San Antonio Creek Snorkel Survey Report 2018

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Abstract

From June 26, 2018 to July 12, 2018, a snorkel survey was conducted on an 8.5 mile sampled reach of San Antonio Creek. Data collected contributed to estimating southern California steelhead (*Oncorhynchus mykiss*) relative abundance and distribution as well as quantifying stream habitat type and trout cover types available. Snorkelable stream habitat was dominated by flatwaters (63%) and pools (37%). On average, the surveyed habitat units contained little habitat complexity, with unit's surface area containing a mean of 47.5 ± 1.9% (mean ± SE) of trout cover. The cover mostly consisted of aquatic vegetation (47.0 ± 2.0% [mean ± SE]) and cobble/boulder (28.7 ± 1.8%). No inferences could be made about trout abundance or distribution trends as no *O. mykiss* were observed through the course of the survey. Changes in average habitat unit measurements, cover complexity, and *O. mykiss* observations from surveys conducted in previous years appear to be the result of persisting drought conditions followed by a large wildfire and subsequent winter rain events. Future monitoring efforts are recommended to continue collecting data on *O. mykiss* relative abundance and habitat availability and potential anadromous *O. mykiss* repopulation in San Antonio Creek.

Introduction

Steelhead (*Oncorhynchus mykiss*) along the west coast of North America have been divided into Distinct Population Segments (DPS) based on discrete factors separating populations from each other. The southern California steelhead DPS comprises the southernmost extent of the specie's range (NOAA 1997). Since 1997 this DPS has been listed as endangered under the U.S. Endangered Species Act due to dramatic declines in abundance caused by habitat loss and degradation (NOAA 1997). In response, a recovery plan for the southern California DPS was released in 2012 by the National Marine Fisheries Service (NMFS). This recovery plan determined multiple factors that affect the current endangered status of southern California steelhead (SCS) and the ability for recovery. Critical to steelhead recovery is the understanding of the interactions between steelhead and their freshwater habitat (NMFS 2012).

In southern California, steelhead fresh water habitat is dominated by short streams and rivers with flashy, intermittent flows and seasonal accessibility for anadromous trout. Since 2011, Southern California has experienced persistent drought conditions (NOAA 2018) further limiting the freshwater habitat use and availability for steelhead. The Thomas Fire, which burned from December 2017 through January 2018, impacted 1,909 miles of stream habitat within the fire perimeter, nearly 80 miles of which are designated critical habitat for southern California steelhead (Klose 2018). Shortly after, during the winter of 2018, strong rain events caused extremely high flows and the movement of boulders, debris, and sediment through creeks impacted by the fire. Fish mortalities and extirpation of small populations have been observed as a result of flooding and debris flows following wildfires (Bozek and Young 1994; Rinne 1996; Howell 2006). Monitoring efforts following these events are important for understanding steelhead trout abundance, distribution, and habitat utilization in affected critical SCS habitat (Klose 2018).

An important aspect of understanding how trout interact with their freshwater habitat is observing how trout utilize cover within their environment. Cover types utilized by trout include overhanging and instream vegetation, woody debris, boulders, bedrock crevices, root wads, undercut banks, and surface water turbulence. Cover is recognized as one of the essential components affecting trout abundance and distribution in streams (Raleigh et al. 1984). For individual fish, cover functions as protection from predators, reduction of competition, and shelter from water flow (Allouche 2002). In addition to providing instream shelter for fish, certain cover (e.g. large woody debris and boulders) aid in the creation of scours and pools which trout can utilize as habitat (Fausch and Northcote 1992; Allouche 2002).

A snorkel survey was conducted on San Antonio Creek between June 26, 2018 and July 12, 2018 by Pacific States Marine Fisheries Commission (PSMFC). The purpose of this study was to estimate the relative abundance, distribution, cover availability, and cover use of *O. mykiss* within the survey reach.

San Antonio Creek begins with headwaters in the Topatopa Mountains of the Traverse Range and flows along the city of Ojai to a confluence with the Ventura River. The San Antonio Creek watershed drains approximately 32,746 acres out of a total of 144,967 acres that makes up entire Ventura River watershed. According to the Thomas Fire Burned Area Emergency Response (BAER) assessment, approximately 73 percent of the San Antonio subwatershed and 6.7 stream miles of San Antonio Creek's designated steelhead critical habitat was burned by the fire (Klose 2018). The survey reach began at the confluence of San Antonio Creek and the Ventura River (34.38071, -119.30747) and extended 8.5 miles ending the Grand Ave. bridge (34.45434, -119.22169). This end point was chosen as it is an established break between survey reaches and San Antonio Creek upstream of this point was observed to be dry at the time of the survey.

