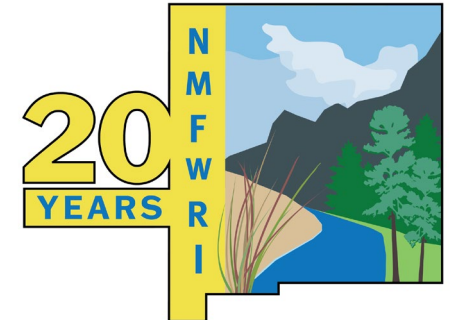


# Forest Treatments: Do They Work, and How Do We Know?

Evidence from New Mexico

NATE TOMCZYK, KATHRYN MAHAN  
NEW MEXICO FOREST & WATERSHED RESTORATION INSTITUTE  
OCTOBER, 2026





# Southwest Ecological Restoration Institutes



**SWERI**

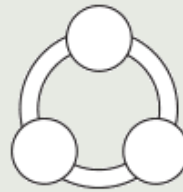


# Southwest Ecological Restoration Institutes



## Science

Located at public universities, each institute has direct access to resources and cutting-edge knowledge to apply to our work in forest science, collaboration, watershed health, resilience, and restoration economics.



## Collaboration

The SWERI work to provide engagement, knowledge, and science support to collaborative partners, which helps guide collaborative decision-making informed by best available science.



## Actionable Knowledge

The SWERI use restoration science and collaboration to deliver actionable knowledge to our partners through locally relevant, evidence-based solutions.

# The New Mexico Forest and Watershed restoration institute

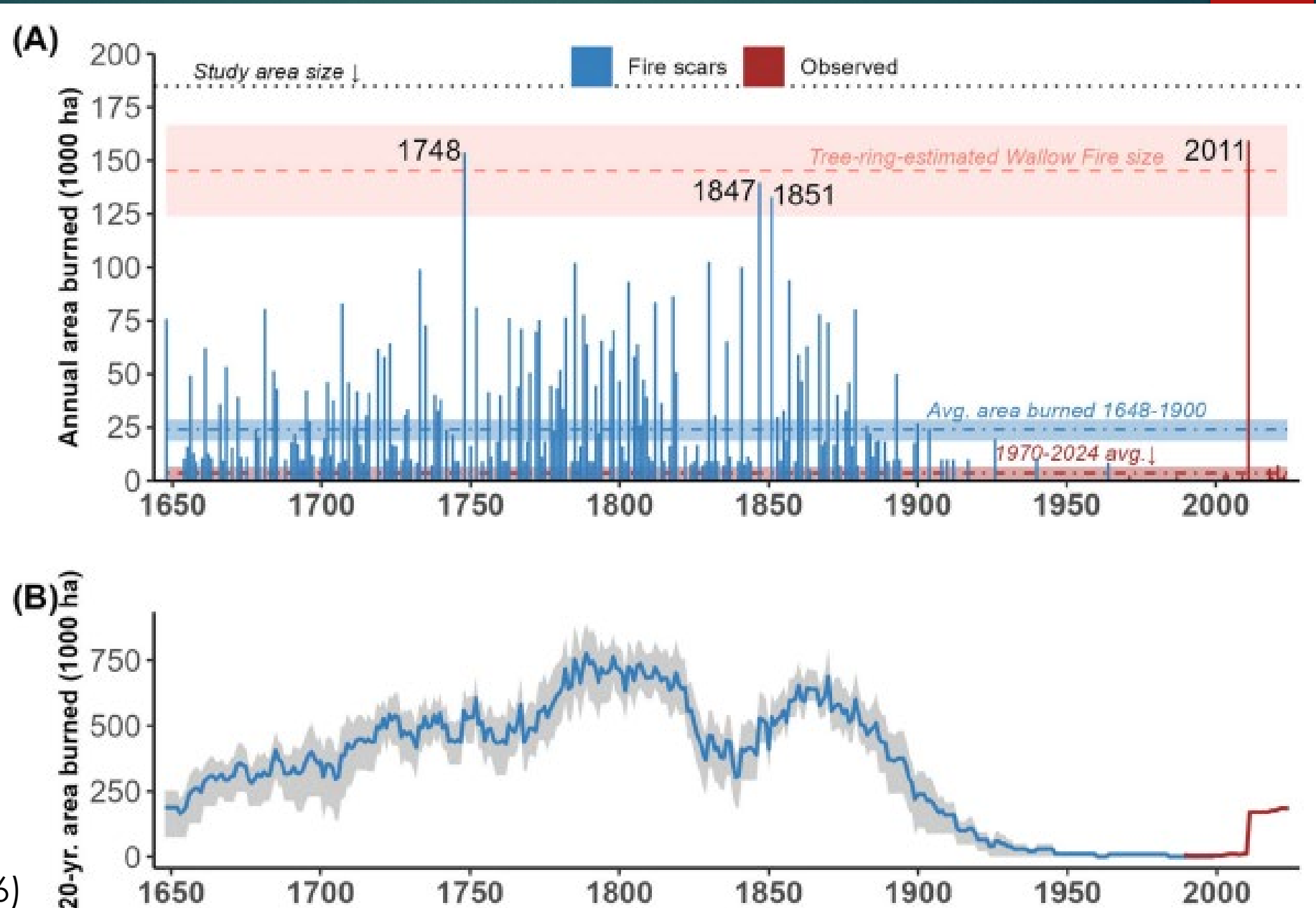
- ▶ Geospatial information systems
- ▶ Ecological monitoring
- ▶ Research
- ▶ Collaboration
- ▶ Education and community engagement



# Outline of talk

- ▶ •What are fuel treatments
- ▶ •Do they work?
- ▶ •Observations from Hermits Peak Calf Canyon and Collaborative Forest Restoration Program
- ▶ •Case studies

# Large fire deficit







**Pre-wildfire**

**During Wildfire**

**Post-wildfire**

**Untreated**



Thin + Rx Burn

Pre-wildfire



During Wildfire



Post-wildfire





# Are fuel treatments effective?

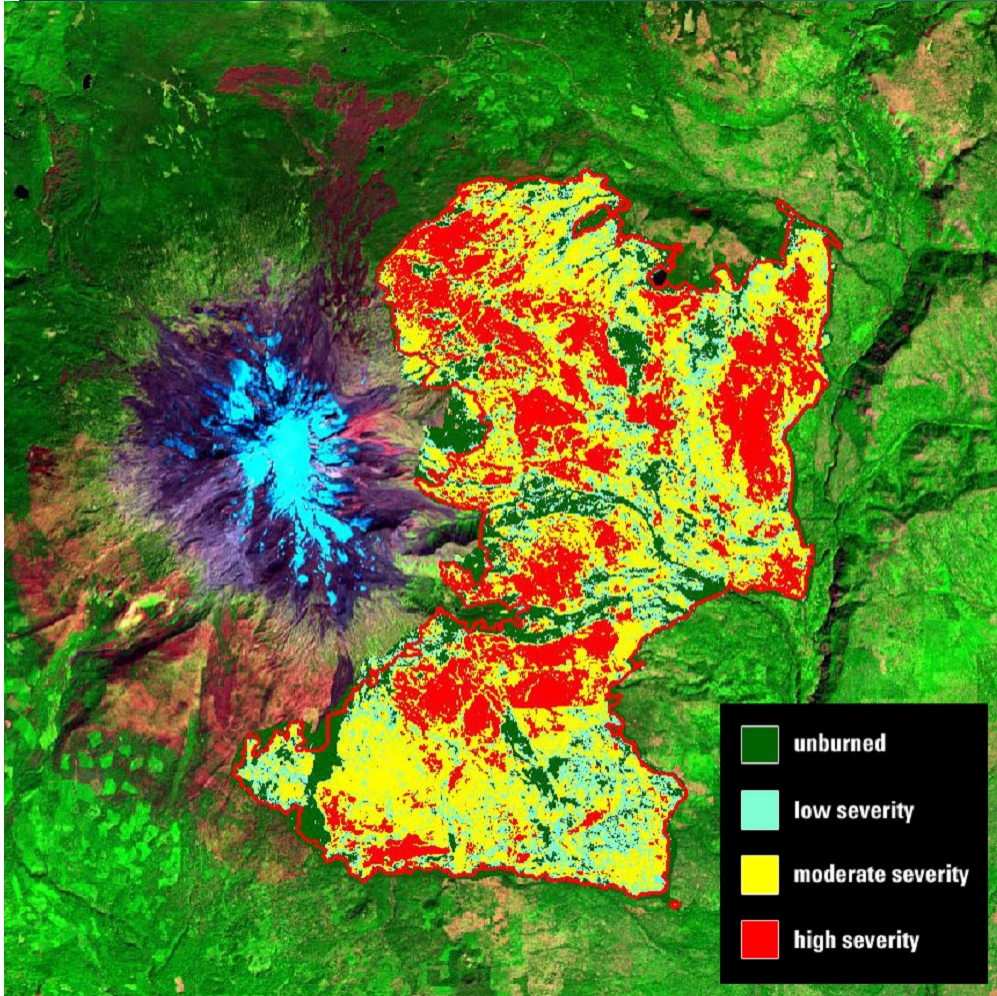


# Effectiveness

- ▶ The capability of producing a desired result or achieving a set goal.
  - ▶ Reduce the negative effects of fire
  - ▶ Reduce the spread of fire



# Fuel treatments reduce *burn severity*



- ▶ A measure of change
  - ▶ Trees
  - ▶ Soils
  - ▶ Combinations (e.g., the composite burn index)
- ▶ Scaled with satellites





Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

# Forest Ecology and Management

journal homepage: [www.elsevier.com/locate/foreco](http://www.elsevier.com/locate/foreco)



## Tamm review: A meta-analysis of thinning, prescribed fire, and wildfire effects on subsequent wildfire severity in conifer dominated forests of the Western US

Kimberley T. Davis<sup>a,\*</sup>, Jamie Peeler<sup>b</sup>, Joseph Fargione<sup>c</sup>, Ryan D. Haugo<sup>d</sup>, Kerry L. Metlen<sup>e</sup>, Marcos D. Robles<sup>f</sup>, Travis Woolley<sup>g</sup>

<sup>a</sup> Missoula Fire Sciences Lab, Rocky Mountain Research Station, USDA Forest Service, Missoula, MT, USA

<sup>b</sup> Department of Ecosystem and Conservation Sciences, University of Montana, Missoula, MT, USA

<sup>c</sup> The Nature Conservancy, Minneapolis, MN, USA

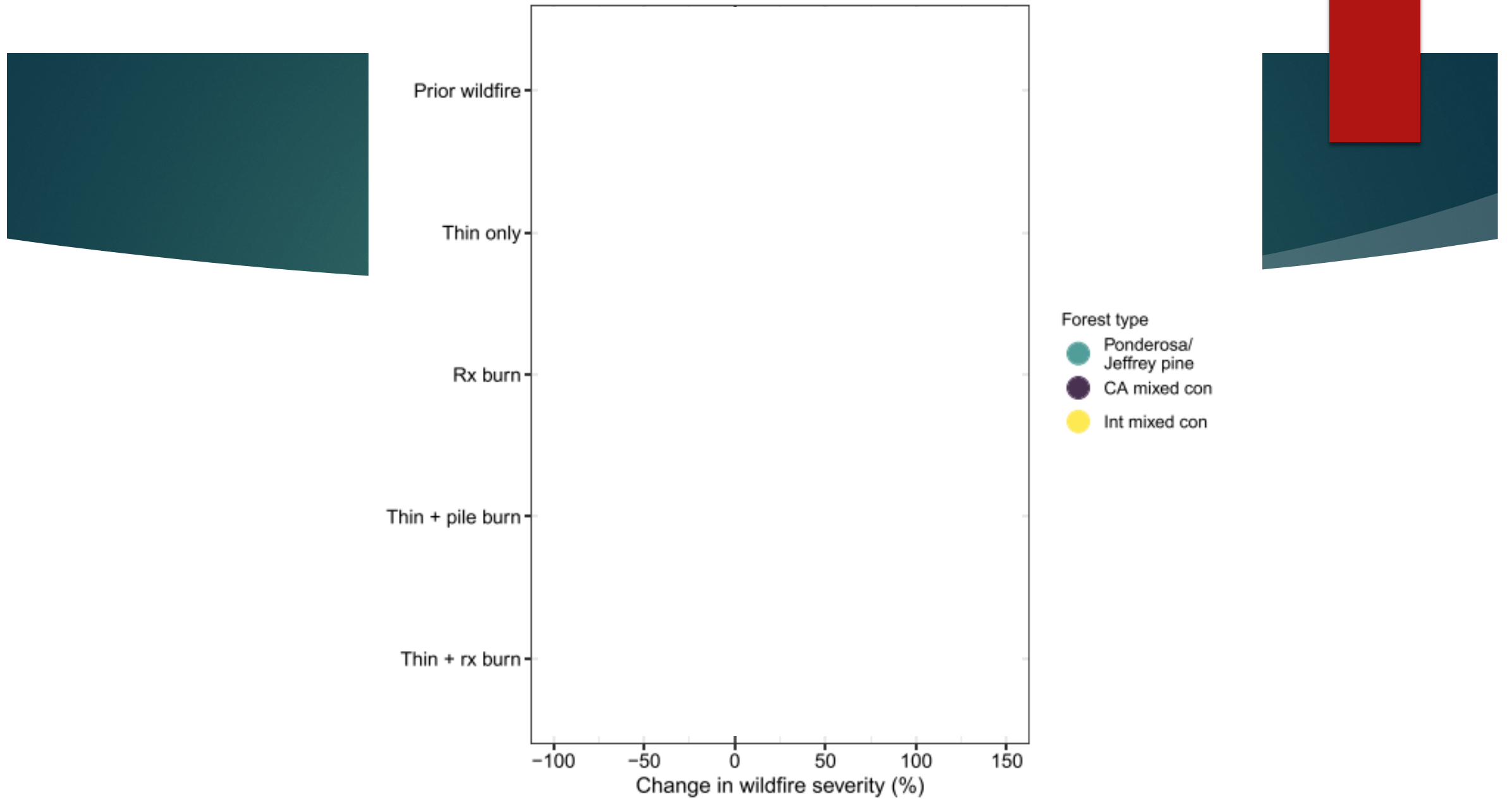
<sup>d</sup> The Nature Conservancy, Portland, OR, USA

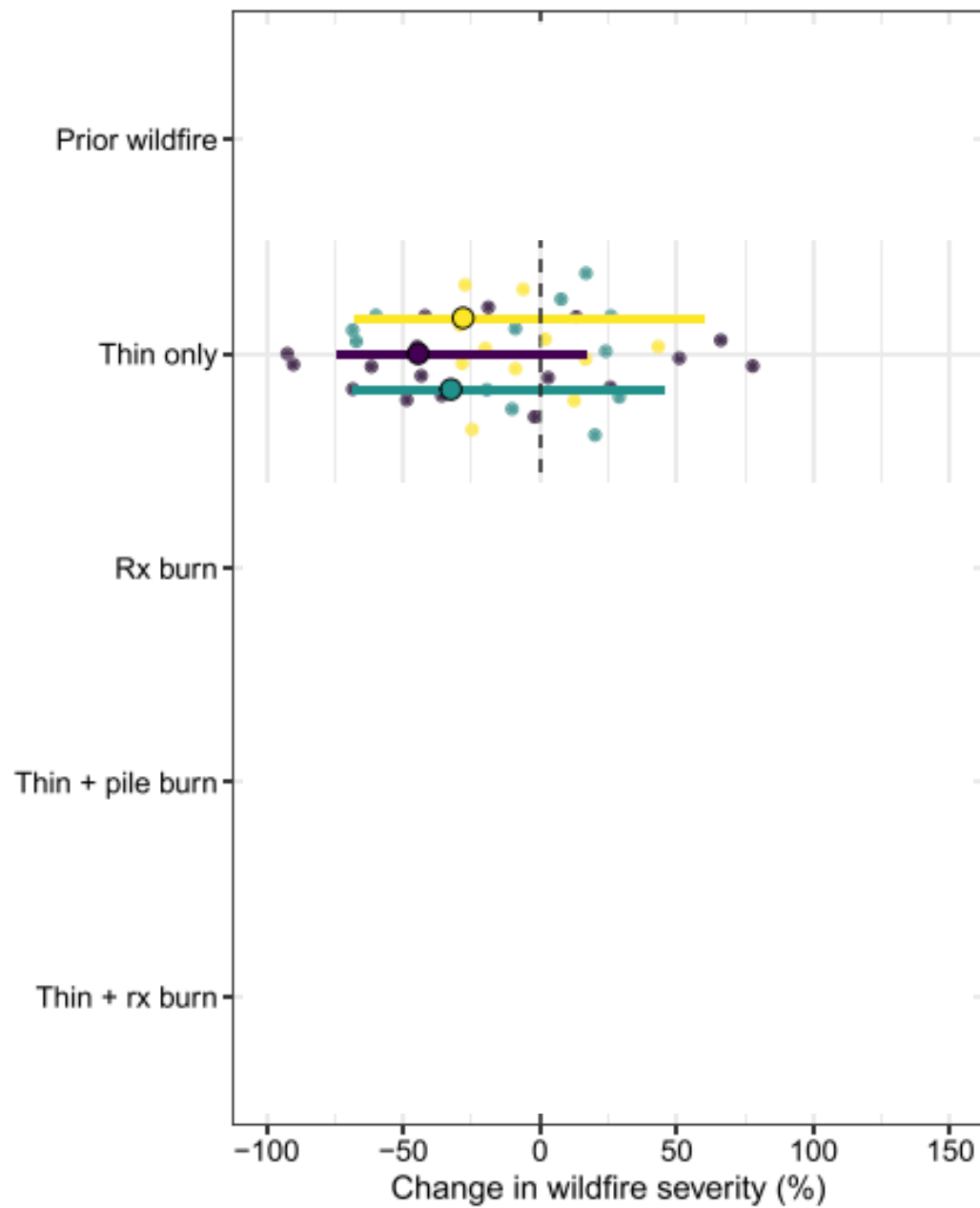
<sup>e</sup> The Nature Conservancy, Ashland, OR, USA

<sup>f</sup> The Nature Conservancy, Tucson, AZ, USA

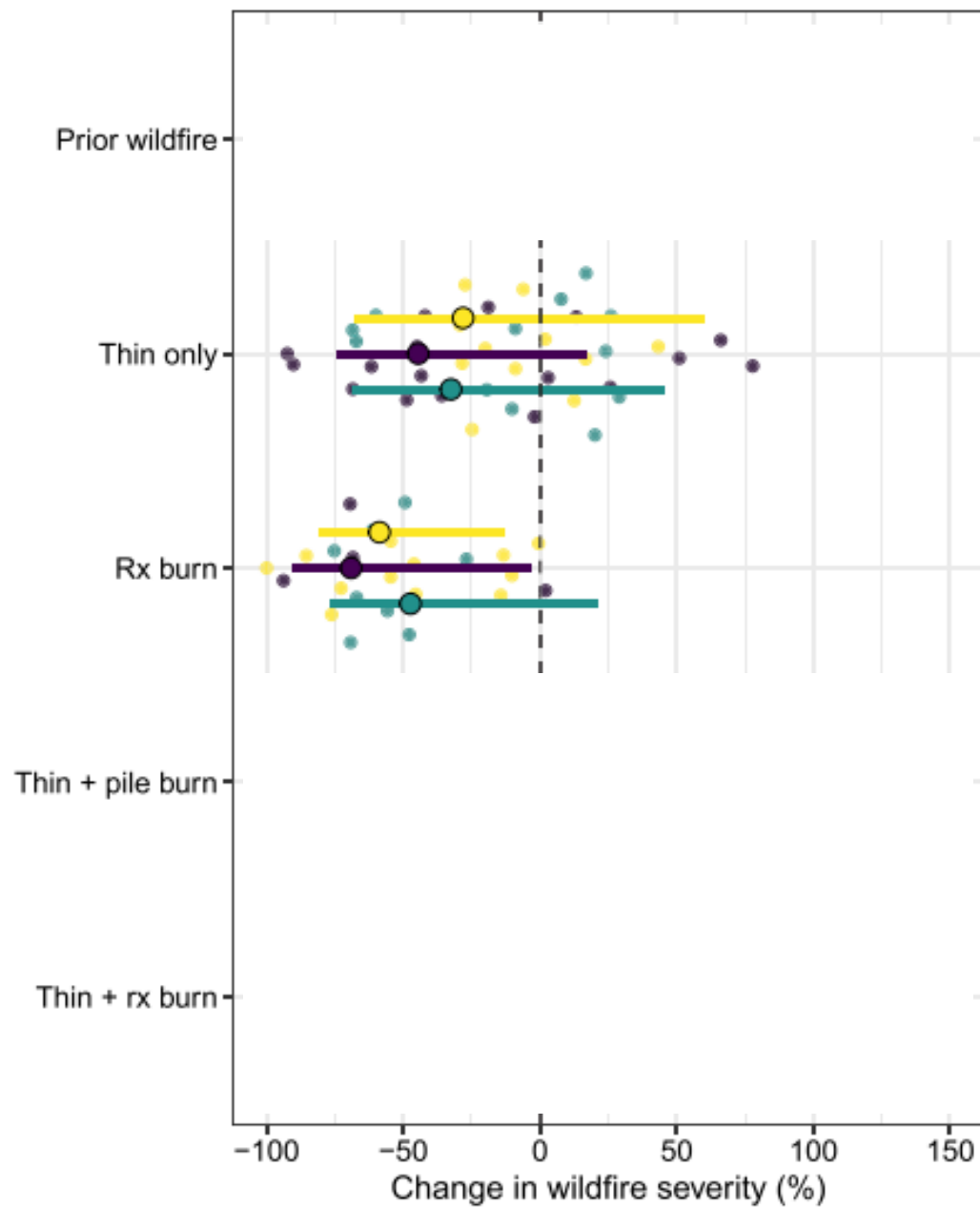
<sup>g</sup> The Nature Conservancy, Flagstaff, AZ, USA

