Influence of post-fire vegetation and fuels on fire severity patterns in reburns

Implications for restoration

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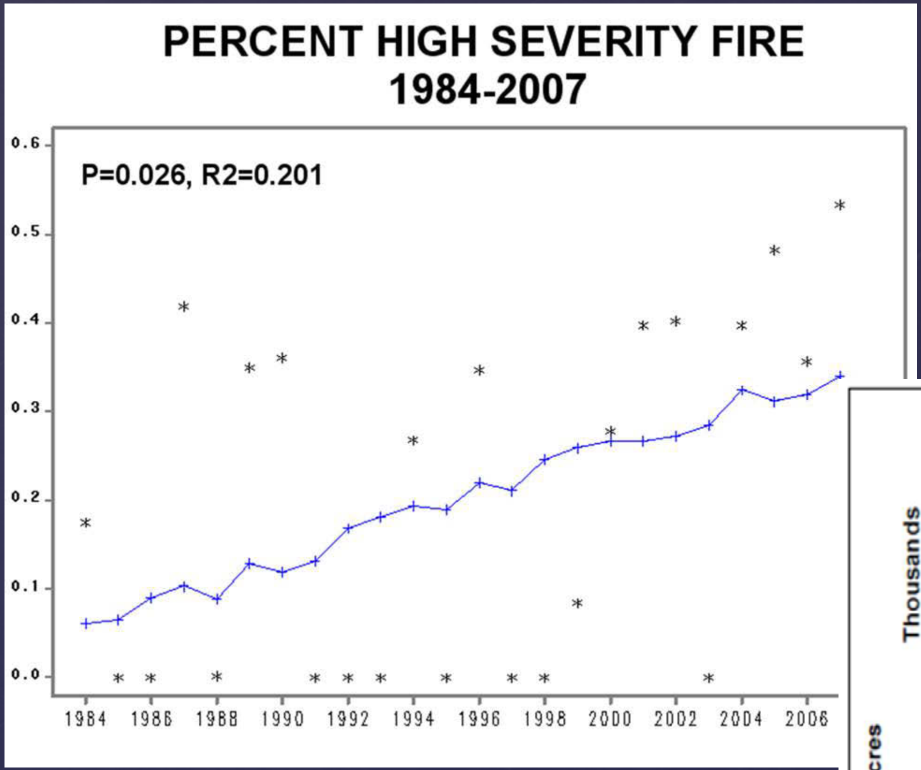
Wildfire-driven management

Before wildfire

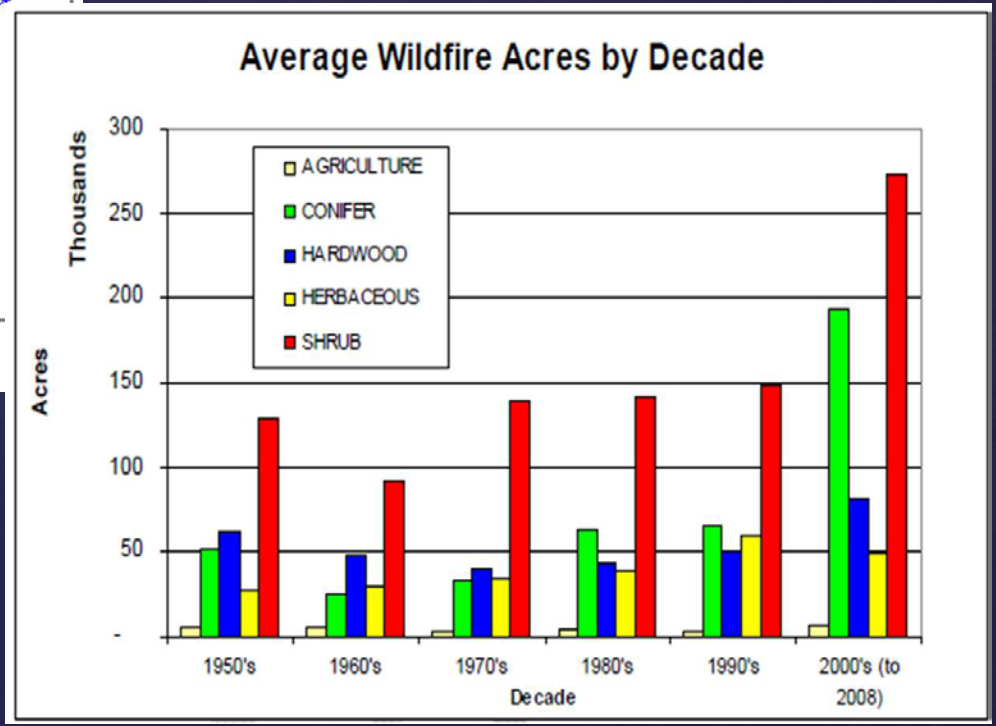
During wildfire

Wildfires across the Western US:



(HFQLG Project Area)

Increasing in size and severity



Shift to burned landscapes

2007 Moonlight Fire
(photo credit: Sierra Pacific Industries)

2007 Angora Fire
(photo credit: UC Cooperative Extension)

What does post-fire restoration look like?

K. Sable, USFS

UC Cooperative Extension

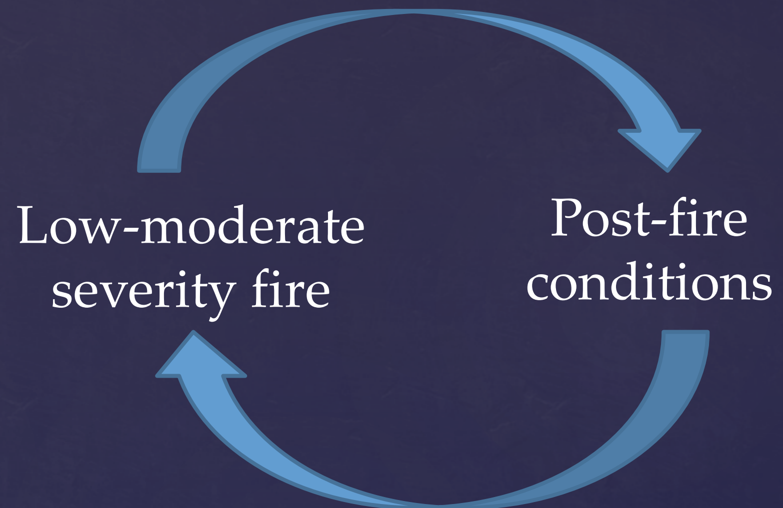
R Tompkins, USFS

UC Cooperative Extension

How do we increase resilience of burned landscapes to future fires?

Resilience of burned landscapes

Examples where wildfires may achieve restoration objectives



Fuel consumption

Intact overstory

(Collins et al. 2009, Lydersen and North 2012, Parks et al. 2014)

Altered landscapes

Fire suppression and past timber harvest

↓

altered forest structure and contemporary fire patterns

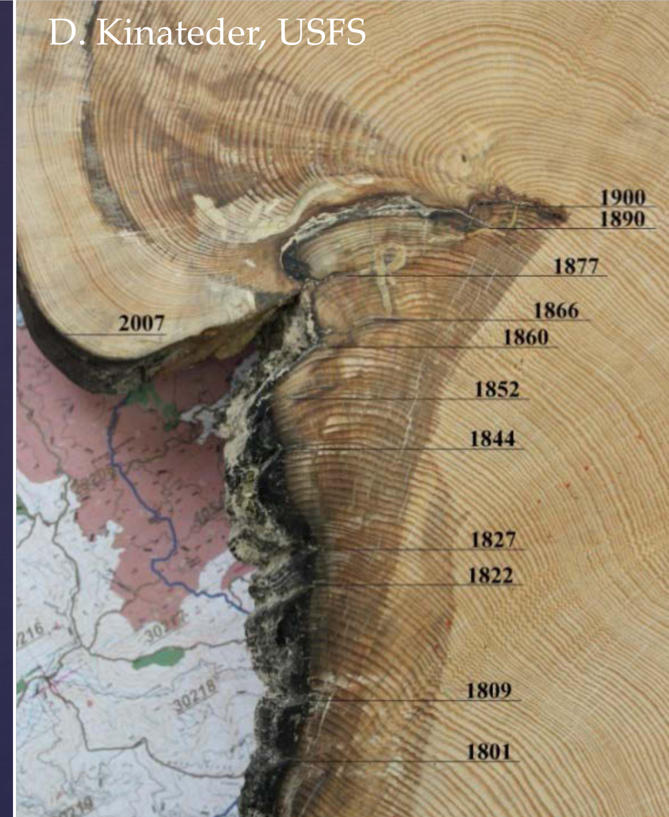
High severity fire

Post-fire conditions

?

