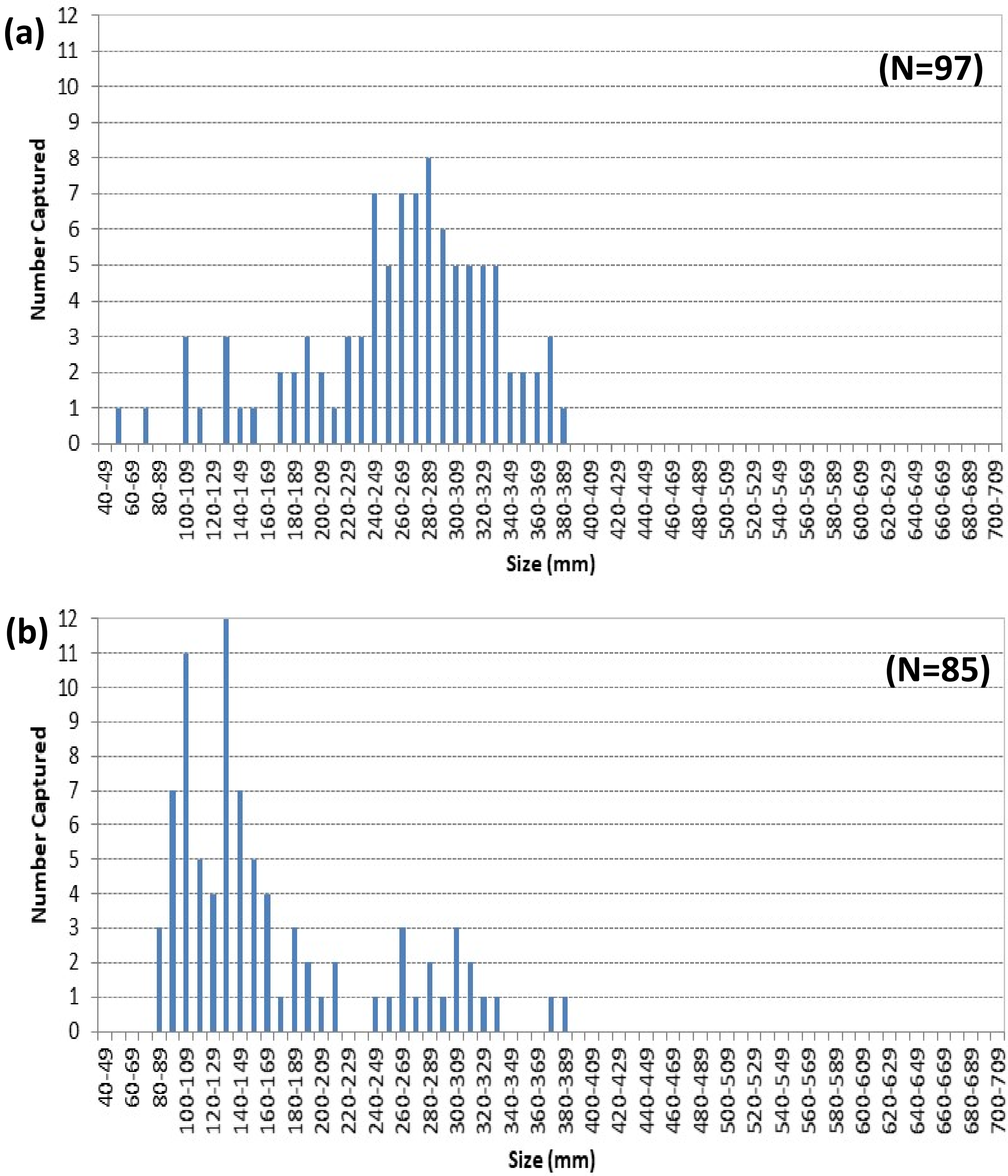


Figure 68: WY2022 Hilton Creek trap length-frequency histogram in 10-millimeter intervals for (a) upstream and (b) downstream *O. mykiss* migrant captures.

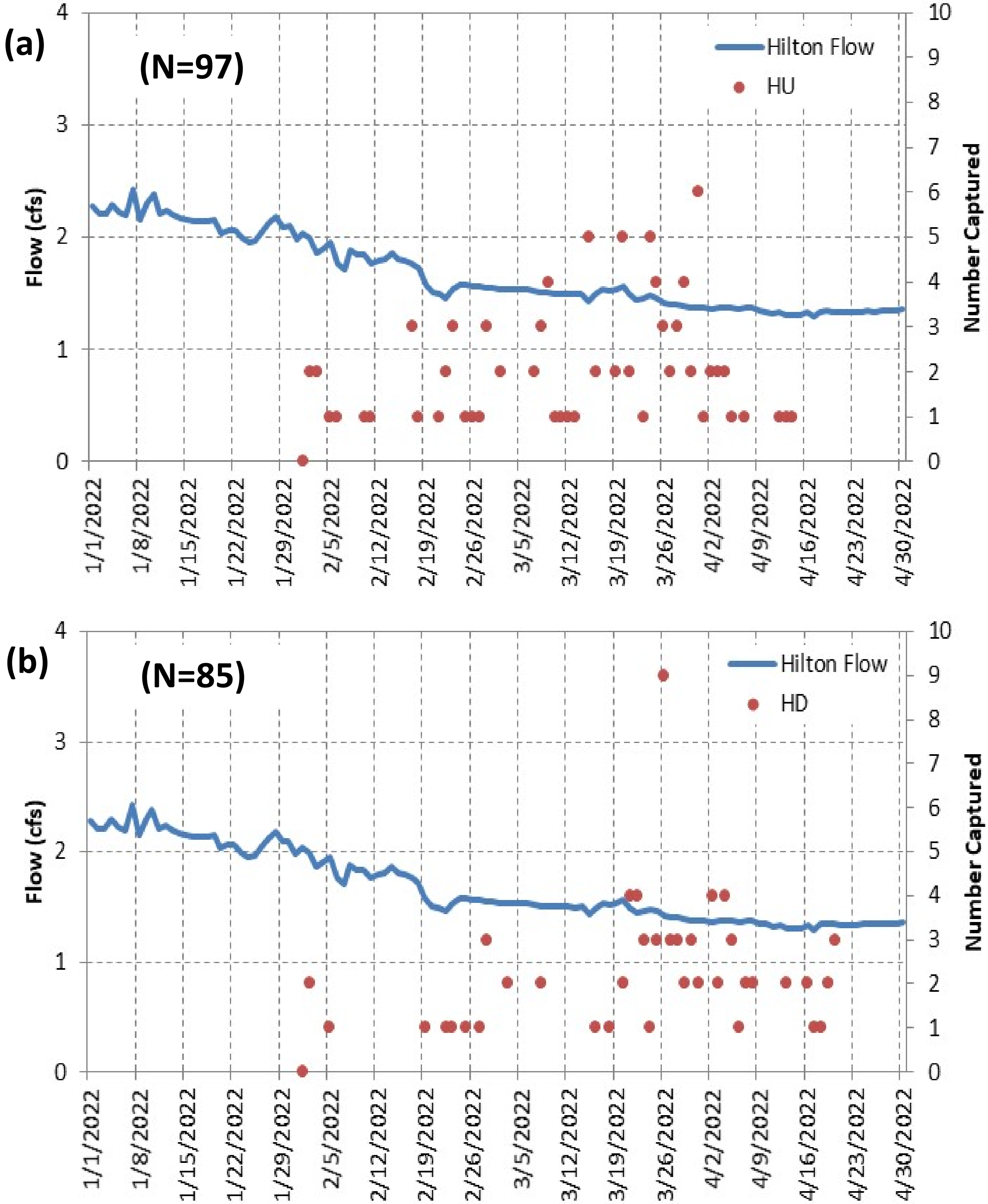


Figure 69: WY2022 Hilton Creek *O. mykiss* migrant captures (red dots) vs. flow for (a) upstream migrant captures and (b) downstream migrant captures. Trapping started on 2/1/22 and ended on 4/19/22 due to NOAA take issues.

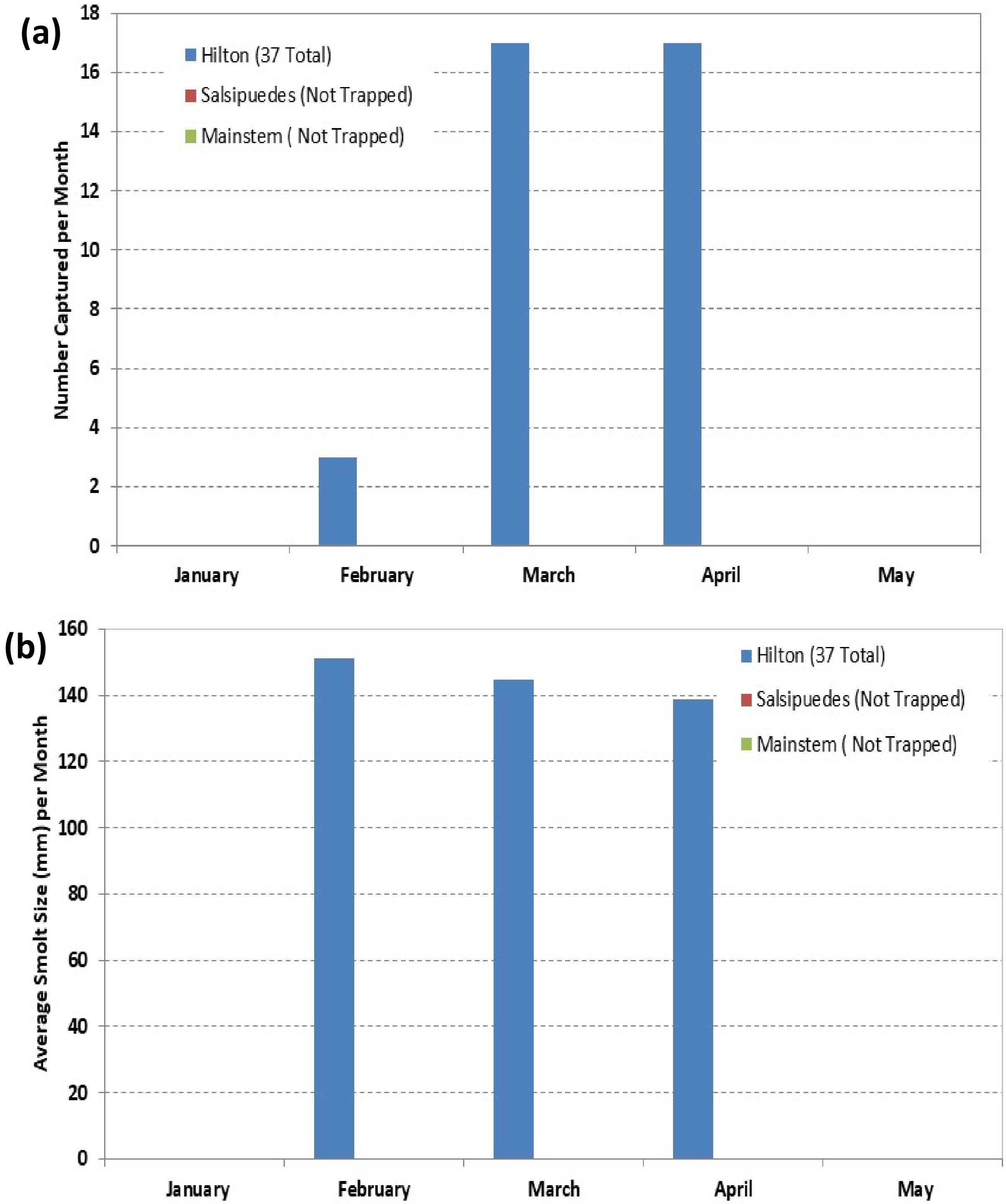


Figure 70: Monthly *O. mykiss* smolts captured at the Hilton Creek, Salsipuedes Creek, and LSYR mainstem traps in WY2022 showing: (a) number of smolts captured and (b) average size of smolts captured at each site by month.

Table 10: Tributary upstream and downstream *O. mykiss* migrant captures for Hilton Creek and Salsipuedes Creek and the Santa Ynez River mainstem in WY2022; blue lettering represents breakdown of smolts, pre-smolts, and resident trout for each size category.

Hilton Captures		Size		Salsipuedes Captures
(#)		(mm)		(#)
		Upstream Traps		
0		>700		
0		650-699		
0		600-649		
0		550-599		
0		500-549		
0		450-499		
0		400-449		
30		300-399		
49		200-299		
16		100-199		
2		<99		
97		**Total**		
		Downstream Traps		
0		>700		
0		650-699		
0		600-649		
0		550-599		
0		500-549		
0		450-499		
0		400-449		
9		300-399		
12		200-299		
	0	***Smolts***		
	0	***Pre-Smolt***		
	12	***Res***		
54		100-199		
	11	***Smolts***		
	25	***Pre-Smolt***		
	18	***Res***		
10		<99		
	0	***Smolts***		
	1	***Pre-Smolt***		
	9	***Res***		
85		**Total**		

Table 11: The results of WY2022 scale analyses of *O. mykiss* migrant captures and carcasses found over the monitoring period aggregated by 10 mm size classes.

		Age:									
Size (mm)	**Amount**	**0+**	**1**	**1+**	**2**	**2+**	**3**	**3+**	**4**	**4+**	**5**
<120	**			2							
120-129	***			3							
130-139	************			12							
140-149	******			4	2						
150-159	*******			5		2					
160-169	***					3					
170-179	***			1		2					
180-189	***					3					
190-199	***				1	2					
200-209	***					3					
210-219											
220-229	**					2					
230-239	**							2			
240-249	****					1	1	2			
250-259	***						2	1			
260-269	****						1	3			
270-279	****							4			
280-289	****						2	2			
290-299	*****							5			
300-309	***							3			
310-319	**							1		1	
320-329	**							1	1		
330-339	**							1	1		
340-349	*						1				
350-359											
360-369	*							1			
370-379	****							1	2	1	
380-389	*								1		
390-399											
Total:	**89**	**0**	**0**	**27**	**3**	**18**	**7**	**27**	**5**	**2**	**0**

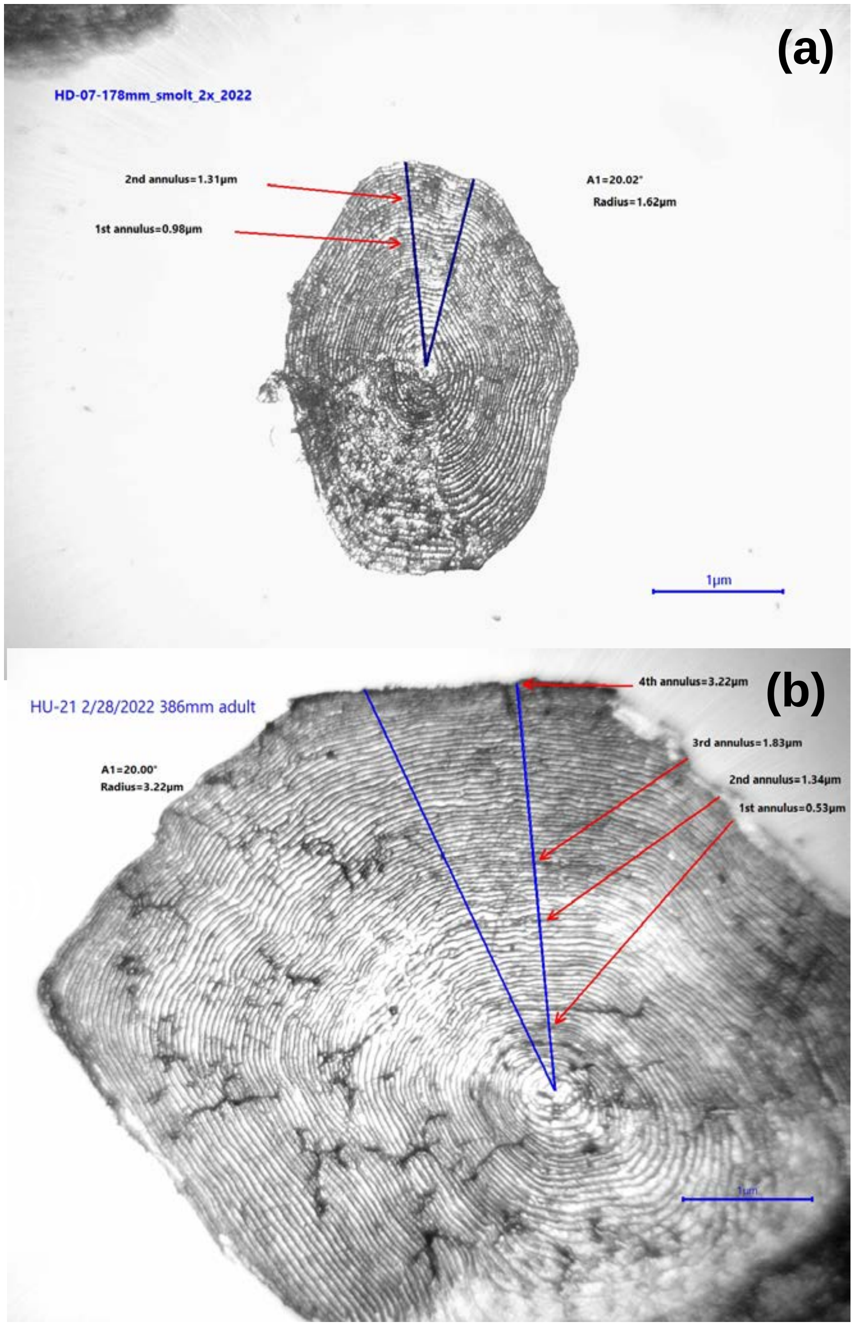
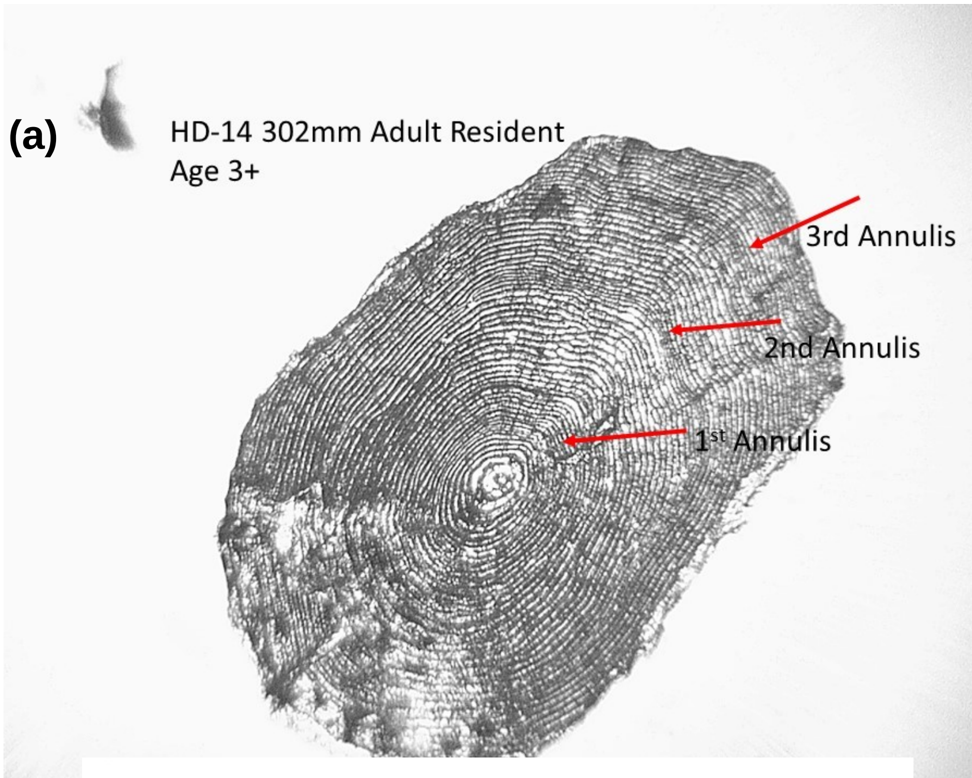


Figure 71: Examples of *O. mykiss* scale analyses for (a) a 2+ year old Hilton Creek 178 mm downstream migrating smolt, and (b) and a 4 year old Hilton Creek 386 mm upstream migrating resident fish.



(b)

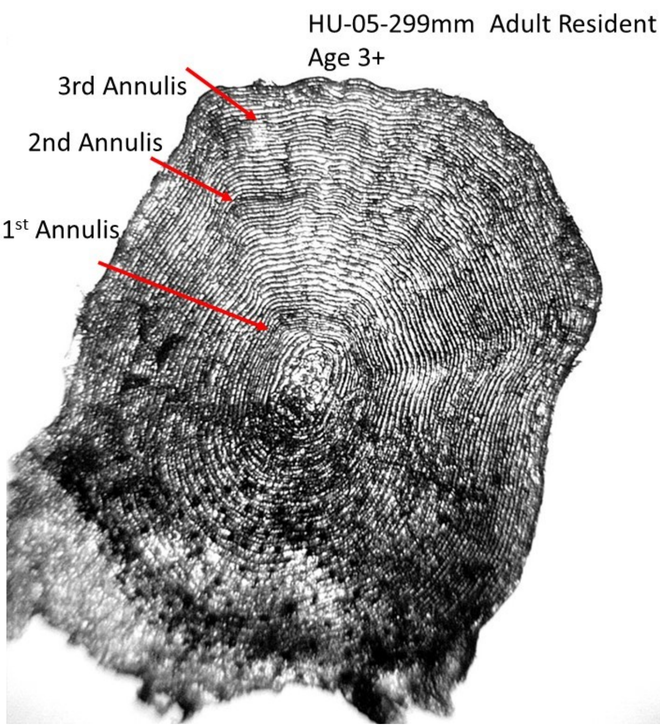


Figure 72: WY2022 scales showing (a) a downstream migrating 302 mm resident adult aged at 3+ and (b) an upstream migrating 299 mm resident adult aged at 3+.

