Effectiveness Monitoring Committee Full Project Proposal Form

Full Project Proposals will be requested directly from Applicants by email with the due date clearly identified. In general, applicants will have one (1) month after notification to return the Full Project Proposal.

Project #: EMC-2024-002 **Date Submitted:** 07/24/2024

Project Title: Soil, plant, and hydrologic dynamics as indicators of ecosystem function and fire vulnerability across diverse forest health and fuel reduction treatments in the Coast Forest Southern Sub-District

Principal Investigator(s), Affiliation(s), and Contact Information (email, phone): Christina Richardson1, Adina Paytan1, Sasha Wagner2

1University of California at Santa Cruz, 1156 High Street, Santa Cruz, CA, 95060
2Rensselaer Polytechnic Institute, 110 8th St, Troy, NY 12180

Collaborator(s) and Affiliation(s): Stewart Wilson, California Polytechnic University
Grey Hayes, Swanton Pacific Ranch

Project Duration and Dates (MM/YY - MM/YY): 12/1/2024-3/31/2027

Written Proposal Requirements:

Please build upon the information provided in the Initial Concept Proposal, addressing each of the following for consideration by the EMC. For further information please see the Request for Proposals or consult sections 2.4, 4.0, and 5.0 of the EMC's Strategic Plan. Include figures, tables, or photos as needed.

1. **Project Description**
   a. **Background and Justification**
   b. **Research Questions, including Objectives and Scope**
2. **Research Methods**
3. **Scientific Uncertainty and Geographic Application, including monitoring locations**
   Please consult section 4.4 of the EMC's Strategic Plan for further information. Indicate the specific geographic locations, counties, or regions of the state to which this project may have benefits; if benefits are anticipated to apply across the state, indicate "Statewide". If the benefits are also anticipated to occur outside of the state, please explain.
4. **Critical Questions and Forest Practice Regulations Addressed**
   Please identify the Critical Questions by number and letter (as identified in the EMC's Strategic Plan), and any associated regulations by number. Please also describe how your project will address these questions and assess the efficacy of each regulation.
5. **Roles, Collaborations, and Project Feasibility**
   Please describe the roles of the Principal Investigators and collaborators and how the collaboration and affiliations will benefit the project and increase project feasibility.

6. Project Deliverables

Describe in a table the anticipated products that would be produced as a result of this research, including presentations, scientific papers, technical reports, analytical methods, or other products utilized to provide scientific translation of the research results. Include a timeline for when each item would be delivered to the EMC. See example table below:

ACTIVITY OR DELIVERABLE	TYPE		Year 1 *07/22–06/23*				YEAR 2 *MM/YY–MM/YY*				YEAR 3 *MM/YY–MM/YY*				ONGOING *MM/YY–MM/YY*			
	Act.	Del.	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Establish Study Sites	X		9															
Sampling	X			4				4				4						
Sample Processing	X			5				5				5						
Sample Analysis	X			6				6				6						
Project Update to funders/collaborators*		X				12		6		12		6		12				
Project Presentation to funders/collaborators*		X							8				8					
Final Project Presentation funders/collaborators*		X										6						
Completed Research Assessment (CRA) presentation to EMC*		X										6		12				
CRA presentation to the Board*		X										6		12				
Conference presentation(s)		X							9			2					7	
Submission of manuscripts to peer-refereed journals		X											7			6		
Graduate project(s) report submission(s)		X						5				6			3			

Key: A = Fiscal Year (FY) Quarter 1 (Jul 1–Sept 30); B = FY Quarter 2 (Oct 1–Dec 31); C = FY Quarter 3 (Jan 1–Mar 31); D = FY Quarter 4 (Apr 1–Jun 30)

Act = Activity; D = Deliverable

Include Month in the cell, if known; Identify months as numbers 1–12, Jan–Dec.

* REQUIRED CATEGORIES

7. Requested Funding

Please provide the total requested amount of funding along with a line item budget for each fiscal year of the project (see page 2). Please ensure that all "Categories" below are addressed in your budget. This will ensure that all information required by the state contracting process is present. You may break each "Category" into as many sub-categories as needed to fully describe your budget. Provide supporting documentation if desired. See sample table below:

Category	Description	Year 1	Year 2	Year 3	TOTAL
Personnel Salaries and Wages					
Fringe Benefits					
Contractual Expenses					
Operating Expenses					
Travel					
Other					
Indirect Costs					
EMC FUNDING REQUESTED*					
Matching or In-Kind Contributions					
Total Budget					

* REQUIRED

8. Additional Required Forms

a. ***Employer Identification Number (EIN).*** *Non-profit applicants shall provide Articles of Incorporation including the Seal from the Secretary of State. Business applicants shall provide proof of active business registration with the California Secretary of State.*
b. ***Letters of Support.*** *If collaborations or partnerships are noted in the proposal, letter of support or other forms of evidence that partners are aware of and in support of the proposed project should be provided.*
c. ***Sample Resolution.*** *If nonprofit or local agency, please provide a Sample Resolution (see example at https://www.fire.ca.gov/media/10181/calfire_fhgrants_resolution19_20.pdf).*
d. ***Nondiscrimination Compliance Statement –*** *Form Std 19 (https://www.documents.dgs.ca.gov/dgs/fmc/pdf/std019.pdf)*
e. ***Drug-Free Workplace Certification –*** *Form Std 21 (https://www.documents.dgs.ca.gov/dgs/fmc/pdf/std021.pdf)*
f. ***Payee Data Record –*** *Form Std 204 (https://www.documents.dgs.ca.gov/dgs/fmc/pdf/std204.pdf)*

Response to June 2024 EMC comments:

1) The research project proposes a large budget, and the EMC would like to see a modified proposal with a reduced budget where possible.

As suggested, we have reduced the baseline budget by ~$240,000 (40%). We have also presented the black carbon work as an optional add-on ($51,462).

Baseline study: $358,978
Black carbon add-on: $51,462

2) The EMC is concerned about the ambitious nature of the project. Please clarify how the project will ensure successful collection of all proposed data; there were concerns that even with the high budget, there may be difficulty in obtaining and completing all proposed data collection due to a relatively short timeline and highly variable environment.

We recognize that this project has a broad scope that demands unique expertise, but we feel that the project's reduction in site numbers and team of experts justifies the project's work plan, proposed datasets, and scope. This is a unique opportunity to start monitoring at the early stages of treatment implementation and re-stocking, and our proposed datasets and collaborations were specifically chosen to maximize this opportunity.

Site number reduction: We have scaled the number of sites down to five, all co-located within one watershed. Moreover, excluding the prescribed burn sites will significantly reduce logistical planning efforts, as those sites were within different regions and had unclear timelines for implementation. This change significantly reduces field efforts and potential logistical challenges.