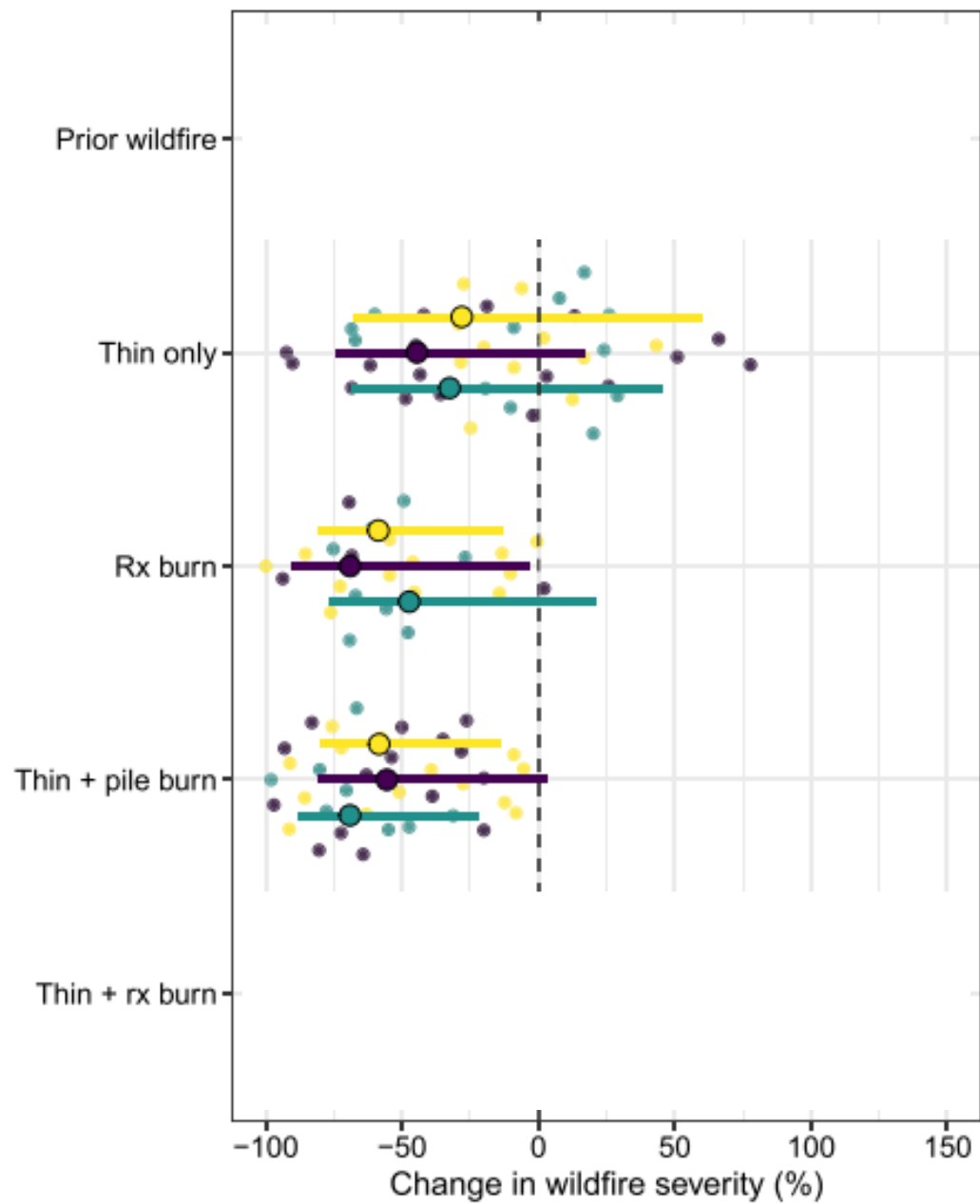


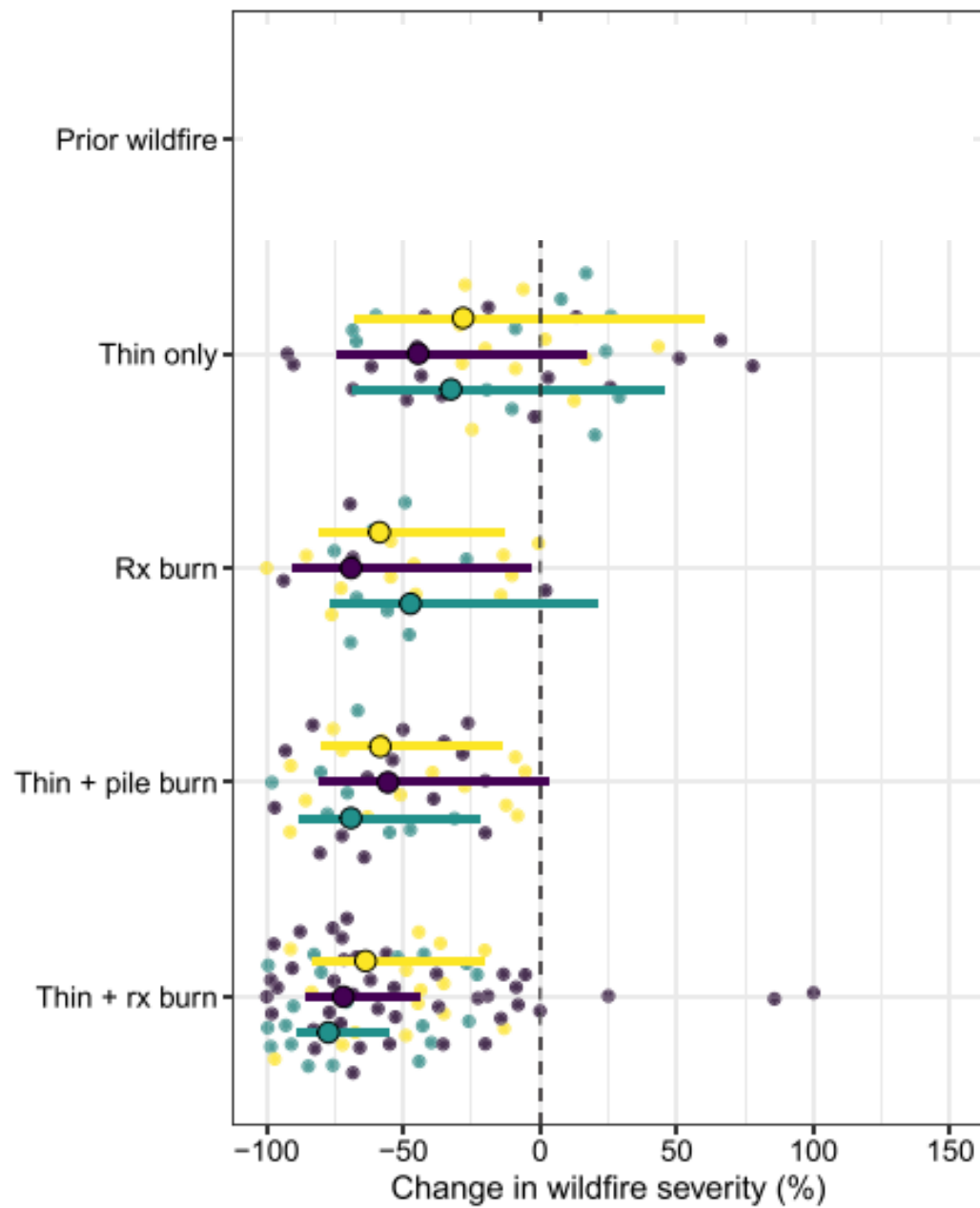














# Main finding

- Treatments reduce burn severity on average
- Thin + prescribed fire is most effective



# What about fire spread?

# What about fire spread?

Science

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🔒 | **RESEARCH ARTICLE** | WILDFIRES



## Wildfire damages and the cost-effective role of forest fuel treatments

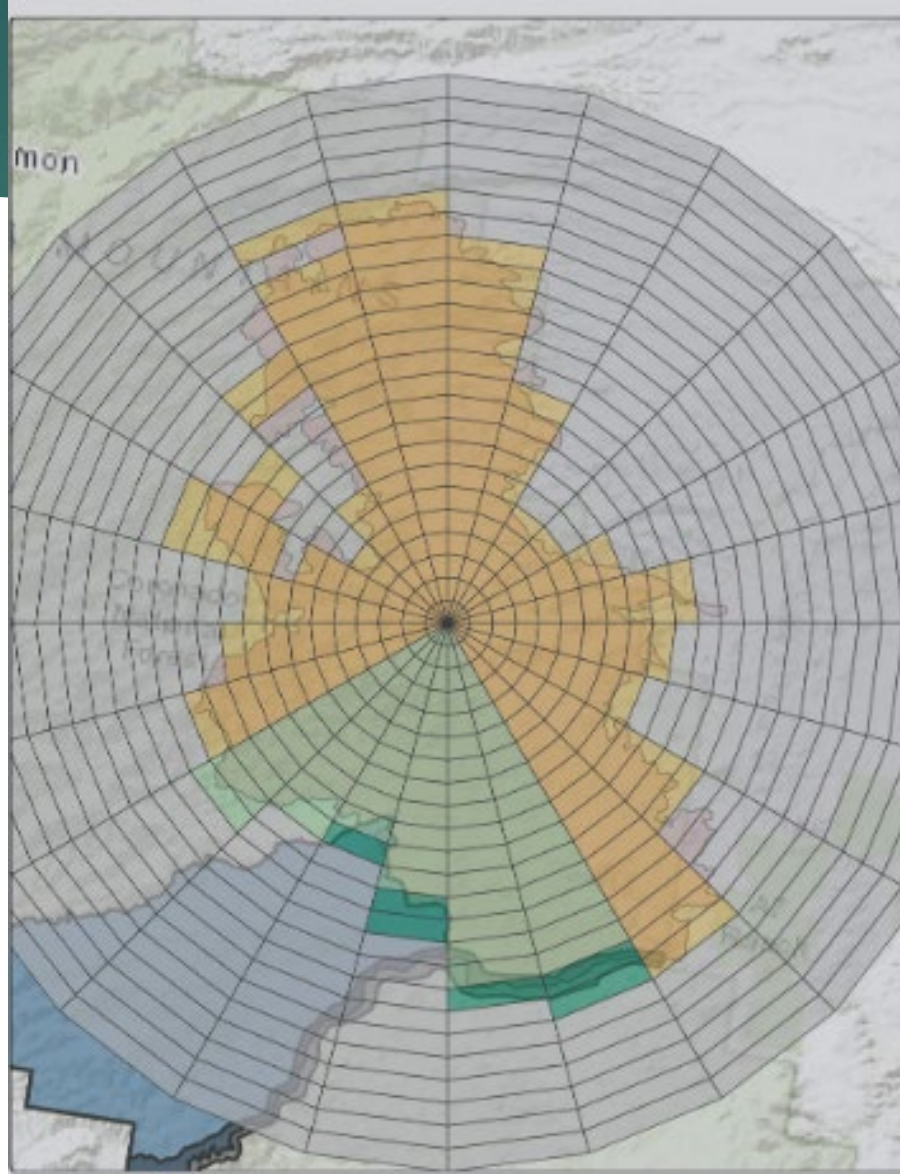
[FREDERIK STRABO](#) , [CALVIN BRYAN](#) , AND [MATTHEW N. REIMER](#)  [Authors Info & Affiliations](#)

**SCIENCE** • 7 May 2026 • Vol 392, Issue 6798 • pp. 629-635 • [DOI: 10.1126/science.aea6463](https://doi.org/10.1126/science.aea6463)

Strabo et al. 2026



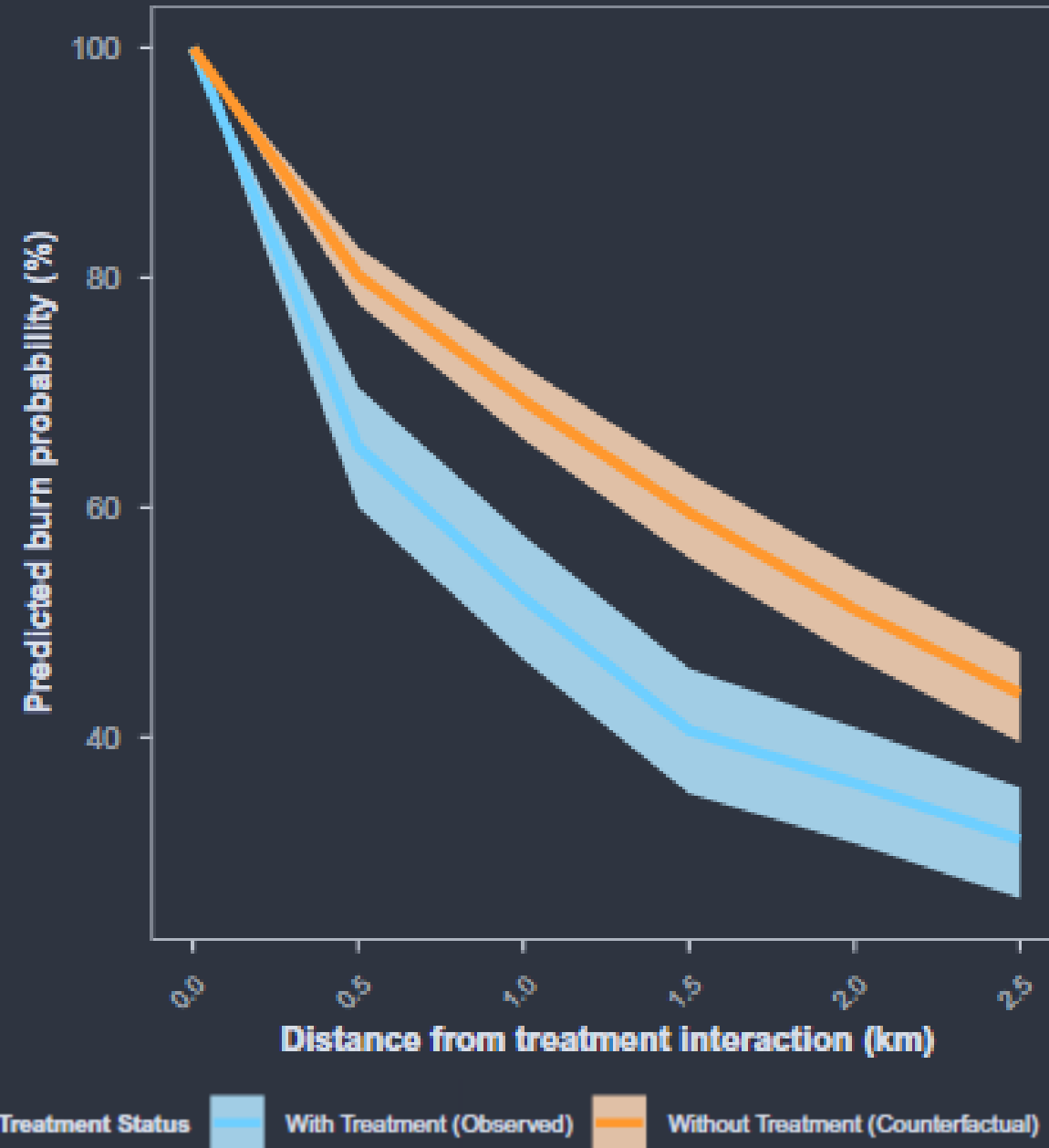
# What about fire spread?





**A**

### Cumulative Burn Probability



# Cost Effectiveness

# Cost Effectiveness

## A. Physical savings

| Acres burned | Structures lost | CO <sub>2</sub> emissions (tons) | PM <sub>2.5</sub> emissions (tons) | Deaths |
|--------------|-----------------|----------------------------------|------------------------------------|--------|
| 152,111      | 4,090           | 2,721,775                        | 25,757                             | 59     |

# Cost Effectiveness

## A. Physical savings

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| 152,111      | 4,090           | 2,721,775                        | 25,757                             | 59     |

## B. Economic costs and savings

| Treatment cost (\$) | Housing values (\$) | Social cost of carbon (\$) | Health and labor (\$) | C-BCR* |
|---------------------|---------------------|----------------------------|-----------------------|--------|
| \$79,093,417        | \$895,147,361       | \$503,528,343              | \$1,393,806,540       | 35.31  |



# Cost Effectiveness

## A. Physical savings

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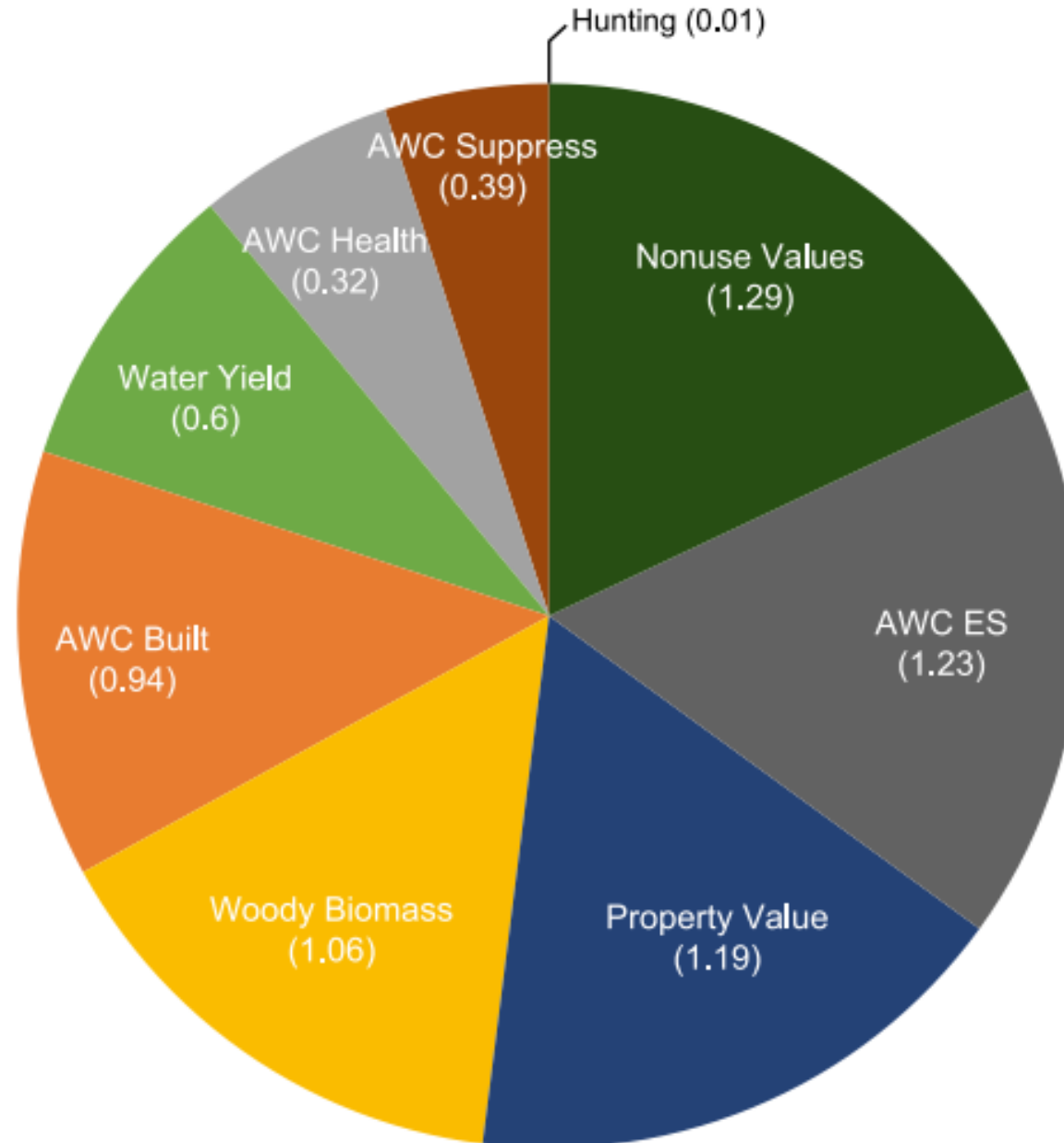
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|---------------------|---------------------|----------------------------|-----------------------|--------|
| \$79,093,417        | \$895,147,361       | \$503,528,343              | \$1,393,806,540       | 35.31  |

## C. Ex ante benefit-cost ratios

| Small (75 to 600 acres) | Medium (600 to 2400 acres) | Large (>2400 acres) | Total | Median |
|-------------------------|----------------------------|---------------------|-------|--------|
| 2.99                    | 3.19                       | 5.59                | 3.73  | 9.05   |

Sum of the Benefit-Cost Ratios = 7.04

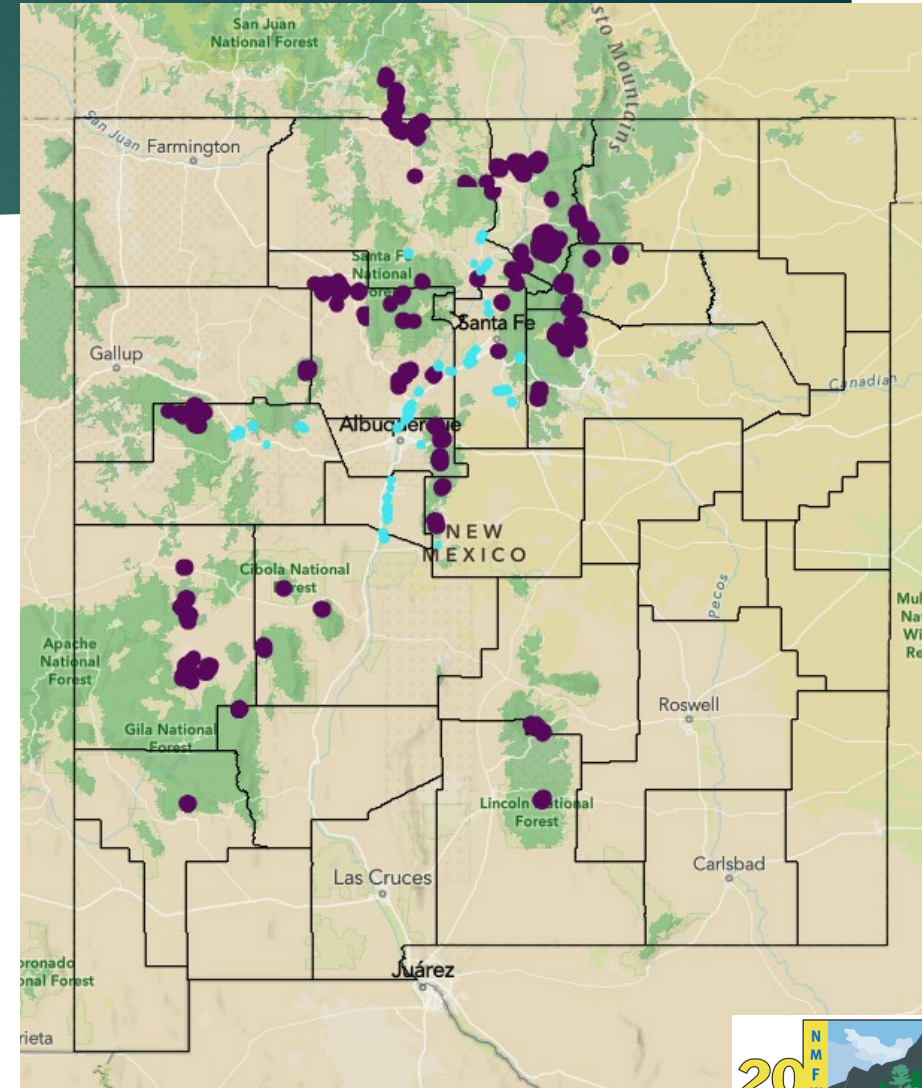


# Summary from literature

- ▶ Treatments reduce severity
- ▶ Treatments reduce likelihood of fire spread
- ▶ Benefits outweigh monetary costs

# NMFWRI Ecological Monitoring

- ▶ Collect data on **~2600 long-term forest monitoring plots** across the state
- ▶ Provide **training to students** and recent graduates in monitoring methods
- ▶ **Support to local agencies & researchers**
- ▶ **Presentations and fairs** with the general public on what we are seeing and what to expect





# Case Study: CFRP

- ▶ Program ran 2001-2020
  - ▶ 200+ projects
  - ▶ 600+ partners
  - ▶ 33,000+ acres
- ▶ NMFWRI handled long-term monitoring (approx. 25%)
  - ▶ 31 projects
  - ▶ 150 entries
  - ▶ 1600+ plots
  - ▶ 9,000+ acres

CFRP Projects with NMFWRI Monitoring Data



# Forest Treatment Objectives within CFRP

- ▶ 1. Wildfire Threat Reduction (tons/acre of fuels; ladder fuels)
- ▶ 2. Ecosystem restoration, include non-native species reduction (species composition)
- ▶ 3. Re-establishment of historic fire regimes (prescribed fire and low-impact wildfire)
- ▶ 4. Reforestation (regeneration; changes in size distribution)
- ▶ 5. Preservation of old and large trees (retention on the landscape)



