North Fork Matilija Creek Snorkel Survey Report 2018

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Abstract

From June 4, 2018 to June 18, 2018 a snorkel survey was conducted on a 4.35 mile sampled reach of North Fork 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 riffles (86.7%). On average, the surveyed habitat units contained little habitat complexity, with approximately one-third of units' surface area containing cover. Dominant cover types observed were bubble curtain (44.1 ± 1.2% [mean ± SE]) and cobble/boulder (42.9 ± 1.0%). No inferences could be made about trout abundance or distribution trends because only one *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 anadromous *O. mykiss* repopulation in North Fork 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).

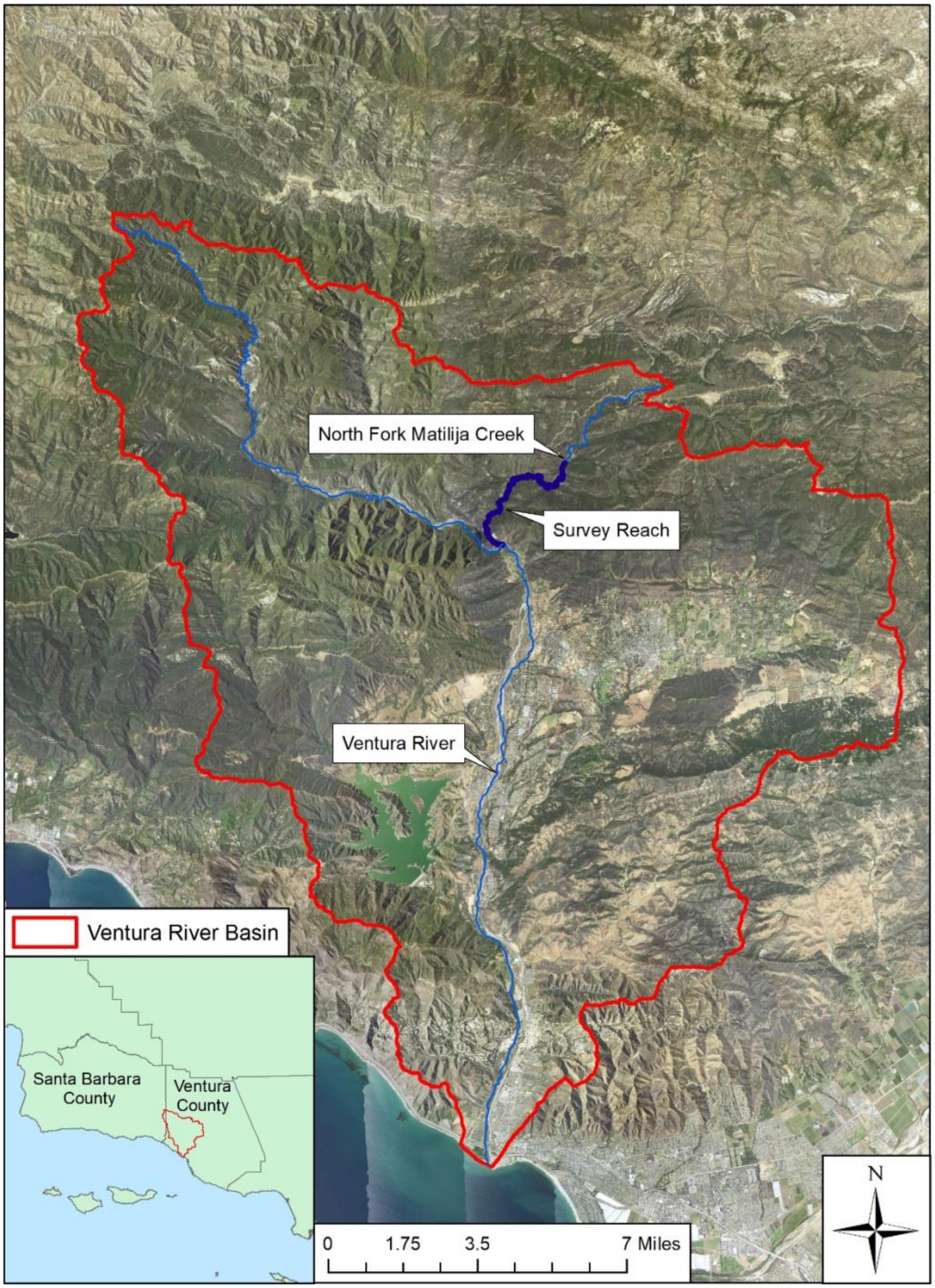
In southern California, steelhead fresh water habitat is dominated by short streams and rivers with flashy, intermittent flows and seasonal accessibility for anadromous trout. Since 2011, Southern California has experienced persistent drought conditions (NOAA 2018) further limiting the freshwater habitat 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 such as 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 North Fork Matilija Creek between June 4 and June 18, 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 by *O. mykiss* within the survey reach.

