Wildfire and Mudstone: Fine Sediment Input One Year Post-wildfire in a Coastal California Stream

Rosealea Bond, Marelle Arndt, Adrienne Chenette, Jeffery Perez, Alexander Hay, Cynthia Kern, Joshua Meko, Joseph Kiernan

1. Fisheries Collaborative Program, Institute of Marine Sciences, University of California, Santa Cruz. 2. Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 3. Watershed Stewards Program

PRESENTED AT:

AGU FALL MEETING
New Orleans, LA & Online Everywhere
13–17 December 2021
Poster Gallery brought to you by WILEY

INTRODUCTION

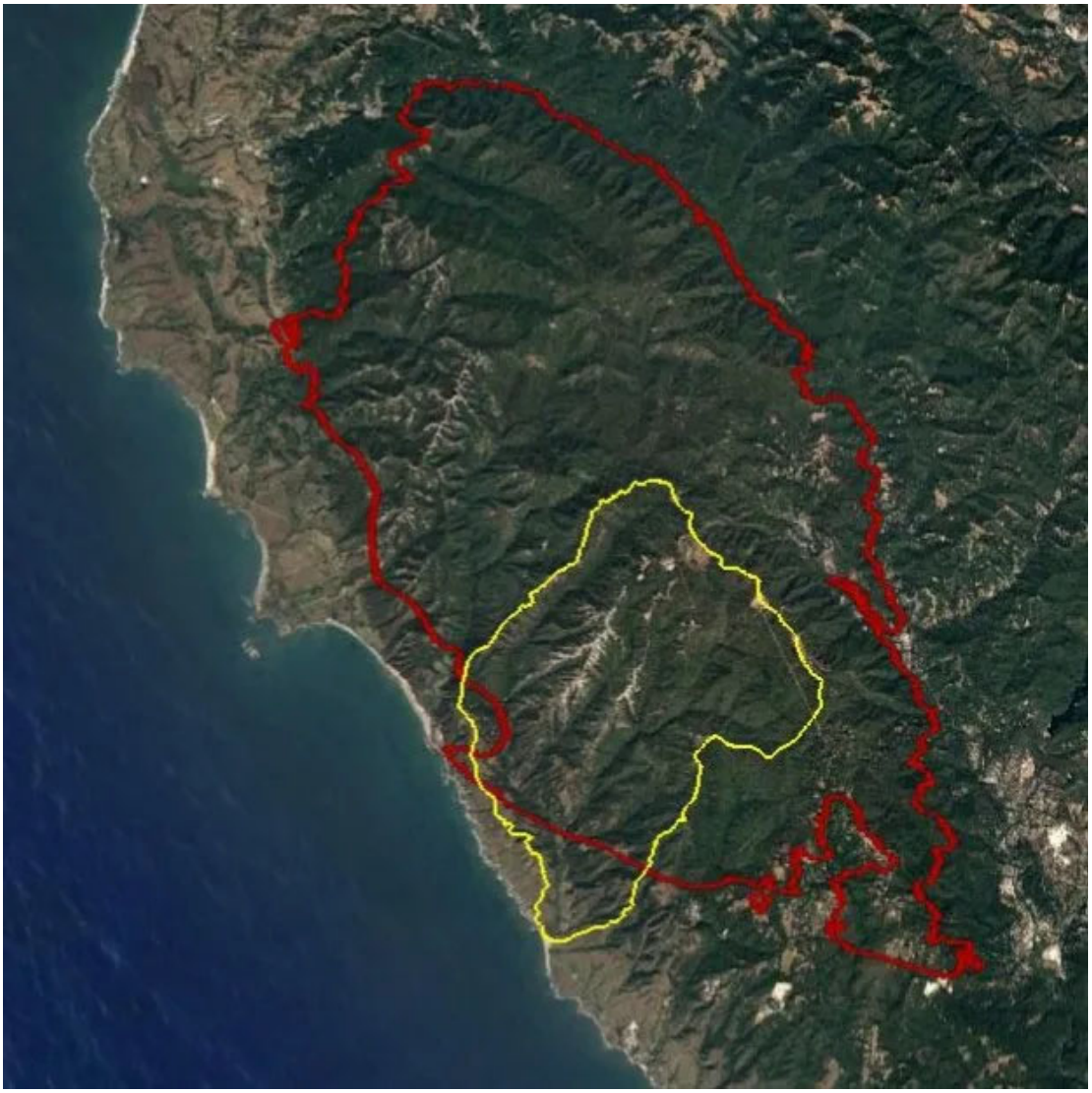

Fig. 1 Approximately 87% of the Scott Creek Watershed (yellow outline) was within the CZU Lightning Complex fire perimeter (red outline).

Debris flows after wildfires can significantly impact watershed processes and may be beneficial and(or) detrimental to aquatic biota at varying spatiotemporal scales. **Land managers are especially concerned about elevated fine sediment (<6mm) inputs** in streams directly after wildfires which can negatively affect habitat quality, nutrient cycling, and population viability. Fine sediment fluxes are highly variable, therefore additional research is needed to investigate potential shifts in geomorphic, biogeochemical, and ecosystem structure at the landscape scale.

In August 2020, the CZU Lightning Complex fire burned more than 350 km2 of coastal forests and hills in the Santa Cruz Mountains region (Santa Cruz and San Mateo counties, California, USA). Among the watersheds severely affected was Scott Creek, a small (70 km2) coastal basin, where approximately 87% of the watershed was within the fire perimeter (Fig 1). Post-fire

watershed assessments by multiple agencies identified (1) **significant amounts of bare soil and unstable slopes**, (2) extensive moderate to high soil burn severity (SBS; 61.5% and 21.2% respectively), and (3) predicted a high likelihood of debris flows in subsequent storm events **throughout the Scott Creek watershed** (State of California Watershed Emergency Response Team 2020).

