

From Ashes to Logs

Long-term Monitoring of Post-fire Harvests in Western U.S. Forests

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Context

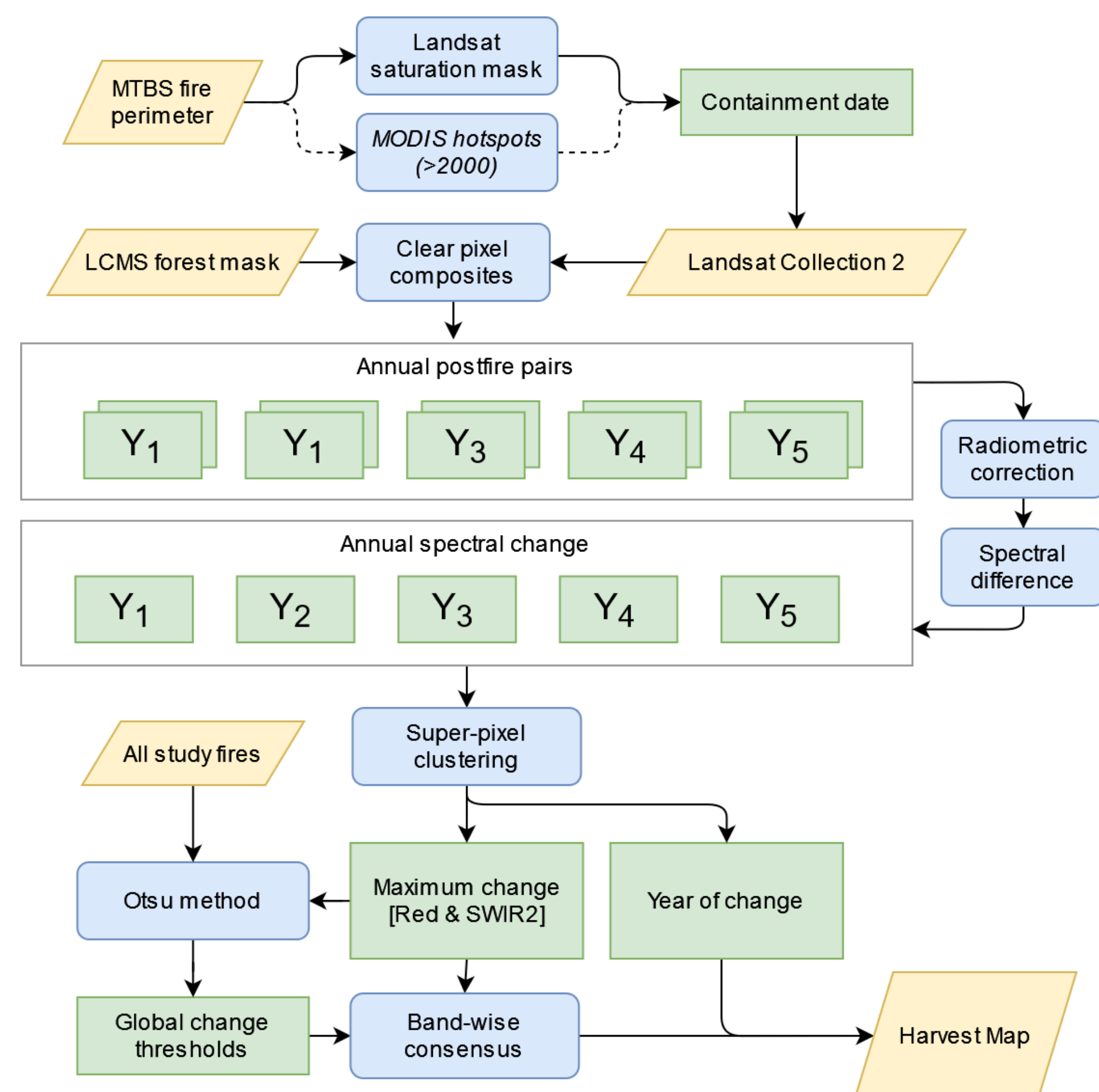
Post-fire harvests have complex economic and ecological impacts, but our understanding of their extent and distribution is limited at regional scales. Past efforts to map salvage logging (e.g. Schroeder et al. 2012 and Zhao et al. 2022) repurposed existing remote sensing approaches with limited success, revealing the **unique challenges** of detecting harvests in burned forests. We propose a new method for identifying post-fire harvests, leveraging unsupervised bitemporal change detection with the 39+ year **Landsat** archive to identify the **presence and timing** of harvests at broad spatiotemporal scales.