North Fork Matilija Creek is located in the Los Padres National Forest north of the city of Ojai in Ventura County, California. North Fork Matilija Creek begins with headwaters in the Topatopa Mountains of the Traverse Range and flows to a confluence with Matilija Creek to form the Ventura River. The North Fork Matilija Creek watershed drains approximately 10,297 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 96 percent of the North Fork Matilija subwatershed and 4.1 stream miles of North Fork Matilija Creek’s designated steelhead critical habitat was burned by the fire (Klose 2018). The survey reach began at the confluence of Matilija Creek and North Fork Matilija Creek (34.48530, -119.29973) and extended 4.35 miles ending at total barrier at Wheeler Gorge Campground (34.51270, -119.27442).

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 4, 2018 to June 18, 2018 along a 4.4 mile reach of North Fork 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.



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. 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. Additionally, a HOBO U26 Dissolved Oxygen Data Logger was deployed within the survey reach to continuously record dissolved oxygen and water temperature.

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

North Fork Matilija Creek was surveyed for 4.35 miles (22,968 ft) from June 4 to June 18, 2018. A total of 11,993.8 ft of stream length was snorkeled with a mean unit length of 47.0 ± 3.0 ft (mean ± SE) and mean unit width of 6.2 ± 0.2 ft (mean ± SE). The total unit area snorkeled was 66,375.2 ft^2, with a mean unit area of 260.3 ± 18.1 ft^2 (mean ± SE). A total of 255 habitat units were snorkeled. Of the snorkeled units, 86.7% (n=221) were classified as riffles, 11.8% (n=30) as pools, and 1.5% (n=4) as flatwaters. The mean depth of units surveyed was 0.5 ± 0.0 ft (mean ± SE) and units had a mean maximum depth of 1.1 ± 0.0 ft (mean ± SE). The total volume snorkeled through the course of the survey was 34,785.9 ft^3, with a mean unit volume of 136.4 ± 9.7 ft^3 (mean ± SE). Water visibility varied between snorkeled units throughout North Fork Matilija Creek with 61 units (24%) rated as having poor visibility, 127 units (49.8%) with average visibility, and 67 units (26.7%) with excellent visibility.

The mean percentage of available trout cover by surface area in units surveyed was 30.1 ± 1.1% (mean ± SE), with 69.9 ± 1.1% open. The predominant cover types observed consisted of bubble curtain (44.1 ± 1.2% [mean ± SE]) and cobble/boulder (42.9 ± 1.0%). Aquatic vegetation made up 5.1 ± 0.4%

(mean ± SE) and small woody debris made up 3.4 ± 0.4%. Bedrock ledge, root mass, terrestrial vegetation, other/artificial cover, 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 North Fork Matilija Creek snorkel survey.

Cover Type	Mean Percentage (%)	Standard Error (±%)
Open	69.94	1.11
Covered	30.06	1.11
Bubble Curtain	44.10	1.17
Cobble / Boulder	42.88	0.98
Aquatic Vegetation	5.10	0.40
Small Woody Debris	3.43	0.39
Bedrock Ledge	1.51	0.34
Root Mass	1.08	0.27
Terrestrial Vegetation	1.02	0.18
Other / Artificial Cover	0.59	0.35
Large Woody Debris	0.29	0.15
Soil Undercut	0.00	0.00