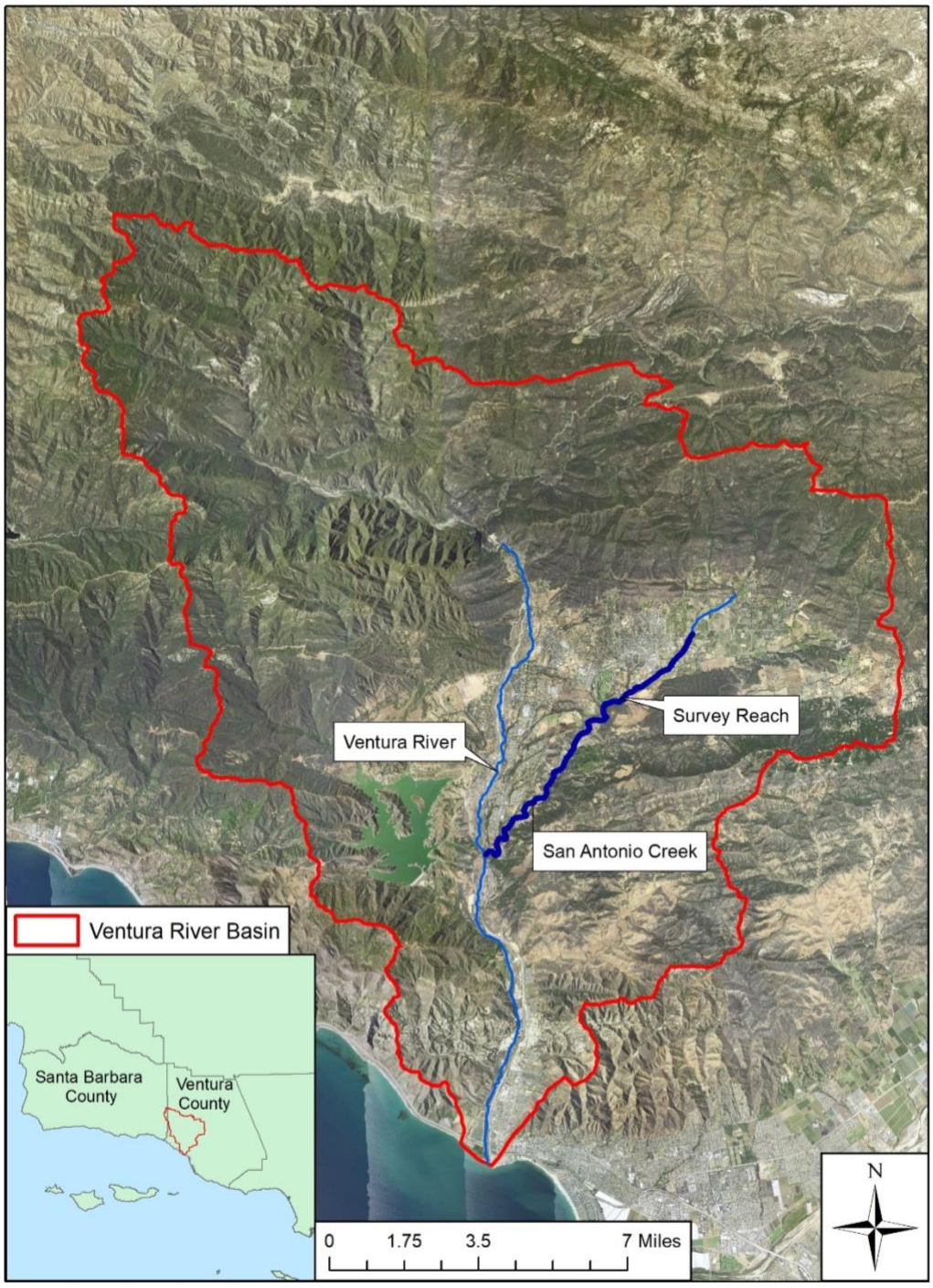
Methods

This study was conducted using elements of a snorkel survey protocol written by Tsai & Van Meeuwen (2016, unpublished). This protocol was 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). Snorkel surveys were used to gather relative abundance estimates of trout and quantify the available trout habitat and cover usage.