Scott Creek is of special management concern as it supports the southernmost extant population of endangered coho salmon (*Oncorhynchus kisutch*; Central California Coast [CCC] evolutionarily significant unit) in North America, as well as federally threatened CCC steelhead (*O. mykiss*; Fig. 2). **Both species rely on clean gravels** at multiple life stages; especially for spawning (i.e., reproduction), egg incubation, and juvenile rearing. Increased sedimentation from anthropogenic sources have been identified as a major contributing factor to the decline of salmonid populations throughout their range" (National Marine Fisheries Service 2012).

Fig. 2 Adult coho salmon (top photo) and steelhead (bottom photo) found in Scott Creek.

The Scott Creek watershed is dominated by Miocene aged Santa Cruz Mudstone (mudstone, siltstone, and sandstone) with Mesozoic granite in the upper portions of the mainstem and tributaries (Brabb 1989; Brabb, Graymer, and Jones 2000; Fig. 3). **Santa Cruz Mudstone is highly erodible and mobile** because it has a low particle density (Hecht and Golling 1982; Nicol et al. 2015). Major changes in sediment delivery post-wildfire could significantly impact freshwater species that are already strained from other anthropogenic stressors.

Fig. 3 Fresh debris flow deposit (mixture of granite and mudstone) on top of channel bottom (mudstone).

Here we highlight initial findings from pebble count, turbidity, and juvenile salmonid sampling conducted throughout the Scott Creek watershed directly after the fire (Fall 2020) and one winter post-wildfire (Summer/Fall 2021). Our study was guided by the question, **"How does wildfire affect watersheds that are already highly erodible?"** Extensive physical, chemical, and biological monitoring has been conducted throughout the watershed and we plan to continue these efforts over the coming years. Although it may take multiple years to see the indirect effects of wildfire on freshwater biota, we report juvenile fish densities pre and post wildfire for some biological context.

METHODS

Fig. 4 The team used a half-meter sampling frame and gravelometers to collect pebble count data directly after the wildfire and one winter post-wildfire.