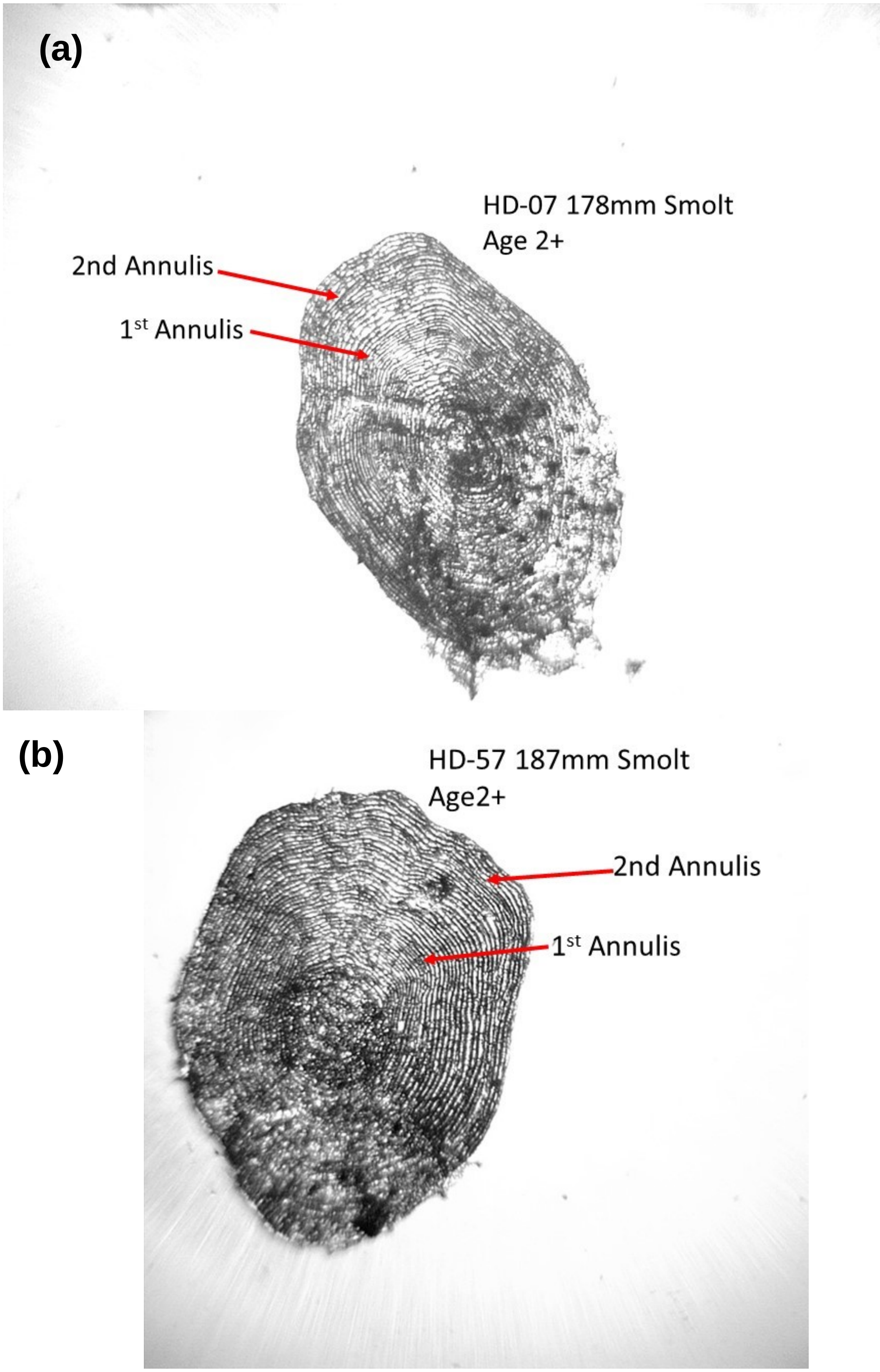


Figure 73: WY2022 scales showing (a) a downstream migrating 178 mm smolt aged at 2+ and (b) a downstream 187 mm smolt aged at 2+.

Table 12: WY2022 *O. mykiss* redd survey results for the tributaries (Upper Salsipuedes, El Jaro, Quiota, and Hilton creeks) and LSYR mainstem; lengths and widths are given in feet.

Location	Date	Redd #	Length*	Width**
Hilton Creek	1/3/2022	1	3.5	1.8
	1/27/2022	2	2.6	1.2
	1/27/2022	3	3.3	1.5
	1/27/2022	4	3.0	1.3
	1/27/2022	5	4.1	1.7
	1/27/2022	6	3.2	1.4
	1/27/2022	7	3.0	1.4
	2/9/2022	8	5.1	1.9
	2/9/2022	9	3.9	1.8
	2/9/2022	10	2.9	1.3
	2/9/2022	11	3.6	2.1
	2/9/2022	12	2.6	1.3
	2/9/2022	13	3.2	1.3
	2/9/2022	14	2.9	1.4
	2/14/2022	15	4.3	1.2
	2/17/2022	16	3.5	1.8
	2/17/2022	17	4.5	1.8
	2/17/2022	18	2.7	1.7
	3/1/2022	19	3.7	1.6
	3/22/2022	20	3.3	1.7
	3/22/2022	21	2.7	1.3
	3/22/2022	22	3.2	1.4
	3/22/2022	23	5.9	1.7

Location	Date	Redd #	Length*	Width**
Salsipuedes Creek	2/8/2022	1	3.6	1.5
	2/8/2022	2	3.4	2.0
	2/8/2022	3	3.7	1.3
	2/8/2022	4	3.0	1.3
	3/2/2022	5	4.5	1.6
	3/2/2022	6	4.0	1.7
	3/2/2022	7	3.9	1.6
	3/2/2022	8	3.5	1.4
	3/2/2022	9	2.5	0.9
	3/3/2022	10	4.2	1.5
	3/3/2022	11	2.3	1.1
	3/3/2022	12	2.2	1.1
	3/3/2022	13	2.2	0.7
	3/3/2022	14	3.4	1.6
	3/3/2022	15	1.9	0.9
	3/3/2022	16	4.2	1.4
El Jaro Creek	3/8/2022	1	4.7	1.8
	3/8/2022	2	2.8	1.4
Quiota Creek	1/26/2022	1	1.9	0.9
	4/7/2022	2	2.0	1.0
Highway 154	3/1/2022	1	3.7	1.5

* Pit length plus tailspill length.

** Average of pit width and tailspill widths.

Table 13: WY2022 tributary redd observations by month for each creek surveyed.

	January	February	March	April	May	Total
Hilton Ck	7	11	5	0	n/s	23
Quiota Ck	1	0	0	1	n/s	2
Salsipuedes Ck	0	4	12	0	n/s	16
El Jaro Ck	0	0	2	0	n/s	2
Los Amoles CK	n/s	n/s	n/s	n/s	n/s	n/s
Ytias Ck	n/s	n/s	n/s	n/s	n/s	n/s
					Total:	**43**

n/s - not surveyed due to trubid conditions or low water level.

Table 14: WY2021 LSYR mainstem redd survey results within the management reaches (Refugio and Alisal) by month.

	January	February	March	April	May	Total
Highway 154	n/s	0	1	n/s	n/s	1
Refugio Reach	n/s	0	0	n/s	n/s	0
Alisal Reach	n/s	n/s	n/s	n/s	n/s	n/s
Narrows Reach	n/s	n/s	n/s	n/s	n/s	n/s
					Total:	**1**
n/s - not surveyed due to trubid conditions or low water level.						

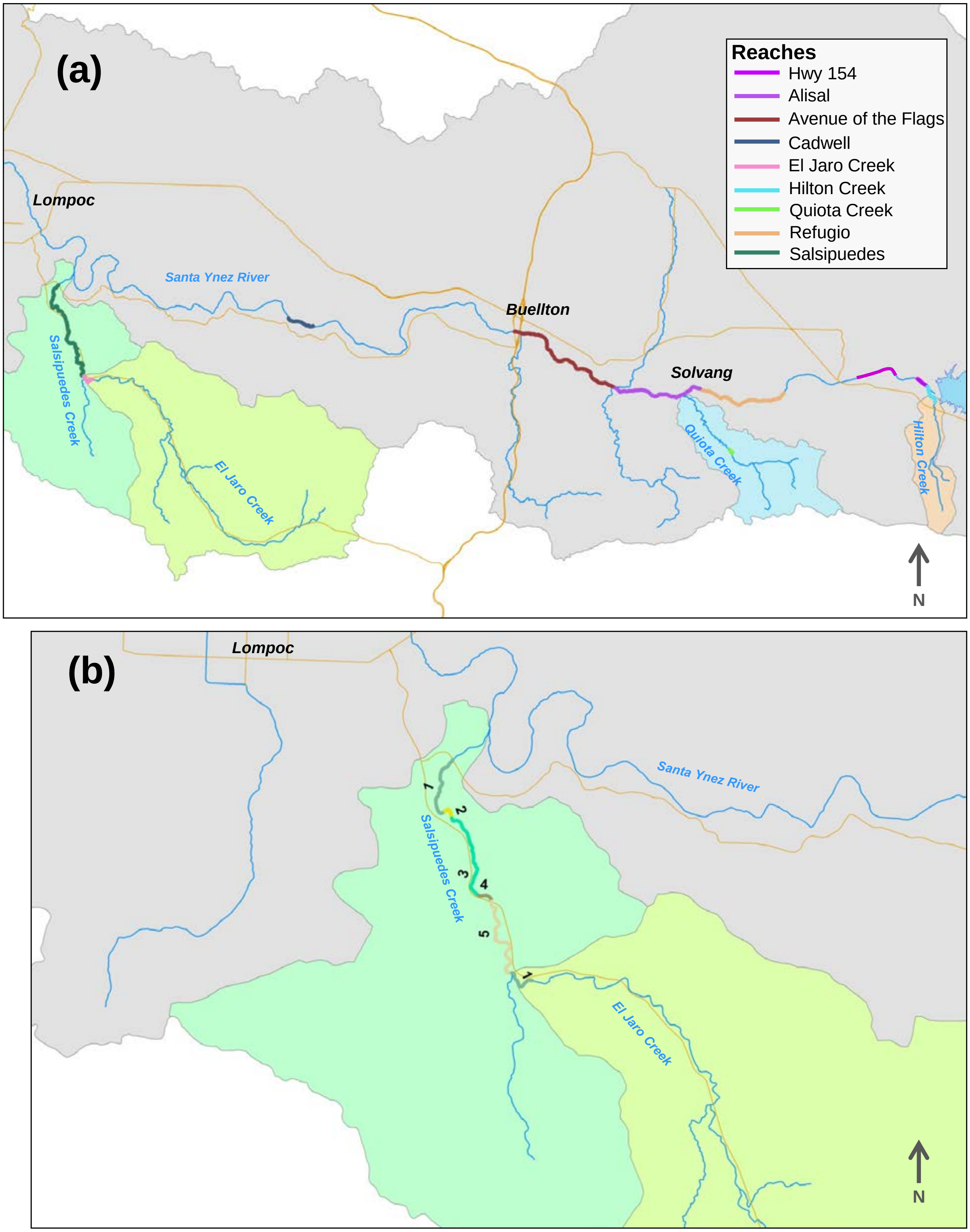


Figure 74: Stream reaches snorkel surveyed in 2022 with suitable habitat and where access was granted within the (a) LSYR mainstem and its tributaries, and (b) Salsipuedes Creek.

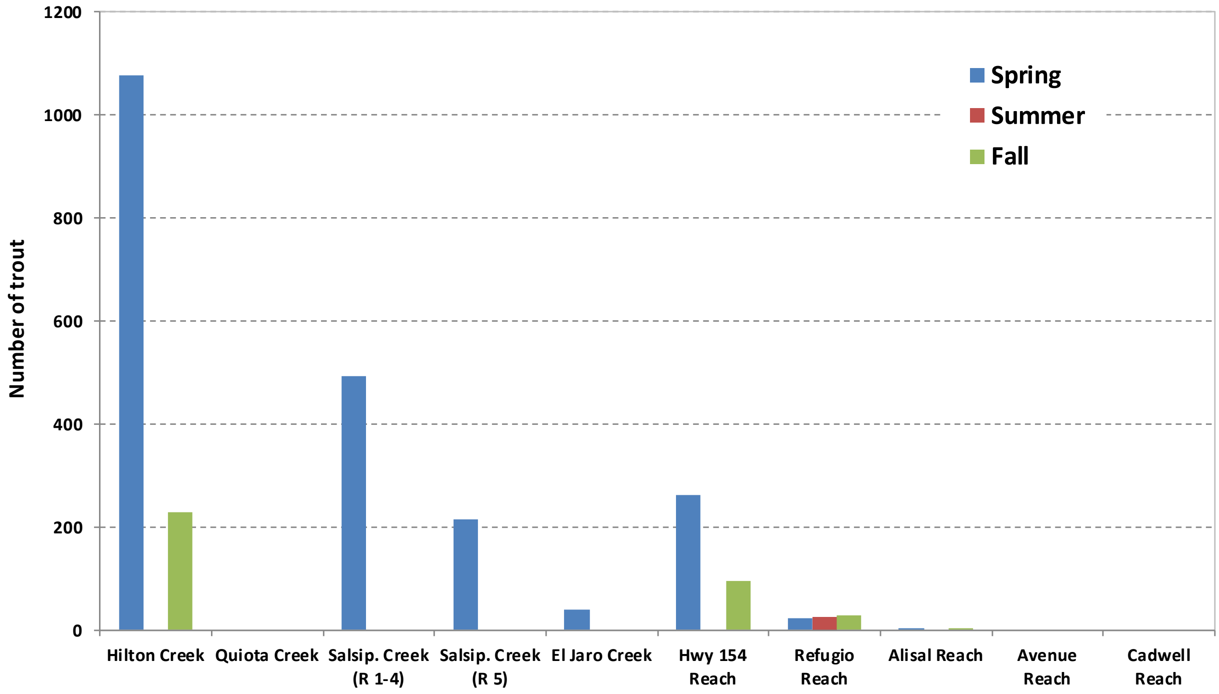


Figure 75: 2022 LSYR *O. mykiss* observed during spring, summer, and fall snorkel surveys.

Table 15: 2022 LSYR mainstem snorkel survey schedule.

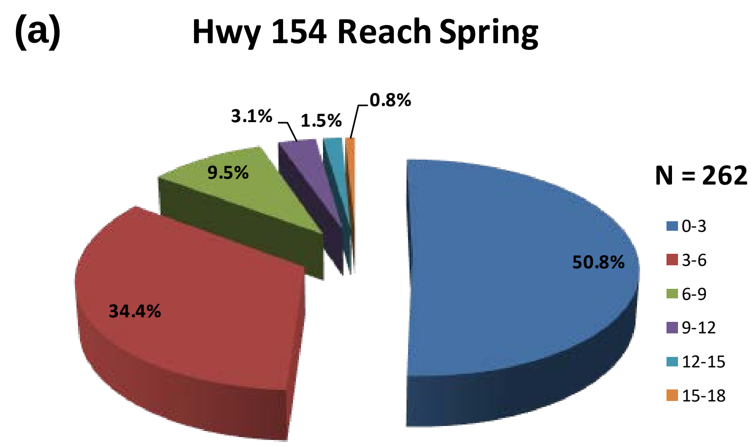
Mainstem/Stream Miles	Season	Survey Date
Hwy 154 Reach	Spring	7/15/2022
(LSYR-0.2 to LSYR-0.7)	Summer	n/s
	Fall	10/26/2022
Refugio Reach	Spring	6/1/2022
(LSYR-4.9 to LSYR-7.8)	Summer	8/1/2022
	Fall	10/6/22 & 10/12/22-10/13/22
Alisal Reach	Spring	6/2/22 - 6/6/22
(LSYR-7.8 to LSYR-10.5)	Summer	8/10/22 - 8/11/22
	Fall	10/13/22 & 10/17/22
Avenue Reach	Spring	n/s
(LSYR-10.5 to LSYR-13.9)	Summer	8/11/22 - 8/12/22
	Fall	10/17/22 - 10/18/22
Reach 3 Downstream of Avenue	Spring	n/s
(LSYR-13.9 to LSYR-25.0)	Summer	8/15/2022
	Fall	10/19/2022

Table 16: LSYR mainstem spring, summer, and fall snorkel survey results in 2022 with the miles surveyed; the level of effort was the same for each snorkel survey.

LSYR Mainstem	Spring (# of *O. mykiss*)	Summer (# of *O. mykiss*)	Fall (# of *O. mykiss*)	Survey Distance (miles)
Hwy 154 Reach	262		97	0.26
Refugio Reach	23	26	29	2.95
Alisal Reach	2	0	0	2.80
Avenue of the Flags Reach		0	0	3.4
Cadwell Reach		0	0	0.3

Table 17: LSYR mainstem spring, summer, and fall snorkel survey results in 2022 broken out by three-inch size classes.

Survey	Reach	Size Class (inches)									Total
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	
Spring	Hwy 154	133	90	25	8	4	2				262
	Refugio		1	5	9	6	1	1			23
	Alisal					1	1				2
	Avenue										n/s
	Cadwell										n/s
Summer	Hwy 154										n/s
	Refugio			3	6	7	6	3	1		26
	Alisal										0
	Avenue										0
	Cadwell										0
Fall	Hwy 154	1	39	52	4		1				97
	Refugio				6	17	5	1			29
	Alisal						1				1
	Avenue										0
	Cadwell										0



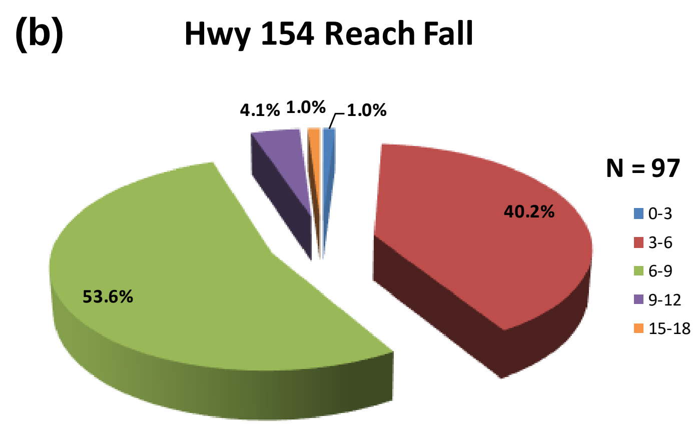


Figure 76: 2022 LSYR mainstem Hwy 154 Reach snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring and (b) fall.

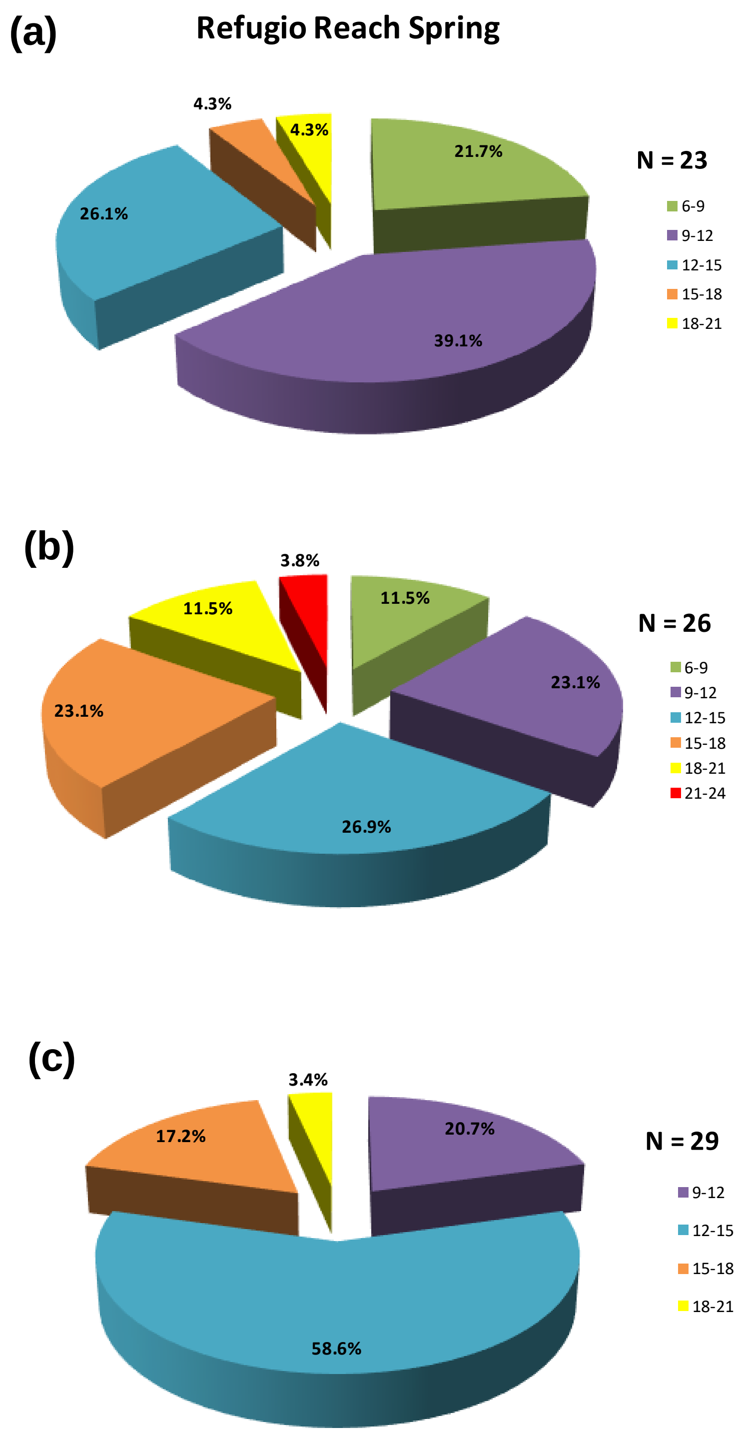


Figure 77: 2022 LSYR mainstem Refugio Reach snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, (b) summer, and (c) fall.

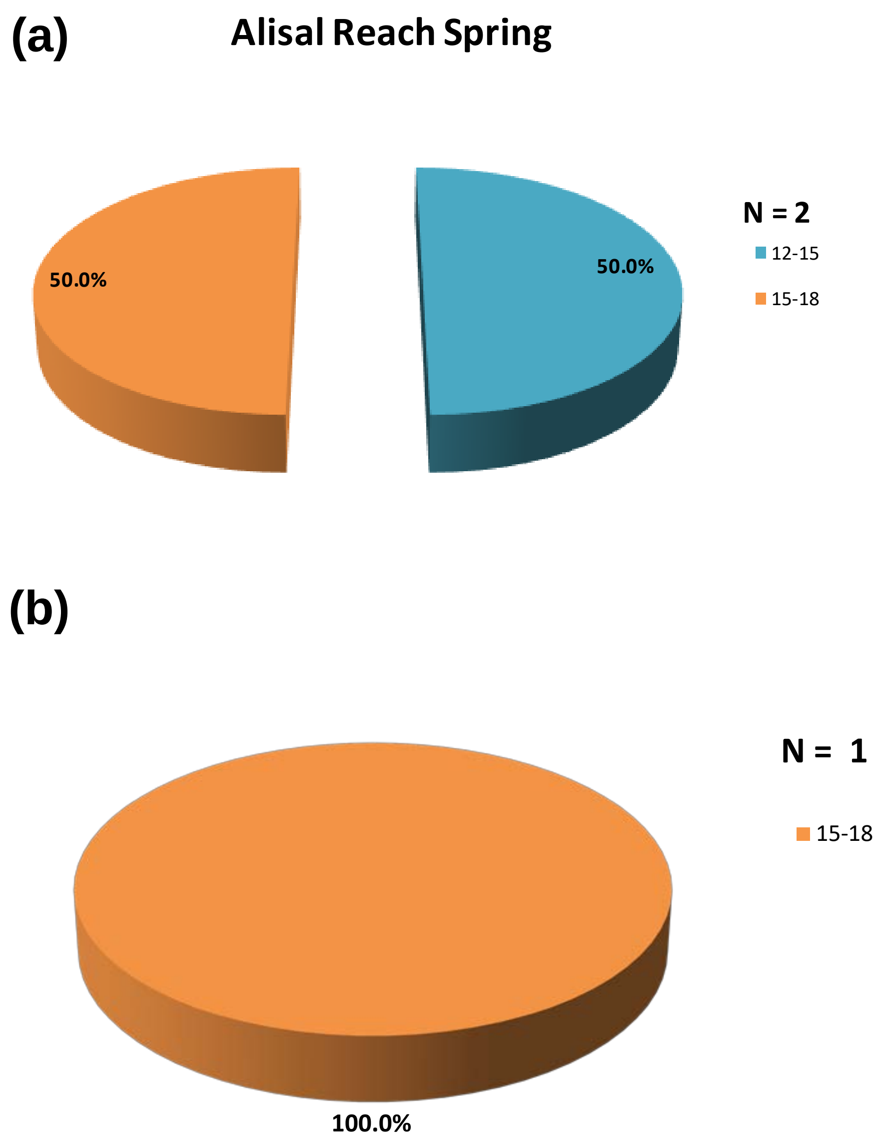


Figure 78: 2022 LSYR mainstem Alisal Reach snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring and (b) fall; no fish were observed in the summer.

