# Monitoring of Southern California Steelhead Rainbow Trout within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains Biogeographic Population Groups

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California Department of Fish and Wildlife

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## ABSTRACT

This study is a continuation of long-term monitoring efforts initiated by the California Department of Fish and Wildlife (CDFW) and the Pacific States Marine Fisheries Commission (PSMFC) in 2013 to ascertain the abundance, productivity, spatial structure, and diversity of Southern California *Oncorhynchus mykiss* (*O. mykiss*), which were designated as an endangered distinct population segment (DPS) under the U.S. Endangered Species Act (ESA) in 2012, after their initial ESA listing as an evolutionary significant unit (ESU) of the species in 1997( NMFS 2012). Southern California *O. mykiss* were also recently listed as endangered under the California Endangered Species Act (CESA) in April 2024. Southern California *O. mykiss* monitoring efforts currently are part of CDFW's California Monitoring Plan for salmonids. For recovery planning purposes, the National Marine Fisheries Service (NMFS) divided coastal watersheds that have historically supported *O. mykiss* into Biogeographic Population Groups (BPGs). This report discusses *O. mykiss* monitoring efforts conducted between July 17, 2023, and August 5, 2024, within the Monte Arido Highlands, Conception Coast, and the Santa Monica Mountains BPGs. Monitoring efforts incorporate multiple methods. Sonar camera deployments provide potential unbiased counts of returning anadromous *O. mykiss*. Electrofishing capture and snorkel observation surveys provide *O. mykiss* habitat use, spatial structure, and abundance data. Electrofishing capture provided opportunities for genetic sample collection and the deployment of Passive Integrated Transponders (PIT) tags which can be paired with detection array antennas allowing for smoltification rate and marine survival estimates. Finally, spawning ground (redd) surveys allowed for additional estimates of *O. mykiss* abundance, spatial structure, and reproduction attempts.

Sonar cameras (DIDSON and ARIS) were deployed at five monitoring sites and captured footage was primarily analyzed for observations of targets $\geq$ 30 cm in length. Every fish observation was measured for length and when possible, classified to species. Excessive and prolonged periods of elevated streamflow contributed to various sonar camera deployment and footage review challenges. Despite these challenges, approximately 374.5 days of footage were acquired across the monitored BPGs. Two anadromous *O. mykiss* observations were made in the acquired footage, both within Salsipuedes Creek, a tributary to the Santa Ynez River.

PIT tagging surveys were conducted on Topanga Creek between December 4 and December 7, 2023, in which 37 *O. mykiss* were captured, 29 of which met the criteria for PIT tag implementation. Three PIT tag antenna array sites were deployed, two within the Ventura River watershed (Monte Arido Highlands BPG) and one within the Topanga Creek watershed (Santa Monica Mountains BPG). High streamflow storm events caused damage to each array and contributed to several periods of non-operational status due to technical issues. No upstream or

downstream migrants were recorded at the Ventura River and San Antonio Creek antenna array sites and one PIT tagged *O. mykiss* was recorded at the Topanga Creek array.

Redd surveys were conducted in multiple streams within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains BPGs. Within the Monte Arido Highlands BPG, these surveys documented four redds and 687 *O. mykiss* observations. Within the Conception Coast BPG, no redds were observed, but 318 *O. mykiss* were. Within the Santa Monica Mountains BPG, one redd and 328 bankside *O. mykiss* observations were made.

Low-flow surveys following guidance listed within Fish Bulletin 182 were implemented for the first time within the region. These efforts were focused within Conception Coast BPG streams. A total of 117 short reaches were considered for low-flow surveys, with survey efforts taking place on 37 short reaches. Crews surveyed 443 habitat units, comprising 3,925 meters of stream channel. A total of 27 resident life stage *O. mykiss* were observed during these efforts.

## 1.0 INTRODUCTION

Steelhead Rainbow Trout (*Oncorhynchus mykiss*) are a species of salmonid native to coastal streams of the North American and Asian portions of the Pacific basin. Their current range extends from the Kamchatka Peninsula in Russia southeast through the western coast of Canada and the United States to the northern extent of the Baja California Peninsula. *O. mykiss* can express two distinct life history strategies; resident *O. mykiss* (i.e., Rainbow Trout) complete their entire life cycle within freshwater streams and anadromous *O. mykiss* (i.e., Steelhead Trout) rear in freshwater streams, migrate to the ocean to mature, and return to their natal stream to spawn (Peven et al. 1994). This diversity in life history provides *O. mykiss* populations resilience as they can persist in diverse habitats and endure a wide range of environmental conditions (Moore et al. 2014). However, anthropogenic impacts have caused significant declines in *O. mykiss* populations, particularly at the southern extent of their range. Historical estimates suggest Southern California anadromous *O. mykiss* run sizes exceeded 30,000 individuals annually (Moyle et al. 2017) while current runs are estimated to be less than 500 anadromous individuals (CalTrout 2026). CDFW and other organizations conducting *O. mykiss* monitoring efforts within Southern California have rarely observed more than ten annual anadromous individuals. Current projections suggest that the Southern California *O. mykiss* DPS could become extinct within 50 years unless specific actions are taken to address the issues that have caused the population to decline (Moyle et al. 2017).

In 1997, anadromous *O. mykiss* inhabiting Southern California streams between Point Conception to Malibu Creek were listed as a federally endangered evolutionarily significant unit (ESU) by the National Marine Fisheries Service (NMFS), under the U.S. Endangered Species Act (ESA; NMFS 2012). This designation was expanded to include coastal watersheds between the Santa Maria River and the United States/Mexican border in 2002. In 2006, the anadromous *O. mykiss* within this portion of Southern California were distinguished as a Distinct Population Segment (DPS) based on discrete factors separating it from other *O. mykiss* populations. In 2022, CalTrout filed a petition with the California Fish and Game Commission to list Southern California *O. mykiss* as endangered under the California Endangered Species Act (CESA). In April 2024, the California Fish and Game Commission voted unanimously to list Southern California *O. mykiss* (all life history expressions in anadromous waters) under CESA.

The watersheds within the Southern California *O. mykiss* DPS are further divided into five distinct biogeographic population groups (BPGs) based on unique combinations of physical and ecological characteristics that present differing natural selective regimes for *O. mykiss* populations (NMFS 2012): Monte Arido Highlands, Conception Coast, Santa Monica Mountains, Mojave Rim, and Santa Catalina Gulf Coast (Figure 1). The NMFS recovery plan for Southern California *O. mykiss* outlines goals to ensure the persistence of viable populations throughout the DPS (NMFS 2012). A statistical and ecological monitoring framework known as the California Monitoring Plan (CMP) was developed by CDFW to collect data that can be used to track progress towards *O. mykiss* recovery goals and assist in habitat restoration decision-making. The CMP and the recommended monitoring structure was established in Fish Bulletin 180 (Adams et al. 2011) and further refined for central and Southern California in Fish Bulletin 182 (Boughton et al. 2022). The monitoring and data reporting structure was designed around the Viable Salmonid Population (VSP) framework (McElhany 2000), which suggests four main viable salmonid population parameters to be measured for assessing population trends: abundance, productivity, spatial structure, and diversity (McElhany 2000, NMFS 2016). A core principle of the monitoring recommendations in Fish Bulletin 182 is that estimates of various VSP parameters are produced at the scale of the BPG.

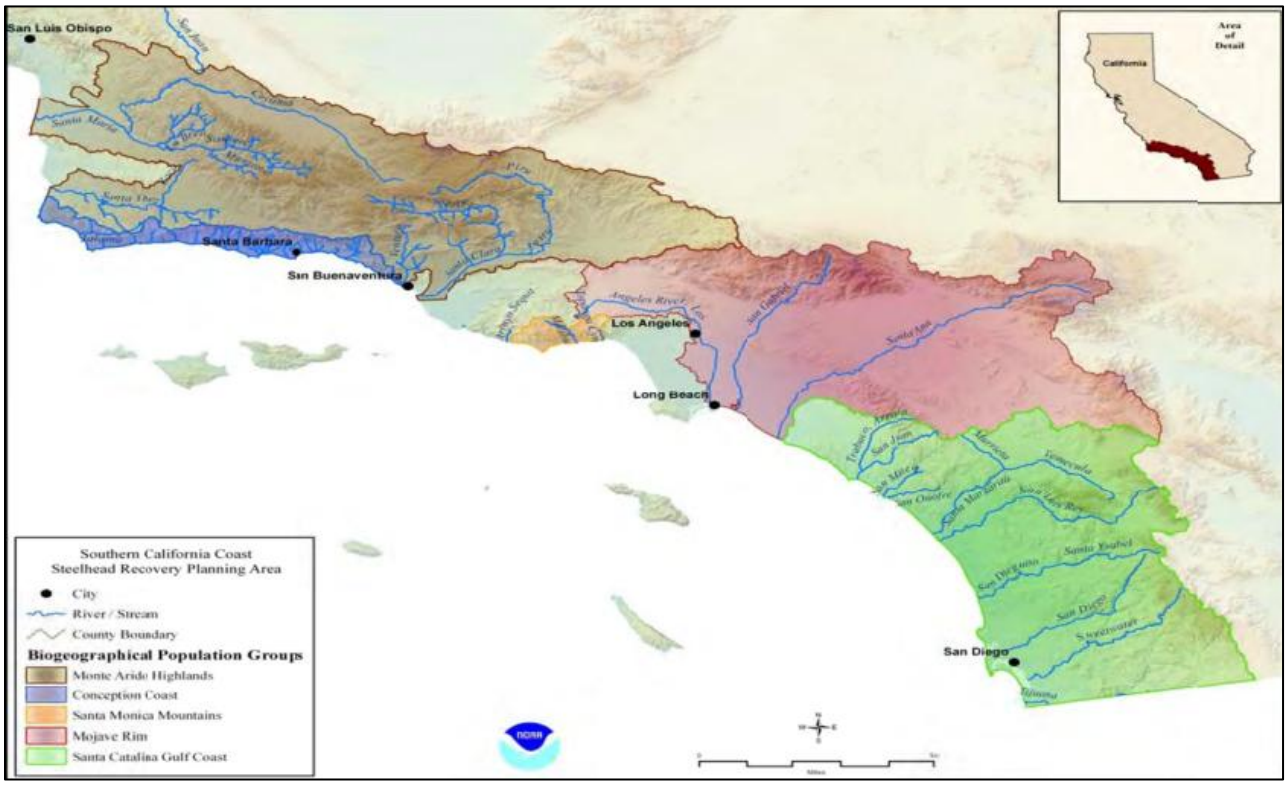



**Figure 1:** Locations of the five Southern California *O. mykiss* Biogeographic Population Groups (BPGs) (NMFS 2012).

Fish Bulletin 180 and 182 recommend utilizing five sampling methods to accurately assess VSP parameters. These include the use of sonar cameras (i.e., DIDSON & ARIS) during salmonid migration periods to collect counts of anadromous adults within focal streams which provides data on abundance and spatial structure. DIDSON & ARIS sonar cameras produce

near video-quality imagery and allow for data collection at night and during periods of high flow and turbidity (Sound Metrics 2018). These conditions are common in Southern California where highly episodic stream flows result in dynamic hydrology. Sonar cameras also allow for passive collection of data and minimizes impact to *O. mykiss* behavior or inadvertent harm to listed species (Pipal 2012). Spawning ground surveys (hereafter redd surveys) are recommended to provide an index of *O. mykiss* productivity and estimation of spatial structure. Previous studies using redd surveys have demonstrated that anadromous and resident *O. mykiss* redds can be distinguished by redd size (Zimmerman and Reeves 2000). This information provides insight into the complex interplay between resident and anadromous life history strategies in focal watersheds. Pairing redd counts with abundance data provided by sonar cameras allows for calibration of a redd to spawner ratio to be used in nearby stream systems without counting stations, fulfilling a critical component of life cycle monitoring (LCM) stations. Redd surveys provide data on the timing and habitat for spawning activity that guide management and restoration decisions.

Low-flow electrofishing and snorkel surveys produce data to assess juvenile spatial structure and abundance. These surveys are conducted during periods of consistent and prolonged low streamflow during the summer and autumn dry periods. Electrofishing surveys are data rich, allowing surveyors to collect biological data including length, condition, and genetics of individual fish via fin clips. These surveys are an opportunity to deploy passive integrated transponder (PIT) tags within fish. The Southern Steelhead Recovery Plan (NMFS 2012) identifies the use of PIT tags and in-stream reader stations as a viable means to estimate anadromous *O. mykiss* runs and an index of smoltification rate (Boughton 2010). PIT tagging efforts augment the estimates of diversity and abundance by providing insight into the anadromous fraction of the population, particularly when compared with sonar camera monitoring results. Placement of PIT Tag antennas in proximity to sonar cameras provides the opportunity to confirm species identification made when reviewing sonar camera footage if those PIT tagged *O. mykiss* are also recorded by antennas.

Initial *O. mykiss* monitoring efforts within the Southern California *O. mykiss* DPS were focused on watersheds assigned a Core 1 status, the highest priority for *O. mykiss* recovery by NMFS. In 2011, CDFW assumed monitoring operations from NMFS within the Ventura River watershed. In 2014, Pacific States Marine Fisheries Commission (PSMFC) began collaborating with CDFW to conduct monitoring efforts, data analysis, and reporting. Initial PSMFC and CDFW monitoring efforts were concentrated within the Ventura River watershed, with eventual expansion into other watersheds. In 2019, CDFW adopted monitoring work in the Santa Monica Mountains BPG from the Resource Conservation District of the Santa Monica Mountains. Fish Bulletin 182 provides guidance intended to reduce spatial and temporal bias by creating a standardized and statistically robust sampling scheme that allows for analysis of salmonids at multiple geographic scales. For the 2023–2024 monitoring season, CDFW incorporated Fish Bulletin 182 monitoring recommendations into *O. mykiss* sampling efforts, with comprehensive BPG-scale monitoring implementation in the Conception Coast BPG (Table 1). Our intention is to establish Fish Bulletin 182 sampling schemes methodologies for the Monte Arido Highlands and Santa Monica Mountains BPGs in future sampling seasons. Data synthesis and analysis will help refine monitoring protocols for *O. mykiss* in Southern California watersheds. It will also inform resource managers on the status of endangered Southern California *O. mykiss* populations and help to identify and prioritize restoration projects.

**Table 1:** Overview of *O. mykiss* monitoring efforts conducted within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains Biogeographic Population Group streams.

| Type of Monitoring Efforts Conducted | Monte Arido Highlands BPG | Conception Coast BPG | Santa Monica Mountains BPG |
|---|---|---|---|
| Sonar Camera Life Cycle Monitoring Station | Yes (3 sites utilized) | Yes (in Carpinteria Creek) | Yes (in Topanga Creek) |
| Redd Surveys | Yes (in multiple streams) | Yes (in multiple streams) | Yes (in multiple streams) |
| Snorkel Abundance Surveys | No | Yes (in 2 streams) | No |
| Electrofishing Abundance Surveys | No | No | Yes (in Topanga Creek) |
| PIT Tagging | Yes | No | Yes (in Topanga Creek) |

## 1.1 Study Sites: Conception Coast, Santa Monica Mountains, & Monte Arido Highlands BPGs

The watersheds that make up the Conception Coast, Monte Arido Highlands, and Santa Monica Mountains *O. mykiss* BPGs have headwaters that originate within the transverse mountain ranges of Southern California. These mountain ranges are oriented east to west and contain small coastal watersheds that make up the Conception Coast and Santa Monica Mountains BPGs and large watersheds that extend further inland and make up the Monte Arido Highlands BPG. Downstream portions of the watersheds in these BPGs transition into lower elevation coastal terraces before reaching the Pacific Ocean (NMFS 2012). The Conception Coast and Santa Monica Mountains BPGs consist of numerous relatively small coastal watersheds that drain from south-facing slopes of the Santa Ynez Mountains and Santa Monica Mountains, respectively. Streams in these watersheds are relatively short and steep. The Monte Arido Highlands BPG, by contrast, consists of a much larger land area with four large distinct watersheds and eight smaller sub-watersheds. The four main watersheds of the Monte Arido Highlands, the Santa Maria River, Santa Ynez River, Ventura River, and Santa Clara River, extend further inland than watersheds that make up the Conception Coast and Santa Monica Mountains BPGs and drain out from large interior portions of the transverse mountain ranges with large broad coastal plains in the lower portions of the watersheds. The dominant vegetation across these three BPGs is chaparral woodlands intermixed with savanna oak woodlands consisting of Coast Live Oak (*Quercus agrifolia*) and Valley Oak (*Quercus lobate*). Groves of conifers such as Big Cone Spruce (*Pseudotsuga macrocarpa*), Grey Pine (*Pinus sabiniana*), and Coulter Pine (*Pinus coulteri*) are present at higher elevations. Riparian areas within the assessed watersheds typically include Sycamores (*Plantus racemose*), Arroyo Willow (*Salix lasiolepis*), White Alder (*Alnus rhombifolia)*, and Fremont Cottonwood (*Populus fremontii*).

Coastal Southern California is characterized as a semi-arid Mediterranean climate with wet winters and warm, dry summers. Approximately 90% of annual precipitation typically occurs between November and April. Frequency, intensity, and duration of winter and spring precipitation events can vary greatly from year to year throughout Southern California. Extreme and persistent drought conditions occurred throughout Southern California between 2012 and 2016. During this period, annual precipitation ranged from 40–69% of normal across Santa Barbara County and 38–67% of normal across Ventura County (Santa Barbara Public Works

Department 2024, Ventura County Watershed Protection District 2024). Annual rainfall fluctuated between below and above average amounts between 2017 and 2022 with below average rainfall occurring during the 2017–2018, 2020–2021, and 2021–2022 water years. Well-above-average precipitation occurred during the 2022–2023 and 2023–2024 water years, with 169% to 237% of normal precipitation occurring across Santa Barbara County and 132 to 222% of normal occurring across Ventura County during the 2022–2023 water year (Santa Barbara Public Works Department 2024; Ventura County Watershed Protection District 2024). During the 2023–2024 water year (the current reporting period), 143% of normal precipitation occurred across Santa Barbara County and 111% to 180% of normal precipitation occurred across Ventura County (Santa Barbara Public Works Department 2024; Ventura County Watershed Protection District 2024). Additionally, the amount of precipitation that occurs in the watersheds of the five BPGs can vary significantly with additional orographic precipitation occurring at higher elevations.

Stream flow and stream channel connectivity in Southern California streams is highly dependent on precipitation and is characterized by flashy hydrologic events, rising and falling quickly during and after precipitation events. These stream flow regimes and the inconsistency of precipitation in the region result in limited opportunity for *O. mykiss* to complete their anadromous life cycle. *O. mykiss* migration is further limited by seasonal sandbar formation at the mouths of many estuaries within these watersheds. These sandbars typically are not breached until the first large precipitation event occurs. If consistent precipitation events do not occur, stream flow may diminish to a point that limits or prevents *O. mykiss* movement into, within, and out of watersheds. During the dry season, there are steady decreases in residual streamflow, eventually leading to portions of streams experiencing sub-surface flow and dry channel beds. Areas with perennial wetted habitat therefore has greater importance for the over-summer survival of *O. mykiss. O. mykiss* movement through many streams within these watersheds and access to areas of perennial refugia habitat has been further hindered by the widespread presence of manmade structures such as dams, flood control channelization, and roadway crossings (NMFS 2012, Stoecker 2002). Many of these structures limit or entirely prevent *O. mykiss* passage. Some of the major barriers within the Conception Coast, Monte Arido Highlands, and Santa Monica Mountains BPG watersheds are the Matilija Dam (Ventura River watershed), Rindge Dam (Malibu Creek watershed), Twitchell Dam (Santa Maria River watershed), and Bradbury Dam (Santa Ynez River watershed).

Wildfire is an additional threat to the habitat conditions and the persistence of *O. mykiss* within the Conception Coast, Monte Arido Highlands, and Santa Monica Mountain BPGs. Wildfires can have a wide range of impacts to stream channel habitat conditions in Southern California including reduced benthic macroinvertebrate populations, decreased channel bank stability, diminished water quality, decreased habitat unit depth, increased dissolved nutrients, altered pH levels, increased water temperature, and increased turbidity (Klose 2018). Each of these impacts can create individual chain reactions that further alter habitat. For instance, increased water turbidity interferes with sunlight penetration and reduces aquatic vegetation photosynthesis resulting in lower concentration of dissolved oxygen. Increased turbidity clogs the gills of fish, diminishes their ability to forage, and results in decreased growth rates for juvenile salmonids (Bolton et al. 2001). Overall stream ecosystem impacts associated with wildfire adversely impact fish populations as the quality and quantity of habitat available to them is reduced. Many of these negative impacts were exacerbated following the Thomas Fire, which

occurred in December 2017 and burned 281,893 acres (InciWeb 2018) within the Monte Arido Highlands and Conception Coast BPGs. A high intensity rain event following the fire caused major debris flows in many watersheds, which significantly altered stream channel sediment and vegetation dynamics. These streams have begun to recover, but many still bear signs of the debris flows. Since the Thomas Fire in 2018, two other fires have dramatically impacted the landscape of these BPG's including the Alisal Fire in 2021 (Conception Coast BPG) and the Woolsey Fire in 2018 (Santa Monica Mountains BPG).

Invasive flora and fauna also pose risks to *O. mykiss* within these BPGs. Invasive fish species present within the BPGs consist of Common Carp (*Cyprinus carpio*), Black Bullhead (*Ameiurus melas*), Channel Catfish (*Ictalurus punctatus*), Green Sunfish (*Lepomis cyanellus*), Fathead Minnow (*Pimephales promelas*), and Largemouth Bass (*Micropterus salmoides*). These fish compete with *O. mykiss* for resources and may also prey on juvenile *O. mykiss*. Invasive riparian plants found within these BPGs include Giant Reed (*Arundo donax)* and Salt Cedar (*Tamarix*). These plants often outcompete native riparian plants and can alter local stream hydrology and morphology. This may lead to diminished insect populations that contribute to greater food supply impacts throughout riparian ecosystems (Bell 1997). *Arundo* and *Tamarix* also provide minimal shading compared to many native riparian plants and lead to higher stream water temperature, lower dissolved oxygen, increased pH, and potential toxic algal photosynthetic activity (Bell 1997). Dense stands of *Arundo* can also clog stream channels, which increases the risk of flooding and becomes an impediment to the movement of small wildlife within riparian corridors, including fish (Meyer 2020). *Arundo* also poses a greater fire risk than native riparian vegetation. Its tall, well-ventilated stocks make it a ladder fuel that allows fires to burn further into riparian canopies and across stream channels (Meyer 2020). Native fish species commonly present within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains BPG watershed include Threespine Stickleback (*Gasterosteus aculeatus*), Prickly Sculpin (*Cottus asper*), Pacific Lamprey (*Lampetra tridentate*), Arroyo Chub (*Gila orcutti*), and Tidewater Goby (*Eucyclogobius newberryi*) (Walter 2015).

# 2.0 METHODS

## 2.1 Biogeographic Population Group Sample Frame Creation and Establishment

Hydrological sample frames for each BPG were developed following Fish Bulletin 182 guidance. An inclusive approach was used to create the initial draft of each sample frame so all portions of each BPG potentially conducive to supporting *O. mykiss* would eventually be assessed to provide an accurate account of *O. mykiss* abundance, productivity, spatial structure, and diversity trends within the BPG. All streams known to currently or historically support *O. mykiss* were included in each sample frame. Records of historical *O. mykiss* presence such as those listed within Becker & Reining 2008 were primarily relied upon for these determinations. Additionally, streams known or suspected to contain habitat conditions capable of supporting *O. mykiss* were also included in the sample frames. The selection of these streams for inclusion in sample frames was based off existing CMP data, local knowledge, and analysis of aerial and satellite imagery. Assumptions of habitat conditions were made from assessing this imagery as it provided a sense stream channel margin definition, which was considered to be indicative of streamflow presence and rates within the stream. Additionally, the concentration of riparian vegetation, along stream channels was considered a potential indicator of perennial streamflow presence and thus a potential indicator of habitat conditions.

Furthermore, the presence or absence of water within stream channels was also often able to be determined from satellite and aerial imagery analysis. Two criteria were used to determine the extent of each stream that was included in a particular sample frame. The primary criteria was to include all areas located downstream of the known total natural barrier (TNB) location within each stream, despite the TNB being upstream of total anthropogenic barriers. This approach follows the notion that restoration actions will eventually remediate passage restrictions associated with each anthropogenic barrier. California Fish Passage Assessment Database (PAD) records were primarily relied upon for TNB locations. If the location of a TNB was unknown for any stream, the entire extent of the stream was included in the initial version of the sample frame. The extent of the stream included within the sample frame would then be reduced once the TNB was identified.

The next step in sample frame creation was to establish the start and end points of "long reaches" (redd survey reaches) within each stream using ArcGIS 10.6 software (ESRI, Redlands, California). These reaches were mapped to be between one and three kilometers and when possible, establish start and end points at obvious on-the-ground landmarks such as tributary confluences and road crossings. Once long reaches were established, the extent of "short reaches" (low-flow survey reaches) were determined by CDFW GIS specialists by equally dividing up each long reach into 102–to 360–meter sections with the corresponding coordinates of these sections to serve as the start and end points of short reaches. With this approach, short reaches are embedded within each long reach. CDFW GIS specialists also assigned a sampling draw number to each long and short reach using the Generalized Random Tessellation Stratified (GRTS) sampling algorithm. The draw numbers direct the annual sampling rotation order of all reaches within a particular sample frame.

Finalizing each BPG sample frame will require field reconnaissance ground truthing to identify the location of natural limits to anadromy (i.e., TNBs) and the extent of where suitable *O. mykiss* habitat conditions persist in the upper portions of each stream. As this knowledge is slowly gathered, each sample frame will be updated accordingly. Finalizing appropriate sampling extents within each stream of a sample frame can take several years. Once appropriate sampling extents are determined for all streams within a sample frame, a final version will be used in perpetuity. The initial draft of the Conception Coast BPG sample frame was developed in 2022. A revision to this sample frame was completed in August 2023 and was used for the sampling efforts included in this report. This initial revision of the Conception Coast BPG sample frame is likely to be one of several revisions before a final sample frame is established. An initial sample frame for the Santa Monica Mountains BPG was developed in September 2024 and an initial sample frame for the Monte Arido Highlands BPG is currently being developed.

## 2.2 Reach Sampling Selection Methodology

Fish Bulletin 182 provides guidance on the establishment of a sampling panel for each BPG that attempts to provide long-term sampling consistency and minimize spatial bias in sampling across each BPG-specific sample frame. This guidance recommends that a subset of short and long reaches are sampled each monitoring season, which are referred to as "annual" reaches. Other subsets of reaches are assigned to rotating interval sampling panels. For example, reaches assigned to rotating panels may be surveyed every four years, twenty years, and forty years. All reaches not included in annual and rotating panels are considered reserve reaches and are sampled in place of annual and rotating panel reaches that do not meet

sampling criteria or cannot be accessed and sampled. The goal of this sampling methodology is to determine the status of *O. mykiss* across each BPG while also detecting trends in *O. mykiss* populations within each BPG over multiple years of sampling.

Fish Bulletin 182 recommends a sample size of 20 to 80 short and long reaches each monitoring season within each BPG to provide reasonable estimates of *O. mykiss* VSP parameters. For the first season of sampling within each newly created BPG sample frame, it was determined that an initial sampling dataset should be collected prior to the creation and establishment of annual, rotating, and reserve sampling panels. The intent of this approach was to gain experience conducting a new form of sampling in multiple new locations to provide guidance for the development of appropriate sampling panels. Therefore, a goal was set to complete low-flow sampling on the top 40 GRTS draw short reaches within the Conception Coast BPG. Additionally, annual long reaches within the Conception Coast BPG were selected and redd surveys were completed on them. Long reaches selected for repeated annual surveys in the Conception Coast BPG included five reaches in the Mission Creek watershed and five reaches in the Carpinteria Creek watershed. These watersheds were selected for annual redd surveys for several reasons. Foremost, all the reaches within these watersheds are already accessible to CDFW, thus allowing for a full spawning survey census within both watersheds and data comparisons to redd survey data collected via other monitoring methods and more sporadic survey completed within the watersheds. Additionally, both watersheds were designated as core 1, the highest priority for *O. mykiss* recovery by NMFS due to several metrics (NMFS 2012). Furthermore, significant restoration actions including fish passage barrier remediation actions have been implemented within both watersheds. Other redd reaches within the Conception Coast BPG selected for surveys were based on accessibility, locational connectivity, and to a lesser extent, randomly selected sampling draw numbers assigned to reaches. Some reaches were selected for surveys because they could be completed in succession with adjacent reaches that were selected based on their sampling draw number, thus providing a fuller picture of *O. mykiss* presence and spawning activity within those streams. Other reaches were selected for sampling so access, habitat conditions, and sampling considerations could be better understood for future sampling efforts. Long reaches selected for redd surveys within the Santa Monica Mountains BPG and Monte Arido Highlands BPG were legacy reaches, established prior to the release of Fish Bulletin 182.

## 2.3 DIDSON & ARIS Sonar Camera Monitoring Methods

Five sonar camera sites were utilized during the 2023–2024 monitoring season: three sites within the Monte Arido Highlands BPG (Santa Ynez River, Salsipuedes Creek, Ventura River), and one site respectively in the Conception Coast BPG (Carpinteria Creek) and Santa Monica Mountains (Topanga Creek) BPG. Several factors played into the selection and utilization of each site, including site access permission, stream channel conditions, quality camera viewpoints, location security, and ability to mitigate against streamflow hazards.