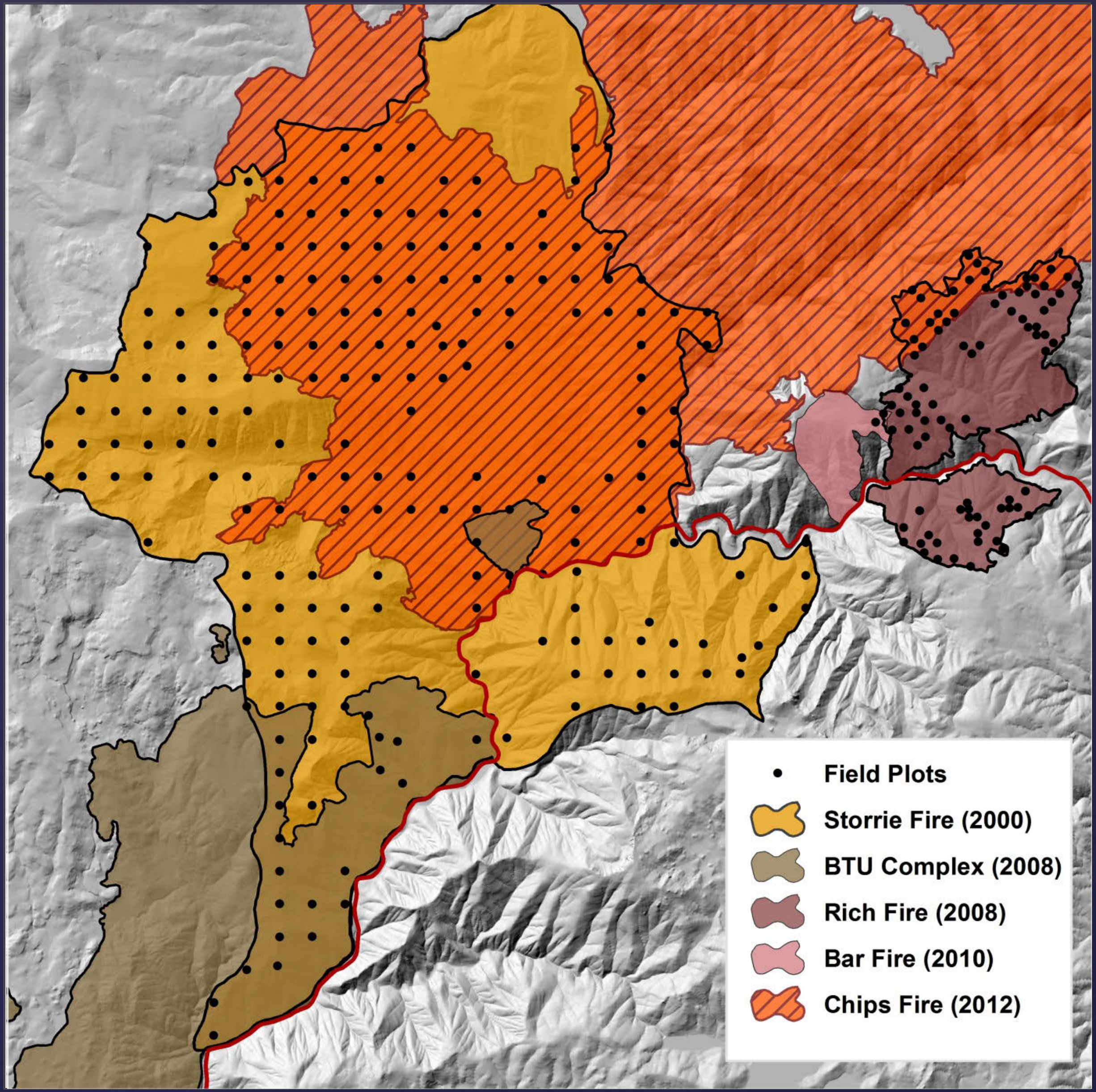
Surface fuels

Shrub response

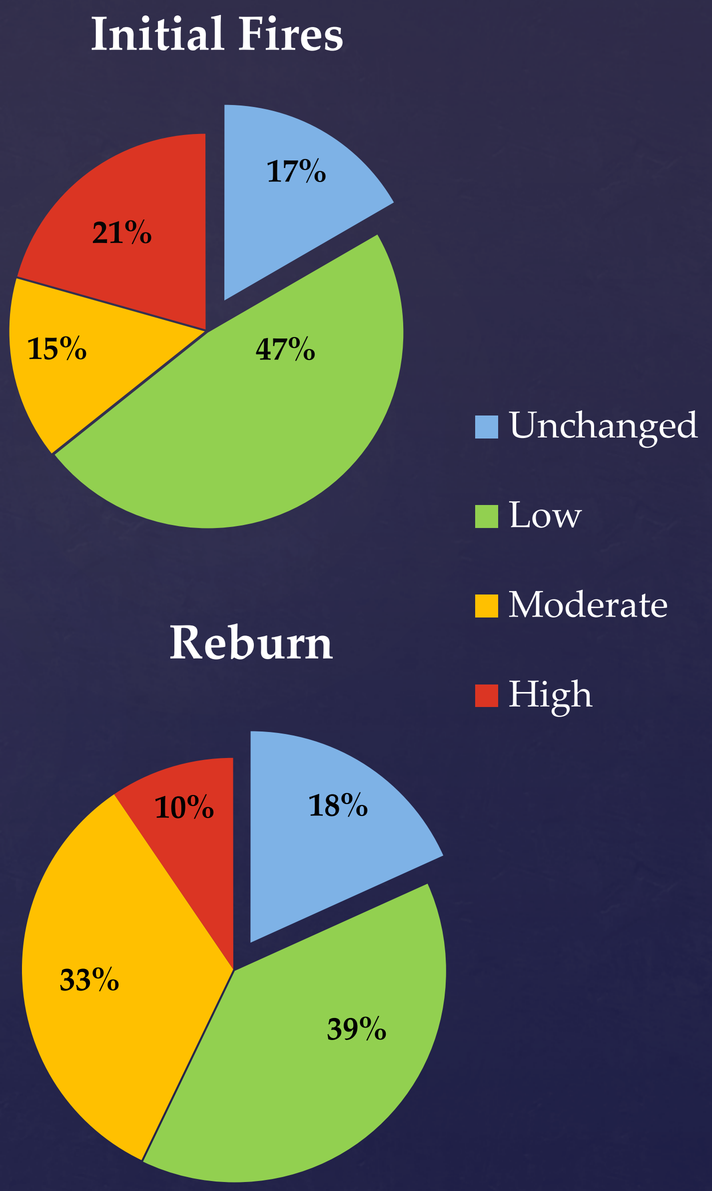


Study Area

- Four wildfires (2000-2010)
- Field plots (n=305)
- 2012 Chips Fire reburned 126 plots



Chips Fire: observations



Chips Fire: reburn observations

Places that initially burned at high severity reburned at high severity

After the 2000 Storrie Fire

After the 2012 Chips Fire

Questions

1) Did the severity of the initial fire and/or the amount of time between fires influence reburn severity? If so, how?

2) What were the important drivers of reburn severity? (vegetation, fuels, topography, fire weather…..)

Goal: identify characteristics that managers could target to create more fire resilient landscapes

