Matilija Creek Snorkel Survey Report 2018

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Abstract

From July 25, 2018 to September 20, 2018 a snorkel survey was conducted on a 6.94 mile sampled reach of Matilija 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. Stream habitat within the survey reach was dominated by shallow flatwaters (45.9%) and pools (35.1%). On average, the surveyed habitat units contained little habitat complexity, with approximately one-quarter of units' surface area containing cover. The dominant cover type observed was cobble/boulder (61.6 ± 0.8% [mean ± SE]). No inferences could be made about trout abundance or distribution trends because only two *O. mykiss* was observed through the course of the survey. Changes in habitat type, cover complexity, and *O. mykiss* observations from surveys conducted in previous years appear to be a result of the December 2017 Thomas Fire and subsequent winter rain events. Future monitoring efforts are recommended to continue collecting data on *O. mykiss* relative abundance and habitat availability and potential *O. mykiss* repopulation in Matilija 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 types (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 Matilija Creek between July 25, 2018 and September 20, 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.

Matilija Creek begins with headwaters in the Santa Ynez Mountains and flows through the Matilija Wilderness to a confluence with North Fork Matilija Creek to form the Ventura River. The Matilija Dam is located approximately 0.5 miles upstream of the mouth of Matilija Creek, blocking access of anadromous steelhead to the rest of the creek upstream. The Matilija Creek watershed drains approximately 34,927 acres out of a total of 144,967 acres that make up entire Ventura River watershed. According to the Thomas Fire Burned Area Emergency Response (BAER) assessment, approximately 97 percent of the Matilija subwatershed and 0.5 stream miles of Matilija Creek's designated steelhead critical habitat (below the Matilija dam) was burned by the fire (Klose 2018). The survey reach began at an established survey reach start above the Matilija Dam and Reservoir (34.49418, -119.33022) and extended 6.94 miles ending at a large waterfall barrier to fish passage (34.53699, -119.40395).