Each camera was housed in Sound Metrics-manufactured silt box encased in a custom-made aluminum box to prevent the camera lenses from fouling and damage by floating debris (Figures 2 & 3). Silt boxes were affixed to custom made steel, sled foot A-frame mounts via plastic ball mount clamps or X2 and AR2 pan and tilt rotators (Sound Metrics, Lake Forest Park, Washington). Ball mount configurations required cameras to be orientated manually while the X2 and AR2 rotator configurations allow for topside mechanical control of camera orientation. A-

frame sleds were held in place with steel stakes that were placed through holes in sled leg base plates and driven into streambed substrate with sledgehammers. Sandbags and/or boulders were also placed on top of the sled leg base plates. To safeguard against theft and potential loss of equipment during elevated rates of streamflow, camera silt boxes and A-frame sleds were tethered to the trunks of nearby large stable trees or structures with steel cables.



**Figures 2 & 3:** ARIS (left) and DIDSON (right) cameras within Sound Metrics-manufactured silt boxes encased within custom-made aluminum debris boxes.

Each sonar camera was connected to a topside control box via a Sound Metrics cable. Laptops running DIDSON and ARIS software were connected to the topside control box to interface with the camera and adjust record settings. Focus and frame rate were set automatically by the software based on camera settings. Gain was left at the default maximum value. Camera-window lengths ranged from 5 to 20 meters and were set to capture as much of the wetted stream channel width as possible at each site. Forty-meter camera window lengths were not used as these result in low-resolution footage and make identification of fish to a specific species very difficult. Recorded footage was captured in 20–minute files and written to external hard drives. When streamflow and general site conditions allowed, poly-vinyl chloride (PVC) framed mesh deflection panels and boulders were placed between the streambank and the camera to prevent species from swimming behind the deployed cameras.

### 2.3.1 Monte Arido Highlands BPG Sonar Camera Monitoring Sites

Two sonar camera monitoring sites were utilized on the Santa Ynez River. The initial site utilized was located adjacent to the Floradale Avenue Bridge crossing, which was utilized for all camera deployments during the 2022–2023 monitoring season. This site is approximately 7.5 miles upstream of the Pacific Ocean and is owned by Santa Barbara County. The second site utilized is approximately a quarter of a mile downstream of the Floradale Avenue bridge crossing and is agricultural land associated with the Lompoc Federal Correctional Complex. This was the first monitoring season utilizing this particular site. Cameras deployed at both the sites on the Santa Ynez River were powered via a trailer equipped with solar panels and batteries which also provides power to all topside camera components.

The Salsipuedes Creek site is located on private property approximately 16.1 miles upstream of the Pacific Ocean and 0.6 miles upstream of the confluence with the Santa Ynez River. The cameras deployed at this site were powered via connection to an electrical source provided by the Hilt Winery. A steel Jobox was utilized to store and protect all top-side components.

The Ventura River site is also located on private property approximately 5 miles upstream from the Pacific Ocean. All top-side components were stored in a mobile storage container connected to an electrical source provided by the Ojai Valley Sanitation District. Significant morphological changes occurred in the stream channel at this site on January 9, 2023, when streamflow is estimated to have exceeded 30,000 cubic feet per second (cfs) (USGS 2023). This extreme streamflow created much wider active channel margins than before the storm. It also resulted in the formation of a sizeable berm within the center of the active channel at the location utilized for sonar camera deployments. When streamflow rates are elevated, a small secondary wetted channel occurs on the river-right side of the berm and is unable to be captured within the acoustic sight of sonar cameras that are deployed on the river-left side of the channel. Therefore, when possible, PVC-framed block fencing is installed across the upper extent of this split channel to prevent fish passage from occurring outside of the acoustic sight of sonar cameras deployed at the site.




**Figures 3 & 4:** DIDSON camera deployments at the Ventura River monitoring site on December 30, 2024 (left) with streamflow at approximately 40 cfs and April 10, 2024 (right) with streamflow at approximately 95 cfs (USGS 2024). The wires for the PIT tag detection array deployed at the site are also visible in the picture on the right.




**Figures 5 & 6:** Santa Ynez River DIDSON deployments on December 22, 2023 (left) near the Floradale Avenue bridge crossing when streamflow was approximately 62 cfs and on April 23, 2024 (right) at the FCC farm site when streamflow was approximately 425 cfs (USGS, 2024).




**Figures 7 & 8:** ARIS camera deployments at the Salsipuedes Creek monitoring site on February 6, 2024 (left) with streamflow at approximately 105 $ft^3/s$ and April 10, 2024 (right) with streamflow at approximately 25 $ft^3/s$ (USGS 2024).

### 2.3.2 Conception Coast BPG Sonar Camera Monitoring Site

The Carpinteria Creek site is located on private property approximately 2 miles upstream from the Pacific Ocean. A Jobox was placed above the streambank and was utilized to store all top-side components. Power supply was provided from a United States Forest Service fire station.




**Figures 10 & 11:** DIDSON camera deployments at the Carpinteria Creek monitoring site on February 2, 2024 (left) with streamflow at approximately 15 $ft^3/s$ and March 3, 2024 (right) with streamflow at approximately 60 $ft^3/s$ (USGS 2024).

### 2.3.3 Santa Monica Mountains BPG Sonar Camera Monitoring Site

The Topanga Creek site is located on California State Park property approximately 0.5 miles upstream from the Pacific Ocean. A mobile storage container was utilized for top-side component storage. The mobile storage container was also connected to a nearby electrical utility line for power supply.



**Figure 12:** A DIDSON camera deployed at the Topanga Creek monitoring site on March 1, 2024.

## 2.4 Sonar Camera Footage Data Processing

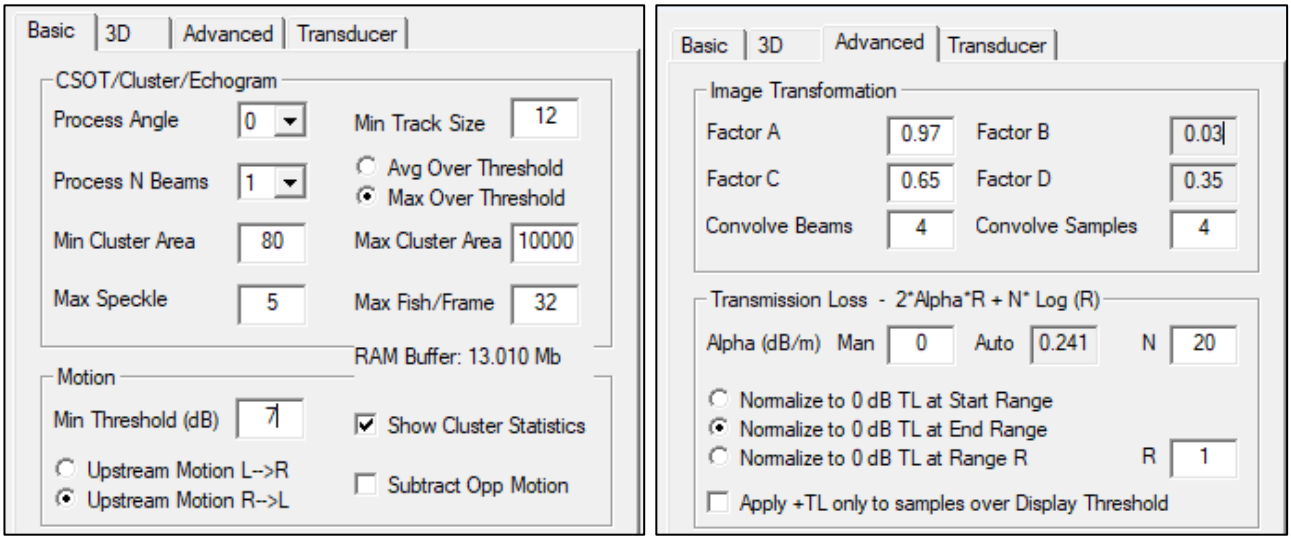
All sonar camera raw footage files were initially processed using the echogram function with background subtraction enabled in the DIDSON and ARIS Sound Metrics software. Echograms produce a visual representation of the entire file by compressing a given frame into a single pixel width along the full image range and background subtraction allows static objects to be filtered out (Sound Metrics 2012). These processes make moving objects easier to detect and expedites footage review. Additionally, to further expedite the review of footage obtained from the Topanga Creek and Carpinteria Creek monitoring sites, Convoluted Samples Over Threshold (CSOT) processing was utilized. CSOT processing uses an algorithm to select frames within DIDSON footage where movement is detected utilizing user-selected parameters of sample size (pixel cluster) and threshold (in decibels) (Pipal et al. 2010). When appropriate settings are selected, the CSOT program shortens large data files to specific frames where movement is detected. In general, processing raw footage data using the CSOT program can reduce file sizes, saving time and effort. The magnitude of file size reduction depends on a variety of factors, such as the number and frequency of targets and objects passing the site, quality of footage, streamflow conditions, water turbidity, and sensitivity parameters used in CSOT processing.

CSOT processing is generally most effective with high-quality footage in which movement is clearly visible. Degraded footage associated with elevated turbidity often results in excessive frames perceived as movement in CSOT processing. To account for this, CSOT processing was not completed for periods in which elevated turbidity was known or suspected to have occurred. As a rule, CSOT processing was not completed for any footage captured within 5 calendar days of considerable increase of streamflow rates, as these periods are often associated with increased rates of turbidity. Furthermore, CSOT processing was not used for any footage captured from the Ventura River, Santa Ynez River, and Salsipuedes Creek sites. Footage from these sites is often lower quality due to extended periods of elevated turbidity and

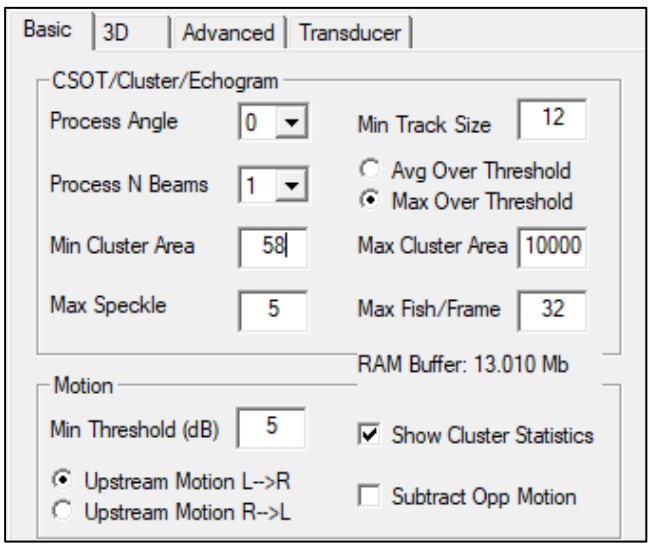
the need to use increased camera-window lengths to capture wide wetted-channel widths that are often present at the sites. Additionally, more fish targets are often present in the footage captured from these sites, resulting in fewer periods of time when movement is not captured in footage acquired from these sites. These factors diminish the effectiveness of CSOT processing and the associated time savings.

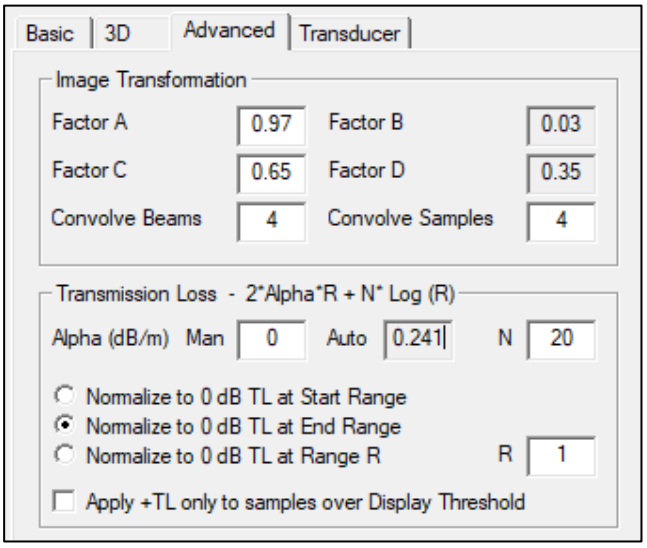
The initial step to conduct CSOT processing for footage captured from the Topanga Creek and Carpinteria Creek site was to organize raw footage files into subfolders for each calendar day. CSOT processing was then completed on each raw footage file.

Once complete, all CSOT files from each calendar day were merged, resulting in a single CSOT file for each calendar day of footage. The echogram function, with background subtraction enabled, was then utilized to create a single echogram for each calendar day of CSOT processed files. These echograms were then utilized to guide review of footage in which signatures of potential fish movement occurred in the footage. Slightly different CSOT sensitivity processing parameters were utilized for footage acquired from the Topanga Creek and Carpinteria Creek sites (Figures 13 - 16). Appropriate CSOT sensitivity processing settings were selected for each site based on testing of the settings on footage acquired from the Topanga Creek and Carpinteria Creek sites during the 2022–2023 monitoring. The results of the various settings were then reviewed and compared to the results of the standard footage review that had been conducted for that footage with specific attention given to instances in which fish had been documented in the footage.




**Figures 13 & 14:** CSOT processing parameters used for DIDSON footage acquired from Carpinteria Creek.




**Figures 15 & 16:** CSOT processing parameters used for DIDSON footage acquired from Topanga Creek.

## 2.5 Sonar Camera Footage Data Analysis

General and specific recording criteria were applied to targets observed in the footage reviewed from each site. Observations of non-fish targets were not required to be recorded. All fish and non-fish targets greater than 40 cm in length were recorded. Specific recording criteria were applied to each site for observed fish targets less than 30 cm in length. These criteria were developed based on fish species and life stages of those fish known or suspected to be present within each monitoring site stream. For footage from the Carpinteria Creek site, all fish and non-fish targets were recorded regardless of length. For footage from the Topanga Creek site, all fish targets 15 cm in length and greater were recorded. For the Ventura River, Santa Ynez River, and Salsipuedes Creek sites, all fish targets 30 cm in length and greater were recorded. All these criteria fall below CDFW's 40–centimeter length size limit for classification of a target as an anadromous *O. mykiss* (CDFW 2020).

Targets were measured using the box method per Pipal et al. (2010). The box method requires the reviewer to pause the footage, drag a box around the object seen in frame, and record the value for either the diagonal or width depending on the object's orientation relative to the camera. Measurement accuracy can be dependent on quality of the footage, frequency the footage was recorded at (high vs low frequency), and distance of the fish target from the camera, but are considered to typically provide reasonably accurate measurements (Pipal et al. 2010). For each fish observation, up to three measurements were taken from separate frames and then averaged as described in Pipal et al. (2010). One exception to this is for fish that could confidently be identified as carp at the Ventura River site. Species determinations of fish targets were based on these measurements as well as behavioral and morphological cues. Observations of non-target aquatic species were designated as either "unidentified terrestrial species", "frog", "turtle", "waterfowl", "snake", "unidentified fish species" or "unknown". In instances where a reviewer was unsure of species designation, files were flagged for secondary review by a more experienced reviewer. For each observation, length, direction of travel, species, range from the camera to the target, timestamp, footage quality, confidence in species

designation, and pertinent metadata (e.g., site location, date of recording, filename, reviewer name, and date viewed) were recorded.

Excel spreadsheets were used to record data from review of acquired sonar camera footage (Appendix 1). The spreadsheets were formatted with data validation rules to limit errors and ensure standardized input among all personnel conducting footage review. Footage review data were recorded within excel spreadsheets for each person conducting review. This also served as quality assurance and control measure. Secondary review was completed by experienced biologist on all footage of all targets recorded as unidentified fish that were over 30 cm in length or flagged as having potential of being an *O. mykiss* during initial footage review to confirm species identification. Secondary review was also completed on approximately 10% of all footage files by an experienced biologist to check for errors and presence of targets that were missed and not recorded during initial review.

Sonar detection efficiency ($D_E$) was calculated for each sonar deployment event. This was calculated by subtracting the amount of time the camera's range was limited ($T_D$) from the total deployment time ($T_T$) and then dividing by total deployment time.

$$D_E = (T_T - T_D) \,/\, T_T$$

For anadromous *O. mykiss* observations, net movement is calculated to estimate escapement. To calculate net movement ($N$) for focal species, the total number of downstream observations ($D$) were subtracted from the total number of upstream observations ($U$) as recommended by Xie et al. (2002) and put into practice by Larson (2013).

$$N = U - D$$

A net positive number would indicate net movement upstream and vice versa. Considerations for potential confounding of counts by downstream movement of post-spawning adults (i.e., kelts) would be addressed on a case-by-case basis.

## 2.6 PIT Tagging Methods

A multiday PIT tagging survey was conducted during the 2023–2024 monitoring season on Topanga Creek between December 4 and December 7, 2023. Survey methodology was adapted from PIT tagging protocols described in the Salmonid Field Protocols Handbook (Temple and Pearsons 2007) and the field manual for capturing, tagging, and handling salmonids written by Bonneville Power Administration (2008 unpublished). Electrofishing was conducted in habitat units with mean water depth greater than 0.5 feet, no obstacles were present that would prevent effective netting or use of the electrofishing anode, and stream water cleared of disturbed sediment within 20 minutes between passes. A maximum of three passes were made for each habitat unit. Water temperature, dissolved oxygen, and conductivity were measured at the beginning of each survey day to ensure conditions were amenable for safe and effective electrofishing. The backpack electrofisher was set at 130 volts, 30 hertz, and 30% duty cycle. Electrofishing ceased when trout activity was no longer observed. Crews consisted of at least one person operating the backpack electrofisher, a minimum of two netters actively catching fish, and a third netter to transfer captured fish into 5–gallon buckets equipped with a battery-powered aerator. Buckets were refilled with fresh stream water whenever temperature exceeded 15.5°C.

All captured *O. mykiss* were assessed for deformities, injuries, or signs of abnormal behavior and kept in separate buckets from other incidentally captured species. The fork length (FL) was measured for each captured *O. mykiss*. *O. mykiss* with a FL greater than 80 mm and in good physical condition (i.e., no apparent injuries, alert, normal swimming behavior) were implanted with HDX ISO PIT tags. *O. mykiss* with a FL between 81 mm and 175 mm were tagged with a 12 mm HDX ISO PIT tag and *O. mykiss* with a FL greater than 175 mm were tagged with a 23 mm HDX ISO PIT tag. These size thresholds are conservative compared to recommendations provided by Vollset et al. (2020) which found increased mortality risk for fish less than 69 mm in length receiving 12 mm tags and fish less than 131 mm in length receiving 23 mm tags.

Fin clips were taken for future genetic analysis to be completed at the Southwest Fisheries Science Center in Santa Cruz, California for captured *O. mykiss* deemed to be in stable condition. All fin clips collected were stored within a small manila envelope and the individual's length, stream, date, and locational coordinates of capture were recorded.

## 2.7 PIT Array and Reader Deployment Methods

Six single-loop PIT tag array antennas were deployed for the 2023–2024 monitoring season at three different sites, each comprised of two arrays. There were two array sites within the Ventura River watershed (Monte Arido Highlands BPG). One of these sites was located within the main stem of the Ventura River approximately five miles upstream from the Pacific Ocean. The third array site was located on San Antonio Creek approximately 0.6 miles upstream of the stream's confluence with the Ventura River. The third array site was located in Topanga Creek (Santa Monica Mountains BPG) approximately 0.5 miles upstream from the Pacific Ocean. The Ventura River and Topanga Creek array sites have been utilized for several monitoring seasons now. This was the first monitoring season utilizing this particular San Antonio Creek array site. The previous San Antonio Creek array site became unsuitable after an extreme streamflow event created a split channel on January 9, 2023. When possible, two array antennas were deployed at each of the three sites and were located within 20 feet of each other. The deployment of two antennas at each site provides the potential of determining upstream or downstream movement of detected trout. Each antenna consisted of size 12 American Wire Gauge (AWG) connected to an HDX Antenna tuner box (Oregon RFID) that was mounted onto a studded T-post pounded into the ground on the stream channel bank. Oregon RFID HDX Marker Tags were also mounted on these T-posts and fixed within the antenna read zone between the tuner box and instream antenna. The Marker Tag includes an HDX PIT tag that is electromagnetically shielded and allowed to transmit on a set interval. A 15–minute interval was set for all Marker Tags to create a record of antenna operation and functionality during extended deployments. From the tuner box, a 100–ohm twin axial cable ran to the topside reader box (Multi-Antenna HDX Reader – Oregon RFID) that was enclosed in a JOBOX security container. The Topanga Creek and San Antonio Creek arrays were powered via two 200W polycrystalline solar panels that supplied power to two deep cycle marine batteries via a charge controller. A 12–hour switch timer was used to alternate discharge and recharge the two batteries. The Ventura River antennas were powered via a permanent, stable power source provided by the Ojai Valley Sanitary District. Upon construction of the PIT tag readers, antennas were tuned to ensure that the frequency emitted by the antenna matched the frequency of the HDX PIT tags. PIT tag read range was also tested to assess the likelihood of tagged trout potentially evading detection when swimming within the water column at the antenna location. At the Topanga Creek array site, each antenna wire was passed through a 1-inch PVC frame.

At the Ventura River and San Antonio Creek array sites each antenna wire was passed through garden hoses. All antenna wires spanned the entire wetted with of the stream channel at their respective sites. Each antenna wire and its respective PVC or garden hose frame was secured in place within the streambed with galvanized metal stakes and in some cases steel cables attached to Duckbill Earth anchors.




**Figures 17 & 18:** The San Antonio Creek PIT array site looking upstream (left) and downstream (right) on March 6, 2024.

## 2.8 PIT Tag Array Data Analysis

The operational efficiency of array antennas, PIT Tag detections, and descriptive statistics were calculated from marker tag detection logs recorded on the HDX readers. For fish detections made on PIT array antennas, the timing is reported, with direction of movement reported if detections were made on both antennas deployed at the monitoring site. Additionally, morphometric data collected at the time each detected fish was tagged is reported.

## 2.9 Redd Survey Data Collection

Redd surveys were conducted in accordance with standardized protocols developed by CDFW CMP scientists for use throughout California (Gallagher 2007; McLaughlin and Christianson 2016). Individual redd survey reach start and end point designations were set to easily identifiable landmarks when possible (e.g., bridges, accessible trails, and stream confluences). Each reach was designed to be completed in a single day. Reaches selected for survey within the Monte Arido Highlands and Santa Monica Mountains BPGs were established during previous sampling seasons. Redd reaches within the Conception Coast BPG were recently established within the newly constructed BPG-specific sample frame based on Fish Bulletin 182 guidance.

Redd surveys were intended to be conducted on each reach approximately every two to three weeks throughout the survey season. Two weeks is typically the minimum amount of time redds remain detectable in Southern California stream systems (R. Bush, National Marine Fisheries Service unpublished data). Weather conditions, excessive streamflow, roadway closures, and personnel limitations impacted our ability to access and consistently survey some of the selected reaches. Repeat surveys were cancelled on some of the reaches located in urban areas due to significantly degraded habitat conditions and the presence of downstream fish passage barriers, resulting in a low likelihood of *O. mykiss* presence and spawning activity.

When conducting redd surveys, teams of two to three surveyors walked reaches in an upstream direction recording redds, bankside *O. mykiss* observations, and threatened and special status aquatic species on handheld data recorders. All fish observed were identified if possible. For each *O. mykiss* observation, it's total length, location, and life history stage (when possible) were recorded. When redds were first observed, measurements were taken for pot and tail spill dimensions (Figure 19). Pot length, width, and depth relative to the adjacent streambed were measured. Tail spill length and width measurements were taken at 1/3 and 2/3 the distance from the upstream end of the tail spill as described in Gallagher 2007. Dominant substrate size was recorded for both the pot and tail spill. Redds were identified with a flag denoting the redd record number, distance, and bearing of the redd from the flag location, date the redd was first identified, and redd age. Redd ages were categorized as the following: 1 – New since last survey, 2 – Previously identified and still measurable, 3 – No longer measurable but still visible, and 4 – No redd apparent. Redd ages were updated and recorded during subsequent observations. Redds were re-measured when pot and tail spill dimensions had noticeably changed following their initial observation.

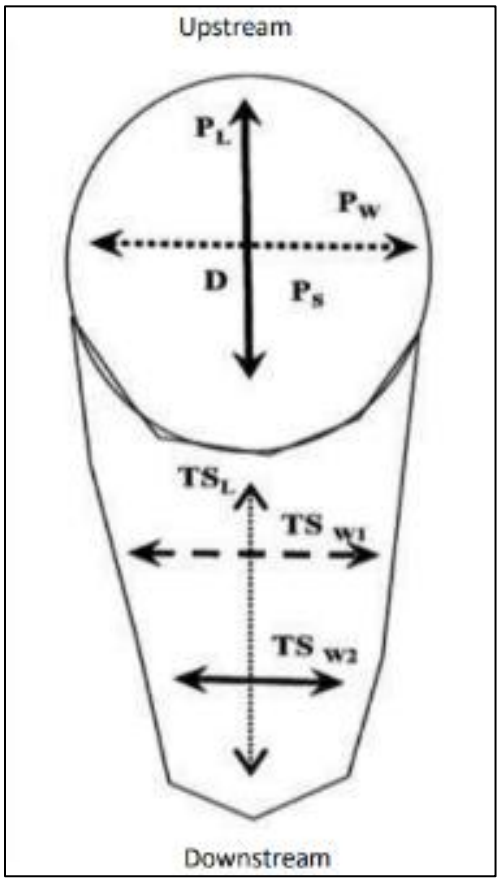



**Figure 19:** Diagram depicting approximate location of physical measurements of redds. P is pot; TS is tail spill; L is length; W is width; $P_s$ is pot substrate.

## 2.10 Redd Survey Data Analysis

The mean ± standard error (SE) number of days between surveys was calculated to examine survey frequency. Water visibility measurements were classified as either "clear" (i.e., visibility = 100%) or "not clear" (visibility < 100%) for each survey. The mean ± SE number of surveys where visibility was 100% was calculated by reach and by watershed for each year.

Redd observations were mapped using ArcGIS 10.6 (ESRI, Redlands, California) and R software (R Core Team 2023). Area and total redd length for each redd were calculated. Redd area was calculated as the sum of pot and tail spill areas per Gallagher et al. (2007). Total redd length is calculated as the sum of the pot and tail spill lengths. Redd dimensions, area, and the size of substrates within the redd are utilized to infer the life stage of the *O. mykiss* responsible for building each redd. Although, there are no established redd or substrate size thresholds to distinguish redds of anadromous *O. mykiss* origin from non-anadromous *O. mykiss* origin, significant size differences have been documented. For example, analysis of anadromous and non-anadromous *O. mykiss* redds constructed within the Elwah River documented a statistically significant difference in redd width, length, and maximum substrate sizes ($P < 0.001$) between these life stages (McMillan et all 2015). In 2022, a redd was documented within the Ventura River with an area of 4,221 $cm^2$ and was assumed to have been built by an anadromous *O. mykiss* as the mean area of the 20 other redds documented in the watershed that year was 988.6 ± 89.9 $cm^2$. Finally, (individual trout observations were mapped to demonstrate spatial distribution throughout the watershed as well as associations with habitat and fish size class.

To characterize any potential changes over time, we compared data collected from surveys conducted in the Ventura River watershed during the 2023–2024 season with data collected from 2013 through 2023 using one-way ANOVA. We used post-hoc analysis using Bonferroni's correction to adjust *p* values and test for differences between individual survey seasons. We compared redd counts, redd area, redd life (i.e., the duration of time redds remained detectable), *O. mykiss* bankside observation totals, and visibility versus year for trends per Gallagher (2005). When evaluating redd and trout count data, comparisons were drawn from data where survey effort was consistent (i.e., years 2015–2024). Analyses of redd life by year were only performed for redds in years where a final status indicated that they were no longer visible (i.e., redd age 4) was recorded. All redds recorded from 2013–2024 were included in our examination of redd area versus year due to low sample size. All analyses were completed using R software (R Core Team 2023).

## 2.11 Low-Flow Surveys (Electrofishing and Snorkeling)

Low-flow surveys were conducted in established short reaches (102–360 meters in length) when low streamflow conditions were present during the summer and autumn time periods, typically between July and December. Short reaches considered for sampling were selected in order of their GRTS temporary draw order as opposed to an established sampling rotation order as recommended in Fish Bulletin 182. This approach was taken to provide a baseline of experience and sampling data to be used in the development of appropriate long-term annual sampling rotations for the short reaches within the sample frames developed for each monitored BPG. Electrofishing using backpack electrofisher units is the primary method of conducting low-flow sampling as it provides the opportunity for *O. mykiss* to be directly counted and assessed, including the collection of genetic samples for analysis. Snorkeling is a secondary low-flow sampling method and is utilized when electrofishing is less likely to be an effective or a practical means to capture *O. mykiss*. Specifically, snorkeling is utilized in habitat units with water depth greater than one meter and within reaches that are located in remote areas and therefore would be difficult to access with all the equipment needed to conduct electrofishing.

As recommended by Fish Bulletin 182, a two-phase approach was utilized for low-flow surveys. The first phase is considered a reconnaissance survey, in which the general habitat

conditions within the short reach are assessed along with general considerations regarding how to best access the reach. This allows for the identification of habitat units within the reach that meet the depth criteria for snorkeling. It also allows reaches that do not contain suitable *O. mykiss* habitat conditions to be identified and replaced by another short reach for sampling. Reconnaissance surveys were often conducted with electrofishing and snorkeling gear on hand so full low-flow sampling could be completed during the same visit to the reach if necessary. The following criteria were used to determine if a short reach contained habitat conditions with the potential to support *O. mykiss* and thus should be sampled or replaced by a different short reach for sampling:

- At least 50 meters of wetted pool and flatwater habitat units present between the reach start and end points with a mean water depth of 0.12 meters (0.4 feet) or greater, and
- Water temperature within the reach is less than 75.2°F (24°C).

