Fire & First Flush Effects on Salmonid Habitat in a Coastal Watershed

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Introduction

In August 2020, the CZU Lightning Complex fire burned more than 350 km^2 (86,500 acres) of coastal forests and hills in the Santa Cruz Mountains region (Santa Cruz and San Mateo counties, California). Among the watersheds severely affected by wildfire was Scott Creek, a small (70 km^2) coastal basin ~ 80 km south of San Francisco Bay (Fig.1). The Scott Creek watershed is of special management concern as it supports the southernmost extant population of coho salmon (*Oncorhynchus kisutch*; Central California Coast [CCC] evolutionarily significant unit) in North America, as well as federally threatened CCC steelhead (*O. mykiss*). Scott Creek is also the location of a salmonid life cycle monitoring station operated jointly by NOAA's Southwest Fisheries Science Center and the University of California, Santa Cruz. Extensive physical, chemical, and biological monitoring conducted throughout the Scott Creek watershed since 2002 provides a unique opportunity to rigorously examine the direct and indirect effects of wildfire on salmonid productivity and carrying capacity. Here we highlight initial findings from sampling conducted soon after the fire in the fall of 2020, and likewise following the onset of winter rain and the first flush event.

Methods

Physical and biological datasets were collected at previously established 100 m index reaches in the Scott Creek watershed (Fig. 2; pink circles). Five additional reaches were established above and below tributary inputs specifically to monitor and characterize sediment change (Fig. 2; green circles). There were 32 total transect locations.

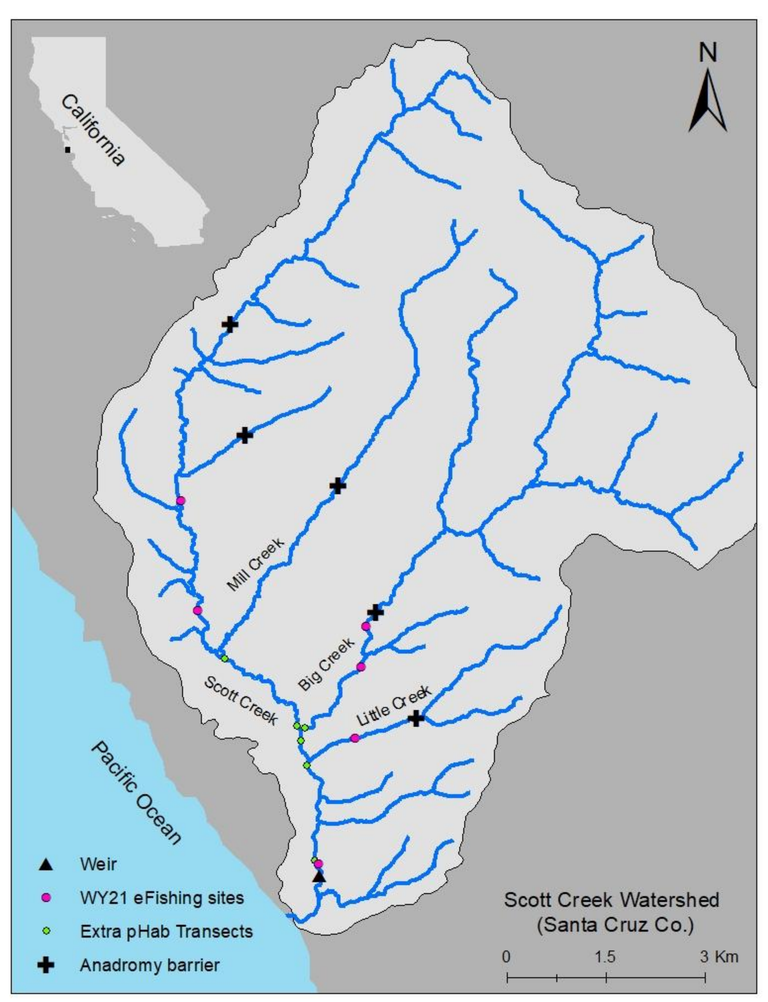

Figure 2: Scott Creek watershed sampling sites.

Data collection timeline:

<u>First round of data collection:</u>
(*Post-fire, pre-rain*) 10/21/2020–11/23/2020

- Salmonid abundance (3-pass depletion eFishing)
- Basal carbon sources (leaf litter)
- Pebble counts (Fig. 3)
- Habitat typing
- % shade

First post-fire rain event: 1/26/2021

<u>Second round of data collection:</u>

- Pebble count (2/24/2021–3/4/2021)
- Water quality (1/1/2021–present)

Figure 3: Sampling frame (0.5 m^2) and gravelometer used during pebble count data collection.

