Assessing physical, chemical and biological parameters of stream communities along watersheds of the Los Padres National Forest

Steve Flores

California State University Monterey Bay

Water Resources Institute, California State University San Bernardino Watershed Management Experimental Learning for USDA Careers

Advisor: Dr. Kristie Klose USDA Forest Service

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Executive Summary

Aquatic habitats of the Los Padres National Forest (LPNF) are degrading through both natural and anthropogenic causes. These factors include, but are not limited to, prolonged interannual and seasonal droughts, increased wildfire frequency, illegal water diversions, increased groundwater extraction from nearby agricultural lands, and fish passage barriers. Altogether these problems make it difficult for the survival of key listed species such as endangered Southern California steelhead (*Oncorhynchus mykiss*) and California red-legged frog (*Rana draytonii*), and threatened arroyo toad (*Bufo californicus*). Monitoring the physical, chemical and biological parameters of streams on the LPNF informs the management and protection of these vulnerable communities and natural resources. To examine relationships between stressors such as drought and wildfire on streams within the LPNF, we surveyed several streams during June – July 2016. In general, streams supporting rainbow trout (*O. mykiss*) had reduced percent open canopy, dissolved oxygen concentrations above 5mg/L, temperatures below 28°C, and substrates comprised primarily of cobbles. Streams in Mediterranean climates present challenges for land management agencies because of large interannual fluctuations in stream discharge, and endangered aquatic biota such as *O. mykiss* being particularly vulnerable to climate change stressors including increased wildfire frequency and drought.

Project Objectives

Overview

For migratory species, maintaining connectivity between populations is key to recovery and survival, and facilitating the unencumbered movement of metapopulations within the Los Padres National Forest (LPNF) is crucial to long-term survival. During drought or other large-scale disturbances such as wildfires, fish require stream connectivity so that they can reach spawning, rearing and maturing habitats. Likewise, the development of fish passage barriers (e.g., roads, streams crossings and dams) on the LPNF has created disruptions to ecologically connected aquatic communities. These barriers can affect the migration patterns of fish, particularly those with anadromous life histories, such as steelhead (*O. mykiss*), with negative consequences to populations and long-term species survival (Limburg and Waldman 2009). Barriers can also lead to changes in stream communities, through the microevolution of isolated biota, and changes to physical and chemical factors, such as water temperature, nutrient concentrations and sediment composition (Helfman 2007). The removal of fish passage barriers can have ecological benefits by improving fish migration and habitat access as well as the dispersal of nutrients and sediments throughout watersheds.

Study Site

The Los Padres National Forest (LPNF) encompasses a wide range of Mediterranean habitats including oak woodlands, grasslands, chaparral and semi-desert areas. There are three major reservoirs within the boundaries of the LPNP, on the Santa Ynez River, that divert water to surrounding cities: Lake Cachuma (Bradbury Dam), Gibraltar Reservoir (Gibraltar Dam) and Jameson Lake (Juncal Reservoir). Like all of southern California, the LPNF has been strongly affected by the recent 5-year drought which has significantly reduced water storage in these reservoirs, and in many cases desiccated streams completely or reduced them to stagnant ponds.

Further, the LPNF has experienced several large wildfires around these reservoirs in recent years including the Zaca (2007) and White (2013) Fires, which has increased sedimentation to surface waters, reduced riparian cover, and increased stream temperatures.

Our selection of streams for monitoring was based upon proximity to the Zaca Fire perimeter (240,207 acres), and with input from our advisor Dr. Kristie Klose who has done numerous research projects on the LPNF. These streams were selected to provide a status update on stream and riparian habitat conditions since the Zaca Fire and inform restoration efforts. They were also based upon the availability of flowing water since the current prolonged drought in this region has significantly or completely reduced flows for many rivers on the LPNF and regionally. The nine creeks selected are tributaries to the Santa Ynez River and fall within the boundaries of Santa Barbara Ranger District (Figure 1). They include Alder, Escondido, Black Canyon, East and West Fork Santa Cruz, Fox, Morse, Gidney, Camuesa, and Buckhorn Creeks.

