Effects of Wildfire on Amphibian and Aquatic Insect Biodiversity in Riparian Ecosystems in the Santa Monica Mountains

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Abstract

Wildfires in Southern California are increasing in frequency and intensity, causing devastating effects on flora and fauna. Previous studies have shown that wildfires increased the most over chaparral ecosystems (Arkle & Pilliod, 2010). An important element of the Santa Monica mountain (SMM) chaparral is the riparian zone surrounding streams. We examined the impact of wildfires on amphibians and aquatic insects in riparian ecosystem streams in the SMM by determining the biodiversity of different species before and after the 2018 Woolsey Fire. We hypothesized that the streams in burned areas would contain higher biodiversity overall because succession and lack of competition often occur with natural disturbances such as wildfire. Six streams in the coastal SMMs were surveyed monthly from February to June 2022. Three streams in burn zones served as the experimental group and three streams in unburned zones served as the control group. Within each stream we categorized sections according to water flow, measured with a flowmeter as: riffle, run, or pool based on fastest to slowest flow rate. We recorded species occurrence and abundance at each section of each stream and measured stream section metrics using a meterstick and a DistoTM E7500i Rangefinder. We found that biodiversity overall in the burned sites was not significantly different from that in the unburned sites. However, there were several species of amphibians and aquatic insects whose abundances were affected, including the near-threatened California Newt. These findings suggest that the population dynamics of several riparian animal species may change in response to wildfire in chaparral ecosystems.

Introduction

Numerous studies have shown that stream morphology heavily correlates with biodiversity within riparian ecosystems (Goutte et al., 2017). One natural disturbance that affects stream morphology greatly is wildfire (Stella & Bendix, 2019; Bateman & Merritt, 2020). Some consequences of wildfires on riparian ecosystems include the increase of ultraviolet radiation on the water's surface, the increase of pesticides in stream water, the increased prevalence of tadpoles with DNA damage, and an increased decline of specialist amphibian species (da Rocha et al., 2020). From this, we studied the effects of wildfire on stream morphology and biodiversity within six streams of the Santa Monica Mountains. The riparian ecosystems of the Santa Monica mountains are surrounded by chaparral shrublands, which have seen a 38% increase in wildfire frequency, the largest increase of any ecosystem in California (Calhoun et al., 2021). The wildfire that allowed this project to come to fruition was the devastating and unprecedented 2018 Woolsey Fire. In the years following the fire, signs of secondary succession occurred and the affected ecosystems have slowly been recovering. We aimed to observe and document the recovery of three riparian sites and compare them to three non-burned riparian sites. We not only would compare the biodiversity between sites according to their burn status, but also perform temporal comparisons between all six sites of the years 2017 and 2022 to see the status of riparian populations before and after the Woolsey Fire. The three burned stream sites included Newton Creek, Upper Arroyo Creek, and Trancas Creek. The three unburned stream sites included Piuma Creek, Upper Cold Creek, and Tuna Creek. The observation and analysis of these creeks allowed us to develop trends and observations for the effects of wildfire on stream morphology and overall riparian biodiversity. From our observations, we were able to narrow our findings to six key observations. We found that the average percent cover of pools in burned and unburned stream sites had decreased by at least 15% between 2017 and 2022. We also discovered that the mean total adult amphibian abundance per 10 meters of linear length was far greater in May 2022 than in May 2017 as a result of wildfires. Finally, while we were unable to confirm many of our trends due to far too numerous variables being present during the times of data collection as well as variables not taken into account, there were numerous animals that we concluded had been affected by the Woolsey Fire, including the California Newt, dragonfly larvae, California and Pacific tree frogs, and their tadpole larvae.

Methods

- 6 stream sites were used, with 3 sites being burned by the 2018 Woolsey Fire and 3 sites being unburned by the 2018 Woolsey Fire
- Each stream was measured monthly from February-June 2022, producing
- Divided streams up into three different sections according to flow speed from largest to smallest: riffle, run, pool
- For each section, a meter stick was used to measure the depth of the stream section and a DistoTM E7500i Rangefinder was used to measure the width and length of the stream section
- To observe and record amphibian and aquatic insect abundances, a transect was performed on each stream to a minimum of 150 meters with a radius of 1 meter to the left and right of the stream
- For each stream, the largest flow was located, which differed from stream to stream, and its flow and metric parameters were measured using a flowmeter and meterstick, which we then used to determine the volume flow rate
- For each stream, the pH, turbidity, and water temperature were measured using the Oakton PCTSTestr™ 50 waterproof probe

Results

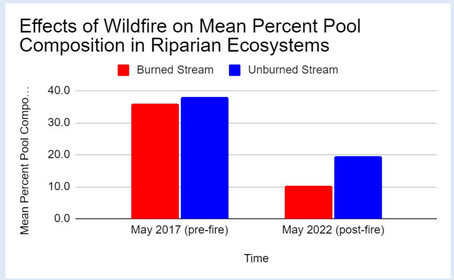


Figure 1. Graph illustrating the effects that wildfire has on the percent pools cover on average in burned and unburned streams before and after a wildfire. Burned sites have less canopy cover have greater evaporation, so there is less water.