Snorkel surveys were conducted in teams of two to three, which included 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). Units were classified as either riffles (R), pools (P), or flatwaters (F) according to certain defining characteristics. These habitat types are adopted from definitions outlined in Flosi et al. (1998).

For this study, all snorkelable units with a maximum depth of 0.7 ft or greater were snorkeled once. The snorkeler entered the water at the downstream end of each habitat unit while being careful to minimize disturbance to the water and sediment. Once in the water, the snorkeler moved in a zig-zag pattern towards the upstream end of the unit making sure to visually search the entire area of the unit. The snorkeler searched the margins of the unit, boulder crevices, and other areas of potential fish cover.

Figure 1. Map of the Ventura River Basin (outlined in red) which drains into the Pacific Ocean and is located approximately 60 miles north of Los Angeles, California. Snorkel surveys were conducted from June 28, 2018 to July 12, 2018 along an 8.5 mile reach of San Antonio Creek (highlighted in dark blue) which serves as a tributary to the Ventura River (highlighted in blue). Data collected contributed to *Oncorhynchus mykiss* relative abundance, stream habitat availability and use.



Cover was defined as any natural or artificial stream feature capable of hiding a 3-inch trout from the surface. To avoid duplicate counts, trout were counted as the snorkeler moved past them.

Once each unit was surveyed, all observations were reported to the bankside data recorder. For each trout observed, the associated cover and estimated length were given. Trout sizes were estimated by 2-inch size bins (0-1.99 inches, 2-3.99 inches, 4-5.99 inches, etc.). Counts were also made for special status species of amphibians and reptiles including Southern Western Pond Turtle (*Actinemys pallida*), Two-striped Gartersnakes (*Thamnophis hammondii*), and California Red-legged Frog (*Rana draytonii*). Additionally, presence and visual estimates of other native fish species were recorded including Arroyo Chub (*Gila orcutti*) and Three-spined Stickleback (*Gasterosteus aculeatus*). For trout cover, snorkelers noted the type of cover used by each trout when first observed. 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 (Table A.1). Other/artificial cover consisted of any manmade products, such as plastic or mesh netting, sandbags, and plywood that potentially provided cover for fish within a habitat unit.

The snorkeler assessed the total trout cover available in each unit by estimating the percent of surface area containing trout cover and surface area containing no cover. The snorkeler also estimated the percentage of total cover each cover type in the unit comprised.

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.

All habitat units were measured for length, mean width, mean depth, and maximum depth. Length was measured along the thalweg (line of lowest elevation within a valley or watercourse) and mean unit width was measured perpendicular to the length (thalweg) line. The percentage of surface area that contained exposed substrate, usually comprised of gravel, boulders, or bedrock, was estimated for each unit. Exposed substrate included areas of dry exposed substrate not accounted for in measurements of unit length or mean width. This allowed for a more accurate surface area calculation of the available wetted trout habitat.

Snorkelers' trout size estimations were calibrated after snorkeling the first habitat unit and subsequently every tenth unit. Three randomly chosen PVC pipes of known lengths were tossed into the unit, after snorkeling was completed, and sampled by the snorkeler. The snorkeler estimated the size bin of each pipe and then confirmed with the data recorder. If an incorrect estimate was given, calibration was repeated until the snorkeler accurately estimated the sizes of all three pipes.

Water and air temperatures were measured with a thermometer at the beginning of each survey day and subsequently after every tenth unit surveyed.

All data was entered into a computer database and analyzed using R (version 3.4.1, R Core Team 2017) and R Studio (version 1.0153, RStudio, Inc 2016). 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 volume, and mean unit volume were calculated. To quantify available trout cover, the mean percent of habitat units containing trout cover and the mean percent each cover type comprised was calculated. Trout cover use was examined by calculating the total number of trout observed using each cover type. For each mean the standard error was calculated.