Objectives

1. Identify **long-term trends** in post-fire harvests across ecoregions and ownerships in the Western U.S.
2. Investigate post-fire harvests in **high-profile case study fires** in the west side of Oregon.

Methods

We mapped post-fire harvests in **339 fires** that cumulatively burned **5 million acres** between **1986-2017** across ownerships in western U.S. forests. For each fire, we 1) composited **annual pairs** of radiometrically-corrected before-after **Landsat** imagery for **five years** following fire, 2) calculated the magnitude and timing of **maximum spectral changes** at super-pixel objects, 3) used the **Otsu method** to determine global change thresholds in the red and short-wave infrared bands, 4) applied **band-wise consensus voting** to classify harvests. We assessed accuracy using photo-interpretation of high-resolution aerial photography at 200 randomly located 30m x 30m plots.

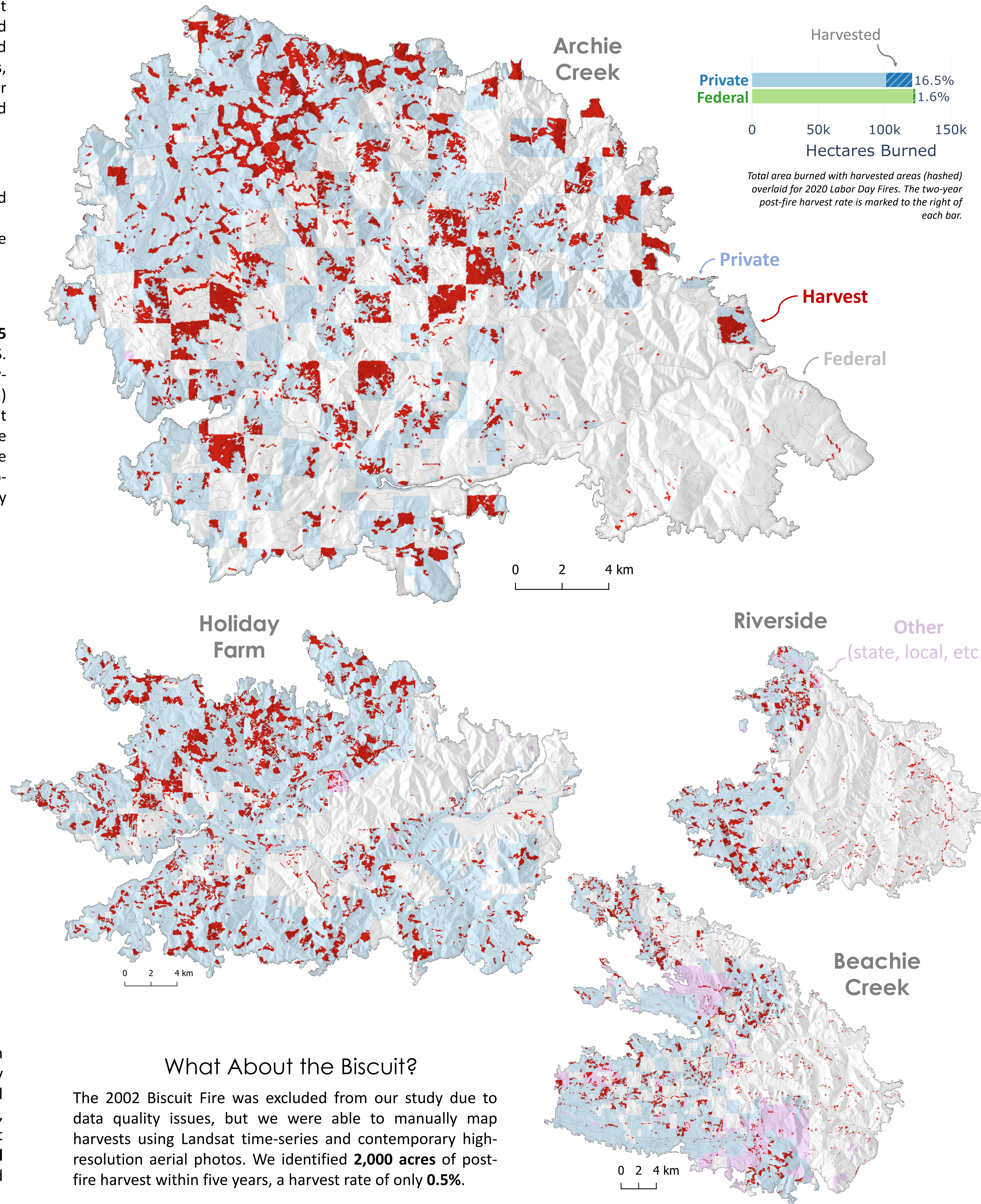


Limitations

1) Our study fires comprise 42% of all forested acres burned in the region because late-season fires (e.g. 2002 Biscuit Fire) could not be reliably mapped due to data quality limitations. 2) Low-intensity harvests and high-intensity **delayed mortality** can cause false negatives and positives, respectively. We achieved high accuracy at a regional scale (94.5%), but results within individual fires were variable. 3) **Salvage logging** and **hazard tree removal** are combined, despite different management goals and impacts.

Case Study: 2020 Labor Day Fires

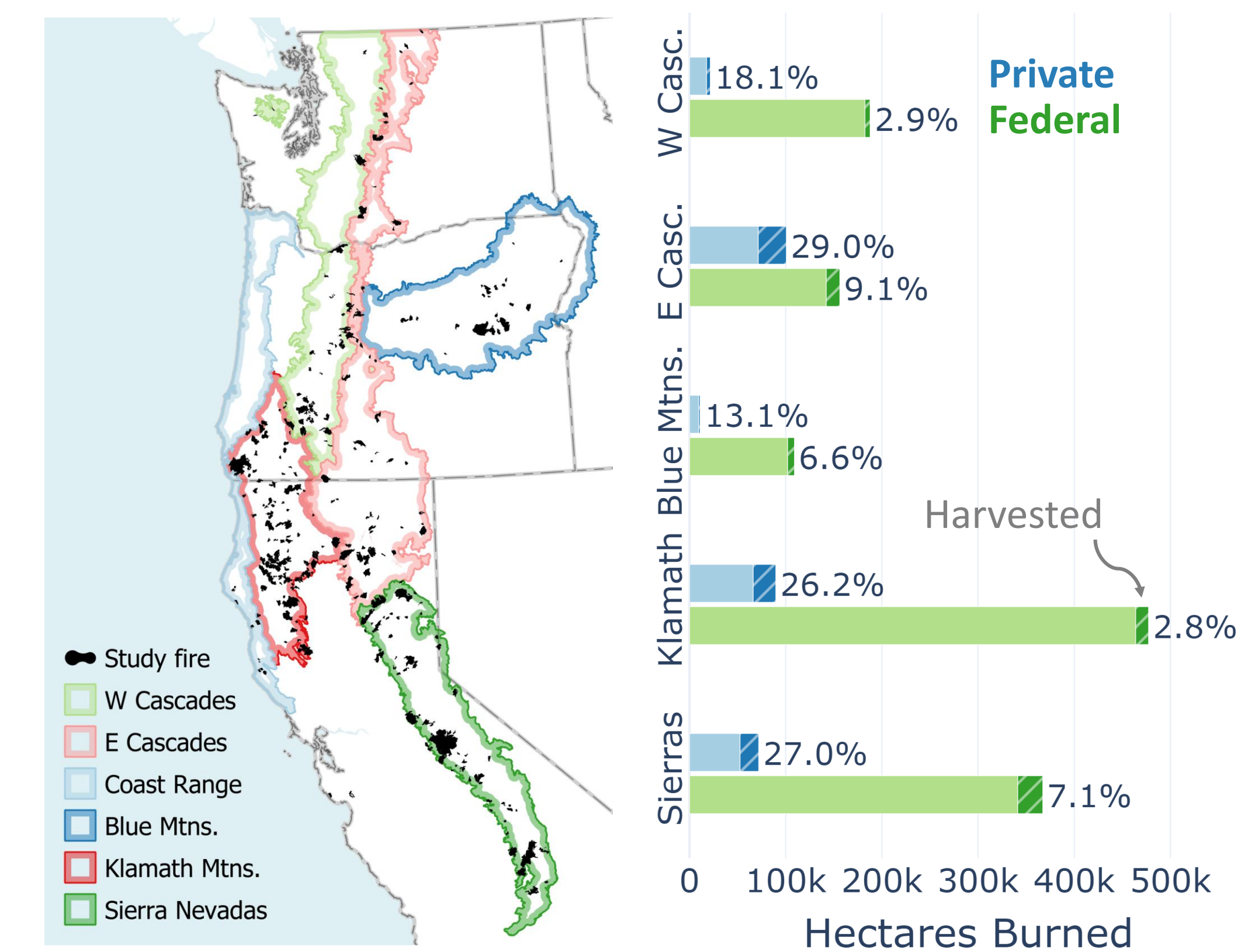
The four large westside 2020 Labor Day fires were mapped separately using a similar methodology. In the two years since fire, **8.9% of the burned area** has been harvested.