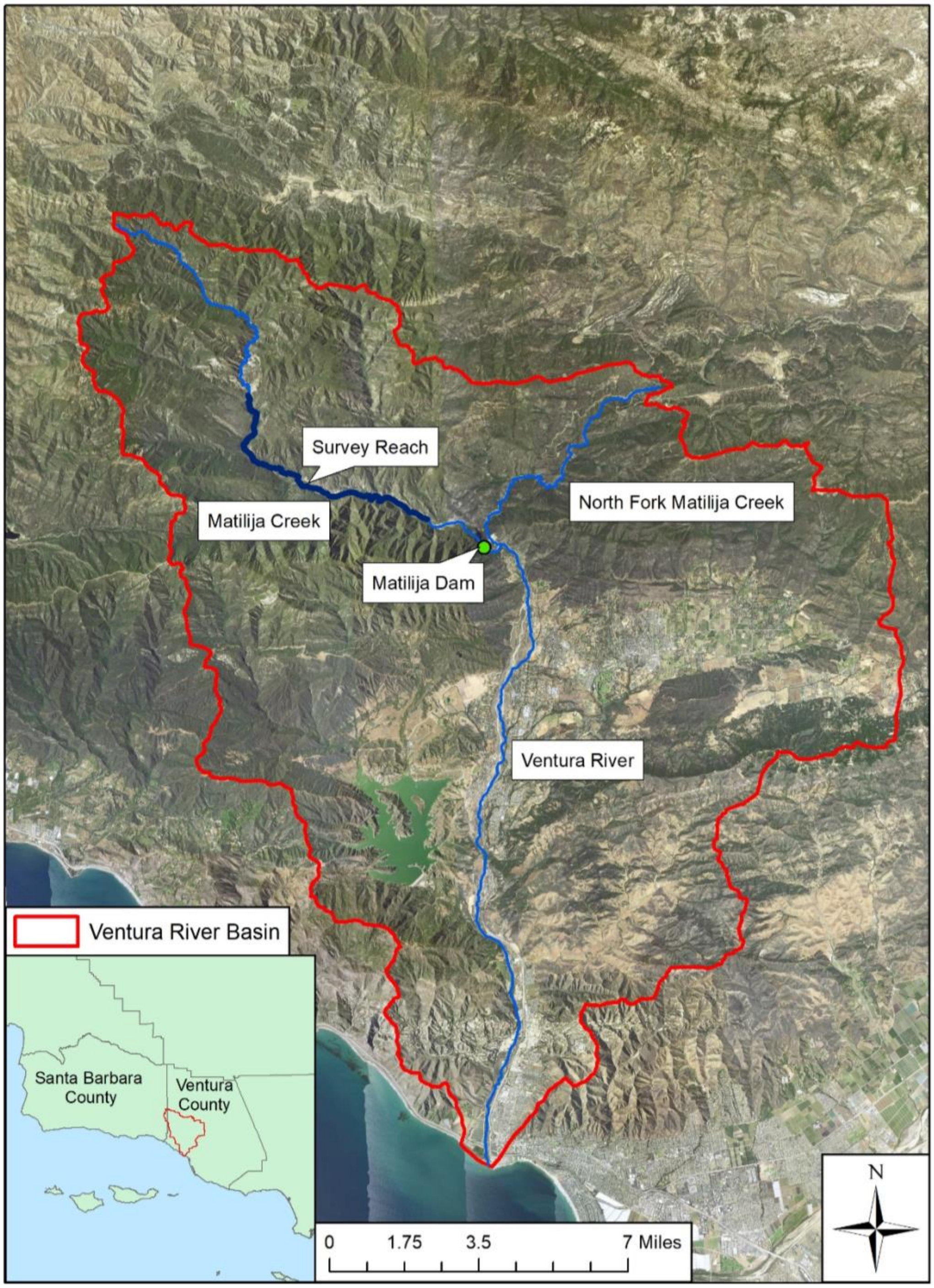
Methods

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

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 July 25, 2018 to September 20, 2018 along a 6.94 mile reach of Matilija 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.



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. 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

Matilija Creek was surveyed from July 25, 2018 to September 20, 2018, for 6.9 miles (36,643 ft). A total of 23,282 ft of stream length was snorkeled with a mean unit length of 35.0 ± 2.0 ft (mean ± SE) and a mean unit width of 7.9 ± 0.2 ft. The total unit area snorkeled was 207,961 ft^2, with a mean unit area of 312.7 ± 23.8 ft^2 (mean ± SE). A total of 663 habitat units were snorkeled. Of the snorkeled units, 45.9% (n=304) were classified as flatwaters, 35.1% (n=233) as pools, and 19.0% (n=126) as riffles. The mean depth of units surveyed was 0.6 ± 0.0 ft (mean ± SE) and the mean maximum depth of units was 1.1 ± 0.0 ft. The total volume snorkeled through the course of the survey was 119,936 ft^3, with a mean unit volume of 180.4 ± 16.1 ft^3 (mean ± SE).

The mean percentage of available trout cover by surface area in surveyed units was 27.1 ± 0.6% (mean ± SE), with 72.9 ± 0.6% open. Cover in Matilija Creek consisted predominantly of cobble/boulder (61.6 ± 0.8% [mean ± SE]). Bubble curtain made up 17.7 ± 0.6% (mean ± SE) of the total cover and aquatic vegetation made up 11.4 ± 0.6%. Root mass, small woody debris, bedrock, terrestrial vegetation, other/artificial cover, large woody debris, and soil undercut each made up less than four percent of the total mean cover (Table 1).

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

Cover Type	Mean Percentage (%)	Standard Error (±%)
Open	27.13	0.59
Covered	72.87	0.59
Cobble/Boulder	61.59	0.76
Bubble Curtain	17.74	0.59
Aquatic Vegetation	11.36	0.57
Root Mass	3.47	0.26
Small Woody Debris	2.68	0.22
Bedrock	2.14	0.36
Terrestrial Vegetation	0.74	0.17
Other / Artificial Cover	0.17	0.05
Large Woody Debris	0.08	0.06
Soil Undercut	0.03	0.02

Water temperatures recorded using thermometers ranged from 60ºF to 80ºF at the beginning of surveys to 73ºF to 89ºF by midafternoon. The mean water temperature recorded over the course of the survey was 76.7 ± 0.2ºF (mean ± SE).

