Leveraging Wildfire Footprints to Increase Forest Resilience to Future High Severity Fire

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Background

The increase in large wildfires across the West has resulted in significant loss of mature conifer forest cover. Yet, these large wildfires also create extensive areas with low- to moderate-severity fire effects, where mature overstory has been retained and surface fuels reduced. These areas often far exceed those treated with mechanical treatments or prescribed fire (Figure 1). In this study, the authors recommend that forest managers consider working in and around wildfire footprints to increase the pace and scale of much needed fuel treatments by capitalizing on two key benefits of recent wildfires. First, recent high severity burn areas can present novel opportunities to treat adjacent unburned or lightly burned forest, potentially with less cost and risk of escape. Second, areas with low to moderate severity fire effects that are characteristic of natural fire regimes may be easier to enhance or maintain compared to untreated areas.

The Sierra Nevada of California illustrates the disparity between the pace of intentional fuel treatments and low- to moderate-severity burn area created by wildfire. From 2001–2022, annual treatment rates averaged 5,098 ha/year of prescribed fire (broadcast burns and pile burning) and 16,879 ha/year of mechanical treatments across 2.3 million ha of mixed conifer forest. By contrast, from 2012–2022, low- to moderate-severity wildfire in that forest type burned on average seven times the area treated by prescribed fire (Shive et al. 2025).

Research Overview

This study used yellow-pine mixed conifer forests in the Sierra Nevada to develop a practical framework for leveraging wildfire footprints to increase the pace and scale of fuel reduction activities and increase resistance to future high severity fire (i.e. burned areas with > 90% overstory mortality). The authors analyzed 1,673 Potential Operational Delineations (PODs) – planning units defined by geographic features that facilitate fire containment – across the Sierra Nevada and used disturbance history (2013–2022) to classify PODs that

MANAGEMENT IMPLICATIONS

- **Use burned edges as containment lines:** Recent wildfire perimeters offer safer, cheaper opportunities for prescribed fire or managed wildfire, especially within 1–3 years postfire when fuels are lowest.
- **Prioritize follow up treatments in low-moderate severity burn areas:** These areas already have partial fuel reduction and present lower operational risk for prescribed fire. In some cases, thinning of dead or live trees may be needed to enable prescribed fire.
- **Maintain high resilience PODs with recurring fire:** High resistance landscapes can support more strategic use of managed wildfire for resource benefit.
- Treat unburned islands inside fire footprints: These naturally bounded areas allow larger prescribed burns with reduced escape risk.
- **Use POD scale planning to identify "where fire fits":** PODs with ≥25% high resistance area are strong candidates for large scale prescribed fire and managed wildfire for resource benefit where it is possible.
- **Adapting environmental regulations to increase beneficial fire in burned landscapes.**
  - Allowances/exemptions (e.g., NEPA, ESA, Clean Air Act) to expedite implementation
  - Programmatic compliance for entire management units (e.g., NEPA for a National Forest).

experienced wildfire or treatment into one of three "resistance pathways":

1. **Create** – Forests with no prior disturbance where recent wildfire edges could serve as containment lines for initial treatments.
2. **Enhance** – Forests with one prior beneficial disturbance: either (a) one beneficial wildfire (moderate resistance) or (b) one mechanical treatment adjacent to burned edges (low resistance), both needing a second treatment to reach high resistance.
3. **Maintain** – Forests with two or more beneficial disturbances, where recurring fire is needed to sustain high resistance.

Key Findings

1. Recent wildfires create major opportunities for fuel reduction
   - •Over 230,000 ha of unburned forest lie adjacent to recent wildfire perimeters where 3,285 km of burned edges could serve as ready made control lines for prescribed or managed fire.
   - •Constructing an equivalent length of fireline is estimated to cost ~$16 million.
2. The largest opportunity lies in enhance areas
   - •Nearly 300,000 ha burned at low to moderate severity could be treated again to reach high resistance levels.
   - •These areas already have reduced fuels and lower risk, making them ideal for follow up prescribed fire or managed wildfire.
3. High resistance areas require recurring fire to maintain resistance
   - •Over 100,000 ha meet high resistance criteria due to multiple beneficial disturbances.

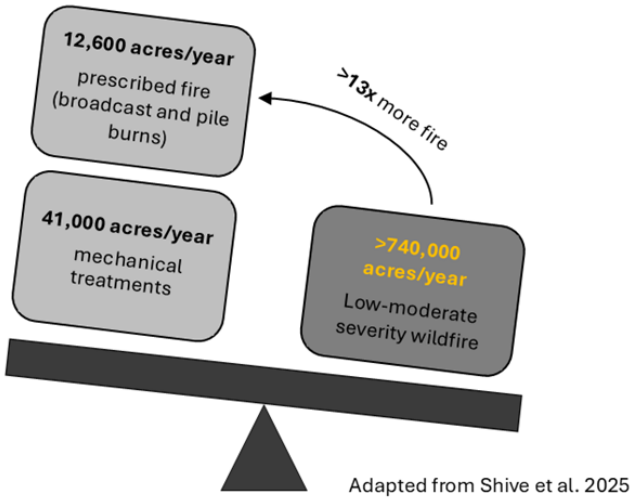

Figure 1. *Area in California treated between 2001-2022 with fuel treatments or beneficial wildfire*

   - •Within these, 95 PODs have >= 25% high-resistance forest and are strong candidates for landscape-scale prescribed fire or managed wildfire.
   - •These areas need ongoing fire every ~10 years to maintain resilience and limit fuel buildup.
4. Burning within wildfire footprints could increase project size while reducing risk and cost
   - •Unburned islands range up to 239 ha in size – 14 times median size of recent prescribed fire projects- representing opportunities for larger prescribed burns using surrounding burned areas as containment.
   - •Burned edges and interior "islands" (unburned patches within wildfire footprints) provide natural boundaries with lower escape risk.

Additional Information

This brief is based on the following article:

Wilson, Kristen N., Kristen L. Shive, John N. Williams, Malcolm P. North, Michelle Coppoletta, J. Nicholas Hendershot, and Charlotte K. Stanley. 2026. "The Pace and Scale Challenge: Leveraging Wildfire Footprints to Increase Forest Resilience to Future High-Severity Fire." Forest Ecology and Management 603: 123443. https://doi.org/10.1016/j.foreco.2025.123443

References:

Shive, K.L., Knight, C.A., Steel, Z.L., Stanley, C.K. and Wilson, K.N., 2025. Leveraging wildfire to augment forest management and amplify forest resilience. Ecosphere, 16(6), p.e70306.

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