Water temperatures recorded using thermometers at the beginning of surveys ranged from 57°F to 67°F and by midafternoon measured as high as 80°F. A HOBO data logger was deployed from June 14 to June 21, 2018, to continuously record water temperature and dissolved oxygen in the habitat unit where the single *O. mykiss* was observed. During the duration of deployment, temperatures ranged from a low of 59.2°F to a high of 81.8°F with a daily mean temperature of 66.8 ± 0.3°F (mean ± SE). Daily mean temperature was calculated by averaging the temperatures of the 6 complete 24-hour periods of deployment, disregarding days in which the logger was only deployed for a portion of the day. Temperature data from a HOBO logger deployed approximately 0.2 miles downstream during the same dates in 2017 recorded a low of 62.6° F, high of 75.0°F, and daily mean of 68.8 ± 0.1°F (mean ± SE) (Figure 2).

Daily fluctuations in dissolved oxygen (DO) were also recorded by the HOBO data logger (Figure 3). DO ranged from a high of 9.53 mg/L on June 18, 2018, to 7.41 mg/L on June 20, 2018. The daily mean DO was 8.69 ± 0.02 mg/L (mean ± SE), which was also calculated from averaging the recorded DO of the 6 complete 24-hour periods of deployment.

One *O. mykiss* was observed under a bubble curtain and was estimated to be between 6 to 7.99 inches in length (Figure A.1). Additional wildlife observations of species of concern were recorded, resulting in nine Arroyo Chub (*Gila orcutti*), two Western Pond Turtles (*Actinemys marmorata pallida*), and one Two-striped Gartersnake (*Thamnophis hammondii*). Additionally, numerous California Treefrogs (*Pseudacris cadaverina*) and tadpoles were observed during this survey, although counts were not recorded.

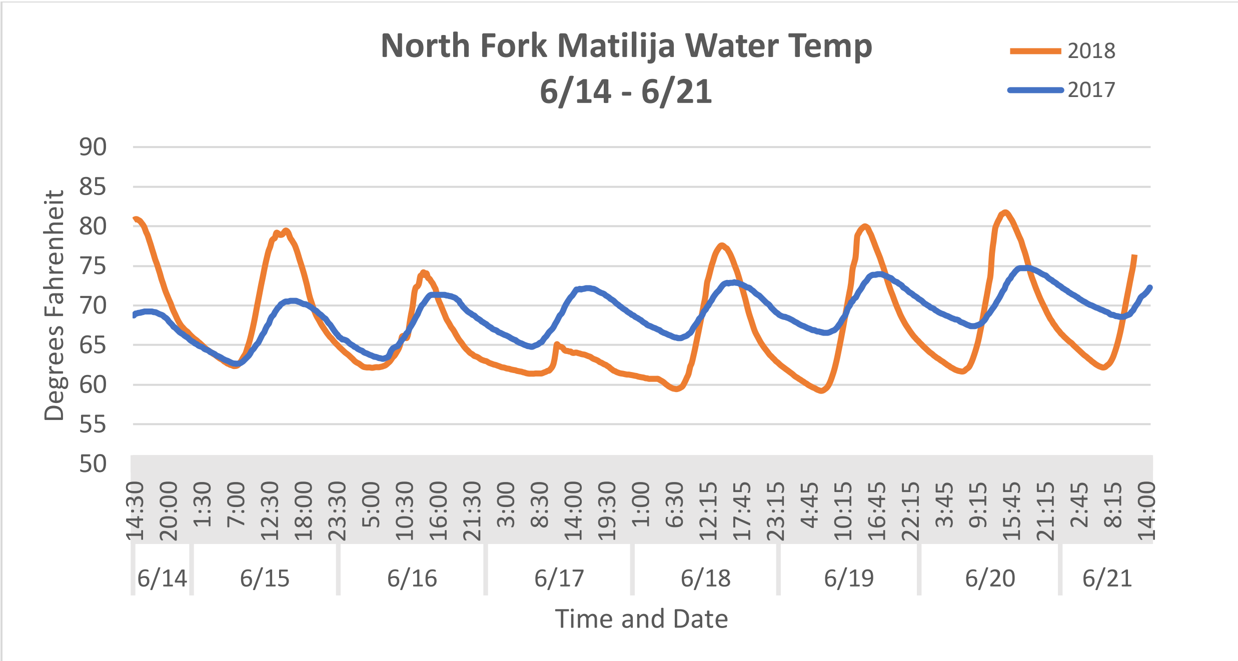


Figure 2. North Fork Matilija Creek water temperatures recorded by continuously recording HOBO loggers from 6/14 – 6/21 in 2017 and 2018.

