Tamarack Fire: Fuel treatment effectiveness, early data on regeneration and recovery, and future monitoring plans

Ali Paulson, PhD
Forest Ecologist – Humboldt-Toiyabe National Forest

Presentation for the Alpine County Forest Health Community Working Group
June 5, 2024

Outline

- Increasing wildfire activity in our region
- Tamarack Fire basics
- Post-fire Restoration Framework
- Fuel treatment effectiveness
- Monitoring of post-fire natural regeneration
- Ongoing/Upcoming projects
  - Seedling monitoring (natural regeneration and planted seedlings)
  - Shrub removal experiment
  - Post-fire regeneration in Eastern Sierra Nevada forests

Outline

- **Increasing wildfire activity in our region**
- **Tamarack Fire basics**
- Post-fire Restoration Framework
- Fuel treatment effectiveness
- Monitoring of post-fire natural regeneration
- Ongoing/Upcoming projects
  - Seedling monitoring (natural regeneration and planted seedlings)
  - Shrub removal experiment
  - Post-fire regeneration in Eastern Sierra Nevada forests

California Fires in the News

California endures record-setting 'kiln-like' heat as fires rage, causing injuries

By **Andrew Freedman**

September 6, 2020 at 7:10 p.m. PDT

Record Wildfires on the West Coast Are Capping a Disastrous Decade

einhard, Nadja Popovich, Tim Wallace and Allison McCann Sept. 24, 2020

Climate Change Is Central to California's Wildfires

By Rebecca Miller, Katharine Mach, Chris Field on Octobe

Decades of mismanagement led to choked forests – now it's time to clear them out, fire experts say

Oct. 18, 2020, 8:38 AM PDT

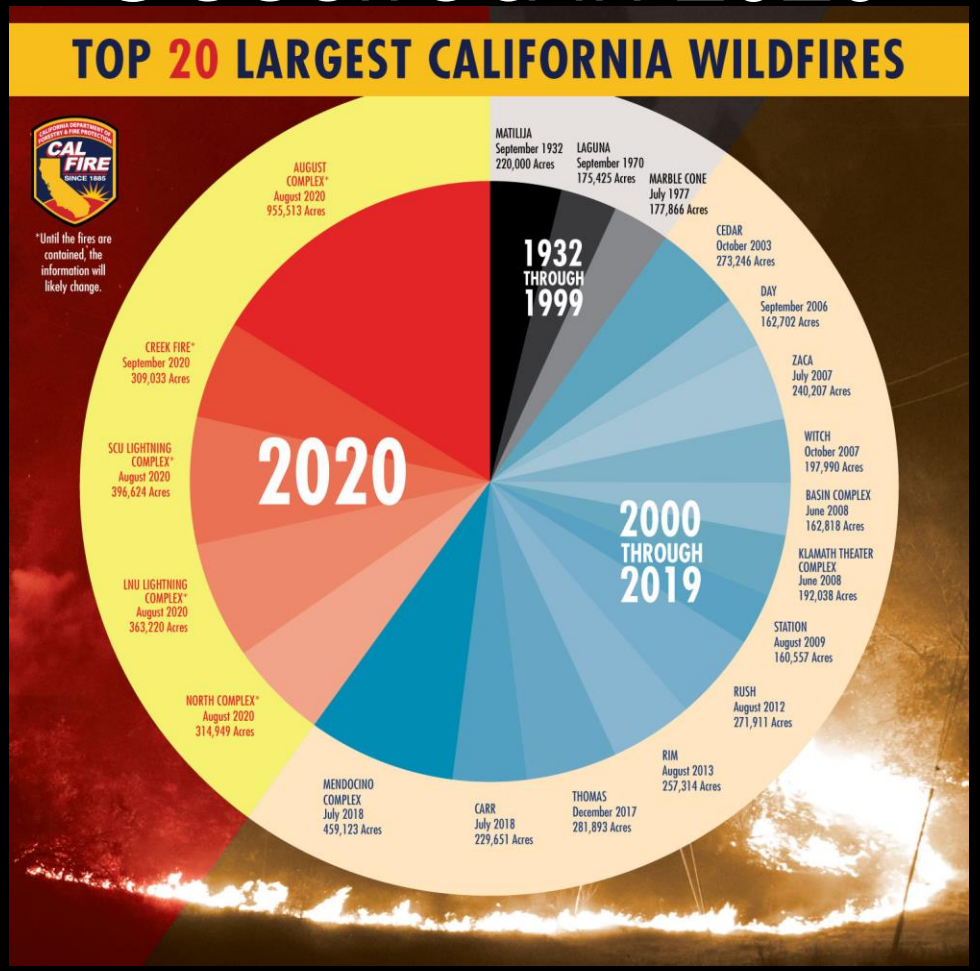
By Alicia Victoria Lozano

Fire Suppression — And Climate Change — Is To Blame For California's Megafires. Experts Unpack The Term.

Ezra David Romero

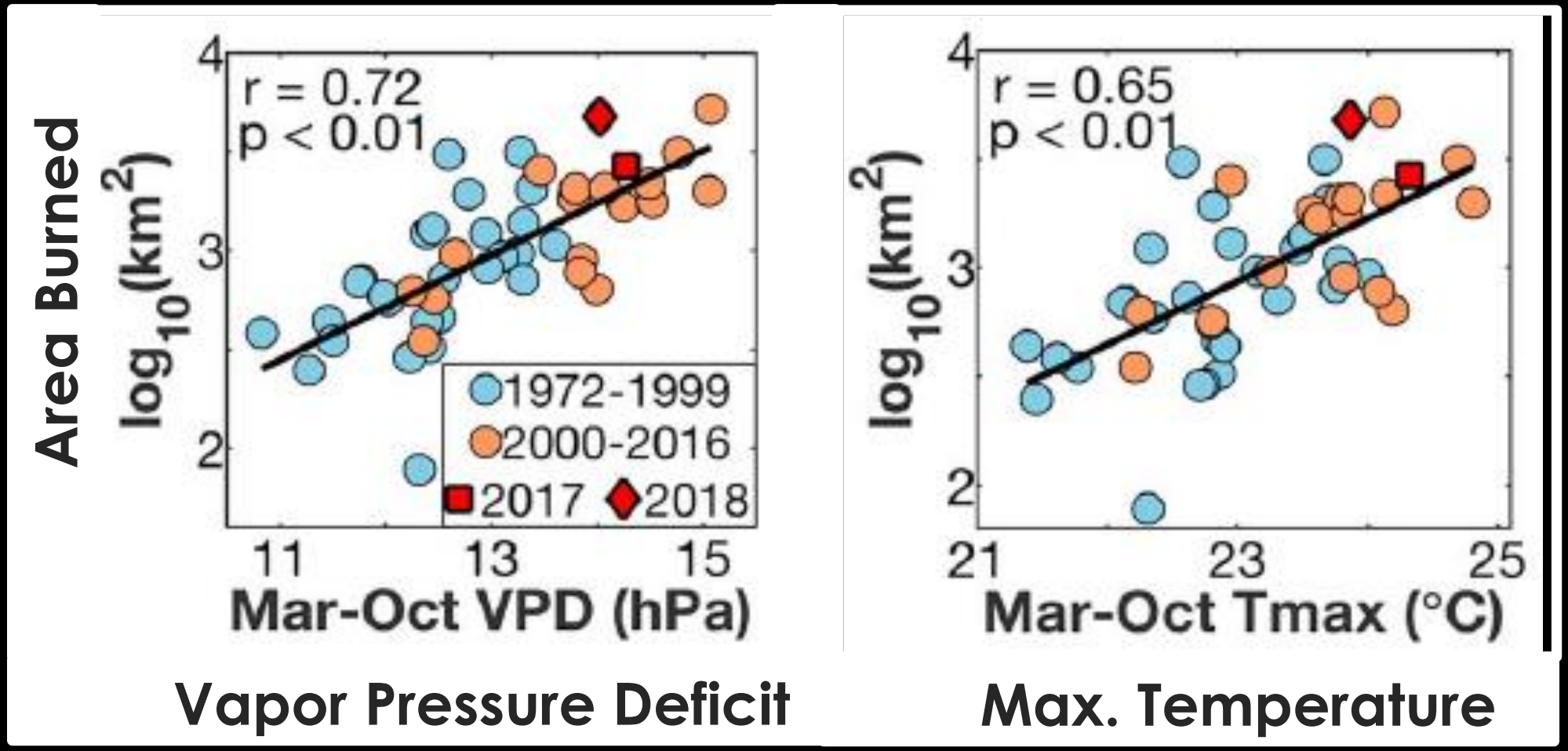
Saturday, September 12, 2020 | Sacramento, CA

Five of the Largest Wildfires on Record Occurred in 2020



CAL FIRE, https://www.fire.ca.gov/

Climate change: Area burned is increasing with warmer and drier conditions



Williams et al. 2019

European Colonization, Fire Suppression, and Logging Changed the Mixed-Conifer Forests of the Sierra Nevada

Historical (1914):

Photo: Dudley, USFS. Stephens et al. 2015.

European Colonization, Fire Suppression, and Logging Changed the Mixed-Conifer Forests of the Sierra Nevada

Historic (1914):

Photo: Dudley, USFS. Stephens et al. 2015.

Modern (2010's):

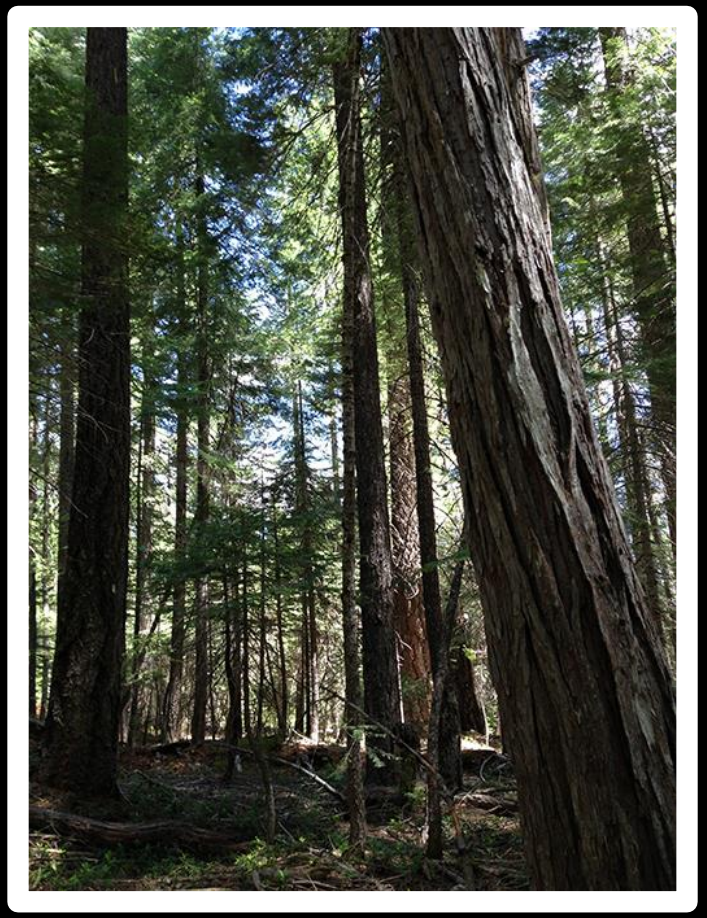


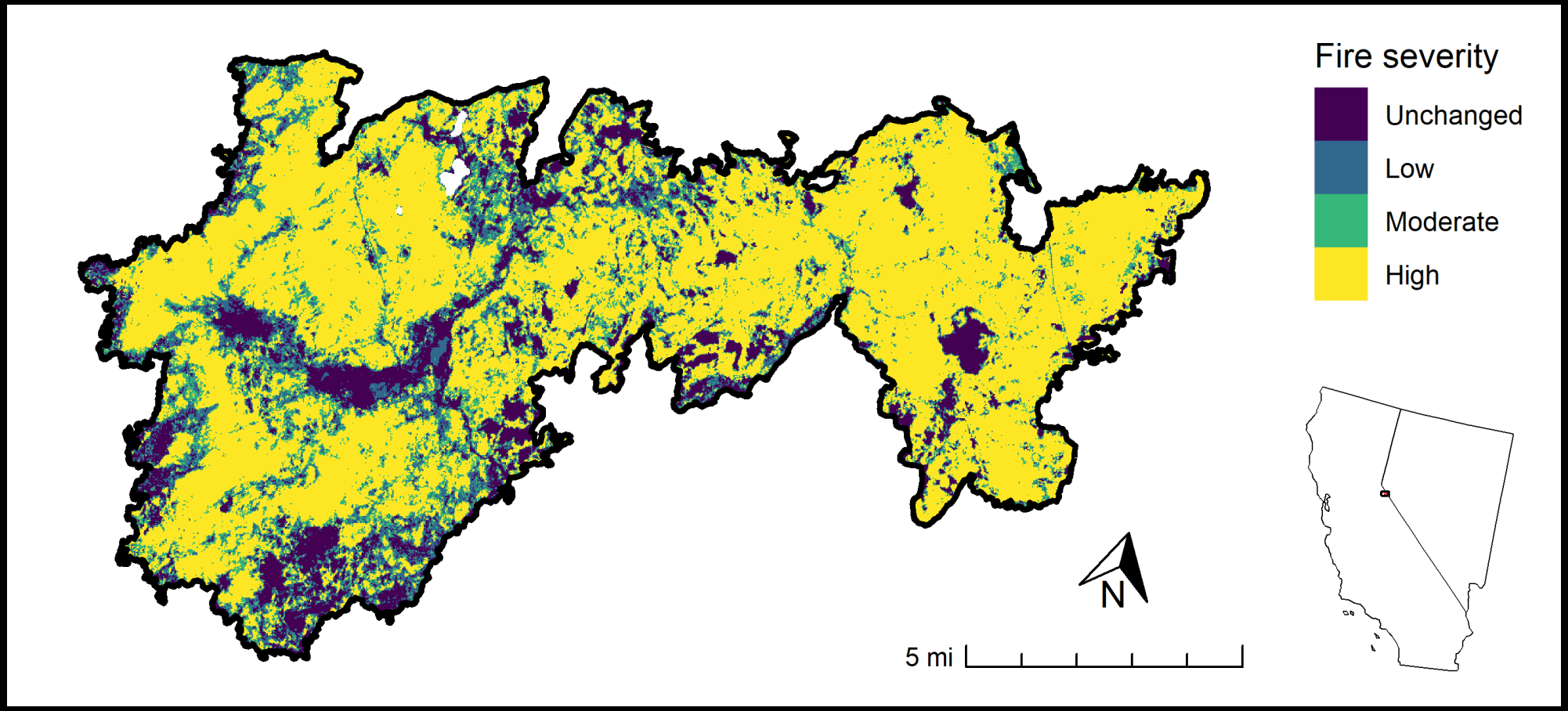
Photo: Carrie Levine

Larger, Higher Severity Fires Are Becoming the Norm

Tamarack Fire 2021

Photo from https://inciweb.nwcg.gov/photos/NVHTF/2021-07-16-1705-Tamarack-Fire/

RAVG Fire Severity



"High" severity corresponds with >75% basal area mortality

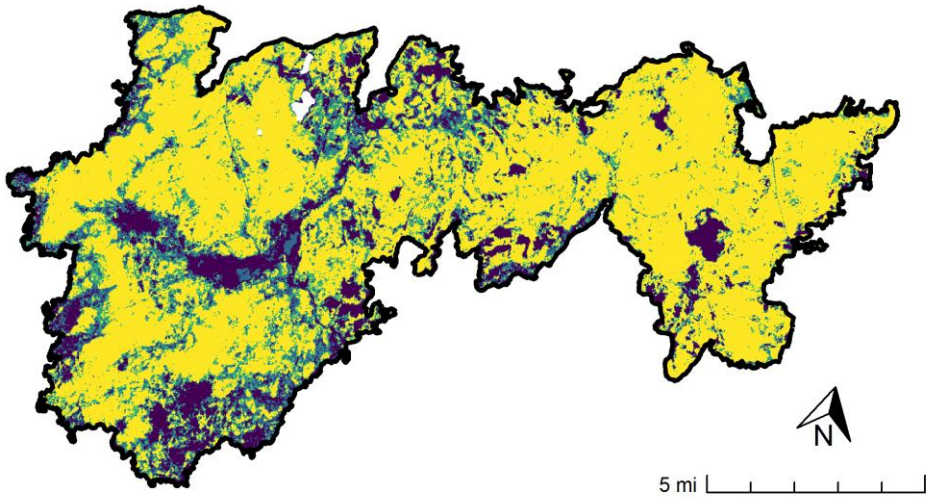
"Low" severity corresponds with <25% basal area mortality