Unique team expertise: The project includes professors (Adina Paytan, Stewart Wilson, and Sasha Wagner), an associate researcher (Christina Richardson), a graduate student, and a team of undergraduates. Each senior team member has significant experience working in heterogeneous environments and with these diverse datasets and is well-prepared to address any obstacles. Dr. Richardson will oversee this project's field and lab efforts, leveraging the team's unique collective experience to ensure high-quality data collection and analysis. Dr. Richardson recently finished a multi-year project in this region (including the proposed study area) examining water and soil dynamics post-fire. Beyond this project, she has worked in a number of other environmental settings on a variety of multi-disciplinary topics that have required extensive field and lab work. She is well-prepared to lead and manage this work. Dr. Paytan has decades of experience working in challenging environments and on complex environmental issues. She brings expertise in environmental biogeochemistry and a well-honed ability to troubleshoot field and lab issues. Dr. Wilson is a professor of soil science and has several ongoing projects in this same watershed. He is extremely familiar with the site conditions and the area's natural variability. His knowledge and ongoing work have directly informed our soil sampling plan. If the add-on is funded, Dr. Wagner will be responsible for the black carbon measurements. Dr. Wagner has worked on samples from this same area, ensuring familiarity with methods needed to process samples for black carbon analysis. She is an expert on black carbon dynamics in post-fire environments. Beyond our team of PIs, we will support several undergraduate students and a graduate student. The selected graduate student has significant field experience working in both this study area and in the challenging conditions of the Sierra Nevada Mountains for their other graduate projects, making many of the same proposed measurements. This means no onboarding time is required, as these measurements are routine for many of us. This specifically curated group is prepared to hit the ground running once funded.

Necessity of a broad multi-disciplinary project framework: While a broad project scope is ambitious, this cross-discipline framework is critical. Multi-disciplinary datasets in these environments are rare, leading to an incomplete understanding of earth system processes and responses to varying forest treatments. Interdisciplinary work is challenging, but our collaborations were thoughtfully planned to accommodate the expertise needed to accomplish the proposed work.

Timeline: The timeline can be accommodated because the forest treatments have already commenced, and the field sites are nearby. Thus, fieldwork is planned to start promptly after funding and equipment are obtained.

Natural variability concerns: Forests are inherently heterogeneous. Our data collection efforts and sampling plan efforts are centered on this. For example, our soil sampling plan will use LiDAR site data to inform a stratified random sampling approach. The LiDAR data allows us to stratify by slope, aspect, and topographic roughness, as these variables are primary controls on soil variability. Further, we can leverage repeated sampling events at each treatment across a year to better constrain intra- and inter-site variability, even for parameters that are not expected to shift significantly across seasons, like soil mineralogy.

These strategies, the reduction in sample sites, and the team's expertise ensure the successful collection of all proposed datasets within the project's timeframe.

3) Some EMC members suggested reducing the scope of the project, and therefore eliminating some of the proposed datasets to be collected, to better ensure successful completion of the project. Alternatively, some members suggested providing multiple scenarios with alternative research questions with accompanying budget(s)/timeline(s). In any case, please provide a line-item budget breakdown for each associated dataset, so that the EMC may view the associated costs linked to each component of this research proposal.

We reduced the project's scope by removing the prescribed burn sites, which, while valuable, were the most challenging given the timeline and the permitting process. We have also presented a breakdown, where possible, of dataset costs.

4) If possible, identify and secure additional sources of matching funding to reduce the proposal request to the EMC.

PI Wagner secured $22,151 in in-kind contributions from their institution for the add-on component.

5) Clarify the linkage of the prescribed fire component to the Forest Practice Rules.

We have removed this project component to minimize costs.

6) Member concerns over similarities to the Caspar Creek (Dahlke/Dalgren) study.

This project is distinct from the previously funded Caspar Creek study (EMC-2017-001) in several ways. Our project has (1) a broader scope and a different focus area, (2) operates at a different spatial scale with a larger range of treatment practices, and (3) utilizes a unique combination of multi-disciplinary measurements.

More specifically, the Caspar Creek study focused primarily on nutrient dynamics in stream water. Unlike the Caspar Creek study, our project will examine several indicators of ecosystem function beyond nutrients in a different physical component of the watershed (e.g., hillslope rather than stream). We also propose to utilize datasets covering soil, hydrologic, and biologic components, offering a more comprehensive view of ecosystem function. For instance, our proposed hydrologic measurements of runoff chemistry and amount are related to stream water chemistry but distinct because runoff (also commonly referred to as overland flow) occurs on the land surface after precipitation and is often less homogenized than stream water.

Working at the plot to hillslope scale at our sites instead of the watershed scale is more informative in understanding how different treatment practices alter ecosystem function. This is because (1) stream water chemistry reflects and homogenizes changes across an entire drainage basin, making drivers of change challenging to pin down without direct characterization of hillslope and plot scale hydro-biogeochemistry, and (2) treatments are often not universally applied across sites. In many regions, this can result in signals of change that are challenging to relate back exclusively to treatment groups. We can minimize these challenges by working at smaller spatial scales and across several treatment groups, as we propose.

In addition, our proposal includes new datasets (soil chemistry, soil properties, soil gas fluxes, runoff chemistry, plant water stress) collected at a different spatial scale and across a broader range of treatment group types. A number of factors influence ecosystem function, and our proposal aims to capture many of these critical elements. For instance, measurements of soil gas fluxes are extremely limited in timberlands but can provide windows into microbial and forest health. These multidisciplinary datasets can amplify our understanding of how post-fire forest treatments impact ecosystem function.

Project Title
Soil, plant, and hydrologic dynamics as indicators of ecosystem function and fire vulnerability across diverse forest health and fuel reduction treatments in the Coast Forest Southern Sub-District

Date Submitted
7/24/2024

Project
EMC-2024-002

Principal Investigator(s):
Christina Richardson[1], Adina Paytan[1], Sasha Wagner[2]

Affiliation(s) of PI(s) and Address(es)
[1]University of California at Santa Cruz, 1156 High Street, Santa Cruz, CA, 95060
[2]Rensselaer Polytechnic Institute, 110 8th St, Troy, NY 12180

Applying Organization
University of California at Santa Cruz

Primary Contact Phone Number(s)
Christina Richardson, [redacted]
Adina Paytan, [redacted]
Sasha Wagner, [redacted]

Primary Email Contact(s) of PI(s)
[redacted] (primary)
[redacted]

Name(s) and Affiliation(s) of Collaborator(s)
Stewart Wilson, California Polytechnic University
Grey Hayes, Swanton Pacific Ranch

Project Duration (Years/Months)
2 years 4 months, 12/2024-03/2027

1. Project Description.

a) Background and Justification

Ecosystem resilience to disturbances, like wildfire and changing climatic conditions, is shaped by soil and hydrologic function. As wildfires and climate change stressors become more common, ensuring current management practices are optimized for resiliency is critical. With climate change, California forests face episodic and chronic perturbations, like drought and extreme heat, increasing fire weather days and risk (IPCC, 2021). Forest Practice Rules (FPRs) and other regulations (CEQA, Timberland Productivity Act, etc.) aim to increase forest resiliency via sustainable forest management and restoration, but whether current FPRs are effective and/or optimized for this goal in the face of climate change is unclear.