Datasets:

- Modified Wolman pebble counts were used to describe surface sediment sizes and detect changes in fine sediment throughout the watershed (Potyondy and Hardy 1994; Harrison et al. 2018; Figs. 4 & 5).

- Turbidity was monitored in the lower watershed ~100m below Station 1 (Fig. 5).

- Multipass depletion electrofishing was used to quantify juvenile salmonid densities at 6 100m index reaches concurrent with pebble counts (Fig. 5).

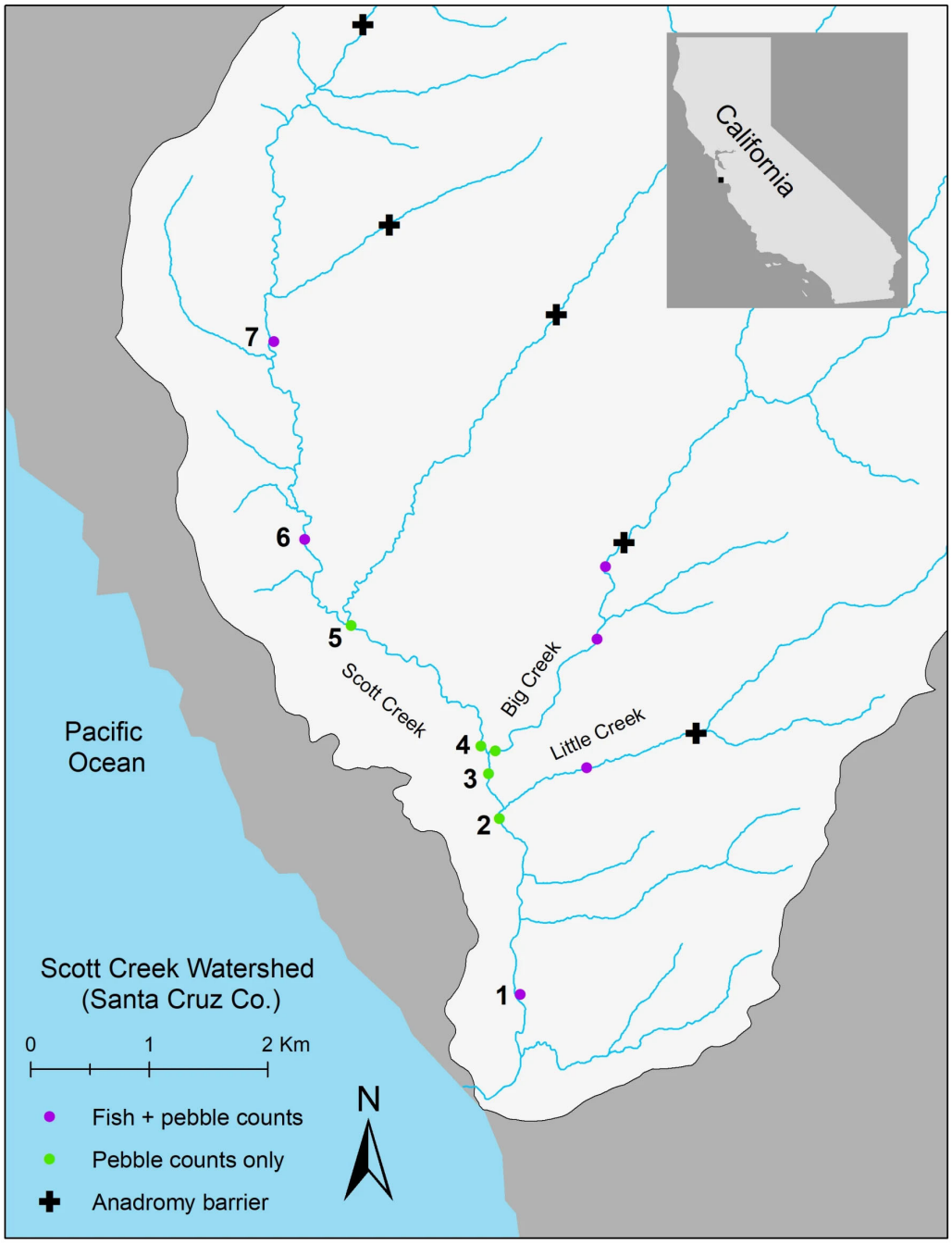

Fig. 5 Sampling locations for juvenile salmonids and pebble count transects (purple circles). Additional pebble counts transects were established above and below tributary confluences to monitor potential sediment changes (green circles). Numbers denote stations along the Scott Creek mainstem.