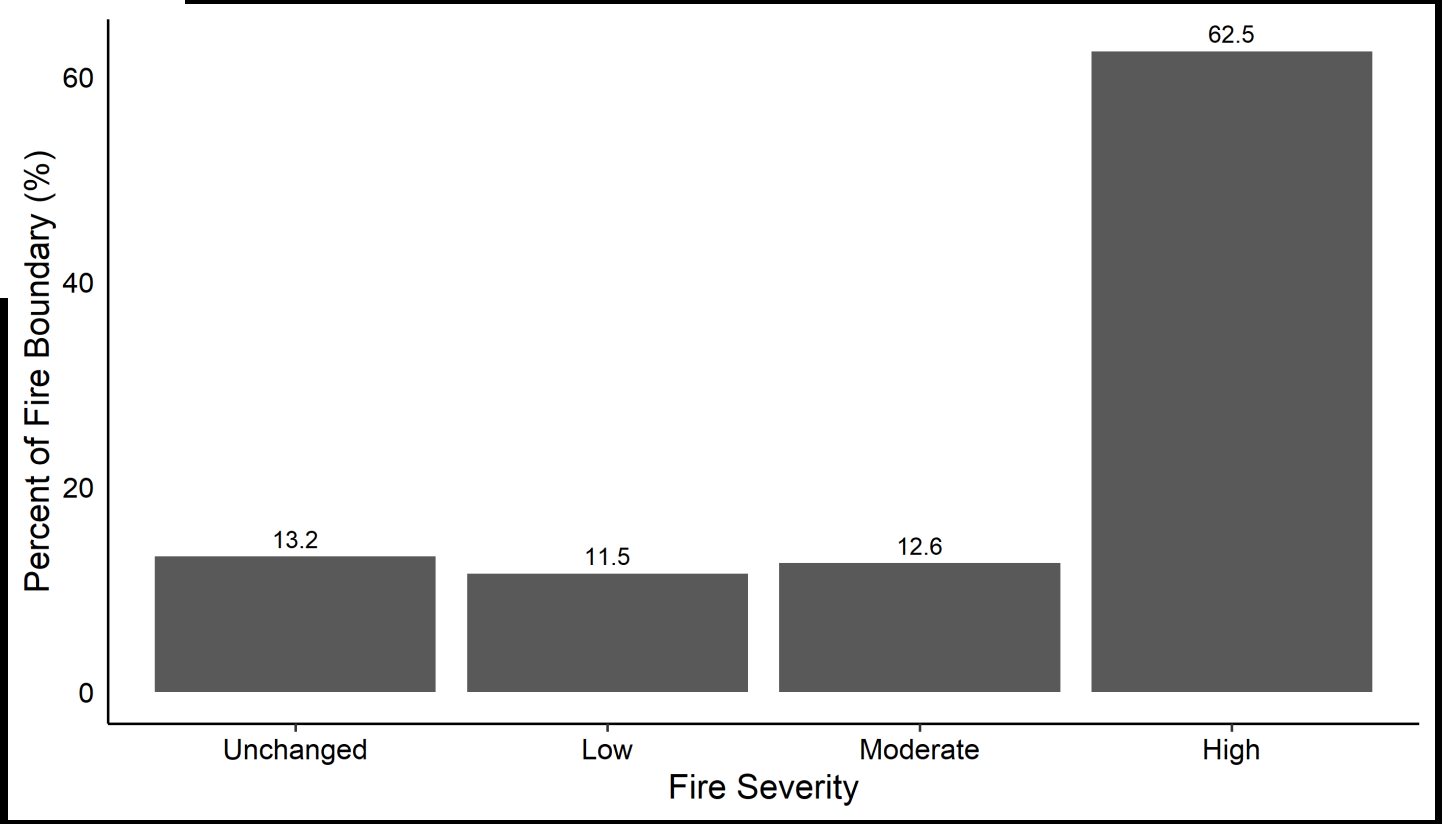
High vs. Low Fire Severity

"High" severity corresponds with
>75% basal area mortality

"Low" severity corresponds with
<25% basal area mortality

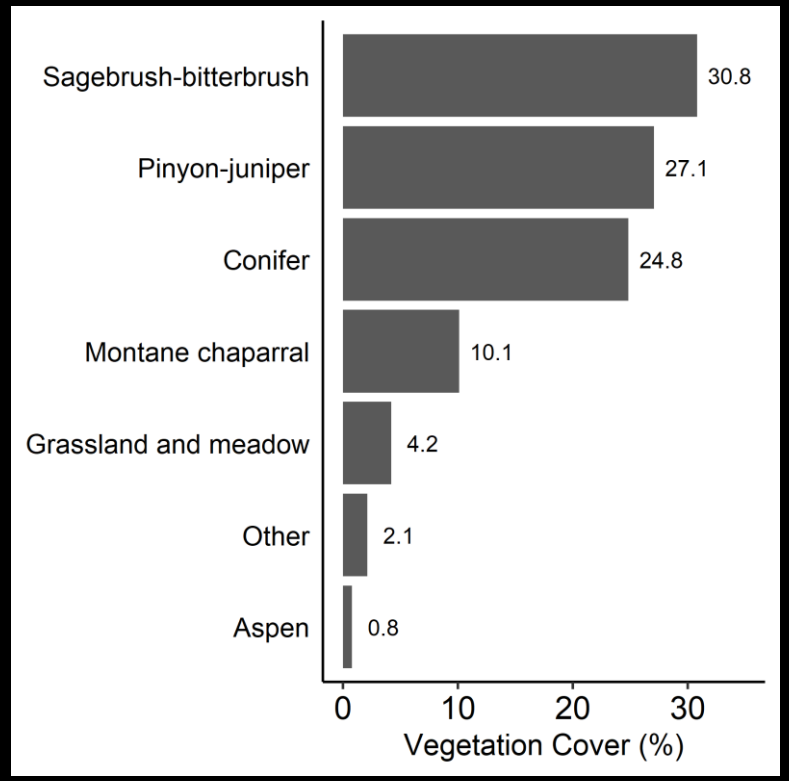
RAVG Fire Severity

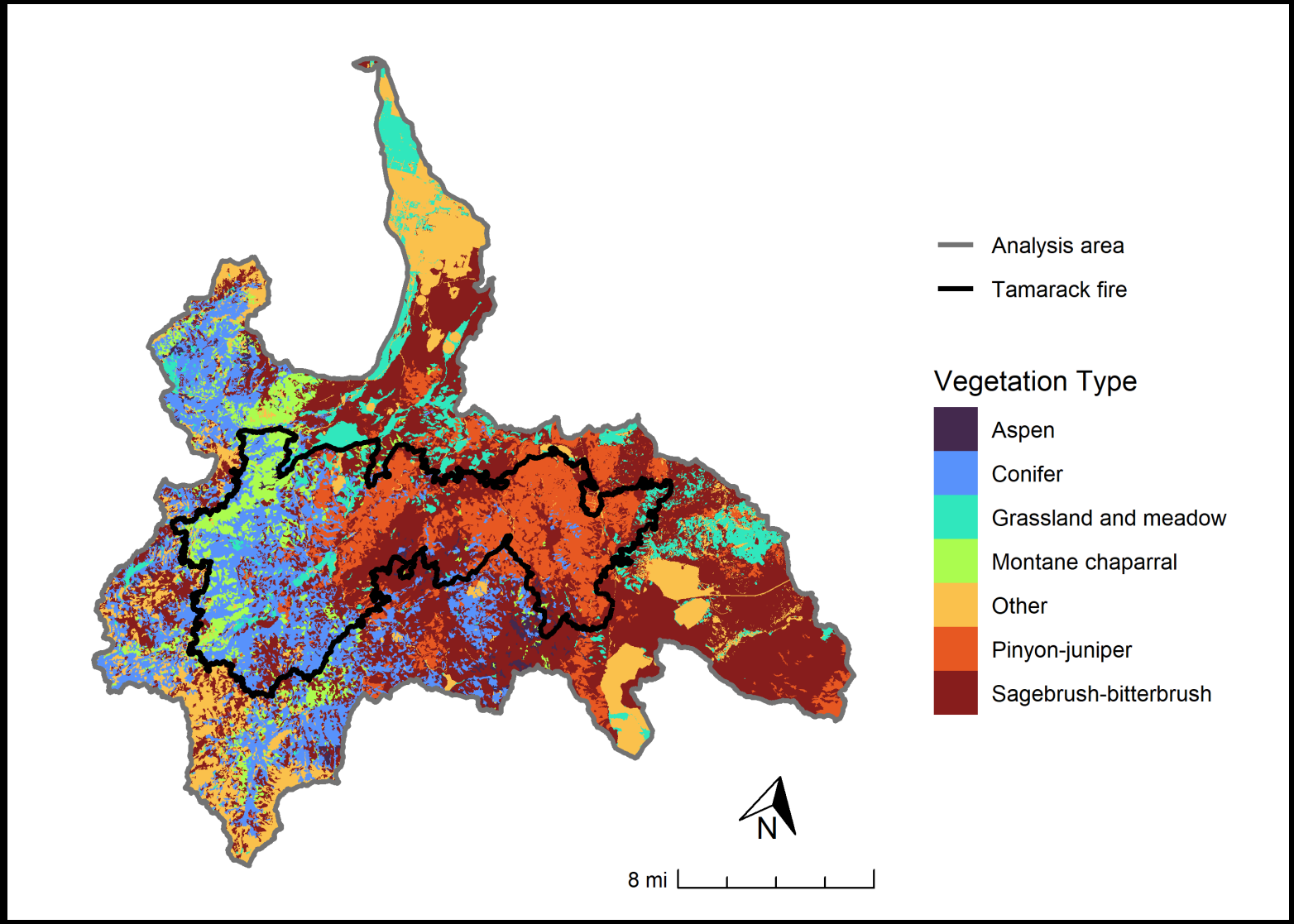




Vegetation Cover Types

Percent cover within the Tamarack fire boundary

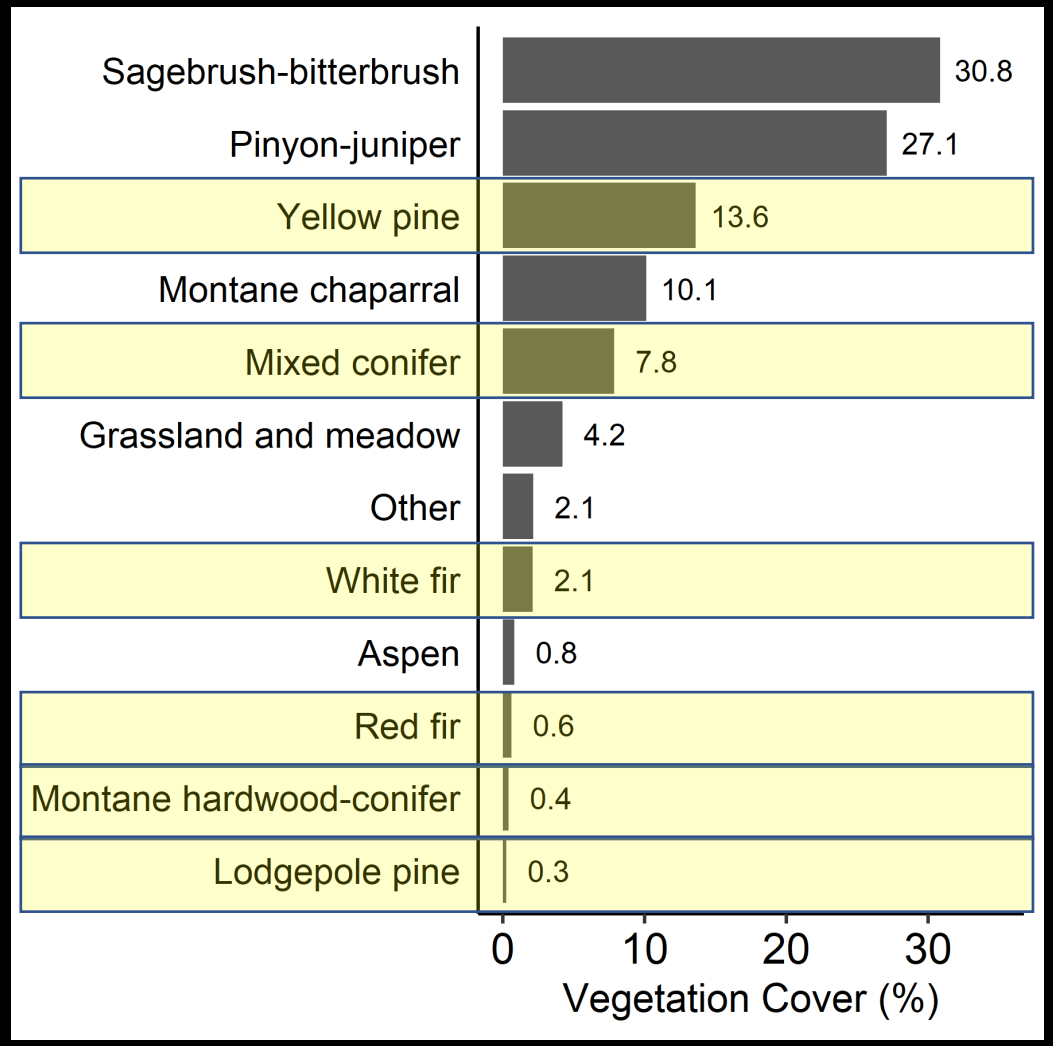


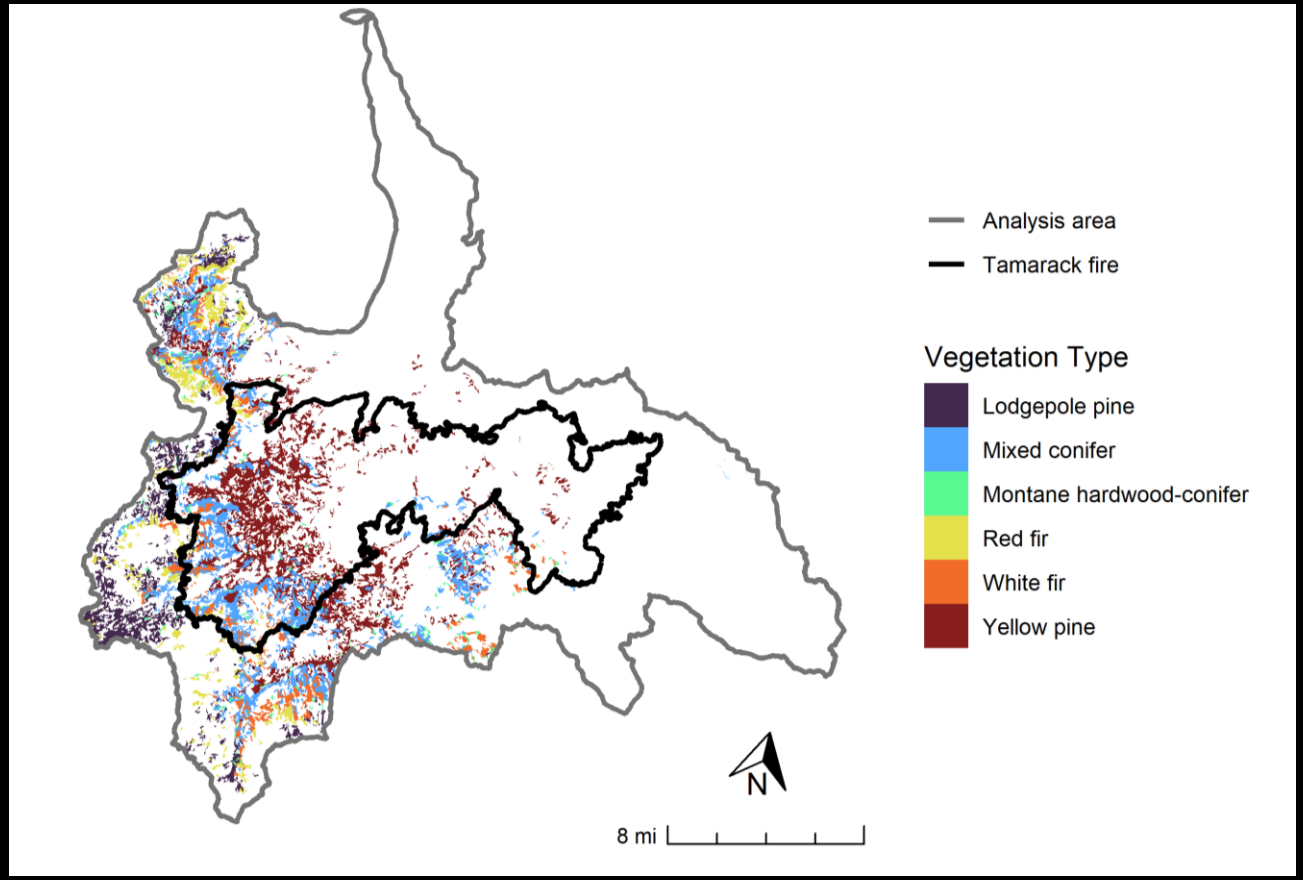


"Conifer" Cover Types

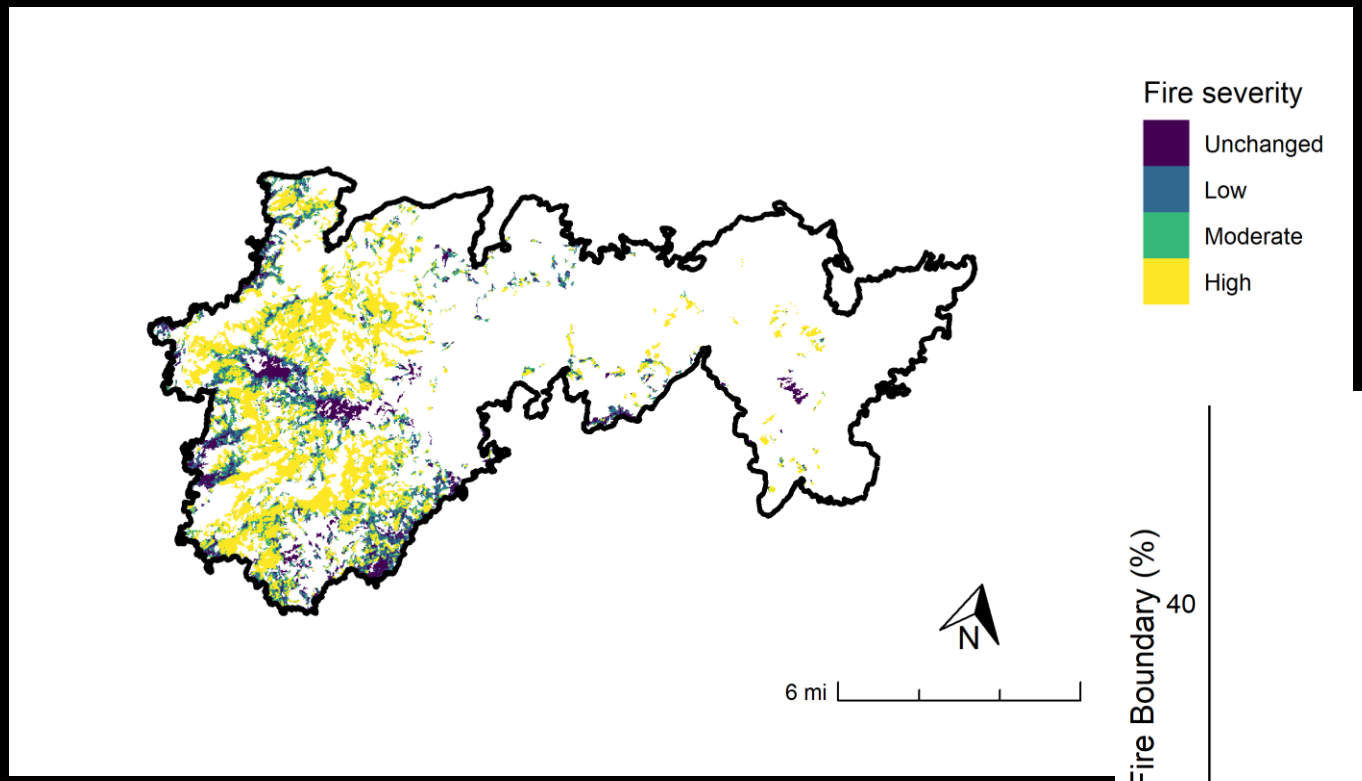
24.8% of Fire Boundary

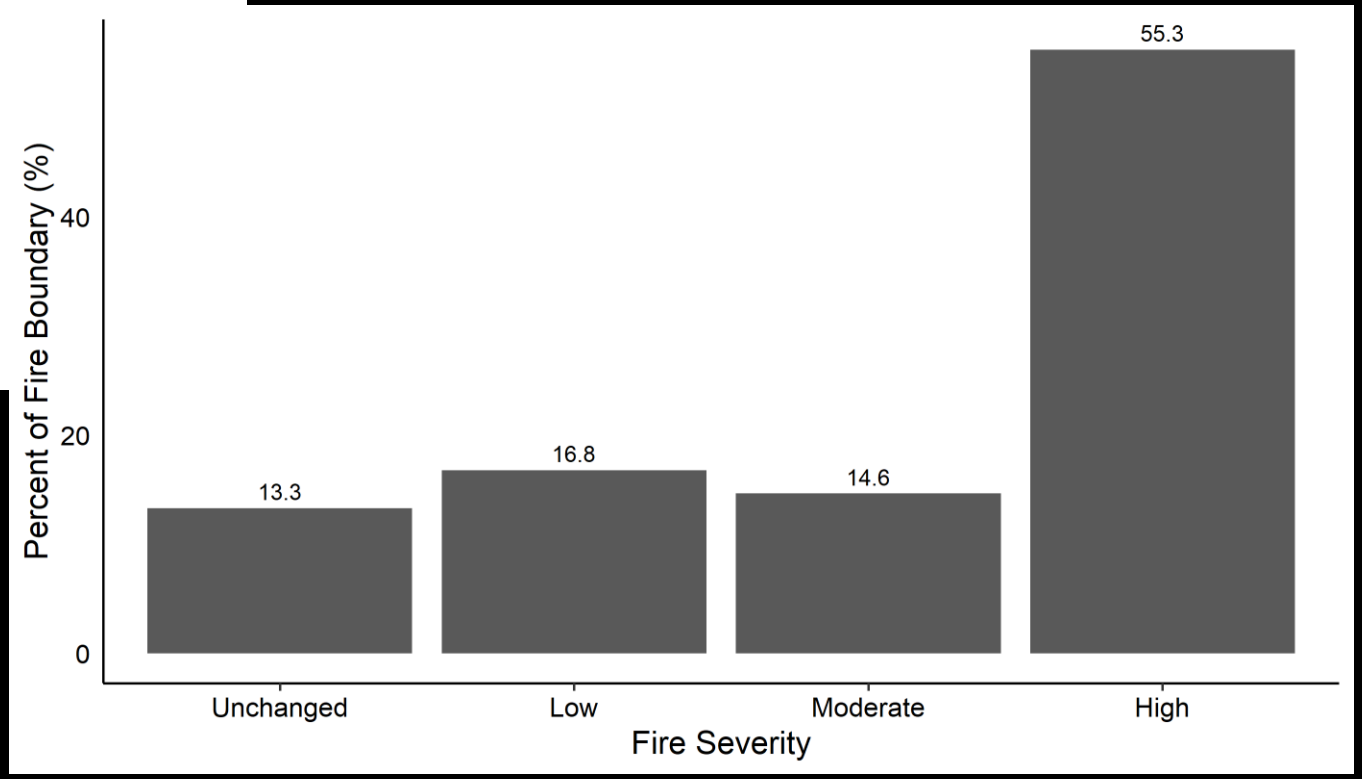
Percent cover within the Tamarack fire boundary





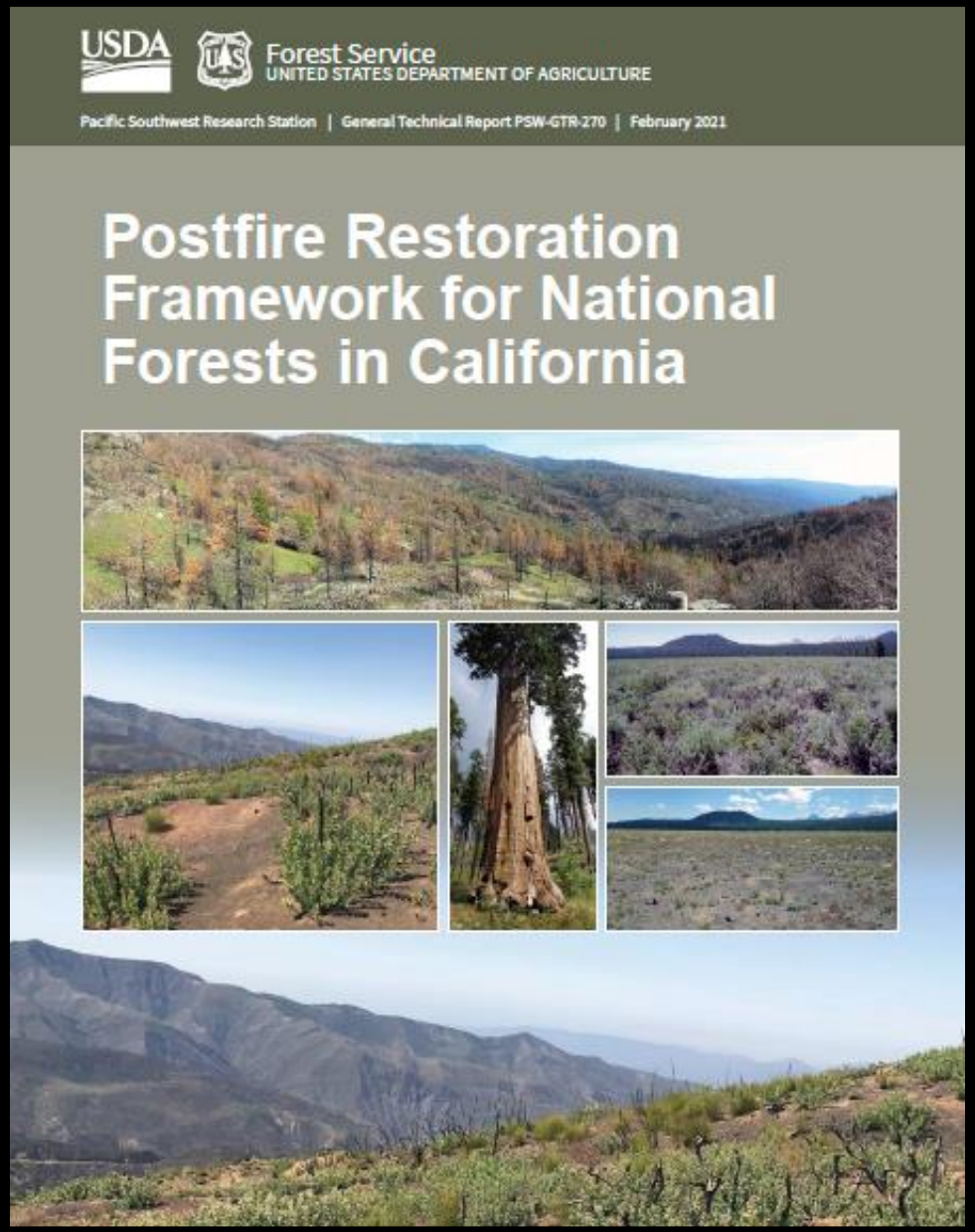
RAVG Fire Severity – Conifer Forest Only





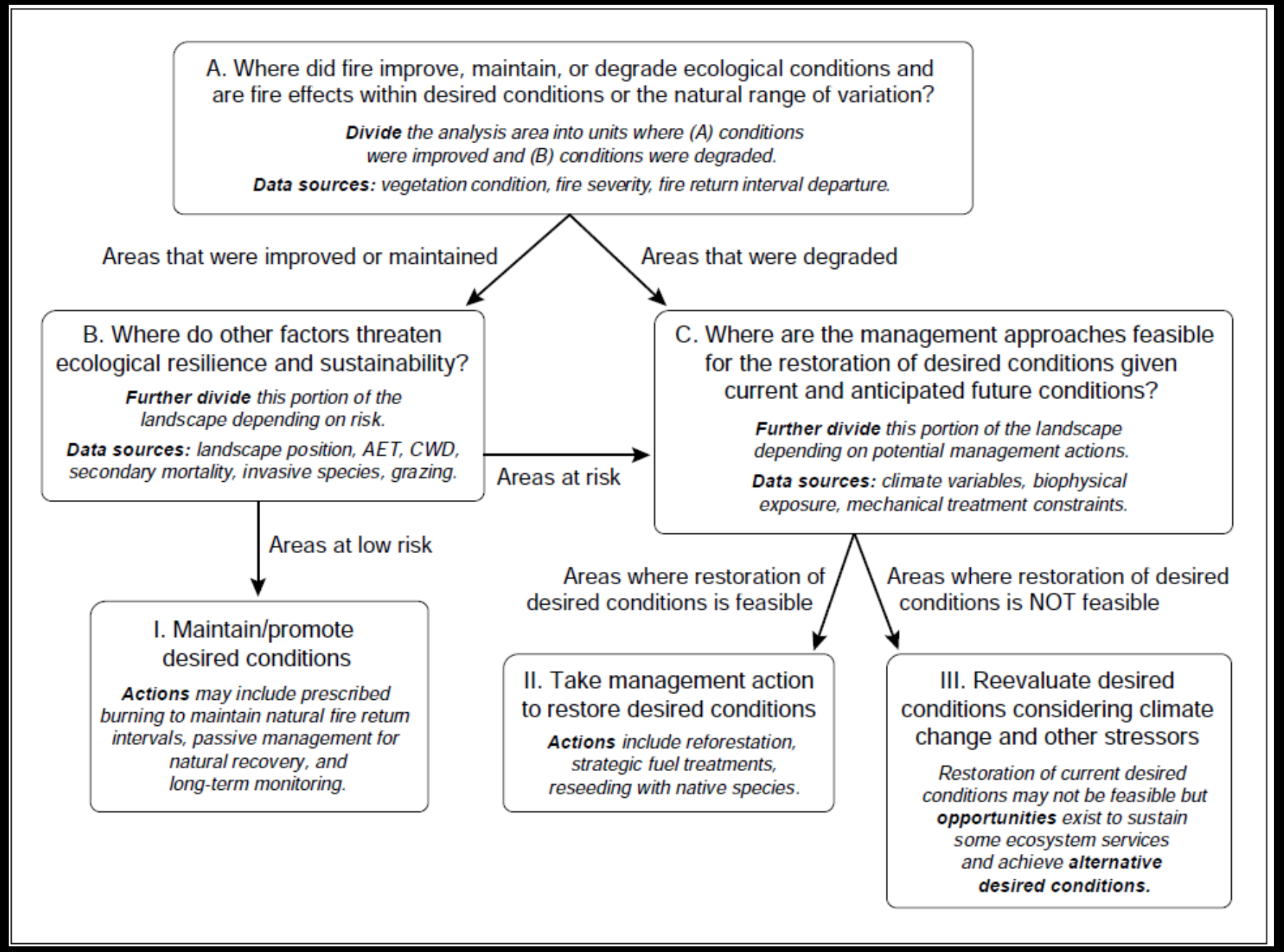
Outline

- Increasing wildfire activity in our region
- Tamarack Fire basics
- **Post-fire Restoration Framework**
- Fuel treatment effectiveness
- Monitoring of post-fire natural regeneration
- Ongoing/Upcoming projects
  - Seedling monitoring (natural regeneration and planted seedlings)
  - Shrub removal experiment
  - Post-fire regeneration in Eastern Sierra Nevada forests



- Science-based framework for postfire restoration
- Assessment of locations where wildfires have contributed to forest conditions outside the historic range of variability
- Encourages thinking across ownerships, at the landscape scale
- Focuses on medium- and long-term postfire management
- Does NOT focus on safety/socioeconomic concerns (e.g., infrastructure, hazard trees)

Meyer, M.D.; Long, J.W.; Safford, H.D., eds. 2021. Postfire restoration framework for national forests in California. Gen. Tech. Rep. PSW-GTR-270.