Two *O. mykiss* were observed through the course of this snorkel survey, both under cobble/boulder cover and estimated to be between 6 to 7.99 inches in length (Figure 2). Species of concern obserations recorded resulted in 150 Arroyo Chub (*Gila orcutti*), one Three-spined Stickleback (*Gasterosteus aculeatus*), 17 Western Pond Turtles (*Actinemys marmorata pallida*), and 12 Two-striped Gartersnakes (*Thamnophis hammondii*). Numerous California Treefrogs and Baja California Treefrogs (*Pseudacris* spp.) and tadpoles were observed during this survey, although counts were not recorded. Additionally, approximately 250 juvenile black bass (*Micropterus* sp.), an invasive species in Matilija Creek, were observed throughout the first 0.57 miles of the survey reach.

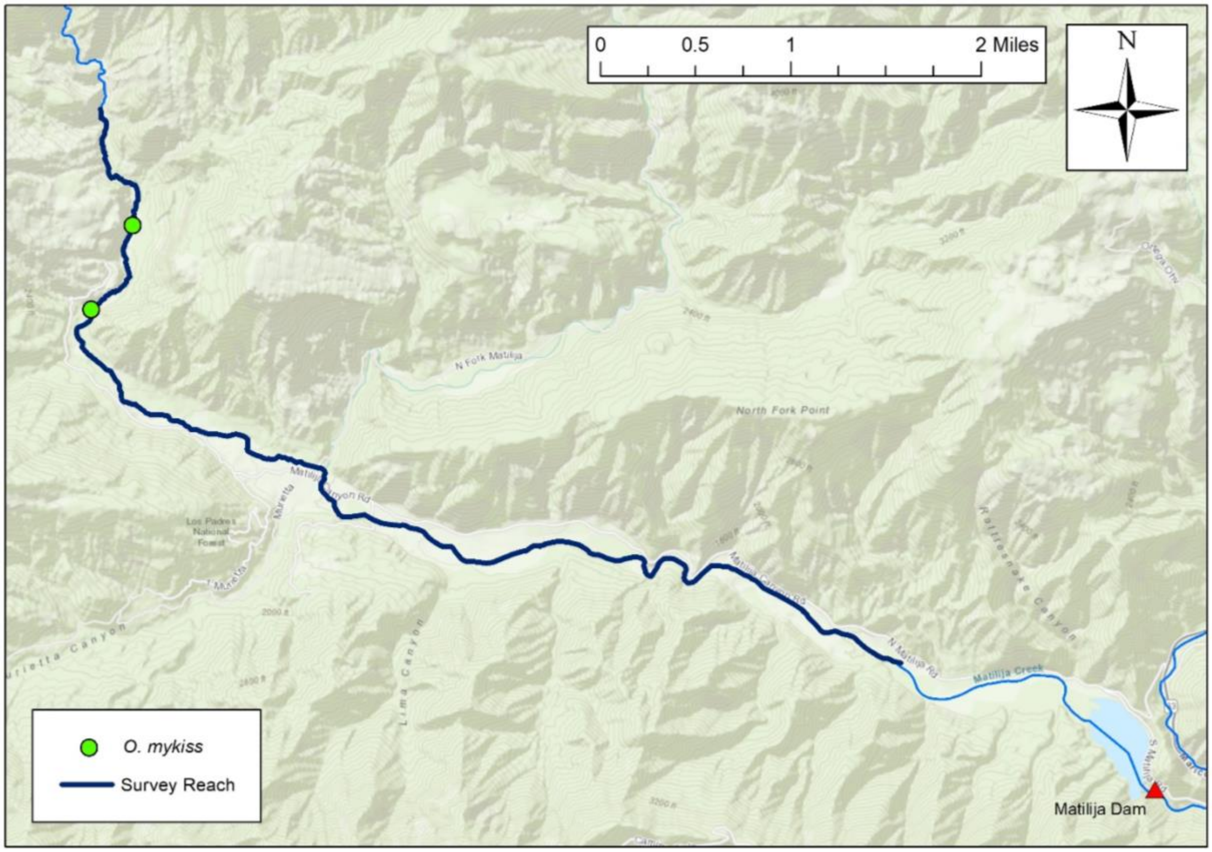
Table 2. A comparison of survey data between surveys conducted in 2017 and 2018 in Matilija Creek. The 2018 survey reach extended 0.8 miles (4,224 ft) further than the 2017 survey reach.