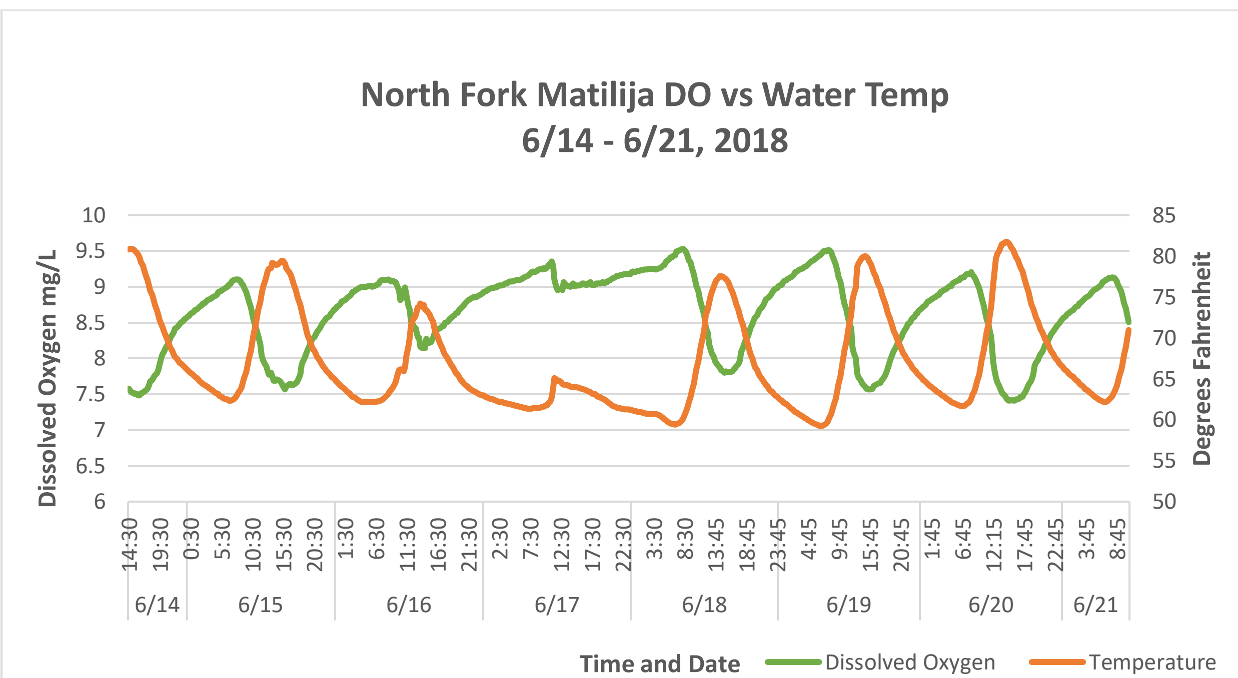


Figure 3. North Fork Matilija Creek dissolved oxygen levels recorded by continuously recording HOBO logger from 6/14 – 6/21, 2018.

Table 2. A comparison of mean habitat unit measurements recorded in North Fork Matilija Creek between surveys conducted in 2013, 2015 and 2018.

Habitat Unit Measurement	2013, 2015		2018	
	Mean (ft)	SE (±ft)	Mean (ft)	SE (±ft)
Width	12.80	0.34	6.19	0.15
Mean Depth	1.23	0.05	0.52	0.01
Max Depth	2.35	0.08	1.07	0.02

Discussion

The entire 4.35 mile surveyed portion of the creek was wetted at the start of this survey. A total of 255 habitat units comprising 11,993.8 ft were snorkeled within the stream reach and just one *O. mykiss* observed. Riffles were the most common habitat type recorded, comprising 86.7% of units snorkeled (n=221). Pool and flatwater units made up just 11.8% (n=30) and 1.5% (n=4) respectively. Depth was limited throughout the surveyed stream with a mean depth of 0.5 ± 0.0 ft (mean ± SE) and a mean maximum depth of 1.1 ± 0.0 ft (mean ± SE). The deepest point measured over the course of the entire survey was 4.2 feet and occurred in a manmade pool while the deepest naturally occurring point measured at 3.5 feet.