RESULTS

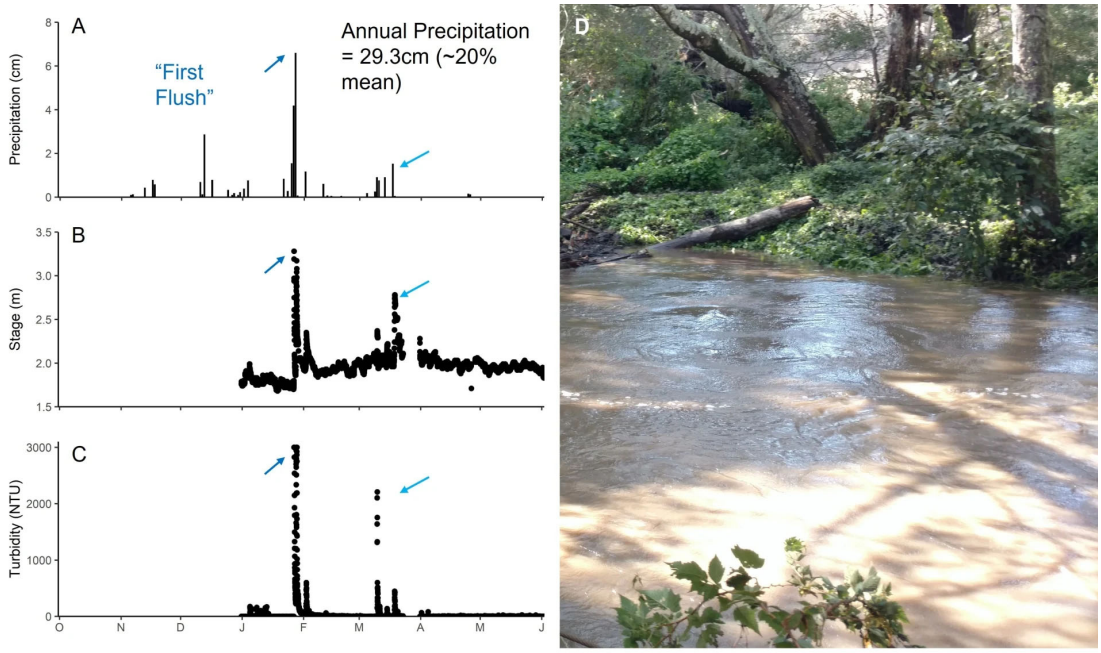

Fig. 6 Turbidity peaks with modest precipitation and changes in discharge in the lower mainstem Scott Creek (Panels A–C). Photo of a high turbidity event in the lower mainstem Scott Creek (Panel D).