The second phase of low-flow surveys consisted of the actual electrofishing and, if necessary, snorkeling of the short reaches. This was accomplished by navigating to the start point coordinates of the short reach and from that point the nearest upstream habitat unit boundary, where a seine net crossed all portions of the wetted channel. A transect tape was then used to measure 100 meters of wetted habitat upstream of this point and another seine block net was placed across the channel at the nearest upstream habitat unit break. The 100-meter measurement was made as close as possible to the thalweg of the stream. If any habitat units with a max depth of one meter or greater were present, additional seine nets were placed across the downstream and upstream extents of these units. The seine nets block movement of any *O. mykiss*, ensuring observed individuals were associated with the habitat unit in which they reside. Disturbance to the survey reach are minimized during sampling preparation. The water temperature, dissolved oxygen (DO) content, and conductivity within the reach were then measured. Electrofishing was postponed if water temperature was 21°C or greater and DO was below 3.0 mg/L to avoid excessive stress to any *O. mykiss*.

Before electrofishing, at least two five-gallon buckets were filled with clean stream water and affixed with battery-powered aerators to serve as live wells for any captured *O. mykiss*. Electrofishing efforts were initiated at the downstream extent of the short reach and proceeded upstream using Smith-Root Model LR-24 backpack electrofishers with a frequency of 30 hertz, voltage of 130, and direct current of 30%. If any units contained a wetted width of three meters or greater an additional eletrofisher unit was used. Two crew members with dipnets joined each electrofisher to capture any stunned fish. All captured fish were placed in the live well buckets with all *O. mykiss* being placed in the same bucket. A multiple-pass depletion method determined the appropriate electrofishing effort within each sampled short reach using the formula listed below until at least a 90% depletion rate was achieved (Flosi et al. 2010). Total seconds of shock was recorded after each electrofishing pass. Additionally, any live well buckets holding *O. mykiss* were refreshed with stream water frequently while electrofishing passes were completed. Each captured *O. mykiss* had its fork length measured with a fish board. Additionally, caudal fin clips were collected from up to 12 of the captured *O. mykiss* for DNA analysis. Once all *O. mykiss* were processed, they were released back into the short reach.

Electrofishing Depletion Formula

$$\text{Pass Depletion} = \left(1 - \frac{N_{i+1} \times E_i}{N_i \times E_{i+1}}\right) \times 100\%$$

Where:

$N_i$ = number of fish of a given species captured on the previous pass

$E_i$ = total number of seconds shocked on the previous pass

$N_{i+1}$ = number of fish of a given species captured on the current pass

$E_{i+1}$ = number of second shocked on the current pass

Snorkeling of habitat units with a depth of one meter or greater was completed following the completion of electrofishing using a single pass observation. Snorkeling protocols were derived from the AFS Salmonid Field Protocol Handbook section on snorkeling (O'Neal 2007). If the width of the wetted stream was greater than three meters, an additional snorkeler was utilized. Prior to snorkeling, each snorkeler completed a calibration for *O. mykiss* size estimation within a separate habitat unit. This was done by placing three PVC pipes ranging from 1.5–14 inches in length within the unit out of the snorkeler's view. Snorkelers then had to correctly estimate the length of each calibration pipe. Snorkelers entered snorkeling habitat units at their downstream extent and proceeded upstream and counted *O. mykiss* as they passed downstream their line of sight. All observed *O. mykiss* lengths were estimated to within two-inch size bins (e.g., 0–1.99 in, 2–3.99 in, 4–5.99 in). If multiple snorkelers were utilized, each snorkeler only counted *O. mykiss* observed on their side of the habitat unit.

After all electrofishing and snorkeling efforts were completed, habitat data points were collected to calculate the habitat unit surface area and volume within the sampled area of the short reach. This included identifying each habitat unit as a pool, flatwater, or riffle. Additionally, measurements were taken of each habitat unit: length at its thalweg, mean width, mean water depth, and max water depth. Fork lengths estimated into two-inch size bins during snorkel surveys were converted into a single millimeter length measurement based on the median length within the bin. For example, fish lengths estimated within the 4–6-inch bin were given a converted measurement value of 127 mm (5 in. = 127 mm).

A regional estimation of *O. mykiss* abundance and density for each surveyed BPG was calculated using statistical methods described in FB182. Furthermore, an RScript outlined in Boughton 2024 was adapted, and extensively used, in this analysis. Total short reach area was estimated by multiplying the total length of the short reaches within the BPG sample frame by the average width of sampled short reaches. Mean short reach area for the entire sample frame was determined by dividing the estimated total area of available habitat by the total number of short reaches within the sample frame. Then the fraction of wet reaches was determined by dividing the number of wet reaches by the total number of short reaches assessed during the reconnaissance phase.

Total Short Reach Area Equation

$$A_1 = L_1 \times \overline{W}$$

Where:

$L_1$ = Total length of short reaches within the sample frame

$\overline{W}$ = Average width of sampled short reaches

Mean Short Reach Area Equation

$\bar{A}_1 = A/N$

Where:

$\bar{A}_1$ = Mean short reach area

A = Estimated total area of available habitat

N = Total number of short reaches within the sample frame

Fraction of Wet Reaches Equation

$f_w = n_w/n_t$

Where:

$f_w$ = Fraction of wet reaches

$n_w$ = Number of wet reaches sampled

$n_t$ = Total number of short reaches assessed during reconnaissance surveys

Next, a depletion estimate was computed for each sampled short reach using the Carle-Strub method. The summation of these short reach-level estimates of abundance is divided by the summed short reach areas to get a regional estimate of density for the whole BPG sample frame. Standard error and 95% confidence intervals were also calculated.

Depletion Estimate Equation

$$\hat{D}_w = \frac{\sum_{i=1}^{n} \hat{M}_i}{\sum_{i=1}^{n} A_i}$$

Where:

$\hat{D}_w$ = Regional estimate of density

$\hat{M}_i$ = Short reach-level estimate of abundance

$A_i$ = Short-reach level estimate of wetted area

The regional estimate of abundance was made for each of the three life stage designations that are determined by the fork length of captured *O. mykiss*, as outlined in FB182. These include adult (>200 mm), enigmatic (150–200 mm), and juvenile (<150 mm) life stages. The regional estimate of abundance is equal to the product of the ratio of each life stage designation to total captured *O. mykiss*, the regional estimate of density, the estimated total area of available habitat, and the fraction of wet reaches. Standard error and 95% confidence intervals were also calculated.

Regional Estimate of Abundance Equation

$$\hat{T}_A = \left(\frac{\sum_{i=1}^{n} a}{\sum_{i=1}^{n} m}\right) \times \hat{D}_w \times A \times f_w$$

Where:

$\hat{T}_A$ = Regional estimate of abundance

*a* = number of *O. mykiss* within the life stage designation

*m* = total number of captured *O. mykiss*

$\hat{D}_w$ = Regional estimate of density

A = Estimated total area of available habitat
$f_w$ = Fraction of wet reaches

## 2.12 Snorkel Specific Surveys

Snorkel surveys were conducted utilizing a protocol adapted from the Salmonid Field Protocol Handbook (O'Neil 2007) and the Underwater Methods for the study of Salmonids in the Intermountain West (Thurow 1994). Surveys were conducted in teams of two to three moving upstream and consisted of at least one data recorder and one snorkeler. During surveys, the wetted stream channel was delineated into discrete, natural units of similar habitat (Hankin 1984). Habitat units were classified as riffles (R), pools (P), or flatwaters (F) according to certain defining characteristics. These habitat types are adopted from definitions outlined in Flosi et al. (2010). Only habitat units with a minimum depth of 0.7 ft or greater were snorkeled in a single pass beginning at the downstream extent of the unit and ending at its upstream extent. The estimated length of each *O. mykiss* observed was recorded in 2–inch size bins (0–1.99 inches, 2–3.99 inches, 4–5.99 inches, etc.). Additionally, the cover type being utilized by each *O. mykiss* when first observed was recorded. Cover types included open (no cover used), boulder, small woody debris, large woody debris, root mass, terrestrial vegetation, aquatic vegetation, bubble curtain, bedrock ledge, undercut bank, and other/artificial cover.

Habitat unit metrics were assessed after the entire unit was snorkeled. This included assessing the total available cover present in each unit by estimating the percentage of unit surface area containing trout cover. The snorkeler also estimated the percentage each cover type in the unit comprised. Cover was defined as any natural or artificial stream feature capable of hiding a 3-inch trout when looking from an overhead view of the unit. Each habitat unit was measured for length, mean width, mean depth, and maximum depth. Length was measured along the thalweg of the stream and mean unit width was measured perpendicular to the length (thalweg) line. The percentage of surface area that contained exposed substrate surrounded by water was also estimated for each unit. Additionally, water visibility was recorded on a scale of zero to three. A value of zero indicates the snorkeler was unable to perform the survey due to a lack of visibility, one was poor visibility, two was adequate visibility, and three was clear visibility. Water and air temperatures were measured at the beginning of each survey day and subsequently after every tenth unit surveyed.

## 2.13 Snorkel Specific Survey Data Analysis

All data was entered into a Microsoft Excel database and analyzed using R (Version 2022.12.0, R Core Team 2022). To examine trout relative abundances, trout density was calculated in three ways, including mean number of trout per unit, mean number of trout per foot, and mean number of trout per square foot. To evaluate trout life stage diversity, the total number of trout per size class was calculated. To examine wetted habitat, the total length surveyed, mean unit length, total unit area, mean unit area, mean unit depth, mean unit maximum depth, total unit area, and mean unit area were calculated. To quantify available trout cover, the mean percent of habitat units containing trout cover and the mean percent of each cover type present was calculated. For each mean, the standard error was calculated.

# 3.0 RESULTS

## 3.1 Monte Arido Highlands BPG Monitoring Results

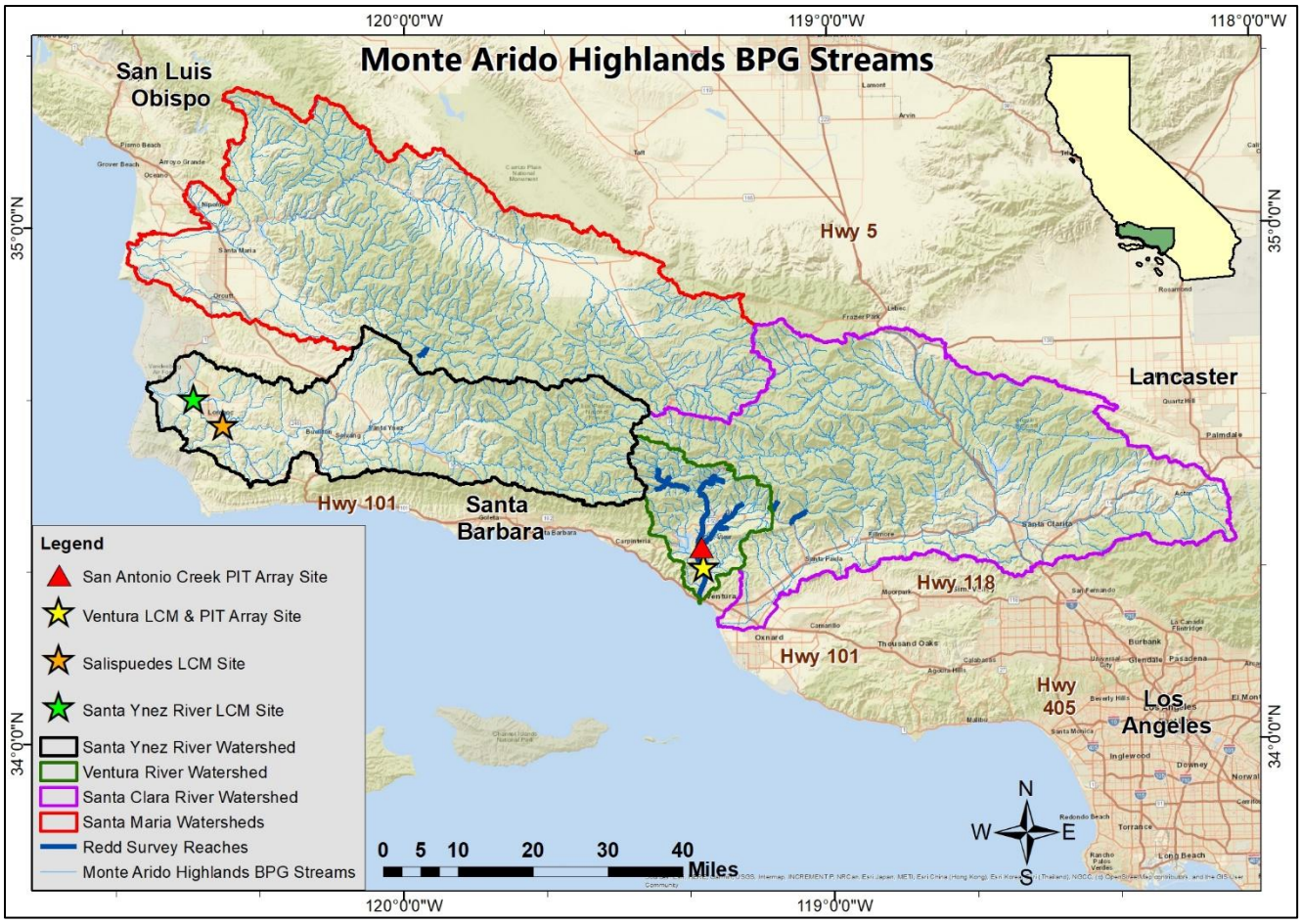



**Figure 20**: Monte Arido Highlands BPG streams and watersheds with 2023–2024 LCM locations and redd survey reaches.

### 3.1.1 Monte Arido Highlands BPG Sonar Camera Monitoring Results

Sonar cameras acquired 5,533 hours (approximately 230.5 days) of footage across the three monitoring sites utilized within the Monte Arido Highlands BPG during the 2023–2024 monitoring season. Sonar cameras were deployed at the Salsipuedes Creek and Ventura River sites once unobstructed surface flow was established between each site and the ocean, providing the potential for anadromous *O. mykiss* returns. Deployment of a camera at the Floradale Avenue Bridge crossing Santa Ynez River site was initially delayed due to coordination with Santa Barbara County and the Lompoc Federal Correctional Complex farm officials to utilize the site. Additional delays occurred in establishing the new monitoring site on the Santa Ynez River due to additional coordination with Lompoc Federal Correctional Complex farm officials. The above average precipitation that occurred throughout the BPG resulted in prolonged streamflow connectivity to the ocean and suitable conditions for potential anadromous *O. mykiss* returns through May 2024 at each monitoring site within the BGP. The amount of precipitation also contributed to various challenges in deploying and maintaining sonar cameras during periods of elevated streamflow. A total of nine gaps in footage acquisition occurred at the three monitoring sites within the BPG due to precautionary camera removal prior

to forecasted precipitation and elevated streamflow events. This accounted for a total time period of 643.2 hours or approximately 26.8 days in which footage was unable to be acquired due to environmental conditions. Environmental conditions also resulted in durations of degraded footage quality obtained from each site. Periods of elevated turbidity levels following precipitation events were especially detrimental to footage quality, review abilities, and target identification. At times, the field of view in recorded footage was significantly diminished due to sound wave feedback from suspended sediments. Changes to stream channel morphology and excessive width of wetted stream channels also created challenges in obtaining quality footage and maintaining full acoustic coverage of wetted channels. Technical issues accounted for 632.7 hours or approximately 26.4 days of missed footage acquisition. The combined deployment operational efficiency of all cameras used within the BPG was 89.6%.

A total of 11,369 targets were recorded within footage reviewed from the three Monte Arido Highlands BPG monitoring sites. Of the recorded targets, 11,179 (98.3%) were classified as fish. Fish targets consisted of Common Carp (*Cyprinus carpio*) (n = 8,597), catfish (*Siluriformes spp.*) (n = 449), Green Sunfish (*Lepomis cyanellus*) (n = 16), Pacific Lamprey (*Entosphenus tridentatus*) (n = 4), *O. mykiss* (n= 415), and fish that could not confidently be assigned as a specific species (n = 1,698) (Table 17). Site-specific details are provided in the sections below.

#### 3.1.1.1 Ventura River Sonar Camera Monitoring Results

A DIDSON camera was deployed at the Ventura River monitoring site from December 22, 2023 through May 28, 2024. In total, 3,252 hours or approximately 135.5 days of footage was recorded at the site. Several gaps in footage acquisition occurred over the course of the monitoring season (Table 2). A 10–meter window length was utilized for nearly all footage acquisition, comprising 99.5% of recorded footage. A 20–meter window was briefly utilized for 15 hours of acquired footage.

**Table 2:** Overview of sonar camera footage acquisition interruptions at the Ventura River monitoring site during the 2023-2024 monitoring season.

| Cause of Footage Aquation Interruptions | Occurrences of Footage Acquisition Interruption | Total Time of Footage Acquisition Interruption Hours (*Days*) |
|---|---|---|
| Camera removal for elevated streamflow events | 5 | 337.5 (*14*) |
| Technical issues | 3 | 181.5 (7.5) |
| Camera maintenance efforts | 7 | 18.5 (*0.8*) |
| **TOTAL** | **15** | **537.5 (*22.4*)** |

The visual field of all recorded footage from the Ventura River site matched the set window length of the camera 82% of the time. The field of view within the reviewed footage was diminished for a combined total of 584.3 hours or approximately 24.3 days. The majority of this was due to turbid streamflow conditions degrading footage quality, accounting for 320.3 hours (55.9%) of diminished visual field periods. Between February 23 and March 1, 2024, the camera was deployed at a poor angle resulting in 167 hours (28.6%) of diminished visual field. Physical obstructions associated with boulders on the river streambed contributed to 84 hours (14.4%) of diminished visual field. Additionally, the field of view was fully lost in 12.7 hours (2.2%) of footage due to the camera being out of the water column as a result of a dropping water level associated with diminishing streamflow.

Streamflow was elevated throughout much of the sonar camera deployment periods at the Ventura River monitoring site during the 2023–2024 monitoring season. This was a result of wetter than average precipitation occurring during the 2022–2023 and 2023–2024 water years. The mean streamflow rate documented at the Ventura River USGS streamflow gage between the initial and final dates of camera deployments was 238 ± 3.0 cfs (USGS 2025). Therefore, the wetted channel was often wide at the site throughout the monitoring period, thus making full acoustic sight of the wetted channel difficult during many portions of camera deployment, even when footage quality wasn't degraded. Overall, the far bankside of the main stream channel was visible 25.1% of the time in acquired footage. Furthermore, block nets were in place on the secondary stream channel at the site to prevent fish passage outside of the sonar camera's field of view for approximately 49.1% of the period in which footage was acquired. Full acoustic coverage of the main stream channel and block net presence on the secondary channel occurred for just 10.8% of the acquired footage. This, coupled with periods of degraded footage quality and gaps in footage acquisition, indicates many opportunities occurred for *O. mykiss* to avoid being detected at the site.

A total of 9,608 recorded targets were recorded in footage obtained from the Ventura River site. A total of 9,525 of these targets were classified as fish, none of which could confidently be classified as *O. mykiss*. Observed fish targets primarily consisted of Common Carp (88.5% of observations). Additionally, 49 targets were classified as catfish (0.05%). Furthermore, 1,051 (11%) of the targets recorded were fish that could not be confidently assigned as a specific species (Table 17). There were also eight targets classified as waterfowl and 75 targets recorded that couldn't be confidently identified as a fish or other type of species.

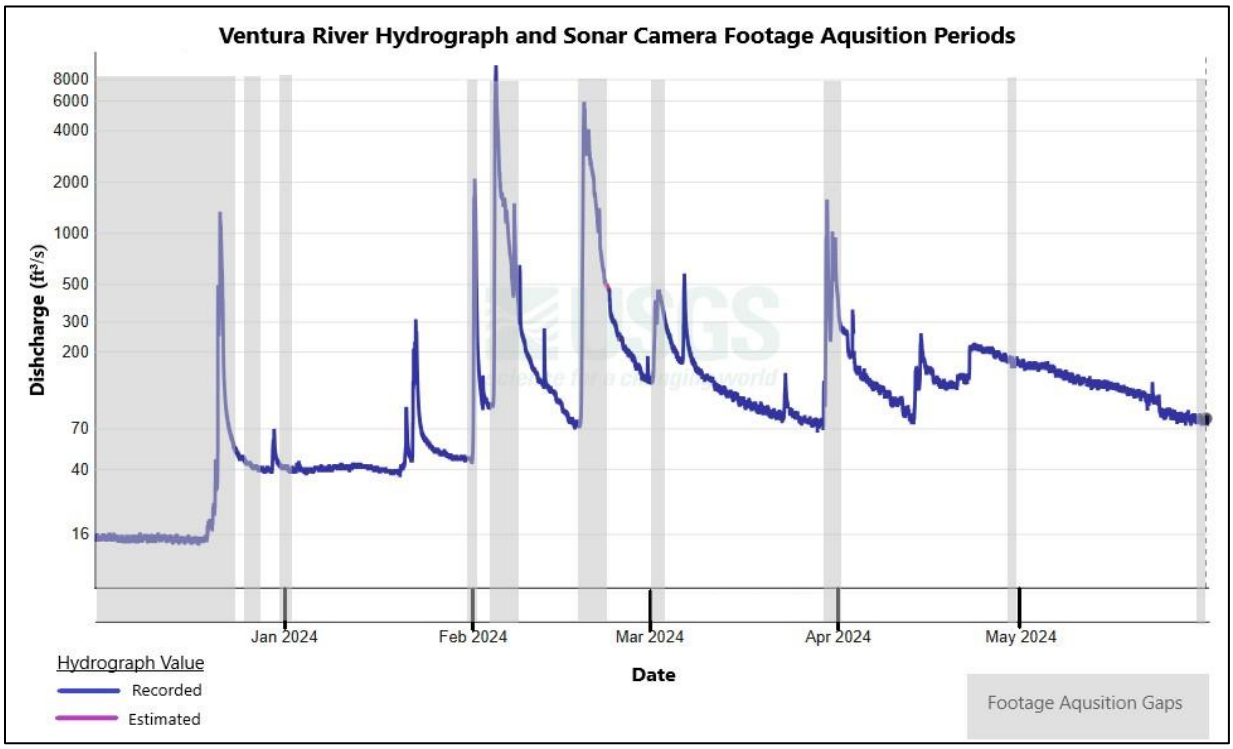



**Figure 21**: Hydrograph and periods of sonar footage acquisition for Ventura River December 2023 – May 2024. Hydrograph is located at Casitas Vista Road Bridge (34.35222, -119.30844) (USGS 2024).

### 3.1.1.2 Santa Ynez River Sonar Camera Monitoring Results

Both an ARIS and a DIDSON camera were utilized at the Santa Ynez River site, though not at the same time. An ARIS camera was initially deployed on January 22, 2024 but removed the following day due to vandalism occurring to the solar trailer that provided power to the camera. Redeployment of a camera in the Santa Ynez River was delayed until April 23, 2024, as a new deployment site had to be identified and established due to concerns of additional vandalism or theft occurring at the existing deployment site. The redeployment delay was prolonged at the new site primarily due to prolonged coordination with the landowner to establish access permissions. As a result, roughly four months of conditions potentially suitable to anadromous *O. mykiss* returns occurred within the Santa Ynez River without sonar camera monitoring efforts occurring. Estuary to ocean connectivity in the Santa Ynez River is believed to have occurred on a temporary basis until February 1, 2024, when streamflow in the lower watershed peaked around 3,000 cfs and remained elevated through the end of May 2024.

A DIDSON camera was utilized at the site between April 23, 2024 and its final removal on May 20, 2024. However, in total only 214.3 hours or approximately 8.9 days of footage was captured during this time due to technical issues occurring with the solar trailer providing power to the camera components. Four efforts were made between these dates to correct the solar trailer power supply issue, but the issue persisted. When a camera was recording at the site, the visual field of footage captured matched the set range 100% of the time. Additionally, the far bankside of the channel was within the field of view for all of the recorded footage. A 5–meter field of view was adequate to capture the far bankside during the January deployment comprising 9.3% of the captured footage. A 20–meter field of view was required during the April and May deployments due to elevated streamflow, comprising 90.7% of the captured footage. Solar trailer repairs were not completed in time for additional camera deployments to be made during the 2023–2024 monitoring season.

**Table 3:** Overview of sonar camera footage acquisition interruptions at the Santa Ynez River monitoring site during the 2023-2024 monitoring season.

| Cause of Footage Aquation Interruptions | Occurrences of Footage Acquisition Interruption | Total Time of Footage Acquisition Interruption Hours (*Days*) |
|---|---|---|
| Camera removal due to vandalism and theft concerns and new site establishment | 1 | 2,186.5 (91.1) |
| Power supply technical issues | 4 | 451.2 *(17.3)* |
| **TOTAL** | **5** | **2,637.7 (109.9)** |

A total of 344 targets were recorded during footage review from the Santa Ynez River site, 320 (93%) of which were classified as fish. The majority of fish targets were identified as Common Carp (n = 172), followed closely by fish that could not confidently be assigned to a specific species (n = 141). Other observed fish targets included catfish (n = 3) and pacific lamprey (n = 4) (Table 17). Other recorded observations include North American beavers (n = 6) and waterfowl (n = 14). No positive identification of *O. mykiss* were made in the footage reviewed from the site. Two of the unidentified fish targets demonstrated swimming motion characteristic of *O. mykiss*, however due to poor footage quality, the fish could not be definitively classified.

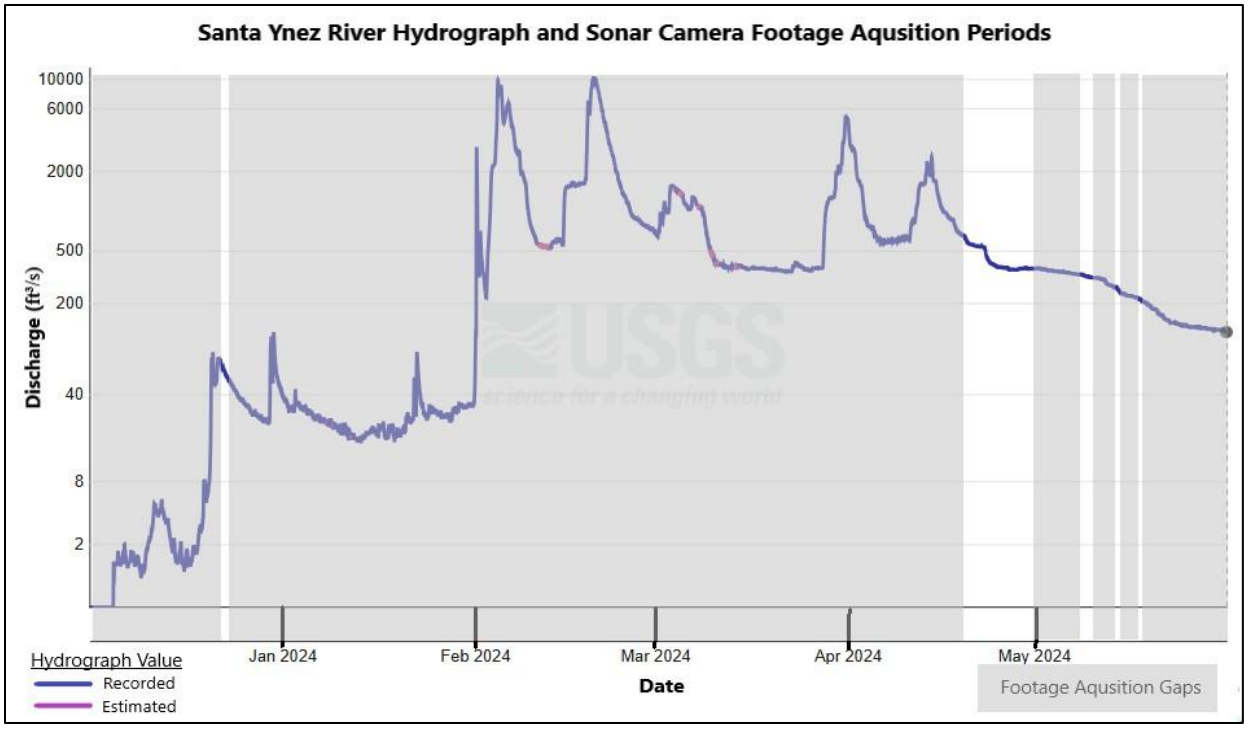



**Figure 22**: Hydrograph and periods of sonar footage acquisition for Santa Ynez River December 2023–May 2024. Hydrograph is located on H Street Bridge in Lompoc, CA (34.66831, -120.45794) (USGS 2024).

### 3.1.1.3 Salsipuedes Creek Sonar Camera Monitoring Results

An ARIS camera was utilized at the Salsipuedes Creek monitoring site and captured a total of 2,067.1 hours, or approximately 86.1 days, of footage from February 1, 2024 through May 23, 2024. There were several gaps in footage acquisition which occurred over the course of the monitoring season (Table 4). No software or user errors occurred during camera deployment at the Salsipuedes Creek monitoring site, resulting in 100% operational efficiency. Unfortunately, the initial three days of acquired footage files were lost and resulted in 44.7 hours of footage that was unable to be reviewed. It is suspected this occurred due to accidental deletion of the folder containing the files.