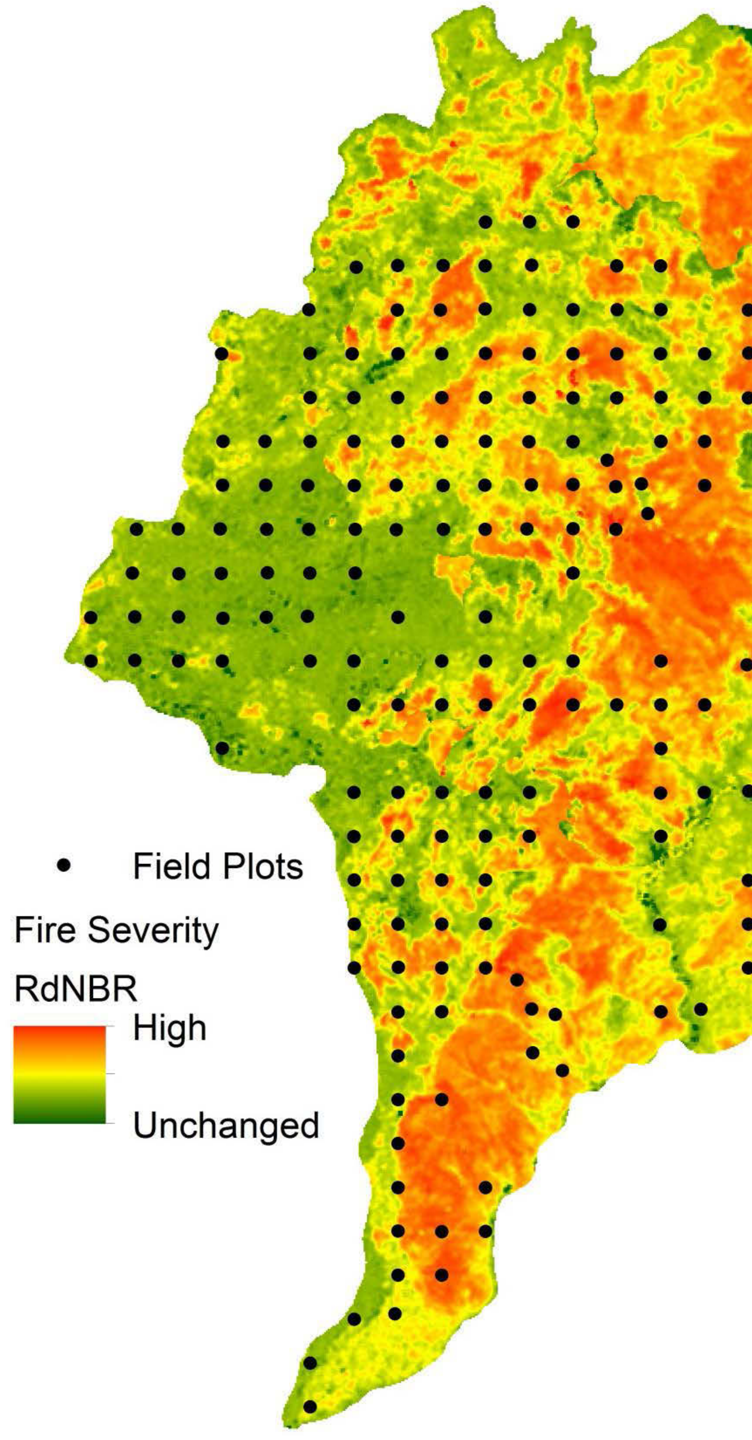
Fire Severity

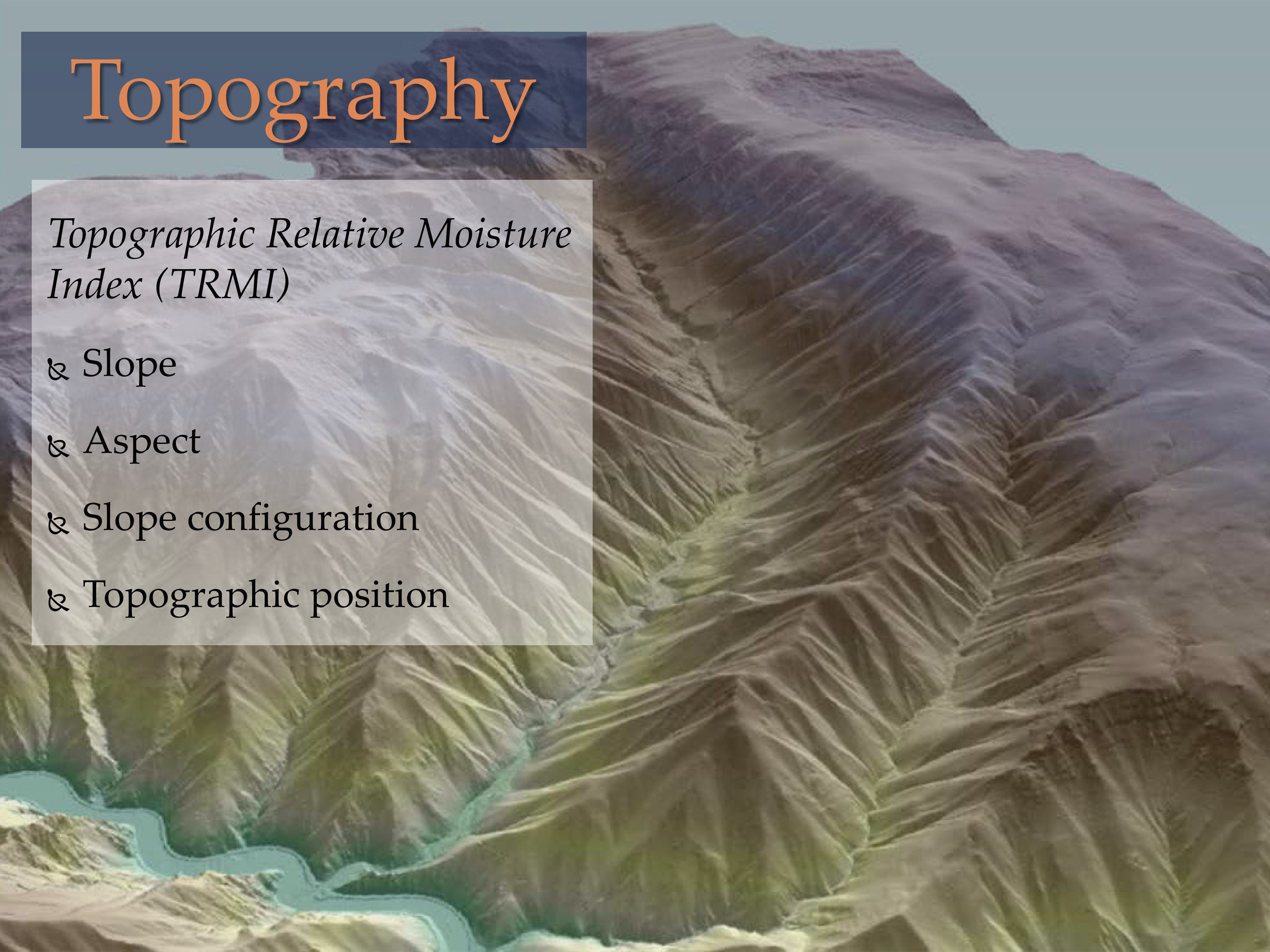
Relative differenced Normalized Burn Ratio (RdNBR)

- Remote sensing datasets (Landsat Imagery)
- Measure changes in vegetation, soil, litter, etc. 1 year after containment

Severity	RdNBR values
High	≥ 641
Moderate	316-640
Low	69-315
Unchanged	< 69

From Miller and Thode 2007





Topography

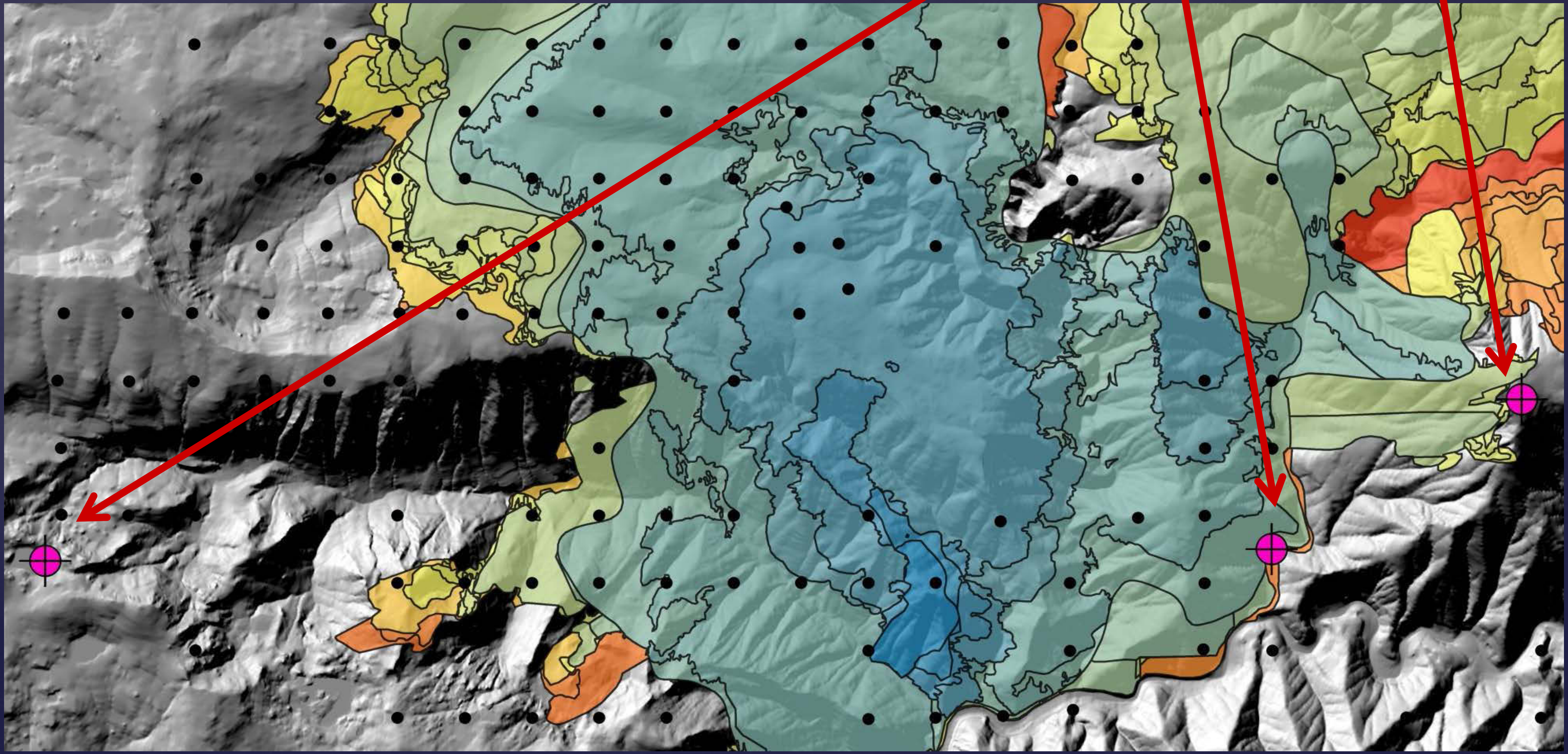
Topographic Relative Moisture Index (TRMI)