Results

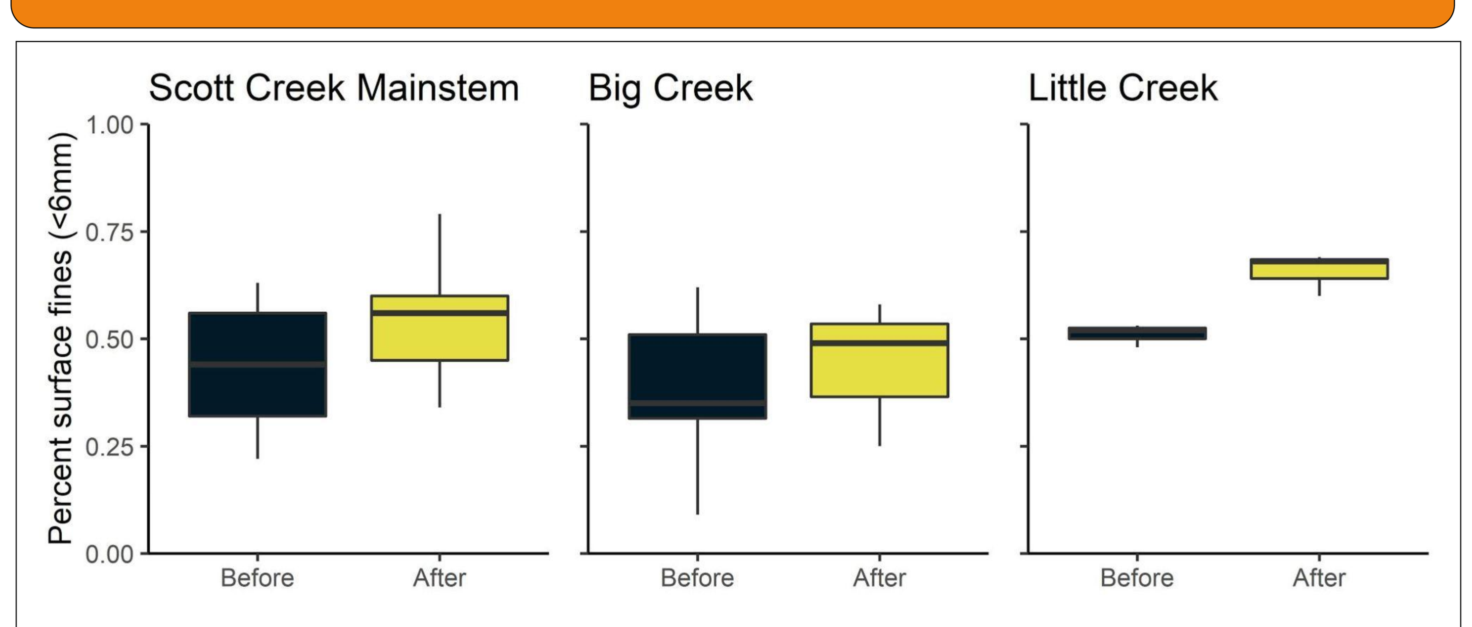

Figure 4: Box-and-whisker plot showing percent surface fine-sediment (<6mm) increase after the first major post-fire rain event, measured from February 24, 2021–March 4, 2021. Horizontal lines in boxes are medians, box-ends are quartiles, whiskers are 5% and 95% confidence intervals. Before data measured from October 21, 2020–November 23, 2020.

Figure 1: Right- ESRI Aerial Imagery of Scott Creek watershed pre-fire (Autumn 2019); Left - Google Earth Aerial Imagery of the same extent post CZU fire (September 2020).

Figure 5: Severe wildfire damage in the riparian zone on Big Creek tributary before (left photo; September 2017) & after fire (right photo; November 2020), looking upstream.

Figure 6: Substantial fine sediment deposit on upper Scott Creek mainstem bank following winter storm event, photo taken on April 8, 2021.