**Table 4:** Overview of sonar camera footage acquisition interruptions at the Salsipuedes Creek monitoring site during the 2023–2024 monitoring season.

| Cause of Footage Aquation Interruptions | Occurrences of Footage Acquisition Interruption | Total Time of Footage Acquisition Interruption Hours (*Days*) |
|---|---|---|
| Camera removal for elevated streamflow events | 4 | 305.7 (*12.7*) |
| Camera maintenance efforts | 5 | 2.2 (*0.09*) |
| **TOTAL** | **9** | **307.9 (*12.8*)** |

The visual field of all recorded footage from the site matched the set window length of the camera 90.7% of the time. The field of view within the reviewed footage was diminished for a combined total of 216.7 hours or approximately 9 days. The majority of this was due to turbid streamflow conditions degrading footage quality and accounted for 77.5% of diminished visual

field periods. There were two short instances in which no field of view was present in recorded footage, due to the camera being out of the water column due to dropping rates of streamflow. Combined, these two periods accounted for 48.7 hours of recorded footage. The far bankside of the stream channel was visible for 87.9% of acquired footage, with degraded footage quality contributing to 77.3% of the time the far bankside was not visible in recorded footage. The other timeframes in which the far bankside was not visible was due to a combination of elevated streamflow and an inadequate visible window length being set on the camera.

A total of 1,416 targets met recording criteria in footage obtained from the Salsipuedes Creek site, 1,318 of which were classified as fish. Observed fish targets consisted of green sunfish (n = 16), catfish (n = 397), *O. mykiss* (n = 415), and fish targets that could not be confidently assigned as a specific species (n = 506) (Table 17). Other targets recorded included waterfowl (n = 40, North American beavers (n =19), turtles (n = 8), and frogs (n = 4). Unidentified fish targets ranged in length from 11 to 52cm with a mean length of 24.8 ± 0.2cm. Measured lengths of all targets identified as *O. mykiss* ranged from 13 to 54cm with a mean length of 36.8 ± 0.3cm. Of these, 134 of the *O. mykiss* targets had a mean length greater than or equal to 40cm, which are typically classified as anadromous steelhead (CDFW 2020). A portion of the *O. mykiss* observed within sonar footage were captured within the Cachuma Operation and Maintenance Board (COMB) migrant fish trap that is operated approximately 200 feet upstream of the sonar camera deployment location. These captured *O. mykiss* were directly observed and examined by COMB staff, including collection and analysis of scale samples which can show rates of growth (COMB 2025). A total of 39 *O. mykiss* were captured in COMB's trap, nine of which had a measured length of 40cm or greater. However, COMB only classified two of those large *O. mykiss* as anadromous based on their appearance, scale sample analysis, and direction the fish were moving in the stream when captured (COMB 2025). The unique factor of COMB trapping results and the limitations of distinguishing different fish from one another that are observed in sonar camera footage reduces confidence in determining an exact number of anadromous *O. mykiss* that were actually present at the site. Analysis of *O. mykiss* targets documented within the acquired ARIS footage from the site with considerable consideration of COMB migrant trapping records, and scale analysis from captured *O. mykiss* suggest there were two to five different anadromous *O. mykiss* at the site over the course of the monitoring season. Table 24 reflects the dates when *O. mykiss* with anadromous traits and appearance captured in the COMB migratory trap may have been observed in ARIS footage. Further details are in Section 4.6 of this report.

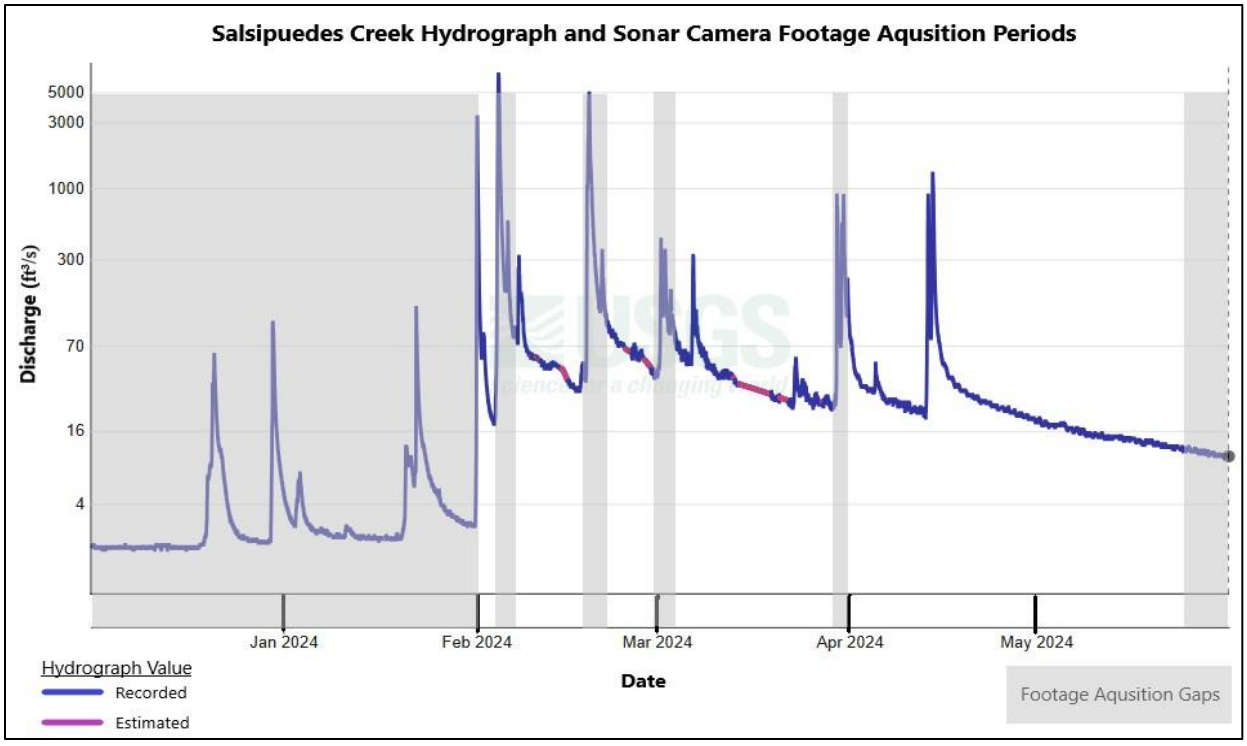



**Figure 23**: Hydrograph and periods of sonar footage acquisition for Salsipuedes Creek December 2023 – May 2024. Hydrograph is located on Jalama Road Bridge near Lompoc, CA. (34.588595, -120.408493) (USGS 2024).

### 3.1.2 Monte Arido Highlands BPG Redd Survey Monitoring Results

Redd surveys conducted within the Monte Arido Highlands BPG during the 2023–2024 monitoring season were focused on legacy redd reaches located within anadromous waters of the Ventura River watershed, though non-anadromous waters were also surveyed (Figure 24). Eighteen redd reaches were surveyed a total of 62 times within the watershed from January 9 to May 20, 2024. Thirteen of these redd reaches were located within anadromous waters. The mean number of days between surveys for all redd reaches within the watershed was 29.53 ± 2.45 (SE) days. Water visibility was variable throughout the spawning season, with diminished water visibility experienced on 11 (18.0%) of the completed redd surveys (Table 17**Error! Reference source not found.**). For these surveys, the mean distance of visibility within the water column was 42.9 ± 7.44 cm. Only one redd was observed; this was in non-anadromous waters of the watershed during a survey of Murietta Creek on January 31, 2024. This redd was only observed once and had a total area of 2,354.4 $cm^2$. Redd life could not be determined as elevated stream flows caused by increased precipitation washed out the redd before Murietta Creek was resurveyed. A total of 150 bankside *O. mykiss* observations were documented within the Ventura River watershed, all of which occurred upstream of the Matilija Dam in the non-anadromous waters of Murietta Creek and Upper North Fork Matilija Creek (Table 18 and Figure 25).

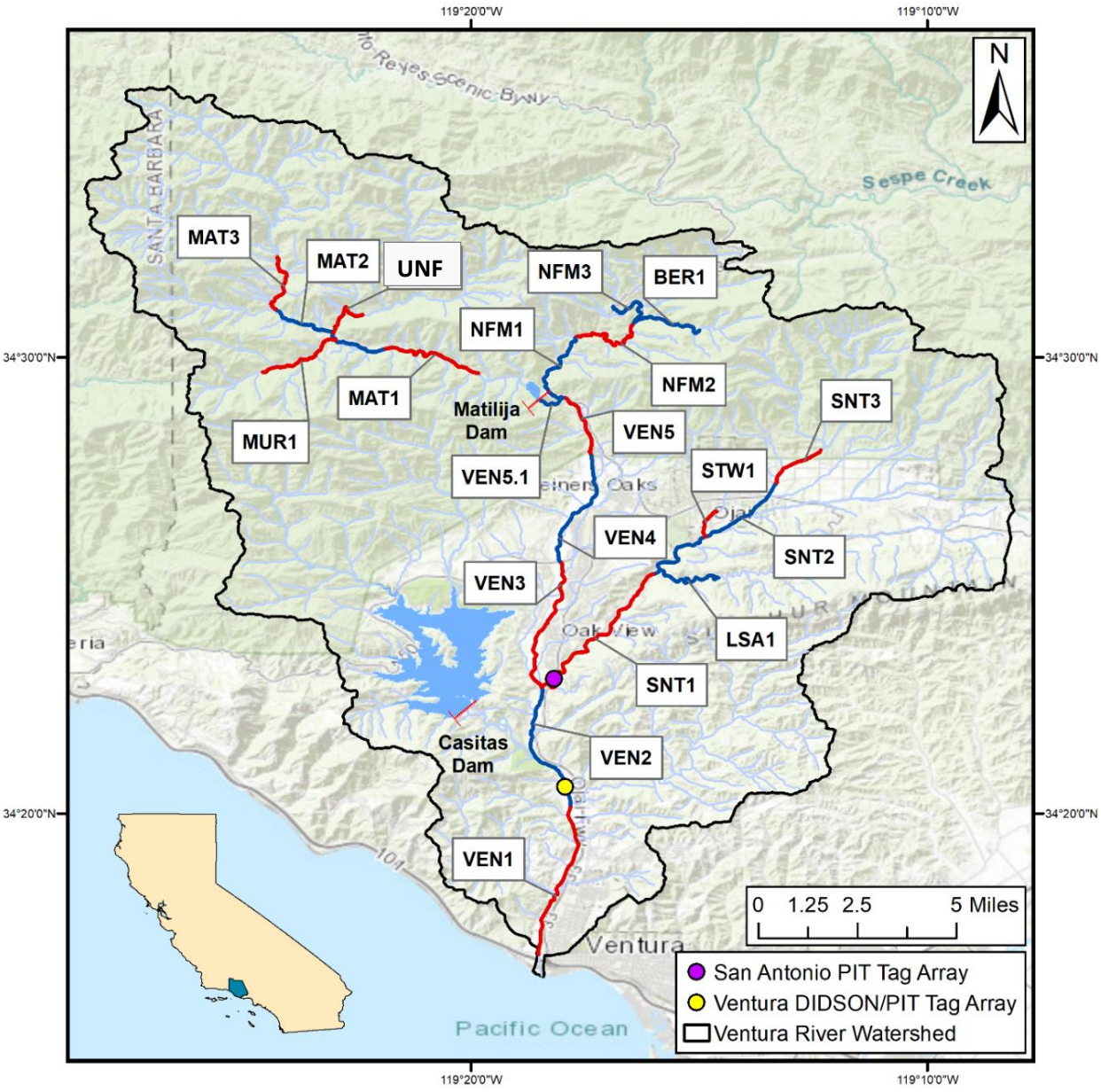



**Figure 24:** Ventura River watershed monitoring locations (Monte Arido Highlands BPG). Individual redd reaches are delineated as well as the location of the sonar camera monitoring and PIT tag array sites.

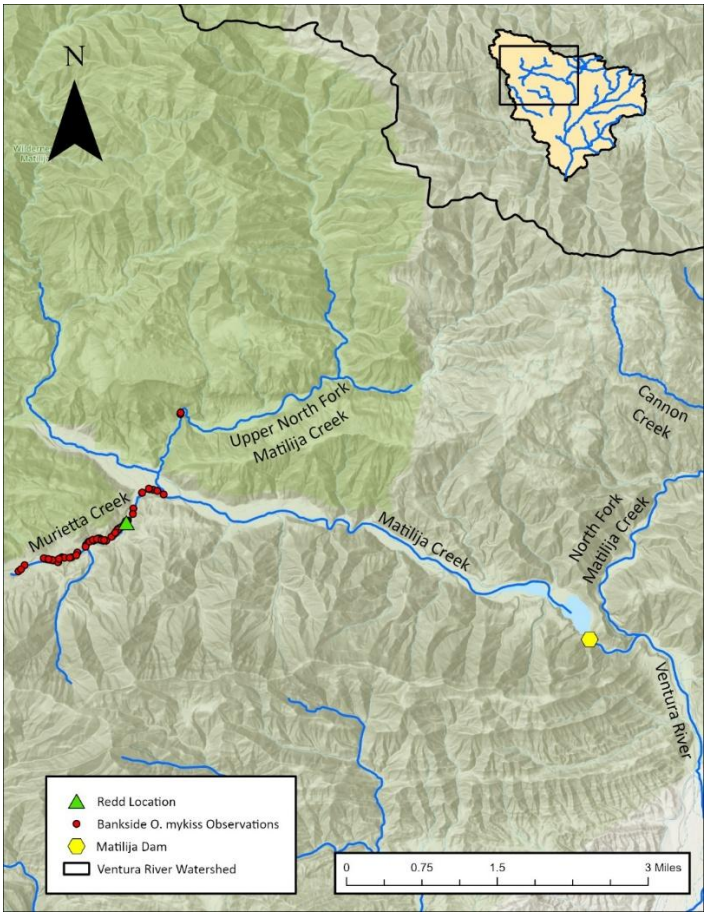



**Figure 25**: Location of all bankside *O. mykiss* (n = 150) and single redd observations within the Ventura River watershed during the 2023–2024 monitoring season. All observations were made in the Matilija Creek basin, non-anadromous waters, upstream of the Matilija Dam.

Additional redd surveys were conducted within the Santa Maria River watershed located within the Monte Arido Highlands BPG. This included six redd surveys performed on Davy Brown Creek and Munch Creek between March 11 and February 23, 2024 (Table 5). These small streams are located in the upper portions of the watershed within a mountainous area of the Los Padres National Forest. Mean number of days between surveys for all redd reaches within the watershed was 21.0 ± 1.08 (SE) days. Water visibility wasn't diminished during any of the surveys conducted (Table 5). Three redds were observed within Davy Brown Creek on March 12, 2024. Only two redds were measured since one had fish activity directly over the redd and surveyors did not want to disrupt any potential spawning activity. Total area of the measured redds were 1,210.0 $cm^2$ and 1,771.7 $cm^2$, respectively. Redd life could not be determined for the documented redds since they were no longer visible on the next survey. A total of 476 bankside *O. mykiss* observations were documented on Davy Brown Creek and Munch Creek. Fish estimated to be within the 0-2 inch size class were observed most frequently with 331 (69.5%) observations, indicating successful spawning. Other *O. mykiss* observed within the watershed were estimated to be in the 2–4 inch size class (2.1%), 4–6 inch size class (8.4%), 6–8 inch size class (12.0%), 8–10 inch size class (5.9%), 10–12 inch size class (1.1%), 12–14 inch size class (0.6%), and 14–16 inch size class (0.2%) (Table 18).

A few surveys were also conducted within non-anadromous waters within the upper portions of the Santa Clara River watershed. This included a single redd survey in Sisar Creek on April 3, 2024, and a redd survey on two reaches of Santa Paula Creek on May 15, 2024. Water visibility was only diminished on the Sisar Creek survey (Table 5). No redds were observed during these surveys, but 60 *O. mykiss* were observed in Sisar Creek, and one 2–4 inch size class *O. mykiss* was observed in Santa Paula Creek. Among the 60 *O. mykiss* observed within Sisar Creek, 49 were in the 0–2 inch size class (81.7%), eight were in the 4–6 inch size class (13.3%), and three were in the 6–8 inch size class (5.0%) (Table 18).

**Error! Reference source not found.**Other bankside observations of threatened or endangered species were made throughout the surveyed Monte Arido Highlands BPG streams, including California Red-Legged Frog (*Rana draytonii*) (n=4), Two-Striped Garter Snake (*Thamnophis hammondii*) (n=6), and Southern Western Pond Turtle (*Actinemys pallida)* (n=10) (Table 19).

**Table 5:** Survey frequency and water clarity overview of redd surveys conducted within the Monte Arido Highlands BPG during the 2023–2024 monitoring season.

| Watershed | Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|---|
| Santa Clara River | Santa Paula Creek 1 | 1 | NA | NA | 0 |
| Santa Clara River | Santa Paula Creek 2 | 1 | NA | NA | 0 |
| Santa Clara River | Sisar Creek 1 | 1 | NA | NA | 1 |
| Ventura River | Bear Creek 1 | 5 | 21.5 | 1.0 | 0 |
| Ventura River | Lion Creek 1 | 4 | 31.3 | 16.5 | 3 |
| Ventura River | Matilija Creek 1 | 1 | NA | NA | 0 |
| Ventura River | Matilija Creek 2 | 2 | 40.0 | NA | 0 |
| Ventura River | Matilija Creek 3 | 2 | 42.0 | NA | 0 |
| Ventura River | Murietta Creek 1 | 4 | 27.7 | 14.2 | 0 |
| Ventura River | North Fork Matilija Creek 1 | 5 | 24.5 | 3.6 | 1 |
| Ventura River | North Fork Matilija Creek 2 | 5 | 23.3 | 2.4 | 1 |
| Ventura River | San Antonio Creek 1 | 3 | 47.5 | 21.5 | 2 |
| Ventura River | San Antonio Creek 2 | 5 | 19.3 | 6.1 | 1 |

| Watershed | Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|---|
| Ventura River | San Antonio Creek 3 | 5 | 24.3 | 4.2 | 0 |
| Ventura River | Stewart Creek 1 | 3 | 36.0 | 7.0 | 0 |
| Ventura River | Upper North Fork Matilija Creek 1 | 3 | 20.5 | 0.5 | 0 |
| Ventura River | Ventura River 1 | 2 | 43.0 | NA | 1 |
| Ventura River | Ventura River 2 | 3 | 66.0 | 1.0 | 1 |
| Ventura River | Ventura River 3 | 4 | 29.3 | 9.3 | 0 |
| Ventura River | Ventura River 4 | 4 | 29.7 | 9.2 | 0 |
| Ventura River | Ventura River 5 | 1 | NA | NA | 1 |
| Santa Maria River | Davy Brown Creek | 3 | 20.5 | 0.5 | 0 |
| Santa Maria River | Munch Creek | 3 | 21.5 | 2.5 | 0 |
| - | **BPG Totals** | **70** | **31.6** | **6.6** | **12** |

### 3.1.3 Monte Arido Highlands BPG PIT Tag Array Monitoring Results

At least one antenna was deployed at the Ventura River site for a total of 66.9 days between January 10 and May 28, 2024. However, antenna functionality was limited to approximately only a combined 10.6 days or 15.8% of the time an antenna was deployed. Antenna tuning issues accounted for 84.2% of the time antennas were not functional. The majority of tuning issues (54.8%) occurred between May 2 and May 28, 2024, when no efforts were made to check or maintain the antennas. Power supply issues appear to account for 15.8% of the time antennas were deployed and believed to not be functioning correctly according to marker tag logs. A summary of antenna deployments, operation, and issues preventing full functionality is provided in Table 6. No upstream or downstream detections were recorded on either of the Ventura River watershed PIT tag arrays during the 2023–2024 monitoring season.

**Table 6:** Summary of Ventura River PIT tag detection antenna deployments and operation during the 2023–2024 monitoring season.

| Date | Antennas Operating | PIT Tag Read Range (inches) | Notes |
|---|---|---|---|
| 1/10/2024 | 1 | ≈ 2 | No maker tag detections following initial testing due to battery depletion in marker tag boxes. |
| 1/17/2024 | 2 | Downstream antenna ≈ 4–5 | N/A. |

| Date | Antennas Operating | PIT Tag Read Range (inches) | Notes |
|---|---|---|---|
| | | Upstream antenna ≈ 1–2 | |
| 1/22/2024 | 2 | 0 for both antennas | Debris accumulation and shifting on the antennas is believed to have contributed to loss of tuning. Marker tag detections stopped occurring on 1/17/2024. |
| 1/24/2024 | 2 | ≈ 2 for both antennas | Antenna maintenance and retuning completed. |
| 1/31/2024 | 0 | N/A | Antennas were removed prior to forecasted elevated streamflow event. |
| 2/13/2024 | 1 | ≈ 2 | Two antennas were deployed but one was unable to be tunned. |
| 2/15/2024 | 1 | 0 | Antenna tunning lost, assumed to have occurred due to antenna shifting. |
| 2/18/2024 | 0 | N/A | Antennas were removed prior to forecasted elevated streamflow event. Prolonged elevated streamflow conditions prevent redeployment of antennas until March 14. |
| 3/14/2024 | 1 | ≈ 4-5 | Thirteen-hour gaps in marker tag detections occurred due to loss of charge in one of the two deep cycle marine batteries. |
| 3/22/2024 | 1 | ≈ 4-5 | Deep cycle marine battery is replaced. |
| 3/24/2024 | 1 | 0 | System voltage issue resulted in reader box power loss. |
| 3/29/2024 | 0 | N/A | Antenna removed prior to forecasted elevated streamflow event. Prolonged elevated streamflow conditions prevent redeployment of antennas until May. |
| 5/2/2024 | 1 | ≈ 4 – 5 | N/A |
| 5/6/2024 | 2 | ≈ 4 – 5 for both antennas | N/A |
| 5/28/2024 | 0 | N/A | Both antennas removed for end of monitoring season. No marker tag detections occurred during majority of final deployment period due to loss of tunning from shifting in strong streamflow conditions. |

Due to delays in establishing a new array site location on San Antonio Creek, an antenna was not able to be deployed and made operational until March 7, 2024. At least one antenna was deployed at the San Antonio Creek site for a total of 76.7 days between March 7 and May 30, 2024. However, antenna functionality can only be confirmed to have occurred for

approximately a combined 9.6 days or 12.5% of the time an antenna was deployed. Actual antenna functionality is likely to have occurred more than this, but there are an assumed 45 days (April 15 to May 30, 2024) in which the marker tag boxes were not functional or set properly. This accounted for 65.8% of the total nonfunctional time documented in reader log records. Technical issues with reader boxes deployed at the site accounted for 25% of the nonfunctional time documented for the site. Power supply issues to the antennas accounted for 6.7% of the nonfunctional time. Finally, tuning issues accounted for 2.5% of the documented nonfunctional time. A summary of antenna deployments, operation, and issues preventing full functionality is provided in Table 7. No upstream or downstream detections were recorded on either of the San Antonio Creek watershed PIT tag arrays during the 2023–2024 monitoring season.

**Table 7:** Summary of San Antonio Creek PIT tag detection antenna deployments and operation during the 2023–2024 monitoring season.

| Date | Antennas Operating | PIT Tag Read Range (inches) | Notes |
|---|---|---|---|
| 3/7/2024 | 1 | Up to 24 | Antenna was only operational for 32 minutes due to loss of power due to faulty charge controller connection |
| 3/8/2024 | 1 | Up to 24 | Charge control connection fixed and antenna was made operational again |
| 3/11/2024 | 2 | 0 | A second antenna was deployed. However, unable to get marker tag detections on either antenna due to suspected issue with the marker tag box. Sporadic gaps in marker tag detections occurred since March 8th. |
| 3/14/2024 | 2 | Up to 24 for both antennas, but not consistently | New reader box installed. System discovered to be operating at excessive voltage |
| 3/15/2024 | 2 | ≈ 1 for both antennas, but not consistently | New reader box installed and charge controller settings checked. Excessive voltage issue persisted. |
| 3/19/2024 | 0 | N/A | Three different antenna wires and manual tuner boxes installed, but the excessive voltage issue persisted. Antennas powered down so reader box firmware updates could be completed. |
| 3/21/2024 | 2 | ≈ 2 for both antennas | Reader box reinstalled, but read range is limited for both antennas. |
| 3/28/2024 | 0 | N/A | Antennas were removed prior to forecasted elevated streamflow event. Sporadic gaps occurred in marker tag detections, likely due to ongoing technical issues and elevated streamflow resulting in antenna tuning issues between March 23rd and 25th. |
| 4/2/2024 | 2 | ≈ 2 to 4 for both antennas | Both antennas redeployed, but marker tag detection ability remains inconsistent. |
| 4/15/2024 | 2 | ≈ 5 to 6 for both antennas | A different reader box is installed at the site. |

| Date | Antennas Operating | PIT Tag Read Range (inches) | Notes |
|---|---|---|---|
| 5/30/2024 | 0 | N/A | Both antennas removed for end of monitoring season. No marker tag detections occurred during majority of final deployment period due. Possible causes include loss of tunning from shifting in strong streamflow conditions, improper marker tag box positioning, or malfunction of marker tag boxes. |

## 3.2 Conception Coast BPG Monitoring Results

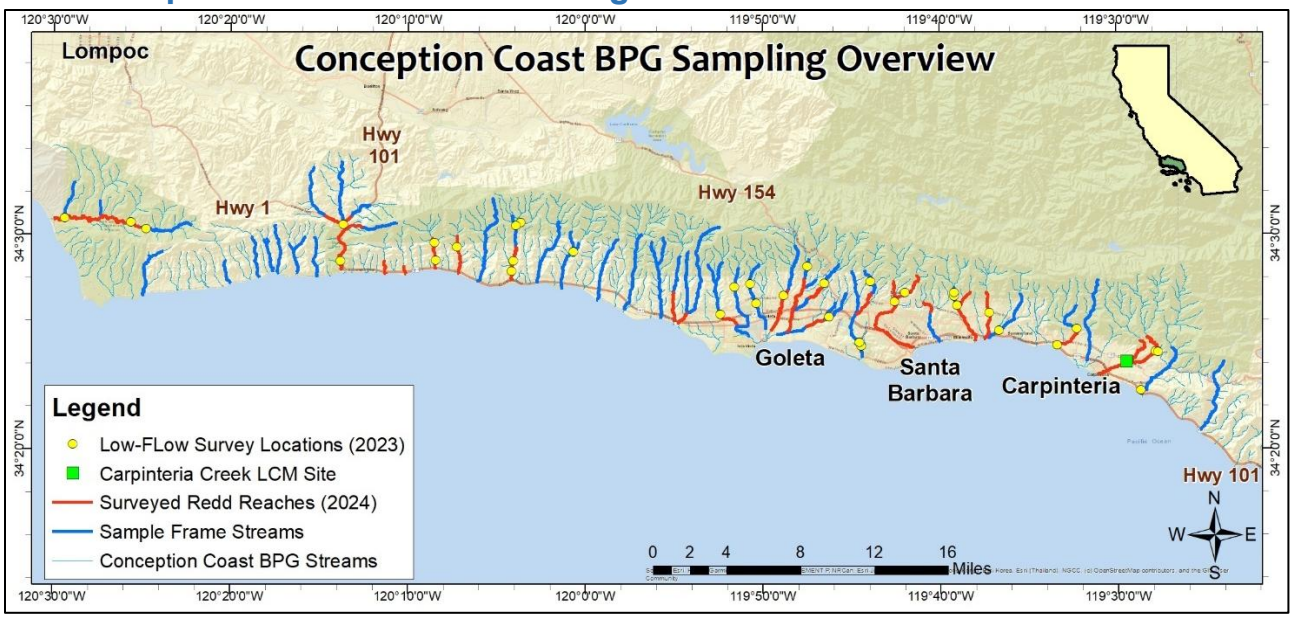



**Figure 26**: Conception Coast BPG sample frame streams with overview of 2023–2024 monitoring effort locations.

### 3.2.1 Carpinteria Creek Sonar Camera Monitoring Results

A DIDSON camera was utilized for all camera deployments at the Carpinteria Creek monitoring site and captured a total of 2,351.1 hours, or approximately 98 days, of footage. The camera had an initial deployment date of December 30, 2023 and was removed from the site on January 8, 2024 due to low streamflow conditions that resulted in unfavorable passage conditions for anadromous *O. mykiss* through the stream channel and challenged camera use. The camera was redeployed on January 22, 2024 and finally removed on May 13, 2024. There were several gaps in footage acquisition which occurred over the course of the monitoring season, which are summarized in Table 8.

**Table 8:** Overview of sonar camera footage acquisition interruptions at the Salsipuedes Creek monitoring site during the 2023–2024 monitoring season.

| Cause of Footage Aquation Interruptions | Occurrences of Footage Acquisition Interruption | Total Time of Footage Acquisition Interruption Hours (*Days*) |
|---|---|---|
| Technical issues | 4 | 432.4 (*18*) |
| Camera removal for elevated streamflow events | 4 | 220.6 (*9.2*) |

| Cause of Footage Aquation Interruptions | Occurrences of Footage Acquisition Interruption | Total Time of Footage Acquisition Interruption Hours (*Days*) |
|---|---|---|
| Camera maintenance efforts | 3 | 1.2 (*0.05*) |
| **TOTAL** | **11** | **654.3 (27.3)** |

Deployments of the camera at the Carpinteria Creek site during periods of elevated and turbid streamflow also caused a diminished field of view in recorded footage. Over the course of the monitoring season the visual field of all reviewed footage from the site matched the set window length of the camera deployed at the site 97.2% of the time, with diminished field of view occurring within 67 hours or approximately 2.8 days of the footage. Diminished field of view was primarily caused by turbid streamflow, accounting for approximately 43.7 hours of footage and 65.2% of these instances. The other portion of diminished field of view was caused by the camera being out of the water due to diminished streamflow resulting in no field of view. This accounted for approximately 23.3 hours of acquired footage and 34.8% of the diminished field of view. Instances of diminished field of view accounted for 48.7% of time when the opposite stream bank was not visible in recorded footage. The other occurrence of the opposite stream bank not being visible in recorded footage occurred for 70.7 hours between February 6 and 10, 2025 as the result of elevated streamflow. During this time, it is estimated no more than 3 feet of the wetted channel was outside of the camera's field of view. Overall, the opposite stream bank was visible within 94.4% of the recorded footage.