- Slope
- Aspect
- Slope configuration
- Topographic position

Fire weather

Remote Automated Weather Stations (RAWs)

- Temperature
- Relative humidity
- Wind speed

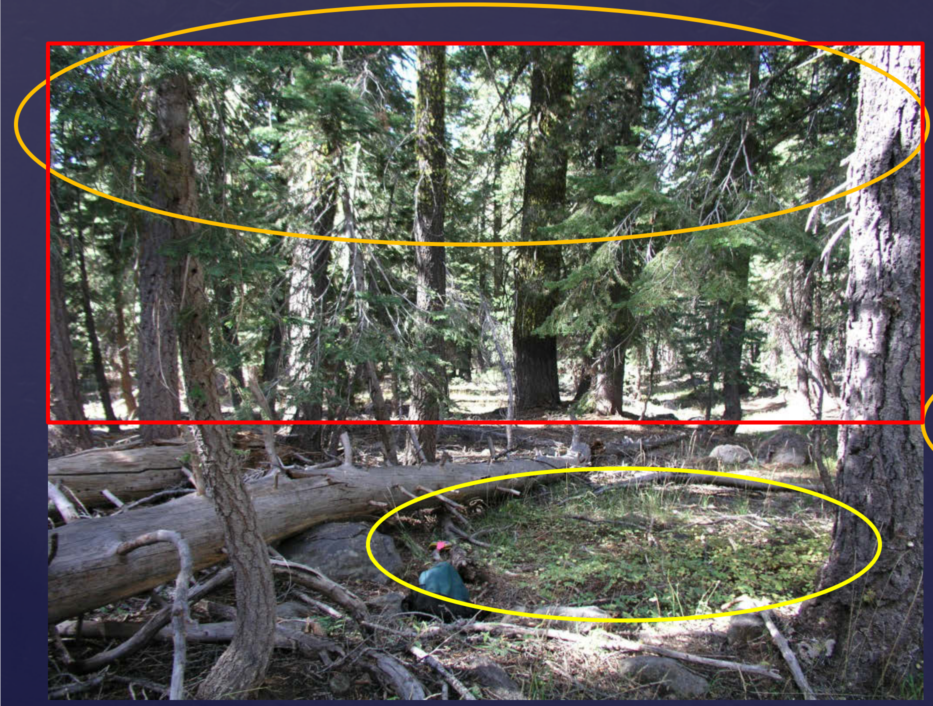


Management Activities

- 19 plots (15%) treated *after* data collection
  - Planting
  - Chipping, piling, and burning of fuels

Field Data – Vegetation and fuels

- Overstory Canopy Cover
- Shrub Cover
- Understory Cover
- Live tree density and basal area
- Snag density and basal area



Ecology CSE Plots

Surface Fuels

- Fine woody debris
- Coarse woody debris (sound and rotten)
- Duff depth

Ground Cover

- Bare ground
- Vegetation
- Rock
- Litter
- Wood

Assembled 22 predictor variables for each plot

Vegetation

Tree, shrub, understory cover (%)

Live and dead tree density (ha^{-1})

Live and dead basal area (m^2 ha^{-1})

Dead and down fuels

Total fine woody debris (Mg ha^{-1})

1000 hour sound/rotten fuels (Mg ha^{-1})

Duff (Mg ha^{-1})

Ground cover

Bare ground, rock, litter, wood, etc.

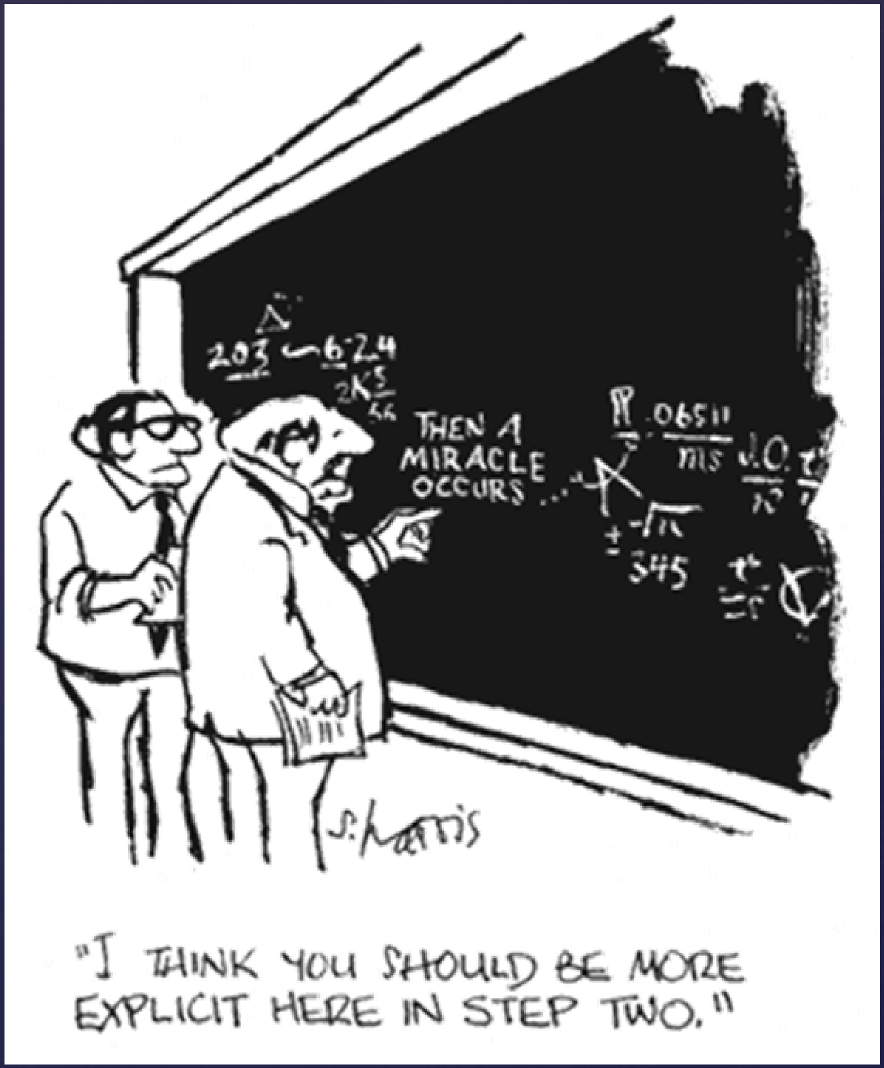
Topography

Topographic Relative Moisture Index (2 spatial scales)