Two small sections of this stream were not surveyed due to water visibility and landowner access issues. The first 0.2 miles of the reach starting at the confluence of Matilija and North Fork Matilija Creeks were not snorkeled due to ongoing poor water visibility. Another 0.3 miles were not snorkeled due to lack of landowner permission on private property.

One *O. mykiss* was observed in a 1 ft deep scour at the head of a long riffle with a mean depth of 0.4 ft and an estimated 10% of total cover. The trout was observed using bubble curtain as cover. However, no conclusions can be made about trout habitat type and cover utilization due to the small sample size. The data show an overall lack of complex cover throughout the North Fork Matilija Creek survey reach. On average, habitat units contained much more open (69.9 ± 1.1% [mean ± SE]), uncovered area than covered (30.1 ± 1.1%). Of that cover, bubble curtain and cobble/boulder made up the majority, comprising a mean 44.1 ± 1.2% (mean ± SE) and 42.9 ± 1.0% respectively. All other cover types made up a combined 13.0% of the total 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 single *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 North Fork Matilija Creek (California Department of Fish and Wildlife, unpublished data). During double pass snorkel surveys conducted in 2014, a total of 78 *O. mykiss* were observed in the first pass and 105 *O. mykiss* in the second pass (van Meeuwen, 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. These events have caused significant changes within North Fork Matilija Creek, overall reducing and degrading available *O. mykiss* habitat.

Physical changes to the riparian zone and streambed of North Fork Matilija Creek from the Thomas fire and winter rain events were noted during spawning surveys conducted from February through May of 2018. As a result of the fire, sediment was 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. Data collected from North Fork Matilija Creek surveys conducted in 2013 and 2015 show habitat characterized by numerous pools and riffles with fewer flatwater units (CDFW, unpublished data). In addition to changes in habitat type composition, our data show a decrease in mean channel width and mean and maximum unit depths from previous years (Table 2). This study indicated a shift in stream structure, with habitat now dominated by long shallow low gradient riffles intermixed with few small pools and flatwater units. While shallow riffles 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 (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.

Daily temperature fluctuations measured during this survey were much greater than measured in previous years, with temperatures fluctuating as much as 20.8°F throughout a single 24-hour period. Water temperature recorded during the same date range in 2017 showed a maximum daily temperature fluctuation of 8.1°F (Figure 2). The highest temperature recorded by the temperature logger during its 2018 deployment was 81.8°F, with sustained temperatures above 75°F occurring for multiple hours during most days. These temperatures are much higher than temperatures recorded throughout all of 2017 with an annual high of 77.4°F recorded on September 2nd (CDFW, unpublished data). Although southern California *O. mykiss* strains have shown the ability to survive higher maximum temperatures, these daily maximum temperatures are well above the accepted 75.2°F (24°C) lethal temperature for *O. mykiss* (Spina 2007). Such drastic changes in the temperature profile of North Fork Matilija Creek may be attributed to several factors. The most noticeable factors being the loss of riparian canopy burned by the fire and/or washed away by the high storm flows and the overall shallowing of the reach due to sedimentation following storm events. These changes have attributed to an increase in the amount of direct sunlight reaching the creek channel and its water column thus heating the water and contributing to higher temperatures. Additionally, the lack of deep pools reduces potential thermal refuge for trout.

Dissolved oxygen (DO) measured and recorded by the deployed HOBO logger showed healthy levels, ranging from 7.41 mg/L to 9.53 mg/L. Levels of DO below 3 mg/L sustained for 3.5 days is considered lethal to salmonids, and sustained levels below 6 mg/L can significantly impair salmonid swimming, feeding, and growth (Carter, 2005). DO levels measured during this survey indicate that unlike water temperature, DO likely did not have negative impact on *O. mykiss* health. Although this is just a sample measured DO from a single habitat unit, these data provide insight into what DO levels were at the time the surveys were conducted. A longer deployment of a DO logger would be needed to get a better understanding of DO trends in North Fork Matilija Creek and its potential implications on *O. mykiss* distribution.