# Forest Types

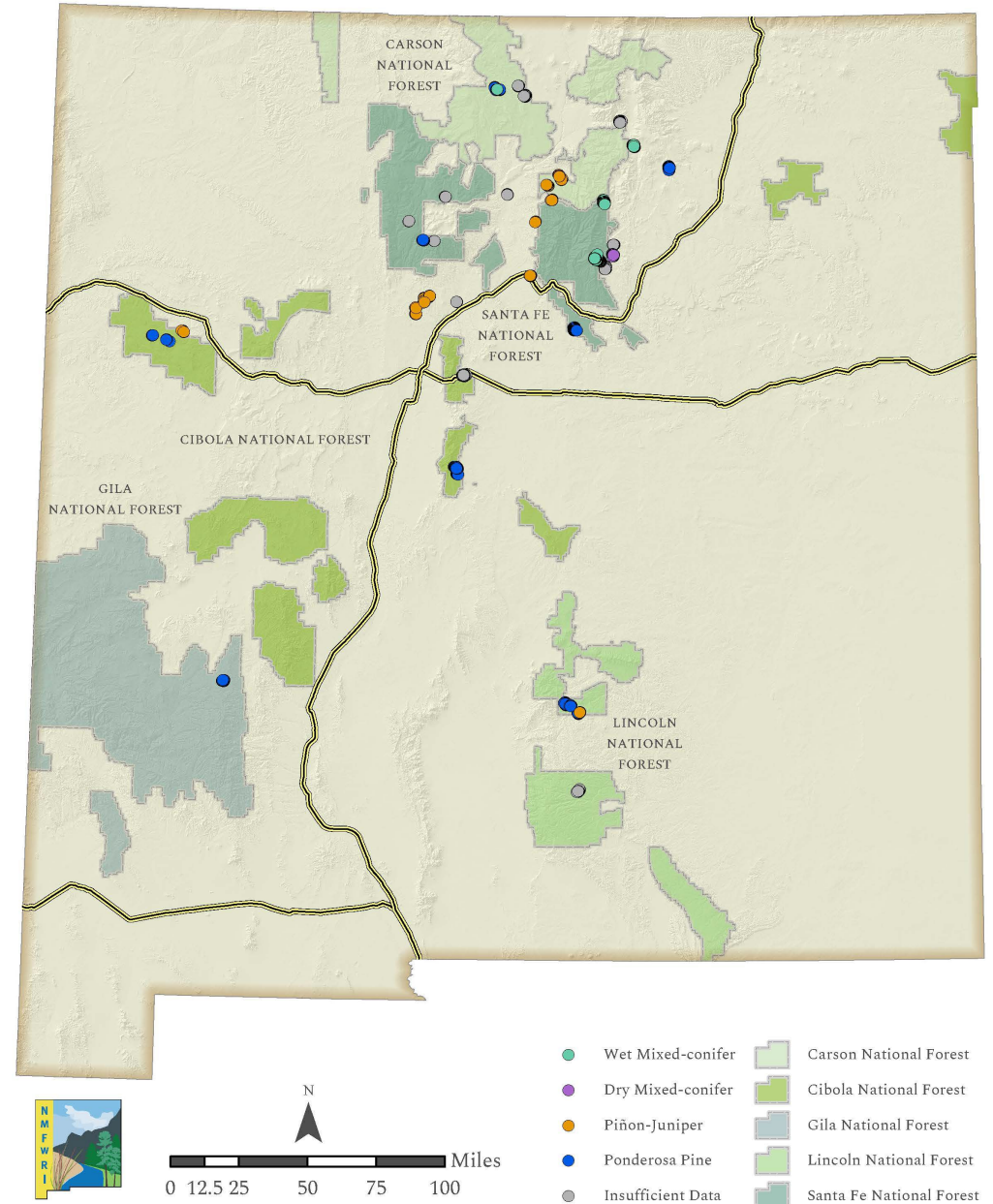
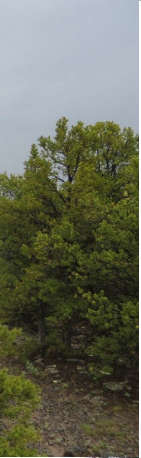
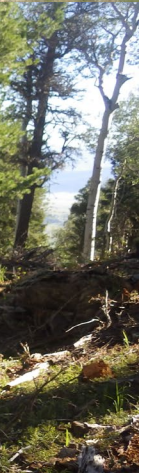
- ▶ Piñon-Juniper
- ▶ Ponderosa Pine
- ▶ Dry Mixed-conifer
- ▶ Wet Mixed-conifer



|     | Pre-tx | Immediate post | 5 year post | 10 year post |
|-----|--------|----------------|-------------|--------------|
| PJ  | 12     | 13             | 14          | 14           |
| PP  | 19     | 12             | 23          | 19           |
| DMC | 7      | 5              | 6           | 2            |
| WMC | 3      | 3              | 6           | 6            |



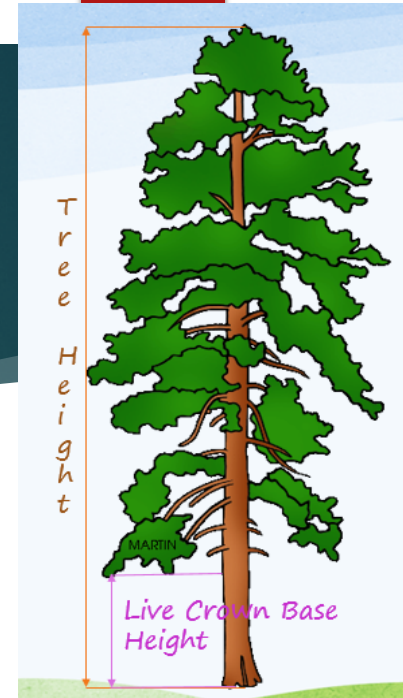
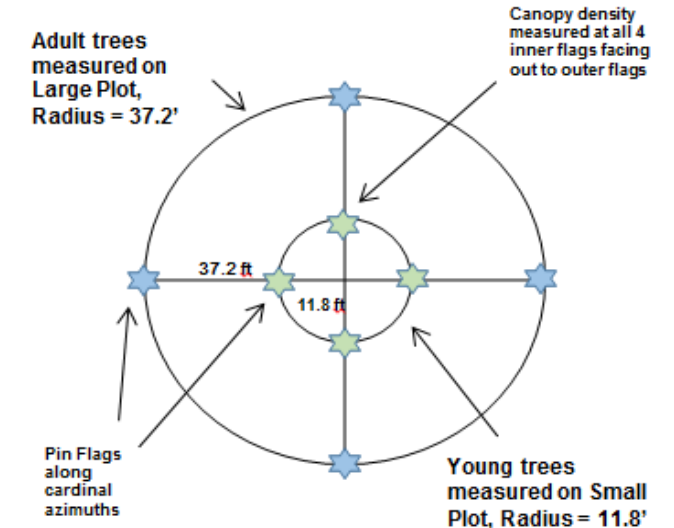
## Forest Types in CFRP Projects monitored by NMFWR I





# What Was Measured?

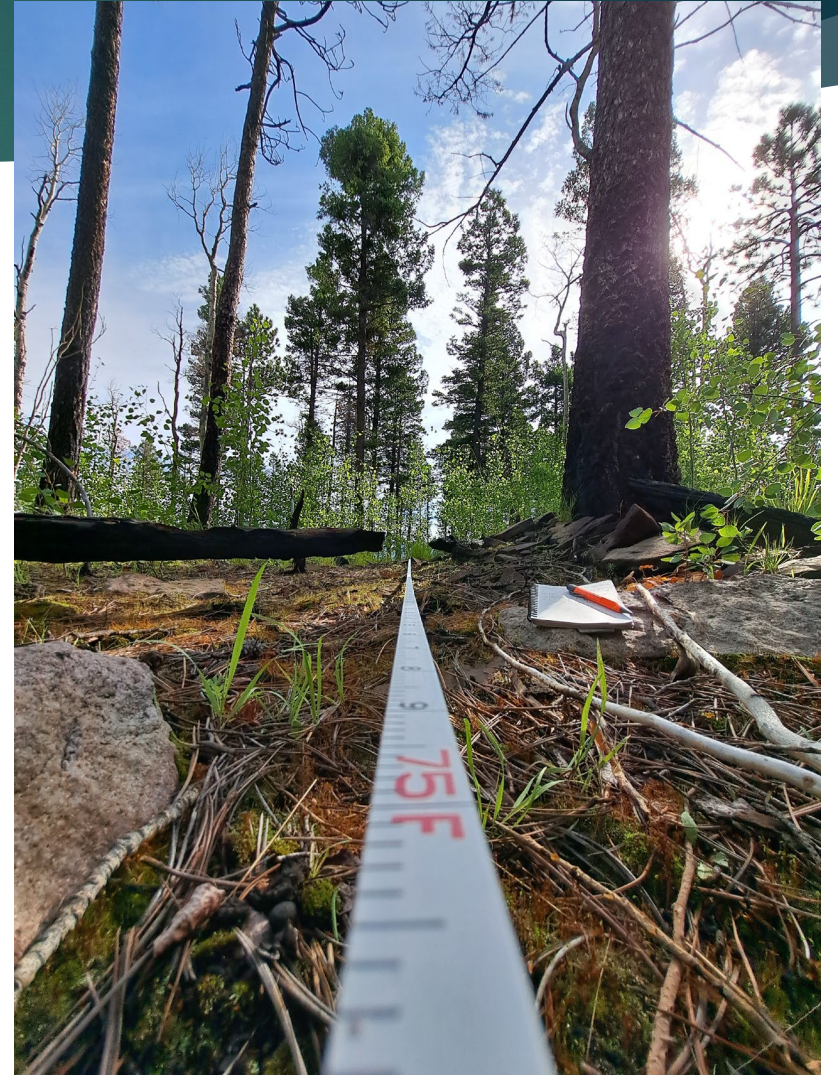
- ▶ trees per acre
- ▶ snags per acre
- ▶ sick trees per acre
- ▶ basal acre per acre
- ▶ quadratic mean diameter for all live trees
- ▶ average height of live trees
- ▶ average live crown base height
- ▶ live saplings per acre
- ▶ live seedlings per acre
- ▶ overstory canopy cover percent
- ▶ grass and forb cover percent
- ▶ bare soil/rock cover percent
- ▶ total tons of surface fuels per acre





# How Did We Assess Projects?

- ▶ By comparing measurable metrics (such as fuel loads, trees per acre, seedlings per acre, etc) at pre-treatment, immediate post-treatment, 5-years post-treatment, 10-years post-treatment, 15 years-post treatment
- ▶ We looked for meaningful change, and how long those changes lasted
- ▶ We compared to historical reference ranges where available





# Historic Range of Variability



**Table 1.** Ranges of reference conditions for ponderosa pine and dry mixed-conifer forests in the Southwestern United States from studies detailed in Tables 3, 6, 7, and 9.

| Forest attribute                                                | Reference conditions by forest type |                          |
|-----------------------------------------------------------------|-------------------------------------|--------------------------|
|                                                                 | Ponderosa pine                      | Dry mixed-conifer        |
| Trees / acre                                                    | 11.7-124                            | 20.9-99.4                |
| Basal area (ft <sup>2</sup> / acre)                             | 22.1-89.3                           | 39.6-124                 |
| Openness (%) <sup>a</sup>                                       | 52-90                               | 78.5-87.1                |
| Openness on sites with strong tree aggregation (%) <sup>a</sup> | 70-90                               | 79-87                    |
| Spatial patterns                                                | Grouped or random                   | Grouped or random        |
| Number of trees / group                                         | 2-72                                | Insufficient data        |
| Size of groups (acres)                                          | 0.003-0.72                          | Insufficient data        |
| Number of groups / acre                                         | 6-7                                 | Insufficient data        |
| Snags / acre                                                    | 1-10                                | ≥ Ponderosa pine forests |
| Logs / acre                                                     | 2-20                                | ≥ Ponderosa pine forests |

<sup>a</sup>Openness is the proportion of area not covered by tree crowns, estimated as the inverse of canopy cover. Openness data for dry mixed-conifer is limited; range of reference condition openness will likely change with additional studies.



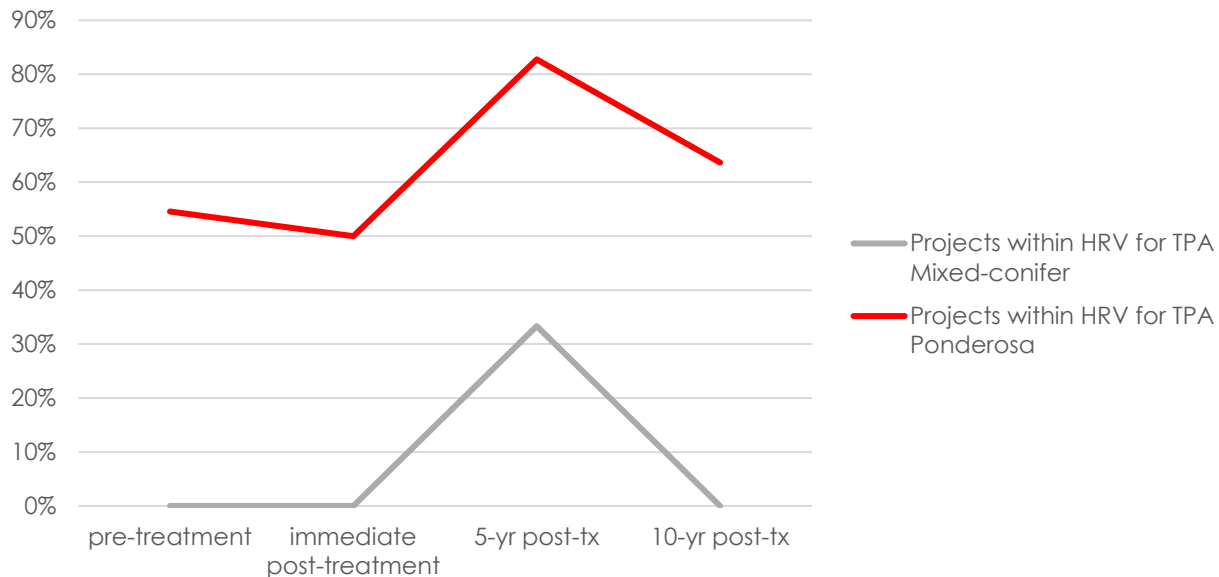
# Takeaways



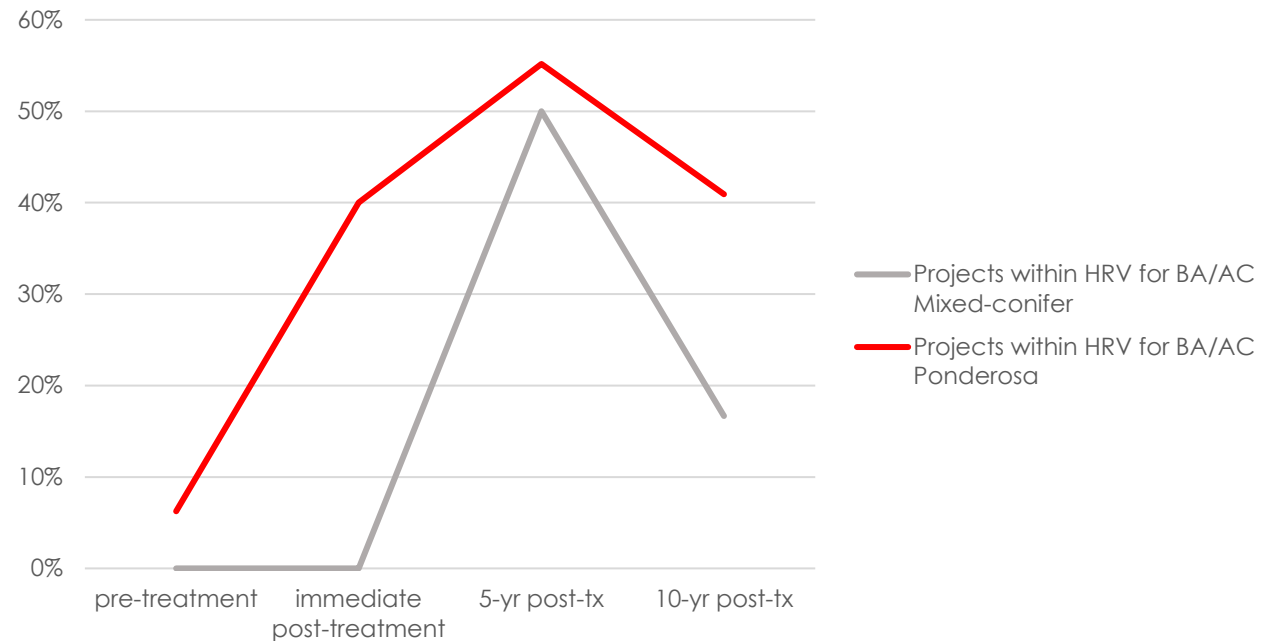
- ▶ Piñon-Juniper
  - ▶ Preliminary results suggest longest duration of treatment of the 4 forest types
  - ▶ Low natural regeneration rates
- ▶ Ponderosa Pine
  - ▶ treatment impacts are variable in duration
  - ▶ Fuel management needed after treatment
- ▶ Dry mixed-conifer
  - ▶ without maintenance or re-entry, many projects have escaped targets by 10 years post-treatment
  - ▶ Provide maintenance or other disturbance within 10 years of initial entry
- ▶ Wet mixed-conifer
  - ▶ generally, needed different treatment methods than “standard” thinning to reach goals

# CFRP – historic range of variability

Percent of Monitored CFRP Projects within Historic Range of Variability for Trees per Acre



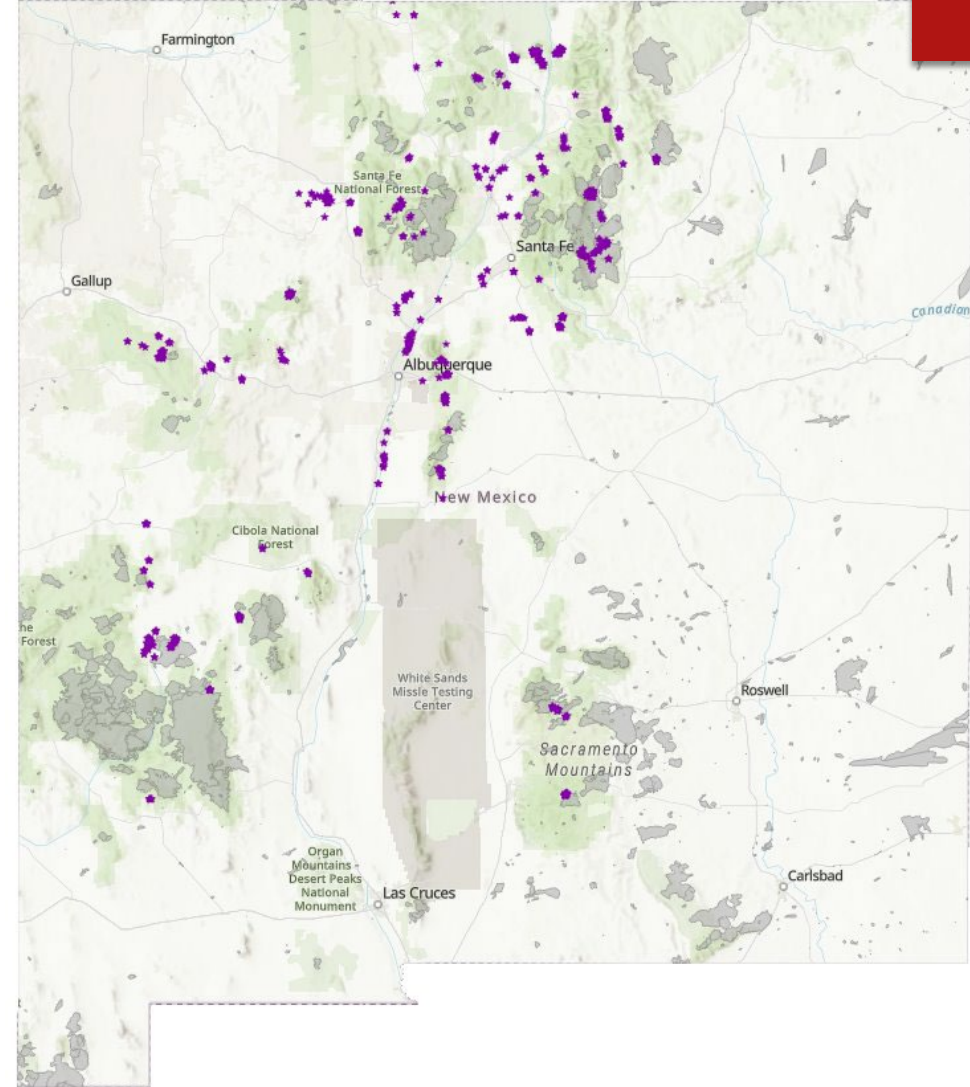
Percent of Monitored CFRP Projects within Historic Range of Variability for Basal Area per Acre





# Post-fire work across the state

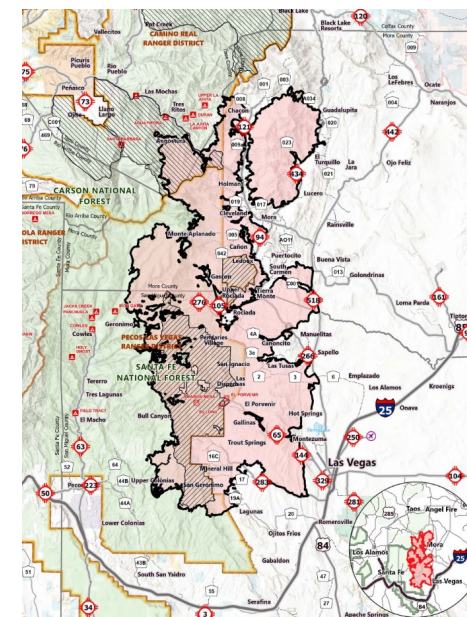
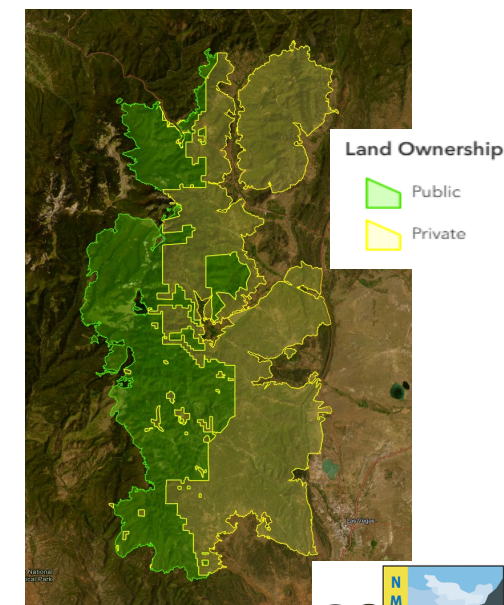
- ▶ 30% (800 out of 2686) long-term plots around the state are in burn scars
- ▶ McBride, Cooks Peak, South Fork, McGaffey, Moon Mountain, Thompson Ridge, Las Conchas, Hermit's Peak/ Calf Canyon