A. Where did fire improve, maintain, or degrade ecological conditions and are fire effects within desired conditions or the natural range of variation?
Divide the analysis area into units where (A) conditions were improved and (B) conditions were degraded.
Data sources: vegetation condition, fire severity, fire return interval departure.
Areas that were improved or maintained
Areas that were degraded
B. Where do other factors threaten ecological resilience and sustainability?
Further divide this portion of the landscape depending on risk.
Data sources: landscape position, AET, CWD, secondary mortality, invasive species, grazing.
Areas at risk
C. Where are the management approaches feasible for the restoration of desired conditions given current and anticipated future conditions?
Further divide this portion of the landscape depending on potential management actions.
Data sources: climate variables, biophysical exposure, mechanical treatment constraints.
Areas at low risk
Areas where restoration of desired conditions is feasible
Areas where restoration of desired conditions is NOT feasible
I. Maintain/promote desired conditions
Actions may include prescribed burning to maintain natural fire return intervals, passive management for natural recovery, and long-term monitoring.
II. Take management action to restore desired conditions
Actions include reforestation, strategic fuel treatments, reseeding with native species.
III. Reevaluate desired conditions considering climate change and other stressors
Restoration of current desired conditions may not be feasible but opportunities exist to sustain some ecosystem services and achieve alternative desired conditions.

Post-fire Restoration Tamarack Fire Flowchart

1. Where did the Tamarack fire degrade ecological conditions?
   a) Identify high severity patches >100 acres

2. Where is low to moderate tree regeneration predicted?
   a) Areas with low to moderate tree regeneration may be good candidates for reforestation

3. Where do large, high severity patches overlap with low regeneration potential?
   a) These sites could be a “high” priority for reforestation, depending on feasibility

Simplified Tamarack Fire Flowchart – Degraded Conditions

Where did the Tamarack fire degrade ecological conditions?

a) Identify high severity patches >100 acres

Natural regeneration probability is low/moderate (<0.6)

↓

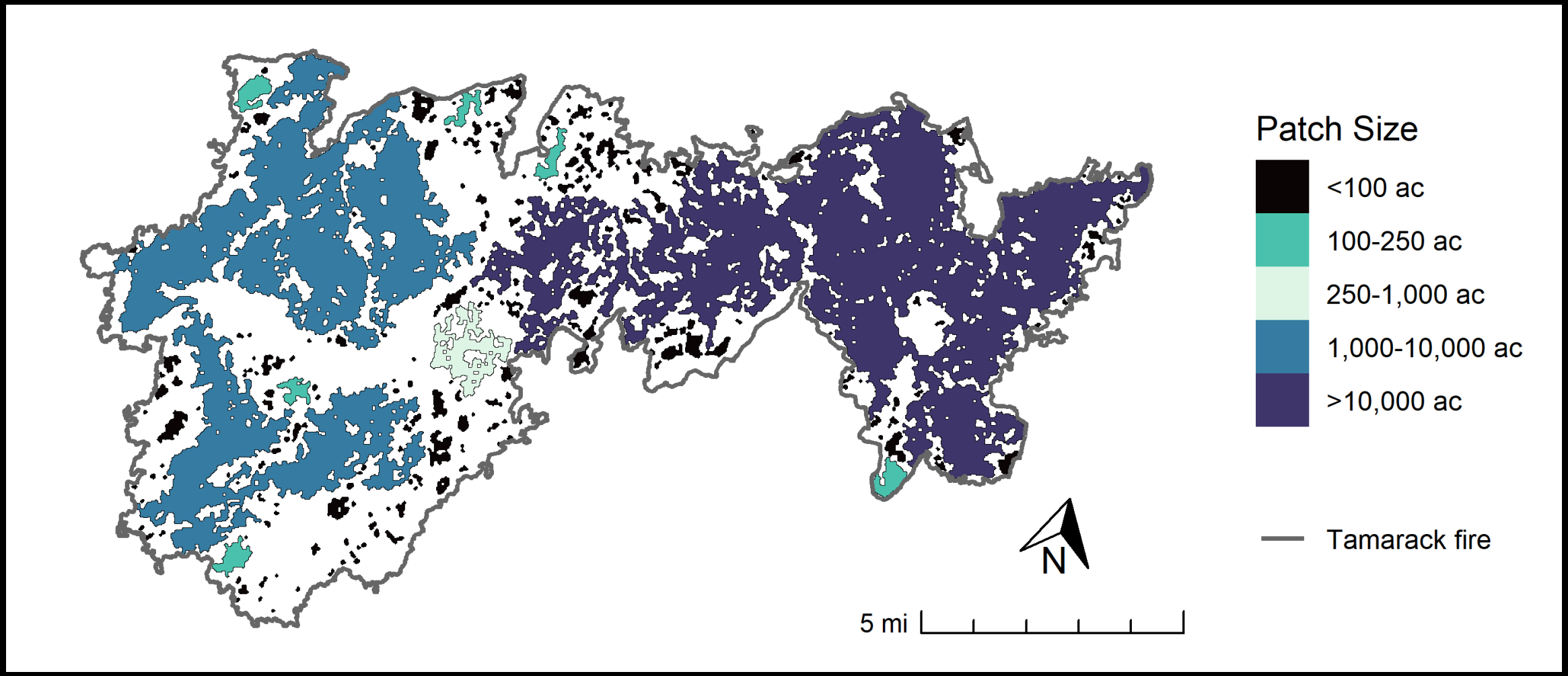
"High" priority for reforestation

Natural regeneration probability is high (>0.6)