Results

San Antonio Creek was surveyed from June 26 to July 12, 2018, for 8.5 miles (44,616 ft). A total of 8,516 ft of stream length was snorkeled with a mean unit length of 61.7 ± 4.3 ft (mean ± SE) and a mean unit width of 10.16 ± 0.4 ft. The total unit area snorkeled was 93,584 ft^2, with a mean unit area of 678.2 ± 66.2 ft^2 (mean ± SE). A total of 138 habitat units were snorkeled. Of the snorkeled units, 63% (n=87) were classified as flatwaters and 37% (n=51) as pools. No riffles were snorkeled through the course of this survey. The mean depth of units surveyed was 0.7 ± 0.0 ft (mean ± SE) and units had a mean maximum depth of 1.3 ± 0.1 ft (mean ± SE). The total volume snorkeled through the course of the survey was 73,711 ft^3, with a mean unit volume of 534.1 ± 73.9 ft^3 (mean ± SE).

The mean percentage of available trout cover by surface area in units surveyed was 47.5 ± 1.9% (mean ± SE), with 52.5 ± 1.9% open. The predominant cover types observed consisted of aquatic vegetation (47.0 ± 2.0% [mean ± SE]) and cobble/boulder (28.7 ± 1.8%). Root Mass made up 8.9 ± 1.2% (mean ± SE) of the total cover, small woody debris made up 7.8 ± 1.1%, and terrestrial vegetation made up 5.1 ± 0.8%. Bedrock, bubble curtain, artificial cover, soil undercut, and large woody debris each made up less than two percent of the total mean cover (Table 1).

Table 1. Mean Percent and standard error of habitat unit cover types recorded during the 2018 San Antonio Creek snorkel survey.

Cover Type	Mean Percentage (%)	Standard Error (±%)
Open	52.50	1.87
Covered	47.50	1.87
Aquatic Vegetation	47.03	1.96
Cobble/Boulder	28.70	1.79
Root Mass	8.95	1.22
Small Woody Debris	7.75	1.13
Terrestrial Vegetation	5.11	0.81
Bedrock	1.05	0.45
Bubble Curtain	0.62	0.34
Other / Artificial Cover	0.40	0.28
Soil Undercut	0.22	0.11
Large Woody Debris	0.18	0.15

Water temperatures recorded using thermometers ranged from 62°F at the beginning of surveys to 84°F by midafternoon. One shallow section of creek lacking any riparian canopy measured 92°F, prompting the end of the survey day for the safety of the survey crew. The mean water temperature recorded over the course of the survey was 70.0 ± 0.5°F (mean ± SE). This mean temperature calculation only considers water temperatures that were recorded once every 10 habitat units sampled and not any additional temperatures recorded at the end of the survey day made to assess whether the survey should be ended for heat safety.

Zero *O. mykiss* were observed through the course of this snorkel survey. Large numbers of Arroyo Chub (*Gila orcutti*) and Three-spined Stickleback (*Gasterosteus aculeatus*) were observed throughout the survey reach, although specific counts were not recorded. Observations of species of concern included eight Western Pond Turtles (*Actinemys marmorata pallida*), one adult California Red-legged Frog (*Rana draytonii*) and numerous *R. draytonii* tadpoles. Additionally, numerous Baja California Treefrogs (*Pseudacris hypochondriaca*) and *P. hypochondriaca* tadpoles were observed during this survey, although counts were not recorded.

Table 2. A comparison of mean habitat unit measurements recorded in San Antonio Creek between snorkel surveys conducted in 2016 and 2018.

Habitat Unit Measurement	2016		2018	
	Mean	SE	Mean	SE
Length (ft)	53.28	7.42	61.72	4.33
Width (ft)	8.49	0.65	10.16	0.36
Mean Depth (ft)	0.74	0.07	0.67	0.03
Max Depth (ft)	1.43	0.13	1.29	0.06
Area (ft^2)	517.57	111.43	678.15	66.15
Volume (ft^3)	505.75	151.98	534.14	73.92