# Case Study: Hermit's Peak/Calf Canyon Wildfire

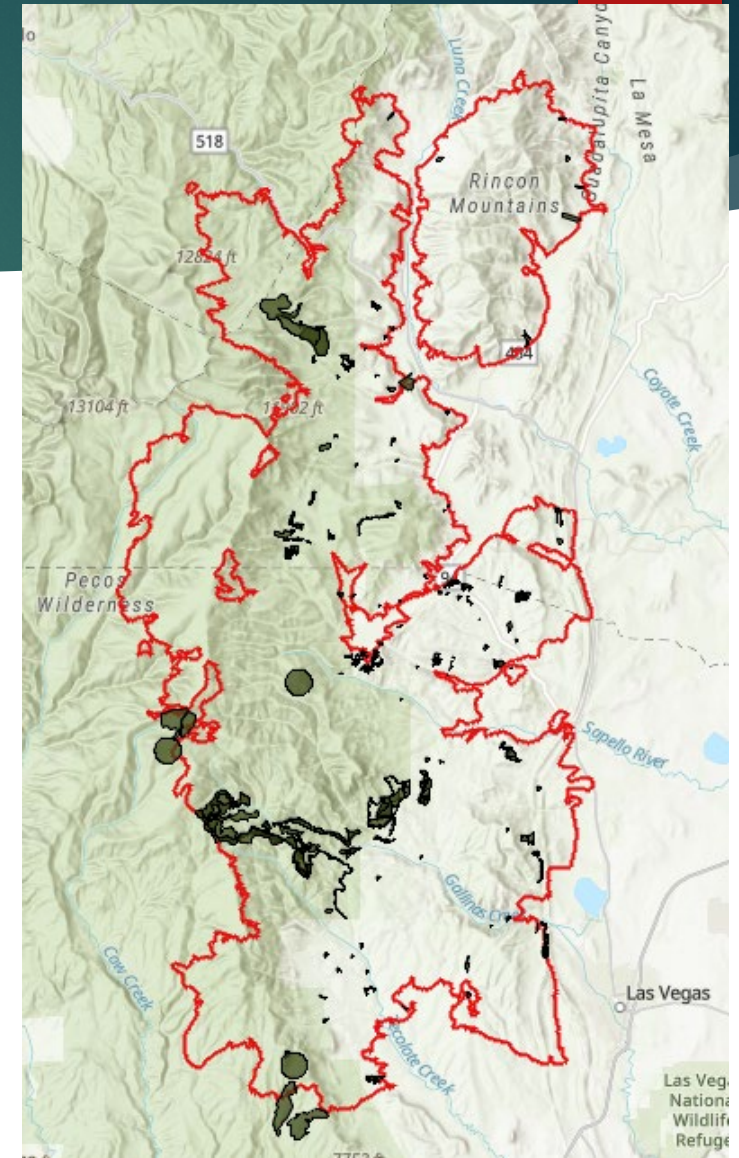
- ▶ The 2022 Hermit's Peak / Calf Canyon (HPCC) wildfire was the largest in New Mexico's History
  - ~341,000 acres
    - 58% included private working lands
  - Over 900 structures destroyed
  - 54% burned at moderate-high severity
  - \$5.14 billion in losses (Dec 2024)





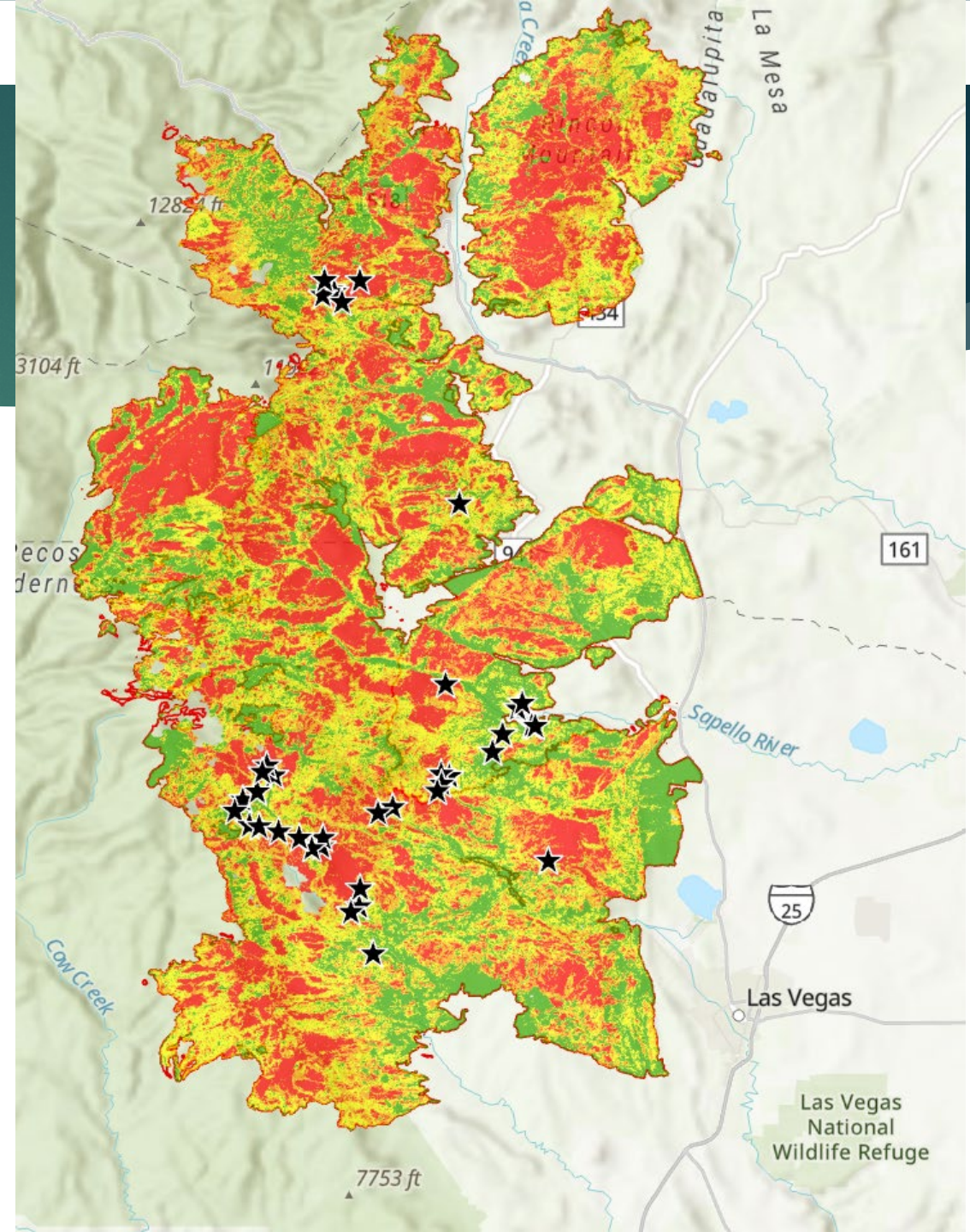
# Pre-fire treatments in HPCC

- ▶ Approximately 600 treatments were recorded in the years prior to HPCC (2013-2021)
  - ▶ Including NMFD-funded private land work
- ▶ Mean treatment size was 29 acres
- ▶ Total acres treated was around 17,000, less than 5% of the burn scar



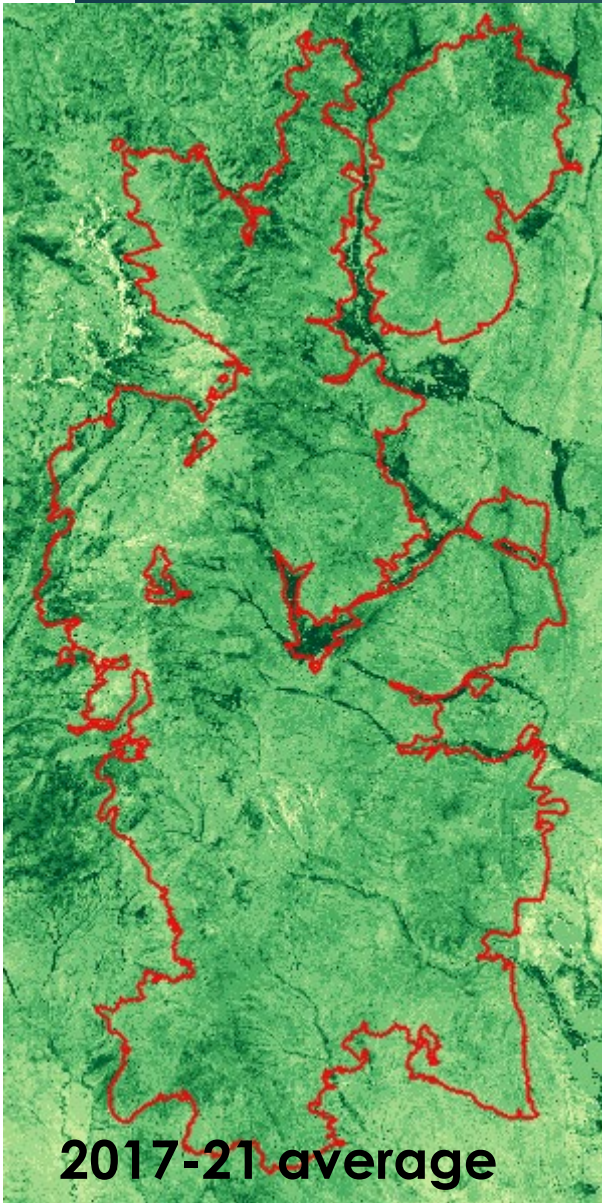
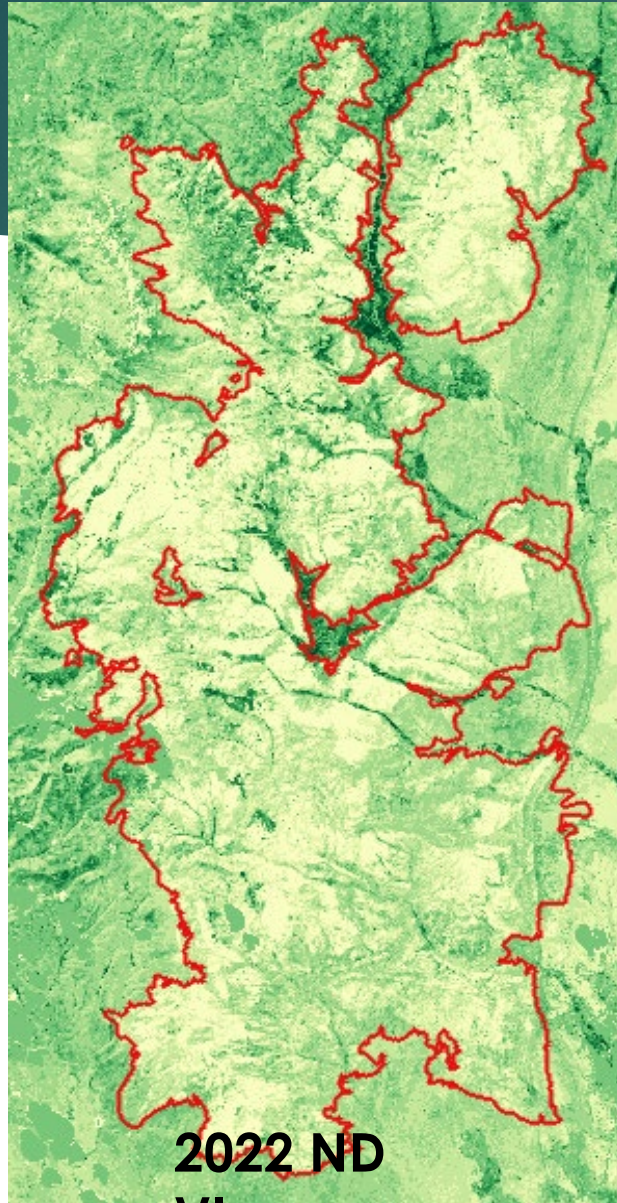
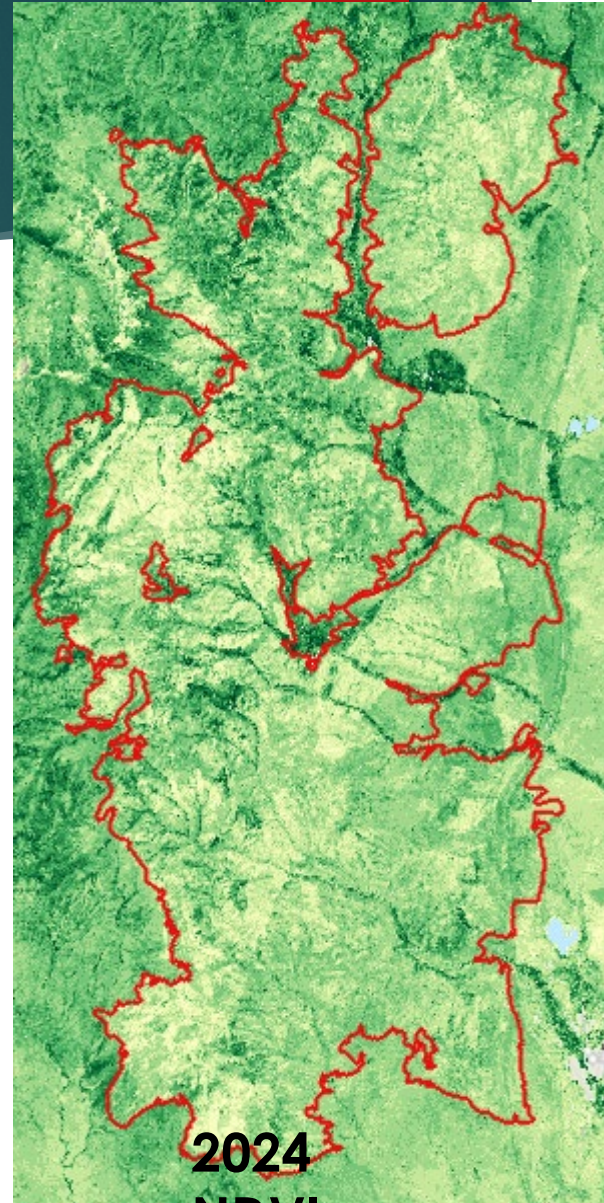


HPCC  
RAVG/CBI





# Changes in NDVI



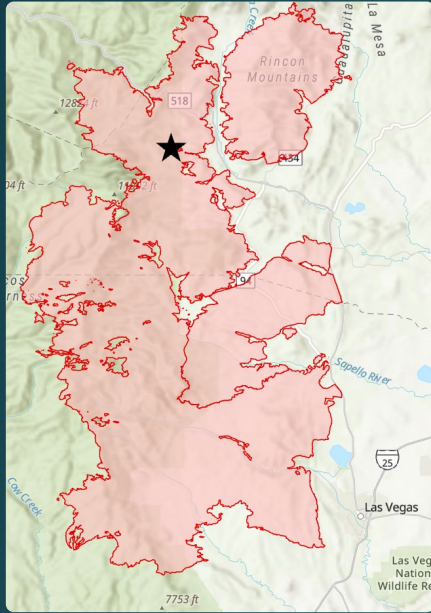




# Pre-Fire Treatments & HPCC Outcomes

*Figures in this section credit to  
Emily Yannayon, NMFWR*



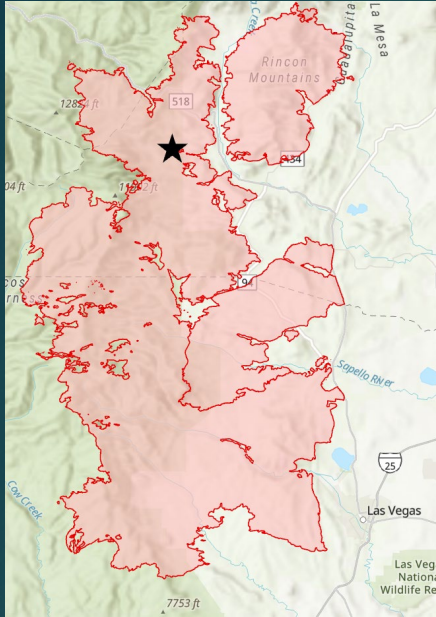


12.16 Upper Mora  
Walker Flats, plot  
13  
Mixed Conifer  
Forest  
Untreated Pre-Fire



2018



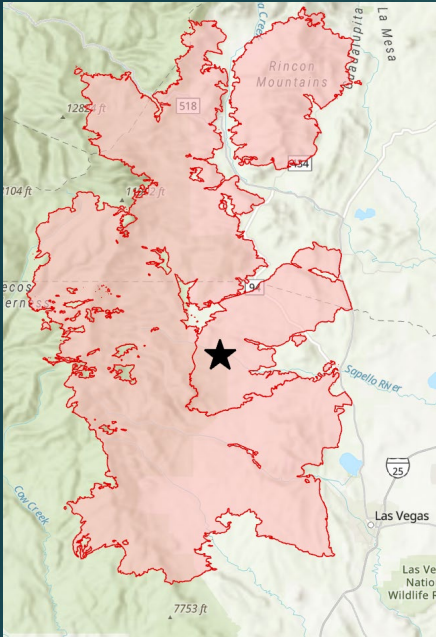


12.16 Upper Mora  
Walker Flats, plot 13  
*Mixed Conifer Forest*  
Untreated Pre-Fire



2024



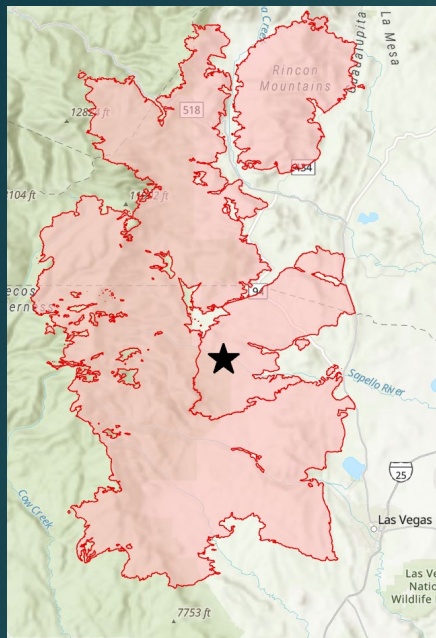


32.09 Maestas  
Northridge,  
Plot 3  
*Ponderosa Pine  
Forest*  
Thinned 2011-2012



2011



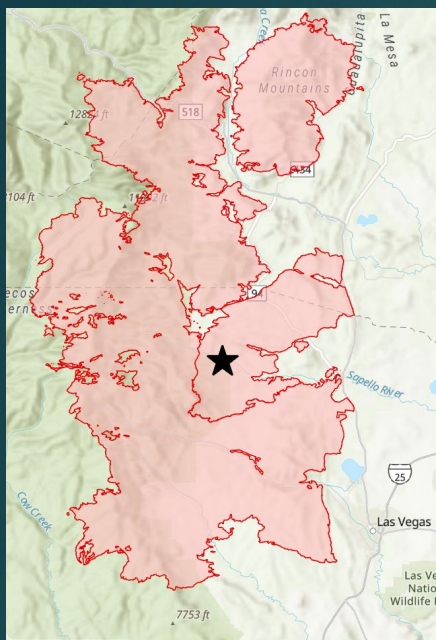


32.09 Maestas  
Northridge,  
Plot 3  
*Ponderosa Pine  
Forest*  
Thinned 2011-2012



2019

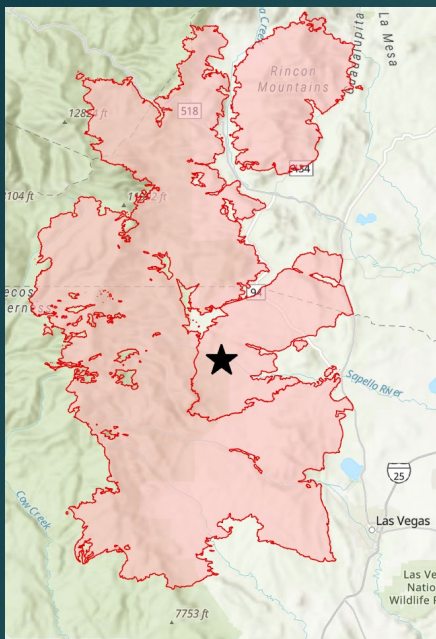




32.09 Maestas  
Northridge,  
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Thinned 2011-2012





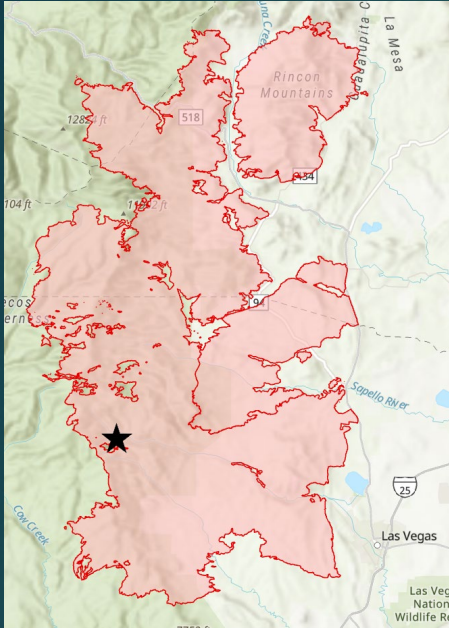


32.09 Maestas  
Northridge,  
Plot 3  
*Ponderosa Pine  
Forest*  
Thinned 2011-2012



2025



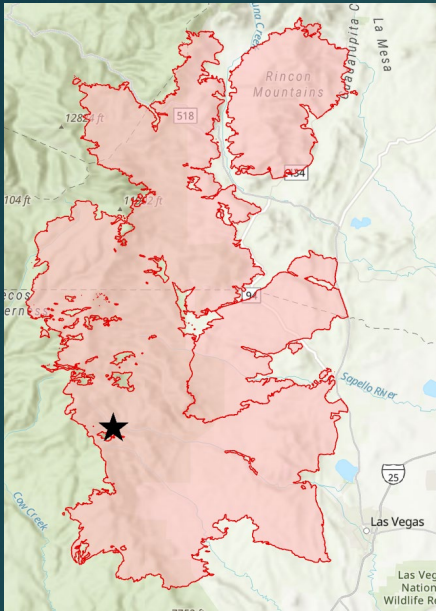


21.12 Calf  
Canyon, Plot 1  
Mixed Conifer  
Forest  
Thinned 2014;  
Prescribed Fire  
2018



2014

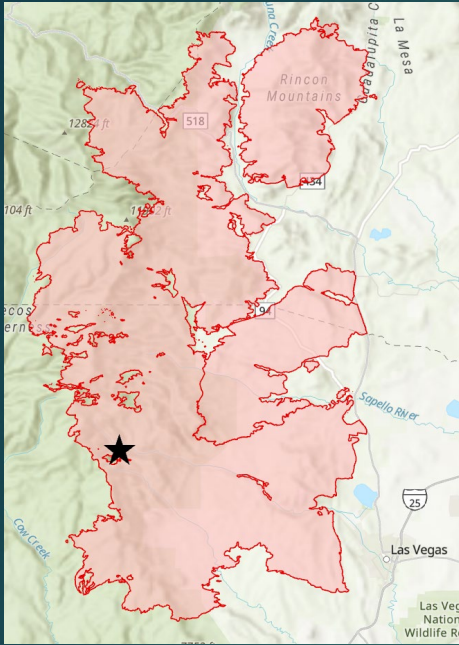




21.12 Calf  
Canyon, Plot 1  
*Mixed Conifer  
Forest*  
Thinned 2014;  
Prescribed Fire  
2018







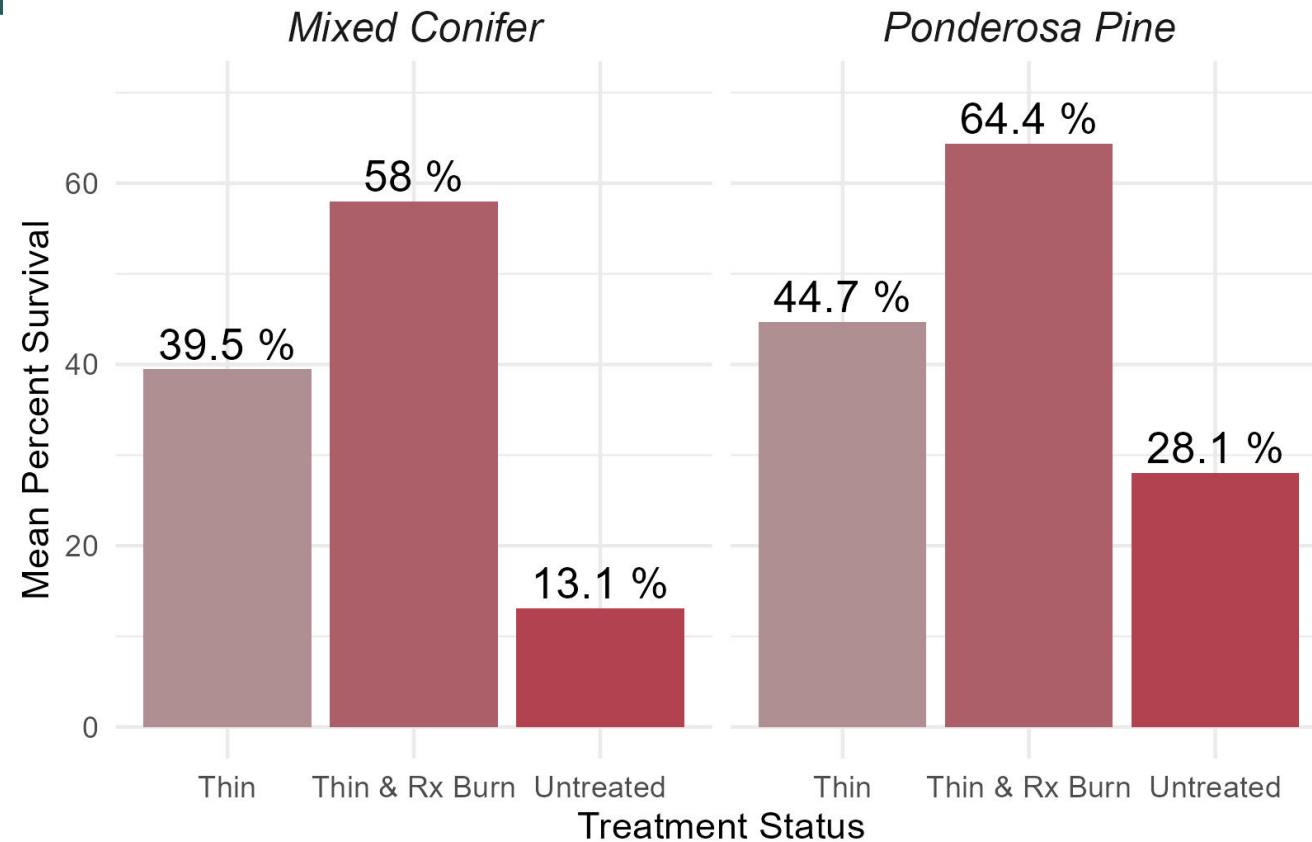
21.12 Calf  
Canyon, Plot 1  
*Mixed Conifer  
Forest*  
Thinned 2014;  
Prescribed Fire  
2018