Forest health and fuel reduction treatments often involve salvage logging after a wildfire. However, questions remain about ideal canopy retention levels for forest resilience and, thus, long-term economic viability. Evaluating the effect of variable retention of canopy cover on ecosystem function could provide insight into what treatments lead to better forest health and resiliency outcomes in post-fire systems. Similarly, post-fire reforestation efforts have faced difficulties in some regions of California, suggesting current stocking standards may not be optimized for survival or wildfire resilience. Evaluating how low- versus high-density stocking drives changes in soil, plant, and water dynamics could afford new insight into best management practices for long-term forest health and restoration outcomes. The USFS and the State of California have committed to treating at least 1 million acres by 2025, highlighting the critical need for addressing these research knowledge gaps.

b) Research Questions, Objectives and Scope

This study aims to evaluate how a range of forest health and fuel reduction treatments impact soil, plant, and hydrologic components of overall ecosystem function in a post-fire system. We will leverage sites on private forestlands of the Coast Forest Southern Sub-District with variable forest health and fuel reduction treatments, including salvage logging, thinning, and understory treatments, to examine how current and potential changes to FPRs impact key components of ecosystem function, like plant water stress, soil and runoff chemistry, soil gas fluxes, and soil water availability, that directly affect fire risk and forest resilience (Fig. 1).

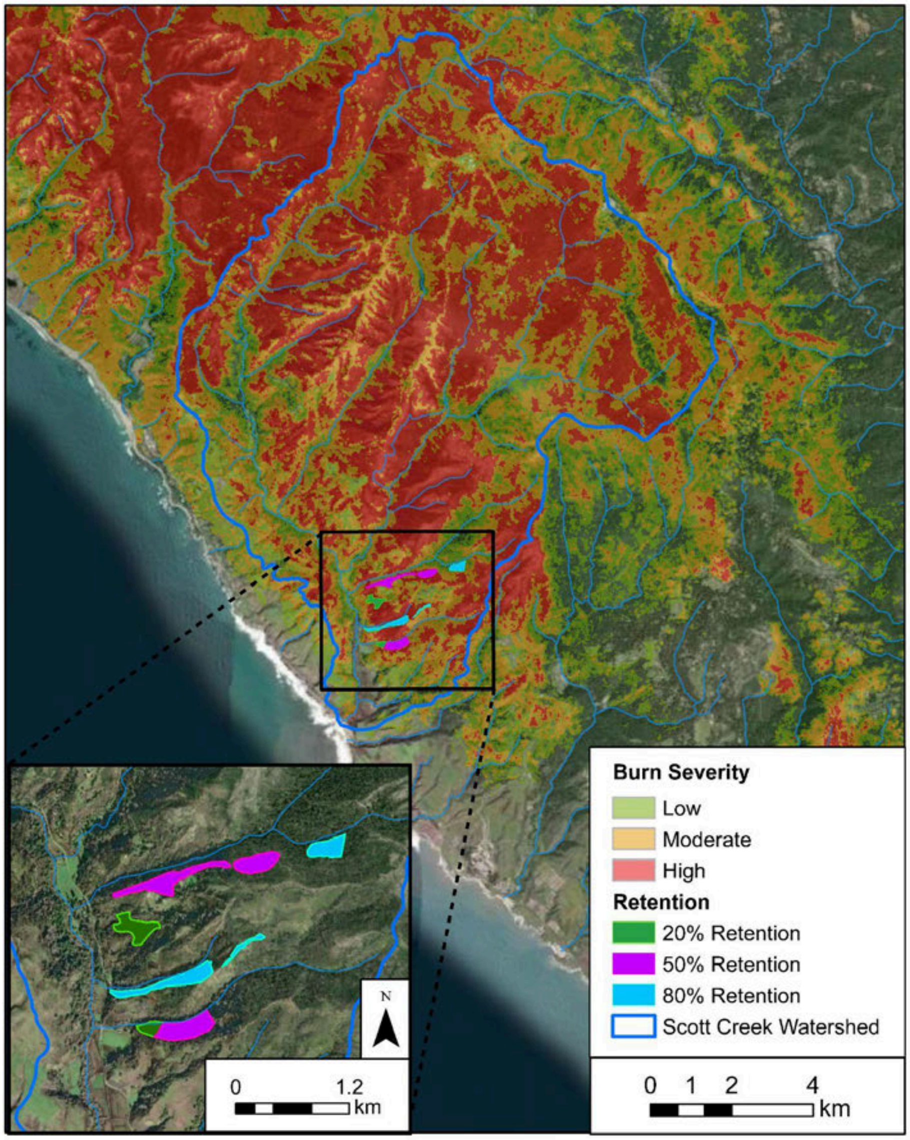

Fig. 1. An overview of the study area showing the Scott Creek Watershed and the variable retention treatment areas. Burn severity from the 2020 CZU Lightning Complex Wildfires is also shown.

Removal of canopy cover has been shown to increase soil temperatures and reduce soil moisture through increased light availability that drives evaporative loss (Marcolin et al., 2019), suggesting that forest management can alter these key functions. Soil moisture can proxy plant water availability and, thus, fuel loads (Sharma et al., 2021) and live/dead fuel moisture (Fan et al., 2018; Masinda et al., 2021). In some areas, soil moisture content can predict fire vulnerability better than other common weather and drought indices (Krueger et al., 2022), making it a valuable indicator of forest health and fire risk.

Physical properties of soil (ex., bulk density, hydrophobicity, infiltration capacity) can likewise shed light on changes in water pathways and storage capacity, which are central to understanding wildfire resilience and forest health. Salvage logging has been shown to alter soil compaction, among other properties (see Wagenbrenner et al., 2023). Post-fire logging also affects vegetation structure and plant water use (Donato et al., 2006; Boucher et al., 2014). Direct indices of plant water stress, like leaf water potential, can provide key information on water availability across species with different rooting zone depths and is linked to live fuel moisture content, an indicator of flammability (Boving et al., 2023).

Other aspects of soil and hydrologic function, including soil chemistry and runoff amount and chemistry, mediate forest ecosystem health and are often altered after wildfire and further manipulated due to varying post-fire management efforts (Prats et al., 2019). For instance, changes to soil bulk density and hydrophobicity from salvage logging can increase runoff generation and sediment transport (see Wagenbrenner et al., 2023). Physical and chemical soil properties similarly influence forest structure (Royo et al., 2016; Serrano-Ortiz et al., 2011) and soil quality (García-Orenes et al., 2017).

Measurements of soil gas fluxes can be used to examine ecosystem respiration of CO_2, and other important greenhouse gas fluxes (CH_4, N_2O) that are indicators of microbial and vegetative health. In temperate forests, soil respiration occurs via tree roots and microbes, accounting for most of the total ecosystem respiration (Goulden et al., 1996; Longdoz et al., 2000). Microbes are critical to nutrient cycling and decomposition in forest ecosystems (Li et al., 2023). Both of these processes affect plant health and the accumulation of surface litter and, thus, fuel loads and fire risk. Disturbances, like fire and post-fire management, can alter below-ground soil microbiomes, impacting key ecological functions (Bowd et al., 2021) that might be reflected in soil gas fluxes.