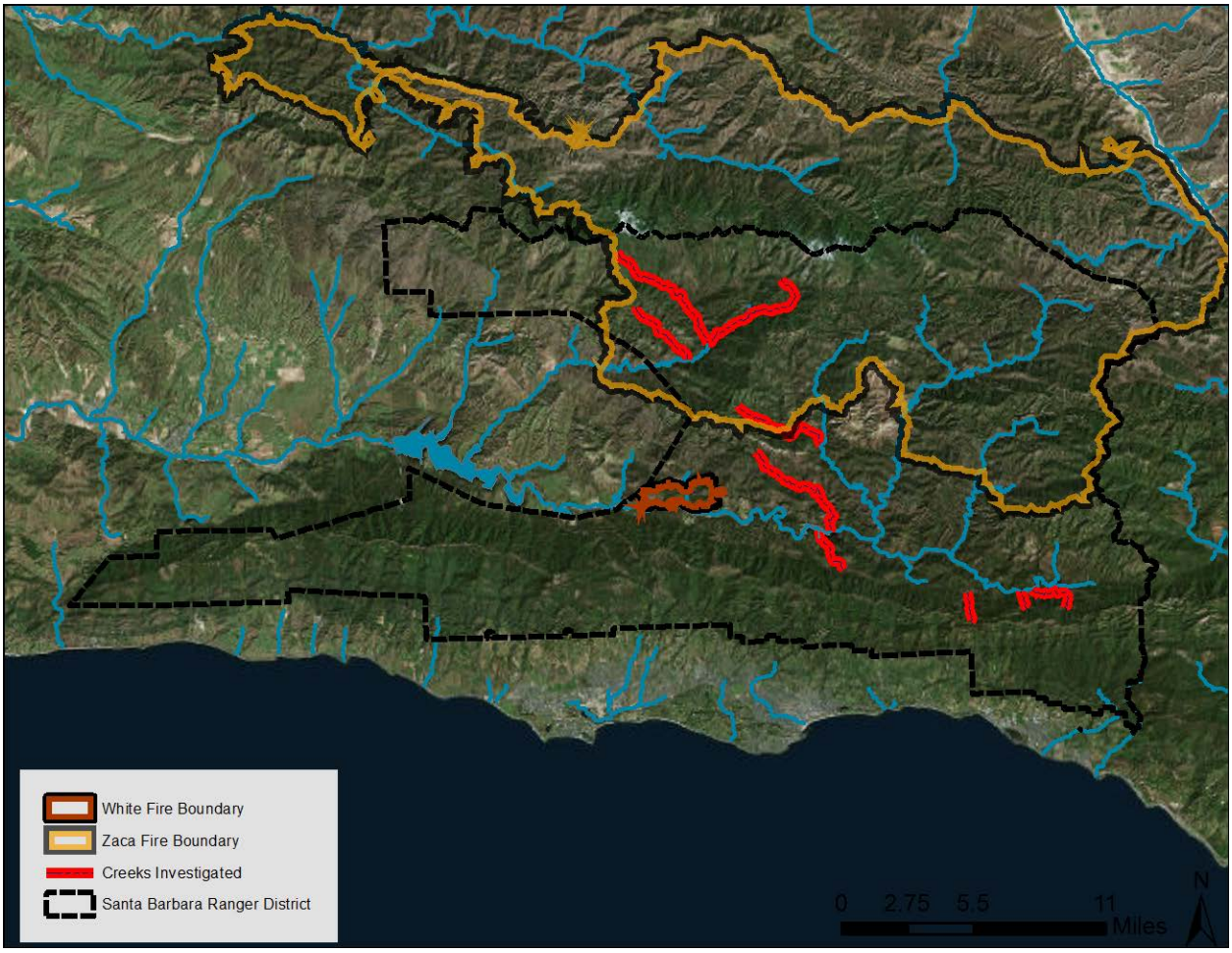

Figure 1. Location of the nine creeks that were investigated the Los Padres National Forest. Only Black Canyon, Camuesa, East and West Fork Santa Cruz fall within the Zaca Fire boundary.