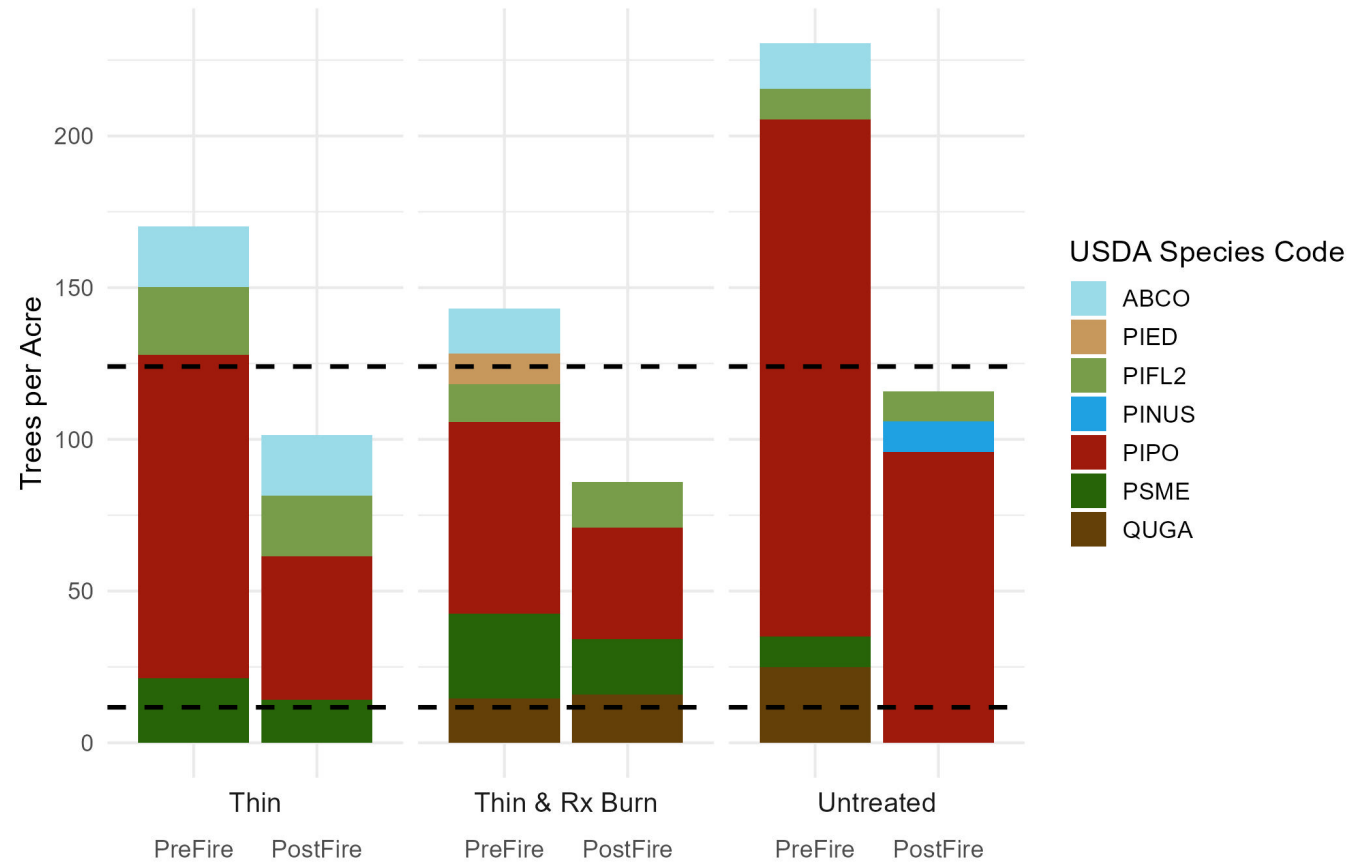
# Summary: Survival Rates By Treatment

## Survival Rates of Mature Trees vs. Pre-Fire Treatment Status



# HPCC & Historical Range of Variability

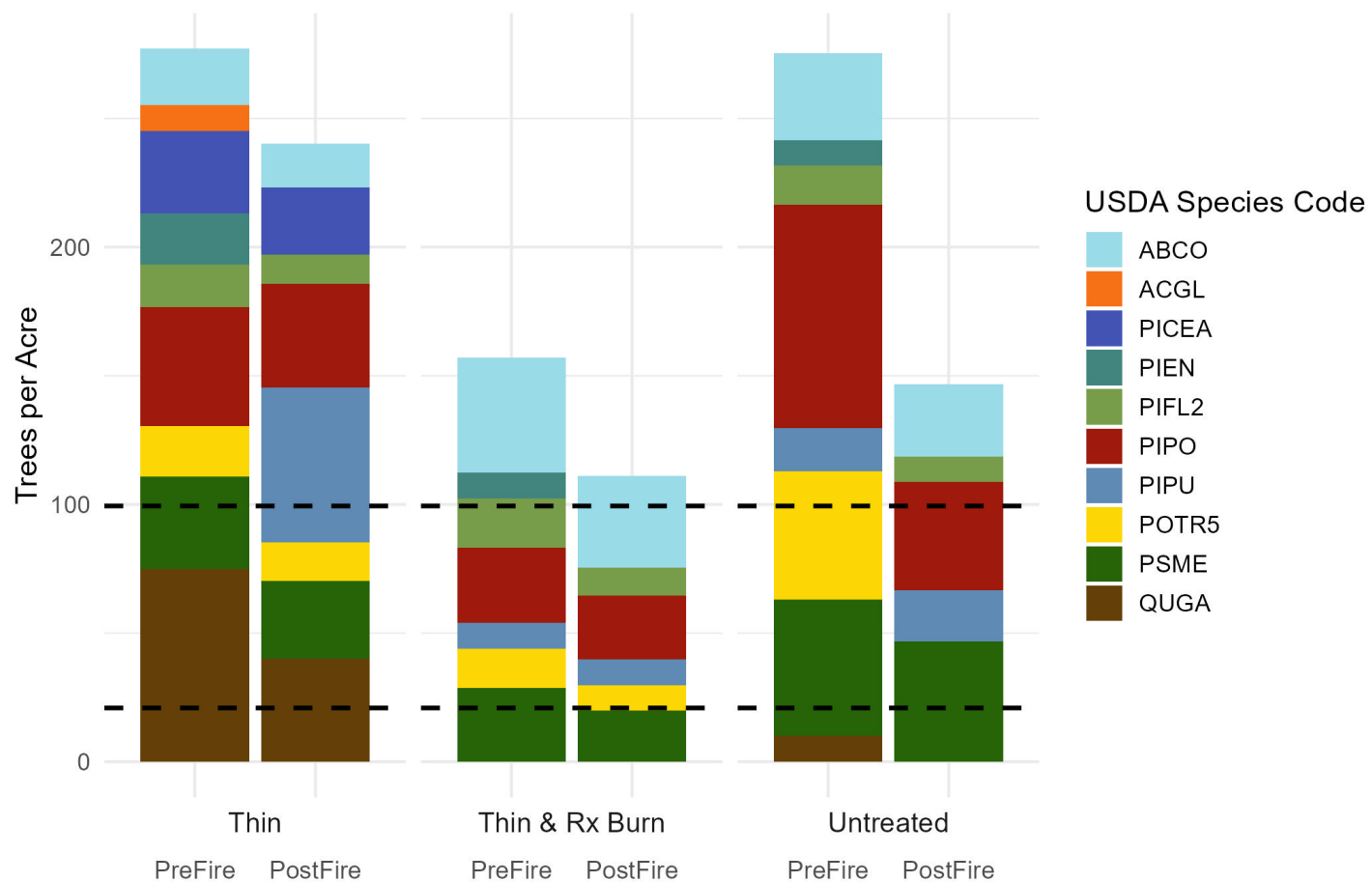
## Trees per Acre - Ponderosa Pine Forest





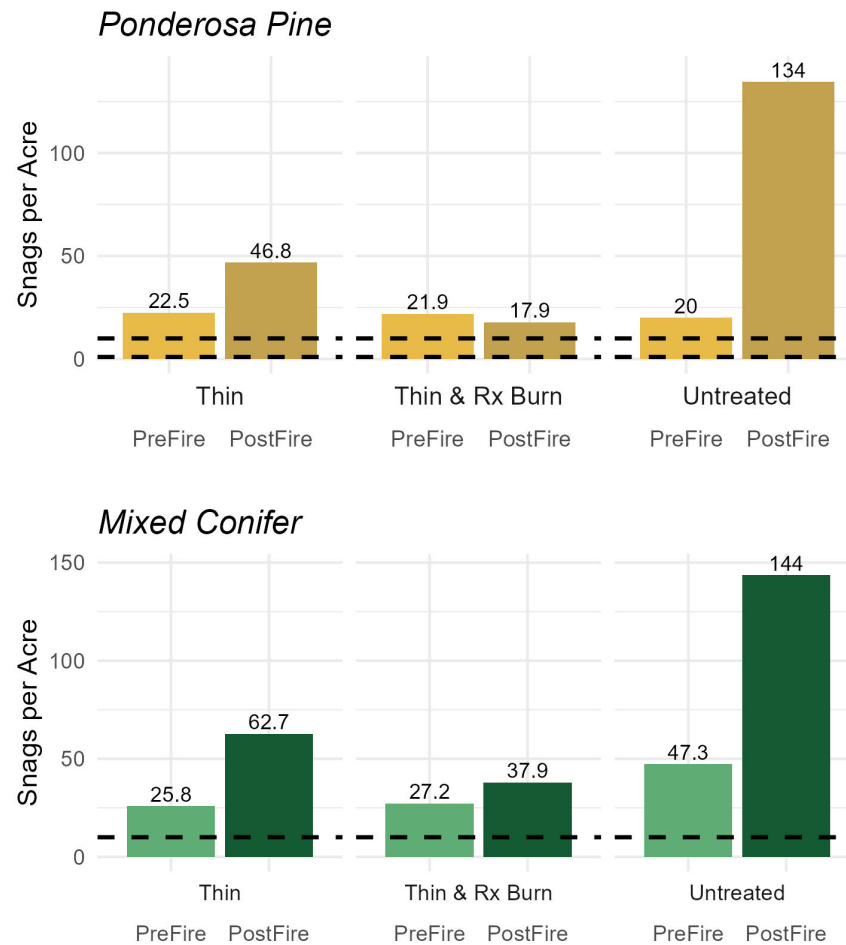
# HPCC & Historical Range of Variability

## Trees per Acre - Mixed Conifer Forest



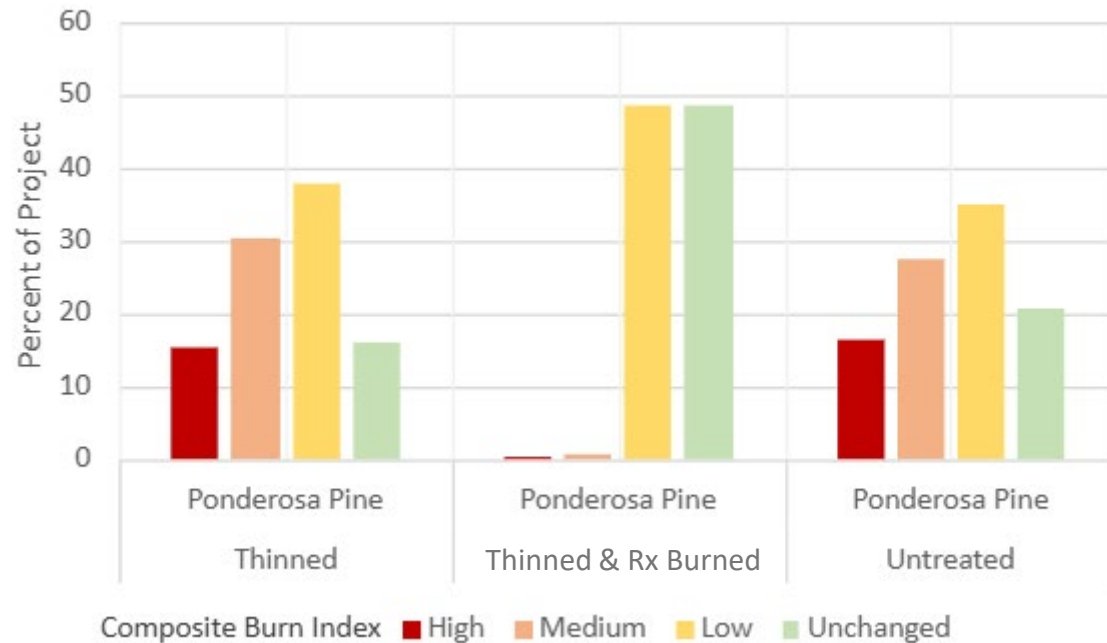
# HPCC & Historical Range of Variability

## Snags per Acre

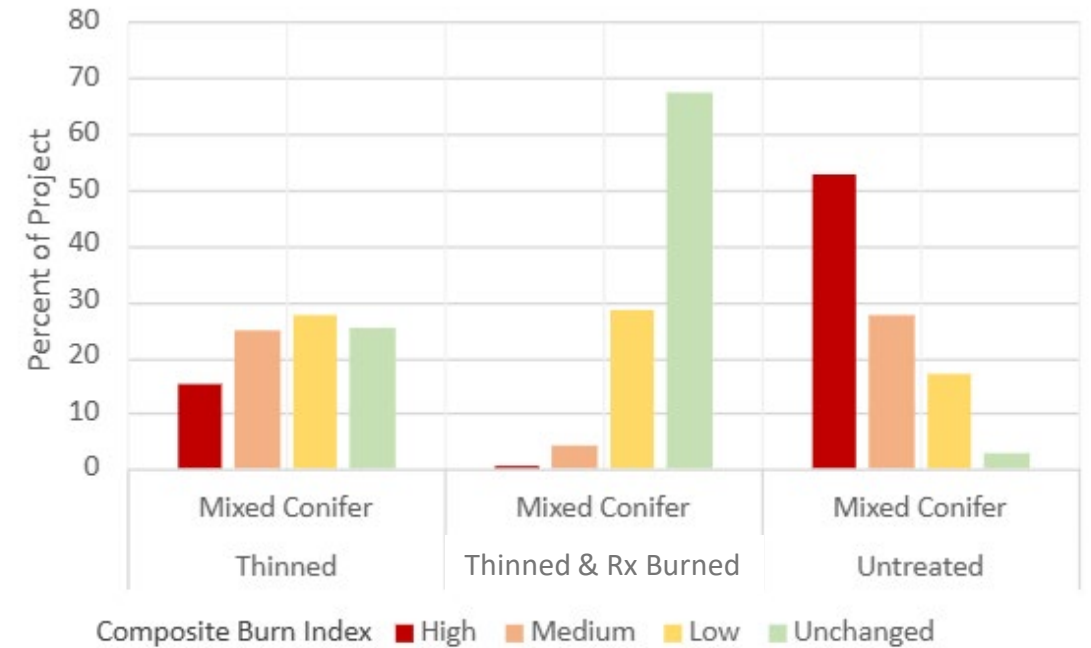




Burn Severity (CBI) - Ponderosa Pine



Burn Severity (CBI) - Mixed Conifer



Summary: Burn Severity By Tx

# What we still don't know





# Three case studies

- ▶ Do really small treatments work?
- ▶ How long to do treatments last?
- ▶ What should treatment prescriptions be?



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***WILDLAND FIRE***

RESEARCH PAPER  
<https://doi.org/10.1071/WF26008>



International Association  
of Wildland Fire

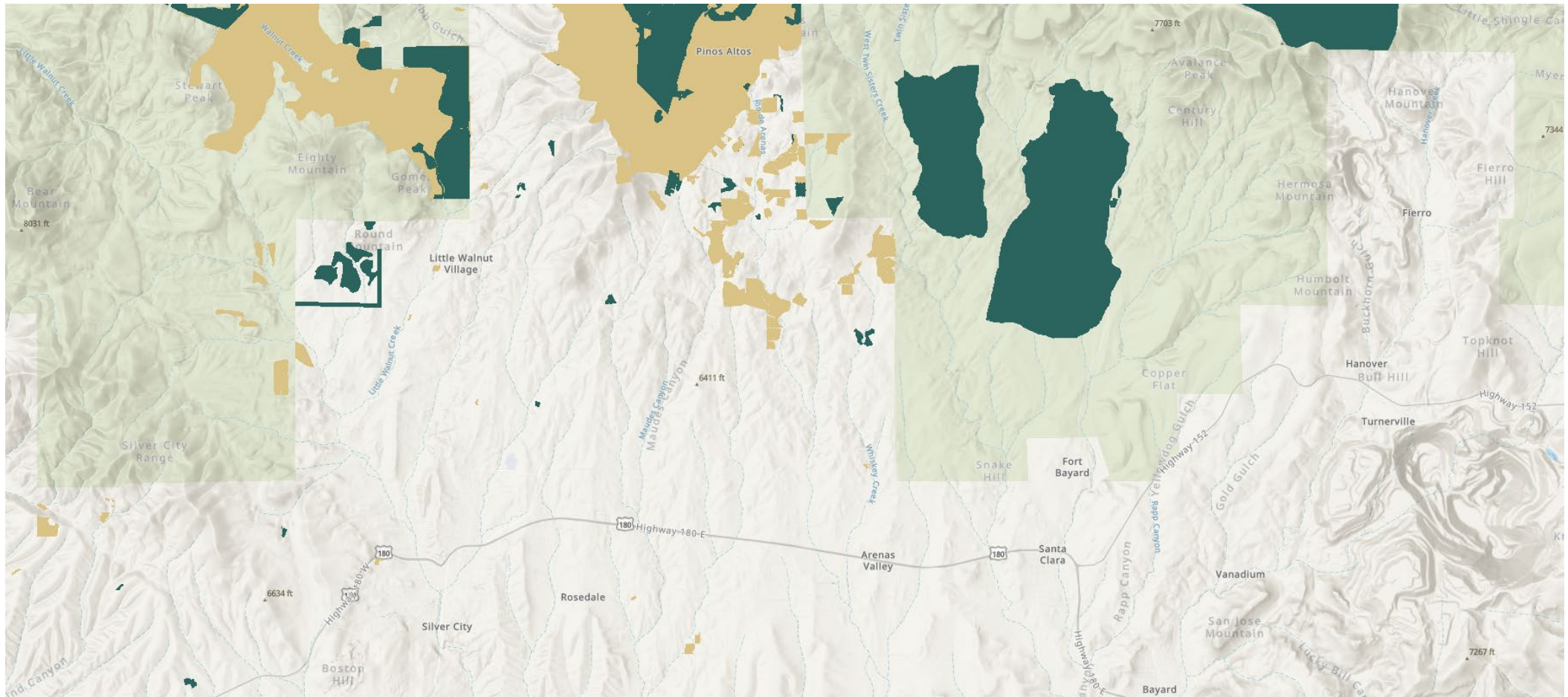
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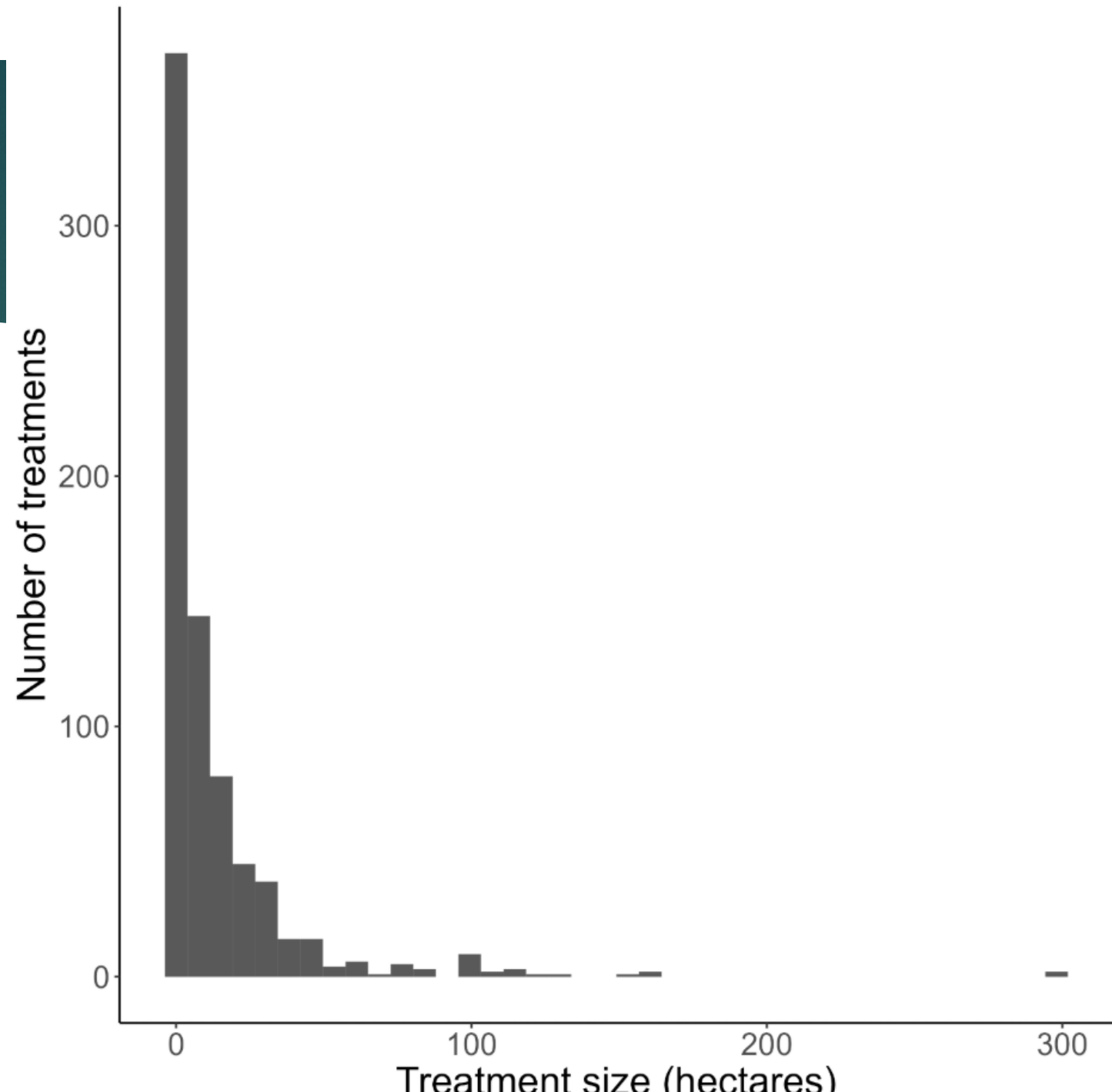
## Effects of small-scale forest treatments on reducing wildfire burn severity