In another example, “black carbon (BC),” produced during fire when vegetation is converted to charcoal and soot, has fundamentally different physicochemical properties from unburned biomass and, therefore, modulates ecosystem stability and resilience. Forest management practices, like salvage logging and fuel reduction, have been shown to alter soil BC content (DeLuca and Aplet, 2008; Ward et al., 2017; Busse et al., 2014). BC is hydrophobic, carbon-rich, and highly resistant to degradation, influencing carbon storage, ecological recovery, and forest resilience on short and long timescales. BC mobilization and decomposition are driven by burn severity, hillslope characteristics, soil moisture, and temperature (Abney et al., 2019; Cheng et al., 2008; Nguyen and Lehmann, 2009), which modulates microbial activity and soil gas fluxes (Liang et al., 2010). Our previous work indicates that the aging and oxidation of charcoal within a year after fire enhances its solubility and, thus, the fate of BC in fire-affected landscapes (Barton et al., 2023). It is clear that BC left behind after a fire can alter ecological processes and might also be impacted by treatment practices; however, these changes are highly context-dependent and would be better constrained and predicted following a field experimental approach, as is proposed herein.

<u>Research Questions</u>

- After wildfire, how does soil, plant, and hydrologic function differ across the variable canopy retention sites?
    - Based on these indicators, what canopy retention levels improve ecosystem function outcomes in terms of fire and forest resilience?
- After wildfire, how does soil, plant, and hydrologic function differ across low- versus high-density re-stocked sites?
    - Based on these indicators, what stocking density improves overall ecosystem function outcomes in terms of fire and forest resilience?

2.) Research Methods. Describe the methods for collecting, analyzing, and interpreting the data.

<u>Monitoring Locations</u>

We will examine soil, plant, and hydrologic function (1) across experimental gradients in post-fire canopy cover treatments (no treatment versus 20%-80% retention) and (2) across gradients in stocking density (low versus high) in a post-fire environment (Fig. 1, 2). These post-fire sites are an important and timely statewide analog for understanding how to optimize forest recovery after a recent wildfire, a growing issue for California.

Specifically, the post-fire sites will cover regions of California Polytechnic State University's Swanton Pacific Ranch. Swanton Pacific Ranch resides with the Scott Creek Watershed, a 77 km^2 area, averaging 970 ± 540 mm rainfall annually (Richardson et al., 2024). Land cover is dominated by evergreen forests mainly comprised of Coast redwood (*Sequoia sempervirens*) and Douglas fir (*Pseudotsuga menziesii*), and other non-coniferous species, such as Red alder (*Alnus rubra*), Tanoak (*Notholithocarpus densiflorus*), Bay laurel (*Umbellularia californica*), and Bigleaf maple (*Acer macrophyllum*). Over 96% of this basin burned in the 2020 CZU Lightning Complex Wildfires (Fig. 1; Richardson et al., 2024).

Swanton Pacific Ranch has leveraged the post-fire recovery period to implement treatment gradients in canopy cover retention, mechanical understory work, and stocking densities to serve as natural experimental laboratories. This work has the unique opportunity to examine the early stages of fuel reduction treatments and forest re-stocking in these coastal timberlands. In the case of re-stocking, this is a critical time period when new plantings are particularly vulnerable to prevailing environmental conditions.

Fig. 2. A Swanton Pacific Ranch site before (left) and after (right) salvage logging and fuel reduction treatments.

<u>Data collection and analysis</u>
Long-term monitoring data will be paired with seasonal discrete sampling campaigns. Long-term monitoring will include high-frequency measurements (15-min) of soil moisture content and soil temperature at 6 depths to 120 cm, using a GroPoint sensor set in a series of four at each location. Light intensity will be measured using Hobo Pendant loggers at the surface of each soil moisture sensor. High-frequency monitoring is expected to begin in ~March 2025 for at least a year and longer as time permits. During initial installation, depth profiles of grain size distribution and coarse fragments will also be collected. One weather station will be installed to monitor key climate variables (air temperature, rainfall, atmospheric pressure), as no proximal weather stations exist.

Seasonal quarterly discrete measurements will include the following:
(1) **physical soil parameters** (water capacity, bulk density, field saturated and unsaturated hydraulic conductivity, hydrophobicity) measured either in the field or via lab analysis of soil samples, (2) **chemical soil parameters** (carbon, nutrients, extractable cations, black carbon characterization, *if add-on funded) measured via lab analysis of soil samples, (3) **soil gas fluxes** (CO_2, CH_4, N_2O) measured via a transportable LiCOR LI-7810 and an LI-7820 coupled with a LiCOR soil chamber, (4) **runoff amount and chemistry** (suspended sediment, nutrients, carbon, black carbon

characterization*; *if add-on funded) collected via an Eijkelkamp Mini Rainfall Simulator and measured with coupled lab analyses, and (5) **leaf water potential** measured via a PMS Instrument Pressure Chamber in the field.

Quarterly soil samples will consist of at least six replicates at each site (n=5) at three depths (0-5 cm, 5-10 cm, and 10-30 cm), with roughly 396 samples expected (360 with an additional 36 to account for 10% duplicate requirement). Soil sampling will be based on a stratified random sampling design to control for site heterogeneity. Pre-existing LiDAR data, acquired by Dr. Wilson, will allow us to stratify by slope, aspect, and topography, which are master controls on soil variability in this region. Soil gas flux, rainfall simulations for runoff generation, and infiltration measurements will occur proximal to the soil sampling sites. Leaf water potential will be measured pre-dawn and at peak sun for species of interest, selecting for both shallow herbaceous and deep tree rooting types at the variable canopy sites and re-stocked species at the variable density stocking sites. Sample sizes for all variables will consider intra- and inter-site heterogeneity for robust statistical comparisons. All data will be publicly available.

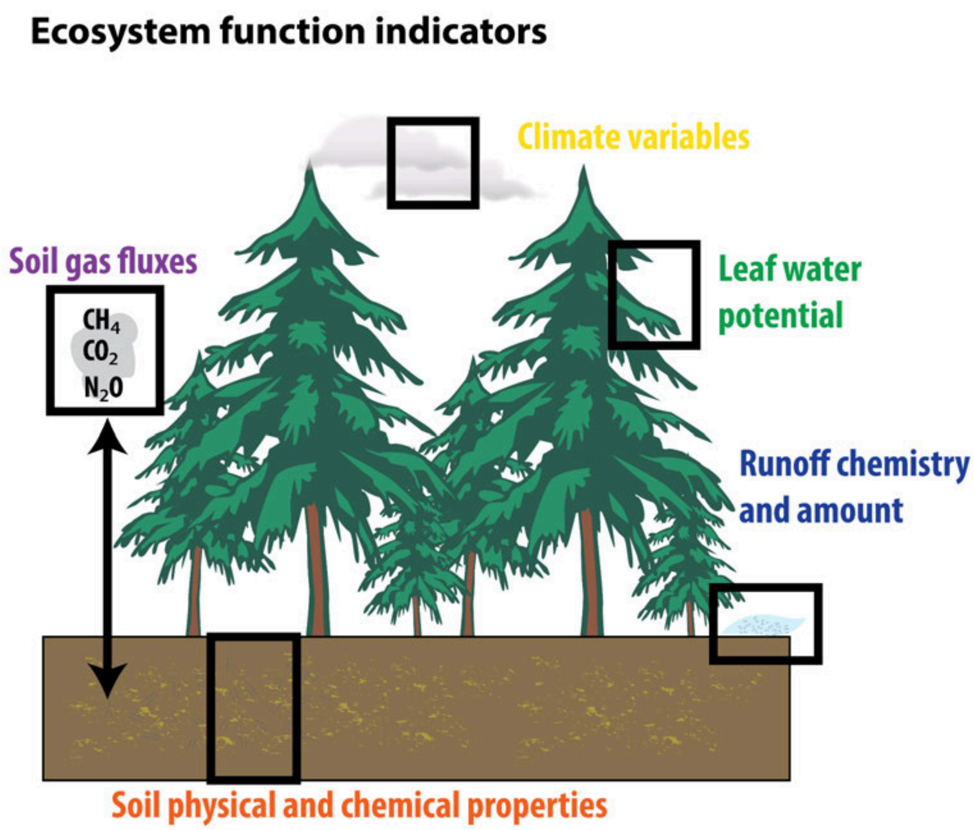

Fig. 3. Overview of the measurements proposed.