Daily fire weather

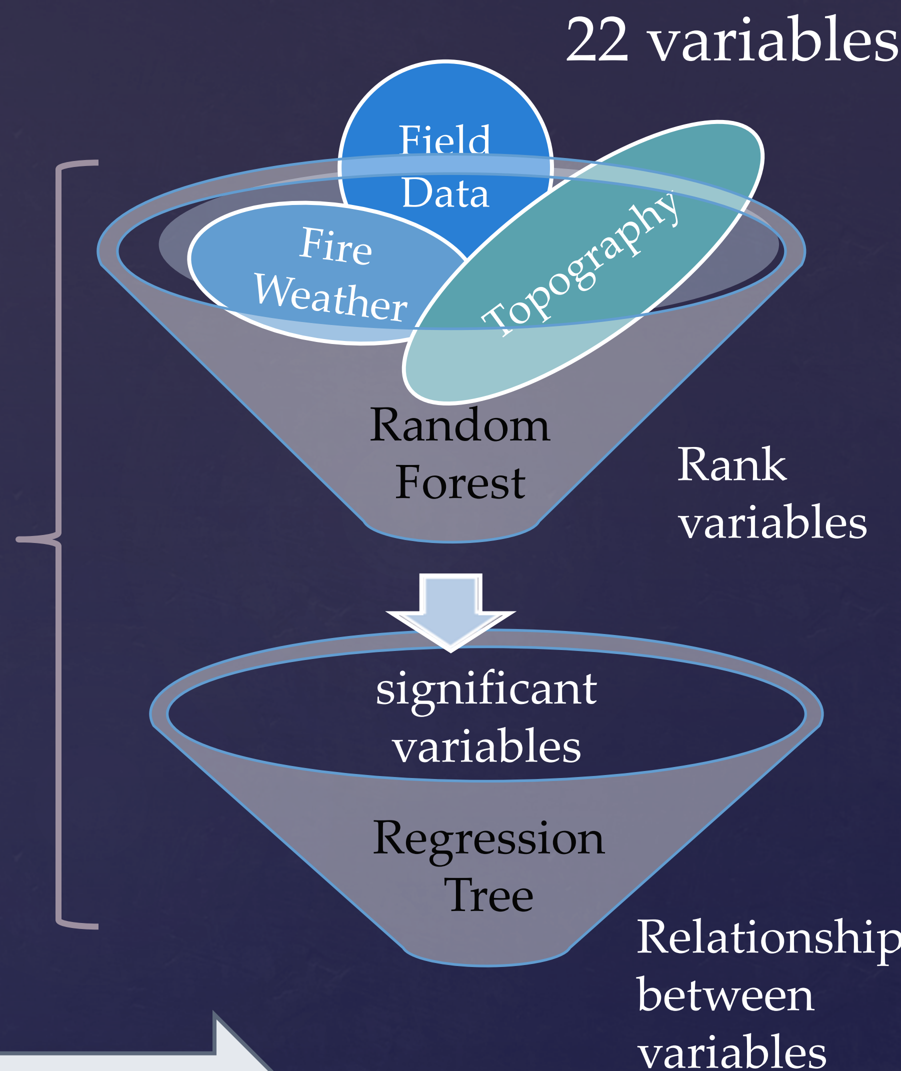
Temperature, humidity, wind speed

Management Activities



Analysis Approach

What is the effect of vegetation, fuels, topography, fire weather, and forest management on reburn severity?