Goals

The objectives of this project in collecting physical, chemical and biological data are three-fold. These data will allow the LPNF to assess the effects of the Zaca Fire on stream communities and trout abundance, inform restoration efforts including the removal of instream barriers, and verify the presence and absence of stream flow.

Finally, this project allowed me to develop skills in field work and stream sampling and will be useful as I apply for government jobs within the USDA or other federal agencies. Having a career with the Forest Service, or Natural Resources Conservation Service, dealing with natural

resources will allow me to assist key decision makers in managing our lands sustainably in order to protect sensitive habitats. This internship served as an important first step in meeting that goal.

Project Approach

Field Work

Due to the severity of the Zaca Fire and ongoing drought there was some uncertainty about the possibility of finding flowing creeks. Thus, we conducted initial stream reconnaissance to each of our study sites to determine the presence and absence of water. If a creek had water, we sampled physical, chemical and biological parameters over 100 m reach (min. 50 m) at 10 m intervals. We began our work at the bottom of each stream reach and sampled upstream to avoid disturbing the biota and substrata and continued to the top of the reach. Pin flags were placed every 10 m and water depth, sediment depth, wetted width, canopy cover, substrate classification, current speed, and presence/absence of trout collected recorded every 10 m over the 100 m reach. Photo-documentation, GPS coordinates (i.e, latitude and longitude), and multi-meter readings (i.e., dissolved oxygen, temperature, pH, conductivity and specific conductance) were taken at 0 m and 100 m. Other readings included slope, habitat observations, and pool-riffle ratios.

Data Entry

After the data were collected, we transferred the data to Excel and created figures describing the results. When more than one data point was collected, a mean and standard error for each variable within the reach was determined and graphed into figures (Appendix A). Substrate size class determinations were performed using the Wentworth grain size scale, which provides a phi value (Φ) for any given substrate (Wentworth 1922). Figures for Wentworth Scale averages for substrates within each stream reach were also plotted (Appendix B).

Project Outcomes

At the onset of our project, we knew that we would encounter a few dry creeks owing the extensive drought affecting the region. As a result, we were only able to sample four of the nine creeks surveyed. Alder Creek, Black Canyon Creek, Fox Creek and Escondido Creek were the only creeks with flowing water (Appendix C). There is a possibility that East and West Fork Santa Cruz creeks had water, but due to remoteness in the LPNF backcountry we were unable to access most of it. The physical and chemical measurements taken at each of the streams suggest that most of the creeks were suitable for fish (Table 1). Ideal habitat requirements for rainbow trout (*O. mykiss*) include clear, cold water, with rocky substrates in riffles and pool-riffle ratios of approximately 1 (Raleigh et al. 1984). Substrate characteristics at each creek indicate that Alder, Fox, Escondido and Black Canyon consist of large pebbles, large gravel, large gravel and medium gravel, respectively (Appendix B).

Table 1. Physical and chemical parameter values for creeks with water present.

Stream	Reach Depth (m)	Current Speed ($m \cdot sec^{-1}$)	Canopy Cover (%)	Water Temperature (°C)	Dissolved Oxygen ($mg \cdot L^{-1}$)	Conductivity ($\mu S \cdot cm^{-1}$)	pH	Substrate Size (Φ)	Pool Riffle Ratio
Fox Creek	0.10±0.02	0.05±0.02	97.0±0.83	18.3±0.95	7.98±0.40	513.5±13.50	8.26±0.09	-3.90±2.48	5.39
Black Canyon Creek	0.06±0.02	0.00±0.00	86.0±2.55	20.7±2.80	6.32±1.45	1740.0±37.00	7.85±0.41	-1.94±1.58	45.95
Escondido Creek	0.18±0.15	0.01±0.00	96.0±0.87	16.2±0.30	6.47±0.29	677.0±7.00	7.86±0.14	-3.52±2.16	3.35
Alder Creek	0.23±0.10	0.02±0.01	95.0±0.91	17.1±0.30	5.36±1.10	728.5±0.50	8.295±0.37	-5.12±1.37	2.13