Table 1. A summary of the proposed measurements and a few examples of their relevance to forest health and wildfire resilience.

	Interpretive value	Relevance to forest health	Relevance to wildfire resilience
Soil gas fluxes	Indicates microbial activity, soil respiration, decomposition, and other related biogeochemical processes	• Microbial processes are key for nutrient cycling and plant growth • Microbes can suppress soil-borne diseases, affecting vegetation health and productivity	• Microbial processes can reduce combustible material accumulating on the forest floor • Vegetation health can affect resistance to pests/diseases and mortality, which can drive die-off events that might increase fuel loads
Soil physical properties	Indicates subsurface structure, water movement, water availability, soil compaction	• Soil structure affects rooting depths and plant stability •Storage and transport of soil water controls rooting depths, plant growth, and overall forest health	• Soil moisture is a predictor of live and dead fuel moisture and can thus indicate flammability and fire risk • Vegetation health can affect resistance to pests/diseases and mortality, which can drive die-off events that might increase fuel loads
Soil chemical properties	Indicates soil health and biogeochemical processes	• Soil health influences vegetation growth and stability (ex., balanced nutrient chemistry supports optimal plant nutrition)	• Healthy vegetation can reduce the accumulation of dry, combustible material
Runoff chemistry and amount	Indicates processes affecting surface and groundwater quality as well as quantity	• Runoff chemistry provides insights into nutrient transport and availability, which can affect plant and aquatic health •Runoff sediment content can indicate soil erosion, affecting forest health	• Runoff amounts can indicate key water storage and transport states and thus can impact fire resilience
Climate variables	Indicates the status of master control variables such as temperature, precipitation, and solar radiation	• Climate variables influence plant growth, water availability, and ecosystem stability	• Climate factors are critical in predicting fire weather conditions and long-term fire risk (ex., precipitation patterns influence soil moisture, vegetation health, and the likelihood of ignition)
Leaf water potential	Indicates plant water stress	• Plant water stress can lead to reduced growth, increased susceptibility to diseases, and lower overall vegetation health • Prolonged water stress can lead to plant mortality, changing forest structure, and vegetation density	• Plants under water stress can have lower moisture content, making them more flammable • Prolonged water stress can lead to plant mortality that alters fuel load • Vegetation health can affect resistance to pests/diseases and mortality, which can drive die-off events that might increase fuel loads
Black carbon characterization	Indicates quality and stability of carbon	• Black carbon can be biotoxic, sorb/desorb contaminants, and affect soil health and nutrient availability	• Healthy vegetation can reduce the accumulation of dry, combustible material

Data Interpretation and Analysis

We will leverage the existing experimental gradients at Swanton Pacific Ranch to see what treatments lead to better forest health and resiliency outcomes. Specifically, the variable canopy cover sites will be compared to one another to evaluate how different canopy cover retention treatments drive changes in soil, plant, and hydrologic function and referenced to a site with no salvage logging and understory treatments for treatment-control comparisons. The low- and high-density stocked sites will be compared to assess if and how stocking standards might affect soil, plant, and hydrologic function differently. All datasets will undergo QA/QC. Statistical analyses will be performed in R and SigmaPlot. We will compute and report baseline statistics for all datasets collected at annual and seasonal timeframes. We will also use statistical tests to evaluate differences across sites and treatment groups and to better understand how variables, like climate conditions, affect each site. Six replicates at each treatment site and quarterly repeated samplings will help constrain site variability. Together, these data can shed light on differences among treatments and their impacts on forest health and resilience, informing future forest management strategies. For instance, by referencing site data, like soil moisture content and temperature, to climate variables, we can better understand how climate conditions propagate change through each site and if there are treatment-related differences in how climate conditions control interlinked variables. This information is critical in anticipating future changes due to climate change, as some treatments may withstand weather anomalies, like extreme heat or precipitation events, better than others.

3.) Scientific Uncertainty and Geographic Application

a.) Scientific Uncertainty

The efficacy of current FPRs at improving forest resiliency to disturbances like wildfire and climate change impacts is understudied. For instance, with climate change, increases in extreme precipitation, drought, and fire weather days are expected (IPCC, 2021). Climate change has already increased aggregate fire weather indices by ~20% in California (Goss et al., 2020). FPRs can help mitigate this increased risk, but few data exist on the effectiveness of FPRs in improving ecosystem function and resilience even outside of the context of climate change. Our proposal will address both elements by pairing discrete sampling events with high-frequency measurements of soil and runoff water chemistry and availability, plant water stress, and soil properties in a forested ecosystem undergoing diverse forest health and fuel reduction treatments in the Coast Forest Southern Sub-District. This dataset will be critical in addressing existing uncertainties in stocking standards and fuel reduction treatments after wildfires. The recovery trajectory of recently burned lands, shaped by FPRs and other management choices, can determine future timberland productivity and forest health for decades. Ensuring that current FPRs and regulations are optimized for these goals is critical. In addition, our plans to leverage long-term measurements of soil, plant, and water dynamics will likely converge with weather anomalies, like extreme heat and/or precipitation events, throughout the monitoring period. We can use these extreme events to understand how timberlands respond to select climate change stressors across treatment types.

b.) Geographic Applicability

While research results are most applicable to the Coast Forest District, the project is expected to have a widespread, state-wide impact and applicability due to our purposeful selection of sites with dynamic disturbance histories and fuel reduction treatments, which represent a range of conditions and treatments currently extant on California's forested lands. Acreage burned in California in 2009-2018 was equivalent to roughly 7% of the state's land area and has doubled since estimates from the 1980s (Buechi et al., 2021). Studying post-fire sites undergoing fuel reduction treatments and re-stocking efforts provides an important and timely analog for the state.

4. Critical Questions and Forest Practice Regulations Addressed

Table 2. Forest Practice Regulations and Priority Critical Monitoring Questions addressed in this study.