(a) **Avenue Reach Spring/Summer/Fall**

No *O. mykiss* observed

Figure 79: 2022 LSYR mainstem Avenue of the Flags Reach snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, (b) summer, and (c) fall.

Table 18: 2022 tributary snorkel survey schedule; no summer surveys were conducted in 2022.

Tributaries/Stream Miles	Season	Survey Date
Hilton Creek	Spring	7/5/22 - 7/6/22
(HC-0.0 to HC-0.54)	Summer	n/s
	Fall	10/26/22 & 10/31/22
Quiota Creek	Spring	7/13/2022
(QC-2.58 to QC-2.73)	Summer	n/s
	Fall	11/1/2022
Salsipuedes Creek	Spring	6/15/22 - 6/16/22
(Reach 1-4)	Summer	n/s
	Fall	11/1/2022
Salsipuedes Creek	Spring	6/14/2022
(Reach 5)	Summer	n/s
	Fall	n/s
El Jaro Creek	Spring	6/14/22
(ELC-0.0 to ELC-0.4)	Summer	n/s
	Fall	n/s
*n/s - not surveyed.		

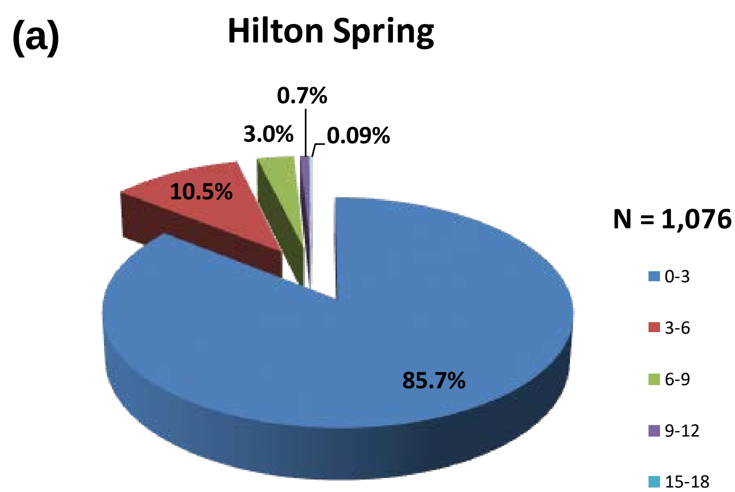
Table 19: *O. mykiss* observed and miles surveyed during all tributary snorkel surveys in 2022; the level of effort was the same for each survey.

Tributaries	Spring (# of *O. mykiss*)	Summer (# of *O. mykiss*)	Fall (# of *O. mykiss*)
Hilton Creek			
Reach 1	594		134
Reach 2	100		77
Reach 3	47		5
Reach 4	113		4
Reach 5	222		8
Reach 6			
Total:	1076		228
Quiota Creek	0		0
Salsipuedes Creek (Reach 1-4)	493		
Salsipuedes Creek (Reach 5)	215		
El Jaro Creek	39		

Table 20: 2022 tributary spring and fall snorkel survey results broken out by three-inch size classes.

Survey	Reach	Size Class (inches)									Total
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	
Spring	Hilton	922	113	32	8		1				1076
	Quiota										0
	Salsipuedes (R 1-4)	400	76	15	2						493
	Salsipuedes (R-5)	165	15	33	2						215
	El Jaro	36	2	1							39
Summer	Hilton										n/s
	Quiota										n/s
	Salsipuedes (R 1-4)										n/s
	Salsipuedes (R-5)										n/s
	El Jaro										n/s
Fall	Hilton	17	176	30	5						228
	Quiota										0
	Salsipuedes (R 1-4)										n/s
	Salsipuedes (R-5)										n/s
	El Jaro										n/s

n/s - not surveyed.



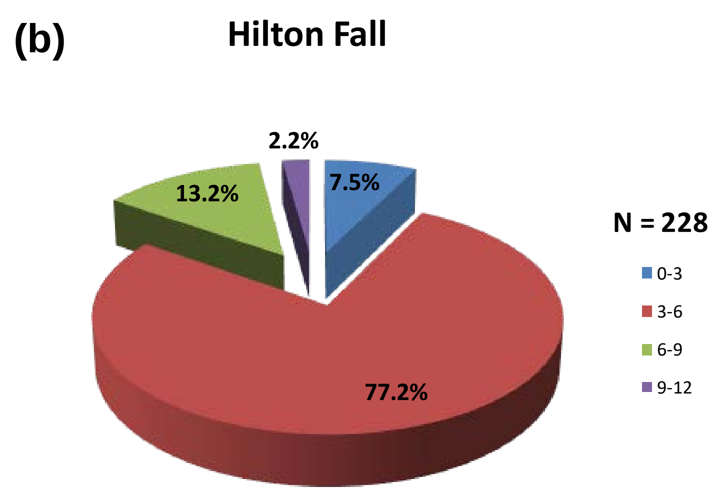


Figure 80: 2022 Hilton Creek snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, and (b) fall.

(a) **Quiota Creek Spring/Summer/Fall**

No *O. mykiss* observed

Figure 81: 2022 Quiota Creek snorkel survey results of *O. mykiss* proportioned by size class in inches; no *O. mykiss* were observed during the fall snorkel survey.

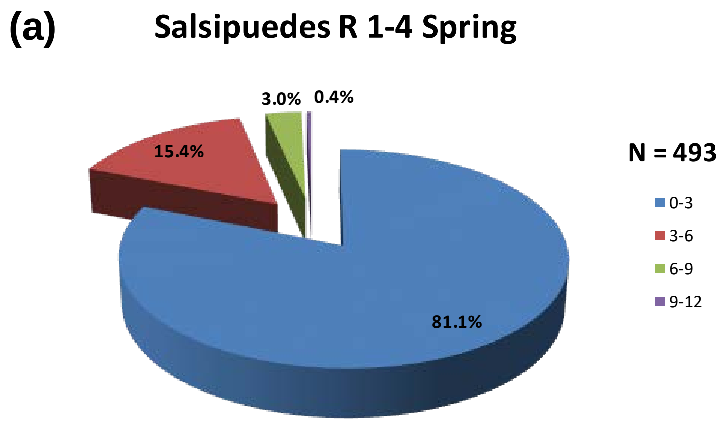


Figure 82: 2022 Salsipuedes Creek Reaches 1-4 snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, and (b) fall, no surveys were conducted due to high turbidity.

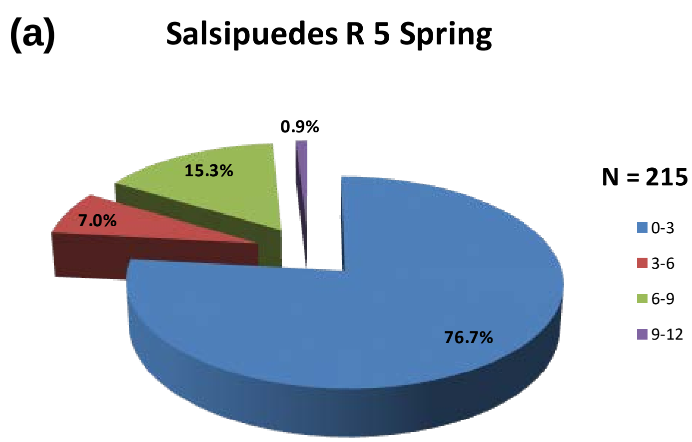


Figure 83: 2022 Salsipuedes Creek Reach 5 snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, and (b) fall, no *O. mykiss* observed.

(a)

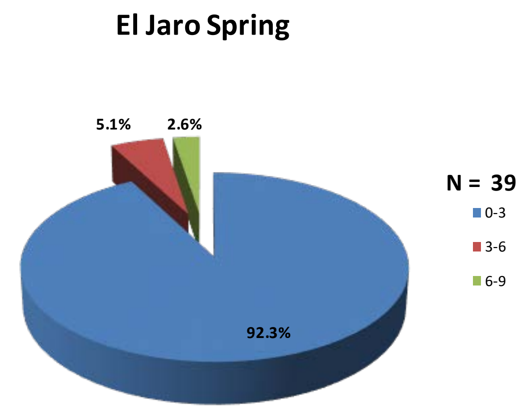
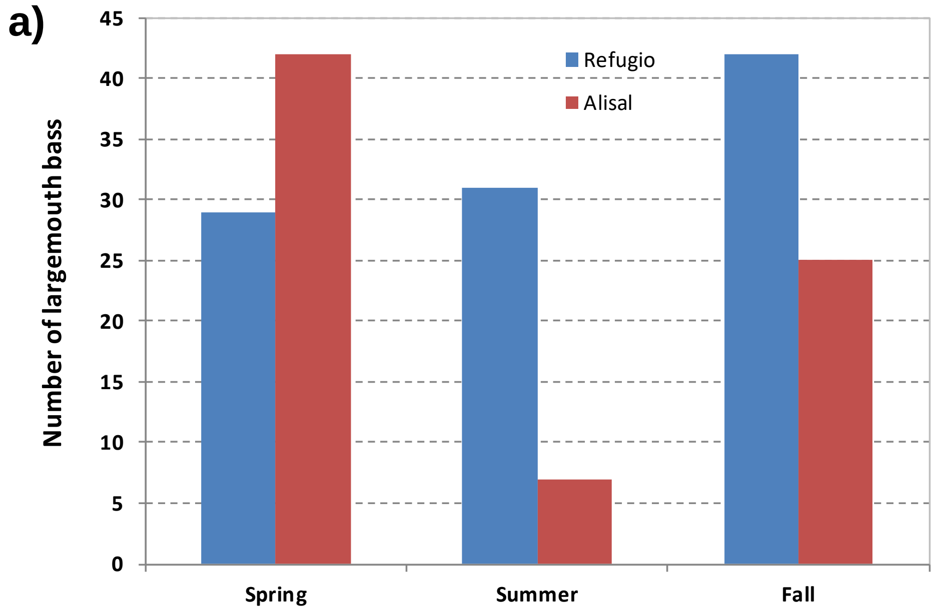


Figure 84: 2022 El Jaro Creek snorkel survey results of *O. mykiss* proportioned by size class in inches in the (a) spring, and (b) fall.



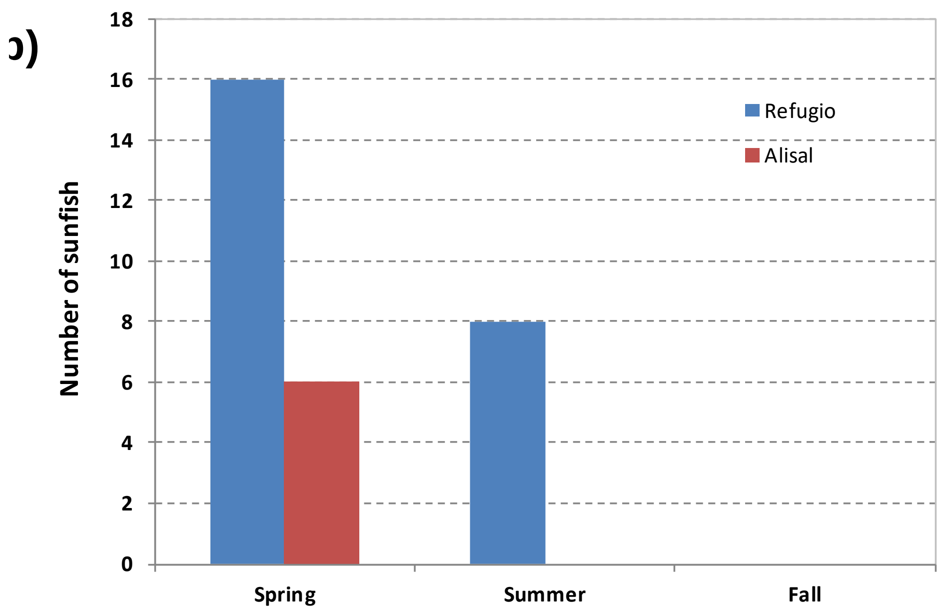


Figure 85: Count of warm water predators, (a) largemouth bass and (b) sunfish, observed in Refugio and Alisal reaches during the spring, summer, and fall snorkel surveys in 2022.

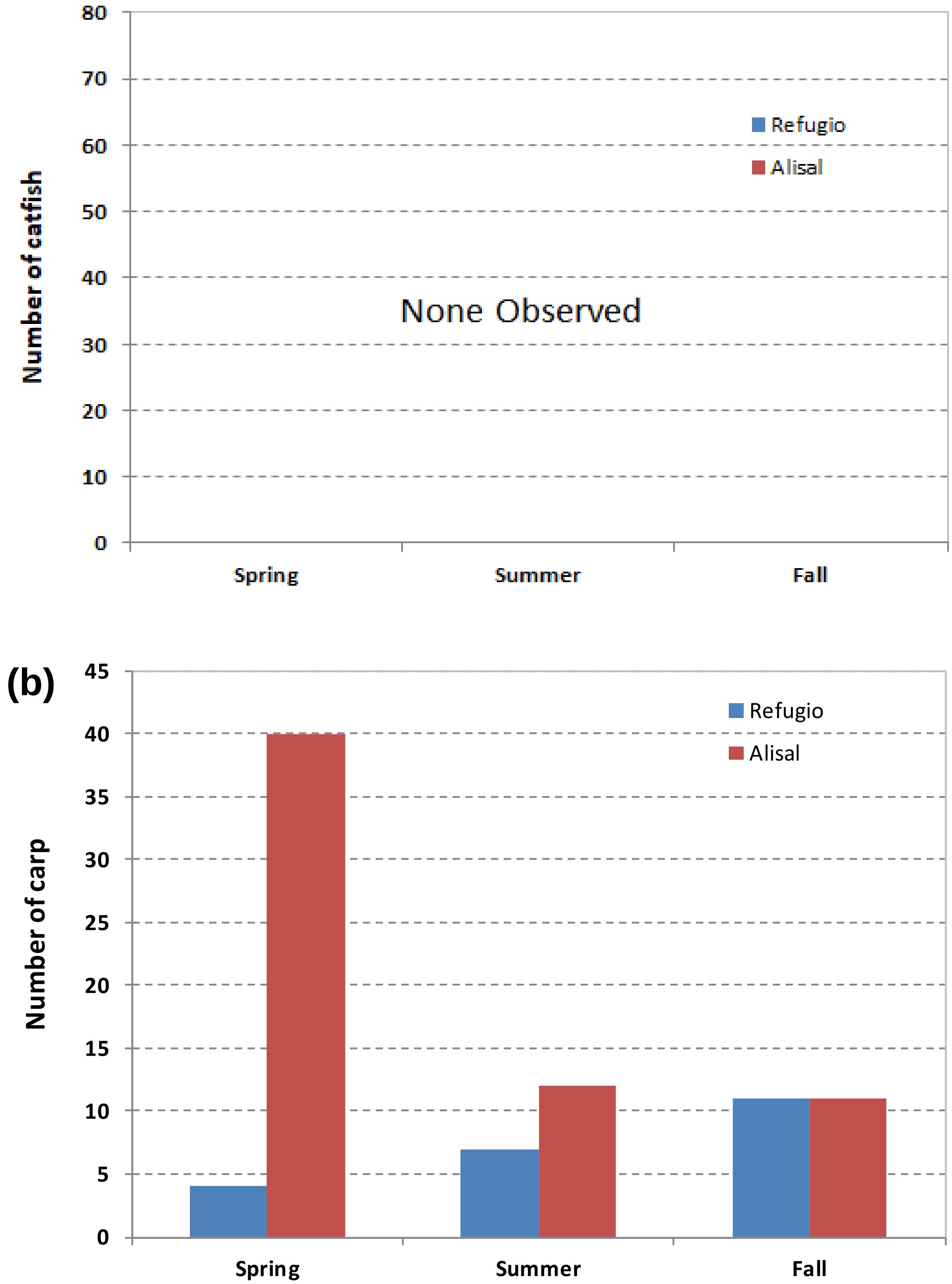
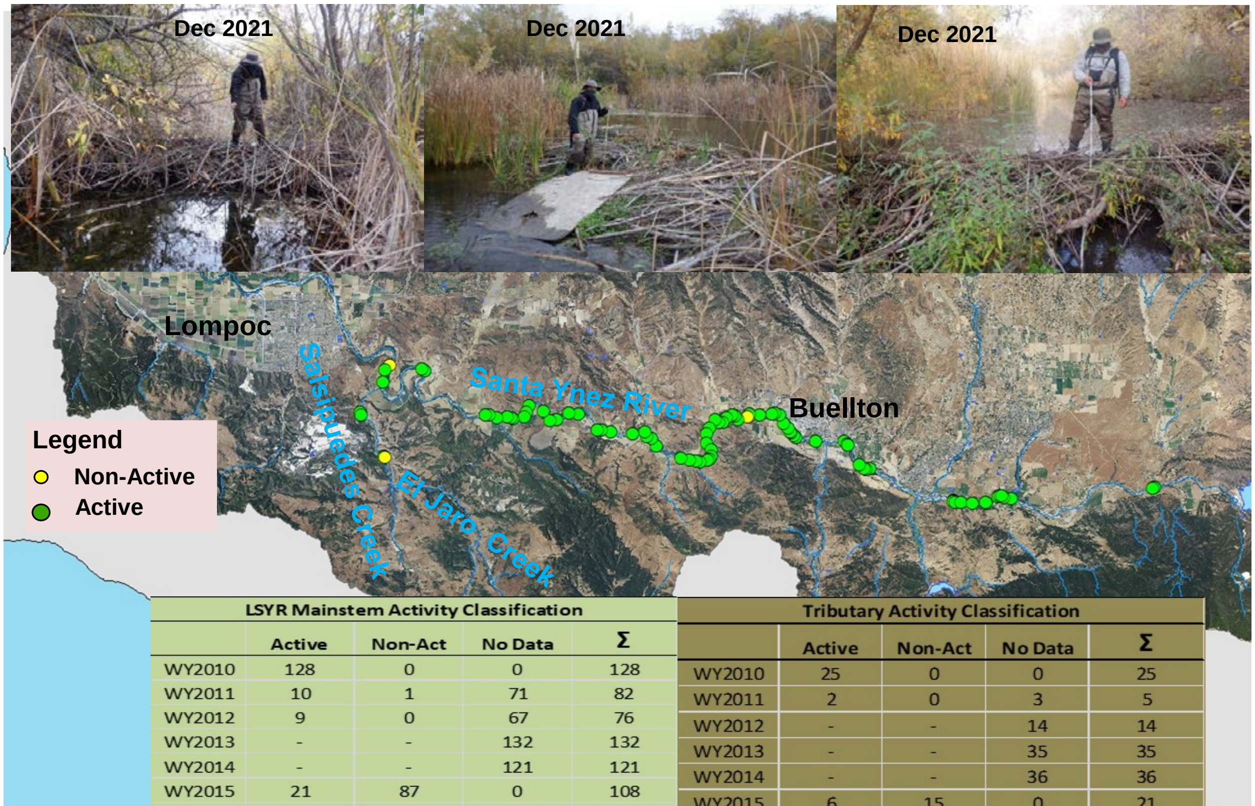


Figure 86: Count of warm water predators, (a) catfish and (b) carp, observed in Refugio and Alisal reaches during the spring, summer, and fall snorkel surveys in 2022.



LSYR 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
WY2018	37	10	0	47
WY2019	42	3	0	45
WY2020	43	15	0	58
WY2021	73	7	0	80
WY2022	76	3	0	79

* Additional reaches surveyed from previous year.
- Indicates limited attribute data taken at each dam site.

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
WY2018	0	2	0	2
WY2019	0	0	0	0
WY2020	2	0	0	2
WY2021	11	0	0	11
WY2022	3	1	0	4

- Indicates limited attribute data taken at each dam site.

Figure 87: Spatial extent of beaver dams from the WY2022 survey within the LSYR drainage where 79 dams (76 active) were observed in the mainstem and three active dams observed in the Salsipuedes/El Jaro Creek watershed.

Table 21: Annual count of WY2010 - WY2022 beaver dams in the LSYR mainstem and Salsipuedes/El Jaro watershed broken out by dam height.

	LSYR 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
WY2018	13	24	9	1	0	47	2	0	0	0	0	2
WY2019	7	24	12	2	0	45	0	0	0	0	0	0
WY2020	13	30	13	2	0	58	1	1	0	0	0	2
WY2021	10	31	35	4	0	80	6	4	1	0	0	11
WY2022	6	46	23	4	0	79	1	3	0	0	0	4

WY2022 Annual Monitoring Summary
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4. Discussion

Table 22: Monthly rainfall totals at Bradbury Dam from WY2000-WY2022.

Month	Water Years:																							Total/	% /
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Month	Month
Oct	0.0	2.64	0.62	0.0	0.0	6.38	0.48	0.16	0.34	0.15	2.2	2.24	0.47	0.12	0.34	0.0	0.30	1.13	0.00	0.17	0.00	0.00	1.79	19.5	4.7
Nov	1.62	0.0	3.27	2.5	1.20	0.33	1.64	0.20	0.06	3.39	0.0	1.42	2.82	1.34	1.14	0.87	0.73	1.21	0.07	1.86	1.52	0.31	0.12	27.6	6.7
Dec	0.0	0.09	2.66	6.73	2.03	13.25	0.73	1.59	2.39	2.46	3.00	9.48	0.35	2.95	0.18	5.88	1.12	1.92	0.00	0.68	7.19	2.00	8.33	75.0	18.1
Jan	1.94	8.40	0.87	0.06	0.32	10.30	7.82	1.30	16.6	0.65	10.34	1.84	1.58	1.75	0.02	0.82	4.03	8.81	3.75	8.07	0.48	8.39	0.44	98.6	23.8
Feb	10.37	5.71	0.24	3.56	6.52	9.22	3.06	3.03	2.33	5.70	4.92	3.36	0.43	0.40	4.11	0.51	1.65	10.61	0.16	8.26	0.06	0.10	0.08	84.4	20.3
Mar	2.76	13.44	0.79	2.40	0.48	3.08	4.31	0.15	0.46	0.85	0.26	11.9	3.63	0.80	3.52	0.08	3.01	0.83	4.85	3.06	8.13	1.02	2.10	71.9	17.3
Apr	4.73	1.35	0.13	2.15	0.0	1.27	4.89	0.81	0.06	0.19	3.15	0.14	3.21	0.19	0.65	0.36	0.0	0.20	0.09	0.11	3.58	0.02	0.25	27.5	6.6
May	0.01	0.06	0.12	2.33	0.0	0.51	1.56	0.0	0.38	0.0	0.05	0.42	0.02	0.02	0.0	0.26	0.0	0.32	0.40	1.57	0.07	0.00	0.00	8.1	2.0
Jun	0.04	0.0	0.0	0.02	0.0	0.04	0.0	0.0	0.0	0.16	0.0	0.34	0.0	0.0	0.0	0.42	0.0	0.00	0.00	0.00	0.00	0.00	0.00	1.0	0.2
Jul	0.0	0.06	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.1	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Sep	0.0	0.0	0.08	0.0	0.0	0.03	0.0	0.17	0.0	0.08	0.0	0.0	0.18	0.0	0.0	0.15	0.0	0.45	0.00	0.01	0.02	0.00	0.02	1.2	0.3
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*	*9.32*	*23.79*	*21.05*	*11.84*	*13.13*	*414.93*	*100.00*

Table 23: Monthly average stream discharge at the USGS Solvang and Narrows gauges during WY2001-WY2022.