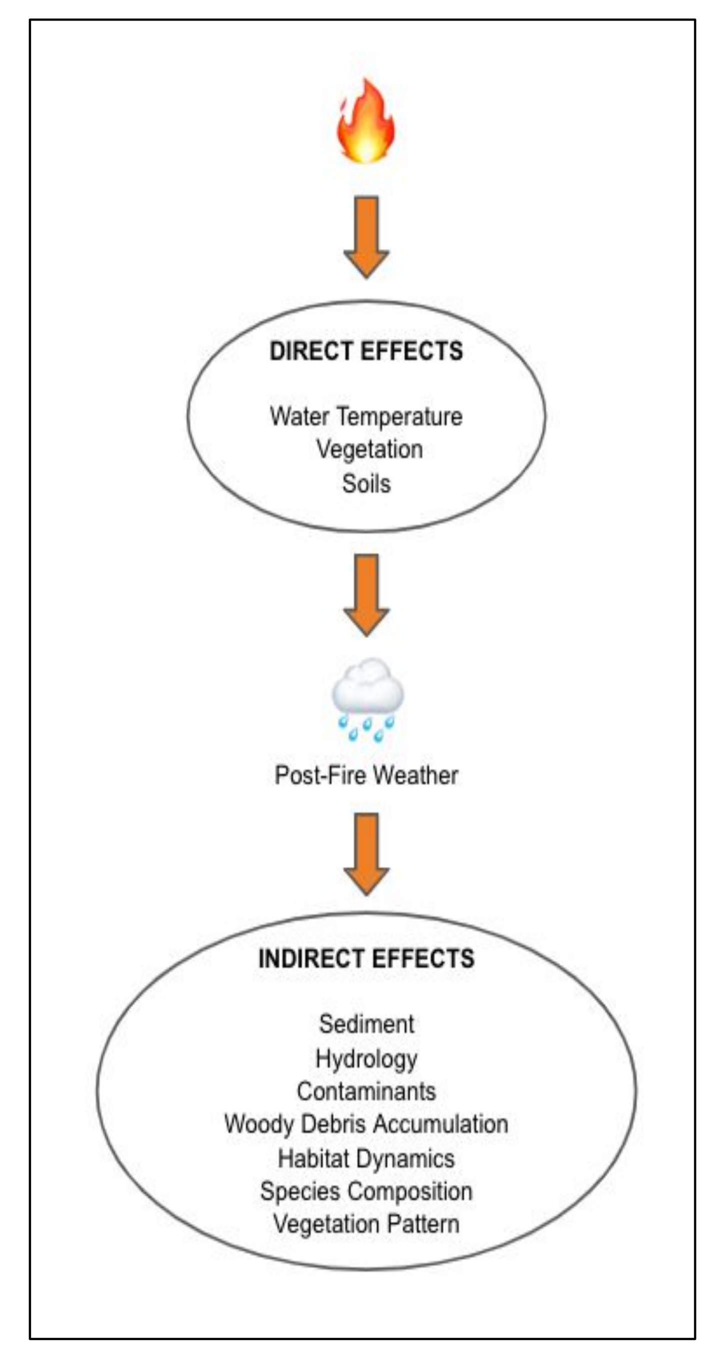

Figure 7: Wildfire effects on terrestrial and aquatic ecosystems (modified from Gresswell, 1999).