Discussion

The 8.5 mile reach of San Antonio Creek was snorkeled from June 26, 2018 to July 12, 2018. A total of 138 habitat units comprising 8,516 ft of stream length were snorkeled within the stream reach. Of the habitat units surveyed, flatwaters were the most abundant habitat type, comprising 63% (n=87) of the total habitat units surveyed. The remaining 37% (n=51) of habitat units were classified as pools. No riffles were sampled through the course of the survey. Water depth was limited throughout the survey reach, with a mean unit depth of 0.7 ± 0.0 ft (mean ± SE) and a mean maximum unit depth of 1.3 ± 0.1 ft (mean ± SE). Although the majority of the habitat surveyed consisted of shallow flatwaters, several pools with substantial depth were recorded, with the deepest point measured at 6.6 ft deep. Large adult *O. mykiss* require pool habitat in order to thrive due to protection provided from terrestrial predation and lower velocities which contribute to energy conservation, while shallow riffles and flatwaters are suitable habitat for fry and small juveniles due to the protection they provide from predation and competition (Raleigh et al. 1984; Rosenfeld and Boss 2001). Although a few deep pools were observed throughout the survey, the overall shallow depths of the surveyed units suggest limited available habitat for adult *O. mykiss* to seek refuge.

Zero *O. mykiss* were observed through the course of this survey. As a result, no inferences could be made about trout habitat type and cover utilization. On average, habitat units contained slightly less covered area than open area, with 47.5 ± 1.9% (mean ± SE) covered and 52.5 ± 1.9% open. Of the available cover recorded, the majority consisted of aquatic vegetation (47.0 ± 2.0% [mean ± SE]) followed by cobble/boulder (28.7 ± 1.8%). Root mass, small woody debris, and terrestrial vegetation made up 8.9 ± 1.2% (mean ± SE), 7.8 ± 1.1%, and 5.1 ± 0.8% of the available cover respectively, while all other cover types made up a combined 2.5% of the available cover. Trout abundance in streams has been observed to increase along with the quality and abundance of cover available (Bjornn and Reiser 1991). The data collected through this survey show that approximately half of habitat units' surface area contained cover, suggesting that cover was available for potential fish within the survey reach to use as protection from predation, competition, and high flow events. Yet habitat units in San Antonio Creek lacked in cover type complexity, indicated by the dominance of aquatic vegetation and cobble/boulder cover and small percentage of all other cover types.

Since trout were not observed in San Antonio Creek during this survey, no inferences could be made about trout densities or distribution trends. In 2016, a snorkel survey was conducted on San Antonio Creek by the California Department of Fish and Wildlife (CDFW) following the same survey methods. A total of 10 *O. mykiss* were observed through the course of the 2016 survey. Prior to that, a 2015 snorkel survey conducted by CDFW resulted in the observation of 32 *O. mykiss*. This number of observations indicates *O. mykiss* relative abundance is the lowest ever recorded in San Antonio Creek (CDFW, unpublished data). The drastic reduction in trout observations could be attributed to one or more factors, including the persisting drought conditions and impacts of the Thomas Fire and subsequent rain events.

Physical changes to the riparian zone and streambed of San Antonio Creek have been noted in surveys following the Thomas fire and winter rain events. Redd surveys conducted by CDFW and PSMFC staff following the Thomas Fire documented significant amounts of riparian vegetation burned by the fire. Snorkel survey data show that habitat unit parameters have changed between 2016 and 2018, with habitat units on average having greater lengths and widths but shallower depths in 2018 (Table 2). The reduced channel depth could be attributed to sediment washed into the creek by strong winter storms in 2017 and 2018. At the time of the 2018 snorkel survey, San Antonio Creek contained more wetted habitat meeting the snorkeling depth requirement compared to the 2016 survey, with 8,516 ft of stream length snorkeled in 2018 compared to 1,545 ft of stream length snorkeled in 2016 and potentially contributed to the increased mean habitat unit width and lengths observed in 2018. Potential factors contributing to the increase in wetted habitat in 2018 include increased precipitation during the winters of 2017 and 2018 compared to 2016, a drastic reduction of vegetation in the riparian zone and subwatershed caused by the Thomas Fire, and completion of the snorkel survey in July of 2018 compared to September of 2016.