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

Month	WY2007		WY2008		WY2009		WY2010		WY2011		WY2012	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	7.29	0.996	24.9	17.5	2.97	0	6.84	0	19.8	18.3	7.6	4.28
Nov	5.8	1	7.43	8.56	5.78	0	1.61	0	6.95	12.8	8.3	11.1
Dec	7.73	10	6.59	13.2	7.02	1.02	6.89	0	53.1	203.3	7.92	14.6
Jan	9.4	15.2	265	496.2	6.14	5.12	72.8	183.6	27.6	85.8	7.98	16.9
Feb	10.5	18.6	401.1	490.1	17.8	33.4	72.1	180.6	24.1	100.3	7.45	14.1
Mar	8.81	10.7	93.8	158.4	12.2	18.6	26.4	67.7	1441	1266	6.04	11.7
Apr	4.5	1.43	8.52	18.8	4.39	5.25	34.9	50.9	321.4	422	8.82	14.7
May	1.47	0.475	6.29	6.78	5.05	0.651	6.07	12.6	39	70.8	5.56	5.53
Jun	1.94	0.13	5.03	2.49	7.1	0.275	1.28	1.85	13.9	29.4	4.74	0.52
Jul	35.8	1.41	7.07	0.421	3.51	0	0.346	0.447	9.27	10.7	4.58	0.03
Aug	55.2	30.9	3.67	0.069	3.72	0	52.7	21.6	7.8	3.05	4.87	0
Sep	31	23.4	3.76	0	4.08	0	29.7	19.2	8.5	2.22	6.60	0

Month	WY2013		WY2014		WY2015		WY2016		WY2017		WY2018	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	4.5	0	42.6	28.8	13.2	0	0.65	0	0.002	0	35	28.2
Nov	2.7	0	22.7	17.1	5.21	0	0	0	0.01	0	8.63	9.67
Dec	5.8	0	8.9	8.1	7.1	0	0	0	0.069	0	2.28	0.586
Jan	6.3	0	4.3	2.2	5.1	0	0.22	0	12.4	29.9	2.63	2.9
Feb	6	3.6	6	3.6	4	0	2.14	0	193.2	432.4	0.649	1
Mar	4.8	4.5	10.6	12.3	1.5	0	2.39	0	12.7	50.5	3.09	9.5
Apr	1.7	0.54	3	1.8	0	0	0.09	0	2.98	9.83	0.138	3.5
May	0	0	0	0	0	0	0	0	0.2	1.99	0	0.38
Jun	0	0	0	0	0	0	0	0	0	0.66	0	0
Jul	51	3	0	0	0	0	54.8	0	0	0	0	0
Aug	59.1	27	0	0	79	0	69.4	34.8	28.9	0	88.8	15
Sep	47.9	28	2.7	0	42	0.77	0.67	2.86	74.1	37.2	10.9	8.4

Month	WY2019		WY2020		WY2021		WY2022	
	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)	Solvang (cfs)	Narrows (cfs)
Oct	0	0.017	0	0	38.5	22.4	5.98	0
Nov	0	0	0	0	24	17.5	3.03	0
Dec	0	0	3.88	0.135	7.82	7.92	14.4	12.1
Jan	14.4	61.7	7.48	0.043	22.8	91.6	7.76	13.9
Feb	139.9	414.5	5.39	0	15.8	45.2	4.65	6.2
Mar	68.7	208	22.8	28.9	8.1	15.9	2.46	2.8
Apr	13.3	35.7	87	114.4	2.37	4.73	1.24	1.61
May	5.79	14.6	15.7	22.2	0.224	0.676	0.077	0.01
Jun	1.91	5.21	3.42	1.13	0	0	0	0
Jul	0.653	0.875	1.8	0	0	0	0	0
Aug	0	0	0.527	0	22.6	0	52.5	0
Sep	0	0	77.5	20.9	9.07	0	67.4	30.7

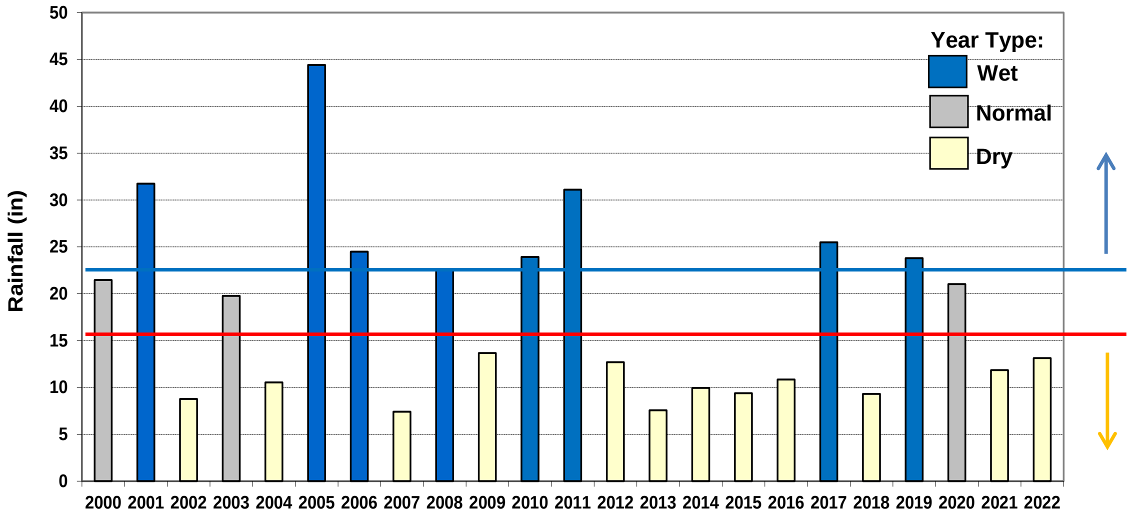


Figure 88: Water year type (wet, normal and dry) and spill years since the issuance of the BO in 2000. Year types are defined as Dry (< 15 inches), Normal (15 to 22 inches) and Wet (> 22 inches) at Bradbury Dam.

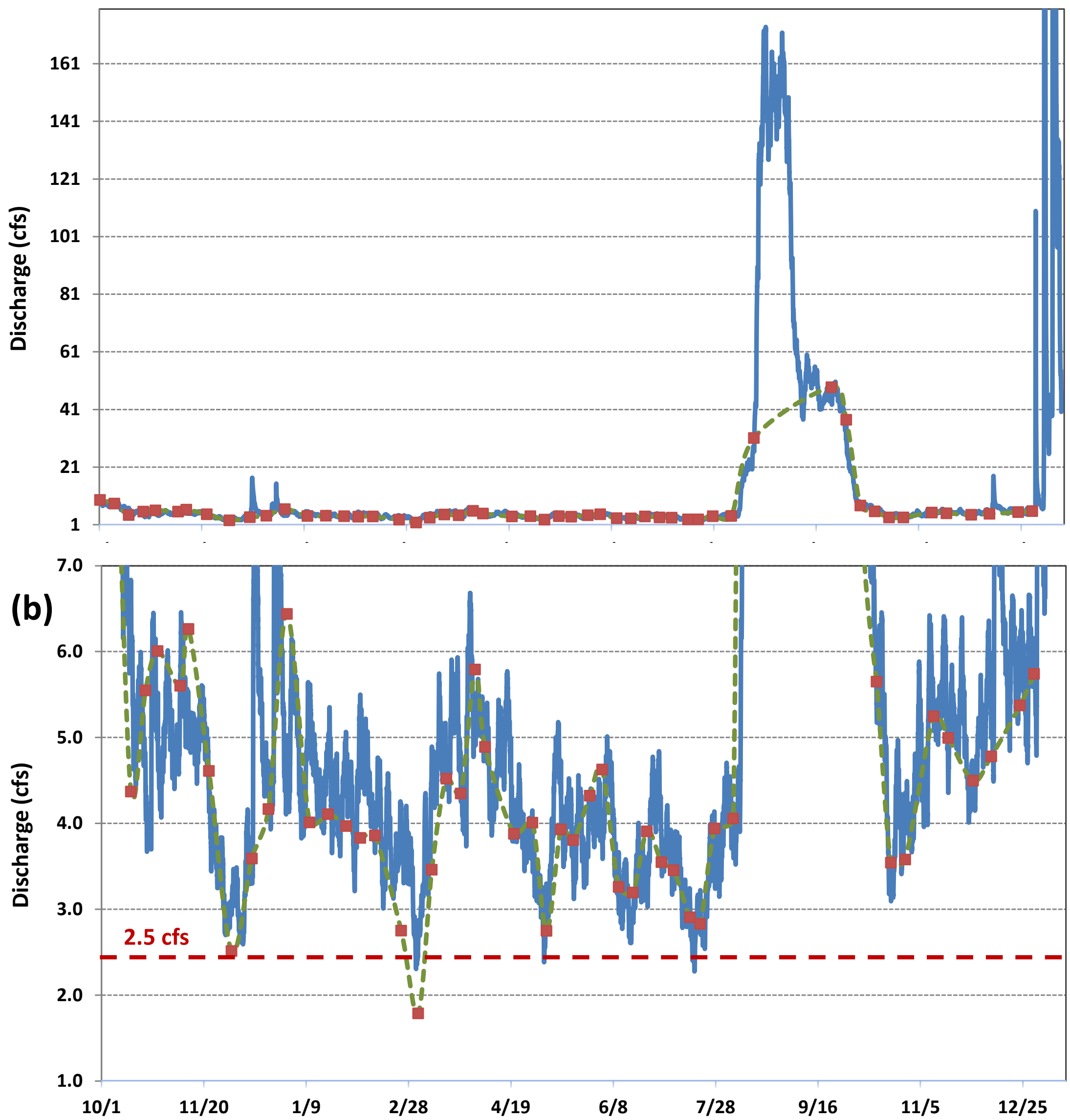


Figure 89: Highway 154 target flow (2.5 cfs) compliance monitoring showing (a) measured discharge (red points) and (b) modeled discharge (blue curve) using 15-minute pressure transducer data and a developed rating curve (source: COMB-FD).

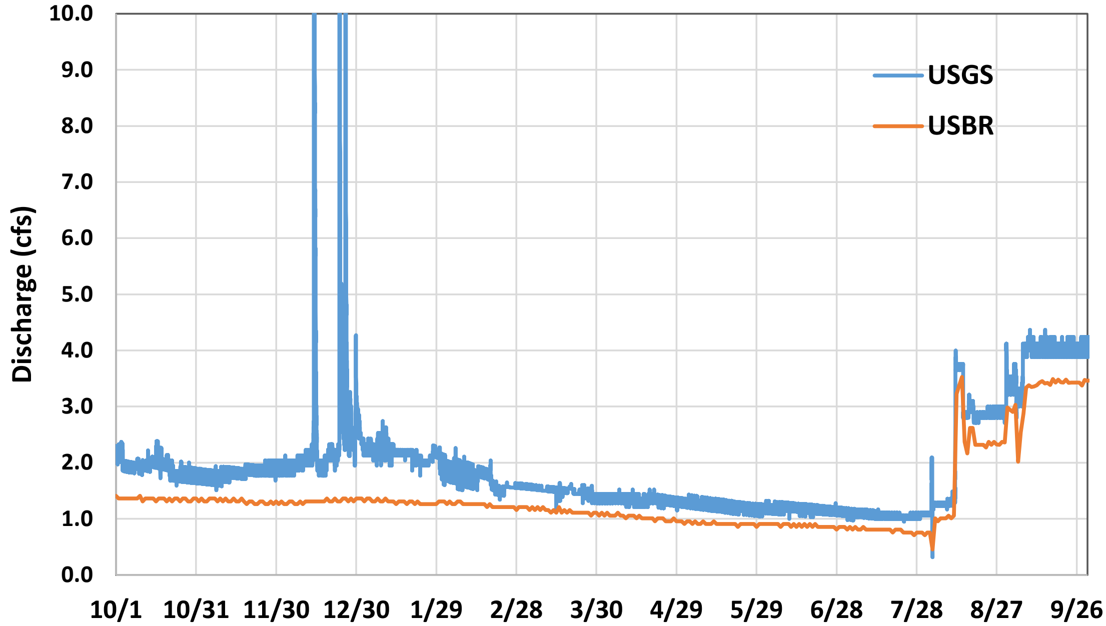


Figure 90: Recorded Hilton Creek discharge from USBR (source: USBR Operations Reports) and USGS (source: online USGS data) at their monitoring site just downstream of the LRP.

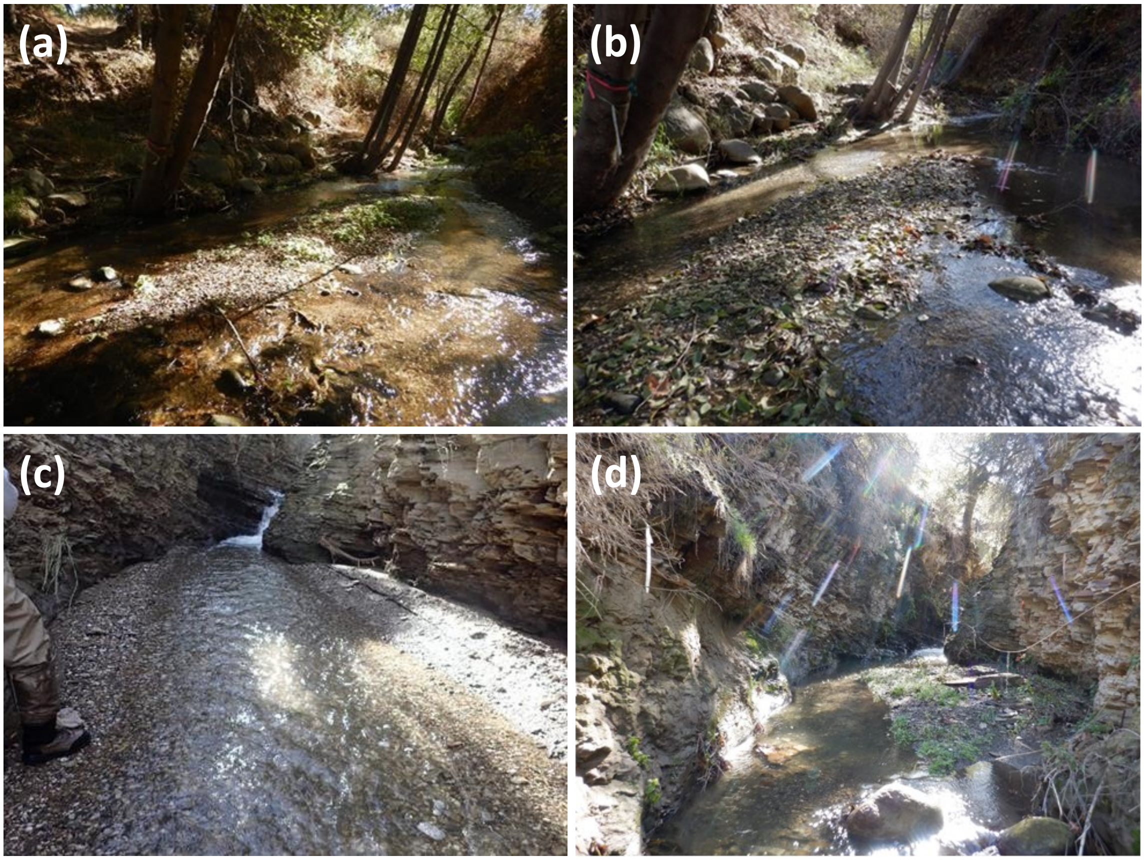


Figure 91: Hilton Creek post-storm habitat conditions showing sediment deposition in the Spawning Pool on (a) 11/16/20 and (b) 1/3/22, and in the Honeymoon Pool just upstream on (c) 1/22/19, and (d) 1/3/22.

Figure 92: Delta formation at the head of the Long Pool along the LSYR mainstem looking up towards the Hilton Creek confluence on (a) 2/4/19 and (b) 5/29/20, and looking down towards the Long Pool on (c) 2/5/19, (d) 11/16/20, (e) 1/3/22, and (f) 7/6/22 showing a newly defined and evolving channel and significant riparian vegetation growth.

Table 24: Number of redds observed in Hilton Creek on Reclamation property from WY2012 through WY2022.

Hilton	Number of Redds observed by Water Year:									
Creek	*2012*[1]	*2013*[1]	*2014*[1]	*2015*[1]	*2016*[2]	*2017*[2]	*2018*[2] *	*2019*[1] *	*2020*[1] *	*2021*[1] *	*2022*[1] *
Reaches 1-5	7	13	17	9	2	2	8	8	24	48	23

[1] Releases to Hilton Creek were conducted from the URP and LRP.

[2] Releases to Hilton Creek were conducted from only the LRP.

* Gravel augmentation.

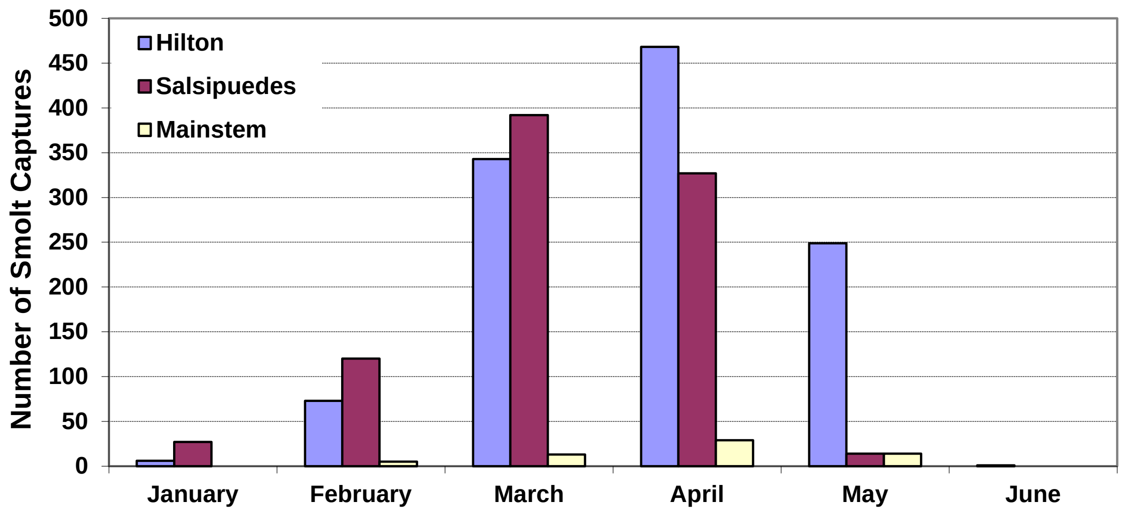


Figure 93: Total smolt captures by month from WY2001 through WY2022.

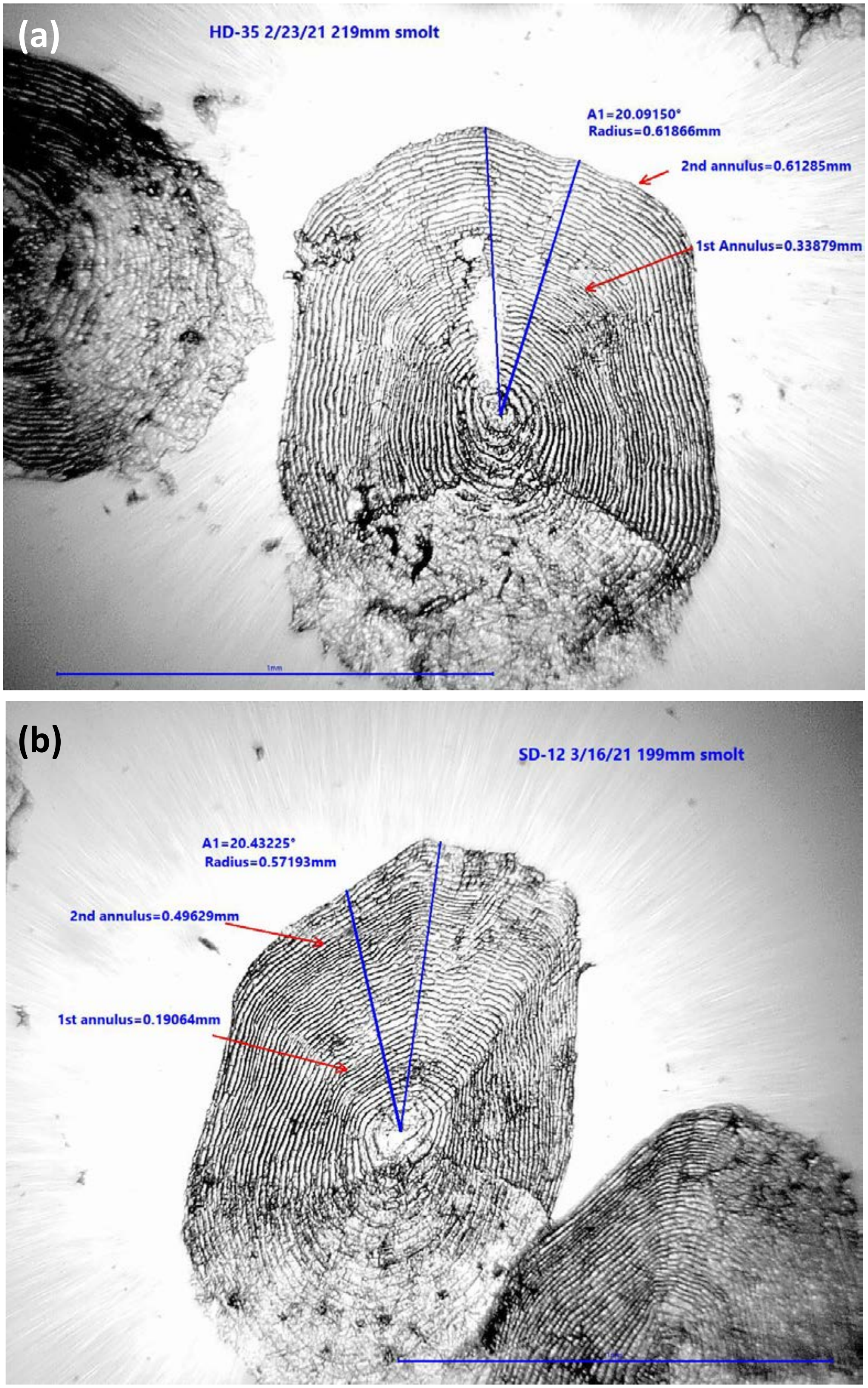


Figure 94: Smolt comparison between Hilton Creek and Salsipuedes Creek in WY2021 showing (a) HC-35 219 mm smolt aged at 2 years and a (b) SC-12 199 mm smolt aged at 2+ years.

Table 25: WY2001-WY2022 Hilton Creek upstream and downstream *O. mykiss* captures.