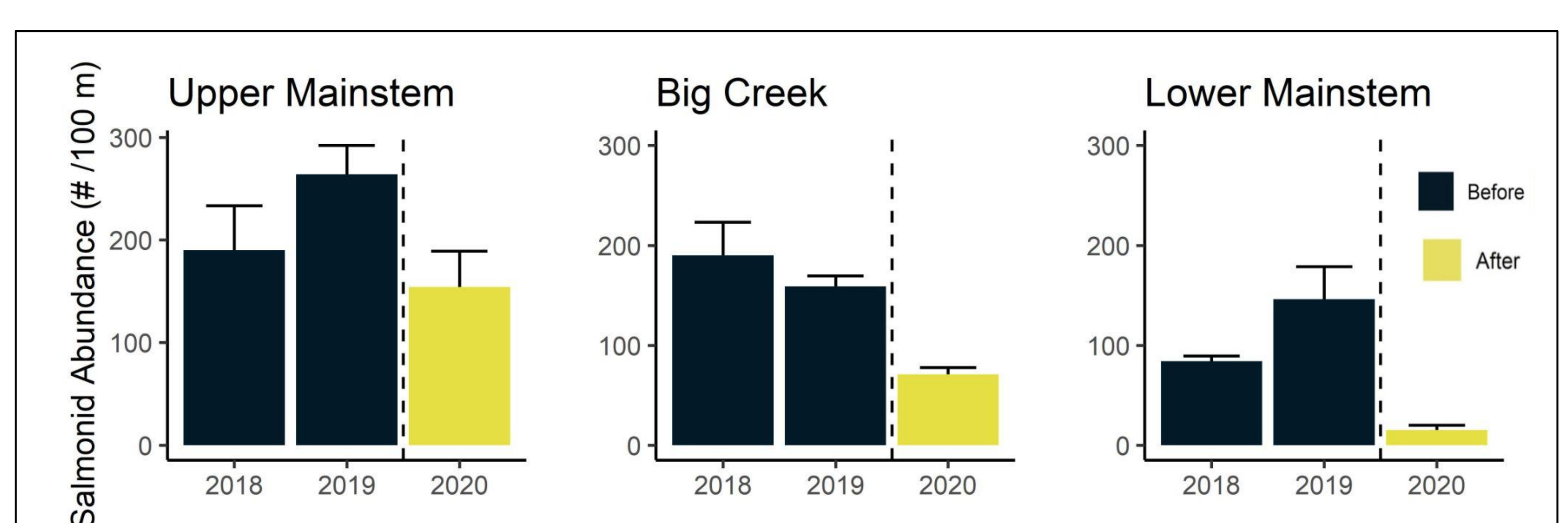

Figure 8: Bar graph showing general decline in total salmonid abundance (+ 95% CI). Data were derived from three-pass depletion electrofishing in three reaches (Upper mainstem, Big Creek, and Lower mainstem) during autumn. 2018 and 2019 data represent pre-fire conditions, whereas 2020 represents post-fire and pre-rainfall.

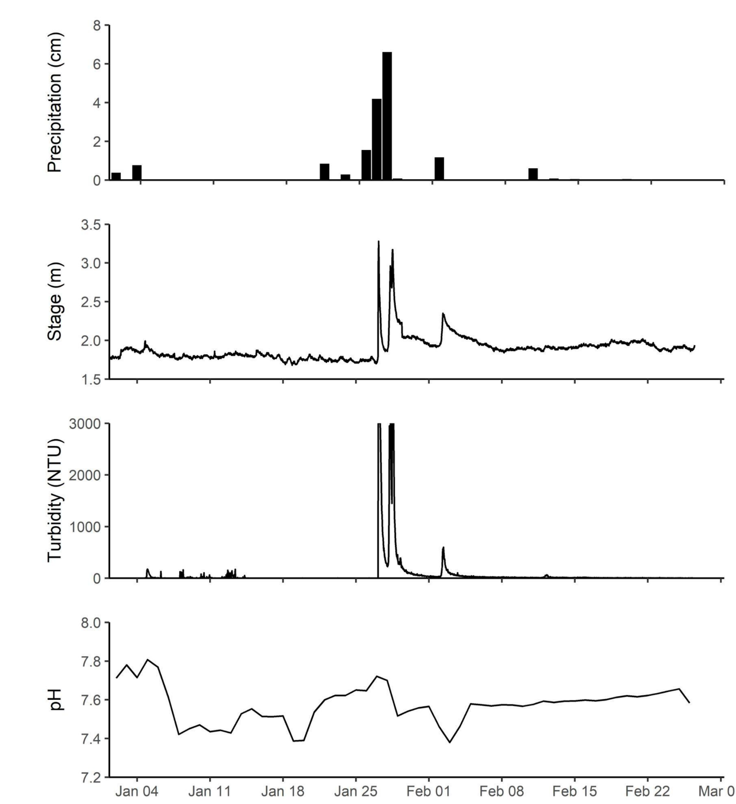

Figure 9: Time series of precipitation, stage height, turbidity, and pH. Water quality parameters were collected on lower mainstem Scott Creek.

Figure 10: Extensive sediment flow at the confluence of Big Creek (foreground) and Scott Creek mainstem (background) following the first major post-fire rain event (January 27, 2021).

Current Outcomes and Future Direction

Extensive watershed-wide increase in fine sediment (<6mm) distribution

- Even the smallest rain events are mobilizing fine sediment
- Overall % surface fines (<6mm) increased across all sampling locations (Fig. 4)
- Sediment deposition (Fig. 6) → habitat degradation[1] → fills in pools, fills in cobbles
- Sediment suspension (Figs. 9 & 10) → blocks fish gills, decreases oxygen for fish redds[4], increases invertebrate drift[5]

General decline in salmonid abundance following the fire

- Salmonid abundance declined following the fire but before any rain event (Fig. 8)
- Smoke and ash fallout have immediate effects on stream water quality. Concentrations of ammonium, nitrate, and phosphate can increase immediately following ash input[2]
- The Scott Creek system may have experienced increased exposure to these nutrients for at least over one month while the fire burned
- Prolonged exposure to these nutrients can lead to food web disturbances and fish toxicity[3]
- More data is needed to understand the impacts of ash input on riverine organisms

Next steps

Comprehensive physical and biological sampling will continue in Summer 2021 and beyond

- Pebble counts
- Electrofishing
- Food web sampling studies
- Canopy loss
- Nutrients (Paytan Biogeochemistry Lab)
- Fish toxicity (USGS Pacific Coastal Marine Science Center)

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