James Biggs<sup>A,\*</sup> and Nathan Tomczyk<sup>B</sup>



# Do small treatments work?







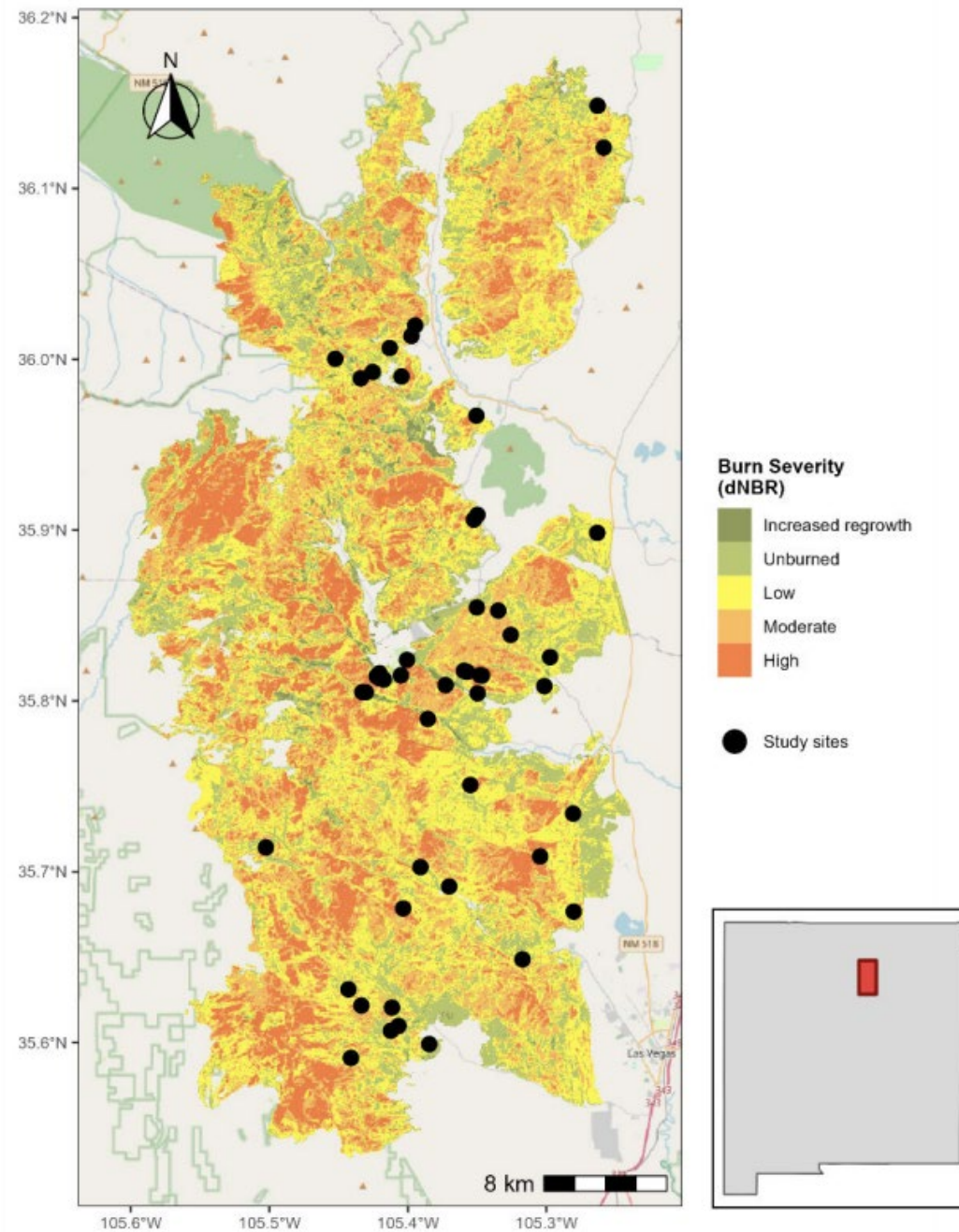


**Fig. 1.** HP-CC Fire, 2022 boundary map. Treatment sites selected for analyses and shown in black and colors represent burn severity as dNBR.

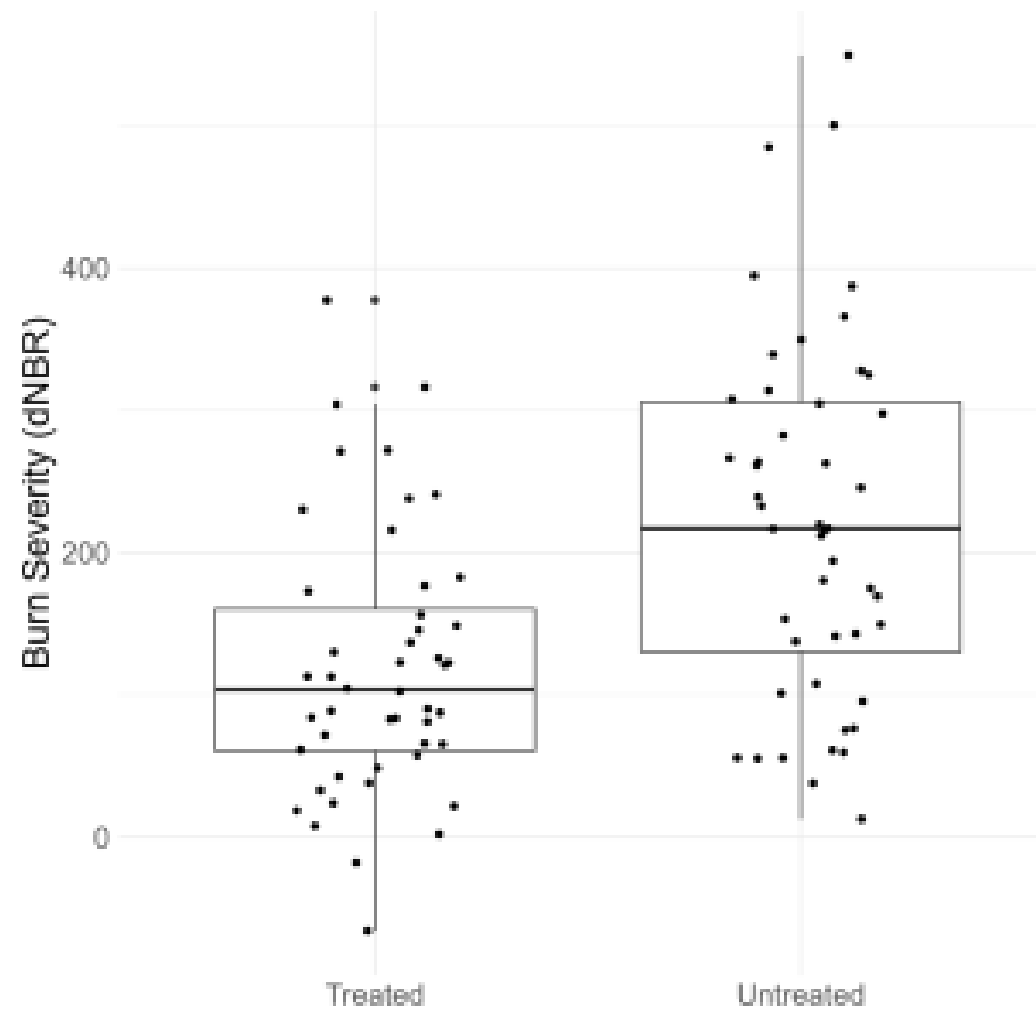


**Fig. 2.** Boxplots of burn severity (dNBR) for treated and untreated sites, HP-CC Fire, 2022.



# Key point

- ▶ Even treatments less than 2.5 acres can be effective in reducing burn severity

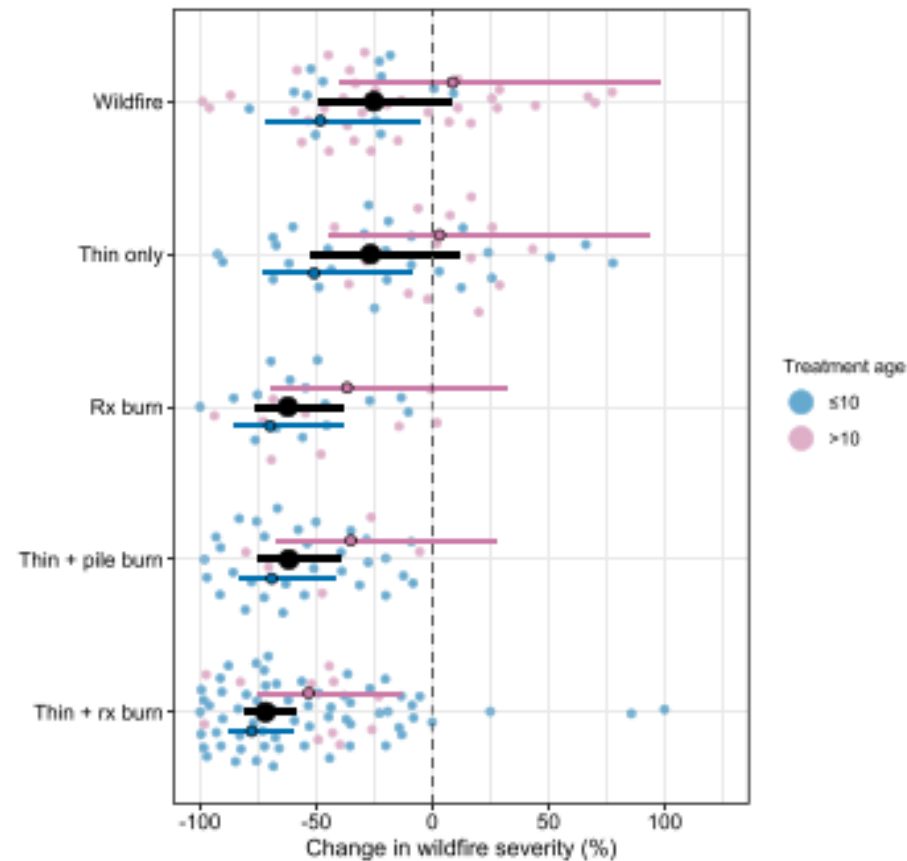
- 
- How long to do treatments last?



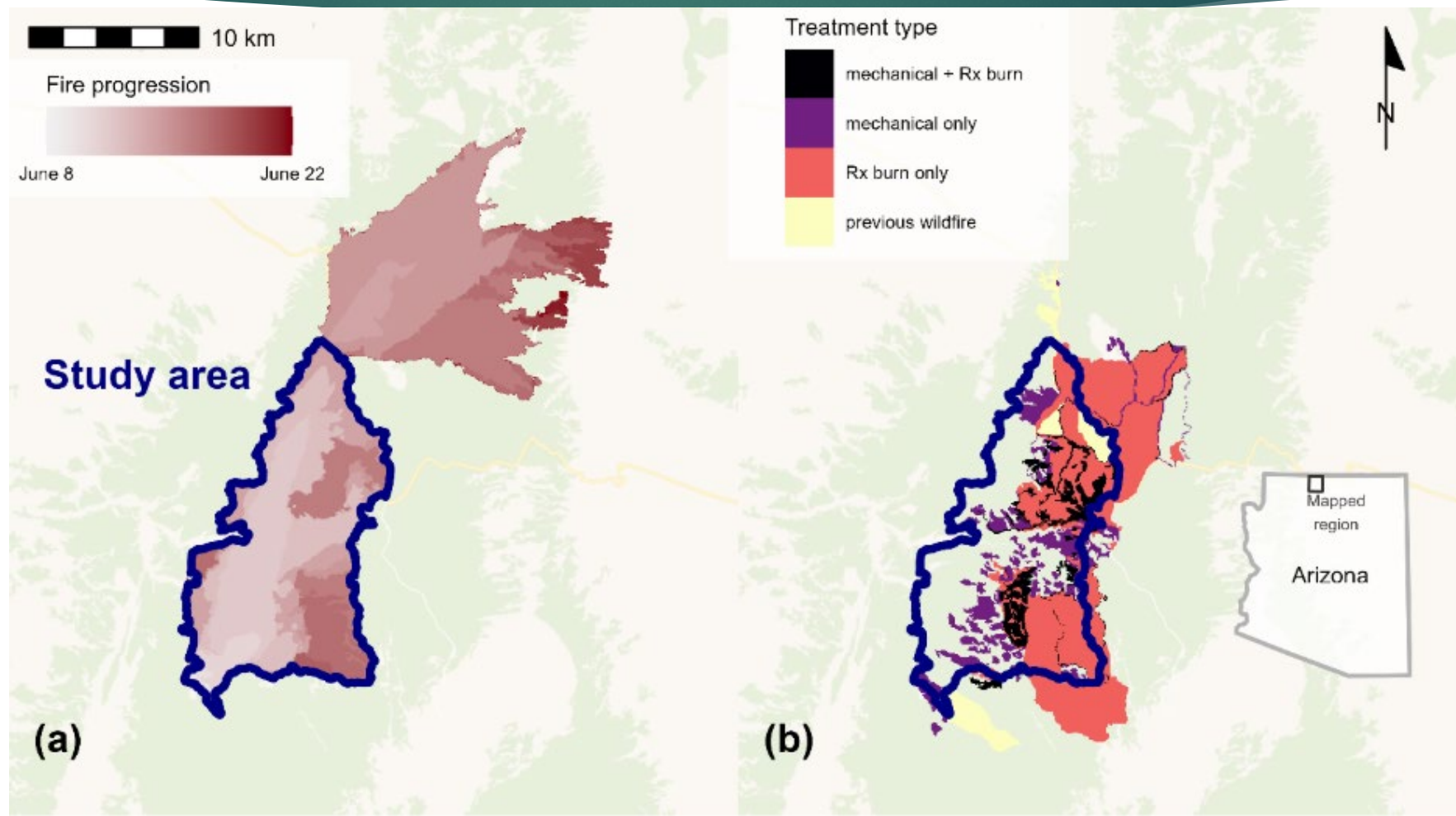
# • How long to do treatments last?

## 3.2.1. Treatment effect in CA mixed conifer, interior mixed conifer, and ponderosa/Jeffrey pine forests

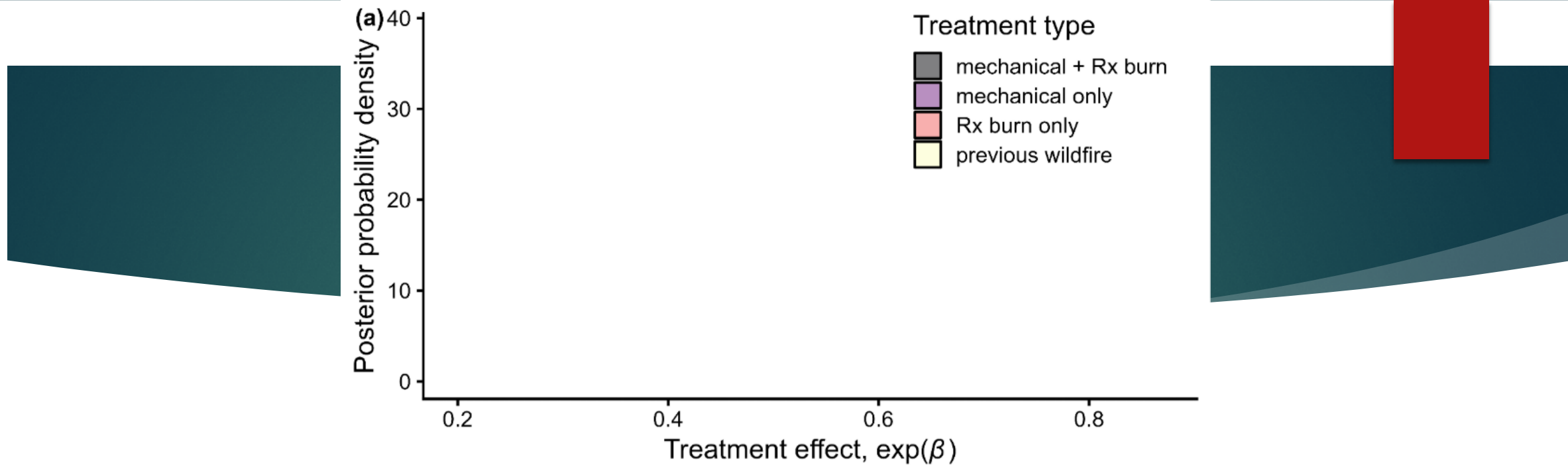
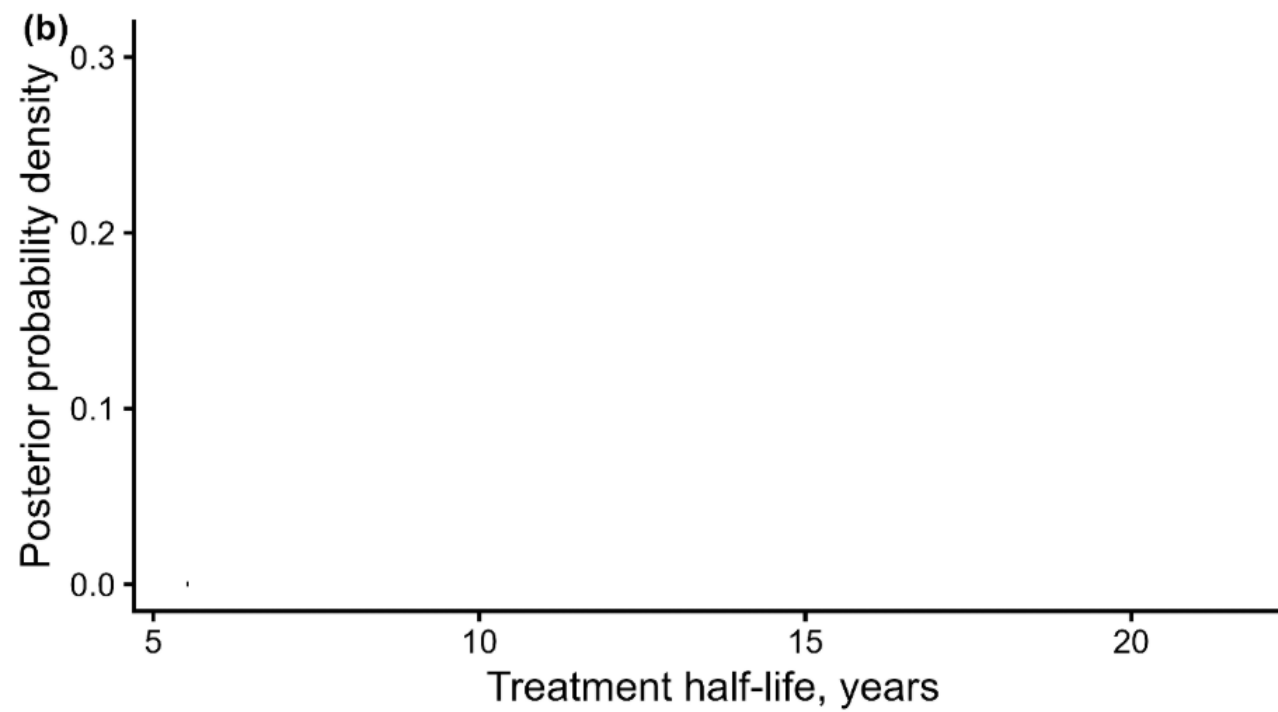
All treatments except “thin only” and “prior wildfire” significantly reduced wildfire severity in CA mixed conifer, interior mixed conifer, and ponderosa/Jeffrey pine forests,

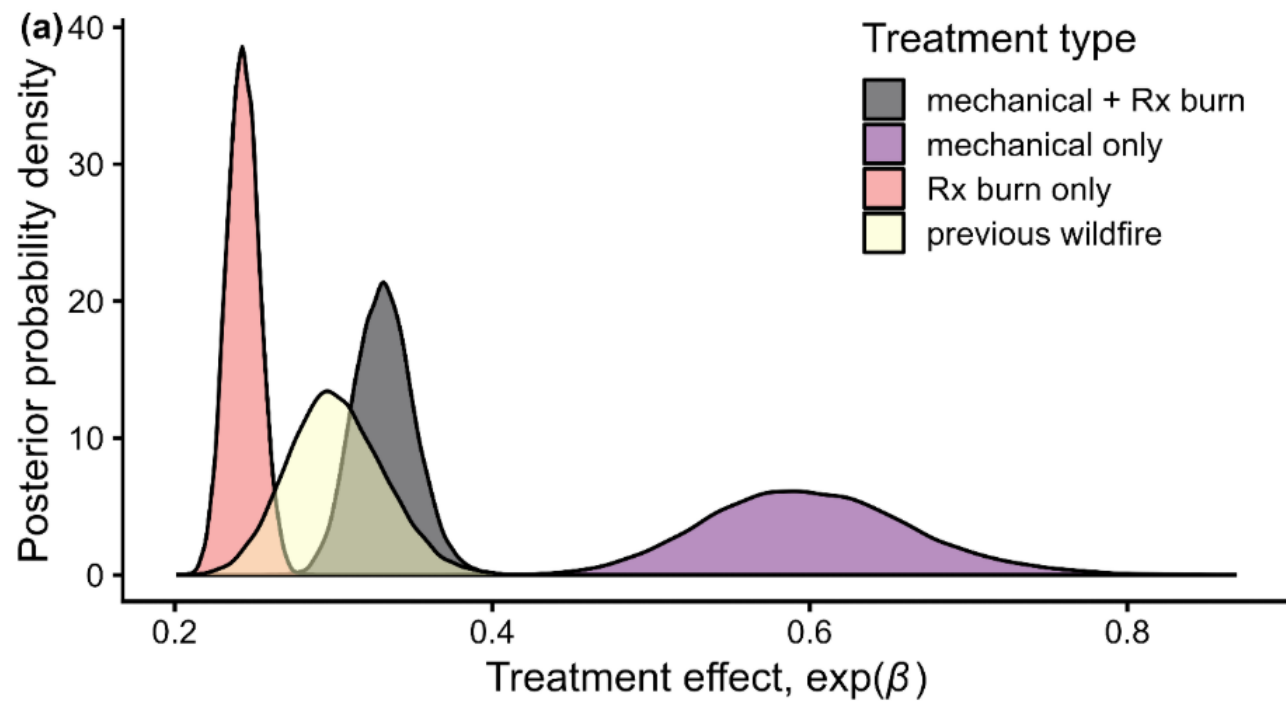
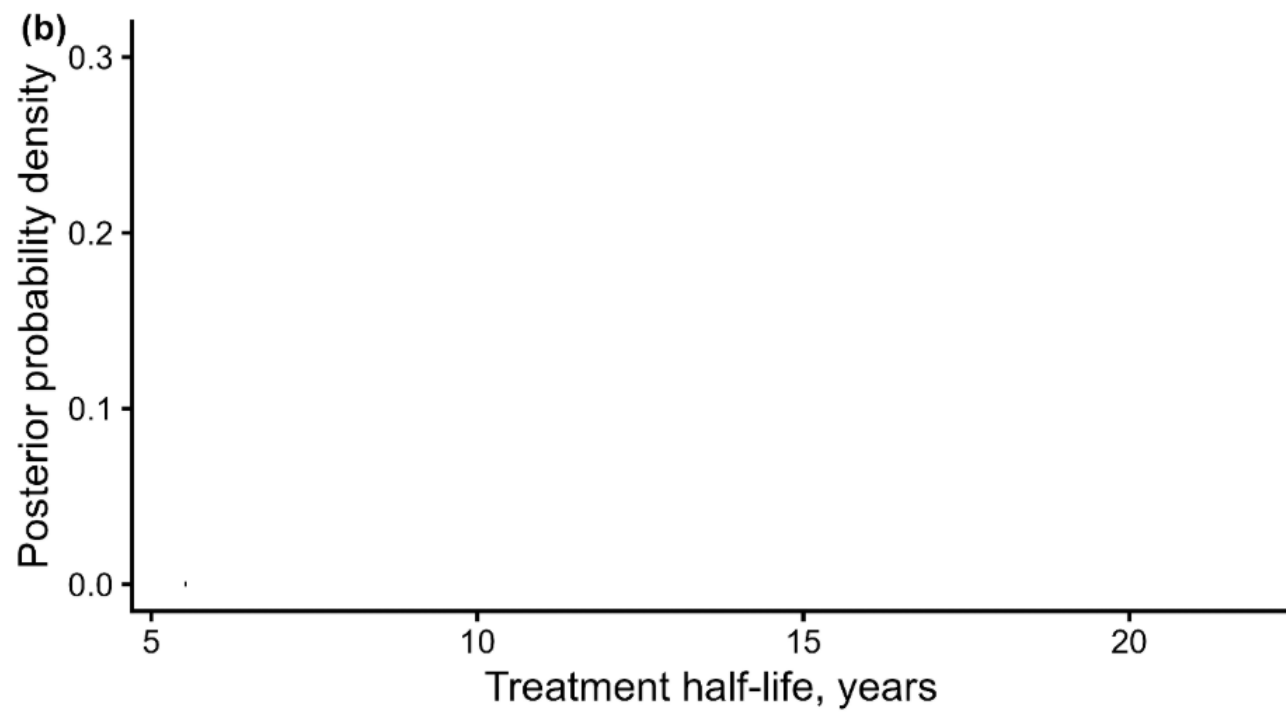


- How long to do treatments last?