	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	*WY2012	*WY2013	*WY2014	*WY2015	*WY2016	*WY2017	*WY2018	*WY2019	*WY2020	*WY2021	*WY2022
	Hilton Creek																					
	Upstream																					
>700	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
650-699	0	0	0	0	0	0	0	4	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
600-649	0	0	0	0	0	0	0	0	1	0	0	0	n/d	0	0	0	0	0	0	0	0	0
550-599	0	0	0	0	0	1	0	2	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
500-549	1	0	1	0	2	2	0	2	1	0	0	0	n/d	0	0	0	0	0	0	0	0	0
450-499	3	0	0	6	8	9	0	13	1	2	0	0	n/d	0	0	0	0	0	0	0	0	0
400-449	5	0	9	11	9	21	2	6	2	1	11	0	n/d	1	0	0	0	1	1	6	2	0
300-399	2	0	10	24	10	31	11	31	27	11	6	12	n/d	24	7	1	0	0	8	13	22	30
200-299	2	0	2	8	7	10	4	22	29	39	11	12	n/d	12	11	5	0	0	9	7	51	49
100-199	11	38	14	27	4	18	15	63	33	39	34	17	n/d	9	6	1	1	5	2	17	10	16
<99	1	1	0	12	1	17	11	29	24	15	23	4	n/d	0	0	1	0	0	0	6	1	2
Total	**25**	**39**	**36**	**88**	**41**	**109**	**43**	**172**	**118**	**107**	**85**	**45**	**n/d**	**46**	**24**	**8**	**1**	**6**	**20**	**49**	**86**	**97**
	Downstream																					
>700	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
650-699	0	0	0	0	0	0	0	2	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
600-649	0	0	0	0	0	0	0	1	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
550-599	0	0	0	0	0	0	0	2	1	0	0	0	n/d	0	0	0	0	0	0	0	0	0
500-549	1	0	1	1	2	3	0	1	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
450-499	2	0	1	2	0	5	0	15	1	2	2	0	n/d	0	0	0	0	0	0	0	0	0
400-449	5	0	3	9	5	6	4	12	0	3	7	0	n/d	1	0	0	0	0	2	2	1	0
300-399	2	0	2	7	3	20	16	28	24	9	10	1	n/d	5	7	0	0	0	1	12	24	9
200-299	0	5	1	5	2	15	9	18	26	38	22	14	n/d	6	35	3	0	4	5	7	40	12
Smolts	0	4	0	3	1	11	7	4	7	1	4	6	n/d	1	11	2	0	3	1	1	2	0
Pre-Smolt	0	0	0	1	0	0	0	2	0	1	0	1	n/d	1	3	1	0	1	0	0	1	0
Res	0	1	1	1	1	4	2	12	19	36	18	7	n/d	4	21	0	0	0	4	6	37	12
101-199	22	45	12	46	6	47	369	178	218	84	82	99	n/d	64	68	91	4	14	8	50	34	54
Smolts	2	19	3	28	6	33	96	59	73	41	37	17	n/d	16	30	54	0	7	1	11	12	11
Pre-Smolt	0	5	0	2	0	5	42	21	36	4	16	48	n/d	27	23	32	2	6	2	18	13	25
Res	21	21	9	16	0	9	231	98	109	39	29	34	n/d	21	15	5	2	1	5	19	9	18
<100	1	7	0	16	2	173	200	47	34	15	16	15	n/d	2	0	1	0	0	1	19	2	10
Smolts	0	0	0	1	0	1	0	0	0	0	0	0	n/d	0	0	0	0	0	0	0	0	0
Pre-Smolt	0	0	0	0	1	163	0	1	0	0	2	0	n/d	1	0	1	0	0	0	2	0	1
Res	1	7	0	15	1	9	200	46	34	15	14	15	n/d	1	0	0	0	0	1	17	2	9
Total	**33**	**57**	**20**	**86**	**20**	**269**	**598**	**304**	**304**	**151**	**139**	**129**	**n/d**	**78**	**110**	**95**	**4**	**18**	**17**	**90**	**101**	**85**
	*Abbreviated trapping season due to NOAA take issues																					

Table 26: WY2001-WY2022 Salsipuedes Creek upstream and downstream *O. mykiss* captures; no trapping conducted in 2013 (NOAA take issues), and 2015, 2016, 2022 (extreme low flows).

	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	*WY2012	*WY2013	*WY2014	*WY2015	*WY2016	*WY2017	*WY2018	*WY2019	*WY2020	*WY2021	*WY2022
	Salsipuedes Creek																					
	Upstream																					
>700	0	0	0	0	0	0	0	1	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
650-699	1	0	1	0	1	0	0	2	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
600-649	0	0	0	0	0	0	0	3	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
550-599	1	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
500-549	0	0	0	0	0	1	0	0	0	0	3	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
450-499	2	0	0	0	0	0	0	0	0	0	2	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
400-449	1	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
300-399	7	3	0	1	0	6	0	0	0	0	1	2	n/d	0	n/d	n/d	0	0	0	0	0	n/d
200-299	9	3	3	11	0	6	2	7	1	4	7	1	n/d	1	n/d	n/d	0	0	0	1	0	n/d
100-199	10	8	22	9	0	4	5	2	9	2	22	0	n/d	2	n/d	n/d	0	0	0	0	1	n/d
<99	0	0	3	0	0	1	0	3	3	0	5	0	n/d	0	n/d	n/d	0	0	0	1	0	n/d
Total	**31**	**14**	**29**	**21**	**1**	**18**	**7**	**18**	**13**	**6**	**40**	**3**	**n/d**	**3**	**n/d**	**n/d**	**0**	**0**	**0**	**2**	**1**	**n/d**
	Downstream																					
>700	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
650-699	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
600-649	1	0	0	0	0	0	0	0	0	1	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
550-599	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
500-549	1	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
450-499	3	0	0	0	0	0	0	1	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
400-449	0	0	0	0	0	0	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
300-399	6	0	0	1	0	4	1	1	0	0	3	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
200-299	21	2	2	2	9	19	3	13	2	20	13	0	n/d	1	n/d	n/d	0	1	1	0	1	n/d
Smolts	8	1	2	0	9	10	0	9	1	18	2	0	n/d	1	n/d	n/d	0	0	0	0	0	n/d
Pre-Smolt	0	0	0	1	0	2	0	1	0	0	1	0	n/d	0	n/d	n/d	0	0	0	0	1	n/d
Res	13	1	0	2	0	7	3	3	1	2	10	0	n/d	0	n/d	n/d	0	0	1	0	0	n/d
101-199	144	4	98	20	46	193	12	41	60	50	160	10	n/d	9	n/d	n/d	0	2	1	0	16	n/d
Smolts	124	3	55	9	45	135	1	31	16	48	100	1	n/d	3	n/d	n/d	0	0	0	0	10	n/d
Pre-Smolt	2	0	21	2	1	50	1	10	13	1	57	7	n/d	6	n/d	n/d	0	2	1	0	4	n/d
Res	18	1	22	9	0	8	10	0	31	1	3	2	n/d	0	n/d	n/d	0	0	0	0	2	n/d
<100	1	0	11	20	0	24	1	6	111	2	24	12	n/d	0	n/d	n/d	0	0	0	1	0	n/d
Smolts	0	0	0	5	0	4	0	0	0	0	0	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
Pre-Smolt	0	0	5	3	0	17	0	0	2	0	17	0	n/d	0	n/d	n/d	0	0	0	0	0	n/d
Res	1	0	6	12	0	3	1	6	109	2	7	12	n/d	0	n/d	n/d	0	0	0	1	0	n/d
Total	**177**	**6**	**111**	**43**	**55**	**240**	**17**	**62**	**173**	**73**	**200**	**22**	**n/d**	**10**	**n/d**	**n/d**	**0**	**3**	**2**	**1**	**17**	**n/d**
	*Abbreviated trapping season due to NOAA take issues																					

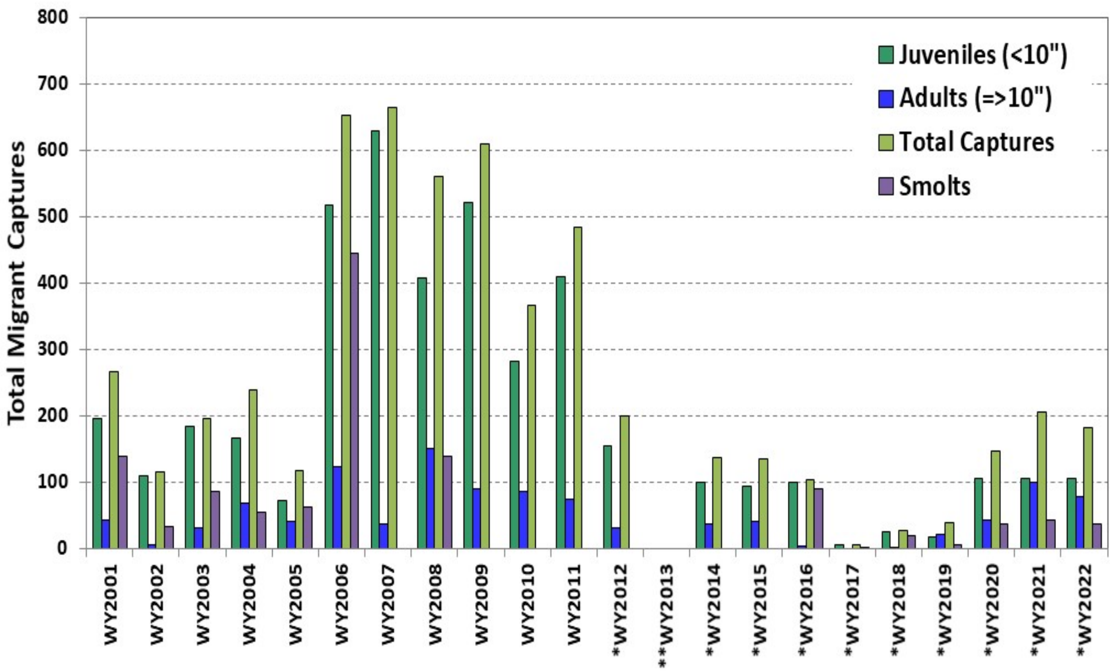


Figure 95: Number of migrant juveniles, adults, smolts, and total migrant captures from WY2001 through WY2022.

Table 27: Total number of migrant captures at all 3 trapping locations from WY2001 through WY2022.

	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012*	WY2013**	WY2014*	WY2015*	WY2016*	WY2017*	WY2018*	WY2019*	WY2020*	WY2021*	WY2022*	Total
Year Type:	Wet	Dry	Normal	Dry	Wet	Wet	Dry	Wet	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Dry	Wet	Dry	Wet	Normal	Dry	Dry	
Hilton	58	96	56	174	61	378	641	476	422	258	224	174	0	124	134	103	5	24	37	139	187	182	3953
Mainstem	nd	nd	nd	nd	nd	17	nd	5	2	30	20	0	0	0	0	0	0	0	0	5	nd	nd	79
Salsipuedes	208	20	140	64	56	258	24	80	186	79	240	25	0	13	0	0	0	3	2	3	18	nd	1419
Total Captured:	**266**	**116**	**196**	**238**	**117**	**653**	**665**	**561**	**610**	**367**	**484**	**199**	**0**	**137**	**134**	**103**	**5**	**27**	**39**	**147**	**205**	**182**	**5451**

* Abbreviated trapping season due to NOAA take limits enforced.

** No trapping conducted.

Table 28: The water years with observed returning anadromous steelhead since monitoring began in WY1994 at the migrant traps at Salsipuedes Creek, Hilton Creek, and the LSYR mainstem. No anadromous steelhead observed since 2011.

Location	WY1997	WY1998	WY1999	WY2001	WY2003	WY2005	WY2006	WY2008	WY2009	WY2010	WY2011**
Salsipuedes Creek	2	1	3	4	1	1	1	7		1	8
Hilton Creek								7	1		1
LSYR Mainstem*								2			
Total:	**2**	**1**	**3**	**4**	**1**	**1**	**1**	**16**	**1**	**1**	**9**

* LSYR Mainstem trap was first installed in WY2006.

** The Hilton Creek anadromous fish was a recapture first observed in Salsipuedes Creek.

Table 29: Genetics and scale aging results from all anadromous fish captures since WY2001 showing the Assignment, Score or confidence (%), watershed of origin, and age (genetics source: NOAA Southwest Science Center).

Fish #	Date	Time	Size (mm)	Size (in)	Sex	Type	Assignment	Score (%)	Watershed	Age (scales)*
SU-04	3/20/2001	0:05	560	22.0	F	Steelhead	failed genotyping	-	-	2.2
SU-11	3/23/2001	19:35	650	25.6	~	Steelhead	no record	-	-	2.3
SD-48	3/25/2001	23:00	625	24.6	F	Steelhead	Salsipuedes	95.383	Salsipuedes Creek (SYR)	ns
SD-149	4/22/2001	12:27	547	21.5	M	Steelhead	Salsipuedes	100	Salsipuedes Creek (SYR)	2.2
SU-17	3/20/2003	22:15	686	27.0	F	Steelhead	Salsipuedes	100	Salsipuedes Creek (SYR)	2.3
SU-01	4/12/2005	23:00	675	26.6	M	Steelhead	SLTjeraB	99.48	Tassajera Creek (Sta. Margarita C, Salinas R)	ns
SU-10	4/15/2006	22:09	515	20.3	F	Steelhead	SCLionB	98.874	Lion Canyon Creek (Sespe C, Santa Clara R)	ns
HU-74	2/7/2008	0:46	659	25.9	F	Steelhead	SLSAntA (AGLBerB)	55.30% (32.66%)	San Antonio River (Salinas R)	ns
HU-100	2/16/2008	6:14	691	27.2	F	Steelhead	SLTjaraB (Quiota)	88.11% (8.46%)	Tassajara Creek (Arroyo Seco, Salinas R)	2.3
HU-119	3/5/2008	6:01	563	22.2	F	Steelhead	Hilton	100%	Hilton Creek (SYR)	5
HU-123	3/7/2008	0:00	660	26.0	F	Steelhead	SLTjaraB	99.10%	Tassajara Creek (Arroyo Seco, Salinas R)	2.3
HU-142	3/23/2008	23:58	688	27.1	F	Steelhead	Hilton (AGMainB)	90.25% (9.34%)	Hilton Creek (SYR)	2.3
HD-109	2/11/2008	6:47	578	22.8	F	Steelhead	Hilton	99.91%	Hilton Creek (SYR)	ns
HD-147	3/4/2008	23:34	617	24.3	F	Steelhead	Hilton	100.00%	Hilton Creek (SYR)	ns
SU-03	2/4/2008	20:58	640	25.2	F	Steelhead	AGLopzA (AGMainB)	74.59% (25.33%)	Arroyo Grande Creek (SLO)	2.2+
SU-04	2/5/2008	7:53	701	27.6	F	Steelhead	AGLopzA (Hilton)	56.19% (43.73%)	Arroyo Grande Creek (SLO)	2.2
SU-08	2/17/2008	7:38	635	25.0	F	Steelhead	Salsipuedes	100.00%	Salsipuedes Creek (SYR)	2.3
SU-11	3/25/2008	21:36	663	26.1	F	Steelhead	Salsipuedes	99.82	Salsipuedes Creek (SYR)	2.3+
SU-12	3/29/2008	9:00	675	26.6	F	Steelhead	Salsipuedes	96.43	Salsipuedes Creek (SYR)	1.3
SU-14	4/14/2008	8:43	608	23.9	F	Steelhead	Salsipuedes	99.86%	Salsipuedes Creek (SYR)	2.3
SD-06	2/7/2008	22:47	496	19.5	F	Steelhead-Lagoon	Salsipuedes	98.33%	Salsipuedes Creek (SYR)	1.4
MU-01	2/10/2008	11:22	678	26.7	F	Steelhead	AGMainB (AGLopzA)	70.04% (24.80%)	Arroyo Grande Creek (SLO)	ns
MU-02	3/18/2008	7:13	600	23.6	F	Steelhead	Quiota	99.99%	Quiota Creek (SYR)	2.2
HU-89	3/22/2009	23:23	605	23.8	F	Steelhead	Hilton	97.22	Hilton Creek (SYR)	1.2.2**
SD-23	3/5/2010	6:18	634	25.0	F	Steelhead	Salsipuedes	100	Salsipuedes Creek (SYR)	ns
SU-05	1/24/2011	18:46	315	12.4	~	Steelhead	Salsipuedes	78.53	Salsipuedes Creek (SYR)	1.2+
SU-24	3/5/2011	1:01	528	20.8	F	Steelhead	Salsipuedes	98.33	Salsipuedes Creek (SYR)	3.2
SU-29	3/11/2011	6:28	481	18.9	M	Steelhead	Quiota (Hilton)	47.14% (39.87%)	Quiota Creek (SYR)	2.1
HUR-06	4/1/2011	20:40	482	18.9	M	Steelhead	Quiota (Hilton)	47.14% (39.87%)	Quiota Creek (SYR)***	2.1
SU-31	4/2/2011	0:05	510	20.1	F	Steelhead	Salsipuedes	99.34	Salsipuedes Creek (SYR)	2.1+
SU-33	4/8/2011	8:25	485	19.1	M	Steelhead	BigMont	94.193 (5.78%)	Big Mountain Creek (Big Sur)	2.1
SU-35	4/10/2011	6:26	507	20.0	M	Steelhead	BigMont	99.44% (0.48%)	Big Mountain Creek (Big Sur)	3.1
SU-36	5/6/2011	6:40	298	11.7	~	Steelhead-Lagoon	Salsipuedes	99.604	Salsipuedes Creek (SYR)	1.1
SU-37	5/6/2011	13:10	242	9.5	M	Steelhead-Lagoon	Salsipuedes (BigMont)	57.87% (39.72%)	Salsipuedes Creek (SYR)	1.1

* Age: F - years in fresh . S - years in salt/lagoon water; ns - no scales taken.
** 1.2.2: 1F.2S.2F.
*** SU-29: This Salsipuedes Creek fish was later recaptured in Hilton Creek (HUR-06), both marked in tan.

Table 30: Total number of smolt captures at all 3 trapping locations from WY2001 through WY2022.

	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006	WY2007	WY2008	WY2009	WY2010	WY2011	WY2012*	WY2013**	WY2014*	WY2015*	WY2016*	WY2017*	WY2018*	WY2019*	WY2020*	WY2021*	WY2022*
Year Type:	Wet	Dry	Normal	Dry	Wet	Wet	Dry	Wet	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Dry	Wet	Dry	Wet	Normal	Dry	Dry
Hilton	4	28	3	35	8	213	145	87	116	47	59	72	n/d	46	67	90	2	17	4	32	28	37
Mainstem	-	-	-	-	-	14	-	1	2	25	14	0	n/d	n/d	n/d	0	0	0	0	5	n/d	n/d
Salsipuedes	135	4	83	20	55	218	2	51	32	67	177	8	n/d	10	n/d	0	0	2	1	0	15	n/d
Total:	139	32	86	55	63	445	147	139	150	139	250	80	0	56	67	90	2	19	5	37	43	37
																					Total=	**2081**

* Abbreviated trapping season due to NOAA take limits enforced.
** No trapping conducted.

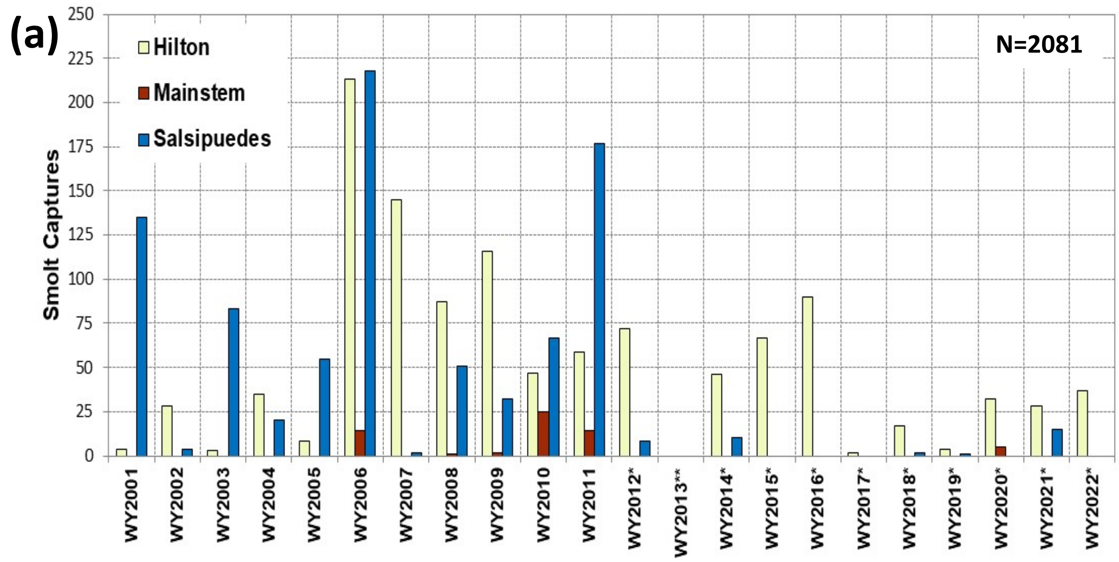


Figure 96: Number of smolt captured at all 3 trapping locations from WY2001 through WY2022.

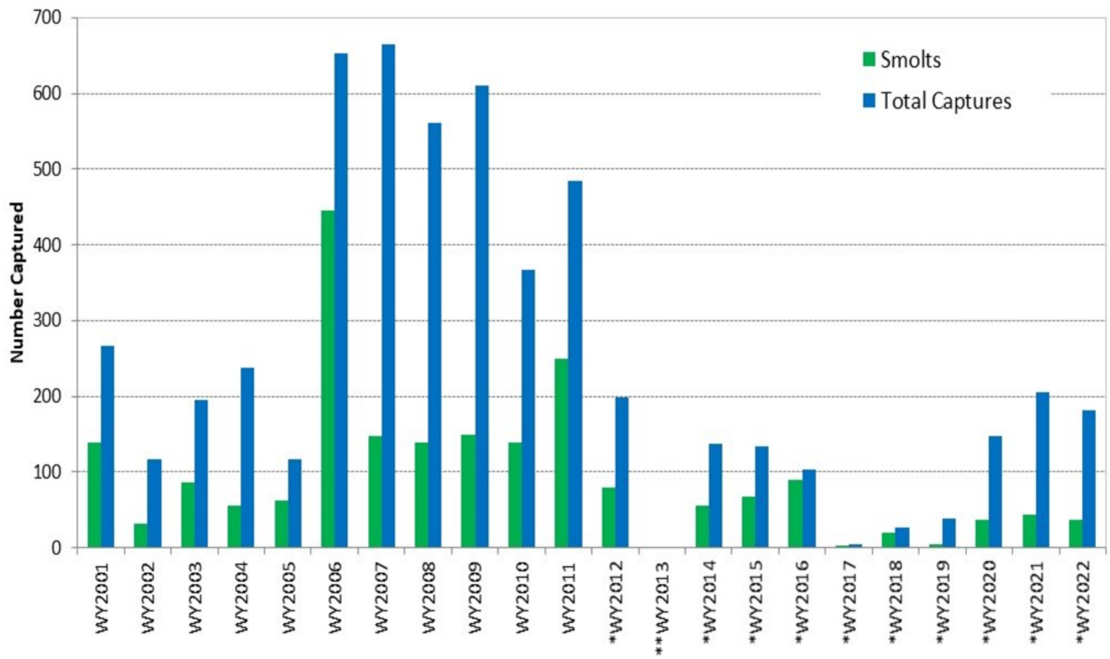


Figure 97: Total number of migrant and smolt captures from WY2001 through WY2022.

WY2008 Adult Steelhead

WY2011 Adult Steelhead

WY2008 Adult Steelhead Captures

#	#	Location	Direction	Size (mm)	Date
1	1	Salsipuedes	US	640	2/4
2	2	Salsipuedes	US	701	2/5
3	3	Salsipuedes	DS	496	2/7
4	4	Salsipuedes	US	635	2/17
5	5	Salsipuedes	US	663	3/25
6	6	Salsipuedes	US	675	3/29
7	1	Mainstem	US	678	2/10
8	2	Mainstem	US	600	3/18
9	1	Hilton	US	659	2/7
10	2	Hilton	DS	578	2/11
11	3	Hilton	US	691	2/16
12	4	Hilton	US	510	2/26
13	5	Hilton	DS	617	3/4
14	6	Hilton	US	563	3/5
15	7	Hilton	US	660	3/7
16	8	Hilton	US	688	3/23

WY2011 Adult Steelhead Captures

#	#	Location	Direction	Size (mm)	Date
1	1	Salsipuedes	US	315*	1/24
2	2	Salsipuedes	US	528	3/5
3	3	Salsipuedes	US	481	3/11
4	4	Salsipuedes	US	490	4/2
5	5	Salsipuedes	US	458	4/8
6	6	Salsipuedes	US	507	4/10
7	7	Salsipuedes	US	298*	5/6
8	8	Salsipuedes	US	242*	5/6
9	1	Hilton	US	481**	4/1

* Lagoon Steelhead.