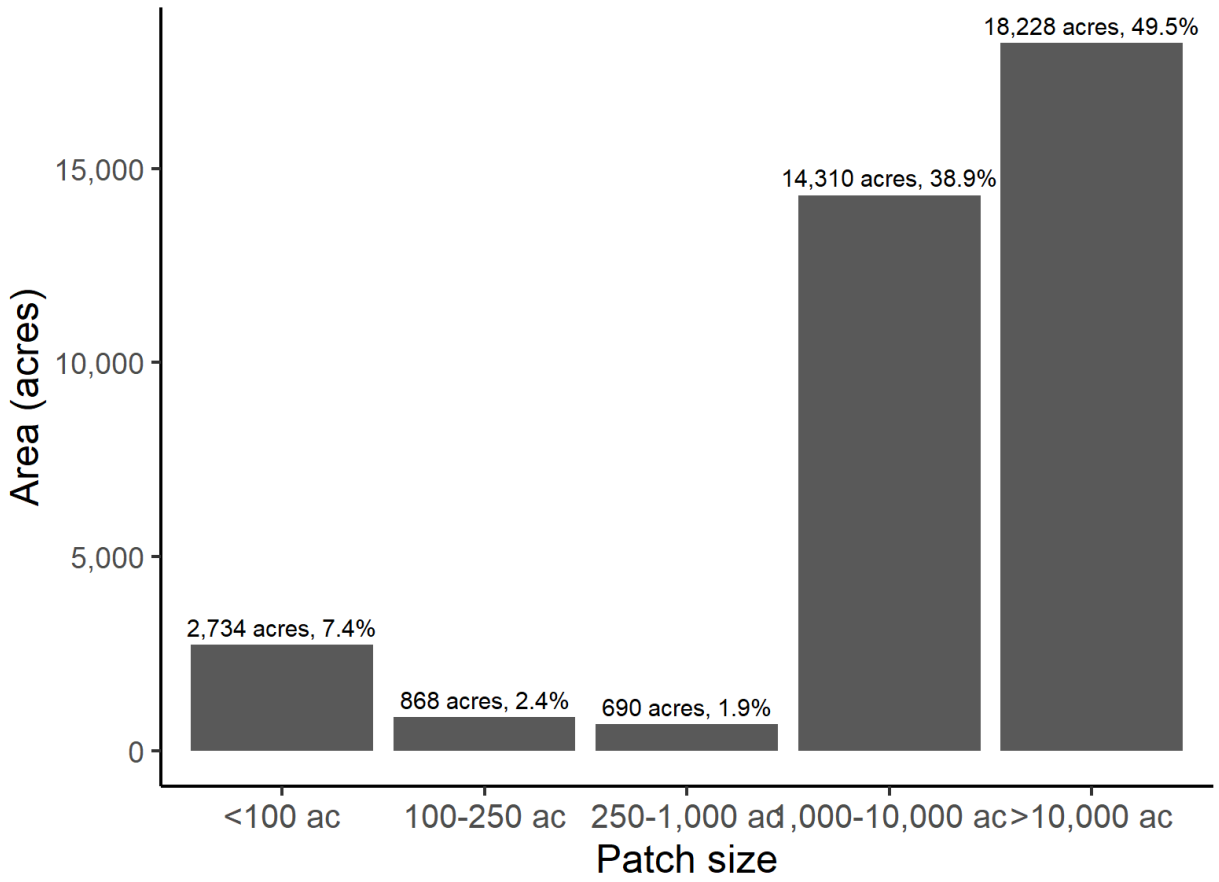
↓

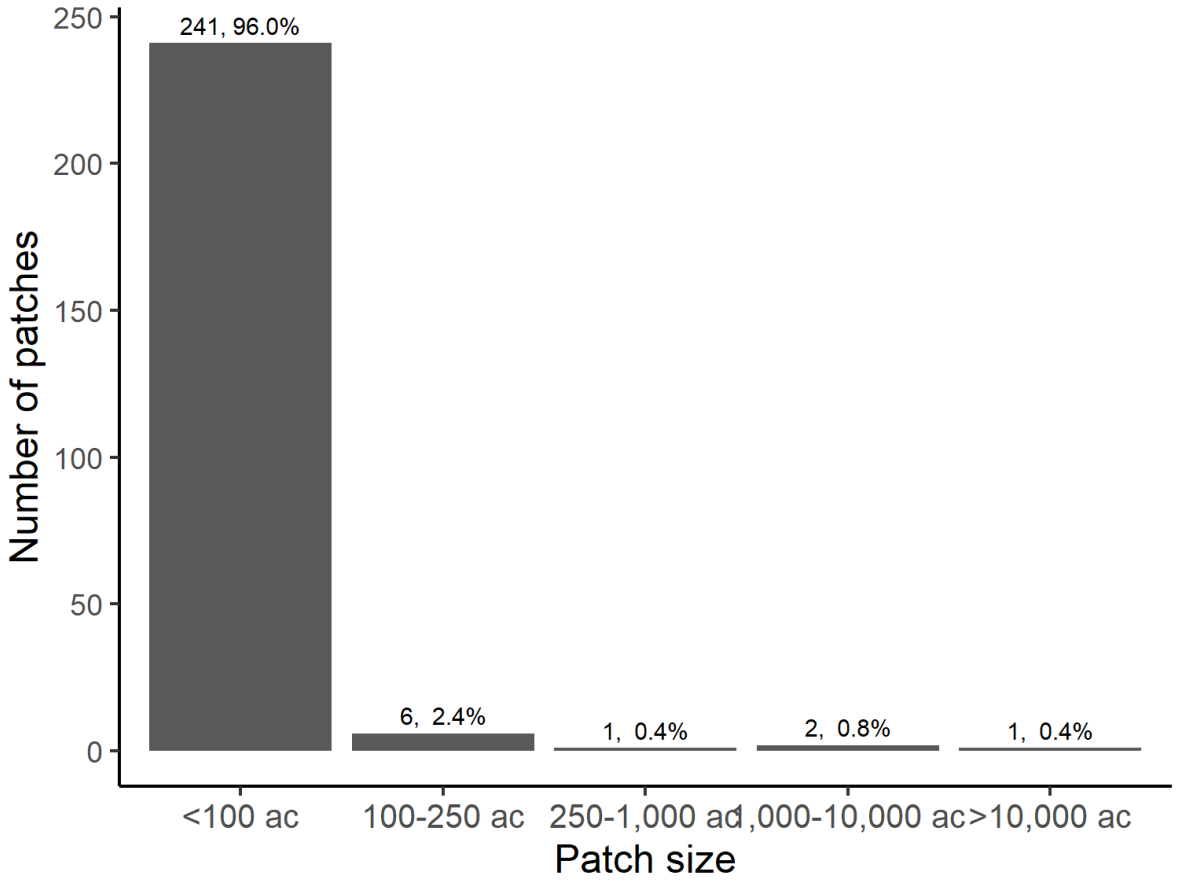
"Low" priority for reforestation

ID large, high severity patches - Patchmorph Tool

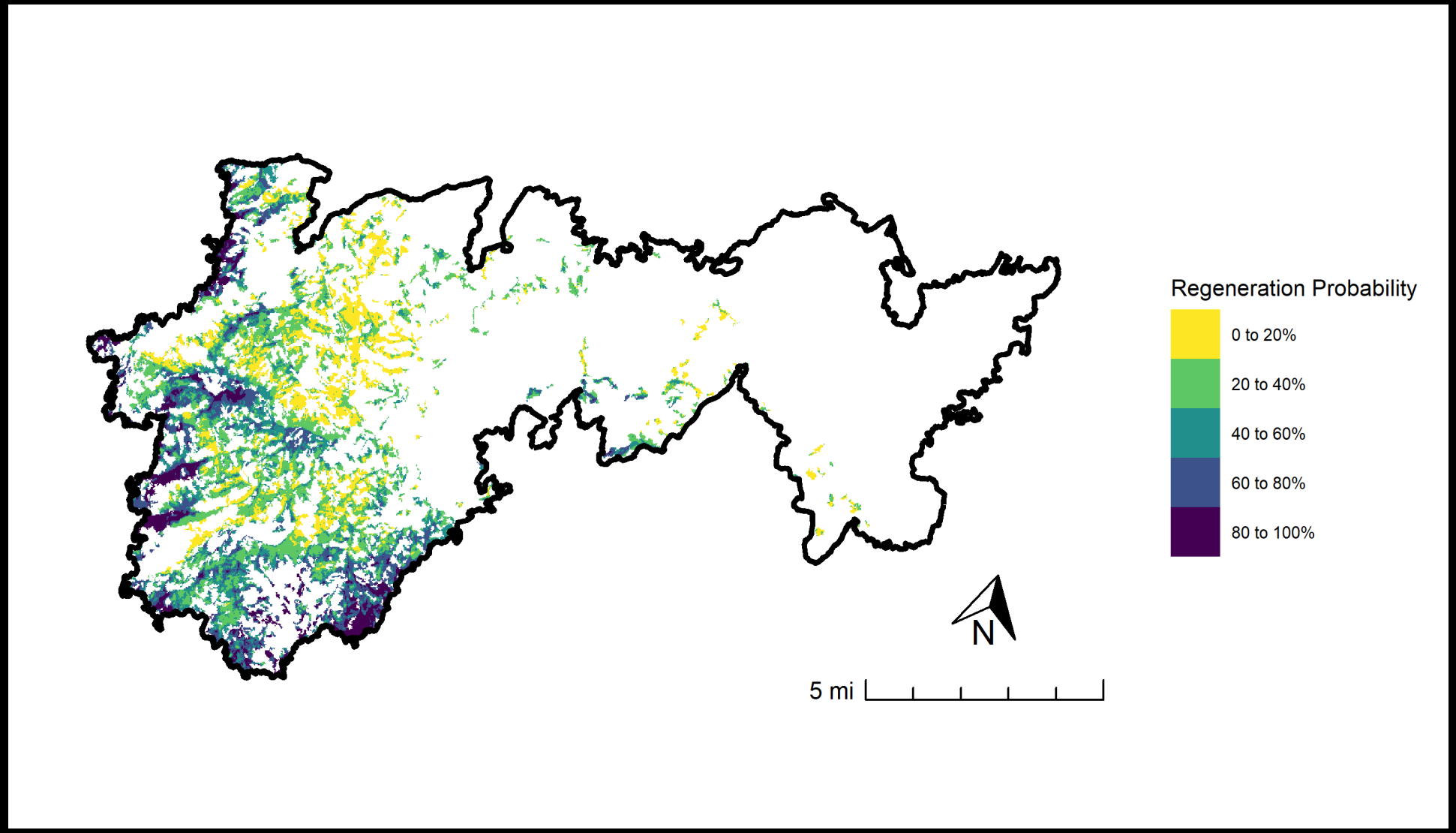


High severity patch size and number



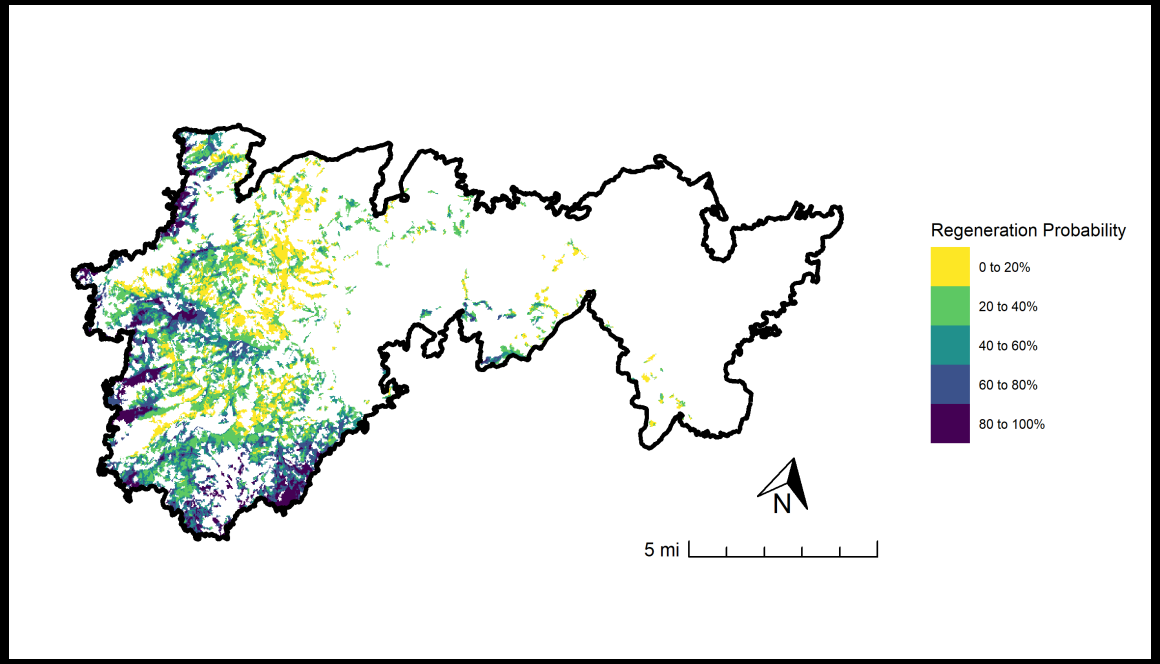


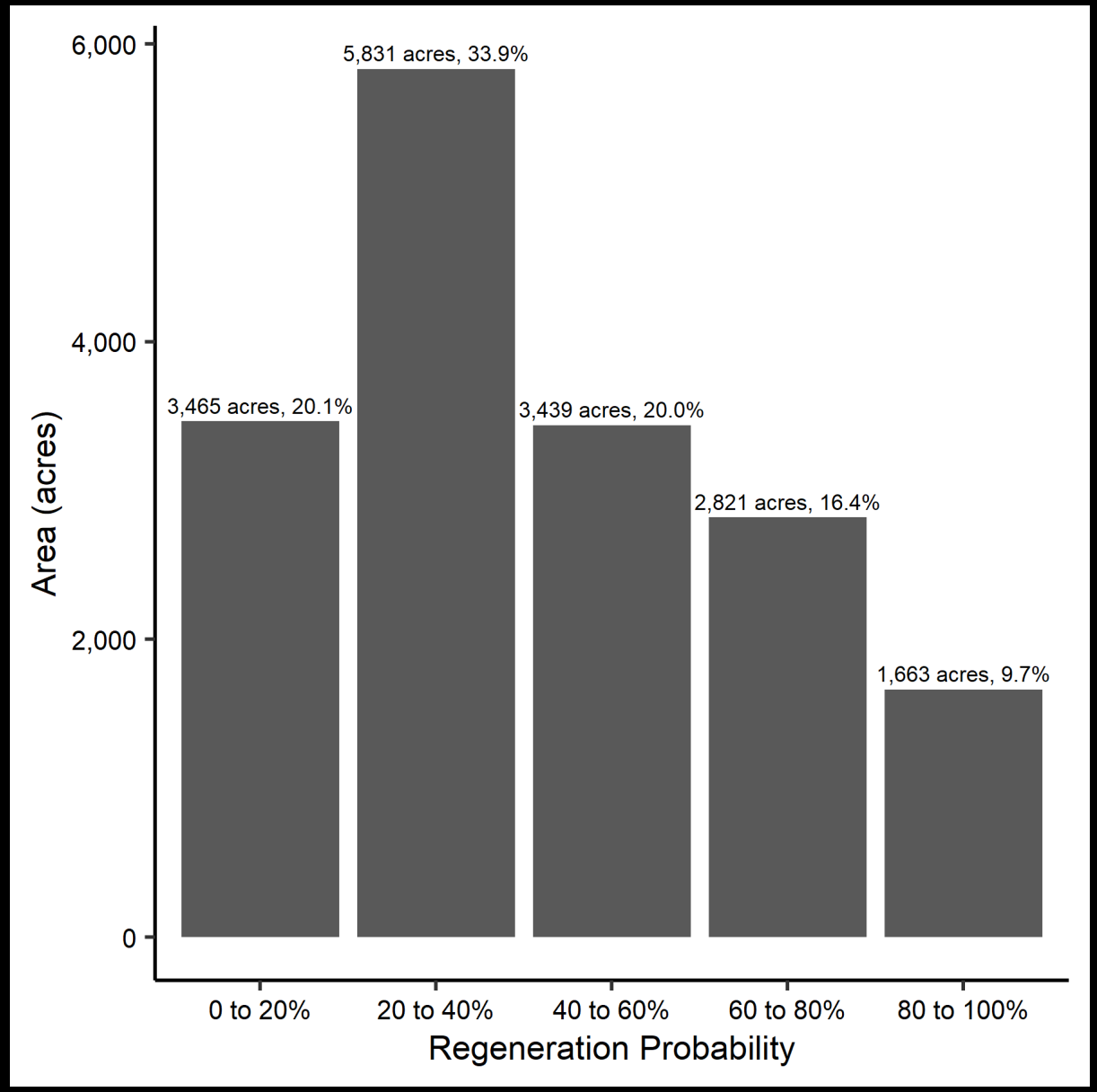
Regeneration Probability – PostCRPT Tool



PostCRPT tool: https://reforestationtools.org/

Regeneration Probability – POSCRPT Tool





Reforestation Decision Matrix - Example

Where should we prioritize reforestation activities?

		Predicted probability of natural regeneration		
Departure from HRV (Based on High Severity Patch Size)		**Low (0-40%)**	**Moderate (40-60%)**	**High (60-80%)**
	Low (<100 acres)			
	Moderate (100-250 acres)			
	High (>250 acres)			

Reforestation Decision Matrix - Example

Where should we prioritize reforestation activities?

		Predicted probability of natural regeneration		
Departure from NRV (Based on High Severity Patch Size)		**Low (0-40%)**	**Moderate (40-60%)**	**High (60-80%)**
	Low (<100 acres)			
	Moderate (100-250 acres)			
	High (>250 acres)	High		

Reforestation Decision Matrix - Example

Where should we prioritize reforestation activities?

		Predicted probability of natural regeneration		
Departure from NRV (Based on High Severity Patch Size)		**Low (0-40%)**	**Moderate (40-60%)**	**High (60-80%)**
	Low (<100 acres)			None
	Moderate (100-250 acres)			
	High (>250 acres)	High		

Reforestation Decision Matrix - Example

Where should we prioritize reforestation activities?

		Predicted probability of natural regeneration		
Departure from NRV (Based on High Severity Patch Size)		**Low (0-40%)**	**Moderate (40-60%)**	**High (60-80%)**
	Low (<100 acres)	Moderate to High	Moderate	None
	Moderate (100-250 acres)	High	High	Low
	High (>250 acres)	High	High	Low

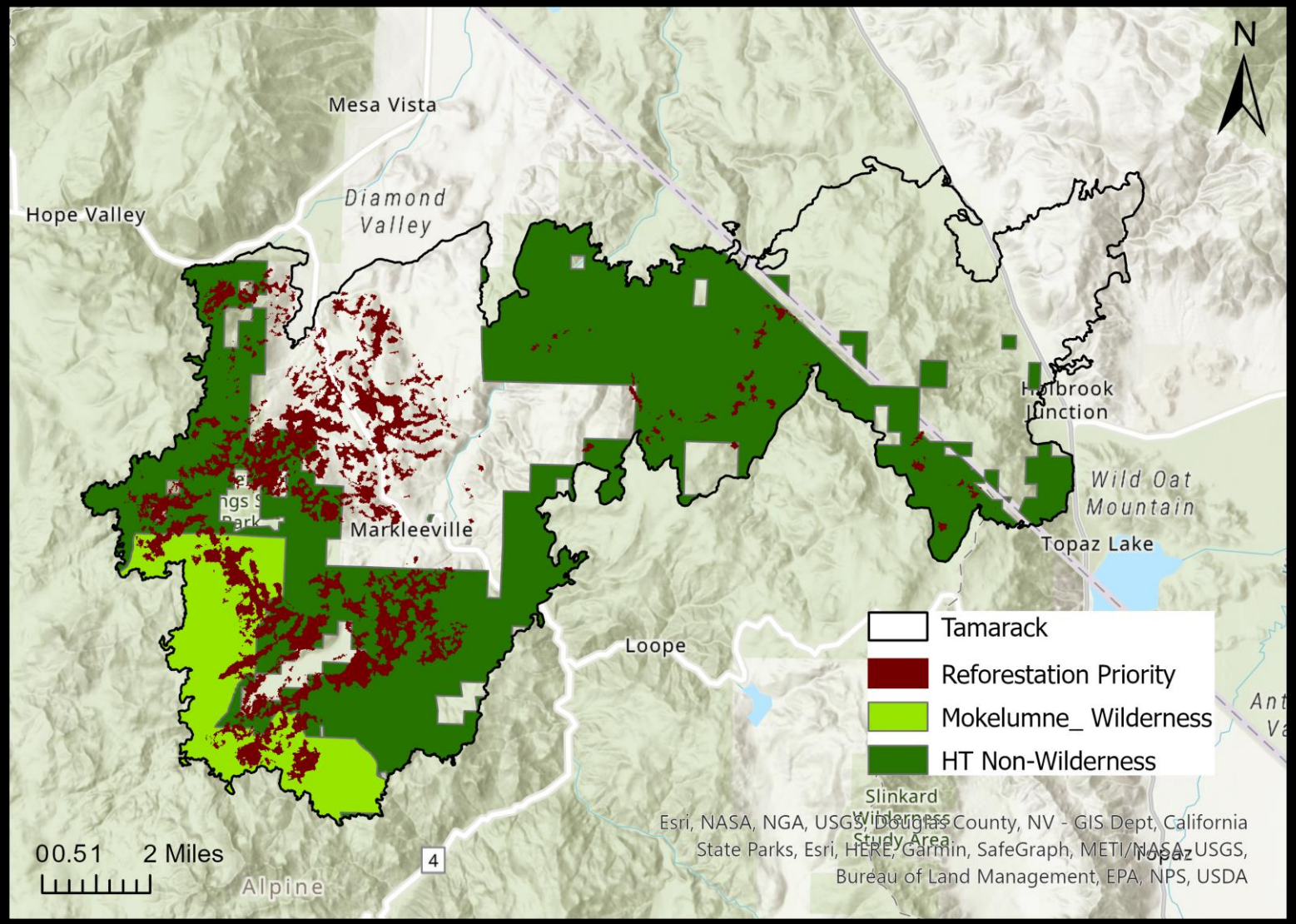
Reforestation Decision Matrix - Example

Where should we prioritize reforestation activities?

		Predicted probability of natural regeneration		
		Low (0-40%)	**Moderate (40-60%)**	**High (60-80%)**
Departure from NRV (Based on High Severity Patch Size)	**Low (<100 acres)**	Moderate to High	Moderate	None
	Moderate (100-250 acres)	High	High	Low
	High (>250 acres)	High	High	Low