Theme	FPRs and Regulations	Critical Monitoring Questions
6. Wildfire Hazard	14 CCR § 897 14 CCR § 912.7 [932.7, 952.7] 14 CCR § 917 [937, 957] 14 CCR § 961 14 CCR § 1038 14 CCR § 1051 14 CCR § 1052 Timberland Productivity Act CEQA	Are the FPRs and associated regulations effective in… (d) managing forest structure and stocking standards to promote wildfire resilience?
12. Resilience to Disturbance in a Changing Climate		Are the FPRs and associated regulations effective in… (a) improving overall forest wildfire resilience and the ability of forests to respond to climate change (e.g., in response to drought or bark beetle; reducing plant water stress) and variability,and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments)?

This research proposal will address **priority Critical Monitoring Questions** (CMQ) **12a** and **6d** (Table 2). By examining how varying treatment types and extents alter key components of ecosystem function in a post-fire environment, we can better anticipate how these systems will respond to ongoing fire hazards and climate change stressors. Our comparison of low versus high stocking densities will provide insight into what and how stocking standards promote forest health and wildfire resilience through changes to soil, plant, and hydrologic function after wildfire.

In addition, our proposal will provide insight into **6f** (Are the FPRs and associated regulations effective in mitigating or reducing the cumulative impacts of post-fire recovery and management actions in affected watersheds?), **6g** (Are the FPRs and associated regulations effective in maintaining timberland productivity, including wood quality and sustained yield after wildfire?), **3a** (Are the FPRs and associated regulations effective in reducing or minimizing management-related generation of sediment and delivery to watercourse channels), **1e** (Are the FPRs and associated regulations effective in maintaining and restoring input of organic matter to maintain or restore primary productivity as measured by macroinvertebrate assemblages), **1f** (Are the FPRs and associated regulations effective in maintaining and restoring riparian function of Class II-L watercourses in the Coast District), and **1i** (Are the FPRs and associated regulations effective in filtering sediment that reaches WLPZs). These questions will be answered through our investigation of treatment outcomes for forest health and through comparisons of treatment realted differences in runoff and soil chemistry. Indirectly, our proposal will provide insight into CMQ Theme 5, as the proposed study areas serve endangered coho and steelhead salmon.

5.) Roles, Collaborations, and Project Feasibility

This project involves collaborations with multiple universities and community groups. Specifically, we will work alongside Swanton Pacific Ranch to accomplish the proposed work. Existing connections with community agencies, like the Santa Cruz County Resource Conservation District, and industry foresters via Dr. Wilson, the California Forest Soils Council chair, will also be used to share findings. Other relevant connections include Swanton Pacific Ranch's ongoing fuels management treatment program through CAL FIRE. Leveraging these relationships and ongoing programs, we plan to use our research sites for engagement with industry foresters, non-profit groups, and government agencies via site tour(s) and other outreach activities.

Our project will also work together with other researchers and groups, when possible, to maximize efforts and datasets. Swanton Pacific Ranch has ongoing (and planned) research projects to examine forest structure and health. For instance, the EMC funded the "Santa Cruz Mountains Post-Fire Redwood Defect Study," evaluating post-fire defects in trees and how they relate to various indices of burn damage.

The project team comprises professors (Adina Paytan, Stewart Wilson, and Sasha Wagner), an associate researcher (Christina Richardson), a graduate student, and a team of undergraduates. The project leads have all previously conducted research at the Scott Creek Watershed, where Swanton Pacific Ranch is located, to evaluate how fire impacts landscape biogeochemistry. The team is well prepared to work at this site, and each person has extensive experience executing projects that culminate in high-tier peer-reviewed publications and community relevance.

Dr. Richardson will be the home institution lead in charge of the project. Dr. Richardson is central to this project; she has the expertise to guide and maintain this complex field and lab project, which would be challenging for any graduate student at this timeline and with this suite of measurements. Dr. Richardson has previously acquired and led projects totaling over $2 million. She has worked in a number of other environmental settings on a variety of multi-disciplinary topics that have required extensive field and lab work, from initial data collection to final publication in high-tier peer-reviewed journals. Dr. Adina Paytan is a senior distinguished professor with expertise in environmental biogeochemistry and disturbance impacts and will provide key project support through lab and analytical access. UCSC will also be responsible for field plans, sampling, instrument deployment/maintenance, and collecting hydrologic and plant data. Dr. Stewart Wilson will co-lead soil sampling with Dr. Richardson and coordinate all soil chemical analyses at UCSC. Dr. Wilson is a professor of soil science and has several ongoing projects in this same watershed. He is familiar with the area's site conditions and natural variability. His knowledge and ongoing work have directly informed our soil sampling plan. If the add-on is funded, Dr. Wagner will be responsible for the black carbon soil and soil leachate measurements. Dr. Wagner has worked on samples from this same area, ensuring familiarity with methods needed to process samples for black carbon analysis. She is an expert on black carbon dynamics in post-fire environments. Beyond our team of PIs, we will also work with a graduate student and a team of undergraduates across UCSC and Cal Poly. The graduate student has experience with nearly all of the proposed measurements, making them an excellent fit for the group.

6.) Project Deliverables

Activity or Deliverable	**Type**		**Year 1 (12/24-6/25)**				**Year 2 (7/25-6/26)**				**Year 3 (7/26-3/27)**			
	Act.	**Del.**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Establish study sites and prepare equipment	X		na	X	X									na
Sensor deployment and maintenance	X		na		X	X	X	X	X	X				na
Synoptic sampling	X		na			X	X	X	X					na
Sample processing	X		na			X	X	X	X	X				na
Sample analysis	X		na			X	X	X	X	X				na
Data analysis and write-up	X		na			X	X	X	X	X	X	X	X	na
Site tour and engagement with industry/agencies	X							X						
Project update to		X	na				7				7			na

funders/collaborators*														
Project presentation to funders/collaborators*		X	na					12						na
Final project presentation to funders/collaborators*		X	na										X	na
CRA presentation to EMC*		X	na										X	na
CRA presentation to the Board*		X	na										X	na
Conference presentation		X	na									X		na
Submission of manuscript(s) to peer-reviewed journal		X	na										X	na

Key: A= Q1 (Jul 1 - Sept 30), B= Q2 (Oct 1 - Dec 31), C= Q3 (Jan 1 - Mar 31), D= Q4 (Apr 1 - Jun 30); na=unfunded project period

The project will result in peer-reviewed publications and a conference presentation at the AGU Fall Meeting in December 2026 in San Francisco, California.

7.) Requested Funding. Please provide the total amount of funding requested from the EMC, broken down by year of expenditure (by FY, i.e., from July 1 through June 30 of each year), with a brief justification of costs not to exceed 200 words.