** Recaptured Steelhead from Salsipuedes Creek 3/11.

Figure 98: WY2008 and WY2011 anadromous (adult) steelhead captures within the LSYR basin.

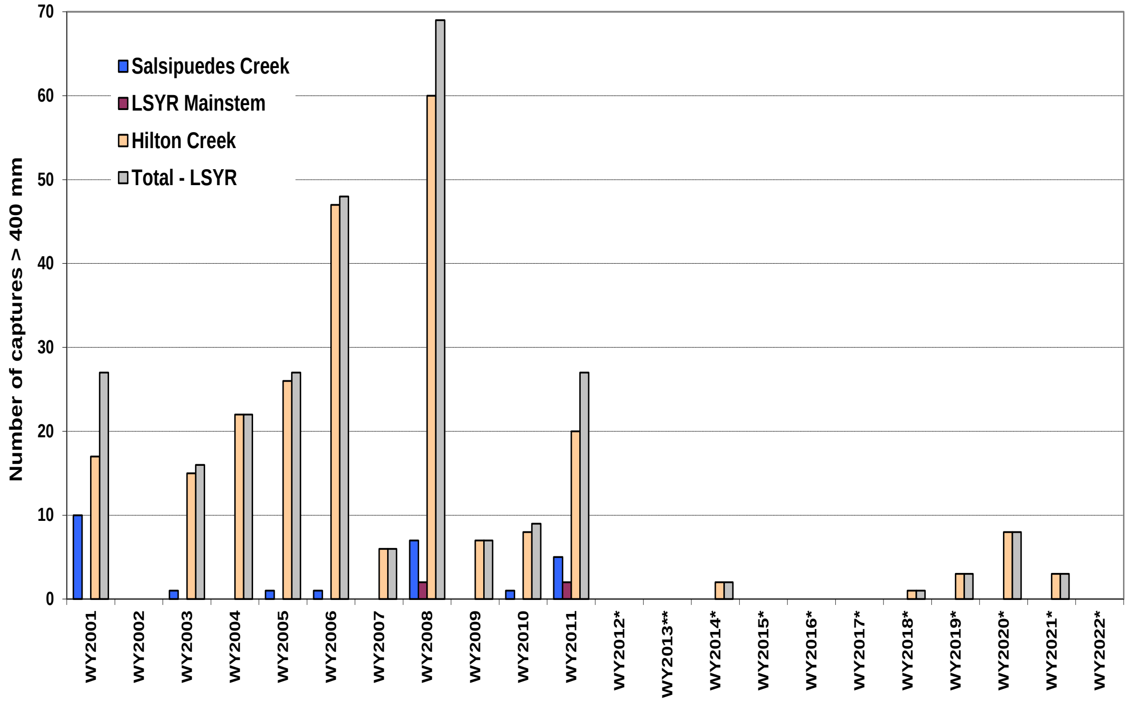


Figure 99: Migrant *O. mykiss* captures equal to or larger than 400 mm (15.7 inches) observed at the 3 trap sites from WY2001 through WY2022; the LSYR Mainstem trap was first installed in WY2006 and was not deployed in WY2007, WY2012, WY2013, WY2014, WY2015, and WY2021 due to low flow conditions.

Table 31: The results of WY2017 scale analyses of *O. mykiss* migrant captures found over the monitoring period aggregated by 10 mm size classes.

		Age:									
Size (mm)	**Amount**	**0+**	**1**	**1+**	**2**	**2+**	**3**	**3+**	**4**	**4+**	**5**
<120											
120-129											
130-139											
140-149	1			1							
150-159	1			1							
160-169											
170-179											
Total:	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 32: The results of WY2016 scale analyses of *O. mykiss* migrant captures found over the monitoring period aggregated by 10 mm size classes.

		Age:									
Size (mm)	**Amount**	**0+**	**1**	**1+**	**2**	**2+**	**3**	**3+**	**4**	**4+**	**5**
<120											
120-129	2	1		1							
130-139	14	1		10		3					
140-149	11			7		4					
150-159	22			12	2	8					
160-169	15			7	1	7					
170-179	10			3		7					
180-189	9			2	1	5		1			
190-199	2					2					
200-209	2					1		1			
210-219											
220-229											
230-239	2					2					
240-249											
250-259											
260-269	1							1			
270-279	1							1			
280-289											
290-299											
300-309	1					1					
310-319											
320-329											
330-339											
Total:	**92**	**2**	**0**	**42**	**4**	**40**	**0**	**4**	**0**	**0**	**0**

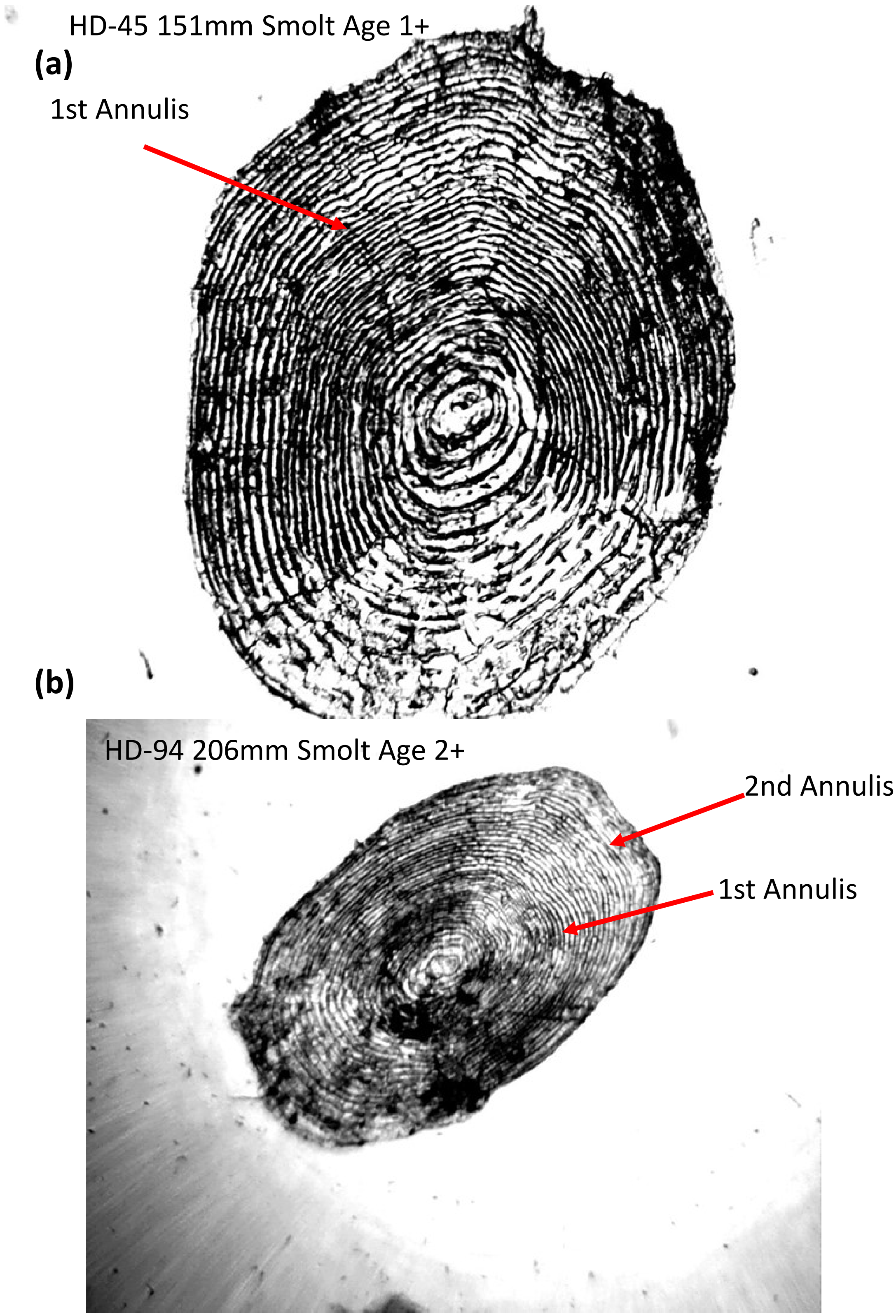


Figure 101: Two WY2016 Hilton Creek downstream migrating smolts, a (a) 151 mm aged at 1+ and (b) a 206 mm aged at 2+ fish.

Table 33: The results of WY2015 scale analyses of *O. mykiss* migrant captures found over the monitoring period aggregated by 10 mm size classes.

		Age:									
Size (mm)	**Amount**	**0+**	**1**	**1+**	**2**	**2+**	**3**	**3+**	**4**	**4+**	**5**
<120											
120-129											
130-139	6			3		3					
140-149	10			7		3					
150-159	13			9		4					
160-169	7			2		5					
170-179	6			2		4					
180-189	8			1		7					
190-199	4			2		2					
200-209	1					1					
210-219	4					4					
220-229	1				1						
230-239	3					3					
240-249	1					1					
250-259	2					1		1			
260-269	6					2	2	2			
270-279	4					1		3			
280-289	1						1				
290-299	1					1					
300-309	1						1				
310-319	2							2			
320-329											
330-339											
340-349	2						1	1			
350-359											
360-369											
370-379	1									1	
380-389	1								1		
390-399	1									1	
400-409											
410-419											
420-429											
Total:	**86**	**0**	**0**	**26**	**1**	**42**	**5**	**9**	**1**	**2**	**0**

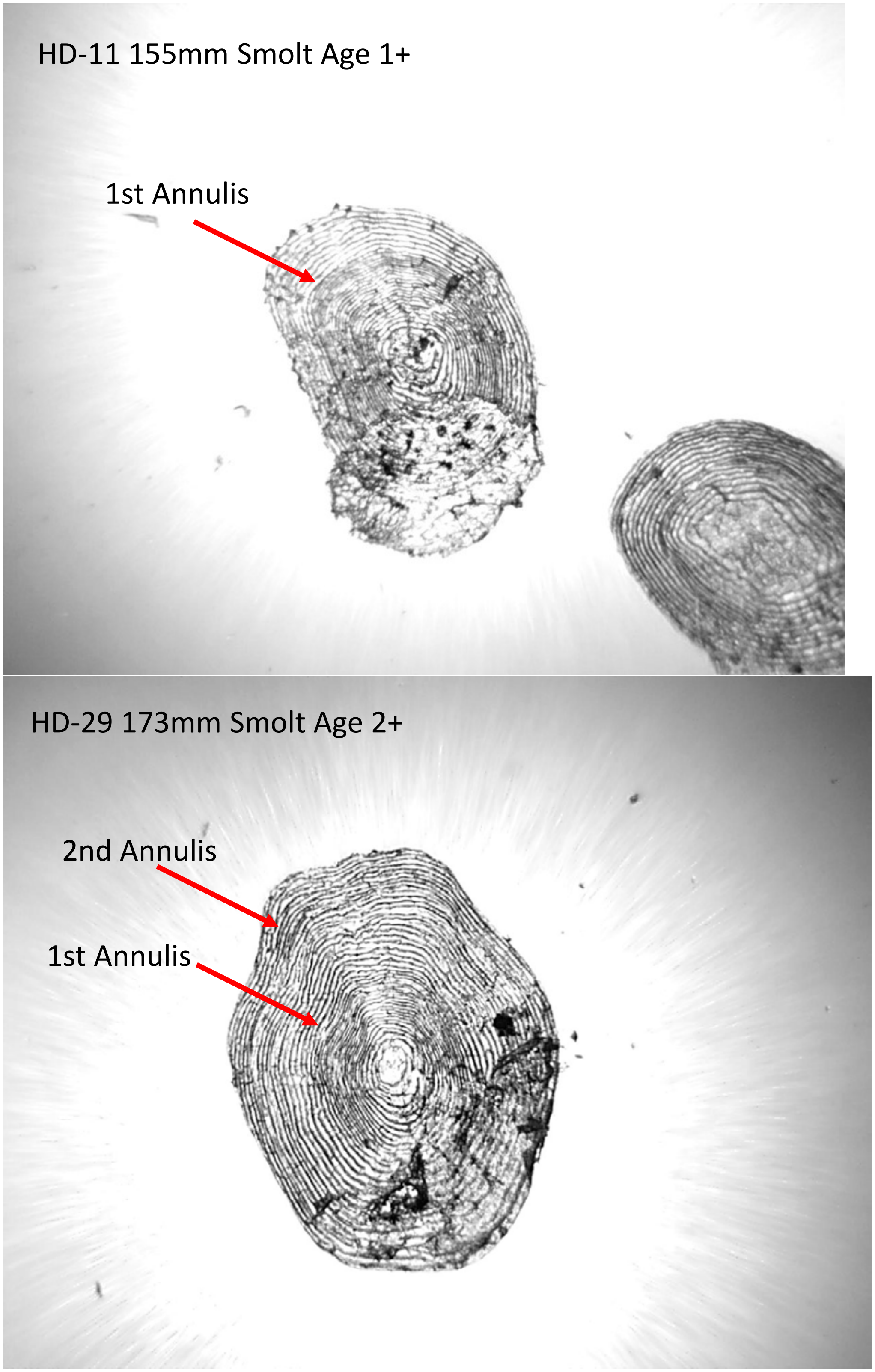
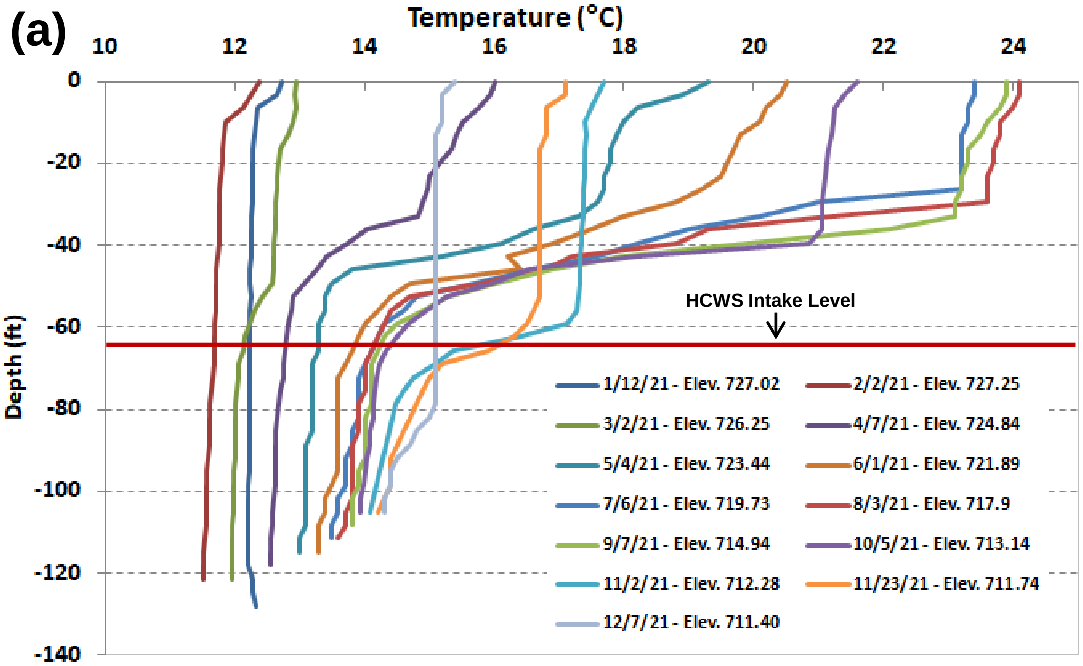


Figure 102: Two WY2015 Hilton Creek downstream migrating smolts, a (a) 155 mm aged at 1+ and (b) a 173 mm aged at 2+ fish.



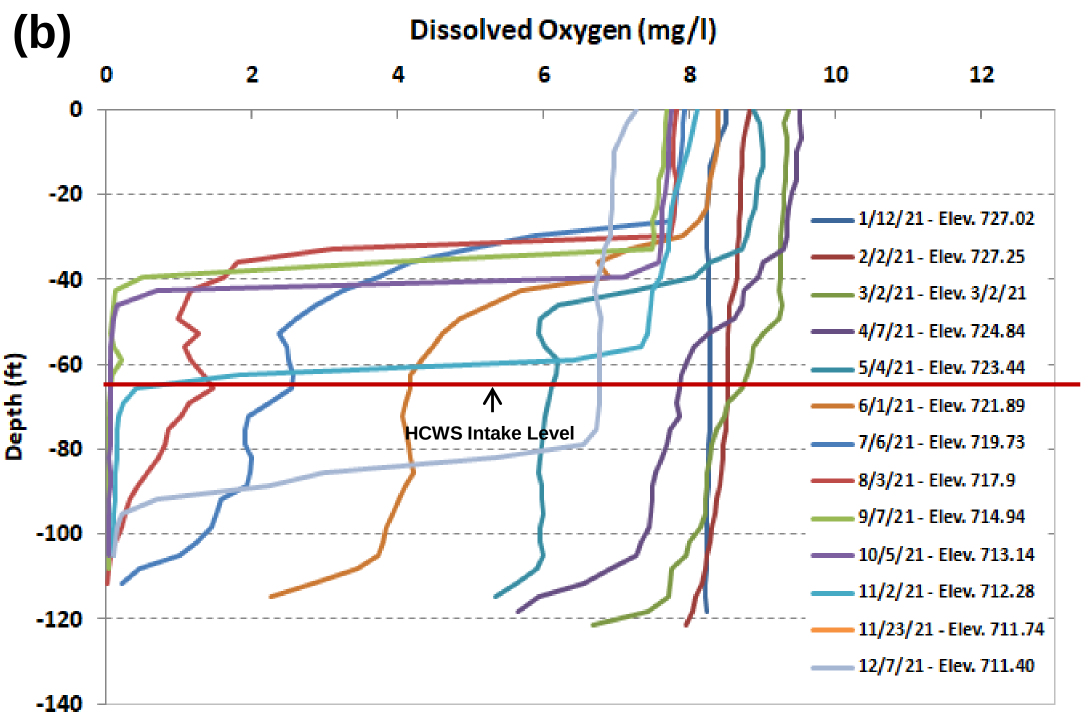


Figure 103: The development of lake stratification and lake turnover in 2022 showing (a) temperature (°C) and (b) dissolved oxygen (mg/L) concentrations going from the lake surface to the bottom with the HCWS intake at 65 feet of depth.

Figure 104: Release points from Lake Cachuma and Bradbury Dam.

Figure 105: Hilton Creek (a) release point configuration showing energy diffusion box and cascade, (b) LRP prior to lake turnover, and (c) LRP after lake turnover.

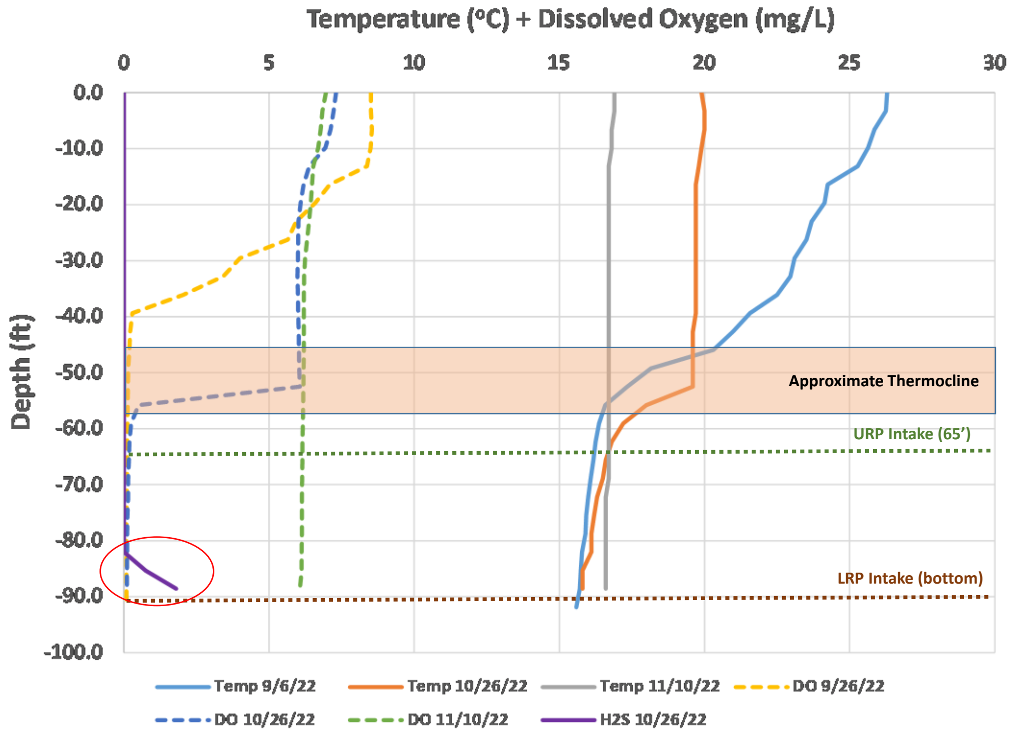


Figure 106: Lake water quality conditions from the surface to bottom for temperature (°C) and dissolved oxygen before and after lake turnover, and hydrogen sulfide (mg/L) on 10/26/22; the red circle highlights the increase of hydrogen sulfide at the bottom.