	2017	2018
Total Length of Survey Reach (ft)	32,419	36,643
Total Length of Units with a Max Depth Greater than 0.7 ft (ft)	27,990	23,282
Total Number of Units with a Max Depth Greater than 0.7 ft	1,009	663
Total Number of Pools with a Max Depth Greater than 0.7 ft	618	233
Total Number of Flatwaters with a Max Depth Greater than 0.7 ft	269	304
Total Number of Riffles with a Max Depth Greater than 0.7 ft	122	126

Table 3. A comparison of mean habitat unit measurements recorded in Matilija Creek between surveys conducted in 2017 and 2018.

Habitat Unit Measurement	2017		2018	
	Mean	SE	Mean	SE
Length (ft)	27.74	0.97	35.01	1.95
Width (ft)	11.33	0.19	7.94	0.16
Mean Depth (ft)	0.71	0.01	0.58	0.01
Max Depth (ft)	1.31	0.02	1.10	0.02
Area (ft^2)	335.68	24.20	312.72	23.84
Volume (ft^3)	322.88	30.20	180.35	16.61

Figure 2. Map of the Matilija Creek snorkel survey reach. The locations of the two *O. mykiss* observations are indicated by green circles.



Discussion

The entire 6.9 mile surveyed portion of the Matilija Creek was wetted at the start of this survey. A total of 663 habitat units comprising 23,282 ft were snorkeled within the stream reach and just two *O. mykiss* observed. Flatwaters were the most common habitat type recorded, comprising 45.9% (n=304) of units snorkeled. Pool and riffle units made up 35.1% (n=233) and 19.0% (n=126) of the recorded habitat units respectively. Water depth was limited throughout the survey reach, with a mean unit depth of 0.6 ± 0.0 ft (mean ± SE) and a mean maximum unit depth of 1.1 ± 0.0 ft (mean ± SE). The deepest point measured over the course of the survey was 4.1 ft and occurred in a natural pool formed by the large waterfall at the end of the survey reach.

Two *O. mykiss* were observed within the Matilija Creek survey reach during the 2018 snorkel survey. Both trout were observed in pools using boulders as cover. However, no conclusions can be made about *O. mykiss* habitat type and cover utilization due to the small sample size. The data show and overall lack of cover availability and complexity through the Matilija Creek survey reach. On average, habitat units contained much more open area than covered, with 72.9 ± 0.6% (mean ± SE) open and 27.1 ± 0.6% covered. Of the available cover recorded, the majority consisted of cobble/boulder (61.6 ± 0.8% [mean ± SE]). Bubble curtain and aquatic vegetation made up 17.7 ± 0.6% (mean ± SE) and 11.4 ± 0.6% of the available cover respectively, while all other cover types made up a combined 9.3% of the available cover. The low percentage of cover availability and lack of cover type complexity suggest that fish within the survey reach have limited protection from predation, competition, and high flow events (Allouche 2002).

Due to the small number of *O. mykiss* observed through the course of the survey, no inferences could be made about trout densities or distribution trends. While previous snorkel surveys have varied in survey methods, this number of observations indicate *O. mykiss* relative abundance is the lowest ever recorded in Matilija Creek (California Department of Fish and Wildlife and PSMFC, unpublished data). During a snorkel survey conducted in 2017, a total of 379 *O. mykiss* were observed. During double pass snorkel surveys conducted in 2014, a total of 184 *O. mykiss* were observed in the first pass and 115 *O. mykiss* in the second pass. Both the 2014 and 2017 survey reaches were just under a mile shorter than the 2018 survey reach. 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. These events have caused significant changes within Matilija Creek, overall reducing and degrading available *O. mykiss* habitat.