Trends

Post-fire harvests took place across **7.9% of the burned area**, varying with time, ownership, and ecoregion.

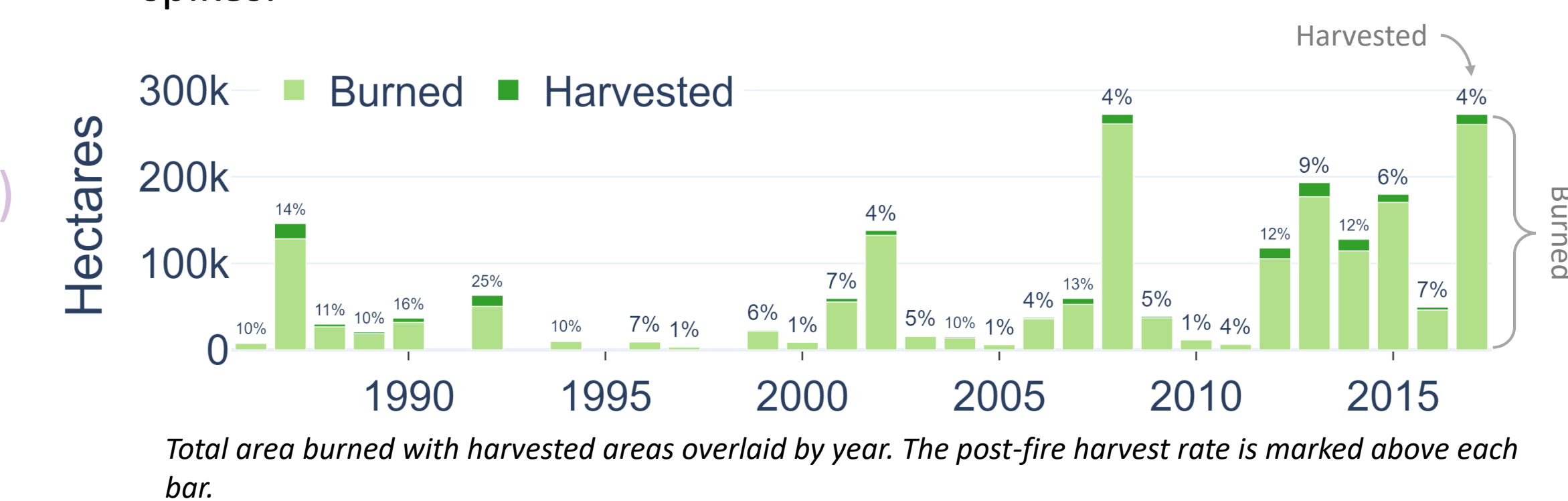
By Ecoregion and Owner



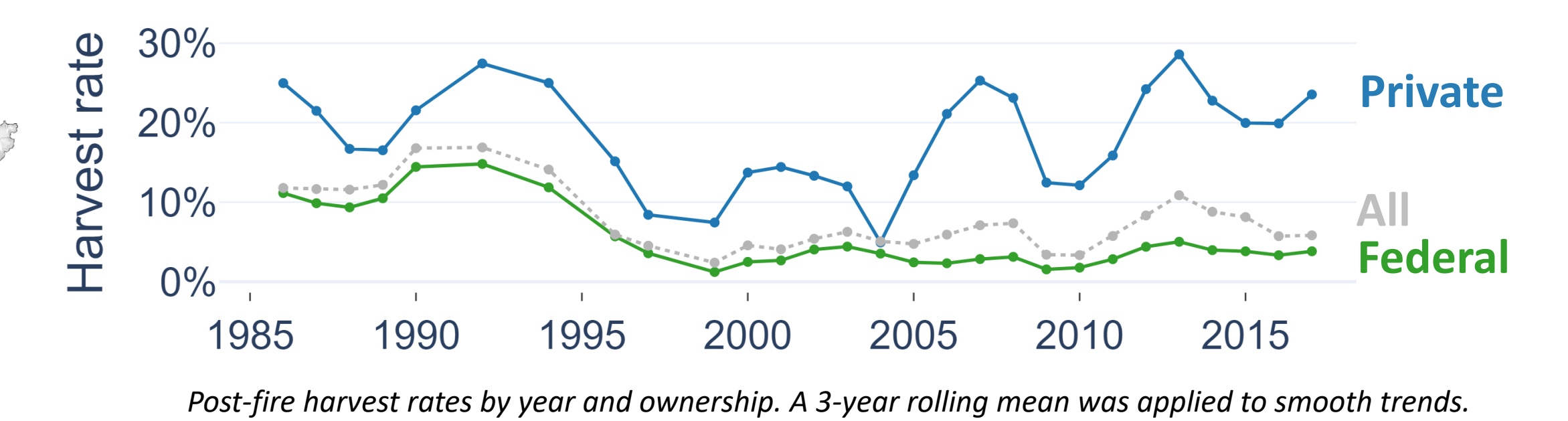
Left) Study area and study fires. Right) Total area burned with harvested areas (hashed) overlaid for 2020 Labor Day Fires. The two-year post-fire harvest rate is marked to the right of each bar.

By Year and Owner

Private harvest rates vary by year but show no long-term trends. Federal harvests peaked in the 1990s (15%) and have remained relatively low since 2000 (2-5%). Overall, post-fire **harvest rates dropped**, although large fires on private lands cause occasional spikes.



Total area burned with harvested areas overlaid by year. The post-fire harvest rate is marked above each bar.



Post-fire harvest rates by year and ownership. A 3-year rolling mean was applied to smooth trends.

Key Findings

- We classified post-fire harvests with **94.5% overall accuracy** and balanced omission and commission errors.
- The overall harvest rate was **7.9%** but **varied by year, ownership, and ecoregion**.
- Overall **harvest rates decreased** in the 1990s and now fluctuate between 1-12%.
- Across ownerships, the majority of harvests (~80%) took place in the **first two years** post-fire.
- Harvests in the **2020 Labor Day fires** are **below regional long-term averages** by ownership.

What About the Biscuit?

The 2002 Biscuit Fire was excluded from our study due to data quality issues, but we were able to manually map harvests using Landsat time-series and contemporary high-resolution aerial photos. We identified **2,000 acres** of post-fire harvest within five years, a harvest rate of only **0.5%**.