A considerable portion of captured footage from the site did contain minor visual obstruction due to fluctuating stream channel morphological conditions within camera deployment locations. These included shallow streamflow, minimal streambed scour near the camera site, and positioning of boulders and rocks within the streambed. When streamflow conditions allowed, boulders positioned within the camera field of view were physically moved or the camera was moved upstream and downstream to more appropriate locations. It is unlikely that any of these minor visual obstructions caused targets to be fully obstructed during footage review. Finally, CSOT processing accounted for 65.7% of the captured footage.

A total of 20 targets met the criteria to be recorded in the footage that was able to be reviewed from the Carpinteria Creek site. None of these targets were believed to be fish but rather consisted of waterfowl (n=9), turtles (n=2), California newts (*Taricha torosa*) (n=3), one unidentified terrestrial species, one frog, and seven targets that could not be confidently identified. Five of the unknown targets were moving downstream and may have been debris. The two unknown targets that were observed moving upstream ranged between 11 and 14 cm in length and are therefore too small to be anadromous *O. mykiss*.

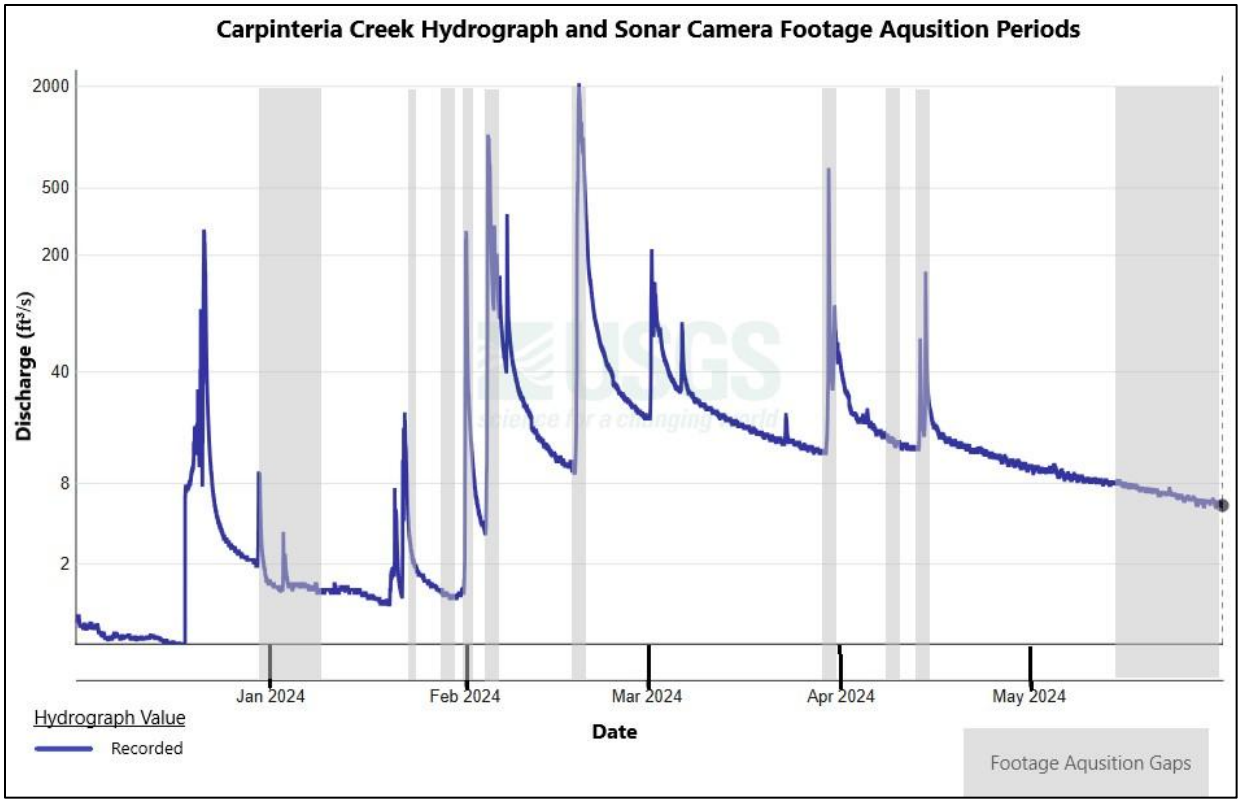



**Figure 27**: Hydrograph and periods of sonar footage acquisition for Carpinteria Creek December 2023–May 2024. Hydrograph is located along Lillingston Canyon Road (34.40138, -119.48651) (USGS 2024).





**Figures 28 and 29:** Removal of image degrading sediment deposited within the DIDSON debris box at the Carpinteria Creek sonar camera monitoring site following elevated streamflow that occurred March 1 – 2, 2024. Streamflow peaked at 206 ft³/s during the streamflow event (USGS, 2024).

### 3.2.2 Conception Coast BPG Redd Survey Monitoring Results

One hundred eighteen redd surveys were conducted within 44 long reaches within the Conception Coast BPG during the 2023–2024 monitoring season between January 1, 2024 and April 30, 2024 (Table 9). Ten of these reaches included non-anadromous water due to the presence of total manmade barriers. Additionally, a redd survey was attempted on the downstream reach in Espada Creek but was unable to be completed due to the presence of extremely dense vegetation that prevented movement through the stream channel. Twenty of the reaches surveyed were in areas that had never been included in previous seasons of redd survey efforts. The five reaches surveyed in the Mission Creek watershed coincided with drought monitoring efforts. Seventeen of the reaches surveyed were only surveyed once due to a combination of persistent limited visibility in the water column and the documentation of overall poor habitat conditions thus reducing the likelihood for *O. mykiss* and their redds to be present. For the 27 reaches that were surveyed multiple times, the mean reoccurrence interval between surveys was 23.1 ± 0.69 days. Water visibility was diminished on 37 (31.4%) of the completed redd surveys (Table 9). For these surveys the mean distance of visibility within the water column was 40.6 ± 3.2 cm.

No redds were observed during the 2023–2024 redd survey efforts in the Conception Coast BPG, but a total of 318 bankside *O. mykiss* observations were documented. All bankside observations were of non-anadromous resident life stage *O. mykiss* and occurred in four streams: Gaviota Creek (n=209), Maria Ygnacio Creek (n=101), Mission Creek (n=1), and Rattlesnake Creek (n=7). Among the *O. mykiss* observed within the Conception Coast BPG, 259 were in the 0–2 inch size class (81.4%), 38 were in the 2–4 inch size class (11.9%), 10 were in the 4–6 inch size class (3.1%), 10 were in the 6–8 inch size class (3.1%), and one was in the 8–10 inch size class (0.3%) (Table 18). **Error! Reference source not found.**Other bankside observations of threatened or endangered species were made on many of the Conception Coast BPG redd surveys, including California Newt (*Taricha torosa*) (n=226), California Red-Legged Frog (*Rana draytonii*) (n=22), Two-Striped Garter Snake (*Thamnophis hammondii*) (n=7), Three-spined Stickleback (*Gasterosteus aculeatus*) (n=58), and Southwestern Pond Turtle (*Actinemys pallida)* (n=118) (Table 19).

**Table 9:** Survey frequency and water clarity overview of redd surveys conducted within the Conception Coast BPG during the 2023–2024 monitoring season.

| Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|
| Arroyo Hondo Creek 1 | 5 | 21.3 | 3.3 | 0 |
| Arroyo Paredon Creek 1 | 1 | NA | NA | 0 |
| Arroyo Quemado Creek 1 | 1 | NA | NA | 0 |
| Arroyo Quemado Creek 2 | 1 | NA | NA | 0 |
| Atascadero Creek 2 (Goleta Slough Complex Stream) | 1 | NA | NA | 1 |
| Bell Canyon Creek 1 | 1 | NA | NA | 0 |
| Canada del Molino Creek 1 | 2 | 21.0 | NA | 1 |
| Canada San Onofre Creek 1 | 1 | NA | NA | 0 |

| Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|
| Carpinteria Creek 1 | 4 | 30.3 | 6.7 | 2 |
| Carpinteria Creek 2 | 4 | 30.3 | 6.7 | 2 |
| Carpinteria Creek 3 | 3 | 24 | 4 | 1 |
| Gaviota Creek 1 | 2 | 30 | NA | 2 |
| Gaviota Creek 2 | 2 | 34.0 | NA | 1 |
| Gobernador Creek 1 | 5 | 22.8 | 1.8 | 2 |
| Gobernador Creek 2 | 5 | 22.8 | 1.8 | 2 |
| Hot Springs Canyon Creek 1 | 1 | NA | NA | 0 |
| Jalama Creek 1 | 3 | 23.5 | 2.5 | 2 |
| Jalama Creek 2 | 3 | 23.5 | 2.5 | 2 |
| Jalama Creek 3 | 3 | 23.5 | 2.5 | 2 |
| Jalama Creek 4 | 3 | 23.5 | 2.5 | 2 |
| Las Canovas Creek 1 (Gaviota Creek Watershed) | 1 | NA | NA | 1 |
| Maria Ygnacio Creek 1 (Goleta Slough Complex Stream) | 3 | 17.5 | 1.5 | 0 |
| Maria Ygnacio Creek 2 (Goleta Slough Complex Stream) | 3 | 17.5 | 1.5 | 0 |
| Maria Ygnacio Creek 3 (Goleta Slough Complex Stream) | 3 | 17.5 | 1.5 | 0 |
| Mission Creek 1 | 5 | 20.8 | 2.1 | 0 |
| Mission Creek 2 | 5 | 20.8 | 2.1 | 0 |
| Mission Creek 3 | 5 | 20.8 | 0.6 | 0 |
| Montecito Creek 1 | 4 | 23.3 | 1.5 | 0 |
| Montecito Creek 2 | 4 | 23.3 | 1.5 | 1 |
| North Fork Las Canovas Creek 1 | 1 | NA | NA | 1 |
| Rattlesnake Creek 1 | 5 | 21.5 | 1.2 | 2 |
| Rattlesnake Creek 2 | 5 | 21.5 | 1.2 | 2 |
| Refugio Creek 1 | 4 | 16.7 | 3.3 | 1 |
| Refugio Creek 2 | 3 | 25.0 | 5.0 | 2 |
| San Antonio Creek 2 (Goleta Slough Complex Stream) | 1 | NA | NA | 0 |
| San Jose Creek 1 | 1 | NA | NA | 1 |

| Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|
| (Goleta Slough Complex Stream) | | | | |
| San Jose Creek 2 (Goleta Slough Complex Stream) | 1 | NA | NA | 0 |
| San Roque Creek 1 | 1 | NA | NA | 1 |
| San Ysidro Creek 1 | 4 | 24.0 | 4.2 | 1 |
| San Ysidro Creek 2 | 4 | 24.0 | 4.2 | 0 |
| Sycamore Creek 2 | 1 | NA | NA | 1 |
| Tecolote Creek 1 | 1 | NA | NA | 0 |
| Tecolotito Creek 2 (Goleta Slough Complex Stream) | 1 | NA | NA | 1 |
| West Fork Gaviota Creek 1 | 1 | NA | NA | 0 |
| **BPG Totals** | **118** | **23.1** | **2.7** | **37** |

### 3.2.3 Conception Coast BPG Low-Flow Survey Results

Low-flow surveys within the Conception Coast BPG during the 2023–2024 season were conducted between September 9, 2023 and December 14, 2023. A total of 117 short reaches were considered for sampling, however only 37 were sampled. Forty-six (39.3%) of the considered reaches were unable to be accessed and sampled due to private property restrictions. This included 23 (19.7%) reaches that access was denied to by property owners, 19 (16.2%) reaches in which no response was provided by property owners to access inquiries, and four (3.4%) of reaches in which property owner contact information was unable to be found. Thirty (25.6%) of the considered reaches were found to not meet the minimum habitat suitability sampling criteria. All these reaches are therefore assumed to have not contained *O. mykiss* at the time they were assessed for sampling suitability. Four (3.4%) of the considered reaches were unable to be safely accessed with sampling gear due to the presence of dense and hazardous vegetation coupled with rugged terrain from any potential access points.

A total of 443 individual habitat units were sampled within the BPG, with flatwater units being the most abundant (n=221, 49.9%) followed by riffles (n=149, 33.6%) and pools (n=60, 13.5%) (Table 10). Additionally, there were seven dry and six intermittent sections of stream channel documented within all sampled reaches. The mean unit length and width were 8.9 ± 0.4 m and 2.3 ± 0.05 m, respectively. The mean depth of sampled units was 0.2 ± 0.01 m and had a mean maximum depth of 0.4 ± 0.02 m. Average estimated volume was 5.6 ± 0.6 $m^3$ for sampled units. Average water temperature, dissolved oxygen, and specific conductivity was 14.3ºC, 8.1 mg/L, and 192.4 µS/cm, respectively. Only one habitat unit was too deep to effectively electrofish and required a snorkel observation survey.

A total of 27 *O. mykiss* were captured or observed in the Conception Coast BPG low-flow surveys, all of which were non-anadromous resident life stage. These *O. mykiss* were

captured or observed on only three of the 37 sampled short reaches, with 25 (92.6%) of them captured in a reach located within the upper portion of Maria Ygnacio Creek. Unfortunately, a 90% depletion capture rate was not achieved for this reach due to diminishing daylight limitations when conducting the electrofishing sampling effort. The two other short reaches in which *O. mykiss* were documented within the Conception Coast BPG were located in the Gaviota Creek watershed with one *O. mykiss* captured in Gaviota Creek and one observed in the West Fork of Gaviota Creek. The mean fork length of all captured and observed *O. mykiss was* 108.4 ± 8.0 mm, with the length of the observed *O. mykiss* being estimated. The majority of captured or observed *O. mykiss* were located within flatwater units (n=16) followed by riffles (n=8), and pools (n=3). The Conception Coast BPG sample frame has an estimated 707,436 $m^2$ of available habitat space, divided into 1,573 individual short reaches, for a mean short reach area of 449.7 $m^2$. Average *O. mykiss* density is 0.0032 ± 0.0029 individuals/$m^2$. The regional estimate of abundance for adult, enigmatic, and juvenile trout is 45 ± 1,487 individuals, 180 ± 4,398 individuals, and 991 ± 31,142 individuals, respectively (Table 11).

**Table 10:** Conception Coast BPG low-flow short reach sampling effort summary.

| Reaches Considered for Sampling | Reaches Sampled | Habitat Units Sampled | Snorkel Survey Units | Riffle Units | Flatwater Units | Pool Units | Dry & Intermittent Units |
|---|---|---|---|---|---|---|---|
| 117 | 37 | 443 | 1 | 149 | 221 | 60 | 13 |

**Table 11:** Summary of *O. mykiss* abundance estimation results within the Conception Coast BPG from collected low-flow survey data.

| BPG | Available Habitat ($m^2$) | Short Reaches In Sample Frame | Mean Short Reach Area ($m^2$) | Estimate of Density (± SE) (fish/$m^2$) | Adult Estimate of Abundance (± SE) | Enigmatic Estimate of Abundance (± SE) | Juvenile Estimate of Abundance (± SE) |
|---|---|---|---|---|---|---|---|
| Conception Coast | 707,436 | 1,573 | 449.7 | 0.0032 (0.0029) | 45 (1,487) | 180 (4,398) | 991 (31,142) |

### 3.2.4 Conception Coast BPG Snorkel Surveys

Snorkel surveys to assess *O. mykiss* presence and relative abundance were conducted in two streams located within the Conception Coast BPG during the 2023-2024 monitoring season. These surveys focused on the portion of each assessed stream located downstream of total natural barrier features to *O. mykiss* upstream movement and covered a total of 2.72 stream miles. The surveys were conducted during the dry season between July 17, 2023, and August 24, 2023, when lower streamflow conditions were present. However, heightened levels of precipitation the previous winter kept a significant portion of assessed stream channels actively flowing and, as a result, many habitat units met the water depth criteria for snorkeling. In total, 175 habitat units consisting of 0.84 stream miles (4,533 feet) of stream channel was snorkeled within the assessed streams, approximately 30.9% of the total assessed distance within the streams. Between July 17, 2023 and July 18, 2023, a total of 2,454 feet of habitat within 71 units was snorkeled in Cold Springs Creek. Between August 15, 2023 and August 24, 2023, a total of 2,079 feet of habitat within 104 units was snorkeled in Mission Creek. A single *O. mykiss* was observed in Mission Creek (2–4 inch) within a pool unit directly below the Rattlesnake Creek confluence (34.44795, -119.70895) (Table 12). Relative abundance of *O. mykiss* within the surveyed streams is 0.0057 trout/unit, 0.00022 trout/ft., or 0.000018 trout/$ft^2$.

The mean length of all snorkeled units was 25.9 ± 1.7 feet (Table 13). The total area of all snorkeled units was 54,897 ft² and the mean area of all snorkeled units was 313.7 ± 21.5 ft² (Table 12). Of the snorkeled units, 111 (63.4%) were classified as pools, 35 (20.0%) as flatwaters, and 29 (16.6%) as riffles. The mean depth of snorkeled units was 1.39 ± 0.05 ft and units had a mean maximum depth of 2.25 ± 0.08 ft (Table 13). Most snorkeled units (n=170, 97.1%) had excellent water visibility. Four snorkeled units (2.29%) had moderate water visibility, zero units had poor visibility, and one unit (0.61%) had inadequate conditions for safe snorkeling. The mean percentage of cover available to *O. mykiss* by water surface area within the snorkeled units was 24.6 ± 1.2%. Boulder cover was the most commonly occurring instream cover type, which was present in 172 of the snorkeled units and accounted for a mean cover percentage of 48.7 ± 1.9%. The surveyed area on Cold Springs Creek (35.6 ± 16%) contained a higher mean percentage of cover by water surface area than Mission Creek (17.6 ± 1.6%). The most common cover type in Cold Springs Creek was aquatic vegetation (40.7 ± 1.9%) whereas Mission Creek cover was predominantly boulder (54.8 ± 2.9%) (Table 14). The entirety of the 0.54 stream miles surveyed on Cold Springs Creek was wetted compared to Mission Creek which was 86.7% wetted across the 2.18 stream miles surveyed.

**Table 12:** Summary of snorkeling survey efforts conducted within Conception Coast BPG streams.

| **Stream** | **Units Snorkeled** | **Stream Distance Surveyed** (mi) | **Total Unit Distance Surveyed** (feet) | **Total Area of Units Snorkeled** ($ft^2$) (Percent of BPG Total Snorkeled Area) | ***O. mykiss* Observations** |
|---|---|---|---|---|---|
| Cold Springs Creek | 71 | 0.54 | 2,454 | 23,507 (42.8%) | 0 |
| Mission Creek | 104 | 2.18 | 2,079 | 31,390 (57.2%) | 1 |
| **Totals** | **175** | **2.72** | **4,533** | **54,897** | **1** |

**Table 13:** Summary of mean ± SE unit dimensions of snorkeled units within Conception Coast BPG streams.

| **Stream** | **Length** (feet) | **Width** (feet) | **Average Depth** (feet) | **Maximum Depth** (feet) | **Surface Area** ($ft^2$) | **Volume** ($ft^3$) |
|---|---|---|---|---|---|---|
| Cold Springs Creek | 35.5 (3.9) | 14.0 (0.8) | 1.3 (0.07) | 2.2 (0.1) | 442.1 (40.1) | 604.9 (78.8) |
| Mission Creek | 20.0 (0.9) | 10.6 (0.5) | 1.5 (0.1) | 2.3 (0.1) | 226.0 (19.5) | 414.4 (62.4) |
| Conception Coast BPG | 25.9 (1.7) | 12.0 (0.5) | 1.4 (0.05) | 2.3 (0.08) | 313.7 (21.5) | 491.7 (49.3) |

**Table 14**: Summary of mean percent ± SE of the habitat cover types of snorkel units within Conception Coast BPG streams.

| Cover Type | Cold Springs Creek | Mission Creek | Conception Coast BPG |
|---|---|---|---|
| Open | 64.44 (1.57) | 82.45 (1.35) | 75.14 (1.22) |
| Covered | 35.56 (1.57) | 17.55 (1.35) | 24.86 (1.22) |
| Cobble/Boulder | 39.72 (1.66) | 54.81 (2.93) | 48.69 (1.95) |
| Bedrock Ledge | 0.00 (NA) | 14.76 (2.44) | 10.46 (1.59) |
| Aquatic Vegetation | 40.70 (1.91) | 7.93 (1.38) | 21.26 (1.66 |
| Small Woody Debris | 2.61 (0.91) | 10.43 (1.01) | 7.25 (0.76) |
| Bubble Curtain | 11.69 (1.17) | 1.39 (0.35) | 5.57 (0.64) |
| Root Mass | 0.00 (NA) | 3.65 (1.13) | 2.17 (0.68) |
| Artificial/Other | 0.21 (0.16) | 3.51 (1.48) | 2.17 (0.89) |
| Terrestrial Vegetation | 0.63 (0.57) | 2.64 (0.88) | 1.83 (0.57) |
| Large Woody Debris | 0.28 (0.28) | 0.72 (0.52) | 0.54 (0.33) |
| Soil undercut | 0.00 (0.00) | 0.10 (0.07) | 0.06 (0.04) |

## 3.3 Santa Monica Mountains BPG Monitoring Results

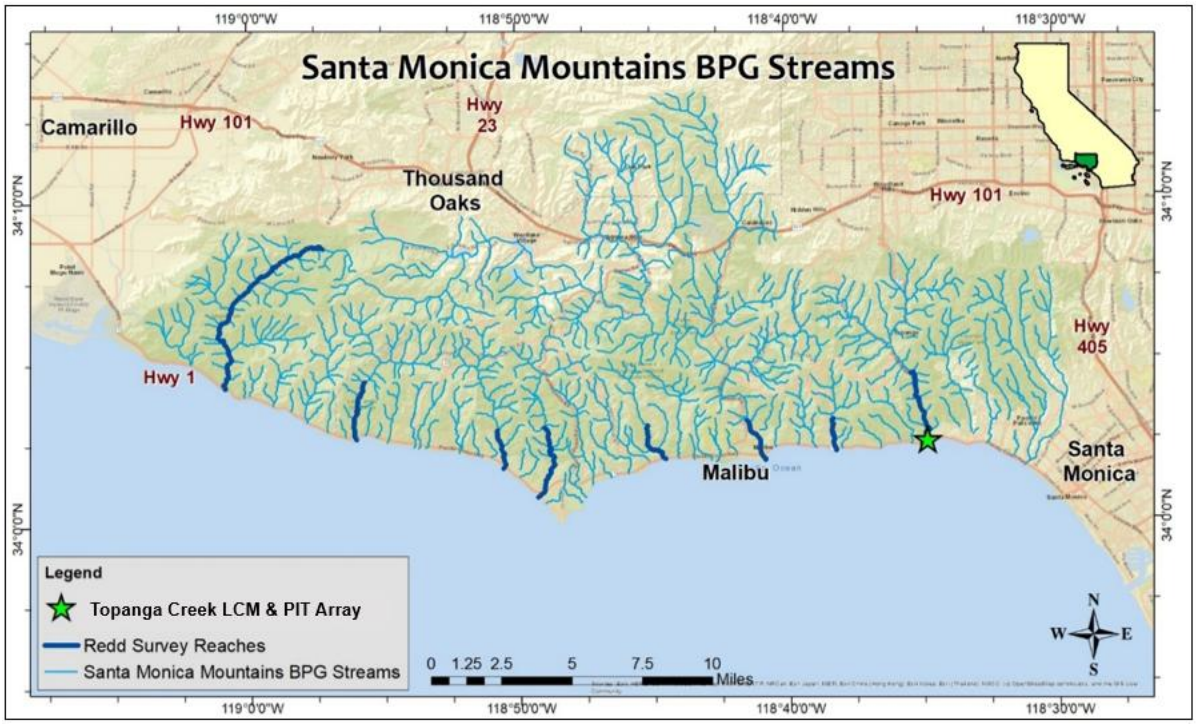



**Figure 30**: Santa Monica Mountains BPG streams with 2023–2024 LCM location and redd survey reaches.

### 3.3.1 Topanga Creek Sonar Camera Monitoring Results

A DIDSON camera was utilized for all camera deployments at the Topanga Creek monitoring site and captured a total of 1,0995 hours, or approximately 46 days of footage. Camera deployment at the site was delayed until February 7, 2024. The delay was a result of a break-in to the mobile storage container used to store topside camera components. It is unknown when the break-in occurred. Repairs to the broken window on the container to reestablish security were completed on December 21, 2023. Additionally, an attempt was made to deploy the camera on January 22, 2024, but was unable to be completed because the power and data cable used to connect the camera to the topside components had been chewed on by wildlife and was no longer functional. The cable was replaced and exposed portions were fortified to prevent further damage. The initial deployment of the camera lasted until February 18, 2024, when it was removed prior to a forecasted precipitation event that resulted in elevated stream flow that could potentially damage the camera if left in the stream. This resulted in a 70.7–hour gap in footage acquisition until the camera was redeployed on February 21, 2024. Following this deployment, the camera remained deployed until its final removal from the site on March 27, 2024. The final removal of the camera was made due to an incident of vandalism, which resulted in damage to the power and data cable (Figure 31). Despite streamflow supporting potential *O. mykiss* migration well after March, additional camera deployments were not made due to concern of additional vandalism and equipment damage occurring. Resource Conservation District of the Santa Monica Mountains (RCDSMM) staff reported that the Topanga Creek estuary initially breached on December 19, 2023 allowing for potential anadromous *O. mykiss* returns. This estuary breach is believed to have been sustained until December 24, 2023. The estuary is believed to have breached again on January 22, 2024 and connectivity between the stream and the ocean is known to have been sustained through at least May 9, 2024. Therefore, DIDSON deployment within Topanga Creek only captured a subset of all possible *O. mykiss* migration opportunities.

The visual field of all reviewed footage from the site matched the set window range of the camera 94.3% of the time. The field of view within the reviewed footage was diminished for a combined total of 62.7 hours or approximately 2.6 days. There were four periods in which there was no visual range in the reviewed footage, accounting for a combined 33.3 hours of footage. Two of these appear to have been associated with turbid water conditions. The other two instances were due to the camera being out of the water column, one of which was a result of diminished streamflow and water level and one of which is believed to be associated with the vandalism incident. Apart from these instances of reduced field of view, the entire width of the wetted channel at the site was able to be captured in the rest of the retained footage from the site.

A total of 420 targets met the criteria to be recorded in the footage that was reviewed from the Topanga Creek site. A total of 315 targets were classified as fish. Eight of the fish targets could not be confidently identified to a specific species, while the 307 other fish targets recorded were identified as *O. mykiss*. A portion of these *O. mykiss* were likely observed in the footage multiple times due to milling behavior. Measured lengths of targets identified as *O. mykiss* ranged from 13 to 36 cm in length with a mean length of 24.9 ± 0.2 cm. Therefore all *O. mykiss* targets are believed to have been non-anadromous residents or smolts. Unidentified fish targets ranged in length from 14 to 28 cm with a mean length of 21.1 ± 1.1 cm. Considering *O. mykiss* are the only known fish species within Topanga Creek currently known to exceed

lengths of 15 cm, it is likely that many, if not all, of the eight unidentified fish targets recorded were non-anadromous *O. mykiss* residents or smolts. Twenty-three of the recorded targets could not be confidently identified to a species; the greatest length was 23 cm, thus ruling out the potential of any of these targets being anadromous *O. mykiss*. All of these targets were moving downstream, so they may have been debris. Other recorded observations include waterfowl (n = 61), frogs (n = 19), and crayfish (n = 2).



**Figure 31:** Result of vandalism on March 27, 2024 to the DIDSON camera deployed at the Topanga Creek monitoring site.

### 3.3.2 Santa Monica Mountains BPG Redd Survey Monitoring Results

Thirty-eight redd surveys were conducted on 17 redd reaches within Santa Monica Mountains BPG streams during the 2023–2024 monitoring season between January 9, 2024 and May 22, 2024. The 17 reaches surveyed were established in previous monitoring seasons and only the two reaches on Zuma Creek included non-anadromous waters from manmade total fish passage barriers. On average, each reach was surveyed every 35.2 ± 2.9 days. Water visibility was diminished on five (13.2%) of the completed redd surveys, however, visibility depth was not recorded for these surveys (Table 15). One redd was observed in anadromous waters of Topanga Creek on February 12, 2024. This redd was only observed once and had a total area of 1605.2 $cm^2$, suggesting it was made by a non-anadromous life stage *O. mykiss*. Redd life could not be determined as the redd was no longer visible when the reach was surveyed again on March 25, 2024.

A total of 328 bankside observations of *O. mykiss* were made during redd surveys conducted within the BPG, all on Topanga Creek. Among the *O. mykiss* observed within Topanga Creek, 183 were in the 0–2 inch size class (55.8%), 117 were in the 2–4 inch size class (35.7%), 9 were in the 4–6 inch size class (2.7%), 5 were in the 6–8 inch size class (1.5%), 8 were in the 8–10 inch size class (2.4%), 3 were in the 10–12 inch size class (0.9%), and one was in the 12–14 inch size class (0.3%). A length estimate for two of the *O. mykiss* observed in the creek were not recorded (Table 18). Bankside observations of Two-Striped

Garter Snake (*Thamnophis hammondii*) (n=3) were also made during redd surveys conducted within Santa Monica Mountains BPG streams (Table 19).