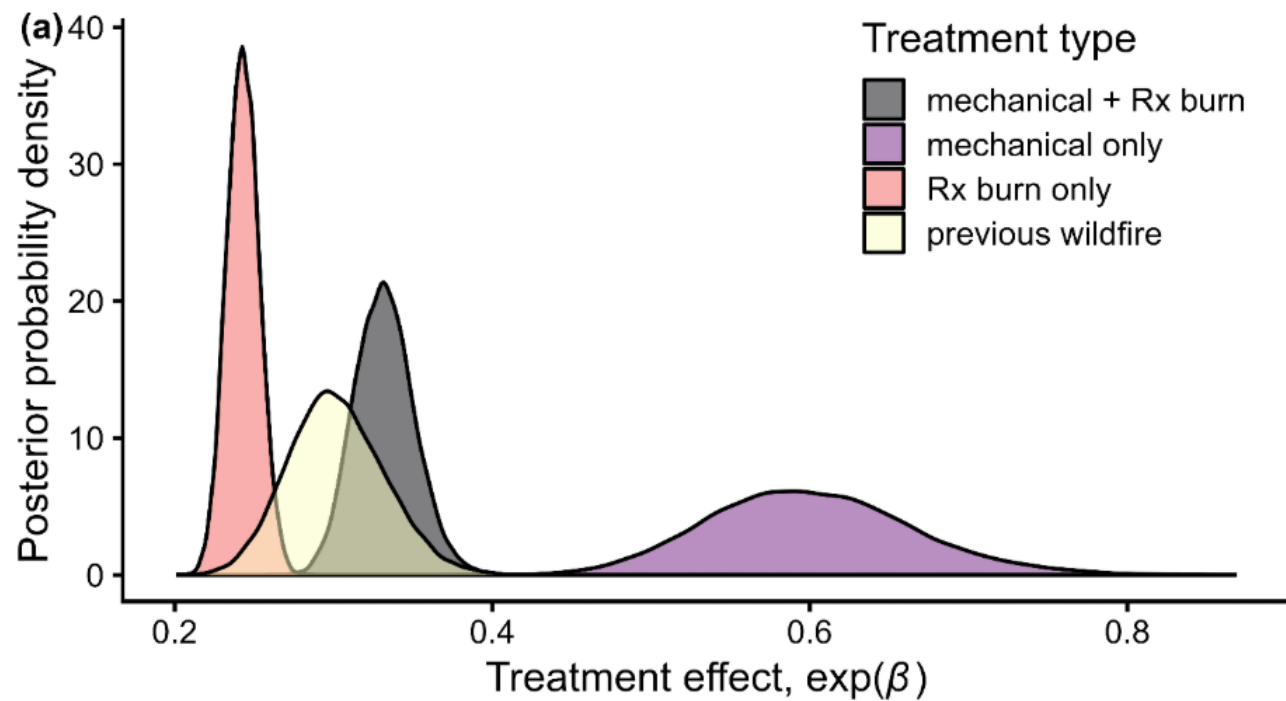
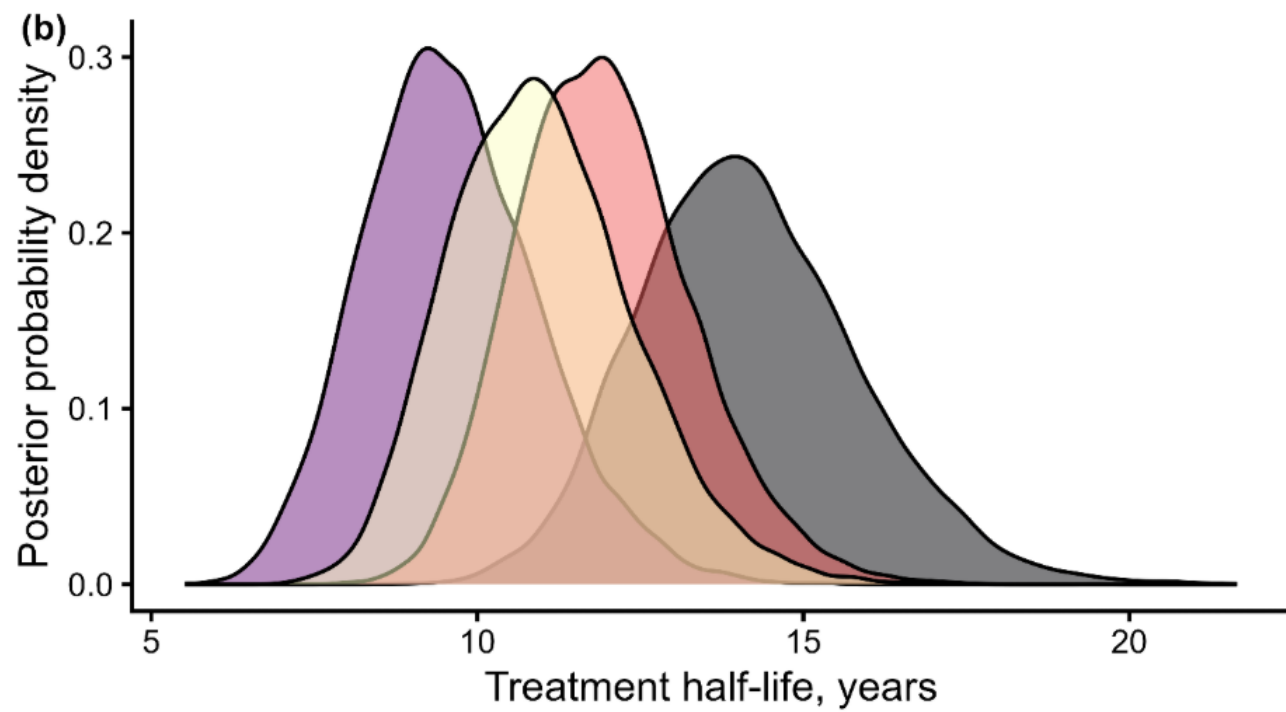












# Key Points

- ▶ Treatments with fire are most effective
- ▶ Effectiveness can stretch beyond 10 years, especially when treatments include fire

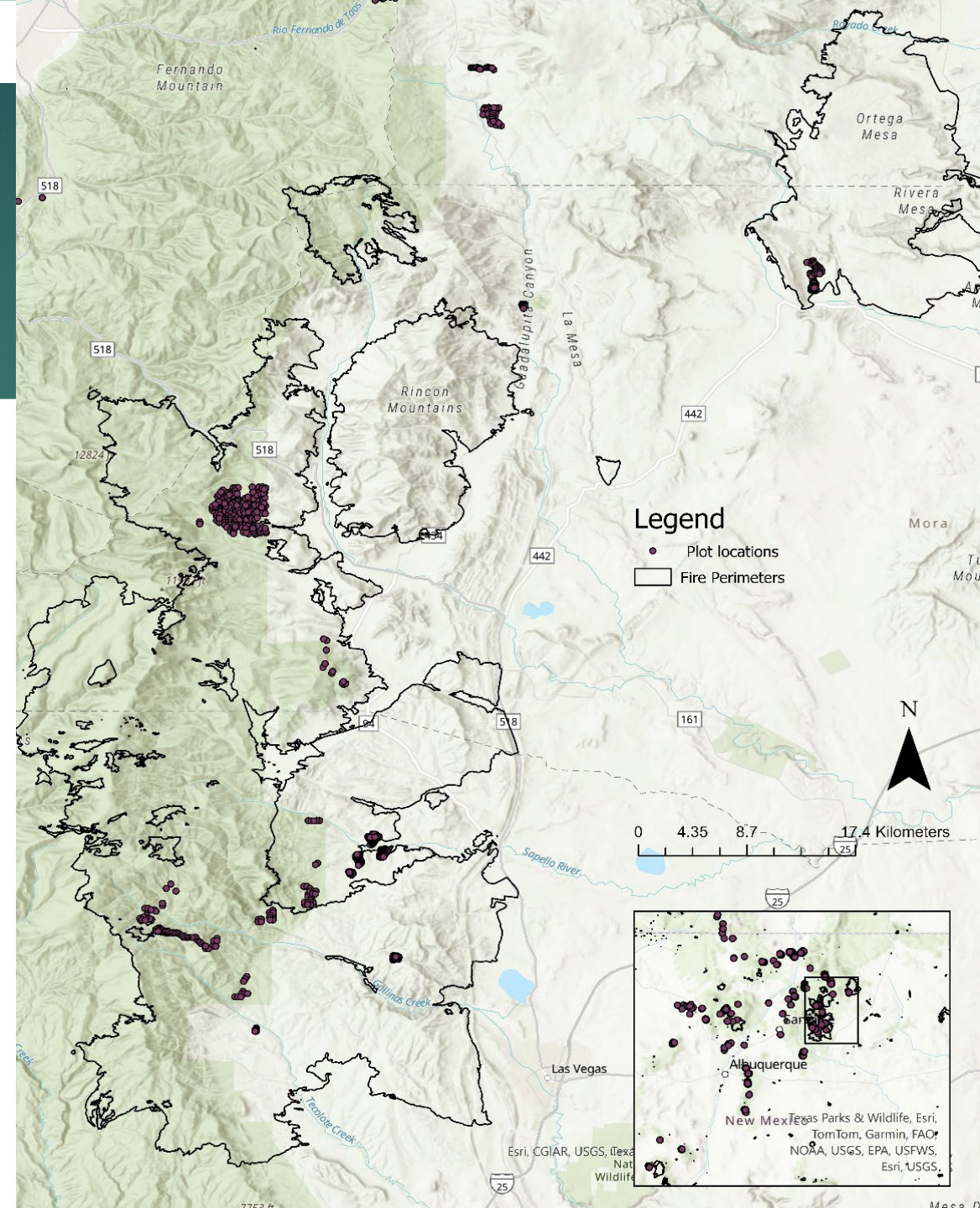




What should treatment prescriptions  
be?



## ► NMFWRI 247 plots!





| Project            | Treatment Types                                 | Pre-fire<br>measurement<br>year | Fire Weather (%) | plots (n) |
|--------------------|-------------------------------------------------|---------------------------------|------------------|-----------|
| Rio de la casa     | Not Treated                                     | 2017-2019                       | 98.4             | 30        |
| T2RB               | Not Treated                                     | 2017                            | 95.3             | 11        |
| Gallinas WUI       | Thinning (2008-2010)                            | 2018                            | 88.1             | 31        |
| <u>Ocate A</u>     | Thinning (2008-2010)                            | 2018                            | 18.0             | 35        |
| <u>Ocate B</u>     | Thinning (2008-2010)                            | 2020                            | 27.8             | 24        |
| Trujillo           | Thinning (2010-2012)                            | 2020                            | 98.5             | 8         |
| Maestas            | Thinning (2011-2012)                            | 2019                            | 61.6             | 5         |
| Tecolote           | Thinning (sometime between 2011 and 2022)       | 2011                            | 97.3             | 10        |
| <u>La Jicarita</u> | Thinning (2005-2008 and 2010-2012), Fire (2008) | 2020                            | 98.5             | 32        |
| Barela             | Thinning (2011), Fire (2017-2018)               | 2018                            | 97.3             | 30        |
| Griego             | Thinning (2011-2012), partial fire (2013-2014)  | 2018                            | 94.2             | 21        |
| Calf Canyon        | Thinning (2014-2015), Fire (2019-2019)          | 2019                            | 95.8             | 9         |

# Specific definition of desired conditions

*Fire Ecology* Volume 14, Issue 1, 2018  
doi: 10.4996/fireecology.140114316

*Haffey et al.: Limits to Ponderosa Pine Regeneration*  
Page 143

## RESEARCH ARTICLE

### LIMITS TO PONDEROSA PINE REGENERATION FOLLOWING LARGE HIGH-SEVERITY FOREST FIRES IN THE UNITED STATES SOUTHWEST

Collin Haffey<sup>1,2\*</sup>, Thomas D. Sisk<sup>2</sup>, Craig D. Allen<sup>1</sup>,  
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United States  
Department  
of Agriculture  
  
Forest Service  
  
Rocky Mountain  
Research Station  
  
General Technical  
Report RMRS-GTR-310  
  
August 2013

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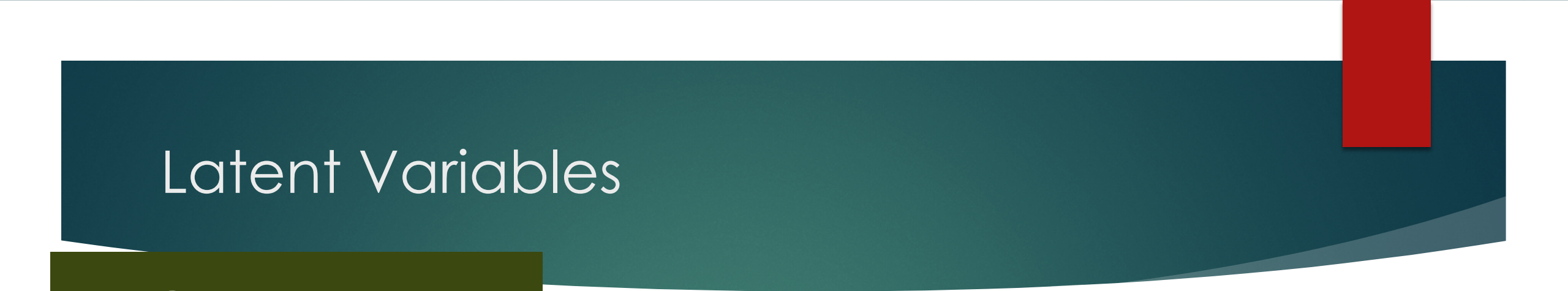
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- ▶  $>10$  trees acre<sup>-1</sup> and  $>20$  ft<sup>2</sup> acre<sup>-1</sup> Basal area