Locations with highest reforestation priority

Within large (>100 acre) high severity patches & low-moderate regen probability



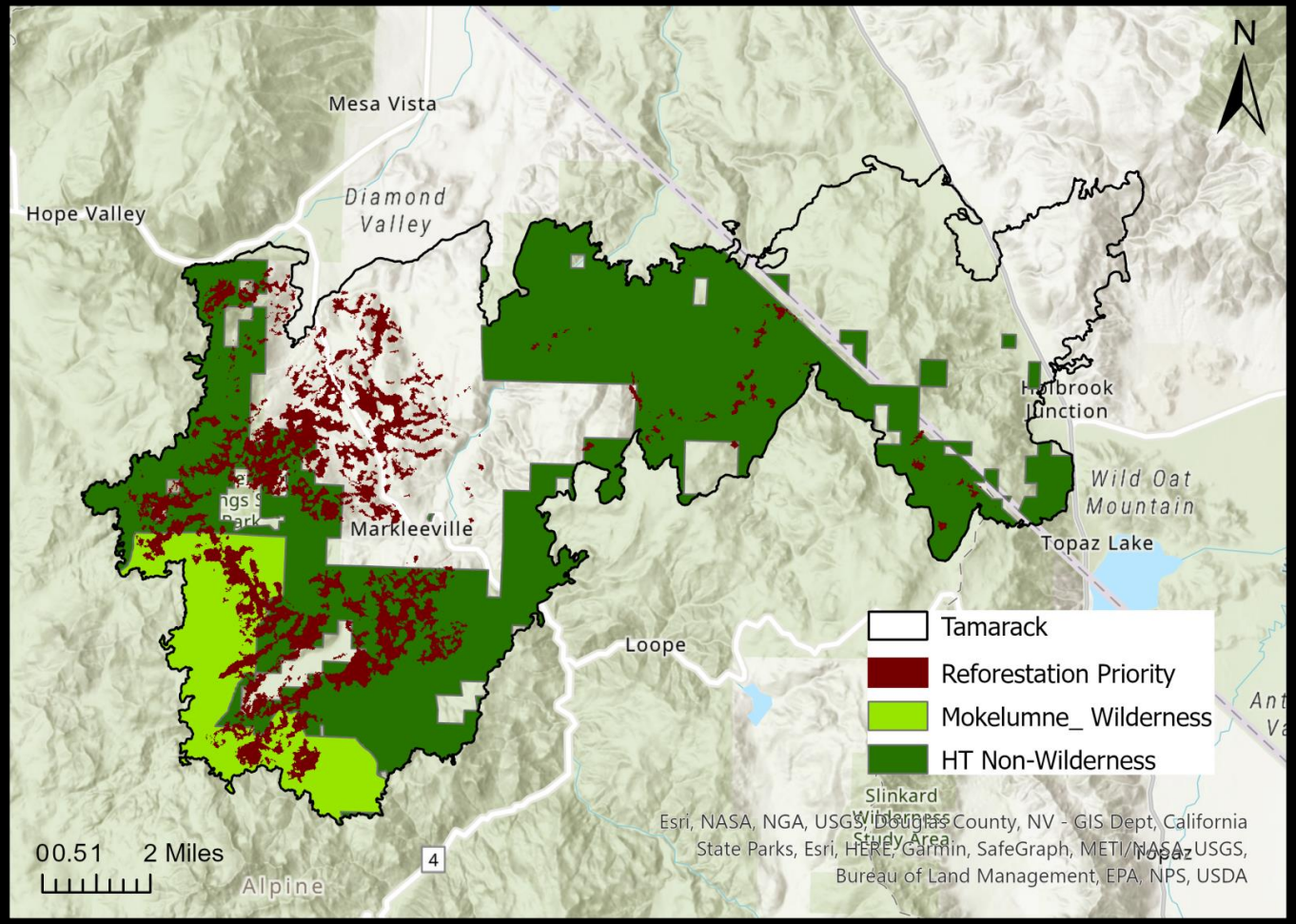
HT Non-Wilderness: 3,533 acres

Mokelumne Wilderness: 1,119 acres

Non-FS: 2,304 acres

Total: 6,965 acres

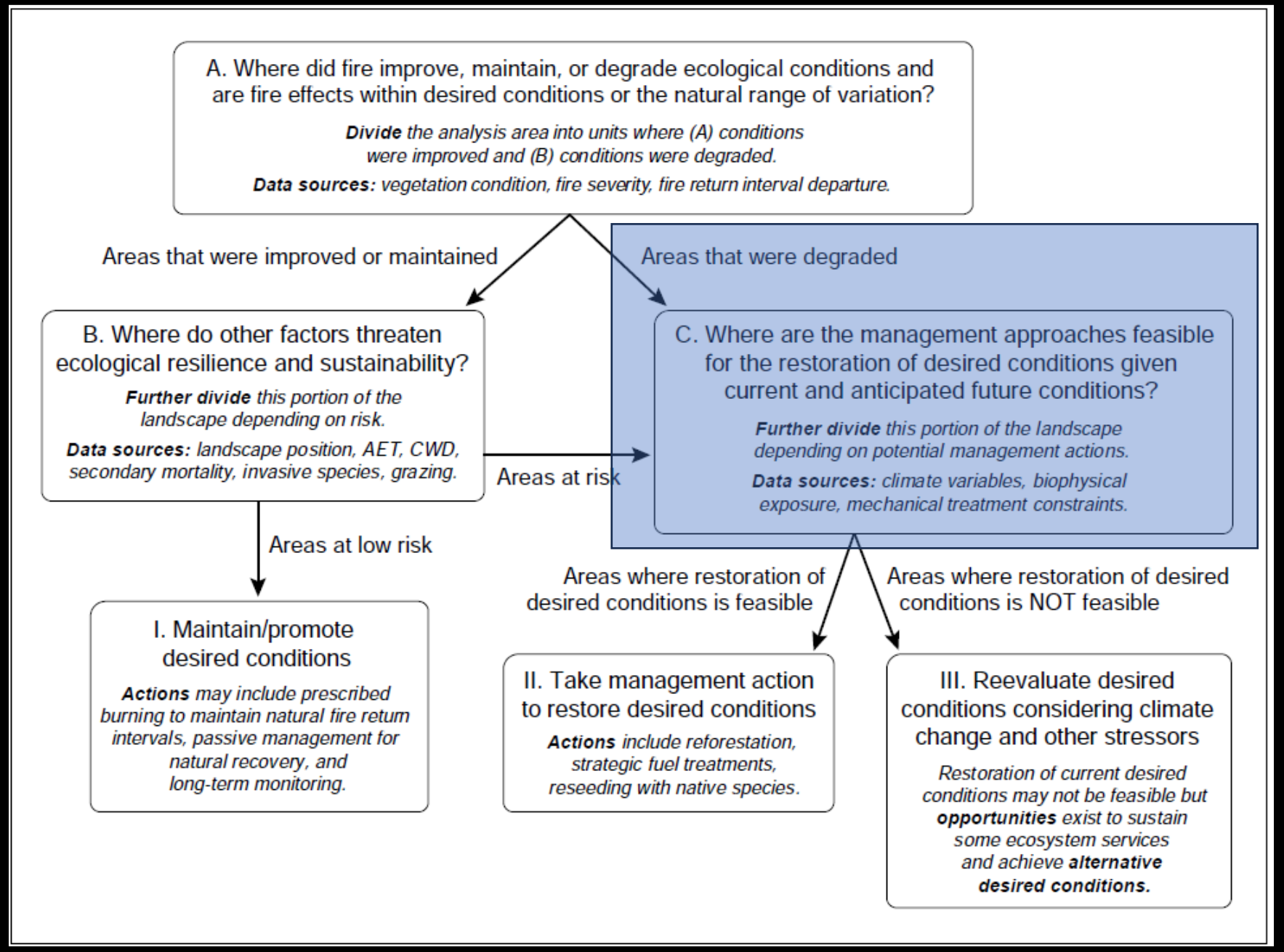
Next steps in reforestation prioritization



Examine likelihood of planting success in these areas (PreSet Tool)

Examine future climate conditions and climate vulnerability in these areas – do we need to reconsider desired conditions at any of these locations?

Accessibility, topography, proximity to communities, etc.


A. Where did fire improve, maintain, or degrade ecological conditions and are fire effects within desired conditions or the natural range of variation?
Divide the analysis area into units where (A) conditions were improved and (B) conditions were degraded.
Data sources: vegetation condition, fire severity, fire return interval departure.
Areas that were improved or maintained
Areas that were degraded
B. Where do other factors threaten ecological resilience and sustainability?
Further divide this portion of the landscape depending on risk.
Data sources: landscape position, AET, CWD, secondary mortality, invasive species, grazing.
Areas at risk
C. Where are the management approaches feasible for the restoration of desired conditions given current and anticipated future conditions?
Further divide this portion of the landscape depending on potential management actions.
Data sources: climate variables, biophysical exposure, mechanical treatment constraints.
Areas at low risk
Areas where restoration of desired conditions is feasible
Areas where restoration of desired conditions is NOT feasible
I. Maintain/promote desired conditions
Actions may include prescribed burning to maintain natural fire return intervals, passive management for natural recovery, and long-term monitoring.
II. Take management action to restore desired conditions
Actions include reforestation, strategic fuel treatments, reseeding with native species.
III. Reevaluate desired conditions considering climate change and other stressors
Restoration of current desired conditions may not be feasible but opportunities exist to sustain some ecosystem services and achieve alternative desired conditions.

Summary

- This postfire restoration framework could be useful beyond the Tamarack fire for planning restoration activities following large-scale disturbances like wildfire (or even deciding where to prioritize treatments before a disturbance)

Summary

- This postfire restoration framework could be useful beyond the Tamarack fire for planning restoration activities following large-scale disturbances like wildfire (or even deciding where to prioritize treatments before a disturbance)
- Many tools are available to help with analyses (PatchMorph, POSCRPT, PreSet, R4 Regeneration Tool, climate vulnerability assessments, etc.)

Summary

- This postfire restoration framework could be useful beyond the Tamarack fire for planning restoration activities following large-scale disturbances like wildfire (or even deciding where to prioritize treatments before a disturbance)
- Many tools are available to help with analyses (PatchMorph, POSCRPT, PreSet, R4 Regeneration Tool, climate vulnerability assessments, etc.)
- Analyses are best carried out at the landscape scale, and results can inform local-scale projects

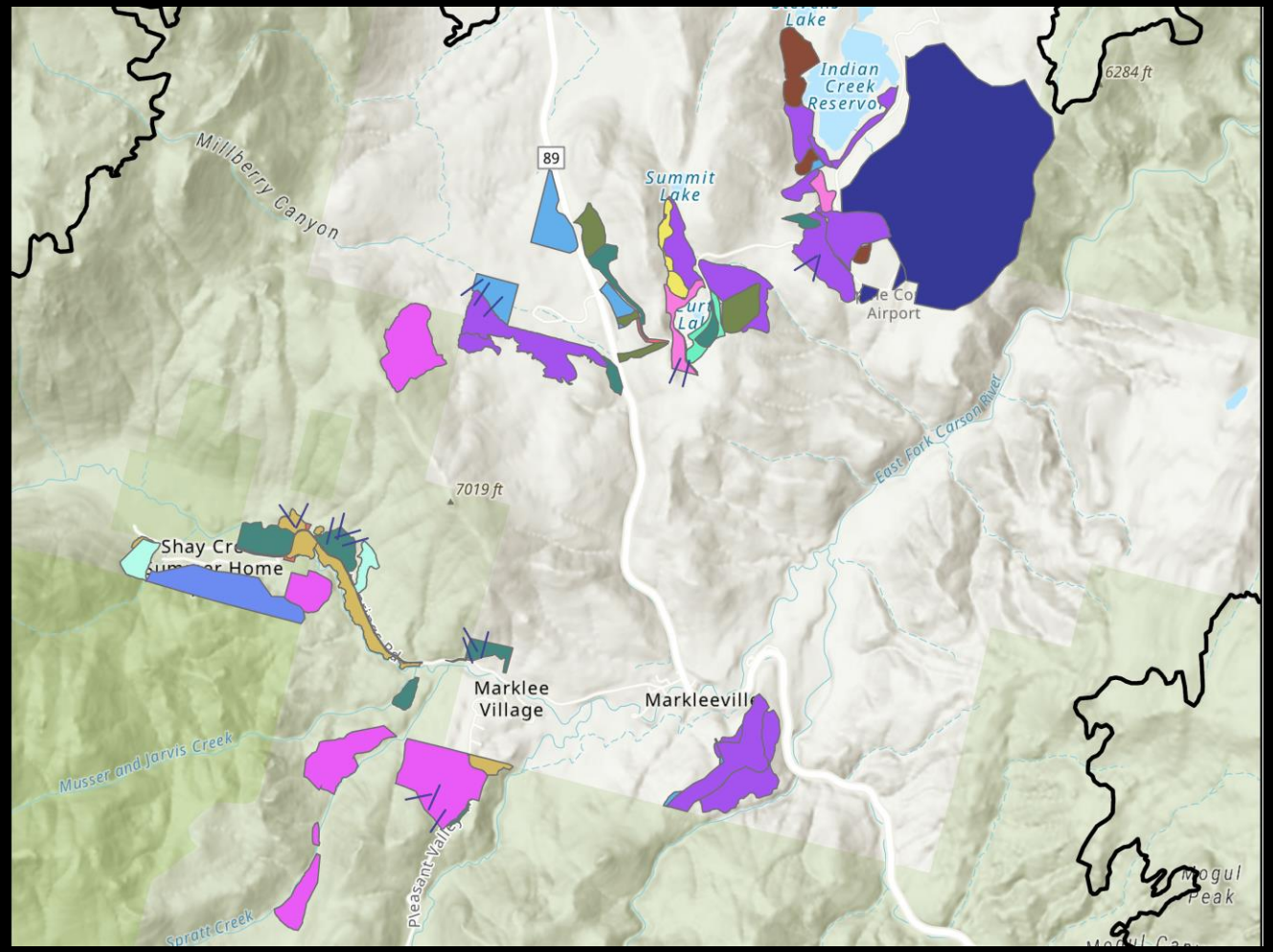
Summary

- This postfire restoration framework could be useful beyond the Tamarack fire for planning restoration activities following large-scale disturbances like wildfire (or even deciding where to prioritize treatments before a disturbance)
- Many tools are available to help with analyses (PatchMorph, POSCRPT, PreSet, R4 Regeneration Tool, climate vulnerability assessments, etc.)
- Analyses are best carried out at the landscape scale, and results can inform local-scale projects
- It's a learning process! We are learning what tools and datasets make sense for use in our region. Efforts like this will likely become more streamlined in the future.

Outline

- Increasing wildfire activity in our region
- Tamarack Fire basics
- Post-fire Restoration Framework
- **Fuel treatment effectiveness**
- Monitoring of post-fire natural regeneration
- Ongoing/Upcoming projects
  - Seedling monitoring (natural regeneration and planted seedlings)
  - Shrub removal experiment
  - Post-fire regeneration in Eastern Sierra Nevada forests

Tamarack Fuel Treatment Effectiveness



- Prior to the fire, several fuel reduction treatments were implemented around the Markleeville, CA area by the Humboldt-Toiyabe National Forest and the Bureau of Land Management.
- Treatments included various combinations of mastication, hand thin/pile/burn, and broadcast burning

Collaborators

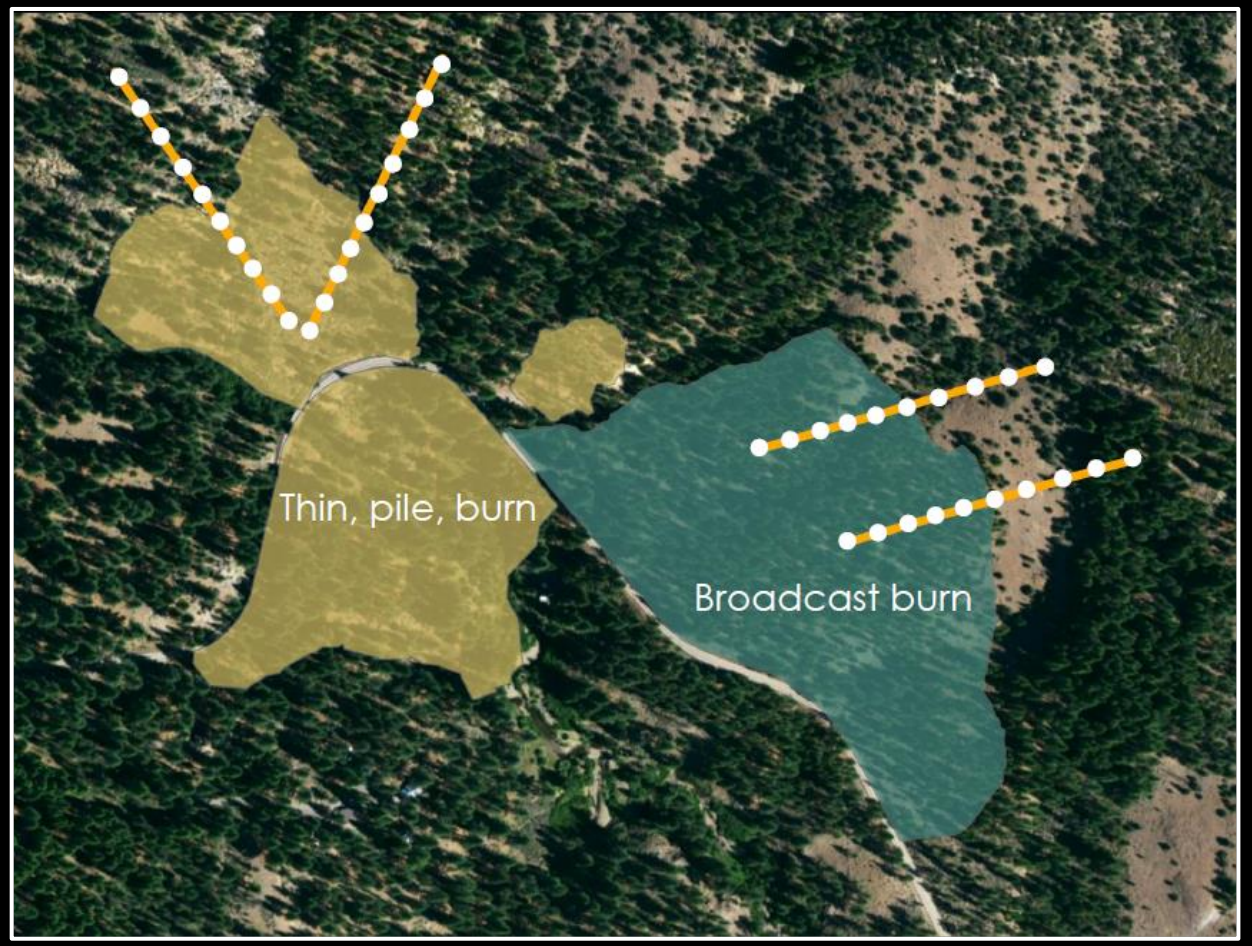
- Hugh Safford (UC Davis, Vibrant Planet)
- Saba Saberi (UC Davis)
- Thanks to many for help in the field:
  - Caitlin Murphy, Mitchell Aikin, Rory Fletcher, Nathaniel Quatier, Emily Chen, Dasha Pechurina, Terra Williams, Stephanie Yelenik, Emily Antunez, Rory Delaney, and Danielle Canning for assistance with field data collection and data entry.