Black Canyon, a tributary to Santa Cruz Creek, was a fairly stagnant creek with overgrown cattail (*Typha* sp.) along majority of the reach (Appendix C). This was the only creek that was sampled and was heavily impacted by the Zaca Fire as evident by the reduced canopy cover (Appendix A). Average substrate size at Black Canyon was smaller than the rest of surveyed creeks and could be the result of the wildfire that burned through. The finer sediments do not provide suitable rearing habitat for rainbow trout (*O. mykiss*) and thus the likelihood of their

presence is slim. Additionally, Black Canyon had a very high pool-riffle ratio which is also unsuitable for rainbow trout (*O. mykiss*) (Table 1). We did not find evidence of trout in Black Canyon Creek, and the presence of tadpoles may indicate the absence of trout.

Fox and Escondido Creek had similar average depths, canopy cover, pool-riffle ratios and substrate characteristics. It appears that both of these creeks were unaffected by the Zaca Fire thus providing the stream with sufficient riparian vegetation. Despite having favorable conditions for fish, we did not find the presence of fish in either creek.

The only stream containing trout was Alder Creek. The headwaters of Alder Creek serve as a source of water for Jameson Lake, which provides municipal water for the City of Montecito. Alder flows past Jameson Lake into the Santa Ynez River; however, there is a diversion dam that is roughly 12 feet tall that diverts some of that water into Jameson Lake. At the bottom of the debris dam we saw one single adult fish; however, upstream were multiple juvenile fish that appeared to be rainbow trout (*O. mykiss*). This supports Limburg and Waldman (2009) argument that dams have adverse effects on fish communities by disconnecting and isolating them.

Conclusion

Continued stream monitoring is a necessity at the LPNF and will inform future restoration efforts, including the systematic removal of dams that historically served as debris basins, and in some cases as water sources for campgrounds. As noted by our results, many creeks are now dried up and will continue to remain parched until the drought subsides in the future. Our results showed that most streams with flowing water are on north facing slopes that are shaded and have intact riparian vegetation that was unaffected by the Zaca Fire, making them more suitable as fish habitat. Additional work at the streams that future interns could do is the biological sampling

(invertebrate sampling and nutrient analysis) we were unable to complete as well as fish counts at Alder Creek.

Working for the LPNF in the Santa Barbara Ranger District has allowed me to continue to develop my skills in the field as well as working and collaborating with others. I have gained insights into different sampling techniques used by fisheries biologist. Additionally, I learned about the numerous issues that the Forest Service must contend with in resource management. I believe that this internship has prepared and made me more qualified to work for the Forest Service and similar government agencies.

References

Helfman GS. 2007. Fish conservation: A guide to understanding and restoring global aquatic biodiversity and fishery resources. Island Press.

Limburg KE, and Waldman JR. 2009. Dramatic declines in North Atlantic diadromous fishes. BioScience 59: 955–965.

Raleigh RF, Hickman T, Solomon RC, Nelson PC. 1984. Habitat suitability information: Rainbow trout. US Fish and Wildlife Service. FWS/OBS-82/10.60. 64 pp