# Latent Variables

Canopy  
fuels

Ladder fuels

Surface  
fuels



# Latent Variables

Canopy  
fuels

Ladder fuels

Surface  
fuels

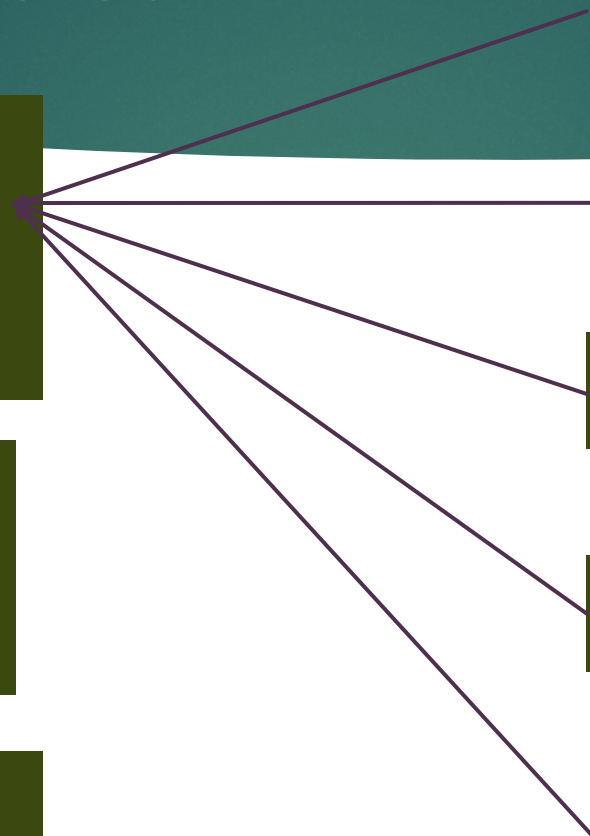
Tree density

Basal area

Snag density

Canopy  
cover

Spatial  
Arrangement



# Latent Variables

Canopy  
fuels

Ladder fuels

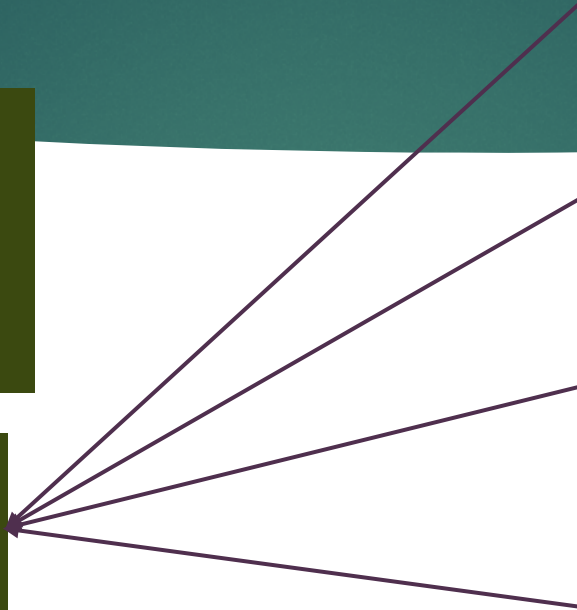
Surface  
fuels

Sapling  
density

Live crown  
base height

lidar point  
density 1-5m

Vertical  
Continuity  
Index





# Latent Variables

Canopy  
fuels

Ladder fuels

Surface  
fuels

1000 hr

100 hr

1 hr

Litter and  
duff



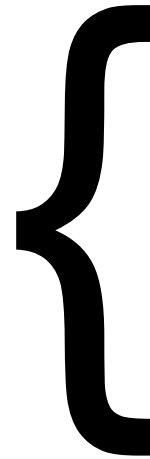
Pre-fire

Canopy  
fuels

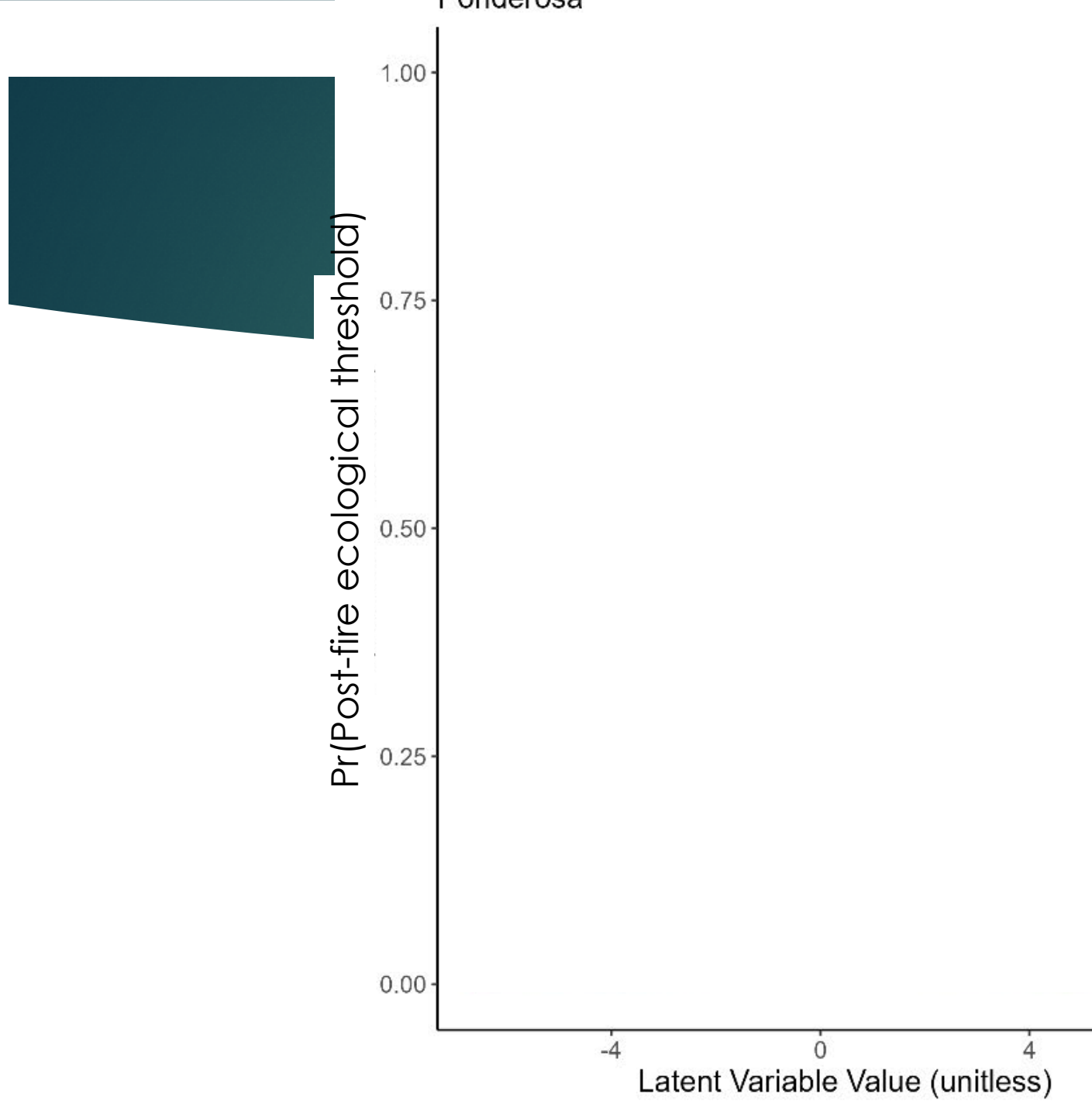
Ladder fuels

Surface  
fuels

Probability  
ecological  
threshold post-  
fire



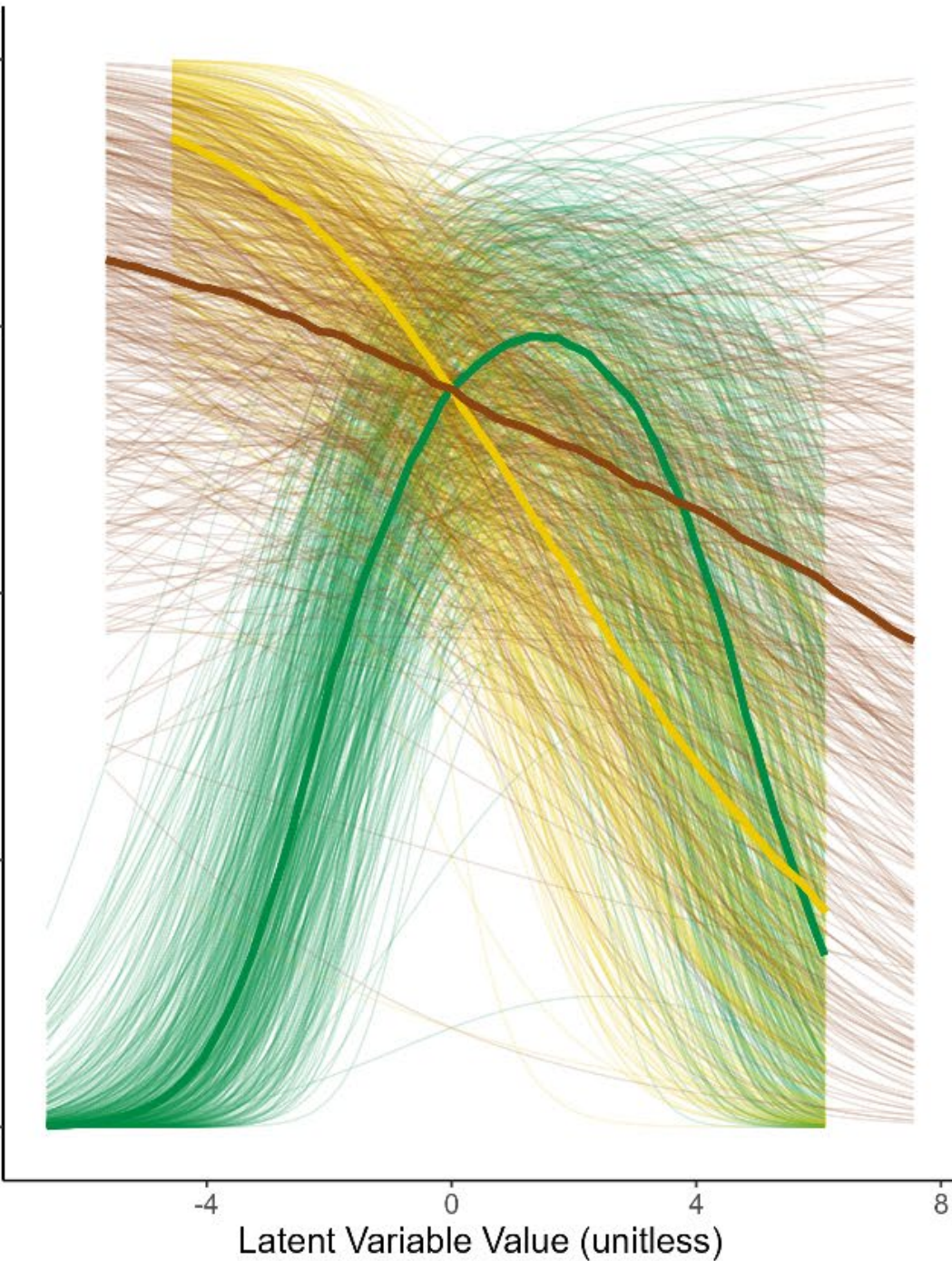






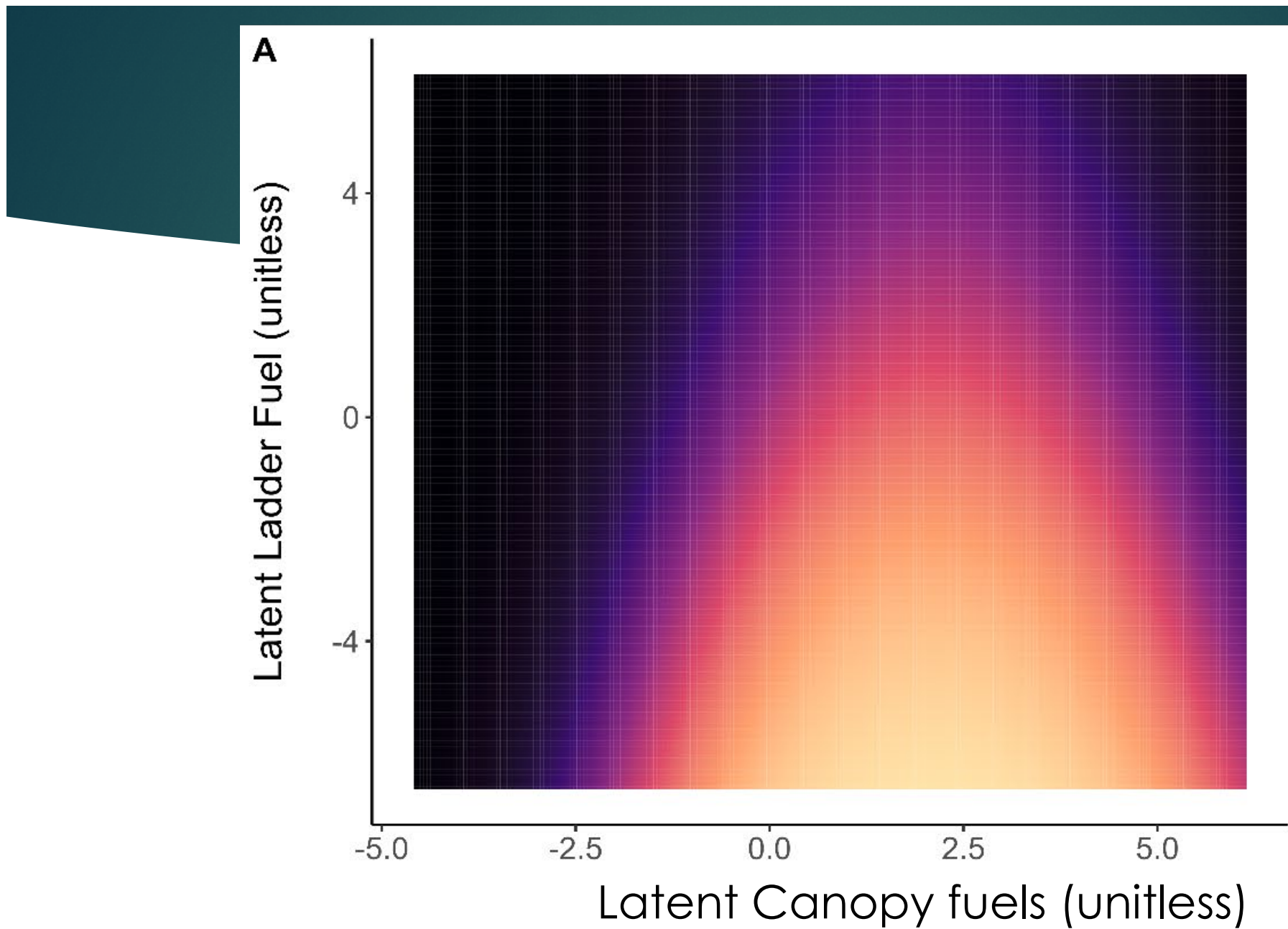
Pr(Post-fire ecological threshold)

1.00  
0.75  
0.50  
0.25  
0.00

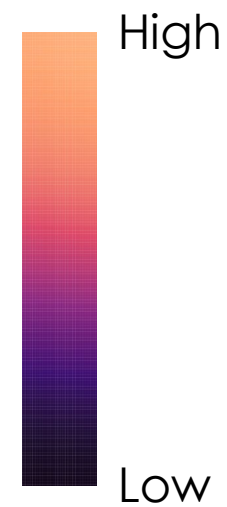


- Ladder fuels
- Surface fuels
- Canopy fuels





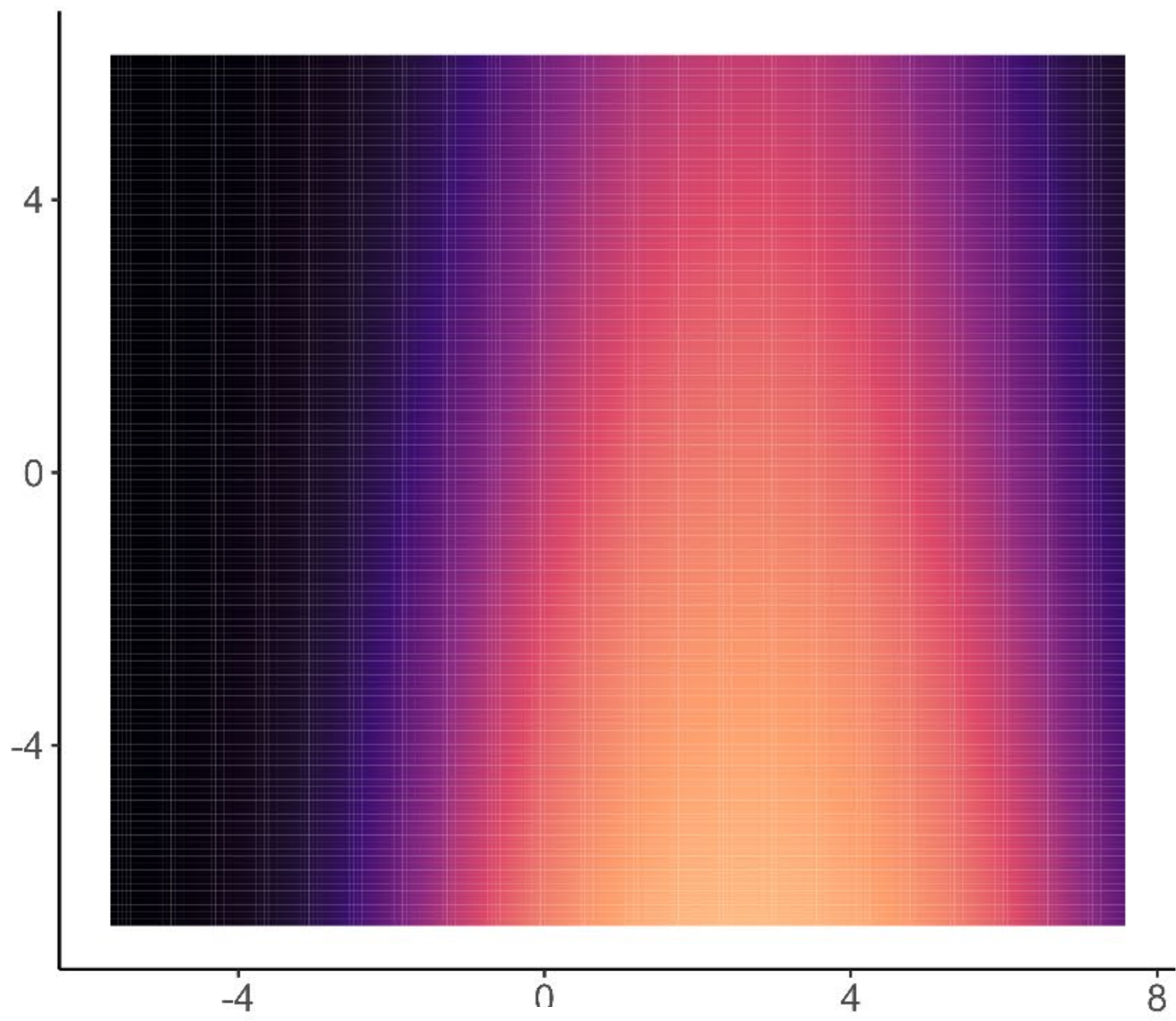
Pr(post-fire ecological t





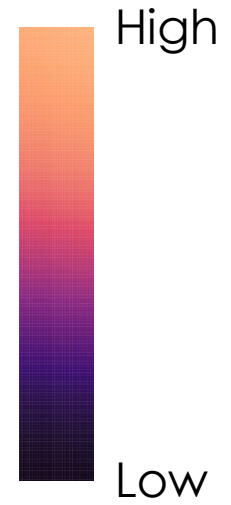
Latent Surface Fuel (unitless)

c

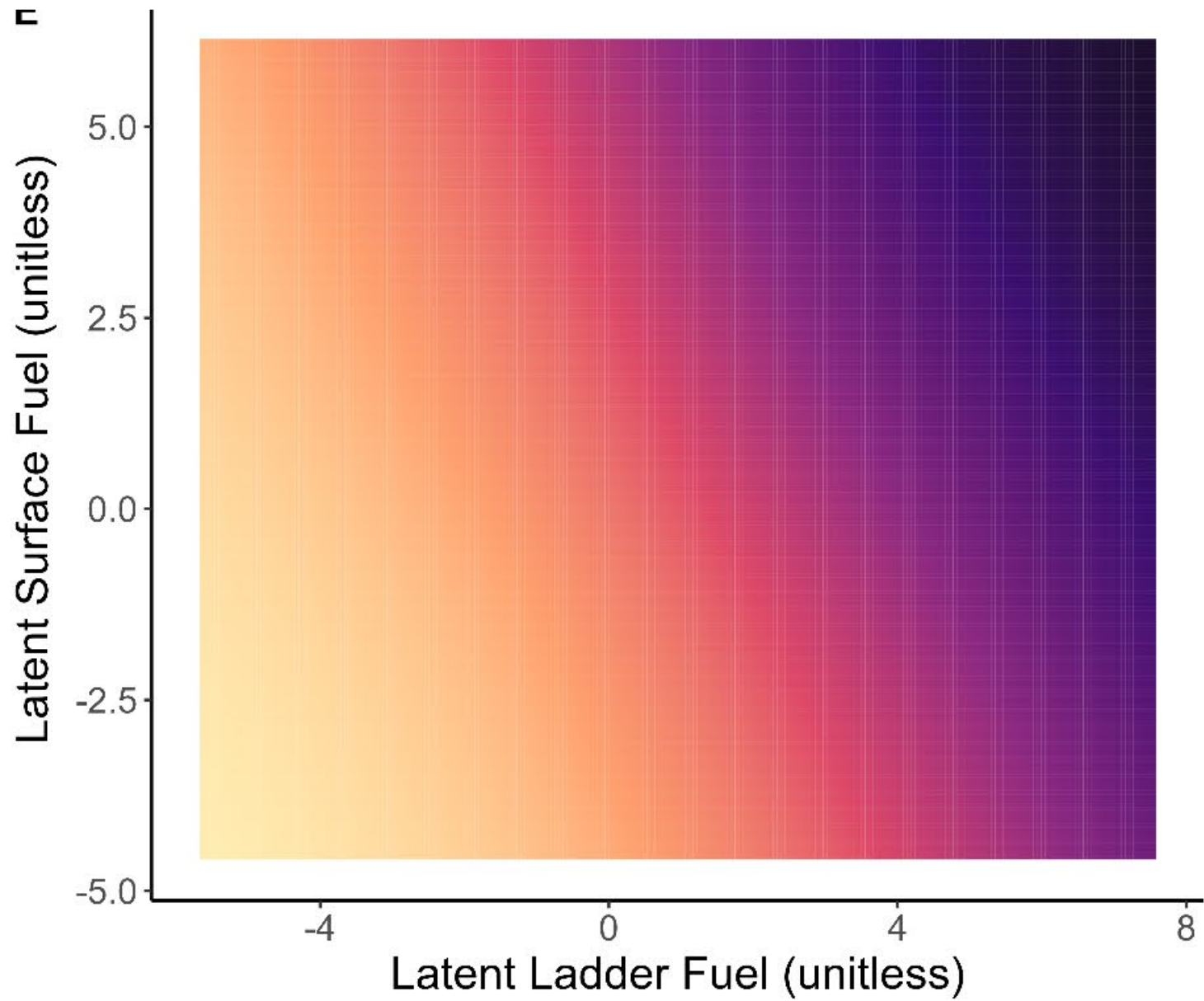


Latent Canopy fuels (unitless)

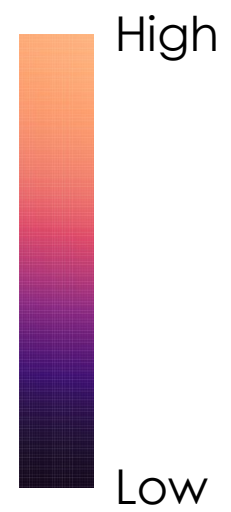
Pr(post-fire ecological t







Pr(post-fire ecological t)







# Moving towards prescriptions

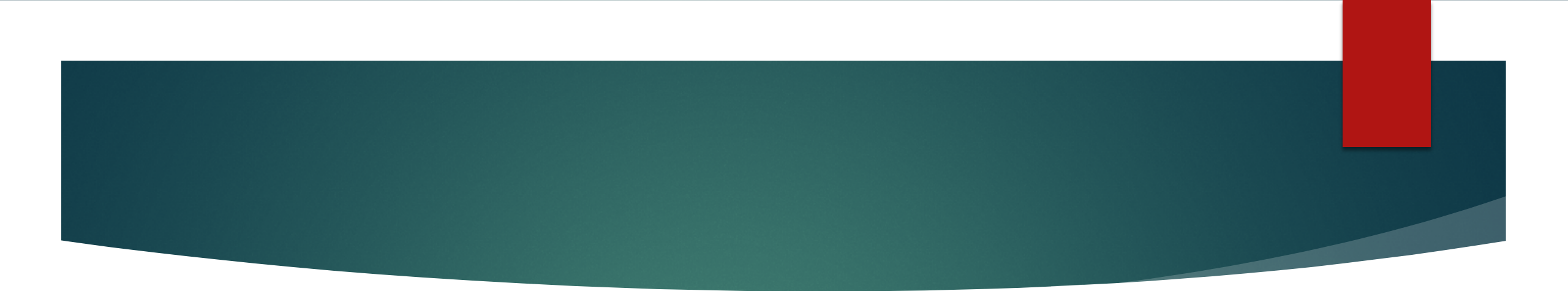
Simulated  
stand  
conditions\*



latent  
variable  
model



Filter for  
outcomes  
with high  
probability



|                                                  | Lower bound | Upper bound |
|--------------------------------------------------|-------------|-------------|
| Tree density (TPA)                               | 50          | 282         |
| Basal area (ft <sup>2</sup> acre <sup>-1</sup> ) | 62          | 127         |
| Snags (a <sup>-1</sup> )                         | 0           | 38          |
| Canopy cover (%)                                 | 22          | 44          |
| Thousand-hour fuels (tons acre <sup>-1</sup> )   | 0           | 11          |
| Hundred-hour fuels (tons acre <sup>-1</sup> )    | 0           | 3           |
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| Live Crown Base Height (ft)                      | 12          | 25          |
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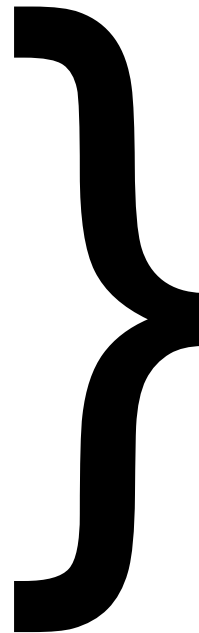


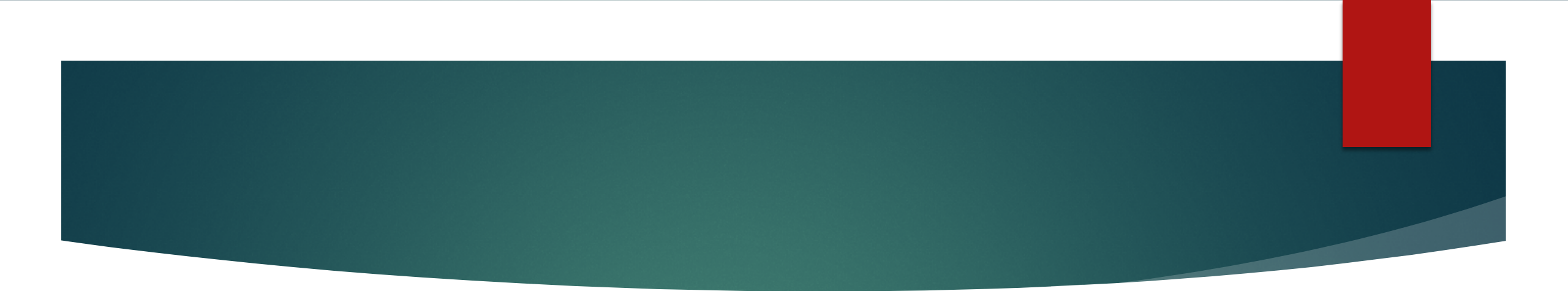
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# Summary

- ▶ Clear tradeoffs between fuel categories.
- ▶ Prescriptions similar to historical conditions – but more detail



Historic Range of Variability - Visuals



# Learn more

- ▶ FIRENM: <https://nfwri.org/stewardship/wildfire-resiliency/>
- ▶ Monitoring Webmap:  
<https://www.arcgis.com/apps/webappviewer/index.html?id=1ff53fe01cbd43d9a24657225a24386c&extent=-12406484.6521%2C3666886.861%2C-10850838.2524%2C4481399.8344%2C102100>
- ▶ Monitoring in the burn scar: <https://nfwri.org/wp-content/uploads/2025/02/HPCCfinal-compressed.pdf>
- ▶ Post-fire monitoring reports: <https://nfwri.org/monitoring/2022-hermits-peak-calf-canyon/>
- ▶ HPCC storymap:  
<https://storymaps.arcgis.com/stories/d48e2171175f4aa4b5613c2d11875653>
- ▶ HPCC hub: <https://hermits-peak-calf-canyon-fire-resources-nmhu.hub.arcgis.com/>

# Find out more about NMFWR I

- ▶ Website: [www.nmfwri.org](http://www.nmfwri.org)
- ▶ Phone: 505-426-2080
- ▶ Email: [nmfwri@nmhu.edu](mailto:nmfwri@nmhu.edu)
- ▶ Follow us on Facebook: <https://www.facebook.com/nmfwri/>
- ▶ Twitter: <https://twitter.com/NMFWRI>
- ▶ Instagram: <https://www.instagram.com/nmfwri/>
- ▶ BlueSky: @nmfwri.bsky.social
- ▶ Connect with us on LinkedIn:  
<https://www.linkedin.com/in/nmfwr-institute-864949228/>





# Thank you!

**Dr Nate Tomczyk – Research Associate, Technical and Applied  
Science**

[ntomczyk@nmhu.edu](mailto:ntomczyk@nmhu.edu)

**Kathryn Mahan - Ecological Monitoring Program Manager**

[krmahan@nmhu.edu](mailto:krmahan@nmhu.edu)