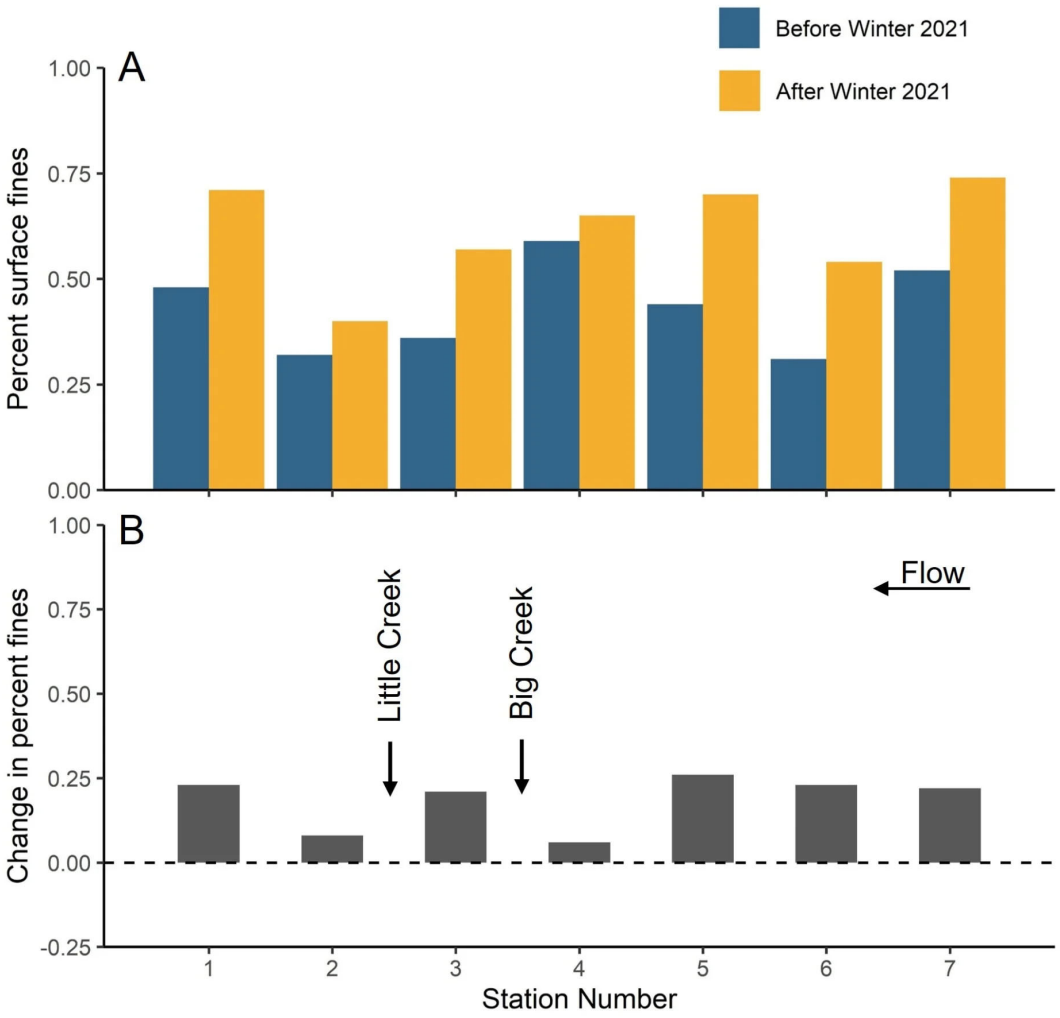

Fig. 7 Percent fines increased throughout the Scott Creek mainstem (Panel A) with highest increases in the upper mainstem (Stations 5–7) and directly below Big Creek (Station 3; Panel B), a major tributary which had documented debris flows. Note: Stations are not equally spaced along mainstem (variable rkm; see Fig 5 for locations).