Water temperatures varied greatly throughout the survey. As expected for the warm summer months in which this survey was conducted, temperatures rose throughout the survey day, with a range of 62^{o}F to 73^{o}F measured in the mornings to a range of 65^{o}F to 84^{o}F measured in the afternoons. Measured water temperatures were lower in sections of creek that contained deeper habitat units and riparian canopy than in sections of creek that were shallow and contained little to no riparian

vegetation. One such shallow, exposed section of creek had a recorded water temperature of 92^{o}F at 1340 hours. Although southern California *O. mykiss* strains have shown the ability to survive higher maximum temperatures, these daily maximum temperatures recorded in large portions of the survey reach are well above the accepted 75.2^{o}F (24^{o}C) lethal temperature for *O. mykiss* (Spina 2007). The deeper habitat units in areas with riparian canopy cover could provide thermal refuge for *O. mykiss*, but high water temperatures would certainly restrict trout movement and survival in the shallow, uncovered portions of San Antonio Creek observed at the time of the survey.

Although snorkel surveys are an ideal method for collecting in-water data, there are limitations. One potential limiting factor is the dependency of the observational data collected on the individual snorkeler. To minimize error, each snorkeler was trained according to the protocol used. Differences in snorkeler observations are possible due to variable observation probabilities. Water depth is one such factor that can influence snorkeler observations. In San Antonio Creek, many habitat units contained shallow sections that were difficult to snorkel effectively. Additionally, snorkelers' ability to observe fish was heavily influenced by the clarity of the water. Thick mats of algae covered the entire surface of many habitat units, creating difficulty for some habitat units to be snorkeled entirely and effectively and resulting in some habitat units not being snorkeled due to lack of water visibility even though depth requirements were met.

This study aimed to describe *O. mykiss* relative abundance and stream habitat in San Antonio Creek in 2018 following the December 2017 Thomas Fire and subsequent winter rain events. Our results found no *O. mykiss* within the survey reach. Physical changes in the creek were recorded, with a reduction of average water depth but an increase in overall wetted habitat compared to previous years. We attribute these changes to the occurrence of strong winter storms over the past two years. In particular, storms following the Thomas Fire have lead to increased sediment filling in the stream channel, reduced vegetation in the subwatershed, and increased wetted habitat due to the increased precipitation.

In order to make reliable population abundance estimates, electrofishing surveys are typically conducted to calibrate snorkel counts (Hankin 1984). However, the use of electrofishing to sample *O. mykiss* is ill-advised in high stress environments including elevated water temperatures. Therefore, future monitoring efforts will likely rely on snorkel surveys to continue collecting data on *O. mykiss* relative abundance and habitat availability. These data will serve as important indicators of anadromous *O. mykiss* repopulation in San Antonio Creek.

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Appendix

Figure A.1. Tanielle Redman, a Fisheries Technician with the Pacific States Marine Fisheries Commission (PSMFC), conducts a snorkel survey of a habitat unit typical of the portions of San Antonio Creek with riparian canopy cover.