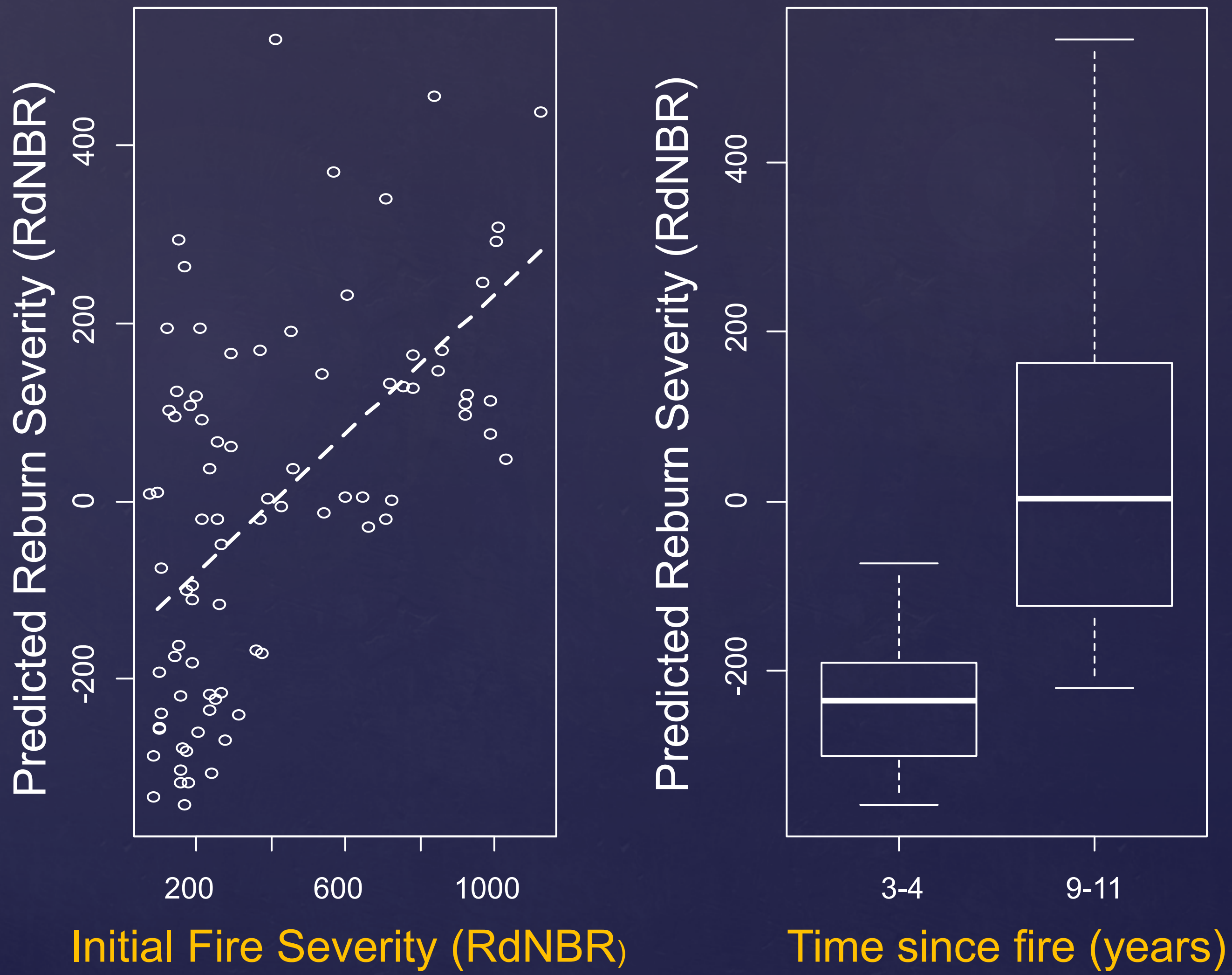
Initial Severity Question

Fire Severity

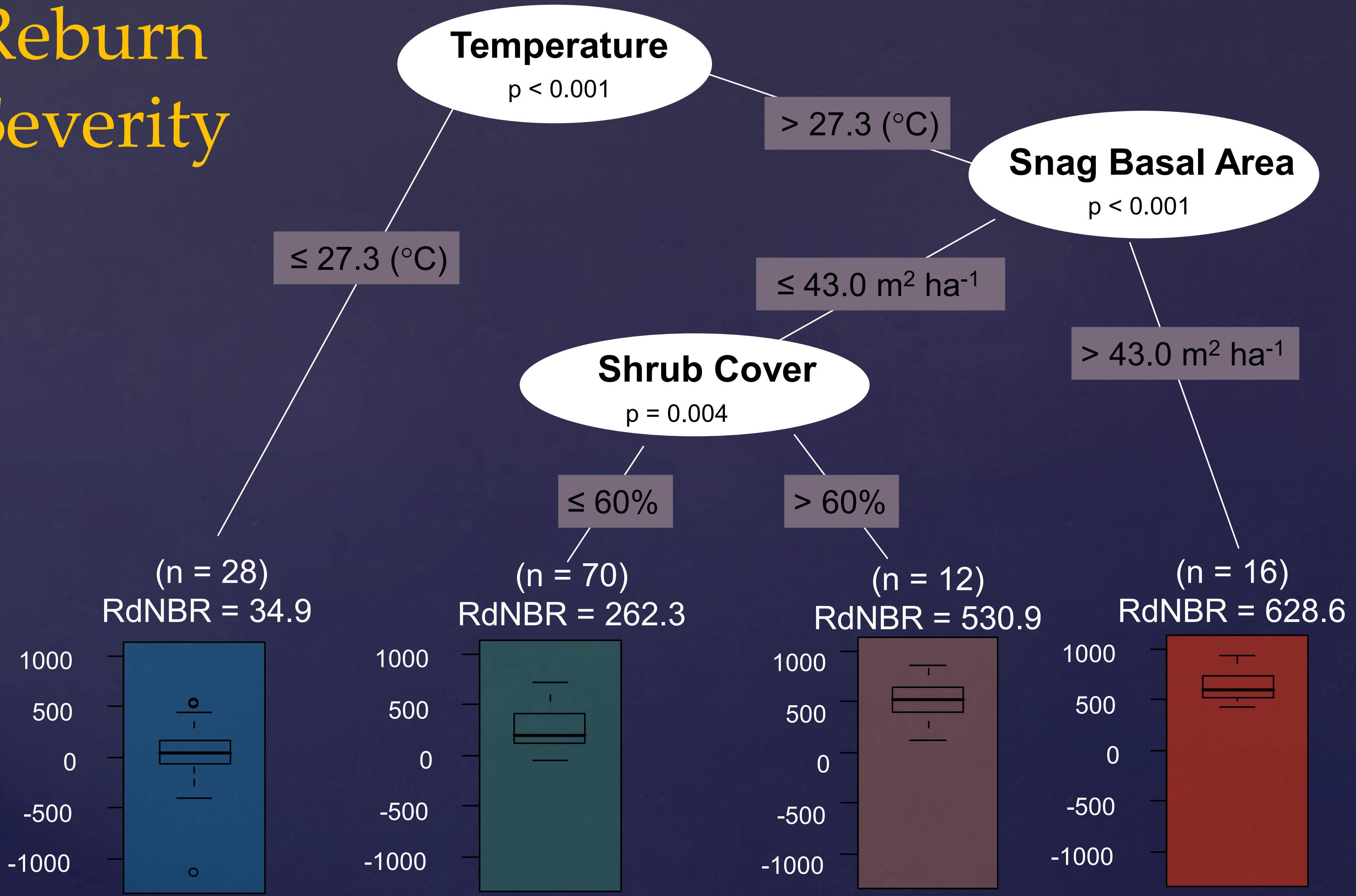
Regression

Important predictors of reburn severity

Initial Severity and Time Since Fire → Reburn Severity



Fire weather, snags, and shrubs → Reburn Severity

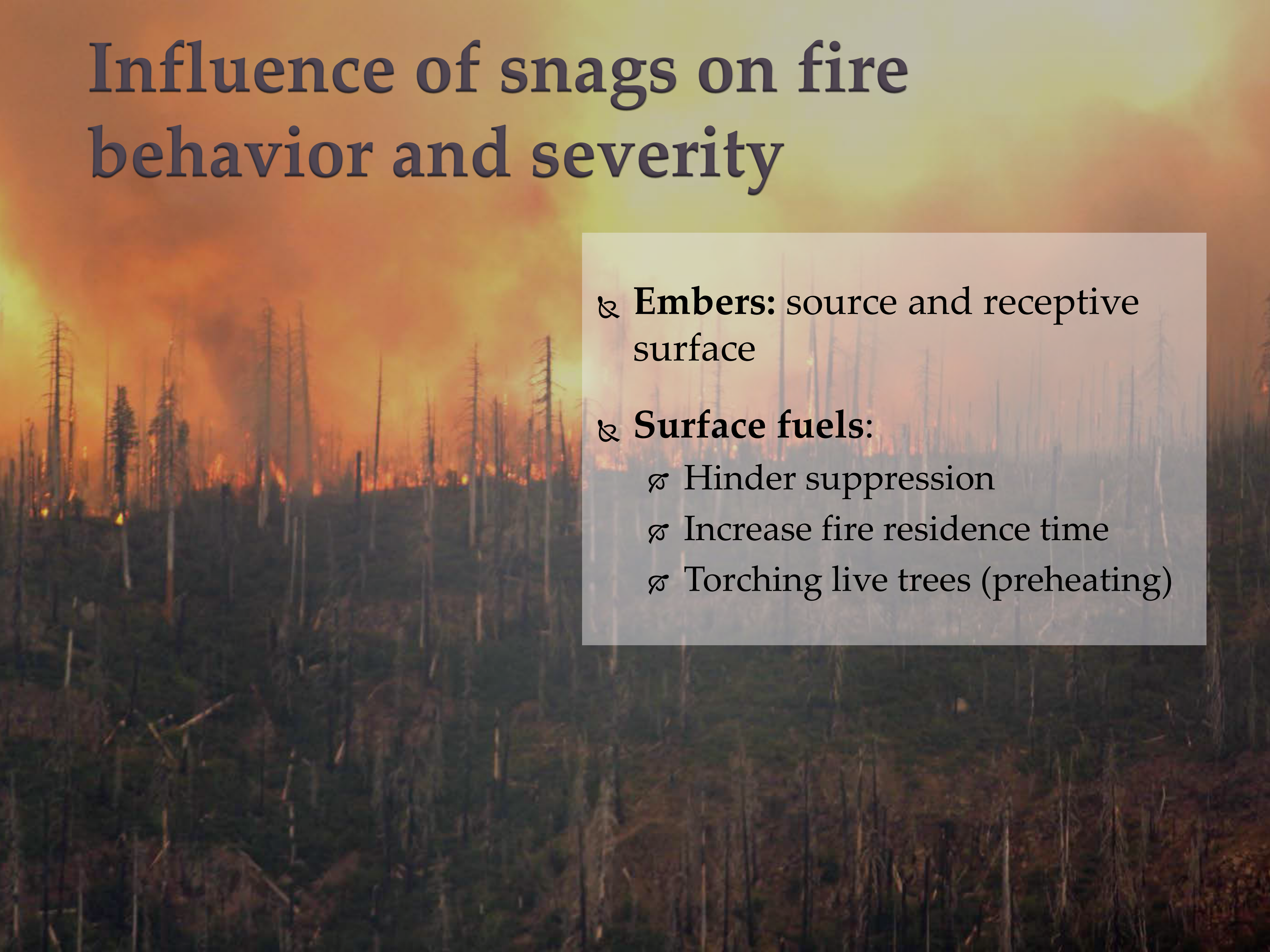


Fire weather

- Drying and preheating of fuels
- Moving moist air away from fuels
- Providing continuous flow of oxygen
- Blowing burning embers

Influence of snags on fire behavior and severity

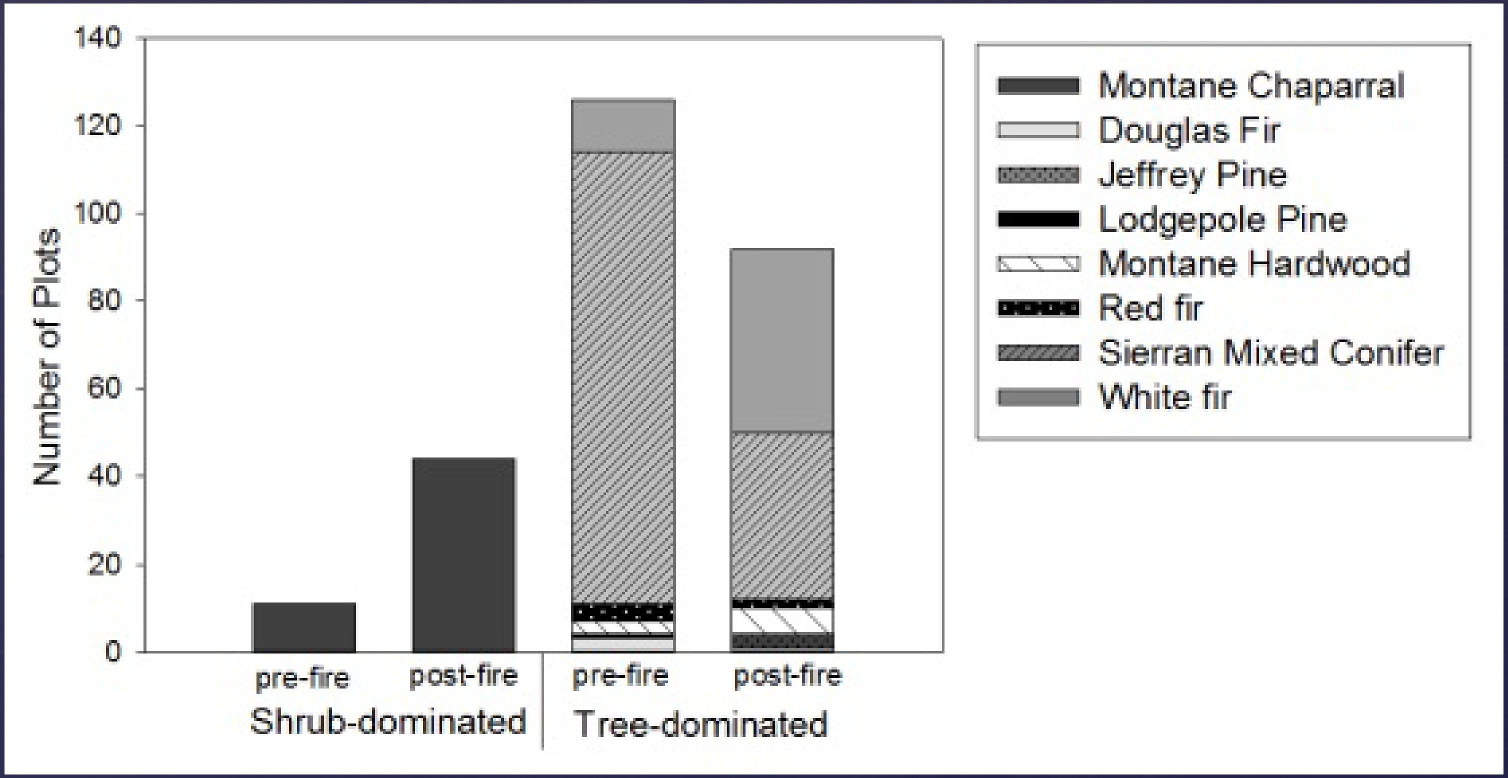
- **Embers:** source and receptive surface
- **Surface fuels**:
  - Hinder suppression
  - Increase fire residence time
  - Torching live trees (preheating)