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. Due to the changes in the streambed following the fire and rain events, many 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. Fine sediment had been washed into the creek contributing to poor water visibility which lasted for months following the winter storms. At the start of this study, suspended fine sediment in the water had still not completely washed out of the system, significantly reducing water clarity in the lower portion of the reach. Diminished water clarity was further worsened by extensive construction efforts on highway 33 taking place in the creek channel 0.2 miles upstream from the North Fork Matilija confluence with the Ventura River. Water clarity through the rest of the surveyed portion of North Fork Matilija creek ranged from poor to excellent.

This study aimed to describe *O. mykiss* relative abundance and stream habitat in North Fork Matilija Creek in 2018 following the December 2017 Thomas Fire and subsequent winter rain events. Our results found a loss in wetted habitat 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 anadromous *O. mykiss* repopulation in North Fork Matilija Creek.

Acknowledgements

We would like to thank all PSMFC and CDFW staff who participated in the planning and implementation of this project. We would like to thank cooperating partner organizations, Watershed Stewards Program and California Conservation Corps, who helped make the scope of this project possible, and recognize the field efforts of Danielle Fitts and Lisa Rachal from WSP. We would like to acknowledge the Fisheries Restoration Grant Program which provides funding for this project through grant P1550013.

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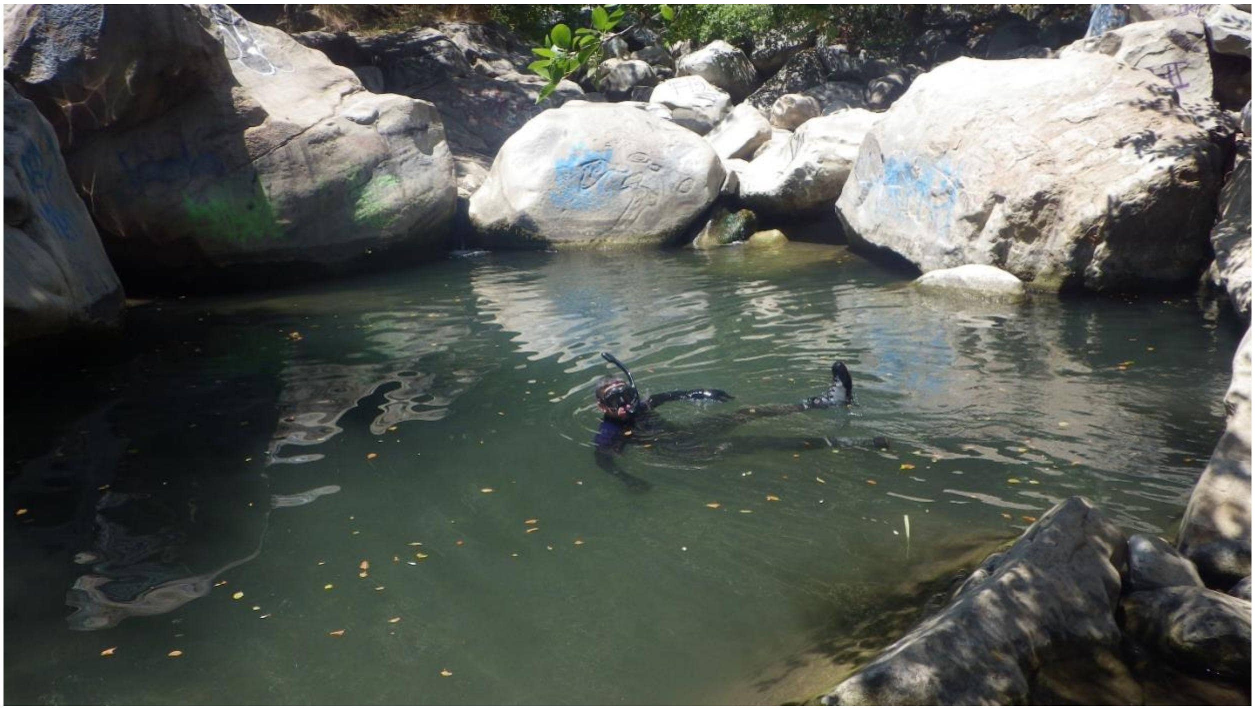
Appendix