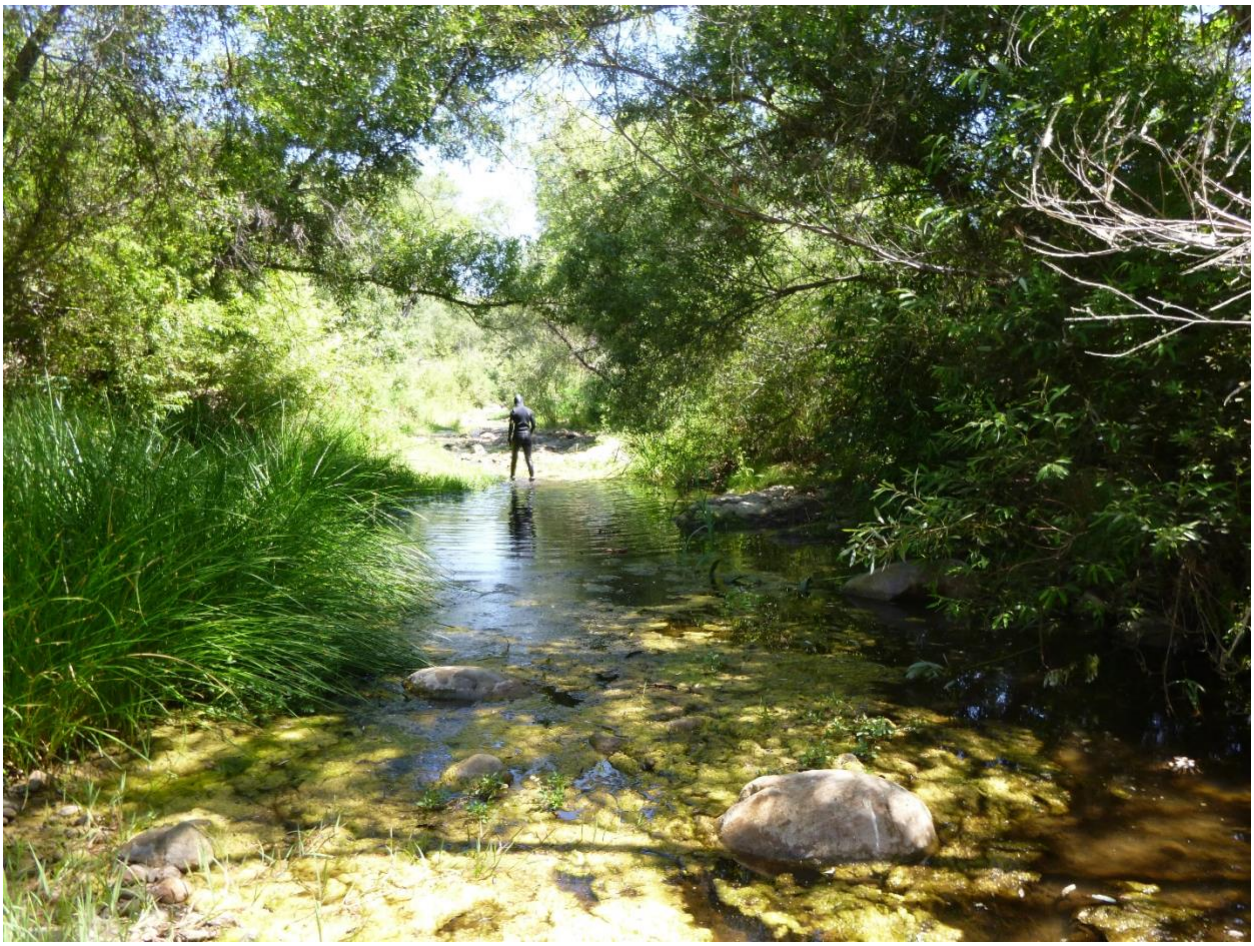

Figure A.2. Kathryn Carmody, a Fisheries Biologist with the Pacific States Marine Fisheries Commission (PSMFC), conducts a snorkel survey of a habitat unit typical of the portions of San Antonio Creek with little or no riparian canopy cover.

Table A.1. Table of the cover types used to quantify the amount of trout cover available within a unit (percentage) and the type of cover being used by trout observed during snorkeling.

Cover Type	Description
Open/No cover	Percentage of the unit that is open and without trout cover. Trout are not hiding, instead milling or swimming in an open area of the unit.
Cobble/Boulder	Rocks less than the size of a Volkswagen Beetle. This category includes instances in which a 3-inch trout could hide in the crevices of a boulder cluster and underneath the ledge of the boulder.
SWD	Small Woody Debris. Fallen (dead) twigs, leaves, tree-related debris, loose roots ("free-wheeling"), and logs less than 12 inches in diameter or less than 6 feet long that is in the water and capable of providing cover to at least a 3-inch fish.
LWD	Large Woody Debris. Logs at least 12 inches in diameter and at least 6 feet long touching the water and capable of providing cover to at least a 3-inch fish.
Bedrock ledge	Rocks larger than a Volkswagen Beetle that overhang the water such that a 3 inch trout could hide underneath (approximately 6 inches deep or greater).
Terrestrial vegetation	Any live, terrestrial vegetation touching or overhanging within 1-foot of the water's surface that is large or complex enough to hide a 3-inch trout.
Aquatic vegetation	Any live, aquatic vegetation that is large or complex enough to hide a 3-inch trout.
Bubble curtain	Bubbles or agitated water created by flow that could provide cover a 3-inch trout.
Root mass	A mat or cluster of live roots (e.g. willow mats) that could provide cover to a 3 inch trout.
Soil Undercut	An area along the margins of the unit comprised mostly of soil that has eroded only underneath the surface to create a ledge. This undercut should be able to hide a 3 inch trout (approximately 6 inches deep or greater).
Other	Snorkeler could not identify the cover type used by the trout, or the cover type used did not fit into the above categories. Details should be included in the comments section. This category should very rarely be used.