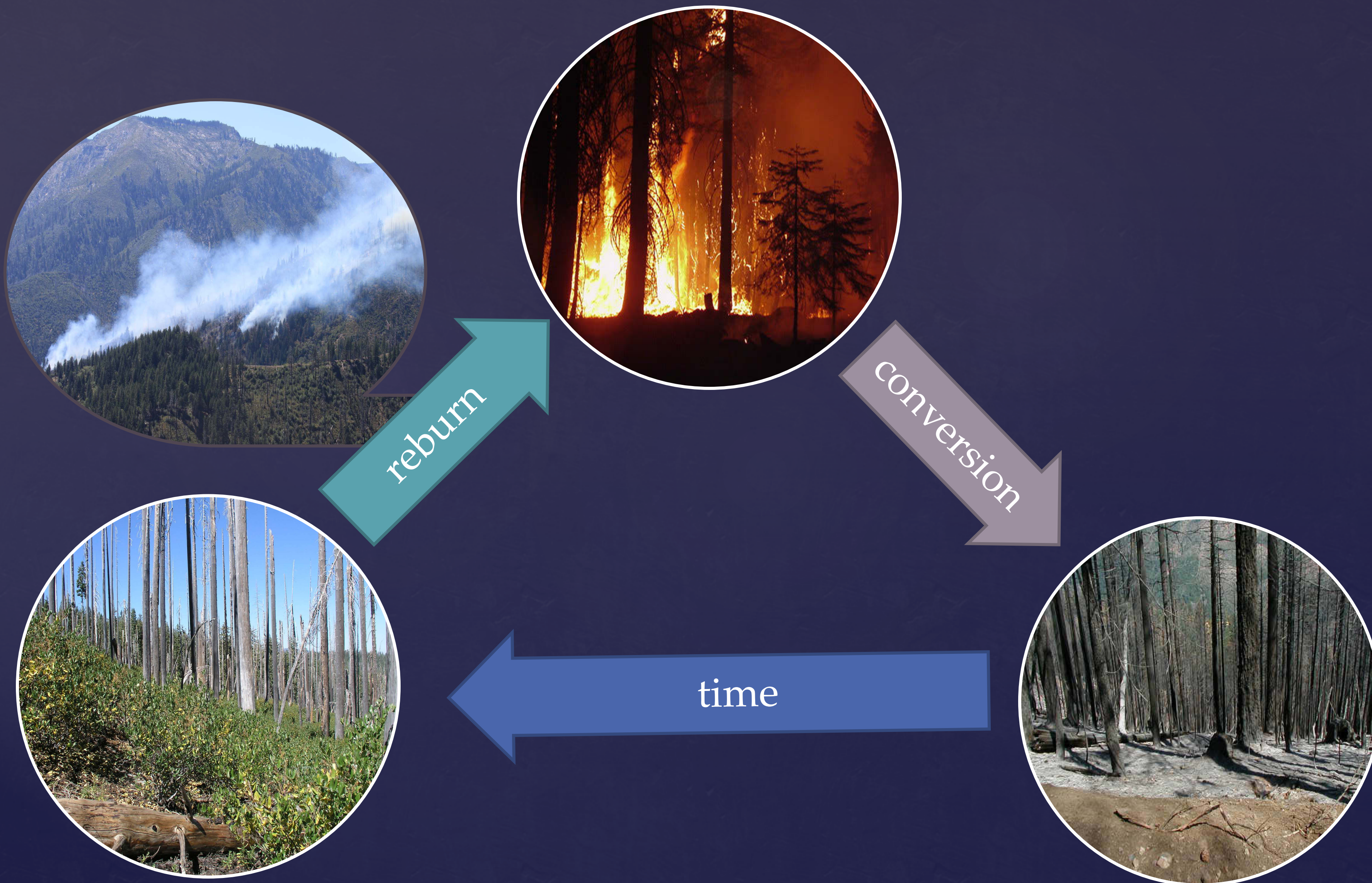
Shrubs and fire

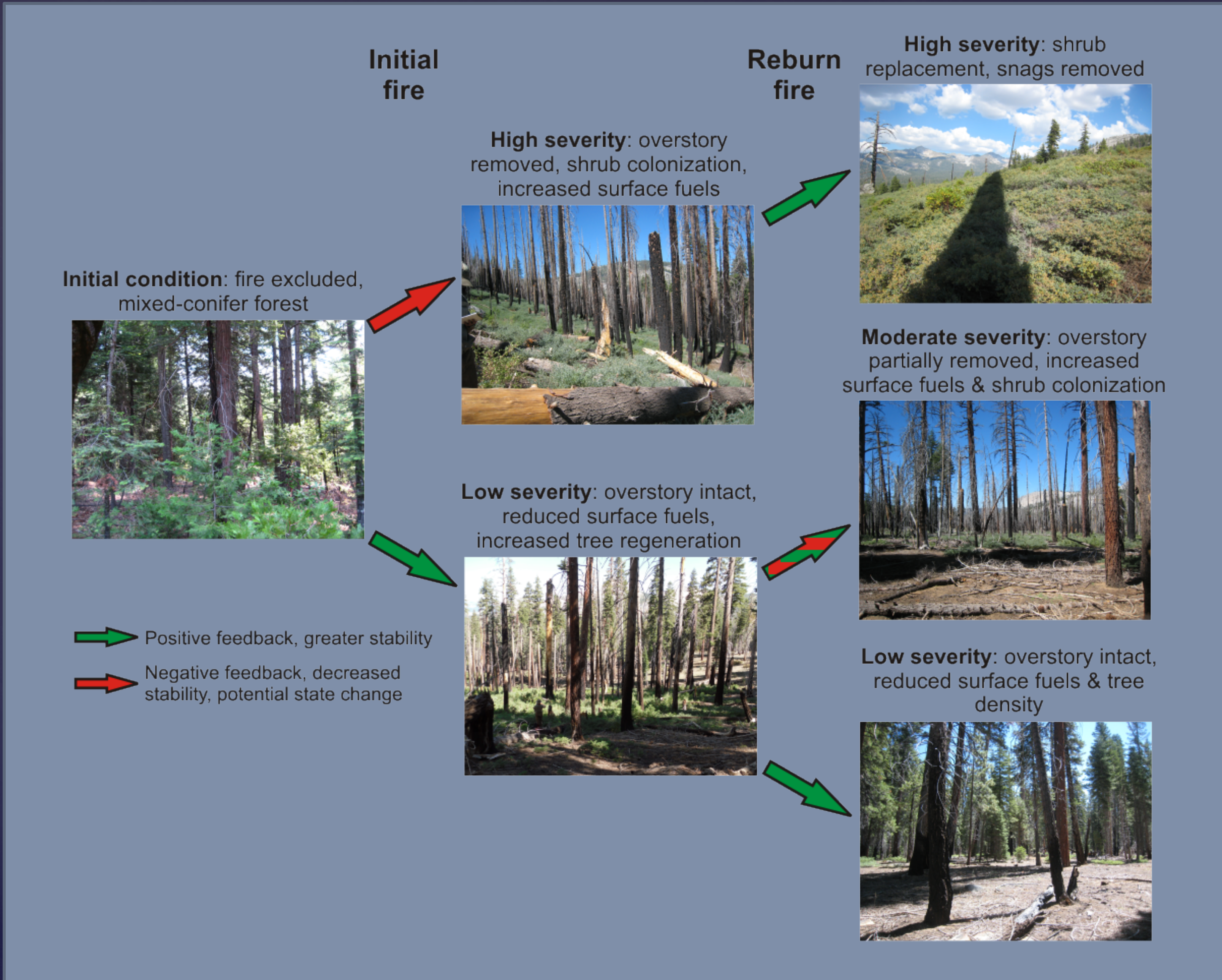
- Well documented relationship
- Over time: increase biomass and dead fuels = increase flammability
- Traits allow survival and persistence between high severity fire events

Initial fires: increased shrub vegetation; decreased live trees and increased snags



Trying to tie it all together…..