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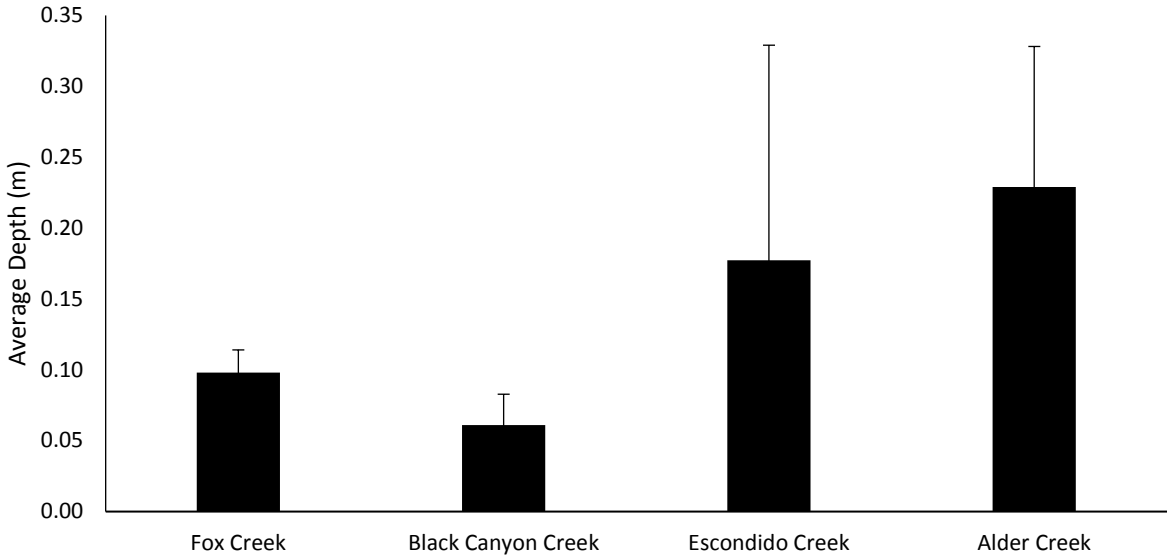
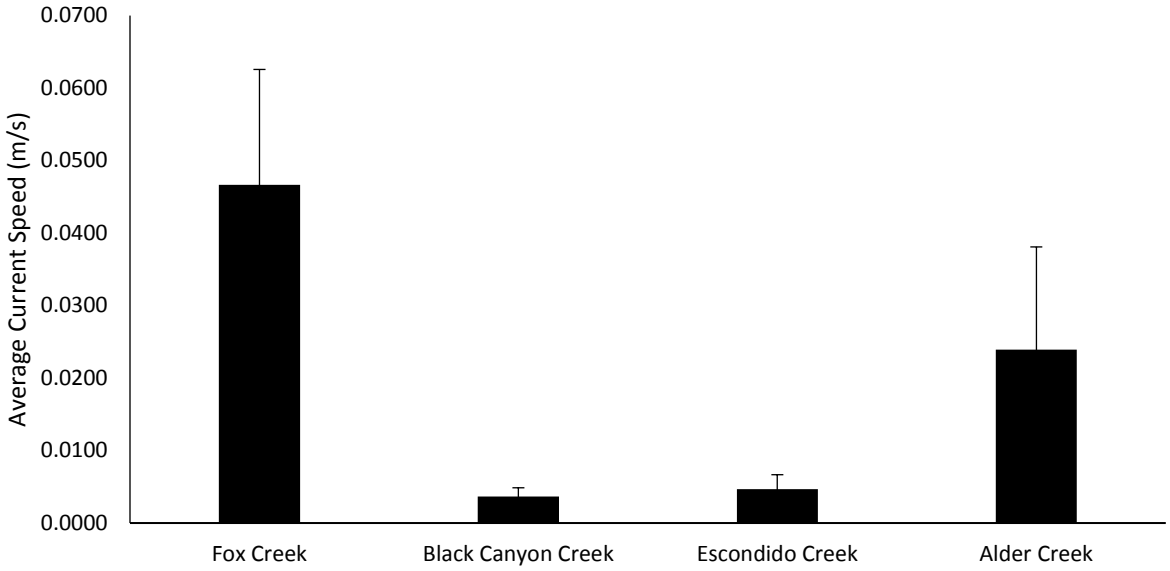
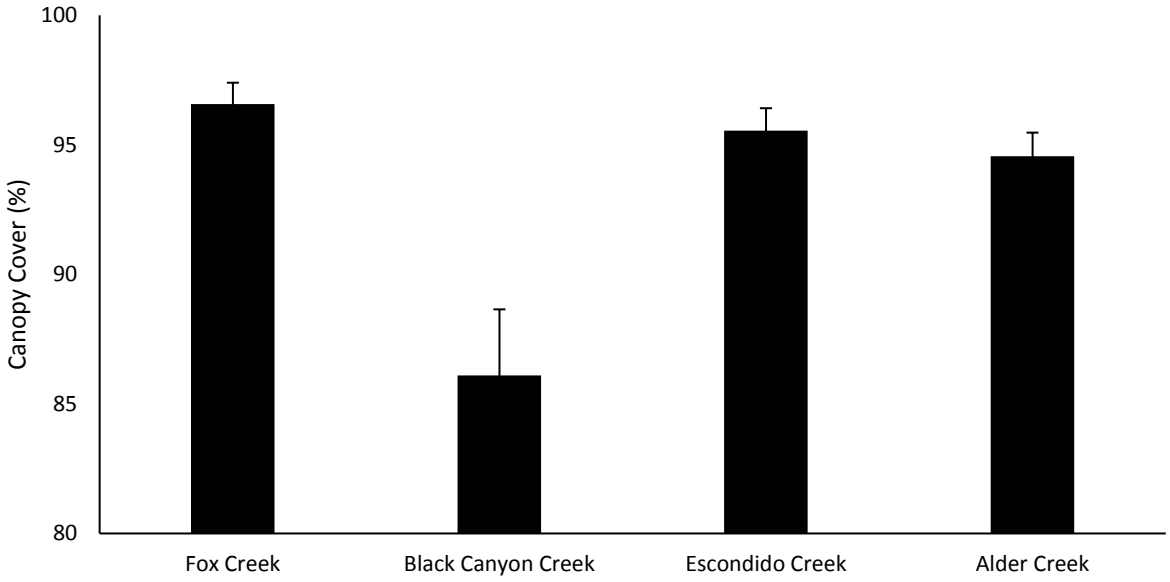
Appendix