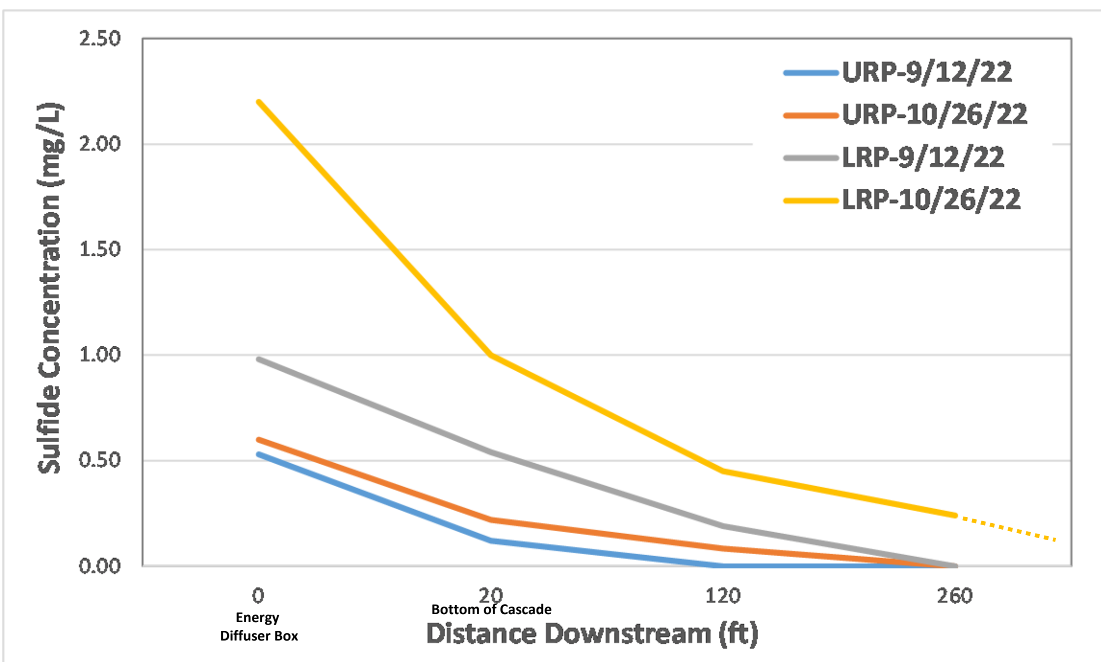
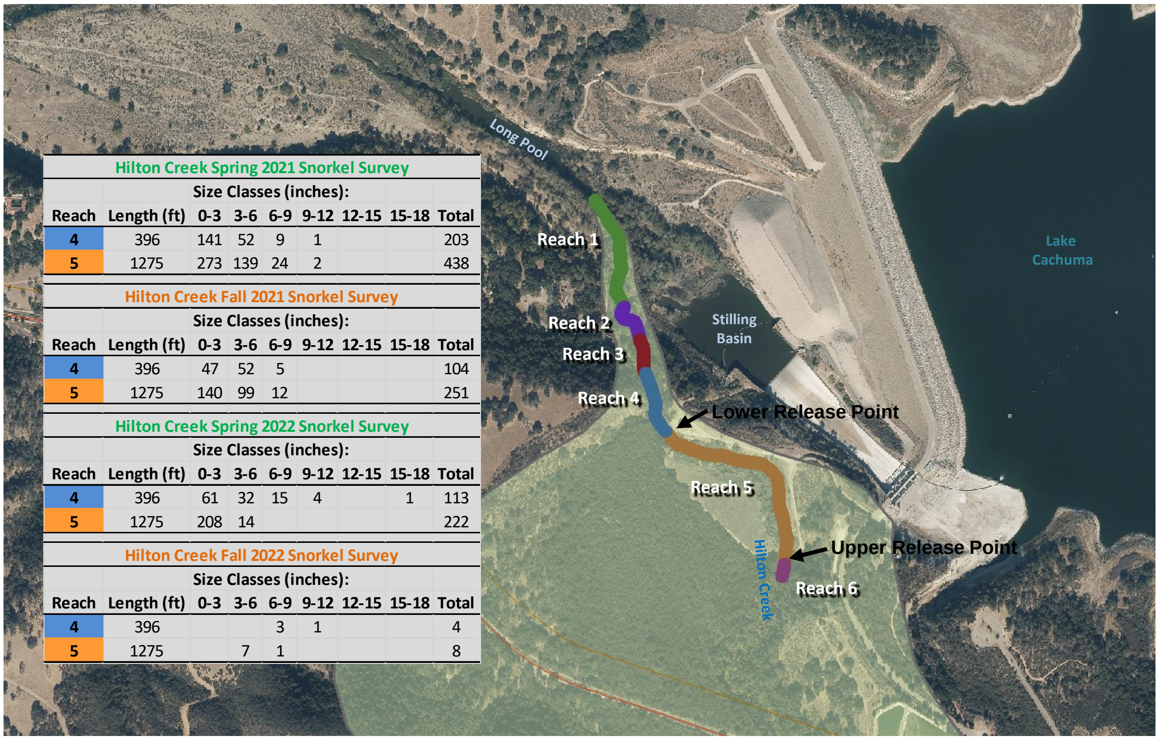


Figure 107: Longitudinal profile taken on 10/26/22 of sulfide (H_2S) concentration going downstream from the energy diffuser box to the bottom of the cascade to 120 feet downstream to 260 feet downstream showing the decrease in concentration moving away from the source.



Hilton Creek Spring 2021 Snorkel Survey

Reach	Length (ft)	0-3	3-6	6-9	9-12	12-15	15-18	Total
		Size Classes (inches):						
4	396	141	52	9	1			203
5	1275	273	139	24	2			438

Hilton Creek Fall 2021 Snorkel Survey

Reach	Length (ft)	0-3	3-6	6-9	9-12	12-15	15-18	Total
		Size Classes (inches):						
4	396	47	52	5				104
5	1275	140	99	12				251

Hilton Creek Spring 2022 Snorkel Survey

Reach	Length (ft)	0-3	3-6	6-9	9-12	12-15	15-18	Total
		Size Classes (inches):						
4	396	61	32	15	4		1	113
5	1275	208	14					222

Hilton Creek Fall 2022 Snorkel Survey

Reach	Length (ft)	0-3	3-6	6-9	9-12	12-15	15-18	Total
		Size Classes (inches):						
4	396			3	1			4
5	1275		7	1				8

Figure 108: Fish avoidance was evident within Reach 4 just downstream of the LRP; Reach 5 had a fish rescue and relocation effort during the week of 8/8/22 when most fish were relocated downstream (446 *O. mykiss*) due to drying conditions.

Table 34: Total Lake Cachuma releases since 2005 to the LSYR mainstem (Outlet Works plus HCWS+HCEBS) during the summertime period (June – September).

Year (June-September) (af):																
2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
2468	2744	11233	4169	4491	8210	3149	3803	13333	3606	11148	11789	9155	8222	3663	7807	5240

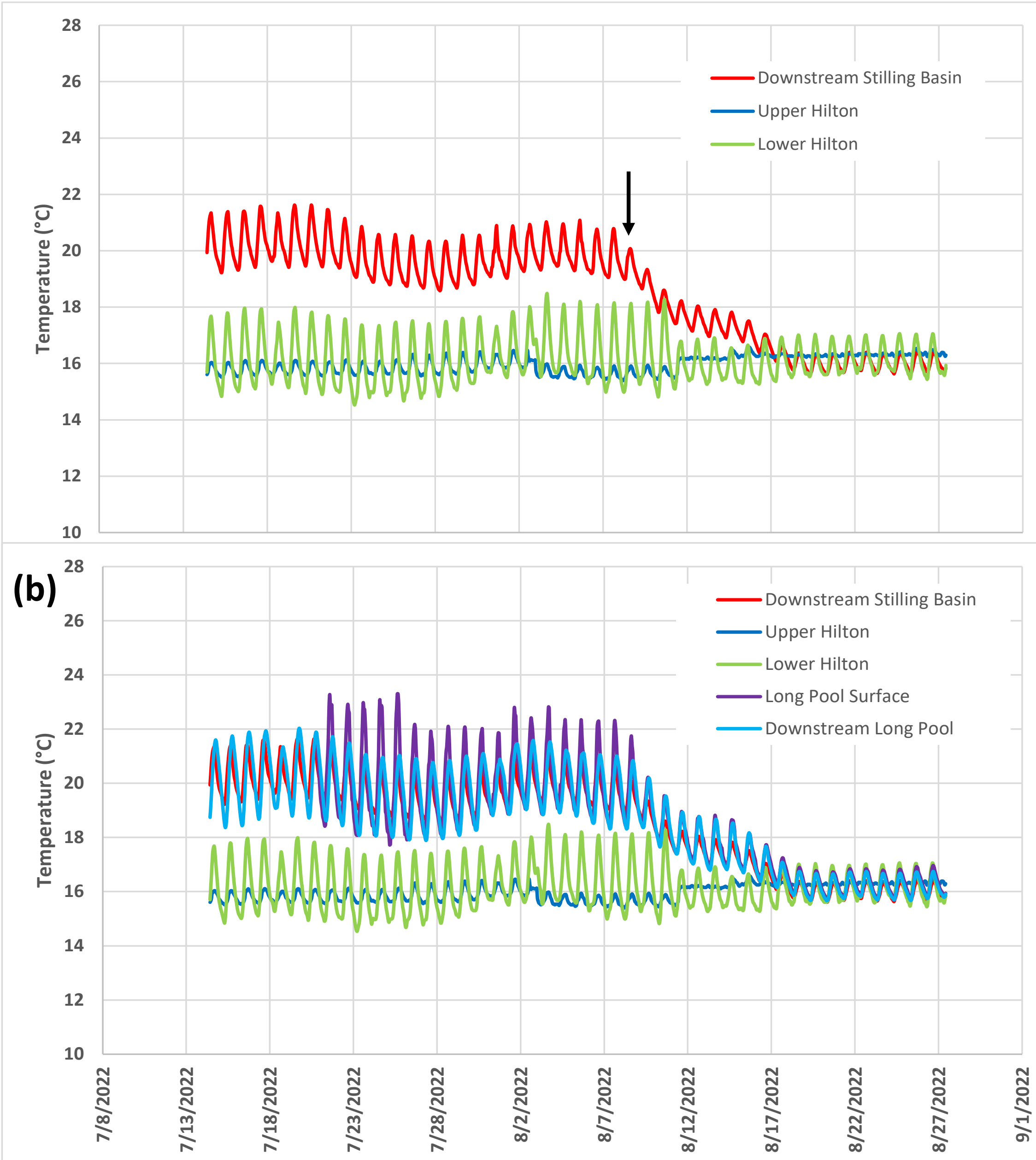


Figure 109: Recorded stream temperatures before, during and after the start of the 2022 WR 89-18 release (a) downstream of the Stilling Basin (LSYR-0.25), upper Hilton Creek (HC-0.54), and lower Hilton Creek (HC-0.12), and (b) at Long Pool (LSYR-0.51) and downstream of Long Pool (LSYR-0.68) showing no temperature spike across all habitats.

Table 35: Fish passage enhancement and stream restoration projects successfully completed within the LSYR watershed since 2000.

#	Project	Drainage	Category*	Timeline
1	Hilton Creek Watering System / Emergency Backup System	Hilton	SR	2000/2015
2	Hwy 1 Bridge Fish Ladder	Salsipuedes	FP	2002
3	Streambank and Side Channel Restoration	El Jaro	SR	2003
4	Jalama Bridge Fish Ladder	Salsipuedes	FP	2004
5	Bradbury Dam Flashboard Installation (Surcharge)	Santa Ynez River	SR	2004
6	Cascade Chute	Hilton	FP	2005
7	Crossing 6 48-ft Bottomless Arched Culvert	Quiota	FP	2008
8	Rancho San Julian Fish Ladder	El Jaro	FP	2008
9	Cross Creek Ranch Fish Passage Improvement	El Jaro	FP	2009
10	Crossing 2 60-ft Bottomless Arched Culvert	Quiota	FP	2011
11	Crossing 7 60-ft Bottomless Arched Culvert	Quiota	FP	2012
12	Crossing 1 60-ft Bottomless Arched Culvert	Quiota	FP	2013
13	Cattle Exclusionary Fencing	Salsipuedes	SR	2014
14	Crossing 3 53-ft Bottomless Arched Culvert	Quiota	FP	2015
15	Crossing 0A 55-ft Bottomless Arched Culvert	Quiota	FP	2015
16	Crossing 4 54-ft Bottomless Arched Culvert	Quiota	FP	2016
17	Crossing 5 58-ft Bottomless Arched Culvert	Quiota	FP	2018
18	Crossing 9 60-ft Bottomless Arched Culvert	Quiota	FP	2018
19	Hilton Creek Gravel Augmentation	Hilton	SR	2018/2019
20	Crossing 8 54-ft Bottomless Arched Culvert	Quiota	FP	2019
21	South Side Erosion Control and Reforestation at Crossing 8	Quiota	SR	2020
*Category: Fish Passage (FP) and Stream Restoration (SR).				

Table 36: 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 2022)
Hwy 1 Bridge on Salispuedes Creek	2001	Completed (2002)
Cross Creek Ranch on El Jaro Creek	2005	Completed (2009)
Hwy 101 Culvert on Nojoqui Creek	2005	Proposed removal from BiOp[1]
Quiota Creek Crossing 1	2003	Completed (2013)
Quiota Creek Crossing 3	2003	Completed (2015)
Quiota Creek Crossing 4	2003	Completed (2016)
Quiota Creek Crossing 5	2003	Completed (2018)
Quiota Creek Crossing 7	2003	Completed (2012)
Quiota Creek Crossing 9	2003	Completed (2018)
Cascade Chute Passage on Hilton Creek	2000	Completed (2005)
Hwy 154 Culvert on Hilton Creek	2002	Proposed removal from BiOp[1]
Total:	**11**	
Projects completed or funded:	***9***	
Projects suggested to be removed:	***2***	
1. Project proposed for removal from the BiOp.		

Table 37: Non-BiOp tributary projects already completed or proposed with their status to date. Completed projects are listed by calendar year.

Tributary Projects	Current Status (as of December 2022)
Jalama Road Bridge on Salsipuedes Creek	Completed (2004)
San Julian Ranch on El Jaro Creek	Completed (2008)
Quiota Creek Crossing 0A	Completed (2015)
Quiota Creek Crossing 0B	In design
Quiota Creek Crossing 2	Completed (2011)
Quiota Creek Crossing 6	Completed (2008)
Quiota Creek Crossing 8	Construction (2019)
Total:	**7**
Projects completed:	***6***
Projects remaining:	***1***

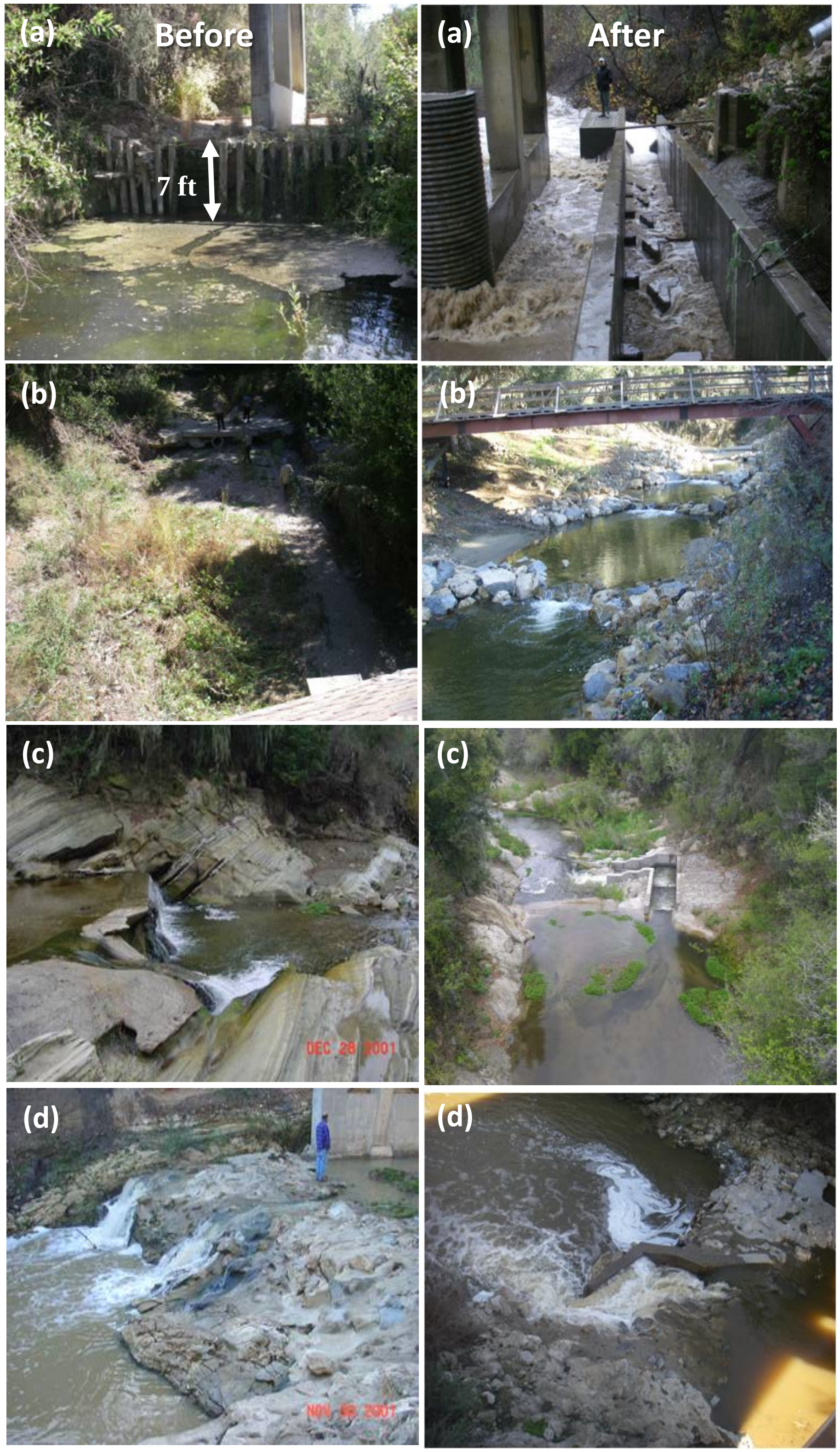


Figure 110: Fish passage and habitat restoration at: at (a) Rancho San Julian Bridge on El Jaro Creek (2008), (b) Cross Creek Ranch on El Jaro Creek (2009), (c) Jalama Road Bridge on Salsipuedes Creek (2004), and (d) Highway 1 Bridge on Salsipuedes Creek (2002).

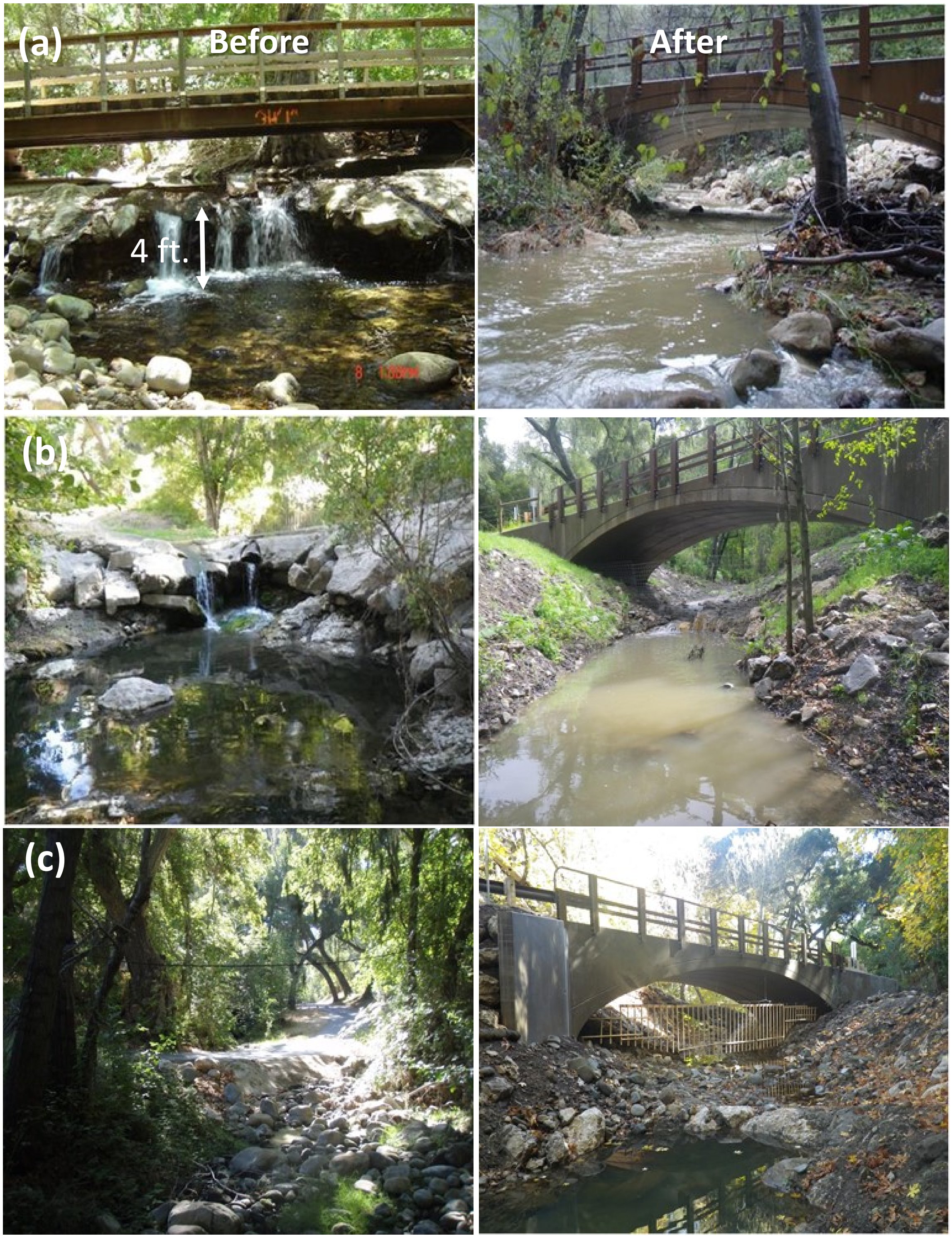


Figure 111: Fish passage and habitat restoration at a) Quiota Creek Crossing 6 (2008), (b) Quiota Creek Crossing 2 (2011), and Quiota Creek Crossing 7 (2012).

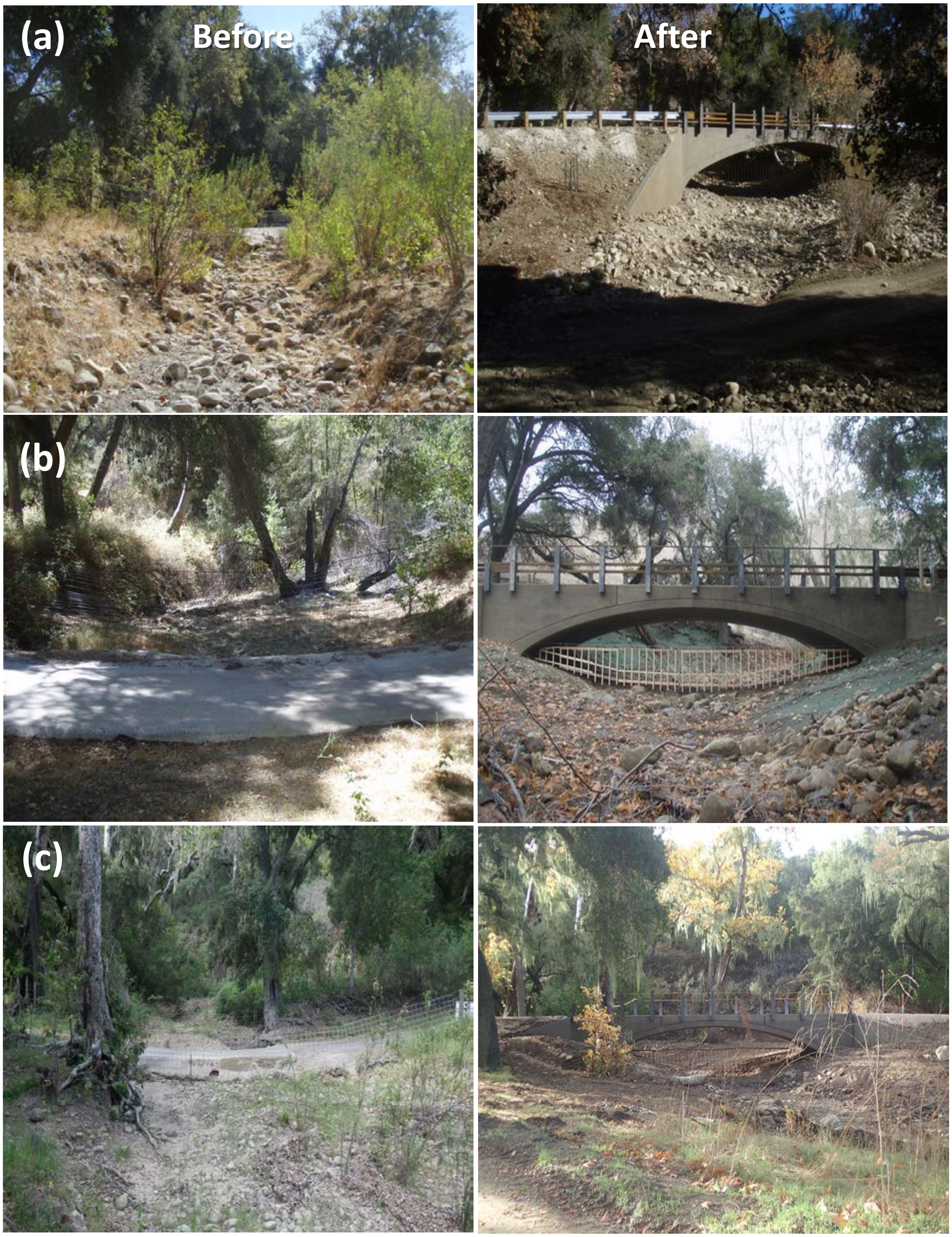


Figure 112: Fish passage and habitat restoration at (a) Quiota Creek Crossing 1 (2013), (b) Quiota Creek Crossing 3 (2015), and (c) Quiota Creek Crossing 4 (2016).