Baseline Project Costs:

	12/1/2024-6/30/2025	**7/1/2025-6/30/2026**	**7/1/2026-3/31/2027**	**Subtotal**
	7 months	12 months	9 months	
Personnel salaries and wages	$5,591	$66,668	$73,035	$145,294
Fringe benefits	$431	$29,386	$31,045	$60,862
Contractual expenses	$0	$0	$0	$0
Operating expenses	$36,700	$14,000	$12,950	$63,650
20 GroPoint soil moisture sensors, installation tool, and data loggers	*$19,800*	*$0*	*$0*	*$19,800*
Soil chemistry analysis (~$50/sample,	*$0*	*$9,900*	*$9,900*	*$19,800*

~396 samples)				
Grain size analysis ($15/sample, 120 samples) at UCSC	*$1,200*	*$0*	*$0*	*$1,200*
Hobo Pendant Light Loggers ($90/each, 4 per site)	*$1,800*	*$0*	*$0*	*$1,800*
Field and lab supplies, tools, and PPE for fieldwork	*$2,750*	*$1,500*	*$750*	*$5,000*
Weather station	*$2,750*	*$0*	*$0*	*$2,750*
Runoff chemistry analysis (sediment content, $5/sample, nutrients, $25/sample, ions, $5/sample - ~120 samples)	*$0*	*$2,100*	*$2,100*	*$4,200*
Eijkelkamp Rainfall simulator	*$7,500*	*$0*	*$0*	*$7,363*
Eijkelkamp Tension infiltrometer	*$4,600*	*$0*	*$0*	*$4,600*
PMS Instrument Pressure chamber and N2 tanks	*$3,800*	*$500*	*$200*	*$4,500*
Travel	$1,750	$2,750	$3,500	$8,000
Field site visits	$1,750	$2,750	$1,250	*$5,750*
AGU Fall Meeting 2026 Conference	*$0*	*$0*	*$2,250*	*$2,250*
Other (participant support as internships)	$9,500	$10,500	$12,000	$32,000
4 Undergraduate Internships	*$2,000*	*$3,000*	*$2,000*	*$7,000*
Graduate Student Internship	*$7,500*	*$7,500*	*$10,000*	*$25,000*
Indirect costs	$6,671	$16,921	$17,967	$41,559
EMC FUNDING REQUESTED	$68,143	$140,225	$150,610	$358,978
Matching or In-Kind Contributions	$0	$0	$0	$0
Total Budget	$68,143	$140,225	$150,610	$358,978

Budget Justification

Funding includes partial associate researcher support for Dr. Richardson, graduate and undergraduate intern support (no tuition costs), equipment, and project supplies for sampling and instrumenting five field sites, as detailed above. Dr. Wilson will be a visiting scientist at UCSC every summer (1 month/year for two years) to enhance our collaboration. Undergraduates and a graduate studnet will be funded via internships to participate in field and lab work at UCSC. All samples and post-field processing will be done at UCSC.

Black Carbon Add-On Option:

	12/1/2024-6/30/2025	7/1/2025-6/30/2026	7/1/2026-3/31/2027	Subtotal
Personnel salaries and wages	$0	$18,452	$19,098	$37,550
Fringe benefits	$0	$2,300	$2,369	$4,669
Contractual expenses	$0	$0	$0	$0
Operating expenses	$0	$0	$0	$0
Travel	$0	$0	$0	$0
Other	$0	$3,600	$3,600	$7,200
Indirect costs	$0	$3,308	$3,405	$6,712
EMC FUNDING REQUESTED	$0	$25,359	$26,103	$51,462
Matching or In-Kind Contributions	$0	$10,916	$11,236	$22,151
Total Budget	$0	$36,275	$37,339	$73,614

Black Carbon Budget Justification

Funding includes PI summer support (2 weeks/year in years 2 and 3), graduate student support (3 summer months across two years), and lab costs for 200 samples for black carbon characterization. The difference between the total indirect costs and 15% supported by the sponsor is listed as an in-kind contribution from Rensselaer ($22,152).

References

Abney, R. B., Kuhn, T. J., Chow, A., Hockaday, W., Fogel, M. L., & Berhe, A. A. (2019). Pyrogenic carbon erosion after the Rim Fire, Yosemite National Park: The role of burn severity and slope. Journal of Geophysical Research: Biogeosciences, 124, 432–449. https://doi.org/10.1029/2018JG004787

Barton, R., Richardson, C., Pae, E., Montalvo, M., Redmond, M., Zimmer, M., Wagner, S. (2023) Hydrology, rather than wildfire burn extent, determines post-fire organic and black carbon export from mountain rivers in central coastal California. Limnology and Oceanography Letters doi.10.1002/lol2.10360

Boucher, D., Gauthier, S., Noël, J., Greene, D.F. and Bergeron, Y., 2014. Salvage logging affects early post-fire tree composition in Canadian boreal forest. Forest Ecology and Management, 325, pp.118-127.

Boving, I., Celebrezze, J., Salladay, R., Ramirez, A., Anderegg, L.D. and Moritz, M., 2023. Live fuel moisture and water potential exhibit differing relationships with leaf‐level flammability thresholds. *Functional Ecology*, *37*(11), pp.2770-2785.

Bowd, E.J., Banks, S.C., Bissett, A., May, T.W. and Lindenmayer, D.B., 2022. Disturbance alters the forest soil microbiome. *Molecular Ecology*, *31*(2), pp.419-447.

Buechi, H., Weber, P., Heard, S., Cameron, D. and Plantinga, A.J., 2021. Long-term trends in wildfire damages in California. International journal of wildland fire, 30(10), pp.757-762.

Busse, Matt D., Hubbert, Ken R., Moghaddas, and Emily E. Y., 2014. Fuel reduction practices and their effects on soil quality. Gen. Tech. Rep. PSW-GTR-241. Albany, CA: US Department of Agriculture, Forest Service, Pacific Southwest Research Station. 156 p.

Cheng, C.-H., Lehmmann, J., Thies, J.E., Burton S.D. (2008) Stability of black carbon in soils across a climatic gradient. Journal of Geophysical Research 113: G02027, doi:10.1029/2007JG000642

DeLuca, T. H., and Aplet, G. H., 2008. Charcoal and carbon storage in forest soils of the Rocky Mountain west. Frontiers in Ecology and the Environment 6: 18-24

Donato, D.C., Fontaine, J.B., Campbell, J.L., Robinson, W.D., Kauffman, J.B. and Law, B.E., 2006. Post-wildfire logging hinders regeneration and increases fire risk. Science, 311(5759), pp.352-352.

Fan, L., Wigneron, J.P., Xiao, Q., Al-Yaari, A., Wen, J., Martin-StPaul, N., Dupuy, J.L., Pimont, F., Al Bitar, A., Fernandez-Moran, R. and Kerr, Y.H., 2018. Evaluation of microwave remote sensing for monitoring live fuel moisture content in the Mediterranean region. *Remote Sensing of Environment*, *205*, pp.210-223.

García-Orenes, F., Arcenegui, V., Chrenková, K., Mataix-Solera, J., Moltó, J., Jara-Navarro, A.B. and Torres, M.P., 2017. Effects of salvage logging on soil properties and vegetation recovery in a fire-affected Mediterranean forest: a two year monitoring research. *Science of the Total Environment*, *586*, pp.1057-1065.

Goulden, M.L., Munger, J.W., Fan, S.M., Daube, B.C. and Wofsy, S.C., 1996. Measurements of carbon sequestration by long‐term eddy covariance: Methods and a critical evaluation of accuracy. *Global change biology*, *2*(3), pp.169-182.

Goss, M., Swain, D.L., Abatzoglou, J.T., Sarhadi, A., Kolden, C.A., Williams, A.P. and Diffenbaugh, N.S., 2020. Climate change is increasing the likelihood of extreme autumn wildfire conditions across California. Environmental Research Letters, 15(9), p.094016.