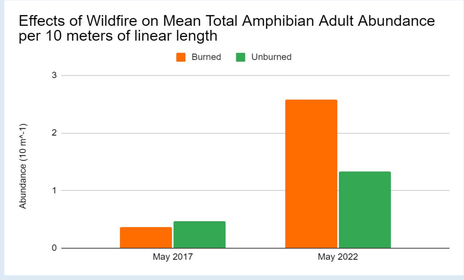


Figure 2. Graph depicting the effects of wildfire on the total amphibian adult abundance per 10 meters of linear length on average. Adult amphibian abundances greatly increased in burned sites due to wildfire.

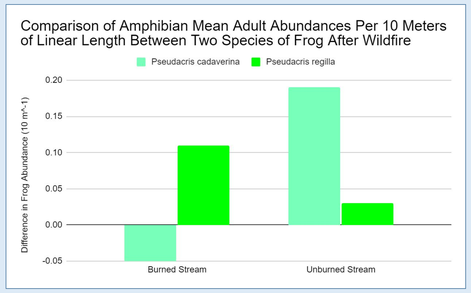


Figure 3. Graph comparing the amphibian mean adult abundance per 10 meters of linear length between the Pseudacris cadaverina and Pseudacris regilla. P. regilla seemed to benefit more from the wildfire than P. cadaverina.

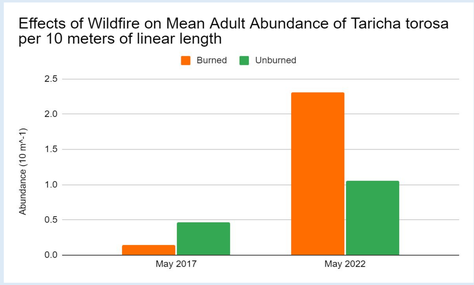


Figure 4. Graph displaying the effects of wildfire on the mean adult abundance of Taricha torosa per 10 meters of linear length. T. torosa seems to have benefited greatly from wildfire in burned sites.

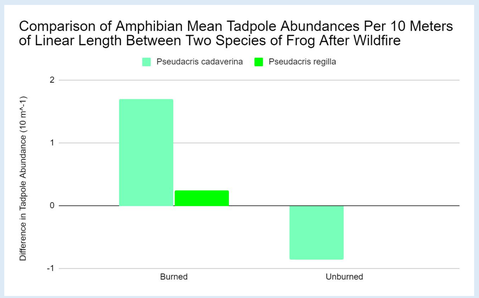


Figure 5. Graph contrasting the amphibian mean tadpole abundance per 10 meters of linear length between the tadpoles of P. cadaverina and P. regilla. P. cadaverina tadpoles seemed to benefit more from the wildfire.

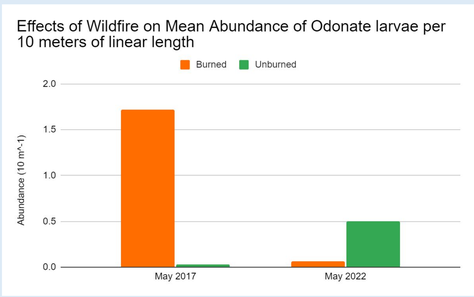
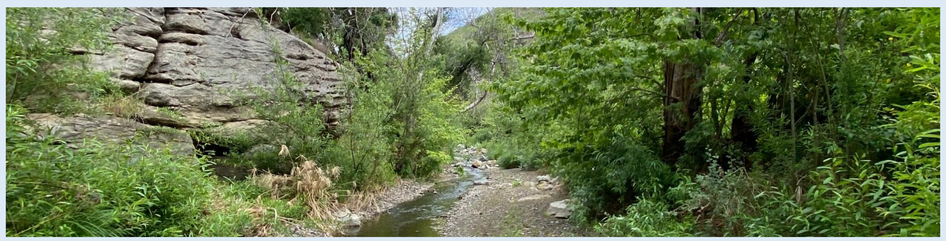


Figure 6. Graph emphasizing the effects of wildfire on the mean abundance of odonate larvae per 10 meters of linear length. The presence of wildfire was very detrimental to odonate larvae populations in burned sites.



Discussion

- Geomorphology and biodiversity in streams affected by the Woolsey Fire were different compared to unburned streams.
- Species such as California Newt, Pacific Tree Frog, and California Tree Frog tadpoles were better adapted to wildfires and their abundance increased, while species such as California Tree Frog, Pacific Tree Frog tadpoles, and dragonfly larvae were not well adapted to wildfires and their abundance decreased.
- The reasons for different species adapting to wildfires are unknown but likely related to recent changes in climate and wildfire frequency in the last two decades (Miller et al., 2018).
- Some changes in species abundance and water levels in unburned sites were attributed to rainfall, evapotranspiration, and temperature instead of wildfire.
- More research is needed to classify the severity of events in riparian ecosystems and understand the many variables, including water flow, vegetation, competition, water quality, rainfall, and temperature.
- Collecting more data in the future would be helpful for trend analysis and understanding correlations between water flow, levels, rainfall, wildfire, and amphibian and aquatic insect behavior.
- This research can assist in preserving riparian ecosystems in the Santa Monica Mountains and preventing high fire frequency where possible to conserve these animals.

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Acknowledgements

We thank Dr. Lee Kats, Dr. Thomas Vandergon, Daphne Green, Michael Kruel, the U.S. Geological Survey, the Summer 2022 USGS team, as well as the Pepperdine Natural Science Division for their assistance and guidance with this project. This research was funded by Pepperdine University and the Natural Science Division.