Questions

1. Did pre-fire fuel reduction treatments reduce fire severity (crown scorch, crown torch, and tree mortality)?

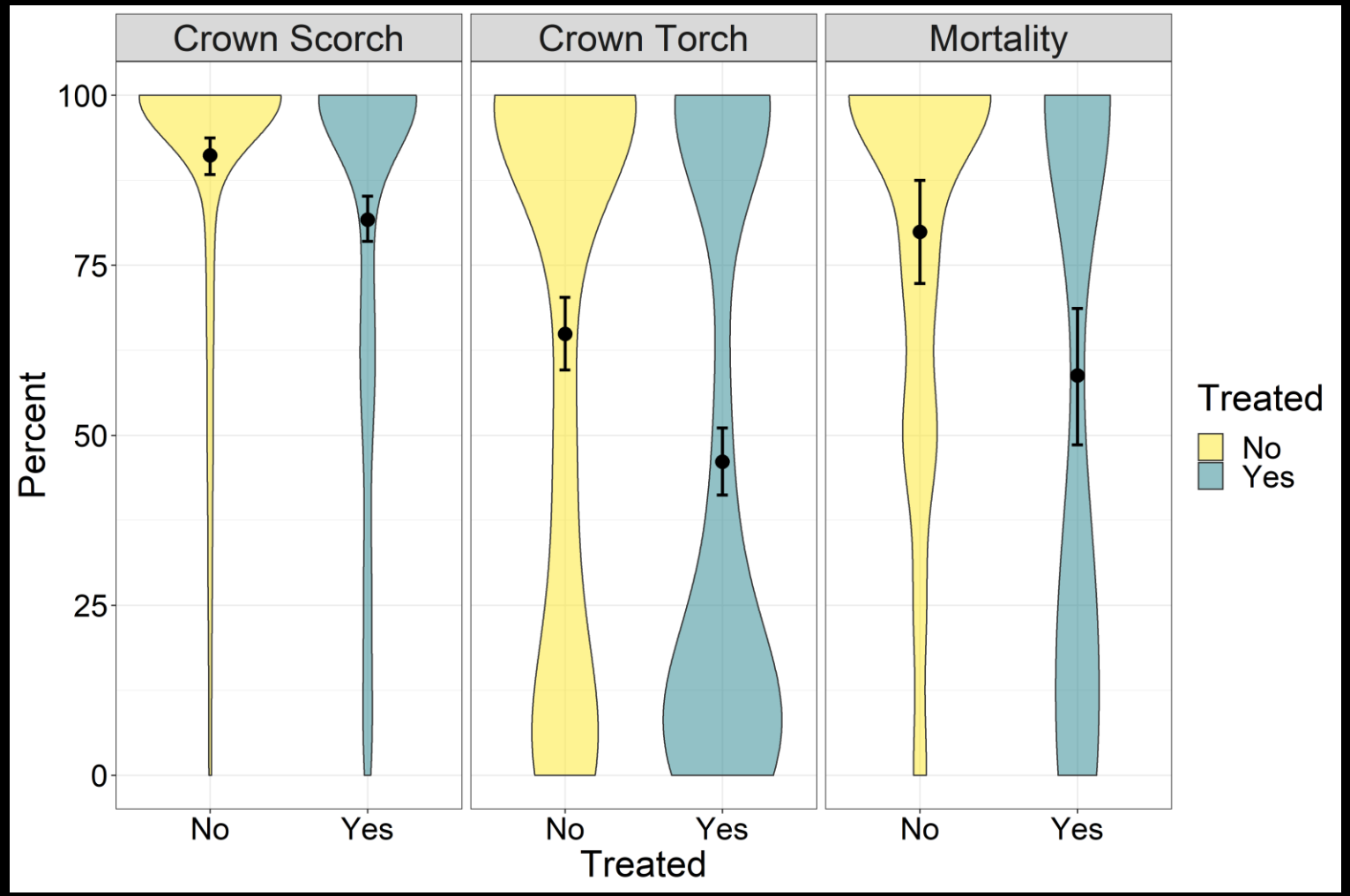
2. Were treatment effects consistent across all treatments?

Methods



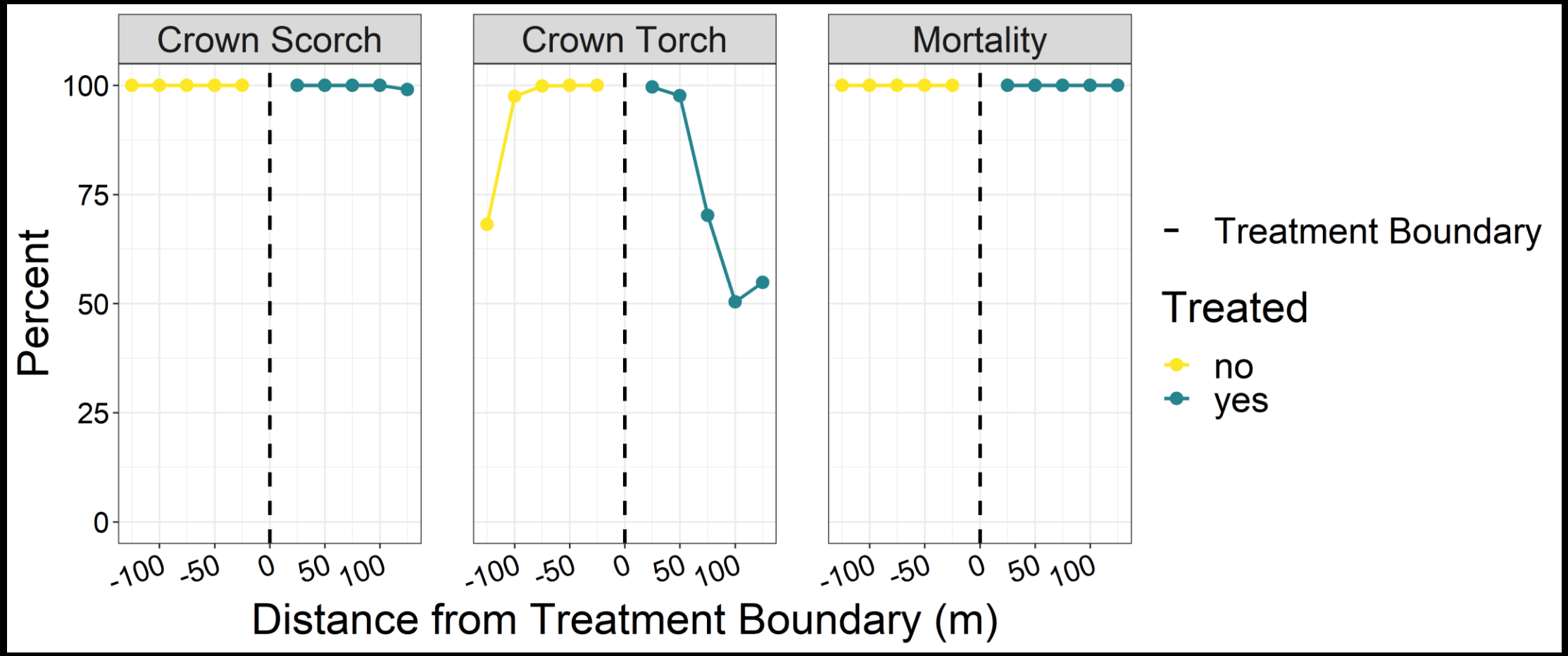
- 15, 225-m transects perpendicular to seven different pre-fire treatment units
- 10 plots spaced 25 m apart along each transect (150 plots total)
- Estimated fire severity metrics for the four trees nearest plot center

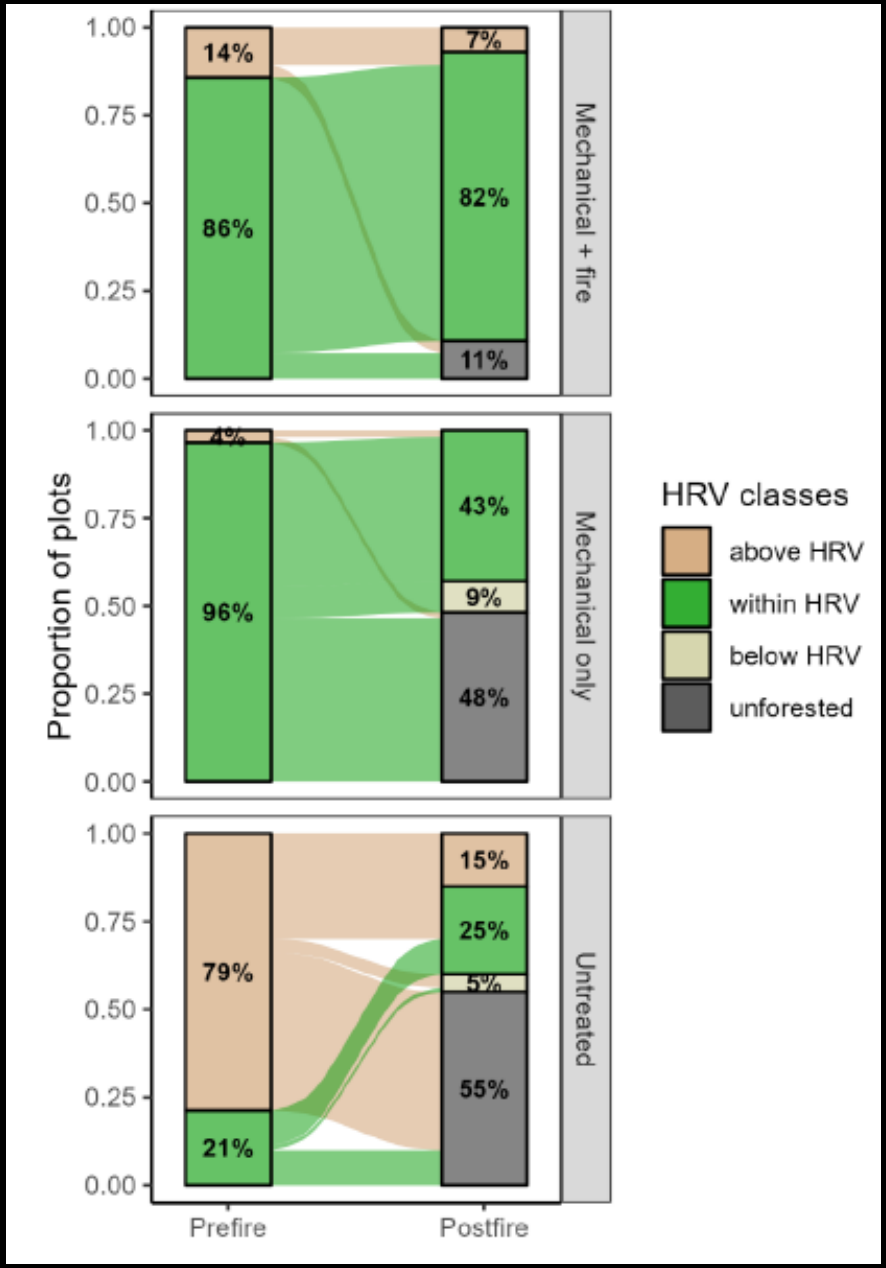
Pre-fire fuel treatments reduced fire severity within treatment areas, as measured by crown scorch, crown torch, and initial tree mortality



Fire severity tended to decrease with distance from the treatment boundary

While treatments typically reduced fire severity, some treatments had little effect on fire severity





2021 Dixie Fire Fuel Treatment Effectiveness

- 86% of mechanical + fire sites were within HRV for tree density prior to the fire, and 82% remained within HRV post-fire
- 96% of mechanical only sites were within HRV prior to the fire, but only 43% post-fire…48% were unforested post-fire!
- 79% of untreated sites were above HRV pre-fire…55% were unforested post-fie

Figure: Kristen Shive et al. (In Review)

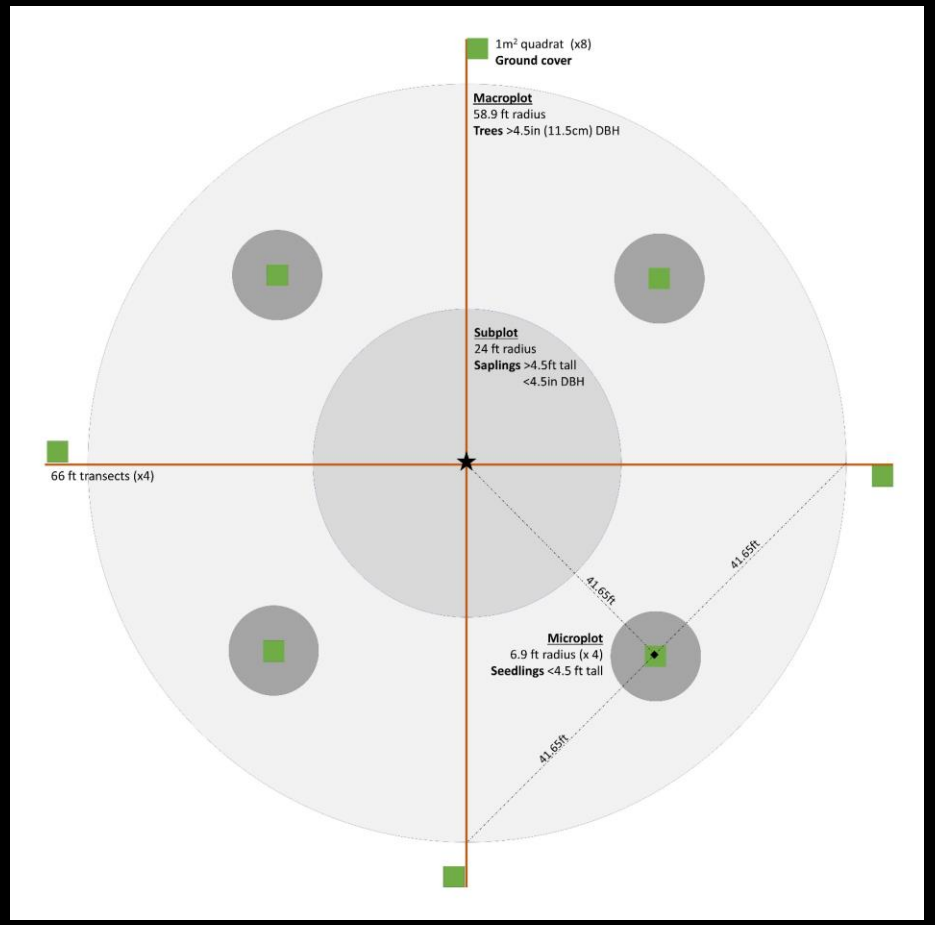
Post-fire Regeneration on the Tamarack Fire

Photo: Rosa Kirk-Davidoff

Tamarack Sampling Crew

- Collaboration between HTNF and the Rocky Mountain Research Station (Dr. Stephanie Yelenik)

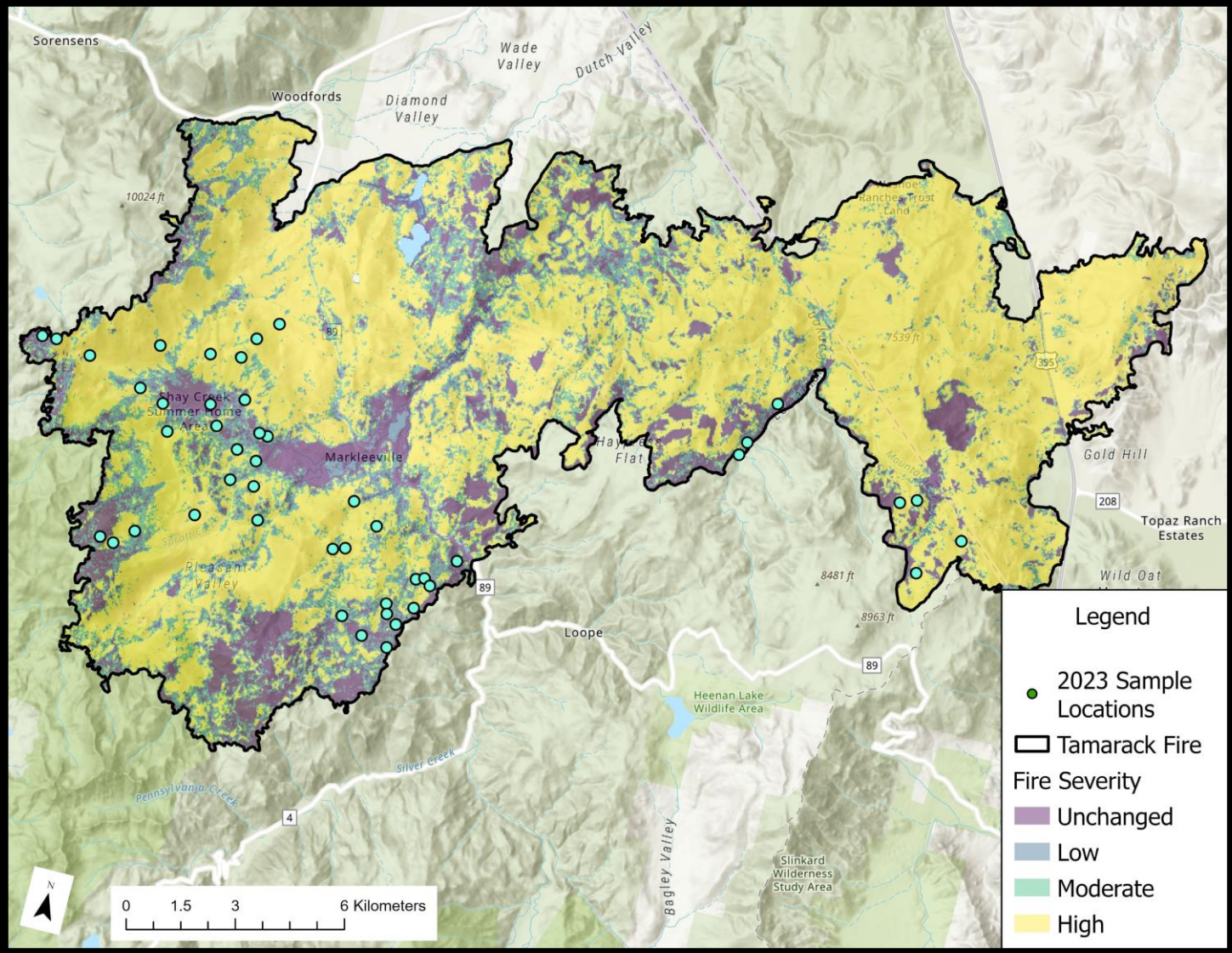
CALM (Climate-smart Approach to Landscape-scale Monitoring) Protocol