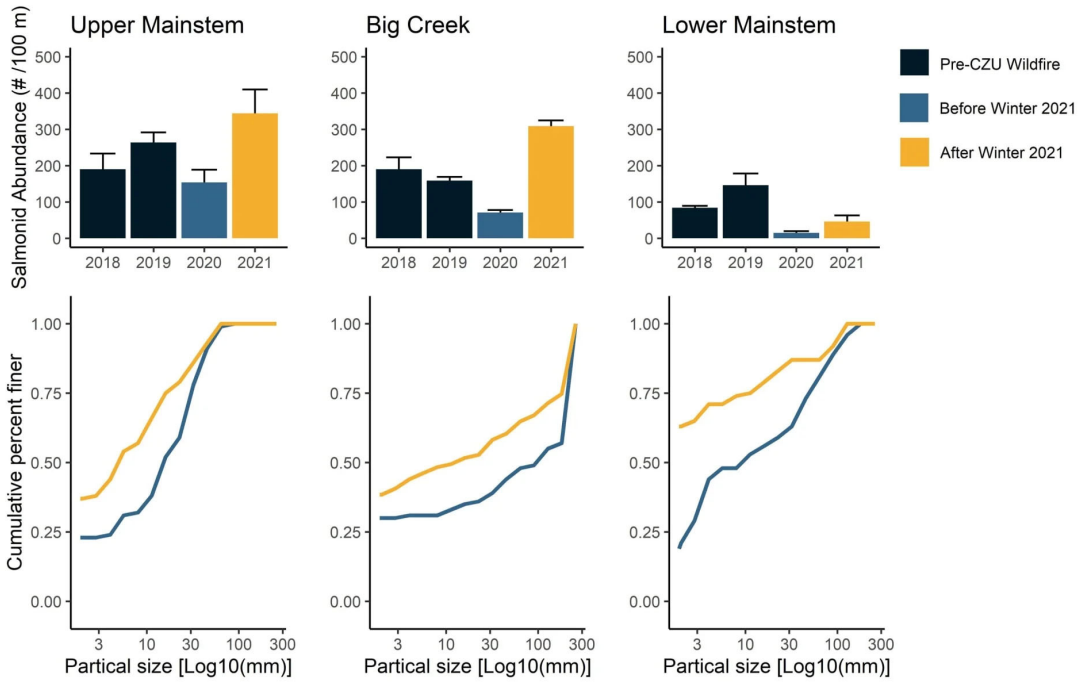

Fig. 8 Salmonid abundance (top panels) decreased directly after the CZU wildfire (blue bars) and increased one year post-wildfire (gold bars). The lower mainstem population didn't rebound as quickly as the other sites which may be related in-part to the large increases in percent fines (bottom panels) one year post-wildfire.

THE BIG TAKEAWAY

Large inputs of fine sediment were identified **throughout the watershed** despite limited precipitation.

FUTURE WORK

Scott Creek has served as a salmonid life cycle monitoring station since 2002, providing a unique opportunity to rigorously examine indirect effects of wildfire on salmonid productivity and carrying capacity. We plan to continue our monitoring efforts over the coming years.

Acknowledgements:

We thank Katie Kobayashi (UCSC) for the Summer 2021 juvenile salmonid data. We also thank California Polytechnic State University's Swanton Pacific Ranch and Big Creek Lumber Company for land access and their continued support of our research and monitoring programs.

AUTHOR INFORMATION

Rosealea Bond

Assistant Research Specialist

Fisheries Collaborative Program, IMS, UC Santa Cruz *affiliated with*
Fisheries Ecology Division, Southwest Fisheries Science Center, NMFS

Email: lea.bond@noaa.gov

Address: NMSF SWFSC 110 McAllister Way Santa Cruz, CA 95060

GitHub Profile: RMBond (https://github.com/RMBond)

ABSTRACT

In August 2020, the CZU Lightning Complex fire burned more than 350 km^2 (86,509 acres) of coastal forests and hills in the Santa Cruz Mountains region (Santa Cruz and San Mateo counties, California). Among the watersheds severely affected was Scott Creek, a small (70 km^2) coastal basin, where approximately 87% of the watershed was within the fire perimeter. Scott Creek 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 has served as a salmonid life cycle monitoring station since 2002, providing a unique opportunity to rigorously examine indirect effects of wildfire on salmonid productivity and carrying capacity. Extensive physical, chemical, and biological monitoring has been conducted throughout the watershed. Here we highlight initial findings from pebble count sampling conducted at 23 transects directly after the fire (Fall 2020) and one winter post-wildfire (Summer/Fall 2021). Despite limited precipitation (~20% of average yearly rainfall), we identified large inputs of fine sediment (< 6 mm) throughout the watershed. Percent fines increased on average 16% (min = -11%, max = 45%) after the first winter post-wildfire. The spatial distribution of fine sediment accumulation in the Scott Creek mainstem was mixed with highest increases in the upper watershed and directly below a major tributary which had documented debris flows.