At times, access was restricted to the four most upstream redd reaches located on Big Sycamore Canyon Creek due to vehicle use restrictions imposed by California State Parks on Big Sycamore Road. Big Sycamore Road is not paved and contains several Arizona crossings of the Big Sycamore Cayon Creek channel. Therefore, these reaches could not be surveyed as often or frequently as desired.

**Table 15:** Survey frequency and water clarity overview of redd surveys conducted within the Santa Monica Mountains BPG during the 2023–2024 monitoring season.

| Survey Reach | Redd Surveys Completed | Mean Survey Frequency | Survey Frequency SE | Diminished Water Visibility Surveys |
|---|---|---|---|---|
| Arroyo Sequit 1 | 3 | 37.0 | 3.0 | 0 |
| Arroyo Sequit 2 | 3 | 31.5 | 2.5 | 0 |
| Big Sycamore Canyon Creek 1 | 1 | NA | NA | 0 |
| Big Sycamore Canyon Creek 2 | 1 | NA | NA | 0 |
| Big Sycamore Canyon Creek 3 | 1 | NA | NA | 1 |
| Big Sycamore Canyon Creek 4 | 1 | NA | NA | 0 |
| Big Sycamore Canyon Creek 5 | 1 | NA | NA | 0 |
| Big Sycamore Canyon Creek 6 | 1 | NA | NA | 0 |
| Las Flores Canyon Creek | 1 | NA | NA | 0 |
| Malibu Creek 1 | 4 | 37.3 | 7.9 | 1 |
| Solstice Canyon 1 | 3 | 56.0 | 7.0 | 0 |
| Topanga Creek 1 | 4 | 29.0 | 2.7 | 1 |
| Topanga Creek 2 | 4 | 31.0 | 5.9 | 0 |
| Topanga Creek 3 | 5 | 33.0 | 8.1 | 0 |
| Trancas Canyon Creek 1 | 1 | NA | NA | 0 |
| Zuma Canyon 1 | 2 | 35.0 | NA | 1 |
| Zuma Canyon 2 | 2 | 35.0 | NA | 1 |
| **BPG Totals** | **38** | **39.9** | **15.3** | **5** |

### 3.3.3 Santa Monica Mountains BPG PIT Tagging Results

The electrofishing and PIT tagging efforts conducted over four days on Topanga Creek between December 4, 2023 to December 7, 2023 resulted in the capture of 37 *O. mykiss.* During the efforts, the mean water temperature was 11.4 ± 0.29 °C, mean dissolved oxygen (DO) was 11.2 ± 0.24 mg/L, and mean conductivity was 1.37 ± 0.01 µS/cm$^3$. The efforts were conducted within a total of 151 habitat units spanning approximately 1.3-mile section of

anadromous waters in Topanga Creek (Figure 32). Of the 151 habitat units electrofished, 99 (65.6%) were flatwaters, 28 (18.5%) were pools, and 24 (15.9%) were riffles. All captured *O. mykiss* were non-anadromous resident life stage and were successfully returned in good condition to the habitat units they were removed from. Of the 37 *O. mykiss* captured, 8 (21.6%) were captured in flatwaters and 29 (78.4%) were captured in pools. Thirteen trout were implanted with 12 mm HDX PIT tags and fifteen were implanted with 23 mm HDX tags. Four of the captured *O. mykiss* were released without tagging due to signs of injury and excessive stress. Five *O. mykiss* had been previously captured and tagged. Fork length (FL) measurements of the recaptured individuals show an average growth rate of 0.382 ± 0.014 mm/day since initial capture the previous winter. All newly tagged *O. mykiss* were also fin clipped for later genetic analysis. Fork length was only measured for 36 of the captured *O. mykiss*. Of the measured trout, mean fork length was 197.6 ± 8.21 mm. Additionally, 106 arroyo chub (*Gila orcutti*) were captured in these efforts.

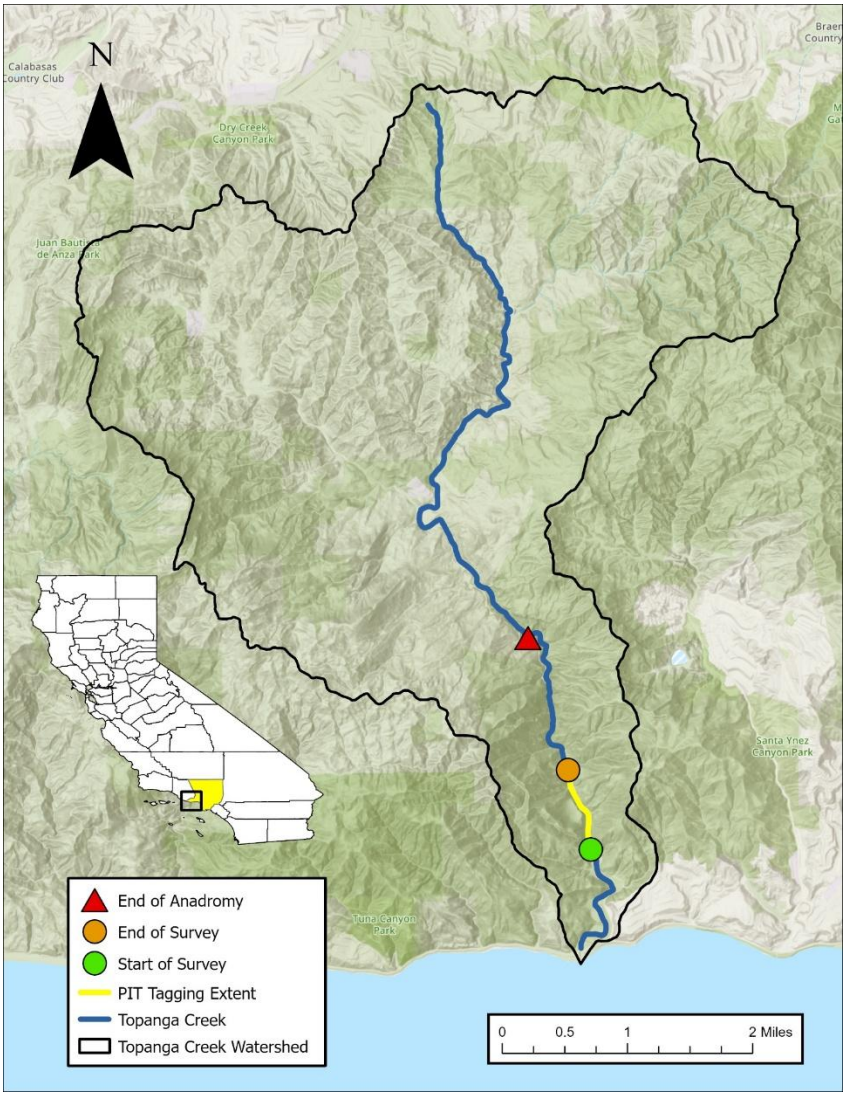



**Figure 32:** Extent of PIT tagging surveys conducted in Topanga Creek between November 25, 2024 and November 26, 2024.

### 3.3.4 Santa Monica Mountains BPG PIT Tag Array Monitoring Results

At least one of the PIT antennas was deployed at the Topanga Creek site for a total of 80 days between December 19, 2023 and March 27, 2024. The antennas experienced several gaps in functionality over the course of the monitoring season due to technical issues, damage from periods of elevated streamflow, and an instance of vandalism (Table 16). The ability to calculate antenna operational efficiency is limited to specific time periods when marker tag detections were produced. Antenna functionality was 100% between January 8 and 22, 2024. Between February 14 and 18, 2024 the single antenna deployed was operational 46.8% of the time. Between February 26 and March 20, 2024 the overall operational functionality of both antennas was 51.9%. It is assumed that diminished operational functionality was primarily a result of periodic loss of tunning in both antennas. A single PIT tagged *O. mykiss* was detected on the Topanga Creek PIT array antennas over the course of all periods of deployment during the 2023–2024 monitoring season. This detection occurred on February 27, 2024, but only one antenna was operational, so direction of movement was unable to be determined. The detected fish had a fork length of 93mm when it was tagged on December 7, 2022, approximately 2.1 miles upstream of where the antennas were deployed. This indicates the fish may have been a smolt.

**Table 16:** Summary of Topanga Creek PIT tag detection antenna deployments and operation during the 2023–2024 monitoring season.

| Date | Antennas Operating | PIT Tag Read Range (inches) | Notes |
|---|---|---|---|
| 12/18/2023 | 1 | ≈ 3–4 | The marker tag box was not operational during this initial deployment period, so the operational efficiency of the antenna was unable to be calculated. |
| 1/3/2024 | 2 | Downstream antenna ≈ 3–4<br>Upstream antenna was unable to be tuned. | The marker tag box for the downstream antenna continued to be non-operational. |
| 1/8/2024 | 2 | Downstream antenna ≈ 3–4<br>Upstream antenna ≈ 3–4 | Batteries were replaced on both marker tag boxes and they were tested to ensure operational functionality. |
| 1/23/2024 | 2 | Downstream and upstream antenna found out of tune. | Loss of tune in both antennas was a result of positional shifting during elevated streamflow event that occurred on January 22. |
| 1/24/2024 | 2 | Downstream antenna ≈ 1<br>Upstream antenna ≈ 1 | N/A |
| 1/31/2024 | 0 | N/A | Both antennas were removed to prevent damage from forecasted elevated streamflow event. No marker tag detections occurred between January 25 and 31, which is assumed to be loss of tunning from strong streamflow conditions. |
| 2/14/2024 | 1 | ≈ 2–4 | N/A |
| 2/18/2024 | 0 | N/A | Antenna removed to prevent damage from forecasted elevated streamflow event. |
| 2/26/2024 | 1 | ≈ 2–4 | N/A |
| 2/27/2024 | 2 | Downstream antenna ≈ 2–4<br>Upstream antenna ≈ 2–4 | N/A |
| 3/27/2024 | 0 | N/A | Both antennas were removed for the season due to occurrence of vandalism. No marker tag detections were recorded between March 20 and March 26, when the vandalism to the antennas is believed to have occurred. This appears to be the result of a mistake made in antenna settings during maintenance performed on March 20. |

## Results Tables

**Table 17:** Total targets recorded for each species observed (% of total targets recorded from each site) from review of DIDSON and ARIS camera footage obtained from each deployment location during the 2023–2024 monitoring season.

| Species | Santa Ynez River | Salsipuedes Creek | Ventura River | Carpinteria Creek | Topanga Creek |
|---|---|---|---|---|---|
| ***O. mykiss*** | 0 | 415 *(29.3%)* | 0 | 0 | 307 *(73.1%)* |
| **Catfish** | 3 *(0.09%)* | 397 *(30.1%)* | 49 *(0.05%)* | 0 | 0 |
| **Common Carp** | 172 *(50 %)* | 0 | 8,425 *(88.5%)* | 0 | 0 |
| **Sunfish** | 0 | 16 *(0.1%)* | 0 | 0 | 0 |
| **Unidentified Fish Targets** | 141 *(41%)* | 506 *(38.4%)* | 1,051 *(11%)* | 0 | *8 (1.1%)* |
| **Pacific Lamprey** | 4 *(1.2%)* | 0 | 0 | 0 | 0 |
| **California Newts** | 0 | 0 | 0 | 3 *(15%)* | 0 |
| **Crayfish** | 0 | 0 | 0 | 0 | 2 *(0.05%)* |
| **Frog** | 0 | 4 *(0.02%)* | 0 | 1 *(5%)* | 19 *(4.5%)* |
| **Turtle** | 0 | 8 *(0.05%)* | 1 *(0.001%)* | 2 *(10%)* | 0 |
| **Waterfowl** | 14 *(4.1%)* | 40 *(0.03%)* | 8 *(0.008%)* | 9 *(45%)* | 61 *(14.5%)* |
| **North American Beaver** | 6 *(1.7%)* | 19 *(0.1%)* | 0 | 0 | 0 |
| **Unidentified Terrestrial Species** | 0 | 0 | 0 | 1 *(5%)* | 0 |
| **Unknown Targets** | 4 *(1.2%)* | 11 *(0.08%)* | 75 *(0.07%)* | 7 *(35%)* | 23 *(5.5%)* |
| **Total Targets Recorded** | 344 | 1,416 | 9,609 | 23 | 420 |

**Table 18:** Total number of *O. mykiss* bankside observations by size class during all 2023–2024 monitoring season redd surveys within each *O. mykiss* BPG and streams within those BPGs. * Length estimates for two *O. mykiss* observed in Topanga Creek and one *O.* mykiss in Davy Brown Creek was not recorded.

| *O. mykiss* BPG | Stream | 0–2” | 2–4” | 4–6” | 6–8” | 8–10” | 10–12” | 12–14” | 14–16” | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Monte Arido Highlands | Davy Brown Creek | 265 | 6 | 23 | 32 | 15 | 4 | 1 | 1 | **348*** |
| Monte Arido Highlands | Munch Creek | 66 | 4 | 17 | 25 | 13 | 1 | 2 | 0 | **128** |
| Monte Arido Highlands | Murietta Creek | 30 | 14 | 48 | 28 | 21 | 4 | 2 | 0 | **147** |
| Monte Arido Highlands | Upper North Fork Matilija Creek | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | **3** |
| Monte Arido Highlands | Santa Paula Creek | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |

| *O. mykiss* BPG | Stream | 0–2” | 2–4” | 4–6” | 6–8” | 8–10” | 10–12” | 12–14” | 14–16” | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Monte Arido Highlands | Sisar Creek | 49 | 0 | 8 | 3 | 0 | 0 | 0 | 0 | **60** |
| Conception Coast | Gaviota Creek | 160 | 36 | 5 | 7 | 1 | 0 | 0 | 0 | **209** |
| Conception Coast | Maria Ygnacio Creek | 98 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | **101** |
| Conception Coast | Mission Creek | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| Conception Coast | Rattlesnake Creek | 0 | 2 | 4 | 1 | 0 | 0 | 0 | 0 | **7** |
| Santa Monica Mountains | Topanga Creek | 183 | 117 | 9 | 5 | 8 | 3 | 1 | 0 | **328*** |
| **-** | **Total** | **852** | **180** | **115** | **105** | **58** | **12** | **7** | **1** | **1,333** |

**Table 19:** Threatened and endangered aquatic vertebrate observations detected during redd surveys in the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains BPGs.

| Species Observed | Monte Arido Highlands | Conception Coast | Santa Monica Mountains | Total Observations |
|---|---|---|---|---|
| California Newt (*Taricha torosa*) | 0 | 226 | 0 | **226** |
| California Red-Legged Frog (*Rana draytonii*) | 4 | 22 | 0 | **26** |
| Southern Western Pond turtle (*Actinemys pallida*) | 10 | 118 | 0 | **128** |
| Three-spined Stickleback (*Gasterosteus aculeatus*) | 0 | 58 | 0 | **58** |
| Two-Striped Garter Snake (*Thamnophis hammondii*) | 6 | 7 | 3 | **16** |
| Coastal Rainbow/Steelhead Trout (*Oncorhynchus mykiss*) | 687 | 318 | 328 | **1,333** |

**Table 20:** Anadromous *O. mykiss* observations made within sonar camera footage acquired between 2011 and 2024. *Sonar camera deployments oversaw by the RCDSMM. **The two anadromous *O. mykiss* observations made at the Ventura River site during the 2020–2021 season were presumed to be the same fish.

| Monitoring Season | Salsipuedes Creek | Ventura River | Topanga Creek | Carpinteria Creek | Arroyo Hondo Creek | Santa Ynez River | Total Observations |
|---|---|---|---|---|---|---|---|
| 2011–2012 | N/A | N/A | 0 | N/A | 0 | N/A | **0** |
| 2012–2013 | 0 | 0 | 0* | N/A | N/A | N/A | **0** |
| 2013–2014 | 0 | 0 | 0* | 0 | N/A | N/A | **0** |
| 2014–2015 | N/A | N/A | N/A | N/A | N/A | N/A | **0** |
| 2015–2016 | 0 | 0 | 0* | 0 | N/A | N/A | **0** |
| 2016–2017 | 0 | 0 | 0* | 0 | N/A | N/A | **0** |

| Monitoring Season | Salsipuedes Creek | Ventura River | Topanga Creek | Carpinteria Creek | Arroyo Hondo Creek | Santa Ynez River | Total Observations |
|---|---|---|---|---|---|---|---|
| 2017–2018 | N/A | 0 | N/A | N/A | 0 | N/A | **0** |
| 2018–2019 | 2 | 1 | N/A | 0 | N/A | N/A | **3** |
| 2019–2020 | 0 | 0 | 1 | 0 | N/A | N/A | **1** |
| 2020–2021 | 0 | 2** | 0 | N/A | N/A | 5 | **7** |
| 2021–2022 | N/A | 2 | 1 | N/A | N/A | N/A | **3** |
| 2022–2023 | 0 | 0 | 0 | 0 | N/A | 5 | **5** |
| 2023–2024 | 2 | 0 | 0 | 0 | N/A | 0 | **2** |
| **Total** | **4** | **5**** | **2** | **0** | **0** | **10** | **21** |

# 4.0 DISCUSSION

## 4.1 Southern California *O. mykiss* VSP Indicators

The *O. mykiss* VSP indicators of abundance, productivity, spatial structure, and diversity have been difficult to assess for the Southern California DPS due to the many challenges associated with monitoring, sampling, and data acquisition that have been discussed. In addition to these challenges, the patchy distribution and overall current low abundance of *O. mykiss* within Southern California often results in low sample sizes, especially when compared to sample sizes obtained from monitoring efforts conducted in Northern California BPGs. These challenges have resulted in relatively generalized knowledge and viability trends regarding the Southern California steelhead DPS. Routine and repeated annual monitoring efforts within Southern California streams have only been implemented since the development of the CMP and its associated monitoring structure established from Fish Bulletin 180 (Adams et al. 2011). Over this time, monitoring efforts within the Southern California DPS have primarily been focused within areas that are easily accessible and generally known to support persisting populations of *O. mykiss*.

Prior to the implementation of modern monitoring efforts, the historical spatial distribution, productivity, abundance, and diversity of *O. mykiss* within Southern California have largely been ascertained from a conglomerate of sources, ranging from official reports and studies to incidental articles, field notes, public agency memoranda, personal correspondence, and interviews with knowledgeable individuals. When comparing historical sources of information to data obtained from modern CMP monitoring, it remains clear that current Southern California *O. mykiss* populations are a fraction of their historical levels. However, due to the relatively spatially focused nature of CMP monitoring, recent Southern California *O. mykiss* viability trends have primarily been drawn from stream- and watershed-centric data, with extrapolation to larger BPG and DPS scales. Fish Bulletin 182 (Boughton et al. 2022) attempts to account for this spatial and accessibility bias with a randomized rotation sampling scheme approach at a BPG-wide spatial distribution. This sampling scheme was implemented for low-flow surveys for the 2023–2024 monitoring season; however, BPG-level abundance estimations extrapolated from the data had high uncertainty due to all the *O. mykiss* observation occurring in only 8.1% of the short reaches sampled. As the sampling scheme outlined within Fish Bulletin 182 is implemented and established for the other CMP monitoring protocols, VSP assessments

will eventually become more representative and reflective of Southern California *O. mykiss* at BPG and DPS wide levels.

Modern CMP monitoring efforts within Southern California have documented the persistence of various *O. mykiss* populations while other populations appeared to have been significantly depressed and, in some cases, may have become extirpated from specific streams and watersheds. This includes San Antonio Creek in the lower Ventura River watershed, where the most recent indication of *O. mykiss* presence was via the observation of a potential anadromous redd in 2017 (Bankston 2018). Also, within the Ventura River watershed, *O. mykiss* have not been observed within North Fork Matilija Creek since 2018 apart from 13 *O. mykiss* that were released into the stream after being rescued from a drying section of Murietta Creek (CDFW unpublished data). Within the Conception Coast BPG, *O. mykiss* have not been observed in the Carpinteria Creek watershed since 2017 or within Arroyo Hondo Creek since 2021 (CDFW unpublished data). Between 2014 and 2021, a total of 4,786 *O. mykiss* were observed in Arroyo Hondo Creek via bankside observations during spawning surveys, this accounted for 95% of all bankside *O. mykiss* observations made within the Conception Coast BPG over this time (CDFW unpublished data). These declines are likely due to the combined impacts of prolonged drought conditions in Southern California between 2012 and 2016 and the Thomas (2018) and Alisal (2021) wildfires, which burned significant portions of the watersheds listed above.

*O. mykiss* have also shown their ability to persist through the impacts of drought and wildfire. This includes populations in Sisar Creek, Santa Paula Creek (Santa Clara River watershed), and non-anadromous portion of the Ventura River watershed upstream of the Matilija Dam, hereafter referred to as the Matilija Basin. The Thomas Fire impacted all of these areas, with the most significant impacts occurring within the Matilija Basin. These impacts were primarily due to a debris flow and general extreme sedimentation influx that occurred shortly following the fire as a result of approximately 6.5 inches of rain occurring over a 48–hour period (Lukashov et al. 2019). A significant decline in redd and *O. mykiss* observations were made in 2018 and 2019 within the Matilija Basin following these events. However, it appears the *O. mykiss* population within the basin has experienced some recovery with increases in redd and *O. mykiss* observations beginning in 2020 (Figure 33).

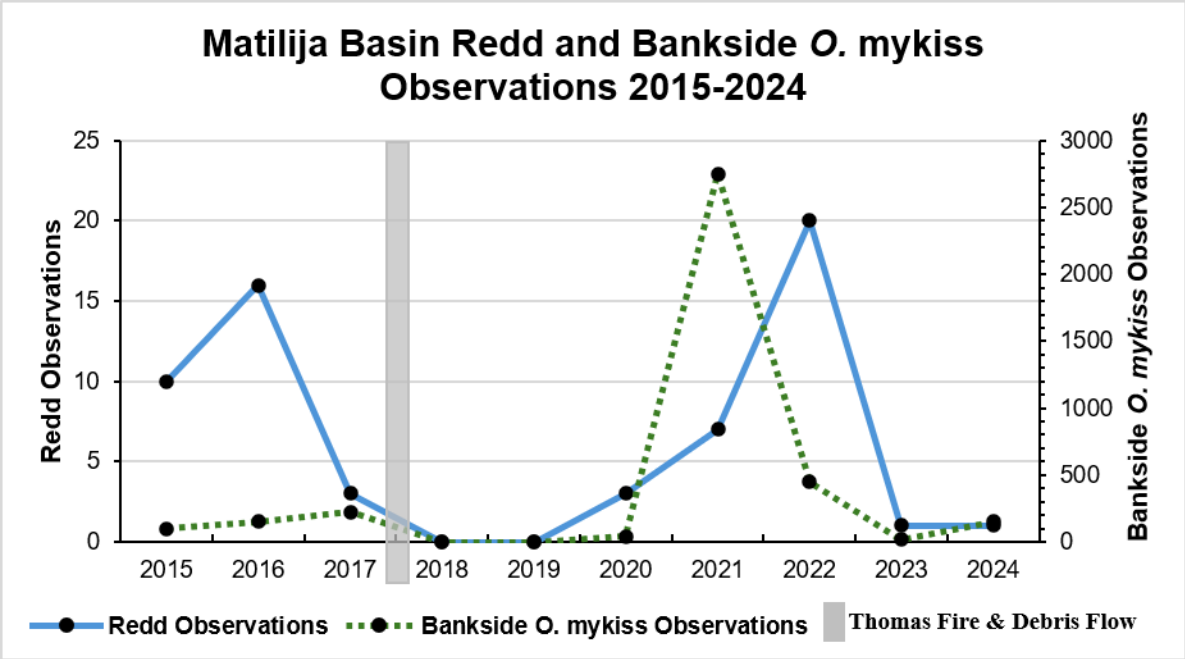



**Figure 33**: Redd and bankside *O. mykiss* observations made from redd surveys conducted in the Matilija Basin (non-anadromous waters of the Ventura River watershed) between 2015 and 2024. Murietta Creek was initially included in redd survey efforts within the basin during the 2019–2020 monitoring season, where 97.8% (n = 3,344) of all bankside observations and 93.9% (n = 31) of all redds within the basin have been observed since.

## 4.2 Multi-year Comparisons

### 4.2.1 Environmental Fluctuations and Impacts on *O. mykiss* and Habitat Conditions

As expected, back-to-back years of above average precipitation appear to have been beneficial to habitat conditions for *O. mykiss* and other aquatic species. Sustained periods of elevated streamflow during the recent rainy seasons resulted in extended windows of favorable conditions for *O. mykiss* migration and dispersal. This is reflected in the mean and median water year streamflow rates recorded by USGS streamflow gages when compared to below average precipitation 2020–2021 and 2021–2022 water years (Table 21). At the Carpinteria Creek and Santa Ynez River streamflow gage sites, streamflow persisted throughout the 2022–2023 and 2023–2024 water years. These sites have commonly experienced intermittent streamflow conditions in the past. The persistence of streamflow in 2023 and 2024 also indicates *O. mykiss* refugia habitat was more widespread and of higher quality during the respective dry seasons This is reflected by analysis of streamflow data acquired during the dry season (June – November) at the Ventura River and Salsipuedes Creek gage sites, where perennial streamflow occurs (Table 22).

**Table 21:** Mean and (median) rates of streamflow ($ft^3/s$) over the course of recent water years (October – September) documented at USGS streamflow gauge sites (USGS 2025).

| Water Year | Carpinteria Creek Gauge | Ventura River Gauge | Santa Ynez River Gauge | Salsipuedes Creek Gauge |
|---|---|---|---|---|
| 2020–2021 | 0.04 *(0.002)* | 2.3 *(2.0)* | 8.1 *(0)* | 4.1 (*0.3)* |
| 2021–2022 | 0.59 *(0.3)* | 10.0 *(5.0)* | 0.33 *(0)* | 1.4 *(0.09)* |

| Water Year | Carpinteria Creek Gauge | Ventura River Gauge | Santa Ynez River Gauge | Salsipuedes Creek Gauge |
|---|---|---|---|---|
| 2022–2023 | 15.8 *(0.4)* | 225.8 *(42.9)* | 619.3 *(80)* | 45.9 *(4.3)* |
| 2023–2024 | 13.8 *(0.2)* | 121.6 *(45.9)* | 359 *(30.5)* | 30.7 *(3.3)* |

**Table 22:** Mean and (median) rates of streamflow ($ft^3/s$) during dry season months (June – November) documented at USGS streamflow gauge sites (USGS 2025).

| Dry Season Year | Ventura River Gauge | Salsipuedes Creek Gauge |
|---|---|---|
| 2021 | 1.2 *(1.1)* | 0.1 (*0.07)* |
| 2022 | 3.1 *(3.1)* | 0.3 *(0.09)* |
| 2023 | 29.4 *(25.3)* | 2.8 *(1.8)* |
| 2024 | 27.0 *(21.6)* | 3.1 *(2.1)* |

Recent occurrences of elevated streamflow also contributed to substrate sorting and increased habitat unit depth from hydrodynamic scour. This was documented in Arroyo Hondo Creek, where long-term monitoring documented habitat recovery following the Alisal Fire in 2021 and unit depth increase following periods of elevated streamflow during 2022–2024 water years (Figure 34) (Cooper et al. 2024). Widespread presence and distribution of suitable *O. mykiss* spawning gravel was also observed in many habitat units within Arroyo Hondo Creek following the 2022 – 2024 water years (CDFW unpublished data). The impact of precipitation amounts on refugia habitat abundance, habitat quality, and wetted stream channel connectivity in Southern California streams is an important factor allowing *O. mykiss* to express their full life-history traits, thus conferring ability for individual survival and overall population health (Capelli et al. 2023). Diminished *O. mykiss* densities, spawning activity, habitat availability, and quality in Southern California was well documented during and following the prolonged drought conditions that persisted between 2012 and 2016 (Capelli et al. 2023, Bankston et al 2015, Dagit et al 2017, and Figure 35). A positive correlation has been shown to occur between *O. mykiss* over-summer survival and cumulative precipitation received the previous winter (Hwan et al 2017).

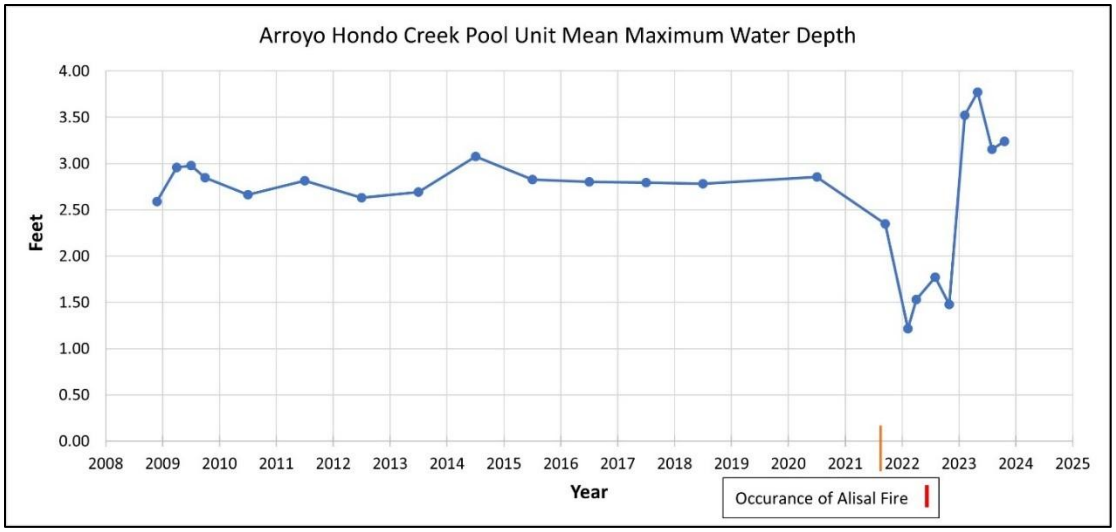



**Figure 34:** Documented changes to the mean maximum water depth measured within an Arroyo Hondo Creek pool habitat unit located at 34.489907, -120.143013 between 2008 and 2023 (Cooper et al. 2024). Decreased water depth was initially documented following the occurrence of the Alisal Fire in 2021. Increased water depth was documented following serval periods of elevated streamflow that occurred in 2023 due to above average precipitation. The increased water depth is representative of widespread scour observed in monitoring areas following periods of elevated streamflow in 2023 and 2024.