Physical changes to the riparian zone and streambed of Matilija 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 and subsequent storms documented changes in stream channel location, depth, and width and significant amounts of riparian vegetation cleared by high flows and burned by the fire. As a result of the fire, boulders, debris, and sediment were easily shifted during the rain flows which led to sediment filling in much of the stream channel. This led to a reduction in overall streambed depth and likely accounted for the reduced number of pools documented during this study. While 2018 data show stream habitat unit type dominated by flatwaters with fewer pools and riffles, data collected from Matilija Creek surveys conducted in 2017 show habitat characterized by numerous pools intermixed with riffle and flatwater units (Table 2). The 2017 survey documented 30 pools with a depth of 3 feet or greater, while the 2018 survey found only 3 pools within this same depth range. In addition to changes in habitat type composition, our data show an increase in mean habitat unit length along with a decrease in mean channel width and mean and maximum unit depths from the previous year (Table 3). While shallow riffles and flatwaters are suitable habitat for *O. mykiss* fry and small juveniles due to the protection they provide from predation and competition, larger adults require pool habitat in order to thrive due to protection provided from terrestrial predation and lower velocities which contribute to energy conservation (Raleigh et al. 1984; Rosenfeld and Boss 2001). The reduced stream depth and number of pools limit the available habitat for adults to access in future spawning seasons.

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 days, with recorded temperatures ranging from 60°F to 89°F. 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°F (24°C) lethal temperature for *O. mykiss* (Spina 2007). While the entire survey reach was wetted at the time of the survey, miles of creek contained shallow habitat units with little to no riparian vegetation or canopy cover. These portions of creek saw the greatest temperature fluctuations and highest daily maximum temperatures. These stretches of open, shallow habitat were seen in parts of the creek that have been historically observed to dry out in the summer months as well as parts of the creek in which the 2018 winter debris flow destroyed the riparian canopy and altered the stream channel. The two *O. mykiss* were observed in heavily exposed and altered portion of creek, in small pools that had seeps of cool underground water. In the pool in which the first *O. mykiss* observation was made, the water temperature under the boulder that the fish was using as shelter measured 68°F while the rest of the pool measured 83°F. These observations indicate that *O. mykiss* in Matilija Creek were dependent on habitat that provided thermal refuge from the potentially lethal maximum daily temperatures recorded throughout the survey. The high water temperatures observed in the shallow, uncovered portions of Matilija Creek would restrict *O. mykiss* movement and survival at the time of the survey.

While 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. Due to the changes in the streambed following the fire and rain events, many units contained shallow sections that were difficult to snorkel effectively.

This study aimed to describe *O. mykiss* relative abundance and stream habitat in Matilija Creek in 2018 following the December 2017 Thomas Fire and subsequent winter rain events. Our results found a reduction in wetted habitat depth and complexity and elevated water temperatures contributing to freshwater habitat not suitable for *O. mykiss* persistence. We attribute these changes to a loss of canopy cover and increased sedimentation which reduced water depths and increased solar thermal heating.

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 *O. mykiss* repopulation in Matilija Creek.