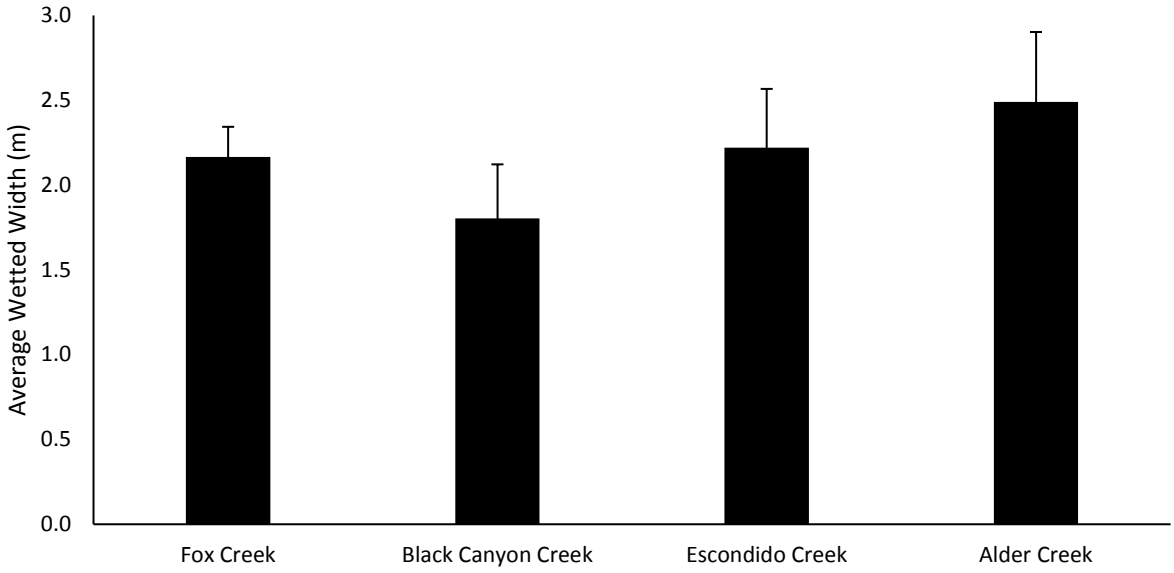
Appendix A

Figure 2. Average stream depth, current speed, canopy cover and wetted width for Fox, Black Canyon, Escondido and Alder Creeks on the LPNF.