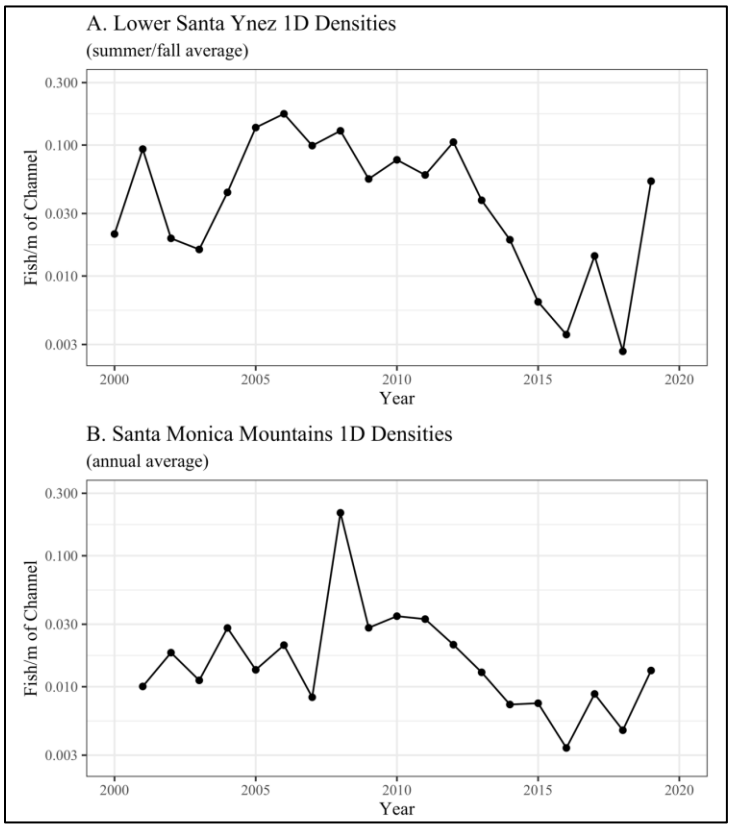



**Figure 35:** Low-flow densities of juvenile *O. mykiss* from annual one-dimensional, uncalibrated snorkel counts conducted within the Santa Ynez River and Santa Monica Mountain streams (Capelli et al. 2023).

However, due to limited *O. mykiss* observations made during the past two monitoring seasons it is currently difficult to make data driven interpretations of the impacts two consecutive wetter than average water years have had on *O. mykiss* populations within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains BPGs. Multiyear comparisons of CMP data is provided in the section below, which provides some insight into recent *O. mykiss* population trends. Impacts associated with back to back wetter than average water years may be better understood as additional monitoring data is collected in the coming monitoring seasons as population trends continue to play out. Climatic modeling efforts have indicated one potential impact associated with climate change is increased likelihood for greater variance in hydrological conditions from water year to water year across much of the west coast, with rapid shifts between periods of drought and wet conditions (Maharjan et al 2025). Furthermore, climate change is also projected to increase the likelihood for extreme dry-to-wet precipitation events to occur associated with persistent storm sequences that result in large precipitation accumulations over relatively short periods of time (Swain et al 2018). This increased tendency for the occurrence of hydrologic whiplash will likely have impacts on Southern California steelhead as pronounced fluctuations in aquatic habitat conditions also occur.

### 4.2.2 Santa Monica Mountains BPG Long Term Monitoring Results

#### *Topanga Creek) PIT Tagging and PIT Tag Array Efforts*

Santa Monica Mountain BPG PIT tagging efforts have now been focused and occurring within Topanga Creek for nearly two decades. With the exception of 2018, annual PIT tagging efforts have occurred within Topanga Creek since 2004. Over this time, 1,341 *O. mykiss* have been tagged. PIT detection arrays were initially deployed in 2009 and only 69 (5.1%) of the tagged *O. mykiss* have been detected. Antennas were unable to be deployed in 2018 and 2019 due to power supply issues. The most detections in a single year were 28 during the 2010-2011 monitoring season. There have been five seasons of antenna deployments in which no detections were made. Between 2012 and 2016 only two detections occurred. This can primarily be attributed to persistent drought conditions over this time that resulted in limited adequate streamflow conditions for *O. mykiss* opportunities to move through the stream channel and past the location of the array. Confident directionality has been unable to be assigned to 31 (44.9%) of the 69 *O. mykiss* detections that have occurred at the Topanga Creek PIT tag array site. Of the 38 *O. mykiss* directionality has been determined for, only two (5.3%) were moving upstream. The annual mean *O. mykiss* detection rate for the site is 4.9 $\pm$ 2.1%. During the 2023-2024 monitoring season, the single *O. mykiss* detected is assumed to have been moving downstream, but this could not be confirmed as the detection only occurred on one antenna.

#### *Topanga Creek Sonar Camera Monitoring Efforts*

Topanga Creek sonar camera monitoring efforts began in 2012 and have now occurred over a total of ten monitoring seasons. The RCDSMM conducted these monitoring efforts for four seasons between 2013 and 2017. No camera deployments occurred within Topanga Creek during the 2014–2015, 2017–2018, and 2018–2019 seasons. There have been two anadromous *O. mykiss* observations made with sonar cameras in Topanga Creek, one in 2020 and the other in 2022 (Table 20).

#### *Santa Monica Mountains BPG Redd Survey Efforts*

Redd surveys within the Santa Monica Mountain BPG have been conducted by CDFW since the 2019–2020 monitoring season. Prior to this, the RCDSMM had been the primary

organization conducting *O. mykiss* monitoring within the Santa Monica Mountains BPG. Over the past several years, *O. mykiss* observations and spawning activity have only occurred within Topanga Creek. The most recent redd observation made outside of Topanga Creek occurred in Malibu Creek in March 2020 (CDFW unpublished data). The last time an *O. mykiss* was observed outside of Topanga Creek was on April 3, 2018, also within Malibu Creek (RCDSMM Snorkel Data 2019). Fifty-six *O. mykiss* redds have been observed on Topanga Creek between 2010 and 2024 (Dagit et al. 2018, CDFW data 2019–2024). Only three of these redds have potential of having been constructed by anadromous *O. mykiss*, one in 2011, one in 2012, and one in 2014 (Dagit et al. 2018). The annual average of redd observations made within Topanga Creek is 3.9 ± 0.8 redds/year with peak redd counts occurring in 2013 and 2014 (9 redds/year, Figure 12). No redds were observed in Topanga Creek during the 2016–2017 and 2022–2023 monitoring seasons (Figure 36). Full comparison of *O. mykiss* bankside observations since 2010 is limited in that the RCDSMM only counted young of the year (YOY) *O. mykiss* observations while conducting redd surveys. Between 2010 and 2017 the mean number of YOY observed was 115.6 ± 31.3. The highest number of YOY observed occurred in 2010 (n=283) and the least occurred in 2016 (n=17). Between the 2019–2020 and 2023–2024 monitoring seasons the mean number of *O. mykiss* observed was 192.2 ± 51.2. The highest number of bankside *O. mykiss* observations during this time frame occurred during the 2023–2024 monitoring season (n=328) and the least observations occurred during the 2022–2023 monitoring season (n=22).

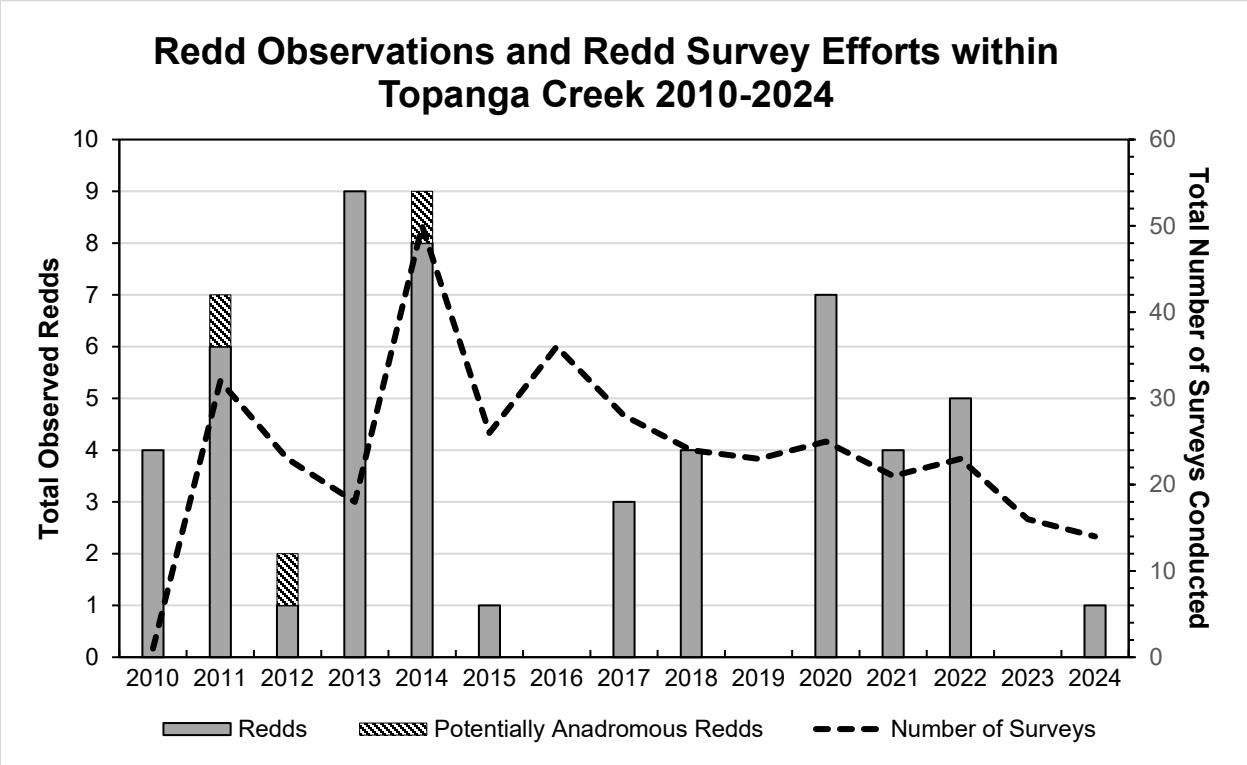



**Figure 36**: Observed *O. mykiss* redds in Topanga Creek in relation to number of surveys conducted each monitoring season from 2010–2024. Redds greater than 1.6 meters in total length (pot length plus tail spill length) may be from anadromous individuals based on redd length observation in northern California (Zimmerman & Reeves 2000).

### 4.2.3 Monte Arido Highlands BPG Long Term Monitoring Results

*Ventura River Watershed PIT Tagging and PIT Tag Arrays*

PIT tag arrays have been deployed in the Ventura River watershed since 2017. PIT tag arrays were installed in North Fork Matilija Creek in 2017 and 2018, in the mainstem Ventura River 2018–2024, and in San Antonio Creek in 2020–2024. A detection of PIT tagged *O. mykiss* has yet to occur within the watershed. One primarily factor contributing to this is nearly all *O. mykiss* that have been PIT tagged in the watershed, have been located within the Matilija Creek basin, upstream of the Matilija Dam. For these fish to potentially be detected at any of the PIT array sites operated within the watershed they would need to successfully gain downstream passage of the Matilija Dam. Specific efforts to tag *O. mykiss* within the Matilija Basin occurred in 2016, 2017, and 2021, resulting in a total of 177 tagged fish. Opportunistic tagging has also occurred periodically in the Matilija Basin in conjunction with efforts to relocate *O. mykiss* from areas of drying habitat. One of these efforts in 2022, resulted in the relocation of 13 *O. mykiss* to the North Fork of Matilija Creek, which is within anadromous waters and therefore increased their potential to successfully migrate downstream and be detected at an array site in the watershed. Prior to this, 2008 was the last time *O. mykiss* were specifically tagged and released in anadromous waters within the Ventura River watershed (Scott Cooper; Casitas Municipal Water District personal communication). Unfortunately, estimates for *O. mykiss* marine survival, outmigration rates, anadromous fraction, or abundance within the Ventura River watershed cannot be produced due to the lack of PIT tag detections at the Ventura River watershed PIT arrays.

*Ventura River Watershed Redd Surveys*

Redd surveys have been conducted within the Ventura River watershed annually since the 2013–2014 monitoring season. The single redd observed within the Ventura River watershed during the 2023–-2024 monitoring season matches the number of redds observed during the 2022–2023 monitoring season. Both redd observations occurred within non-anadromous Murietta Creek, where 93.9% (n=31) of all redds have been observed in the watershed since the occurrence of the Thomas Fire in 2018. Over this time, only 5.9% (n=32) of all redd surveys conducted in the Ventura River watershed occurred in Murietta Creek. Additionally, redd surveys were not conducted in Murietta Creek prior to the 2019–2020 monitoring season. This indicates Murrietta Creek has played a critical role in the persistence of *O. mykiss* in the Matilija Basin following the impacts of the Thomas Fire. The only other locations redds have been observed within the Ventura River watershed since the Thomas Fire are Upper North Fork Matilija Creek (n=1) and the Ventura River (n=1), both of which were observed in 2022. Bankside observations of *O. mykiss* made during redd surveys have also been concentrated within Murietta Creek, with 97.8% (n=3,344) of all observations occurring there since the Thomas Fire. Furthermore, since this fire, 100% (n=3,418) of bankside *O. mykiss* observations and all but one redd observation made within the Ventura River watershed have occurred within the Matilija Basin.

Prior to the occurrence of the Thomas Fire, *O. mykiss* were distributed throughout a greater portion of the Ventura River watershed with *O. mykiss* observations and redds commonly made outside of the Matilija Basin, in anadromous waters (Figure 37). These observations primarily occurred within San Antonio Creek and the North Fork of Matilija Creek, with some observations also made within the Ventura River downstream of the confluence with San Antonio Creek. However, the majority of observations still occurred in the upper watershed,

with 88% of redds and 94% of bankside *O. mykiss* observations occurring within Matilija Creek, Upper North Fork Matilija Creek, and the North Fork of Matilija Creek between 2013 and 2017 (Bankston 2018). This is despite no redd surveys being conducted within the Matilija Basin prior to the 2014–2015 monitoring season. Between the 2014–2015 and 2016–2017 monitoring seasons, 72% (n = 476) of bankside observations and 50% (n = 29) of documented redds were within the Matilija Basin. In general, spatial distribution of *O. mykiss* bankside and redd observations across all years of monitoring in the Ventura River watershed (i.e., 2013–2024), have occurred in the upper watershed, accounting for 98.1% (n = 4,217) of bankside observations and 93.4% (n = 115) of redd observations. This is not surprising as these streams have been well documented to contain widespread perennial streamflow, reliable quality habitat conditions, and overall are less impacted by development than much of the lower watershed. Habitat conditions were degraded throughout the upper watershed following the occurrence of the Thomas Fire and debris flows that followed it resulting in a concentration of redd and bankside observations within Murietta Creek. The concentration of observations within the upper portion of the watershed both prior to and after the Thomas Fire indicates the area is critical to the persistence of *O. mykiss* in the Ventura River watershed. It also serves as one of many justifications for the remediation of fish passage barriers that limit and prevent anadromous returns to this portion of the watershed.

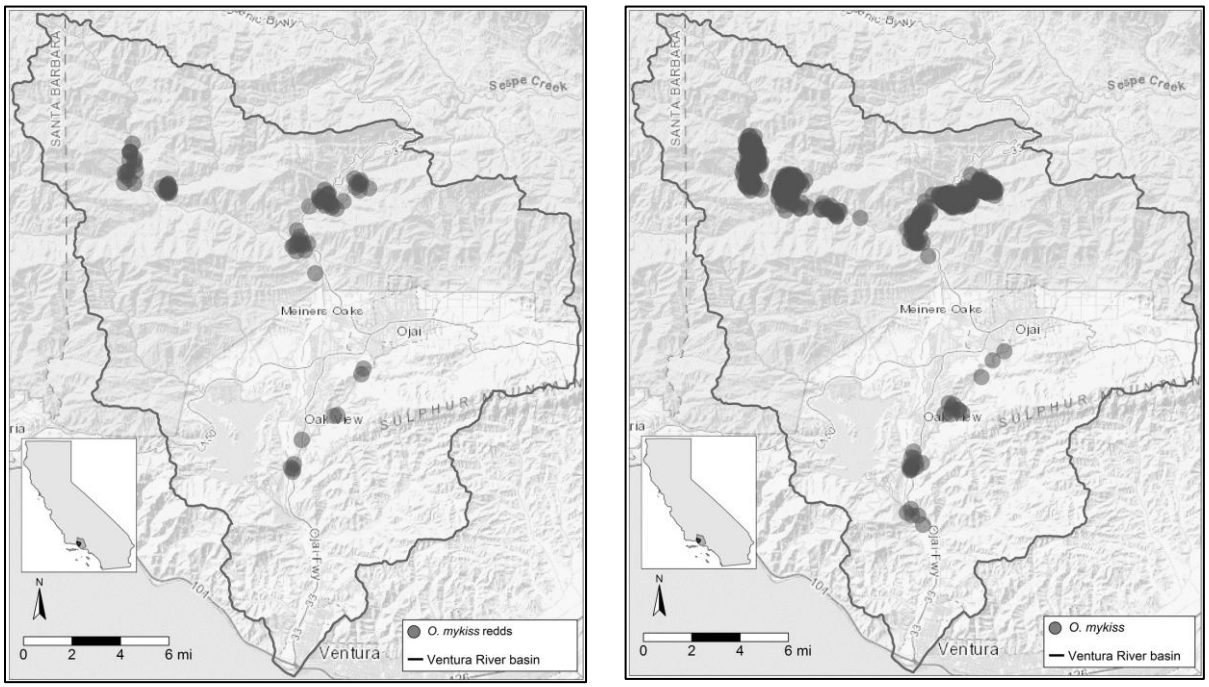



**Figure 37:** Distribution of *O. mykiss* redd observations (left) and individual bankside observations (right) made during spawning surveys conducted within the Ventura River watershed between 2013 and 2017, prior to the occurance of the Thomas Fire (Bankston 2018).

The mean number of annual bankside *O. mykiss* observations made within the Ventura River watershed between 2015 and 2024 is 431.1 ±**Error! Reference source not found.** 259.5. The total number of *O. mykiss* bankside observations decreased by two orders of magnitude following the Thomas Fire during the 2017–2018 monitoring season (*n* = 2) and dropped to zero during the 2018–2019 season (Figure 38). The mean number of annual redds observed within the watershed between 2013 and 2024 is 9.2 ± 2.6. Only one of the 110 redds documented

within the watershed over this time is believed to have been made by an anadromous *O. mykiss*. This determination is based on the size of the redd, which was observed within the Ventura River in 2022 approximately 4.9 stream miles upstream of the Pacific Ocean. The redd had a measured area of 4,221 cm² and total length of 120 cm. The mean area of all other redds observed within the watershed over time is 1,231.6 ± cm² and mean total length of all other redds is 67.9 ± 2.5 cm.

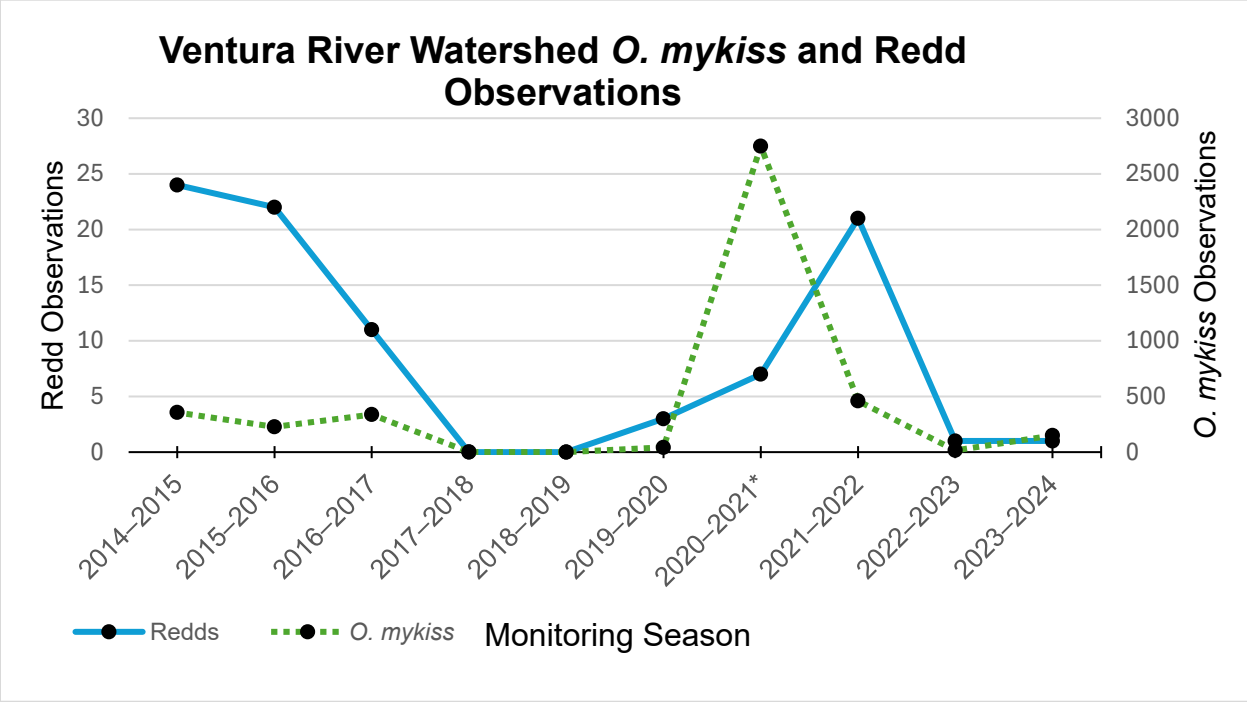



**Figure 38**: Monitoring season redd and bankside *O. mykiss* observations made within the Ventura River watershed between the 2014–2015 and 2023–2024 monitoring seasons. *2,390 (86.9%) of the *O. mykiss* observed during the 2020-2021 monitoring season were young of the year.

**Table 23:** Pairwise t-test comparison of mean redd life between survey years within the Ventura River watershed using Bonferroni adjusted alpha levels (α = 0.005). Significant differences are bolded. 2013 was excluded due to uncertainty of redd ages. 2023 and 2024 were excluded due to being unable to calculate the lifespan of the single redd observed. No redds were observed in 2018 or 2019.

| Year | 2014 | 2015 | 2016 | 2017 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| **2015** | 0.3111 | – | – | – | – | – |
| **2016** | 1.0000 | 1.0000 | – | – | – | – |
| **2017** | 1.0000 | **0.0030** | 0.2142 | – | – | – |
| **2020** | 0.0552 | 1.0000 | 0.2885 | **0.0020** | **–** | **–** |
| **2021** | 1.0000 | **0.0067** | 0.3908 | 1.0000 | **0.0034** | **–** |
| **2022** | 1.0000 | 1.0000 | 1.0000 | 0.0906 | 0.2637 | 0.1822 |

### *Ventura River Sonar Camera Monitoring*

Ventura River sonar camera monitoring efforts began in 2013 and have now occurred for 11 monitoring seasons. No camera deployments occurred during the 2014–2015 monitoring

season due to lack of suitable streamflow conditions for potential anadromous *O. mykiss* returns as a result of drought conditions at the time. There have been a total of five anadromous *O. mykiss* observations made at the Ventura River site (Table 20). However, the two observations made during the 2020-2021 monitoring season were presumed to be the same fish.

### *Santa Ynez River Sonar Camera Monitoring*

Santa Ynez River sonar camera monitoring efforts began in 2021 and have now occurred for three monitoring seasons. A camera was not deployed during the 2021–2022 monitoring season due to security concerns with the established deployment site at that time. Despite only three seasons of camera deployment within the Santa Ynez River, 10 (47.6%) of the 21 anadromous *O. mykiss* observations that have occurred across all sonar camera monitoring sites were made within the river (Table 20). This may be an indication the Santa Ynez River continues to support one of the largest anadromous *O. mykiss* runs within Southern California. Identifying fish species captured from the Santa Ynez River site has been complicated by a lack of knowledge of what fish species are typically present at the site. Two instances of snorkel surveys were conducted at the site in 2024, but persistent turbid conditions prevented the ability to identify fish to the species level.

### *Salsipuedes Creek Sonar Camera Monitoring*

Salsipuedes Creek sonar camera monitoring efforts began in 2013 and have now occurred for nine monitoring seasons. No camera deployments occurred during the 2014–2015, 2017–2018, and 2021–2022 monitoring seasons. A total of four anadromous *O. mykiss* observations have been made in the stream (Table 20). This previous monitoring season was interesting due to 134 *O. mykiss* targets observed entering and exiting the footage acquired from the site with an estimated length greater than or equal to 40cm. This meets the CDFW length criteria to be classified as the anadromous life stage of the species. These targets were observed between March 3, 2024 and May 12, 2024. Measured lengths of all these targets ranged from 36cm to 54cm with a mean length of 44.2 ± 0.16cm. The relatively low variation in length of the targets make it difficult to determine how many separate anadromous *O. mykiss* were actually observed. This is further complicated by 33 observations of targets classified as *O. mykiss* with a mean length between 36cm and 40cm between February 9, 2024 and May 12, 2024. Furthermore, 22 of the entries of *O. mykiss* targets with mean estimated length between 36cm and 40cm were documented on the same day as *O. mykiss* targets with a mean estimated length greater than 40cm. There was never an instance in which two *O. mykiss* targets with a mean length greater than 36cm were documented in the camera's field of view at the same time, indicating many of the observed *O. mykiss* targets were the same fish swimming back and forth in and out of the camera's frame of view.

One metric that is often helpful in determining how many separate anadromous *O. mykiss* were recorded in footage captured from the Salsipuedes Creek site are the results of *O. mykiss* migrant trapping efforts conducted by COMB approximately 200 feet upstream of the sonar camera deployment location. COMB's migrant trapping efforts were conducted for a total of 63 days between the following dates, February 12–17, 2024, March 8–23, 2024, March 25–29, 2024, April 8–12, 2024, and April 17–May 22, 2024 (COMB 2025). The COMB trap was deployed for approximately 63.7% of the time a sonar camera was deployed at the site and resulted in a total of 39 *O. mykiss* captured, nine of which had a measured length of 40cm or greater (COMB 2025). COMB classified two of the captured *O. mykiss* as anadromous, based on size, appearance, scale sample analysis, and direction the fish were moving when captured

(COMB 2025 & Tim Robinson; COMB, personal communication). The two *O. mykiss* classified as anadromous by COMB were moving upstream, one of which was captured on March 22, 2024, measured at 60.8cm and another captured on April 17, 2024 measured at 45.8cm (COMB 2025). Two other *O. mykiss* captured moving downstream on February 12 and 14, 2024 were very silver in color suggesting they may have come from the ocean prior to the initial deployment of the trap (COMB 2025). These *O. mykiss* were measured to be 35.7cm and 44cm respectfully (COMB 2025). The *O. mykiss* measured at 35.7cm is below the CDFW length threshold of 40cm to be considered anadromous, but this doesn't necessarily indicate the fish was not anadromous. The 40cm and greater length designation utilized to distinguish an *O. mykiss* as being the anadromous life stage of the species comes from California freshwater sport fishing regulations Fish and Game Code 5.88, Part A. This designation was established as a simple to follow standalone metric for *O. mykiss* life stage determination by anglers, wardens, and fisheries observers. This metric is likely even more applicable for *O. mykiss* life stage determination when observations are made in sonar camera footage, which provides far less detail for life stage determination than direct in person observation affords when fish are captured. In reality, this length metric is not a robust stand along data point for distinguishing *O. mykiss* as being the anadromous life stage of the species, as appears to have been made evident by the observations and life stage classifications for the *O. mykiss* captured by COMB at their Salsipuedes Creek trapping site.

Yet another factor that can complicate *O. mykiss* life stage determination even when a fish is directly observed through capture is the tendency for anadromous *O. mykiss* to revert to an appearance that is resemblant of their non-anadromous freshwater life stage once they have returned and spent time within a freshwater environment and thus the only way to confidently confirm anadromous life stage of an *O. mykiss* is through chemical composition analysis of otoliths or ear bones (US Fish and Wildlife Service 2025). It appears that some of the large *O. mykiss* captured by COMB and observed in Salsipuedes Creek sonar camera footage could have been anadromous returns that experienced reversion to freshwater life stage appearance characteristics. This possibility is supported by fish growth rate analysis COMB conducted via examination of scales samples collected from *O. mykiss* captured in their trap. Their scale analysis indicated *O. mykiss* captured on February 12 and 14, 2024 and April 17, 2024 displayed growth rates significant enough to potentially be indicative of growth associated with presence in the ocean (COMB 2025). These *O. mykiss* ranged in size from 35.7 cm to 45.8 cm and COMB ultimately classified them as non-anadromous adults due to ambiguity in their appearance and lack of confidence they had in fact returned from the ocean (COMB 2025). Additionally, each of these fish showed clear and similar annuli development indicative of being in a freshwater environment between the 2020 and 2023 water years (COMB 2025). Conditions for anadromous returns and over summering anadromous *O. mykiss* were favorable with the back to back wetter than average water years in 2023 and 2024, therefore further supporting the possibility that more than two of the large *O. mykiss* observed and captured at the Salsipuedes Creek site could have been anadromous.