Figure 113: Fish passage and habitat restoration at (a) Quiota Creek Crossing 0A (2015), (b) Quiota Creek Crossing 5 (2018), and (c) Quiota Creek Crossing 9 (2018).

Figure 114: Fish passage and habitat restoration at (a) Quiota Creek Crossing 8 completed in 2019 and (b) South Side Erosion Control and Reforestation Project at Crossing 8 (completed in 2020).

Figure 115: Fish passage and habitat restoration at Hilton Creek at the Cascade Chute Project that was completed in 2005.

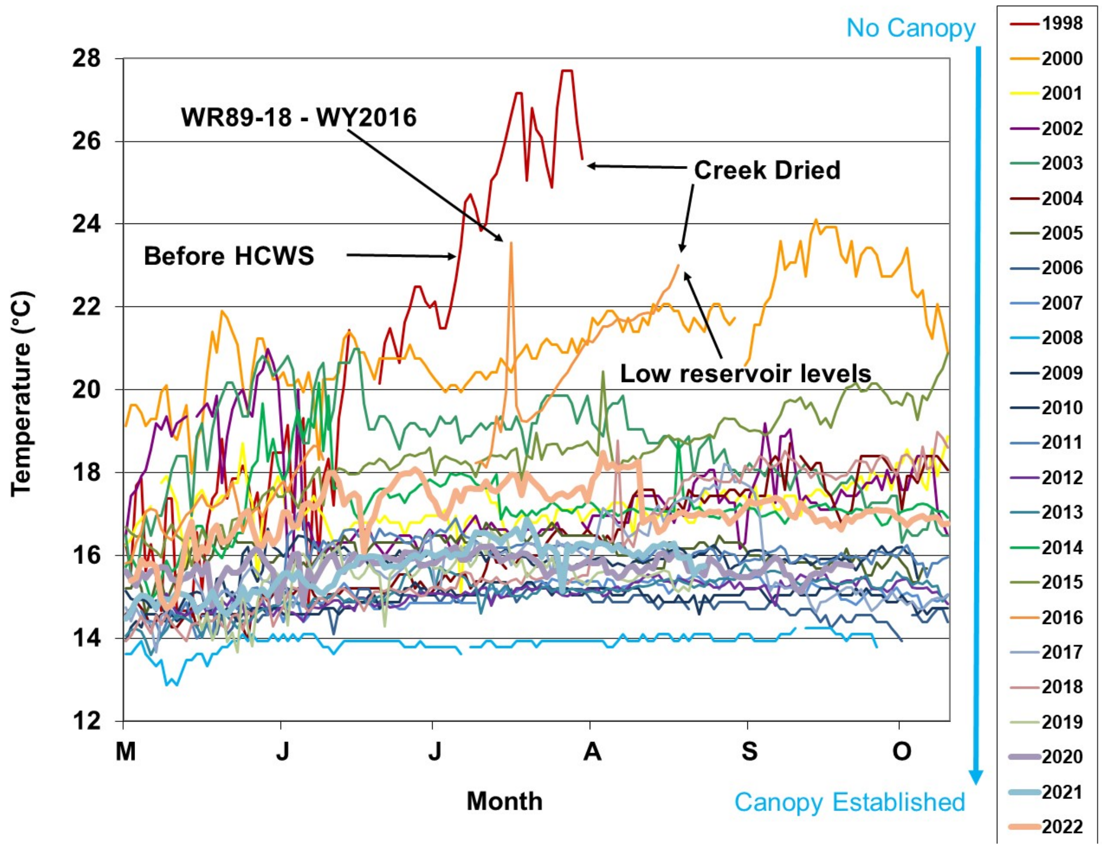


Figure 116 Lower Hilton Creek thermograph maximum water temperature data from 1998 to 2022, the last three years are shown with a wider line.

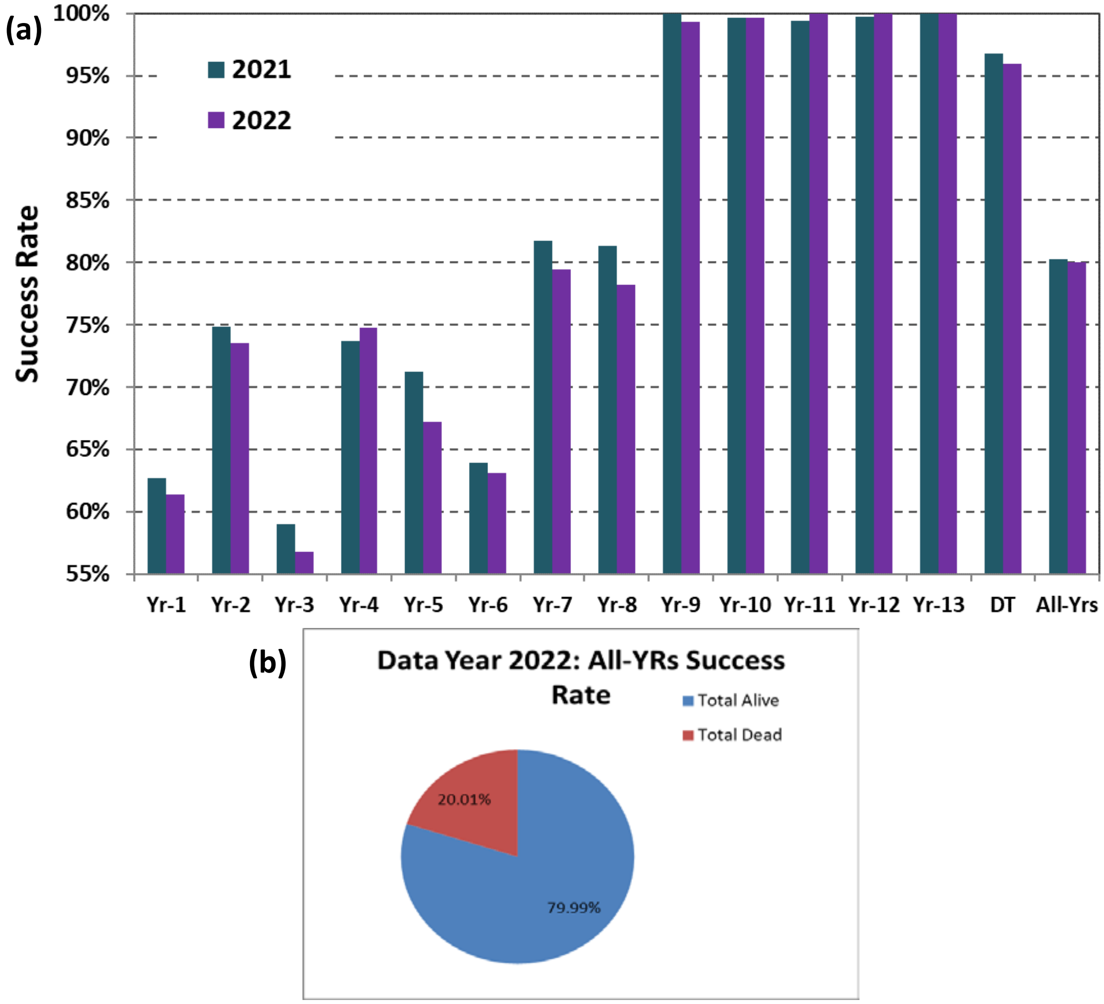


Figure 117: Success rate (a) comparison for all planting year classes plus total from 20121 to 2022 and (b) a detail of the survival rate in 2021; the 2022 inventory is in process.

WY2022 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

Doppler: A sonar situation wherein the target is moving toward the transducer

DPS: Distinct Population Segment

DT: Dam Tender Trees

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

Parr: Young *O. mykiss* distinguished by dark rounded patches evenly spaced along its sides

PG&E: Pacific Gas and Electric Company

PIT: Passive Integrated Transponder

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

SYRWCD: Santa Ynez River Water Conservation District

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 to collect instream habitat data 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 B-1 (Calibration). The parameters and specifications of each instrument are listed in Table B-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 - EXO2 + 6920 (650 MDS) - DO meter	Monthly	Monthly when in use	At a minimum, water saturated air, according to manufacturer's instructions.
pH	YSI - EXO2 + 6920 (650 MDS) - pH meter	Monthly	Monthly when in use	pH buffer 7.0 and 10.0
Conductivity	YSI - EXO2 + 6920 (650 MDS) - Conductivity meter	Monthly	Monthly when in use	Conductivity standard 700 and 2060 µmhos/cm or µS/cm
Redox	YSI - EXO2 + 6920 (650 MDS) - Redox	Monthly	Monthly when in use	Factory calibrated
Turbidity	YSI - EXO2 + 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 - EXO2 + 6920 (650 MDS) - TDS	None	When in use	Conversion from specific conductance to TDS by use of a multiplyer in the instrument
Stream Discharge	SonTek FlowTracker2	When in use	When in use	Software driven calibration
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
SonTek FlowTracker2	Stream Velocity	ft/sec	0.003	±0.0003	± 1% of measured velocity
YSI EXO2 + 6920 (650 MDS) Multi-Probe	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
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

Hobo 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 cable (one foot below the surface), and the bottom unit deployed at the bottom. Precautionary measures are always taken to hide the thermographs from the public, especially in places with high volume traffic. 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.

YSI Sondes - EX02 Multi-parameter Probe

This sonde is used for lake profiles with a 200 foot cable and spot measurements. It is calibrated in the office once a month, or more frequently if under heavy use. Lake profiles are conducted on a calm day and are done from an anchored (stationary) boat. The sonde is lowered on the cable and measurements are taken every meter all the way to the bottom. For spot measurements in a stream, a short cable is used and the sonde is placed usually in the middle of the water column. The data are usually recorded on field datasheets and/or downloaded from the instrument to a desktop computer for analyses and incorporation into the larger dataset.

YSI Sondes 6920 (650 MDS) Multi-parameter Probe

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 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.

YSI ProSolo Temperature/Dissolved Oxygen/Conductivity Probe

The YSI ProSolo is a handheld water quality probe that is used to collect spot measurement during routine monitoring activities to assess site-specific conditions. The instrument has the capability of logging a single or interval data points depending on the field requirement at the time. The unit has been used to collect water temperature and dissolved oxygen readings at individual *O. mykiss* spawning sites as well as site specific conductivity readings when conducting fish rescue operations in conjunction with California Department of Fish and Wildlife.

SonTek Acoustic Doppler Velocimeter

Flows are measured using a SonTek FlowTracker 2 handheld Acoustic Doppler Velocimeter, an engineer's measuring tape and a top setting rod. This is the same equipment that the U. S. Geological Survey (USGS) uses to measure stream discharge. This unit is a software driven instrument that includes real time plot of point data and QC parameters for each measurement thereby increasing accuracy and minimizing data handling. A minimum of 15 transects are established across and measurements collected in each transect cell. Surveyors keep a constant eye on the probe so that no algae or debris moving downstream is blocking the Doppler field by getting caught on the probe. Once each transect is measured, the FlowTracker calculates the transect width, depth, and velocity to determine overall discharge.

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 and evaluate 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 cable (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 manually 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.

Solinst 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 various vertical array locations, specific fish passage projects when applicable, 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/corroborate 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 instrument 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

Thermograph deployment in the mainstem and tributaries is done in such a way as to minimize visibility of the units to prevent tampering/vandalism by the public. This methodology has largely succeeded over the many years of monitoring in the lower river. Since 1995, there have only been three instances of tampering, all of them in and around the Refugio Bridge location (LSYR-7.65), an area of high public use. The latest instance occurred during WY2021. No public tampering or vandalism of the thermograph network occurred in WY2022.

Thermograph data transferred to the Optic Shuttle in the field are downloaded to the HOBOWare 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 and then corrected.

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, graphed, and outliers/anomalous data are identified and removed.

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 input 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 (or the end of deployment) or during the downloads while the unit is out of the water. The other situation causing anomalous 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 2002-2005 in the spring, summer, and fall. After 2005 and continuing through 2022, photo points were scaled down and taken during the spring and fall, typically during May and October. All photo points taken in WY2022 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 some locations had become so overgrown with vegetation to make yearly evaluation impractical, river course changes, or were no longer showing any visible change.

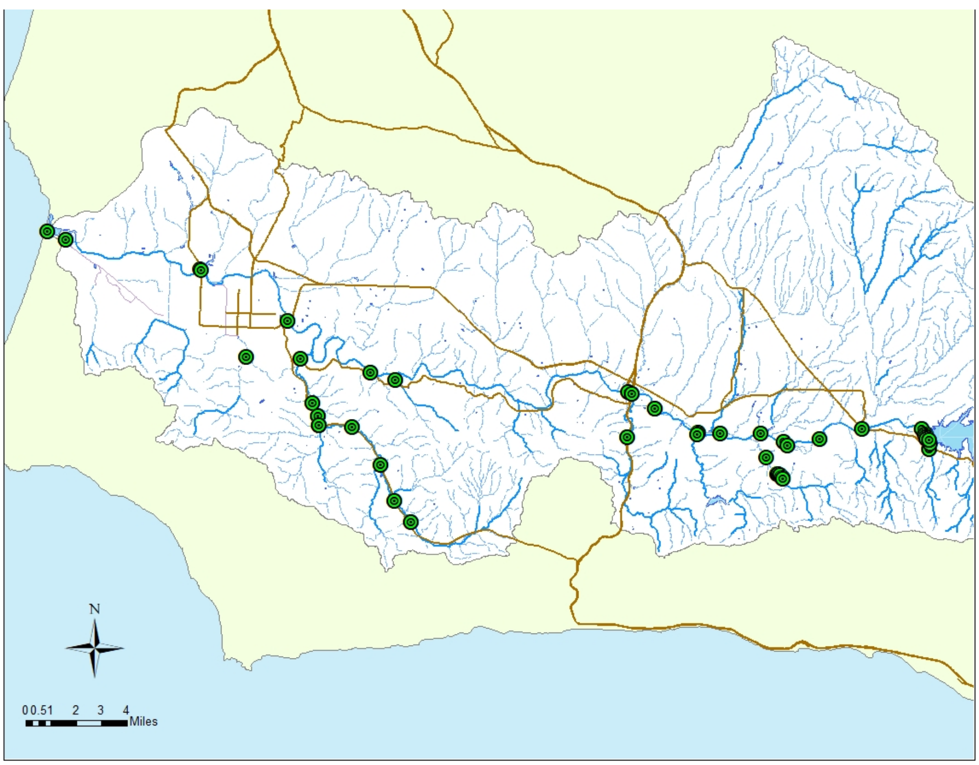


Figure C-1: WY2022 photo point locations.

Table C-1: WY2022 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	May 2022	October 2022
M1	Lower Hilton Creek, photo d/s at ford crossing	X	
M2a	Bluffs overlooking long pool, photo u/s	X	
M2b	Bluffs overlooking long pool, photo d/s	X	
M3	Highway 154 culvert on Hilton Creek, photo u/s		
M4	Highway 154 culvert on Hilton Creek, photo d/s		
M5	Highway 154 Bridge, photo u/s	X	X
M6	Highway 154 Bridge, photo d/s	X	X
M7	Meadowlark crossing, photo u/s	X	X
M8	Meadowlark crossing, photo d/s	X	X
M9	Lower Gainey crossing, beaver dam, photo u/s		
M10	Lower Gainey crossing, beaver dam, photo d/s		
M11a	Lower Gainey crossing, photo u/s		
M11b	Lower Gainey crossing, photo d/s		
M12	Refugio Bridge, photo u/s	X	X
M13	Refugio Bridge, photo d/s	X	X
M14	Alisal Bridge, photo u/s	X	X
M15	Alisal Bridge, photo d/s	X	X
M17	Mid-Alisal Reach, photo u/s	X	X
M18	Mid-Alisal Reach, photo d/s	X	X
M19	Avenue of the Flags Bridge, photo u/s	X	X
M20	Avenue of the Flags Bridge, photo d/s	X	X
M21	Sweeney Road crossing, photo u/s	X	X
M22	Sweeney Road crossing, photo d/s	X	X
M23	Highway 246 (Robinson) Bridge, photo u/s	X	X
M24	Highway 246 (Robinson) Bridge, photo d/s	X	X
M25	LSYR Lagoon on railroad bridge, photo u/s		X
M26	LSYR Lagoon on railroad bridge, photo d/s		X
M27	LSYR at 35th St. Bridge, photo d/s	X	X
M28	LSYR at 35th St. Bridge, photo u/s	X	X
M29	LSYR Lagoon upper reach, photo d/s		
M30	LSYR Lagoon upper reach, photo u/s		
M31	Slick Gardener, looking across towards highway	X	X
M32	Slick Gardener, looking d/s through culvert	X	X
M33	Slick Gardener, looking u/s through culvert	X	X
	Floradale Br-u/s	X	X
	Floradale Br-d/s	X	X

Table C-2: WY2022 photo points on the LSYR tributaries. "X's" denote photos taken.

Tributary Photo Point ID	Location/Description	May 2022	October 2022
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	X
T4	Hilton at ridge trail, photo u/s	X	X
T5	Hilton at telephone pole, photo d/s	X	X
T6	Hilton at telephone pole, photo u/s	X	X
T7	Hilton at tail of spawning pool, photo u/s	X	
T8	Hilton impediment/tributary, photo d/s		
T9	Hilton impediment/tributary, photo u/s		
T10	Hilton just u/s of URP, photo d/s	X	
T11	Hilton road above URP, photo d/s		X
T12	Hilton road above URP, photo u/s		X
T14	Hilton from hard rock toe, photo d/s		
T15	Hilton from hard rock toe, photo u/s		
TX1a	Quiota Creek at 1st crossing, photo u/s	X	X
TX1b	Quiota Creek at 1st crossing, photo d/s	X	X
TX2a	Quiota Creek at 2nd crossing, photo u/s	X	X
TX2b	Quiota Creek at 2nd crossing, photo d/s	X	X
TX3a	Quiota Creek at 3rd crossing, photo u/s	X	X
TX3b	Quiota Creek at 3rd crossing, photo d/s	X	X
TX4a	Quiota Creek at 4th crossing, photo u/s	X	X
TX4b	Quiota Creek at 4th crossing, photo d/s	X	X
T16	Quiota Creek at 5th crossing, photo d/s	X	X
T17	Quiota Creek at 5th crossing, photo u/s	X	X
T18	Quiota Creek at 6th crossing, photo d/s	X	X
T19	Quiota Creek at 6th crossing, photo u/s	X	X
T20	Quiota Creek at 7th crossing, photo d/s	X	X
T21	Quiota Creek at 7th crossing, photo u/s	X	X
T22	Quiota Creek below 1st crossing, photo d/s	X	X
T23	Alisal Creek from Alisal Bridge, photo u/s	X	X
T24a	Alisal Creek from Alisal Bridge, photo u/s	X	X
T24b	Alisal Creek from Alisal Bridge, photo d/s	X	X
T25	Nojoqui Creek at 4th Hwy 101 Bridge, photo u/s		
T26	Nojoqui Creek at 4th Hwy 101 Bridge, photo d/s		
T27	Nojoqui/LSYR confluence, photo u/s	X	X
T28	Salsipuedes Creek at Santa Rosa Bridge, photo u/s	X	X
T29	Salsipuedes Creek at Santa Rosa Bridge, photo d/s	X	X
T38-New	Salsipuedes Creek at Hwy 1 looking u/s from bluff		X
T39	Salsipuedes Creek at Hwy 1 Bridge, photo d/s	X	X
T40	Salsipuedes Creek at Hwy 1 Bridge, photo u/s	X	X
T41	Salsipuedes Creek at Jalama Bridge, photo d/s	X	X
T42a	Salsipuedes Creek at Jalama Bridge, photo u/s	X	X
T42b	Pool at Jalama Bridge	X	X
T43	El Jaro/Upper Salsipuedes confluence, photo u/s		
T44	Upper Salsipuedes/El Jaro confluence, photo u/s	X	
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	X
T53	Ytias Creek Bridge, photo u/s	X	X
T54	El Jaro Creek 1st Hwy 1 Bridge, photo d/s	X	X
T55	El Jaro Creek 1st Hwy 1 Bridge, photo u/s	X	X
T56	El Jaro Creek 2nd Hwy 1 Bridge, photo d/s	X	X
T57	El Jaro Creek 2nd Hwy 1 Bridge, photo u/s	X	X
T58	El Jaro Creek 3rd Hwy 1 Bridge, photo d/s	X	X
T59	El Jaro Creek 3rd Hwy 1 Bridge, photo u/s	X	X
T60	San Miguelito Creek at crossing, photo d/s	X	X
T61	San Miguelito Creek at Stillman, photo u/s	X	X
T62	Rancho San Julian Bridge, photo d/s	X	X
T63	Rancho San Julian Bridge, photo u/s	X	X

D. List of Supplemental Reports Created During WY2022

- WY2021 Annual Monitoring Summary (and Report) (COMB, 2022e).
- WY2022 Migrant Trapping Plan (COMB, 2022f).
- Hilton Creek (Reach 5) Rescue and Relocation of Native Fish including Oncorhynchus mykiss (with collaboration from COMB) (CDFW, 2022)
- Interruption of Flow on 8/2/22 to Hilton Creek Incident Report (COMB, 2022a).
- Interruption of Flow on 9/3/22 to Hilton Creek Incident Report (COMB, 2022b).
- Lake Cachuma Oak Tree Restoration Program 2021 Annual Report with Fiscal Year 2021-2022 Financials and Water Usage (COMB, 2022c).
- RPM 6 2022 Study Plan (COMB, 2022d).
- RPM 6 2022 Monitoring Report (COMB, 2023).
- Steelhead and Sulfur, Lake Cachuma Dynamics and the Downstream *O. mykiss* Population (Robinson and Papen, 2023).

E. Appendices References

CDFW, 2022. Memorandum - Hilton Creek Rescue and Relocation of Native Fish including Onorhynchus mykiss on August 8-10, 2022 Written by Casey Horgan for Kyle Evans, with collaboration from COMB Fisheries Division, California Department of Fish and Wildlife (CDFW).

COMB, 2022a. Interruption of Flow on 8/2/22 to Hilton Creek Incident Report. Cachuma Operation and Maintenance Board (COMB).

COMB, 2022b. Interruption of Flow on 9/3/22 to Hilton Creek Incident Report. Cachuma Operation and Maintenance Board (COMB).

COMB, 2022c. Lake Cachuma Oak Tree Restoration Program 2021 Annual Report with Fiscal Year 2021-2022 Finanacials and Water Usage. Cachuma Operation and Maintenance Board (COMB).

COMB, 2022d. RPM 6 2022 Study Plan Study Plan, Cachuma Operation and Maintenance Board (COMB).

COMB, 2022e. WY2021 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, 2022f. WY2022 Migrant Trapping Plan. Prepared in collaboration with United States Bureau of Recalamation, Cachuma Operation and Maintenance Board (COMB), Fisheries Division.

COMB, 2023. RPM 6 Monitoring Report for the 2022 WR 89-18 Releases. Compliance Report, Cachuma Operation and Maintenance Board (COMB).

Robinson, T. H. and E. Papen, 2023. Steelhead and Sulfur, Lake Cachuma Dynamics and the Downstream *O. mykiss* Population. Fortuna, CA, Cachuma Operation and Maintenance Board (COMB).