- Angela White (USFS – PSW), Morris Johnson (USFS – PNW)
- Comprehensive Sampling of:
  - Trees, saplings, seedlings
  - Shrub cover
  - Fuel loading
  - Canopy cover
  - Understory plant community
  - Non-native plant species
  - Photos

2023 Sampling Locations

- 48 plots in yellow pine-mixed conifer forest
- Randomly stratified across fire severity types
- All plots on Forest Service Land
- Constrains on sampling locations due to accessibility



Research Questions

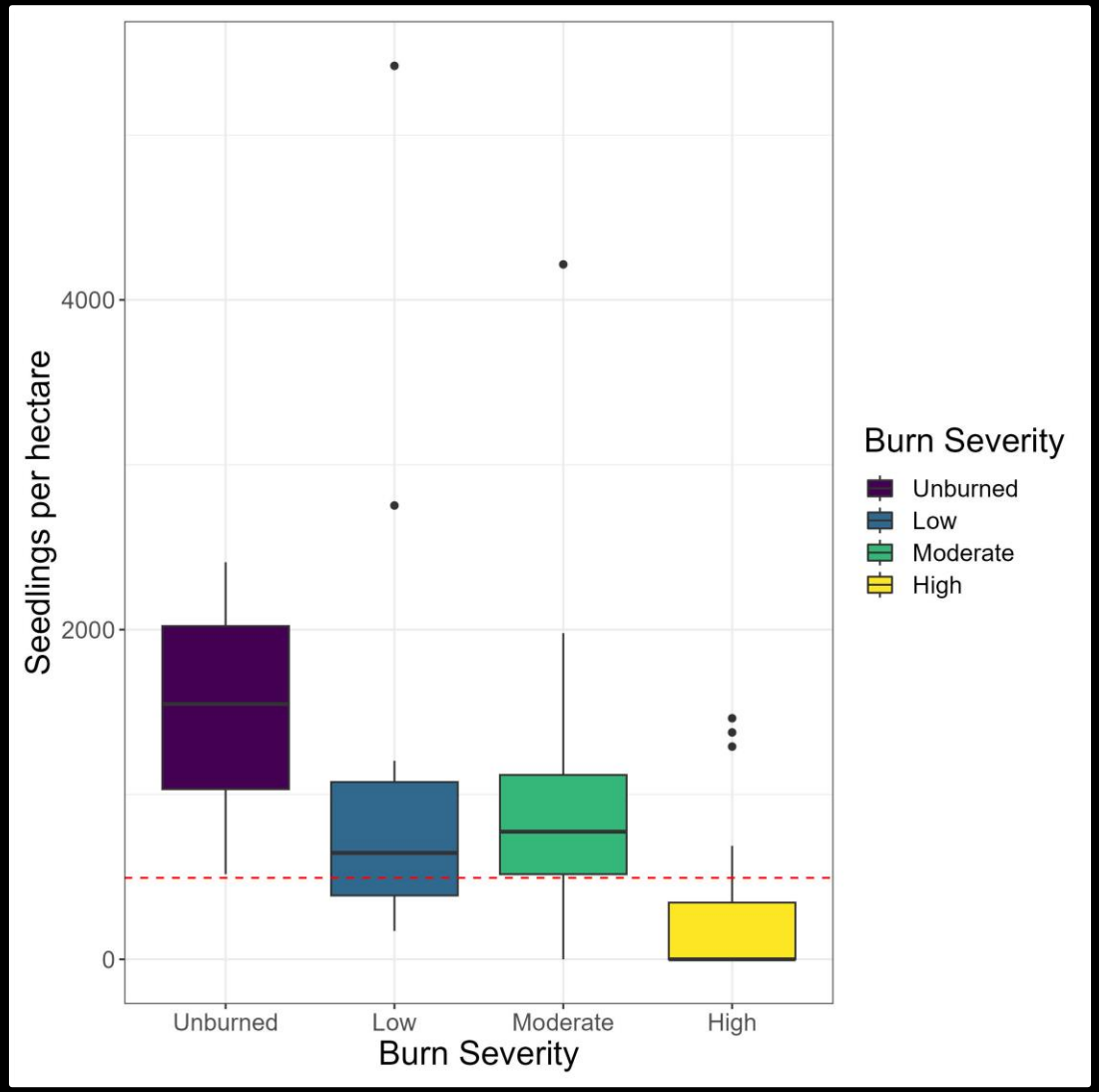
- What were patterns of severity across vegetation types?
- What are patterns of conifer regeneration?
  - How does tree regen relate to fire severity?
  - How does tree regeneration relate to available seed sources?
  - How does tree regen relate to microsite and shrub cover?

Photo: Rosa Kirk-Davidoff

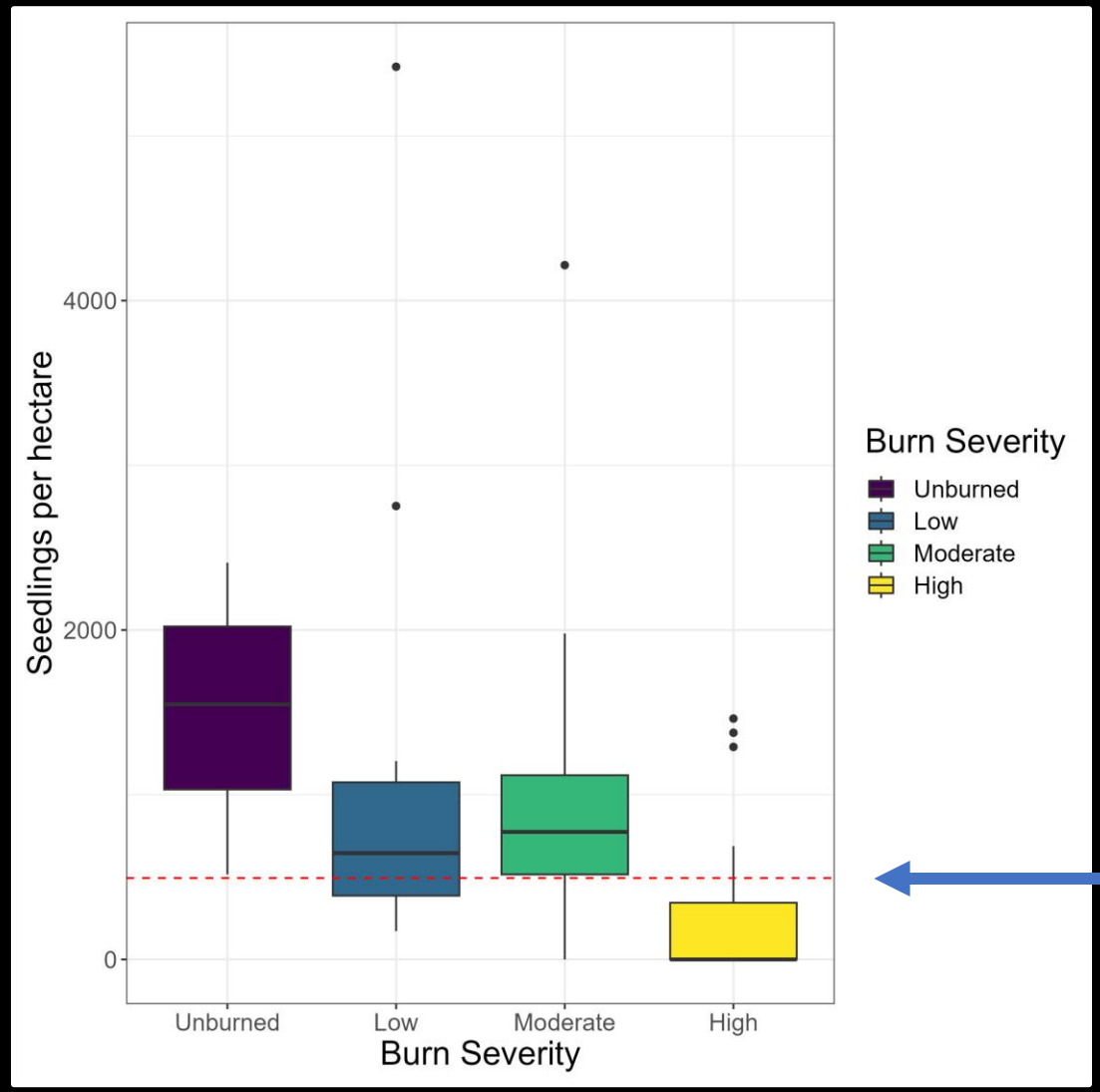
Preliminary Resutls

- 17/48 of our “microplots” did not have any seedlings
  - 15 of these were “high” severity; 2 were “moderate” severity
- We also counted seedlings across the entire 20m radius plot – only 5/48 plots lacked seedlings when counted at this scale
  - All 5 plots without seedlings were in “high’ severity plots

Increased natural regeneration associated with lower fire severity



Increased natural regeneration associated with lower fire severity



Forest Service Stocking Standard:

494 seedlings/ha

(200 seedlings/acre)

Local-scale factors driving seedling survival

- Effort led by UNR Masters student, Rosa Kirk-Davidoff
- Individually tagged up to 12 seedlings per plot in 2023
- Will revisit in 2024 (and 2025?) to assess seedling survival and growth
- How does seedling survival and growth relate to:
  - Shrub cover
  - Canopy cover
  - Microtopography
  - Litter depth
  - Tree composition at the macroscale

Next steps: Eastern Sierra Nevada Yellow Pine Regeneration - CAL FIRE Funded Project

- *Where do we see forest -> shrubland type conversion?*
- *Under what conditions does conifer regeneration fail?*
- *Where will planting be successful?*
  - Stephanie Yelenik, Ali Paulson, Marc Meyer, Malcolm North, Ali Urza, Jeanne Chambers, Beth Leger
  - Conifer seedling surveys in fires 2-10 years old across Eastern Sierra
  - Resurvey 576 tagged seedlings in Tamarack for survivorship/growth in relation to microhabitat
  - Shrub removal experiments in Tamarack fire

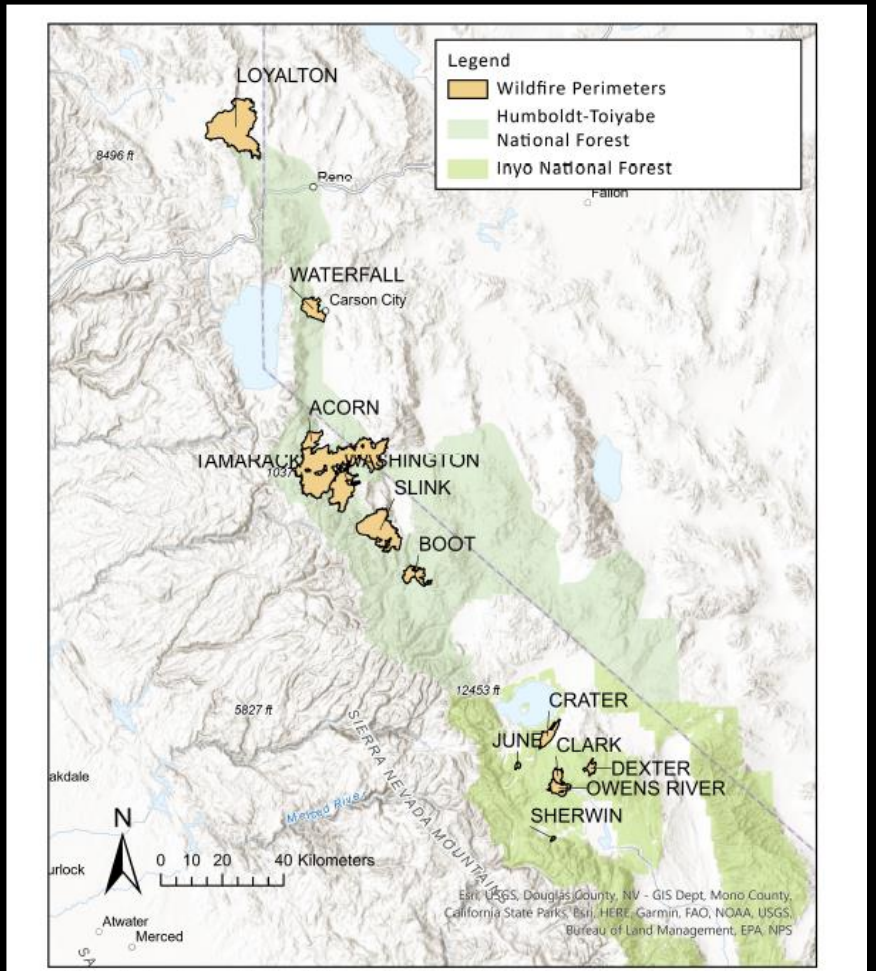


Figure 1: Locations of study wildfires on the Humboldt-Toiyabe and Inyo National Forests: Acorn (1987), Boot (2018), Clark (2016), Crater (2001), Dexter (2003), June (2007), Loyalton (2020), Owens River (2016), Sherwin (2008), Slink (2020), Tamarack (2021), Washington (2015), and Waterfall (2004).

Washington Fire – 76 seedlings yesterday!

Photo: Stephanie Yelenik

Summary

- The Post-fire Restoration Framework for National Forest in California can be used to highlight restoration opportunities following wildfire

Summary

- The Post-fire Restoration Framework for National Forest in California can be used to highlight restoration opportunities following wildfire
- The Tamarack fire burned outside the historic range of variability – far more large, high-severity patches than occurred historically

Summary

- The Post-fire Restoration Framework for National Forest in California can be used to highlight restoration opportunities following wildfire
- The Tamarack fire burned outside the historic range of variability – far more large, high-severity patches than occurred historically
- Fuel treatments from 10-15 years before the Tamarack fire helped to moderate fire severity in terms of tree mortality, scorching, and torching

Summary

- The Post-fire Restoration Framework for National Forest in California can be used to highlight restoration opportunities following wildfire
- The Tamarack fire burned outside the historic range of variability – far more large, high-severity patches than occurred historically
- Fuel treatments from 10-15 years before the Tamarack fire helped to moderate fire severity in terms of tree mortality, scorching, and torching
- We are seeing strong natural regeneration on lower-severity sites, but lower regen on high severity sites

Summary

- The Post-fire Restoration Framework for National Forest in California can be used to highlight restoration opportunities following wildfire
- The Tamarack fire burned outside the historic range of variability – far more large, high-severity patches than occurred historically
- Fuel treatments from 10-15 years before the Tamarack fire helped to moderate fire severity in terms of tree mortality, scorching, and torching
- We are seeing strong natural regeneration on lower-severity sites, but lower regen on high severity sites
- Much more to come!

Thank you!

Ali Paulson
alison.Paulson@usda.gov
(775) 352-1227

Photo: Rosa Kirk-Davidoff