Another complication in attempting to determine the number of anadromous *O. mykiss* that were present at the Salsipuedes Creek site is lack of correlation between *O. mykiss* observations made on sonar camera footage obtained from the site and the time *O. mykiss* were documented within the COMB trap (Table 24). For example, no *O. mykiss* were documented in the ARIS footage captured from February 12 and 14, 2024 and April 17, 2024 suggesting the *O. mykiss* captured in COMB's trap on these dates evaded the visible window of

the camera. The far bankside of the stream channel was consistently visible in the recorded footage obtained from each of these dates as well as the days preceding and following each of these dates, suggesting these *O. mykiss* were able to swim below the camera's field of view despite streamflow at the site during this time frame being approximately 50 $ft^3/s$ on February 12 and 14 and 40 $ft^3/s$ on April 17 (USGS 2024). These rates of streamflow do not suggest that a significantly deep column of water was present in the channel during these timeframes that could have contributed to fish being able to evade the field of view of the ARIS camera that was deployed. Another, perhaps even more stark indication of sonar camera field of view limitations at the site is the anadromous *O. mykiss* documented in COMB's trap on March 22, 2024 appears to have evaded the sonar camera's field of view. All of the *O. mykiss* targets in the sonar camera footage from that date were observed after the anadromous *O. mykiss* was documented in COMB's trap. The anadromous *O. mykiss* captured in the trap was moving upstream, therefore if an observation of this fish was made in the sonar camera footage, it would have occurred prior to it being trapped. Furthermore, none of the *O. mykiss* targets documented in the sonar camera footage have an estimated length that potentially matches the actual measured length (60.8cm) of the anadromous *O. mykiss* captured by COMB on March 22. Between March 3 and 21 the largest estimated mean length of an *O. mykiss* target in the sonar camera footage was 50.6cm, which was observed on March 9, 2024. Evasion of fish from the sonar camera field of view at the Salsipuedes Creek site is likely due to scour occurring within the streambed substrate at the site following the significant streamflow events that occurred during the 2023 and 2024 water years, thus allowing for greater water depth in that portion of the channel. This scour has caused the stream channel at the camera deployment location to resemble a "V" shape as opposed to a "U" shape, with considerably greater water depth present in the center of the channel than at the margins of the wetted channel. In review of sonar footage obtained from the site, this clearly created a gap in the camera's acoustic sight along the bottom center portion of the channel, expect during low, base rates of streamflow. Lack of acoustic field of view at the center of the channel is also apparent in that fish were often observed diving out of view or appearing into view from the center of the image. The possibility of fish passage occurring out of the camera's field of view further complicates attempts to determine how many separate anadromous *O. mykiss* were actually observed in the footage acquired from the site and likely impacts the accuracy of any net movement estimate calculation. One conclusion that is likely safe to draw is that *O. mykiss* present at the Salsipuedes Creek monitoring site during the 2023-2024 monitoring season appear to have exhibited milling behavior resulting in repeated observations of the same fish in the acquired sonar footage. This appears to have been the case for observations of resident and anadromous life stage *O. mykiss*. This milling behavior could be influenced by the presence of the COMB trap acting as a barrier a short distance upstream of the sonar camera deployment location. Another contributing factor may be the habitat unit the sonar camera was deployed within became more suitable for *O. mykiss* rearing due to increased scour and water depth. This places renewed emphasis on sonar camera positioning to ensure acquisition of quality footage with good acoustic view of the entire wetted channel. Ultimately CDFW concurs with COMBs detailed analysis of the *O. mykiss* they captured in their trap and the determination that two of those fish were the anadromous life stage.

**Table 24:** Comparison of *O. mykiss* with anadromous traits and appearance captured at the COMB migrant trap at the Salsipuedes Creek monitoring site to dates those *O. mykiss* were potentially observed in the ARIS sonar camera footage captured from the site during the 2023–2024 monitoring season. Judgement is based on estimated size measurements of *O. mykiss* obtained from ARIS software, direction of fish movement, and dates of observation within the footage. *Scale analysis indicates growth rates potentially associated with presence in the ocean (COMB 2025).

| ***O. mykiss* COMB Trap Capture Date** | **COMB Measured Size** (cm) **& Life Stage Determination** | **Direction of Movement into & out of COMB Trap** | **Date(s) the Captured *O. mykiss* was Potentially Observed in ARIS Footage** *(Additional Context)* |
|---|---|---|---|
| February 12 | 35.7 Adult* | Downstream | **February:** 9 *COMB trap initially deployed on February 12 so footage observation on February 9 could have been of this fish* |
| February 14 | 44 Adult* | Downstream | **March:** 3, 6, 12, 14, 20 **April:** 3, 6, 10, 11, 13, 15 **May:** 7, 9, 12 |
| March 9 | 40.5 Adult | Downstream | **March:** 3, 6, 9 (length and timing match), 12, 14, 20 *COMB trap was deployed on March 8 so footage observations on March 3 & 6 could have been of this fish* **April:** 3, 6, 10, 11, 13, 15 **May:** 7, 9, 12 |
| March 11 | 43.4 Adult | Downstream | **March:** 9, 11 (length and timing match), 12, 14, 18, 20, 21, 22, 23, 24, 25 April: 3, 6, 10, 11, 13, 15 **May:** 7, 9, 12 |
| March 17 | 40 Adult | Downstream | **March:** 17 (length and time match), 18, 20, 21, 22, 23, 24, 25, 28 April: 3, 6, 10, 11, 13, 15 May 7, 9, 12 |
| March 22 | 60.8 Anadromous | Upstream | *The largest estimated measurement of an O. mykiss target made from all ARIS footage acquired from the site was 54cm indicating this fish may have fully evaded the ARIS camera field of view* |
| March 23 | 42.5 Adult | Downstream | **March:** 23 (length and timing match), 24, and 25, 28 **April:** 3, 6, 10, 11, 13, 15 **May:** 7, 9, 12 |
| March 29 | 42.3 Anadromous | Upstream | **March:** 18, 20, 21, 22, 23, 24, 25, 28 **April:** 3, 6, 10, 11, 13, 15 |
| April 17 | 45.8 Adult* | Upstream | **April:** 3, 6, 10, 11, 13, 15 |
| April 19 | 42.8 Adult | Downstream | **April:** 23 **May:** 7, 9, 12 |

### 4.2.4 Conception Coast BPG Long Term Monitoring Results

*Carpinteria Creek Sonar Camera Monitoring*

Carpinteria Creek sonar camera monitoring efforts began in 2014 and have now occurred for a total of seven monitoring seasons. No camera deployments occurred during the 2014– - 2015, 2017– - 2018, 2020– - 2021, and 2021– - 2022 monitoring seasons. No anadromous *O. mykiss* observations have been made in the stream (Table 20).

*Conception Coast BPG Redd Surveys*

The 2023–2024 monitoring season was not the first instance of no redds being observed within the Conception Coast BPG. There was also absence of redd observations during the 2014–2015 and 2020–2021 monitoring seasons, however it should be noted that fewer redd surveys were conducted in fewer Conception Coast BPG streams during the 2015 monitoring season. Additionally, only 24 of the 44 (54.5%) long reaches redd surveys were conducted during the 2023–2024 monitoring season had been surveyed during previous monitoring seasons. In total, 36 redds have been observed within the Conception Coast BPG since redd surveys began within the BPG during the 2014–2015 monitoring season (Figure 39). The mean number of redds observed within the BPG per monitoring season is 3.6 + 1.8. Despite the absence of redd observations during the 2023–2024 monitoring season, 318 bankside *O. mykiss* observations were made within the Conception Coast BPG. Dating back to the 2014–2015 monitoring season, the mean number of annual bankside observations within the BPG is 553.9 ± 233.6.

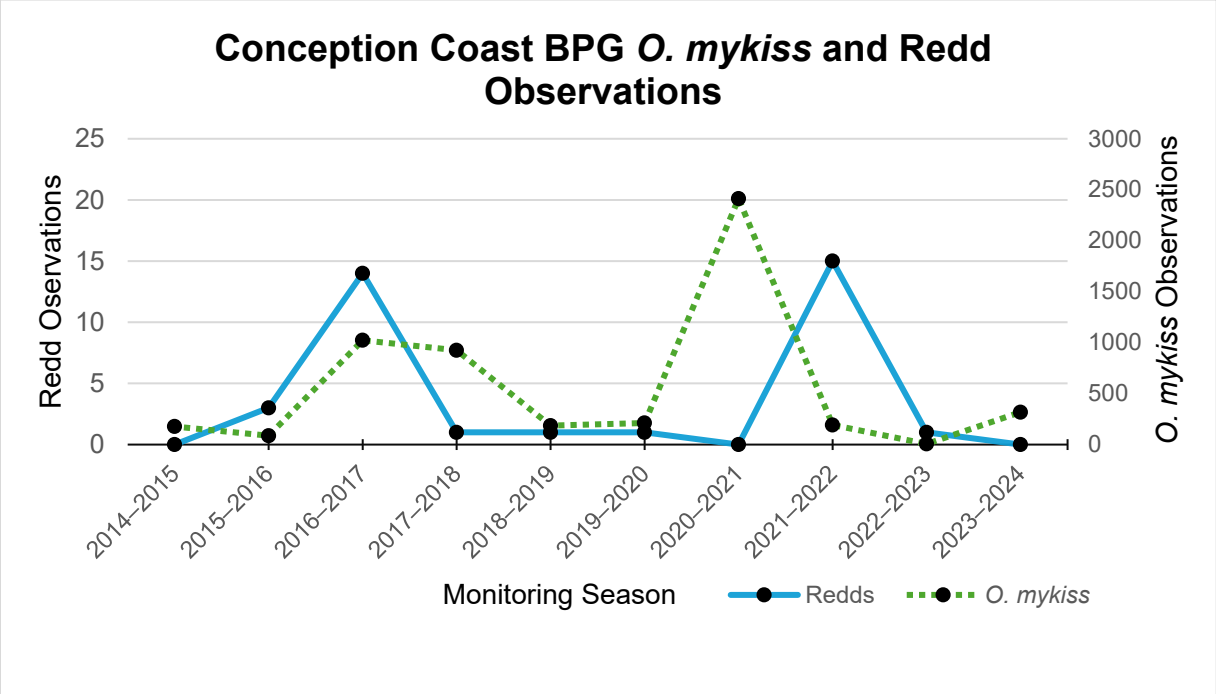



**Figure 39**: Monitoring season redd and bankside *O. mykiss* observations made within the Conception Coast BPG between the 2014–2015 and 2023–2024 monitoring seasons.

Redd and bankside *O. mykiss* observations have typically been concentrated to specific Conception Coast watersheds. Prior to the 2021–2022 monitoring season, all redds observed within the BPG and 95% of bankside observations occurred in Arroyo Hondo Creek. Part of this can be attributed to minimal spatial distribution of redd surveys within the BPG over this time period. No redd or *O. mykiss* have been observed within Arroyo Hondo Creek since the 2020–

2021 monitoring season. In October 2021, the Alisal Fire burned more than 17,000 acres along the Gaviota Coast, including approximately 95% of the Arroyo Hondo Creek watershed (The Land Trust for Santa Barbara County 2021). This led to significant sedimentation loads within the Arroyo Hondo Creek significantly degrading habitat quality and suspected extirpation of *O. mykiss* from the watershed. Similar wildlife impacts occurred within the Carpinteria Creek watershed following the Thomas Fire in 2018. As in the case of Arroyo Hondo Creek, *O. mykiss* and redds have not been observed within the watershed since, thus showing the significant impact wildfires can have on *O. mykiss*.

## 4.3 Monitoring Methods Considerations

### 4.3.1 Environmental Impacts on Monitoring Efforts

Efforts to conduct *O. mykiss* monitoring within Southern California streams are often challenged by a variety of fluctuating environmental conditions, including flashy streamflow, changes in stream morphology, greater water depths, and increased sedimentation and turbidity. In addition to notable pulses of streamflow during the 2023 – 2024 monitoring season, streamflow was also prolonged over the dry season, in part due to consecutive wetter-than-average years from 2022 through 2024As usual, flashy streamflow regimes challenged abilities to deploy sonar cameras and PIT array antennas and keep them functional when deployed. For example, a PIT antenna was only functional for a combined 10.6 days or 15.8% of all deployment the time at the Ventura River site and only 9.6 days or 12.5% of all deployment time at the San Antonio Creek site. These factors, likely are a contributing factor to the absence of detections at these array sites. PIT arrays and sonar cameras were precautionarily removed from stream channels several times to prevent damage and loss during elevated streamflow events resulting in gaps in monitoring abilities and data acquisition. Elevated streamflow also resulted in widespread morphological alterations in many stream channels, particularly within main stem river channels such as the Ventura River and Santa Ynez River. At the Ventura River sonar camera monitoring site fish may have been able to evade detection by using a secondary channel, though block fences were installed when possible to prevent fish passage through the channel (Figure 40). At the Santa Ynez River monitoring site, a wide active channel resulted in low-resolution footage, limiting the ability to identify fish to species level. Similarly, increased water depth may have allowed fish to pass PIT tag antennas and sonar cameras at a greater distance, diminishing the likelihood for them to be detected or identified. Increased turbidity (>400 NTUs) can also diminish the range of sonar cameras (Santa Barbara Channel Keeper 2018), and although footage was degraded, full loss of visibility in 2023–2024 sonar footage was minimal. Not only did higher turbidity result in lower visibility during redd surveys, but the sediment transported can reduce salmonid redd survival and life span (Buxton et al. 2015, Garwood & Larson 2014), a likely mechanism in Southern California streams.

The environmental conditions this monitoring season may have also contributed to only three redd observations being made during the 2023–2024 monitoring season. Elevated turbulent streamflow, water depth, and turbidity compromised streambed visibility during many redd surveys despite efforts to prioritize surveying reaches where conditions would be favorable for streambed visibility. Additionally, elevated streamflow event intervals, the intensity of these events, and the sediment transport they tend to promote have been observed to reduce salmonid redd survival and life span in northern California streams (Garwood & Larson 2014). This is also likely to be the case for redds within Southern California streams considering the nature of streams within the region to exhibit particularly flashy streamflow response to

precipitation events that often result in excessive sediment movement. Redds have also been shown to destabilize sediment beds in comparison to undisturbed sediment beds and thus are more susceptible to sediment mobilization during periods of elevated streamflow (Buxton et al. 2015). Periods of elevated and turbid streamflow are also unfavorable to the ability of *O. mykiss* to spawn and build redds. Therefore, suitable conditions and opportunities for redd building were likely suppressed throughout Southern California during the 2023 – 2024 monitoring season.



**Figure 40:** Looking downstream at the block fencing installed at the upstream extent of the secondary split channel at the Ventura River sonar camera monitoring site on February 12, 2024 when streamflow was approximately 130 cfs (USGS 2024). These block fences were used during lower streamflow rates to ensure fish swam through the primary channel and were more likely to be recorded by the DIDSON camera utilized at the site.



**Figure 41:** Looking from river right towards river left at the downstream extent of the secondary split channel at the Ventura River Site on February 12, 2024.

Due to limited *O. mykiss* observations made during the past two monitoring seasons it is difficult to make data driven interpretations of the impacts two consecutive wetter than average water years have had on *O. mykiss* populations within the Monte Arido Highlands, Conception Coast, and Santa Monica Mountains BPGs. Multiyear comparisons of CMP data provided earlier in the discussion section provides some insight into *O. mykiss* population trends. Impacts associated with back to back wetter than average water years may be better understood as additional monitoring data is collected in the coming monitoring seasons as population trends continue to play out. Climatic modeling efforts have indicated one potential impact associated with climate change is increased likelihood for greater variance in hydrological conditions from water year to water year across much of the west coast, with rapid shifts between periods of drought and wet conditions (Maharjan et al 2025). Furthermore, climate change is also projected to increase the likelihood for extreme dry-to-wet precipitation events to occur associated with persistent storm sequences that result in large precipitation accumulations over relatively short periods of time (Swain et al 2018). This increased tendency for the occurrence of hydrologic whiplash will likely have impacts on Southern California steelhead as pronounced fluctuations in aquatic habitat conditions also occur.

## 4.4 Changes in Low-Flow Sampling Approaches and Techniques

The 2023–2024 monitoring season was the first time low-flow surveys were implemented in Southern California following Fish Bulletin 182 guidance. Prior to the updated guidance established within Fish Bulletin 182, low-flow surveys followed guidance within Fish Bulletin 180 and primarily were completed via snorkel surveys, often in locations with current presence of *O. mykiss*. Fish Bulletin 182 specifies multi-pass depletion electrofishing as the primary method for conducting low-flow surveys, with selective snorkel sampling conducted only in habitat units that are not suitable for effective electrofishing due to excessive water depth or electrofishing equipment accessibility restrictions. Advantages of depletion electrofishing include more accurate counts of *O. mykiss* presence compared to observational counts via snorkeling and the opportunity for direct sampling of fish to include collection of size, weight, and genetic sampling. Disadvantages of electrofishing include greater logistical considerations as more gear and staff are typically necessary compared to snorkeling. Electrofishing also poses greater risk to aquatic species due to increased stress and risk of injury or mortality associated with shocking, capture, and hands on data collection. As a result of these risks, electrofishing is often a permitted activity with established criteria to reduce potential for injury or mortality to fish. Instances of fish mortality occurring are typically less than 1%, with similar mortality risk levels found for other aquatic vertebrates (Boughton et al. 2022). The benefits associated with electrofishing are considered to outweigh the risks when it comes to data acquisition that provides insights into *O. mykiss* abundance, spatial structure, and diversity and thus ongoing recovery efforts and the effectiveness of those efforts. The benefits associated with electrofishing may be more amplified in Southern California streams, where it is common to encounter shallow habitat units under low-flow conditions that are capable of supporting *O. mykis*s, but are difficult to effectively snorkel. CDFW electofishing and various other *O. mykiss* monitoring efforts conducted within Southern California streams are regulated and permitted by the NMFS, with the current permit approved until December 31, 2028.

Fish Bulletin 182 also directs a more encompassing spatially balanced approach to low-flow monitoring efforts via the establishment of long term rotational sampling throughout each BPG. Furthermore, sampling rotations are built upon GRTS draws that attempt to remove bias from sampling location selection. Prior to Fish Bulletin 182, sampling efforts tended to be

concentrated in streams and watersheds that were known to currently support populations of *O. mykiss* thus limiting estimations at a BPG wide scale. For the 2023–2024 monitoring season, low-flow survey efforts were only conducted within the Conception Coast BPG. This approach was intended to provide an initial baseline experience of conducting low-flow surveys following Fish Bulletin 182 guidance that would inform the development and implementation of low-flow sampling efforts in other BPGs. For instance, this allowed for development of new low-flow sampling protocols, datasheets, and databases. These actions were coordinated with CDFW CMP staff throughout the state, especially those conducting monitoring efforts in Region 4 along the Central Coast of California.

Due to the unique conditions within Southern California where extensive stream channel drying occurs during the dry season, specific protocols needed to be developed to determine if selected reaches were suitable for sampling. Fish Bulletin 182 accounts for this by providing guidance to replace dry reaches in the sampling rotation so statistically adequate sample size is achieved and negative bias is avoided in population estimates. Due to commonly encountering wetted habitat during the dry season that consists of very shallow and high temperatures with stagnant intermittent streamflow we felt more detailed criteria should be utilized to determine if selected reaches contained habitat conditions potentially suitable to *O. mykiss* and thus should be sampled. Developed criteria included a max water temperature of 75.2ºF (24ºC) and at least 50 meters of pool and flatwater units with a mean water depth of 0.12 meters (0.4 feet) or greater. Twenty-four degrees Celsius is considered to the be the acute temperature tolerance for *O. mykiss* (Nevada Division of Environmental Protection 2015). The presence of wetted riffle units was not included in habitat suitability criteria because *O. mykiss* typically rely upon pool and flatwater units for rearing and survival during the dry season. One other habitat suitability metric that was considered was dissolved oxygen content, but this was excluded from our criteria as this value can fluctuate daily and hourly, especially when associated with diurnal cycles. We ultimately wanted to avoid developing low-flow habitat suitability criteria metrics that resulted in exclusion of a majority of wetted reaches from sampling efforts while also reducing negative bias in sampling results as a result of widespread sampling efforts taking place in very poor habitat conditions. Adjustments to these criteria may be considered if they contribute to excessive exclusion of selected reaches during future low-flow sampling efforts.

Focusing newly developed low-flow sampling efforts within the Conception Coast BPG also provided insight into conducting sampling efforts, including timeframes involved to conduct reconnaissance and sampling efforts as well as staffing needs based on reach accessibility, habitat conditions, and *O. mykiss* presence versus absence. Furthermore, analysis of collected low-flow data provided insight into establishment of effective levels of low-flow sampling efforts needed to produce statistically sound BPG level population estimates. Fish Bulletin 182 recommends starting with a low-flow sample size of 30 reaches and adjusting as needed to achieve desired precision. Due to current low abundance of *O. mykiss* in Southern California, many zero counts are likely in sampled reaches thus limiting accuracy of population estimates. This issue could potentially be addressed by increasing low-flow sample sizes. However, sample size needs to be balanced with realistic sampling capabilities across multiple BPGs. During the 2023–2024 monitoring season 37 short reaches were successfully sampled within the Conception Coast BPG between September 9, 2023 and December 14, 2023. In coming seasons, the goal will also be to complete low-flow sampling efforts within the Santa Monica Mountains and Monte Arido Highlands BPGs. Accessibility within the Santa Monica Mountains BPG is likely to be similar to accessibility within the Conception Coast BPG, but accessibility is

challenging within much of the Monte Arido Highlands BPG with many areas located within wilderness areas of the Los Padres National Forest. Therefore, additional time and effort will be needed to access, and sample reaches in these areas. The Monte Arido Highlands BPG is also considerably larger than the Conception Coast BPG and therefore

Low-flow sampling efforts within Southern California are also complicated by widespread presence of unsuitable habitat conditions during the dry season. Within the Conception Coast BPG 30 (25.6%) of the reaches considered for sampling efforts did not meet minimum habitat suitability sampling criteria. This added substantial time and effort to conduct low-flow sampling. Considering these efforts were conducted within a much wetter than average water year, an even higher ratio of reaches considered sampling may not meet sampling criteria during low-flow sampling efforts conducted when drought conditions are present. The experience acquired during this initial effort of low-flow sampling following Fish Bulletin 182 guidance indicates that low-flow sampling will likely be the most labor and time intensive monitoring activity. To complete sufficient sampling sizes across multiple BPGs efficiency and adequate staffing will be needed. Additionally, initiating low-flow sampling early in the dry season will also likely be necessary.

## 4.5 Summary & General Considerations

Consecutive years of above average precipitation and the prolonged periods of elevated and connected streamflow have likely provided the most favorable conditions for *O. mykiss* migration and rearing in Southern California since the 2004 – 2005 water year, which was the last time a similar amount of precipitation occurred in the region. However, the environmental conditions brought on by these conditions were associated with challenges to conducting monitoring efforts, especially during the wet season. The spatial coverage, continuity, and effectiveness of the monitoring techniques employed have been impacted compared to past monitoring efforts, especially when compared to the monitoring conditions experienced during the prolonged drought within the region during the 2010s. The monitoring strategies, techniques, and protocols utilized within Southern California and more specifically by CDFW Region 5 were primarily developed and refined during the prolonged drought conditions. The conditions experienced during the 2022–2023 and 2023–2024 monitoring seasons have highlighted areas where improvements in techniques and protocols have been needed.

Challenges and shortcomings with sonar camera monitoring have been particularly apparent, especially in regard to review of the footage captured by the cameras. One contributing factor has been much of the obtained footage is of limited quality. Not much can be done to mitigate the impacts of elevated and turbid streamflow on footage quality, however one action taken during the 2023–2024 monitoring season was avoiding the use of excessive frame window lengths and low frequency settings when recording footage. Footage acquired under these settings during the 2022–2023 monitoring season resulted in extreme difficulty identifying recorded fish to a specific species, hence hampering the goal of using sonar cameras to identify *O. mykiss*. Therefore, during the 2023–2024 monitoring efforts these recording settings were only used for 209.4 hours, or 2.3% of all captured footage. During the 2022–2023 monitoring season these recording settings were utilized for 4,148 hours, or 38.7% of all captured footage from that season. The trade off with this approach is portions of the wetted channel may not be fully captured at times, thus potentially allowing *O. mykiss* to evade detection all together. During the 2023–2024 monitoring season, this issue only occurred at the Ventura River

monitoring site. Despite this, the site remains a good location for ongoing sonar camera monitoring considering it allows for the primary streamflow channel to be captured in footage recorded under high frequency settings under all but very elevated rates of streamflow. Additionally, when the secondary channel has enough streamflow to allow for potential fish passage it is still often small enough that block fencing and be installed to prevent fish passage through the channel. Furthermore, establishing new sonar camera monitoring sites is challenging as this often requires landowner access permission, camera equipment security considerations, and suitable infrastructure such as reliable power sources that can be utilized to power the camera. Another consideration in establishment of a new monitoring site is that future episodes of elevated streamflow may result in rapid and significant morphologic stream channel changes that diminish monitoring suitability at any particular site. For example, new streambed scour at the Salsipuedes Creek monitoring site has resulted in increased water depth that diminished the ability for fish targets to be captured in sonar camera footage acquired from the site. This highlights the importance of camera positioning within stream channels to increase the odds of anadromous steelhead detection in the footage. Camera positioning can also contribute to the quality of acquired footage. For example, poor camera positioning at the Ventura River monitoring site resulted in a diminished visual field in 167 hours of the acquired footage.

An additional challenge with sonar camera monitoring is the tedious and time-consuming nature of reviewing captured footage. Ongoing efforts continue to be taken to reduce the time needed to complete review of sonar camera footage. This included the use of CSOT processing to cut out periods of footage without movement detected in footage acquired from the Topanga Creek and Carpinteria Creek monitoring sites. Attempts will likely be made to utilize CSOT processing for footage acquired from other monitoring sites. Changes were also made to the criteria for recording targets when reviewing footage, including not recording targets under 30 cm in length for footage acquired from all sites except from the Carpinteria Creek site. Additionally, we removed the requirement to enter measurement data as well as frame entry and exit time stamps for all targets that could confidently be identified as not being *O. mykiss*. The potential to use artificial intelligence (AI) to assist with sonar camera footage review in the future could significantly reduce the amount of time and effort involved in the matter. CDFW CMP practitioners throughout the state have begun coordinating with the Fish Identification via Sonar & Ecological Estimation (FISHEYE) team, comprised of scientists from the California Institute of Technology (Caltech), Massachusetts Institute of Technology (MIT), and University of Massachusetts Amherst who have developed an AI model to assist with review of footage acquired with sonar cameras. Their model has demonstrated the ability to identify and measure fish in ARIS sonar footage, but not identify fish to specific species. Utilizing the AI model to highlight portions of footage when anadromous steelhead sized fish are present could potentially greatly limit the amount of footage that requires review. Furthermore, AI could also assist in reducing the error and bias that likely occurs in footage review completed by humans. We intend to share the ARIS footage acquired during the 2023–2024 monitoring season with the FISHEYE team, which will allow for comparison of the fish detection time stamps produced through AI analysis to the time stamps recorded from human review of the footage.

Despite the challenges of conducting various methods of salmonid monitoring within Southern California streams, sonar cameras, spawning surveys, snorkel surveys, electrofishing, and PIT tagging efforts continue to demonstrate as an effective means of gathering important data, which continues to show persistence of southern California steelhead. Ongoing refinement of these existing monitoring methods will continue to inform restoration decisions, actions, and

policies that promote recovery of the species. However, as is the case with all environmental and biological monitoring, these techniques have limitations and do not provide the full picture of current *O. mykiss* abundance, productivity, spatial structure, and diversity trends within the entirety of Southern California. Despite this, the data gathered from these efforts continues to indicate that Southern California *O. mykiss* populations have significantly declined from historic levels but continue to persist and make attempts to complete their life cycle. Comparison of data collected over time also show the remaining populations of *O. mykiss* within the Conception Coast, Monte Arido Highlands, and Santa Monica Mountain BPGs are resilient and appear able to recover from short-term declines, such as those associated with the 2018 Thomas Fire. This provides justification for continued monitoring efforts of the Southern California *O. mykiss* DPS and restoration efforts driven by data acquired from this monitoring.

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**Appendix 1:** Sonar Camera Footage Review Spreadsheet Datasheet

| Site | Hard Drive | Viewed By | Type of Footage (ARIS/DIDSON) | Date of Footage (mm/dd/yy) | File | Species | Direction | Time In hh:mm:ss | Time Out hh:mm:ss | Frame-1 | Length-1 (cm) | Range-1 (m) | Frame-2 | Length-2 (cm) | Range-2 (m) | Frame-3 | Length-3 (cm) | Range-3 (m) | *Footage Quality (1-4)* 1=Best, 4=Unusable | *Species ID* Definite=1 Confident=2 Possible =3 | Total Camera Range (m) | Visible Camera Range (m) | Far Bankside Visible? Y or N | Comments |
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