FY25 Strategic University Research Partnership (SURP)

# Assessing Wildfire Impacts on California's Coastal Water Quality and Aquatic Ecosystems

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## Background

Coastal wildfires can delivered debris to the coastal zone via atmospheric and riverine pathways. In the case of the latter, post-fire rainfall events deliver sediment, nutrients, and ash into nearshore waters via networks of perennial/ephemeral streams and rivers; effectively reducing water clarity, altering nutrient dynamics, and impacting marine ecosystems. Kelp forests, which provide essential ecological and economic services, are vulnerable to declines in underwater light and substrate quality. Yet, the role of postfire water quality changes on kelp canopy dynamics remains poorly understood.

## Objectives

Here we assess the relative change in kelp canopy area and modeled benthic light in relation to wildfire occurrence and frequency along California's coastal draining watersheds. Specifically, we aim to:

1. Quantify changes in kelp canopy area following wildfires (2000–2024)

1. Model benthic light availability (bPAR) using satellite and field data

1. Assess causal links between fire-induced runoff and kelp shifts using a Before–After Control–Impact (BACI) design

## Significance

We leverage NASA satellite assets (MODIS, Landsat) to build a scalable framework connecting upland wildfire severity to coastal waters clarity and kelp forest extent. This work supports NASA's missions in climate adaptation, ecosystem forecasting, and coastal resilience (e.g., PACE, SBG). It also strengthens university partnerships and develops next-gen tools for monitoring land-sea paradigm.

## Approach and Results

- Combined 20+ years of MODIS-Aqua ocean color, in situ light data, and wildfire burn severity maps (MTBS)
- Developed a regional model of benthic PAR (bPAR) to estimate changes in underwater light conditions
- Postfire runoff in areas like Santa Barbara shows significant bPAR decline (20–40%) at kelp-relevant depths (10–25 m) following moderate-to-high severity burns and wet winters
- Paired impacted kelp beds with matched control sites outside fire zones to detect shifts in kelp canopy area at 1-, 3-, and 5-year intervals post-fire

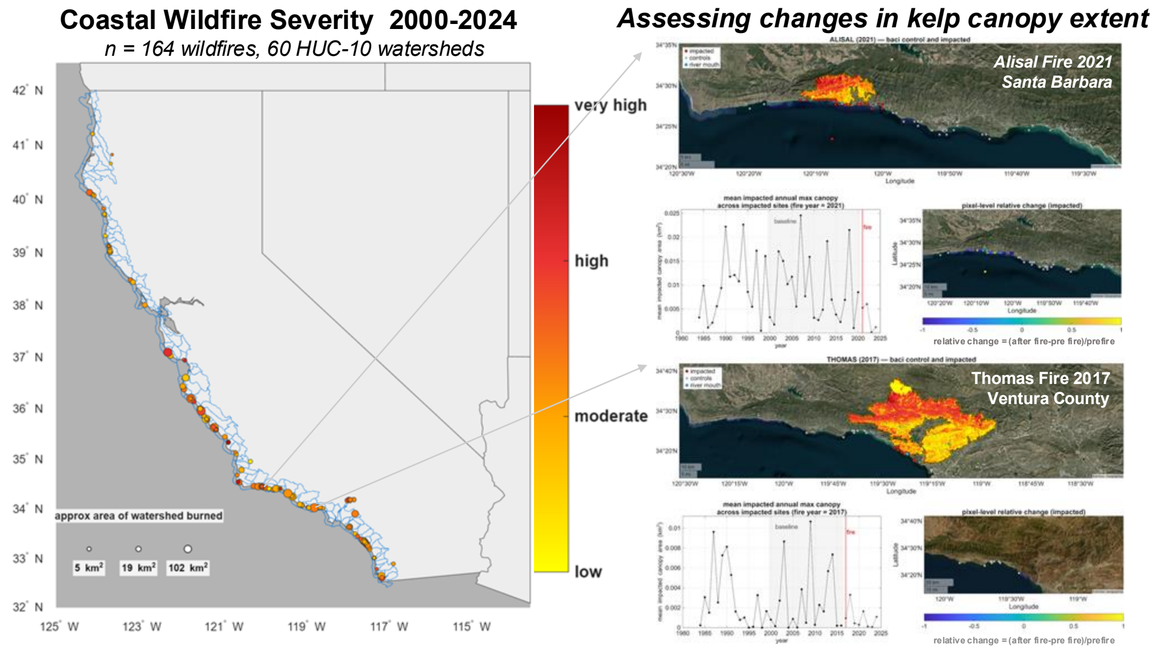


**Figure 1.** Burn severity patterns of California's wildfires from 2000–2024 derived from difference in normalized burn severity data *(Monitoring Trends in Burn Severity)*. Each point represents a wildfire centroid colored by its average burn severity index, a metric for greenness. Panels on the right show the BACI design setup for two fires: Alisal fire (2021) and Thomas fire (2017) and kelp canopy are ($km^2$) of impacted kelp pixels.