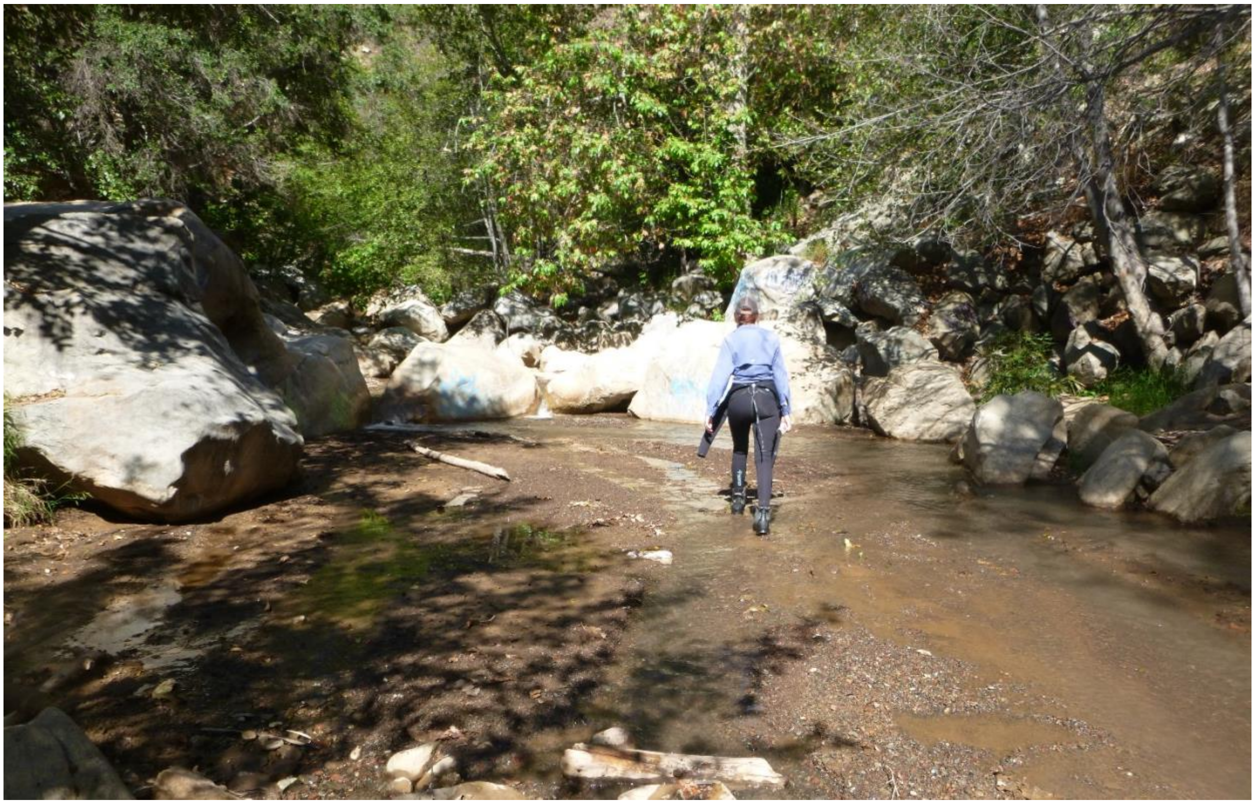
Figure A.1. One southern California steelhead (*Oncorhynchus mykiss*) observed during the 2018 snorkel survey in North Fork Matilija Creek. This was the only trout observed in the 4.35 mile stream survey reach.

Figure A.2. Casey Horgan, a Fisheries Technician with the Pacific States Marine Fisheries Commission (PSMFC) conducts a snorkel survey of a riffle unit in North Fork Matilija Creek. This unit is where the single *O. mykiss* was observed.

Figure A.3. Habitat unit in North Fork Matilija Creek located around 0.8 miles from the survey start. Images of this unit were taken (a) during snorkel surveys conducted in 2016 and (b) during surveys in 2018 following the Thomas Fire and subsequent winter rain events.



(a)



(b)

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.