100
95
90
85
80
Canopy Cover (%)
Fox Creek
Black Canyon Creek
Escondido Creek
Alder Creek

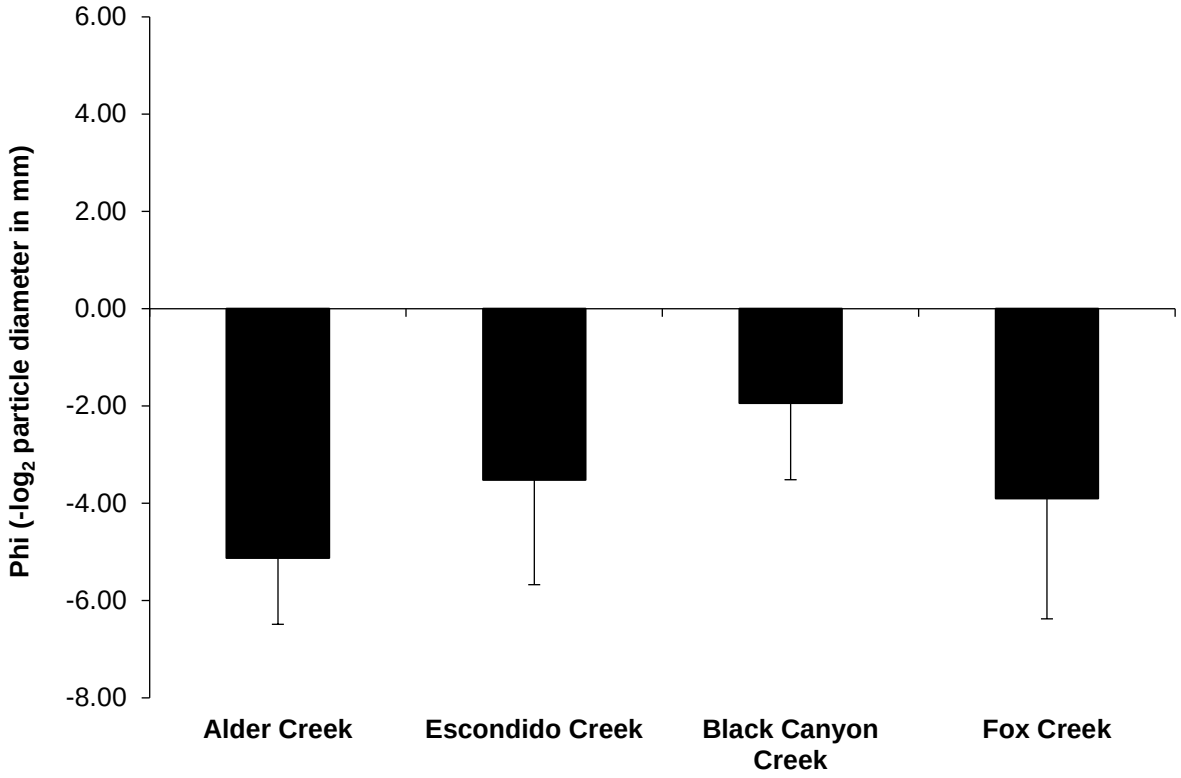

3.0
2.5
2.0
1.5
1.0
0.5
0.0
Average Wetted Width (m)
Fox Creek
Black Canyon Creek
Escondido Creek
Alder Creek

Appendix B

Table 2. Wentworth Scale (Φ) values

Boulder	-8
Large Cobble	-7
Small Cobble	-6
Large Pebble	-5
Small Pebble	-4
Coarse Gravel	-3
Medium Gravel	-2
Fine Gravel	-1
Very Coarse Sand	0
Coarse Sand	1
Medium Sand	2
Fine Sand	3
Very Fine Sand	4
Silt	5

Figure 3. Average substrate diameter at sampled streams.