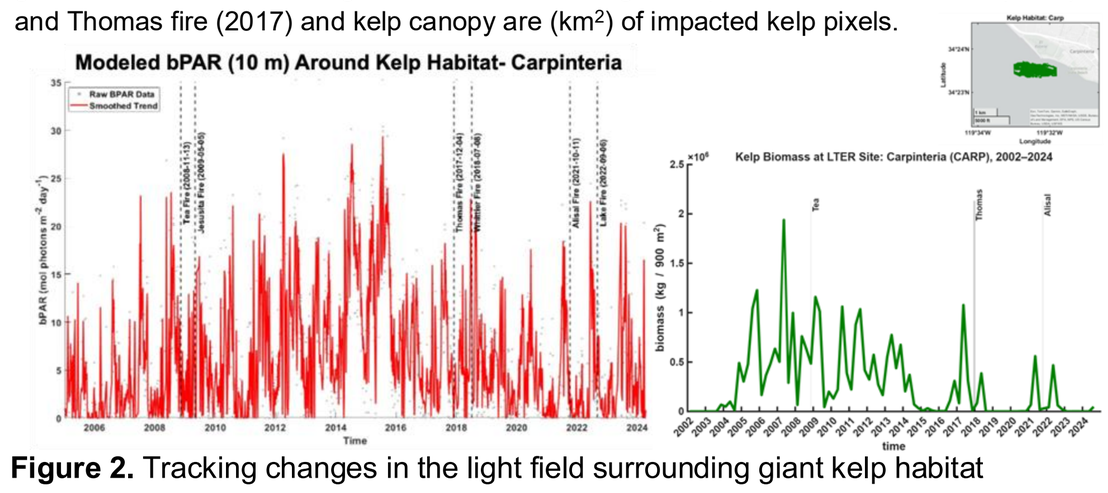


**Figure 2.** Tracking changes in the light field surrounding giant kelp habitat proceeding a wildfire in Santa Barbara

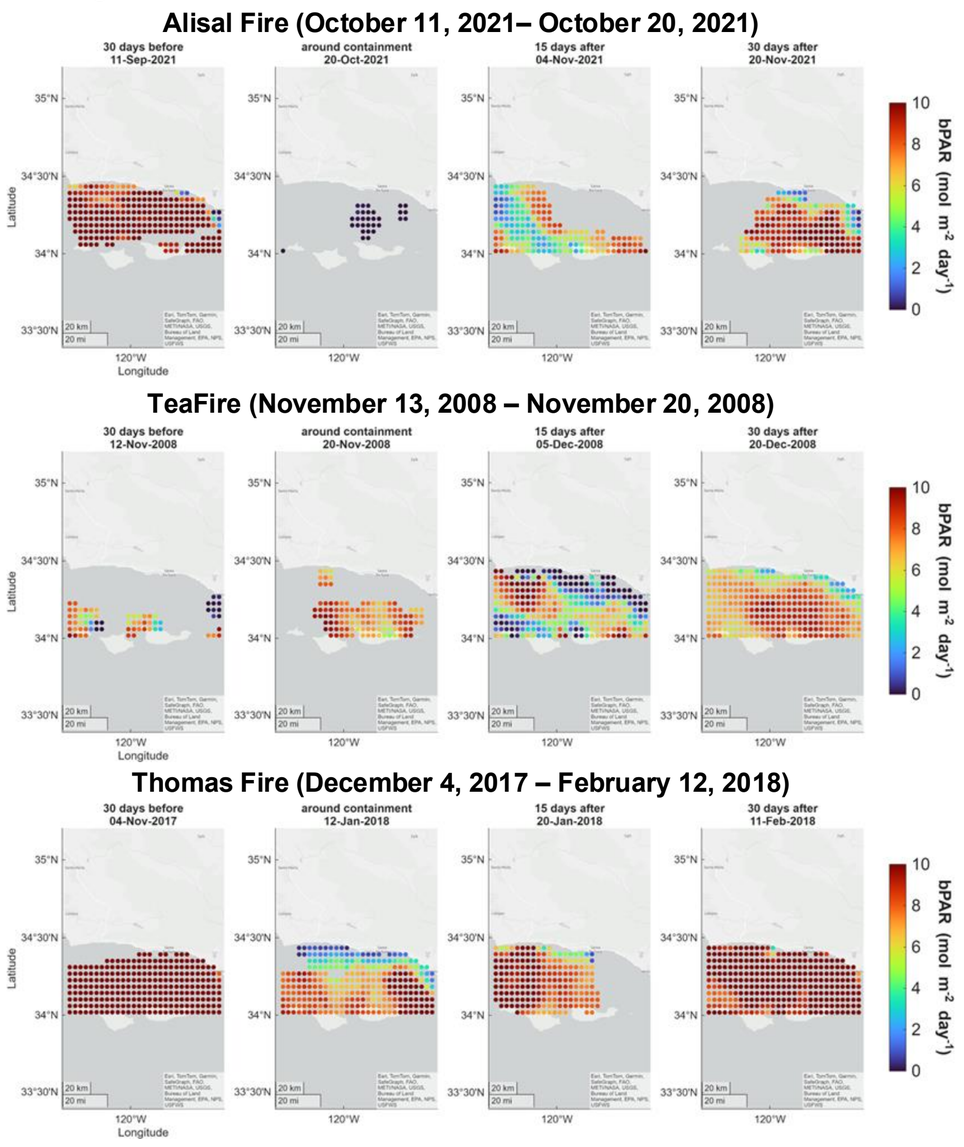


**Figure 3.** Before, During, and After a Wildfire: Modeled bPAR at 10 m show darker conditions following a wildfire.

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RPD-099 Clearance Number: CL#25-4667