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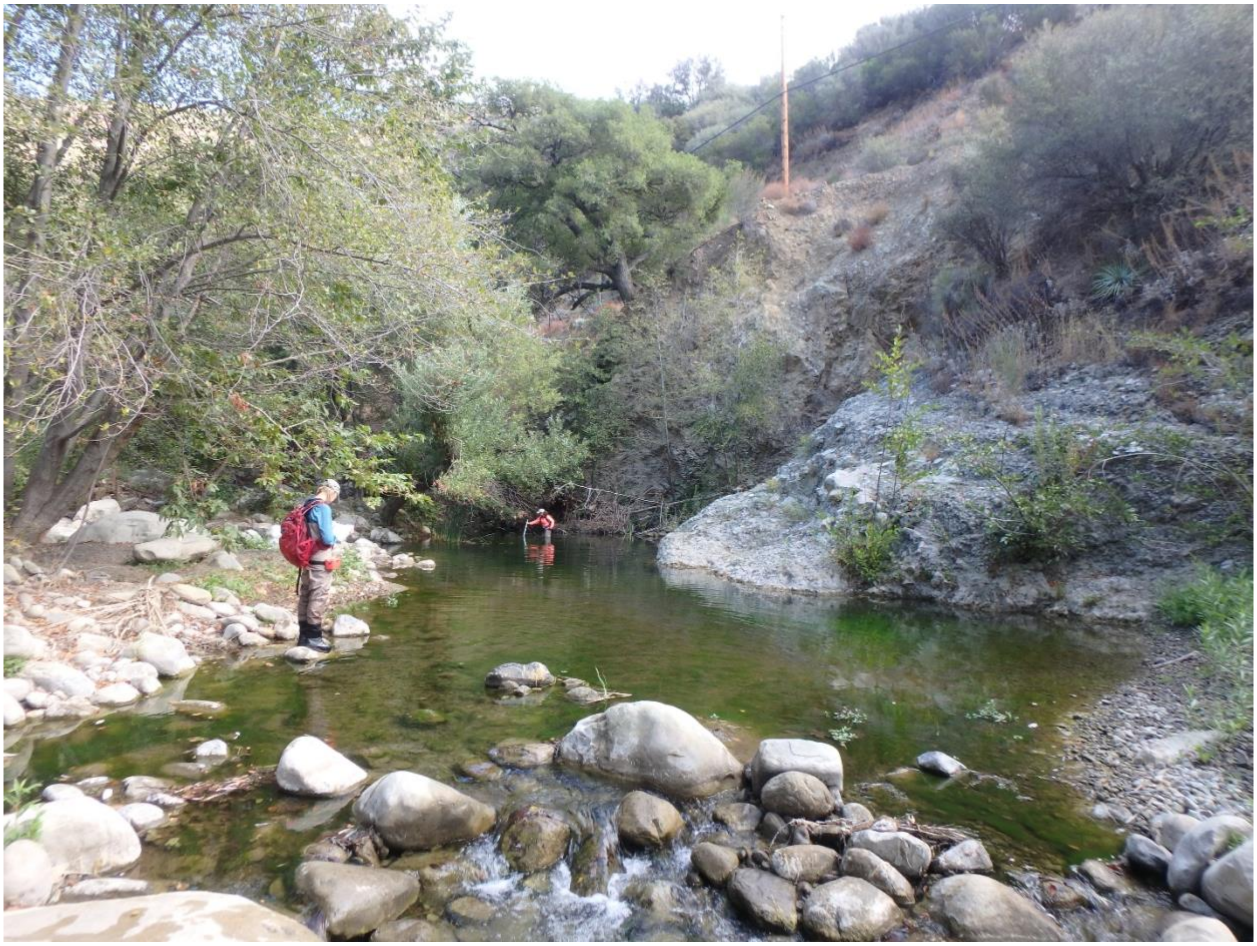
Appendix

Figure A.1. Habitat unit in Matilija Creek located approximately 1.4 miles from the survey start. Images of this unit were taken (a) during snorkel surveys conducted in 2017 and (b) during surveys in 2018 following the Thomas Fire and subsequent winter rain events.

(a)

(b)

Figure A.2. Habitat unit in Matilija Creek located approximately 1.9 miles from the survey start. Images of this unit were taken (a) during snorkel surveys conducted in 2017 and (b) during surveys in 2018 following the Thomas Fire and subsequent winter rain events.



(a)

(b)

Figure A.3. The habitat unit in which the first *O. mykiss* was observed during the 2018 Matilija Creek snorkel survey.

Figure A.4. One of the two southern California steelhead (*Oncorhynchus mykiss*) observed during the 2018 snorkel survey in Matilija Creek. This was the trout observed in the habitat unit pictured above.

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.