Appendix C

Figure 4 - Downstream and Upstream View at Escondido Creek
Escondido Creek - July 15, 2016
Santa Barbara County, California
Coordinates: 34.47761, -119.5672

Figure 5 - Downstream and Upstream View at Black Canyon Creek
Black Canyon Creek - July 11, 2016
Santa Barbara County, California
Coordinates: 34.63214, -119.7657

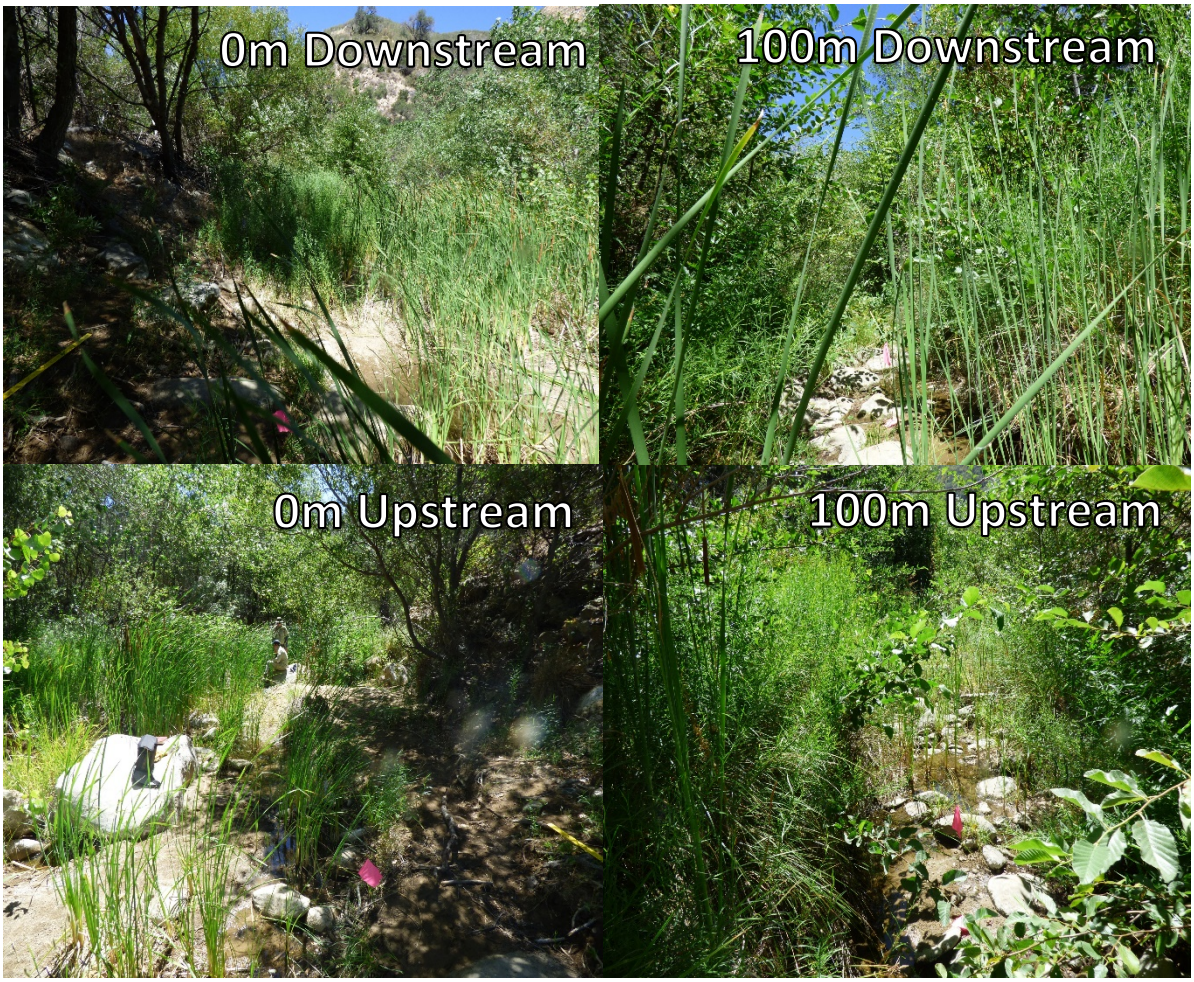


Figure 6 - Downstream and Upstream View at Alder Creek
Alder Creek - July 27, 2016
Santa Barbara County, California
Coordinates: 34.482978, -119.495123

Figure 7 - Dowsntream and Upstream View at Fox Creek
Fox Creek - July 11, 2016
Santa Barbara County, California
Coordinates: 34.485475, -119.529084