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.

Krueger, E.S., Levi, M.R., Achieng, K.O., Bolten, J.D., Carlson, J.D., Coops, N.C., Holden, Z.A., Magi, B.I., Rigden, A.J. and Ochsner, T.E., 2022. Using soil moisture information to better understand and predict wildfire danger: a review of recent developments and outstanding questions. *International journal of wildland fire*, *32*(2), pp.111-132.

Li, F., Zi, H., Sonne, C. and Li, X., 2023. Microbiome sustains forest ecosystem functions across hierarchical scales. *Eco-Environment & Health*, *2*(1), pp.24-31.

Liang, B., Lehmann, J., Sohib, S.P., Thies, J.E., O'Neill, B., Trujillo, L., Gaunt, J., Solomon, D., Grossman, J., Neves, G.E., Luizãoc, F.J. (2010) Black carbon affects the cycling of non-black carbon in soil. Organic Geochemistry 41: 206–213

Longdoz, B., Yernaux, M. and Aubinet, M., 2000. Soil CO2 efflux measurements in a mixed forest: impact of chamber disturbances, spatial variability and seasonal evolution. *Global Change Biology*, *6*(8), pp.907-917.

Marcolin, E., Marzano, R., Vitali, A., Garbarino, M. and Lingua, E., 2019. Post-fire management impact on natural forest regeneration through altered microsite conditions. Forests, 10(11), p.1014.

Masinda, M.M., Li, F., Liu, Q., Sun, L. and Hu, T., 2021. Prediction model of moisture content of dead fine fuel in forest plantations on Maoer Mountain, Northeast China. *Journal of Forestry Research*, *32*(5), pp.2023-2035.

Nguyen, B.T. and Lehmann, J. (2009) Black carbon decomposition under varying water regimes. Organic Geochemistry 40: 846-853

Prats, S.A., Malvar, M.C., Coelho, C.O.A. and Wagenbrenner, J.W., 2019. Hydrologic and erosion responses to compaction and added surface cover in post-fire logged areas: Isolating splash, interrill and rill erosion. Journal of Hydrology, 575, pp.408-419.

Richardson, C., Montalvo, M., Wagner, S., Barton, R., Paytan, A., Redmond, M. and Zimmer, M., 2024. Exploring the Complex Effects of Wildfire on Stream Water Chemistry: Insights From Concentration‐Discharge Relationships. Water Resources Research, 60(2), p.e2023WR034940.

Royo, A.A., Peterson, C.J., Stanovick, J.S. and Carson, W.P., 2016. Evaluating the ecological impacts of salvage logging: can natural and anthropogenic disturbances promote coexistence?. *Ecology*, *97*(6), pp.1566-1582.

Serrano-Ortiz, P., Marañón-Jiménez, S., Reverter, B.R., Sánchez-Cañete, E.P., Castro, J., Zamora, R. and Kowalski, A.S., 2011. Post-fire salvage logging reduces carbon sequestration in Mediterranean coniferous forest. *Forest Ecology and Management*, *262*(12), pp.2287-2296.

Sharma, S., Carlson, J.D., Krueger, E.S., Engle, D.M., Twidwell, D., Fuhlendorf, S.D., Patrignani, A., Feng, L. and Ochsner, T.E., 2020. Soil moisture as an indicator of growing-season herbaceous fuel moisture and curing rate in grasslands. *International Journal of Wildland Fire*, *30*(1), pp.57-69.

Wagenbrenner, J., Coe, D. and Olsen, W., 2023. Mitigating potential sediment delivery from post-fire salvage logging. State of California, The Natural Resources Agency, Department of Forestry & Fire Protection.

Ward, A., Cansler, C., Larson, A., 2017. Black carbon on coarse woody debris in once-and twice-burned mixed-conifer forest. Fire Ecology. 13(2): 143-147.

CAL POLY
College of Agriculture, Food & Environmental Sciences

Natural Resources Management and Environmental Sciences Department
College of Agriculture, Food and Environmental Sciences

Office: 805-756-2702
Fax: 805-756-1402
nres@calpoly.edu
nres.calpoly.edu

July 23, 2024

Effectiveness Monitoring Committee

Board of Forestry and Fire Protection

Dear Dr. Wolf,

I am writing to express my strong support for the proposed project titled "Soil, Plant, and Hydrologic Dynamics as Indicators of Ecosystem Function and Fire Vulnerability across Diverse Forest Health and Fuel Reduction Treatments in the Coast Forest Southern Sub-District." I am a professor of soil science at Cal Poly, with expertise in forest soils and fire affected soils, and I have worked on research projects at Swanton Pacific Ranch for several years. I am excited to collaborate with this team and am looking forward to visiting UCSC over the summer in support of this work. This project aligns well with my ongoing research efforts at Swanton Pacific Ranch to document post-fire changes in soil biogeochemistry, and my existing data will be used to inform sampling strategies and analysis on this study.

I am fully committed to assisting with the project, including soil sampling and processing, which are crucial components of the study. This work will guide forest management and fuels treatment practices, and contribute to enhancing the resilience and health of our forest ecosystems, especially in regions recovering from wildfires. I am also excited about this project because it will fund several undergraduates, providing critical opportunities for development of California's natural resources workforce.

I strongly support funding this proposal.

Warmest Regards,

Stewart Wilson

Dr. Stewart G Wilson
Assistant Professor of Soil Resources
California Polytechnic State University

CAL POLY
College of Agriculture, Food and Environmental Sciences
Swanton Pacific Ranch

7/15/2024

Dr. Kristina Wolf
Effectiveness Monitoring Committee
Board of Forestry and Fire Protection

Dear Dr. Wolf,

I am writing to express my strong support for the proposal being submitted to the California State Board of Forestry and Fire Protection by Drs. Christina Richardson, Adina Paytan, Stewart Wilson, and Sasha Wagner, titled "**Soil, Plant, and Hydrologic Dynamics as Indicators of Ecosystem Function and Fire Vulnerability across Diverse Forest Health and Fuel Reduction Treatments in the Coast Forest Southern Sub-District**."

As the Education and Research Coordinator for Swanton Pacific Ranch, I am excited to work with these researchers on this project by providing site access and associated support as needed. Swanton Pacific Ranch, a field station on a working ranch, focuses on delivering hands-on skills and education to students from California Polytechnic State University, San Luis Obispo. This study would provide experiential learning opportunities for our students, helping to cultivate the next generation of environmental scientists and land managers.

Importantly, this work will also advance our understanding of ecosystem function in the context of varying forest treatments. By examining soil, plant, and hydrologic dynamics across various forest health and fuel reduction treatments, this study will yield critical insights into how different management practices influence forest resilience and fire risk. These findings will be instrumental in guiding forest management strategies at Swanton Pacific Ranch and beyond, especially in the context of increasing wildfire frequency and intensity in California.

Swanton Pacific Ranch is fully committed to supporting this important research project, and we hope you will strongly consider funding it.

Sincerely,

Grey Hayes

Dr. Grey F. Hayes

Education and Research Coordinator
Swanton Pacific Ranch
California Polytechnic State University, San Luis Obispo