Initial fire
Reburn fire
Initial condition: fire excluded, mixed-conifer forest
High severity: overstory removed, shrub colonization, increased surface fuels
Low severity: overstory intact, reduced surface fuels, increased tree regeneration
High severity: shrub replacement, snags removed
Moderate severity: overstory partially removed, increased surface fuels & shrub colonization
Low severity: overstory intact, reduced surface fuels & tree density
Positive feedback, greater stability
Negative feedback, decreased stability, potential state change

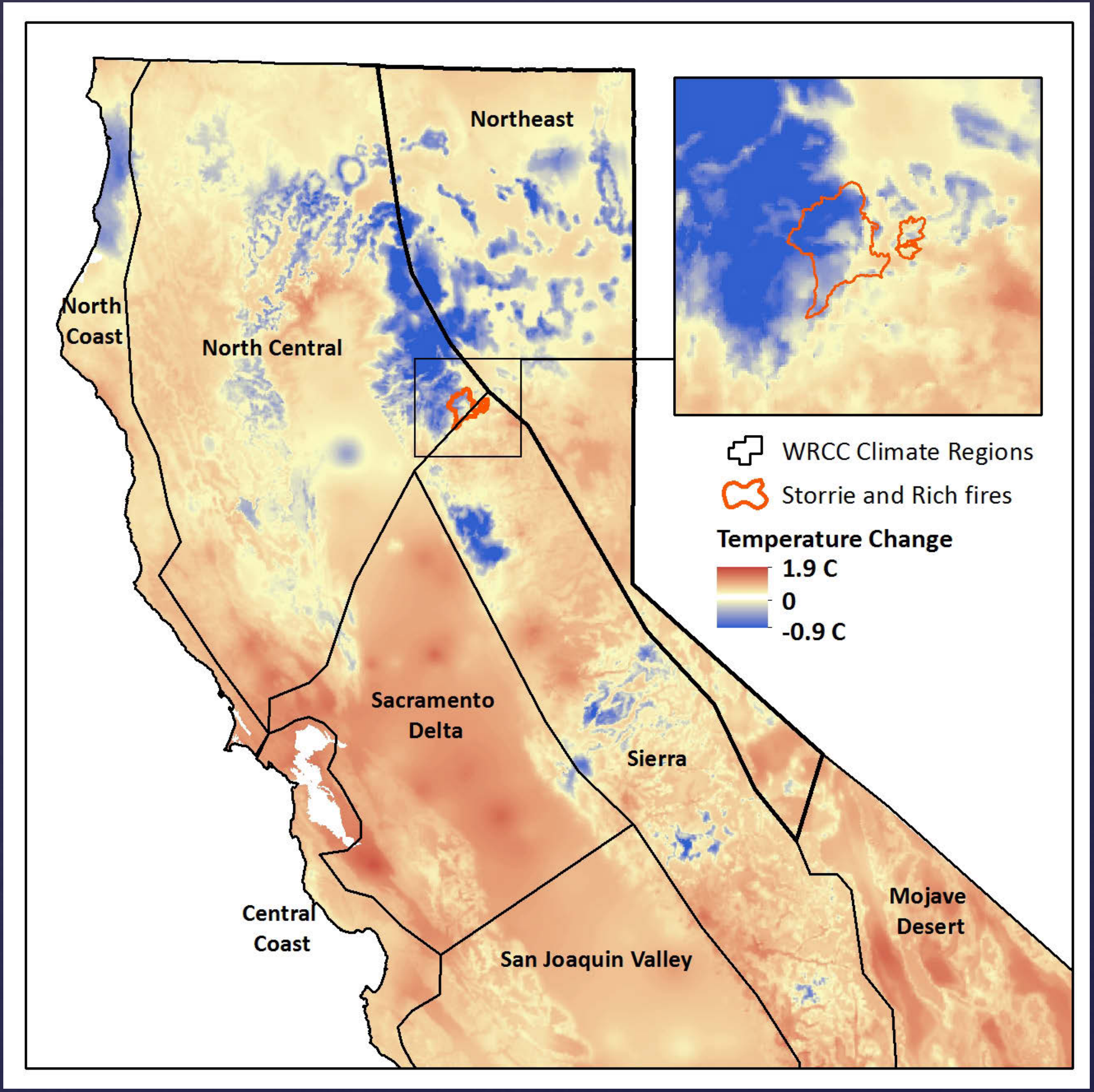
Management in the face of a changing climate

Temperature

- Influenced reburn severity
- Increasing over time

Vegetation and Fuels

- ALSO important drivers of fire severity
- Can be manipulated through management!



Mean annual temperature change (1930-2000); derived from the PRISM climate model

Implications for restoration

Snags and shrubs may influence fire severity, but that doesn't mean we should reduce them everywhere!

- Play an important ecological role
  - foraging and nesting
  - food resources
  - diverse and unique communities

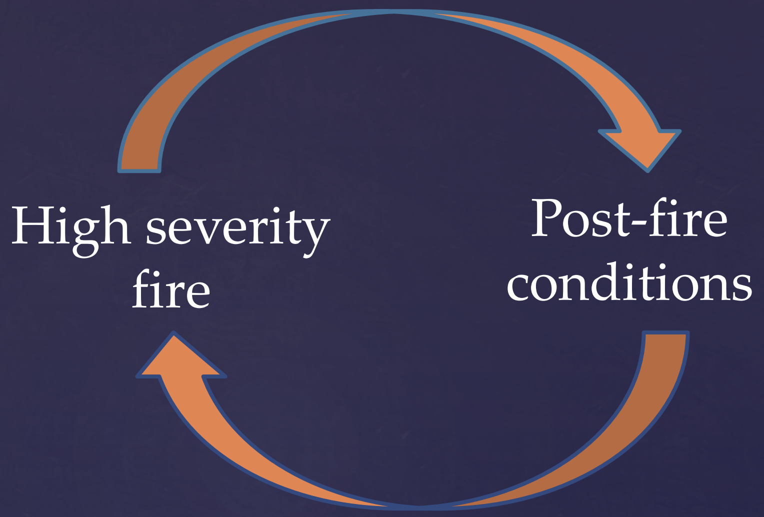
- Lacking in some landscapes

Species such as the Lazuli Bunting are abundant in post-fire landscapes

Implications for restoration

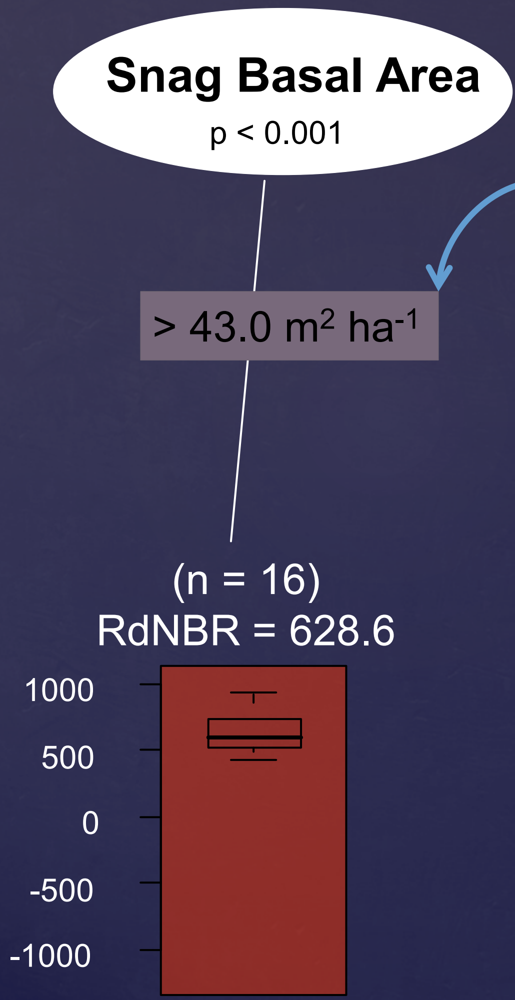
- Understand the role these factors play in reburn severity
- Design restoration activities so that future fires can **increase**, rather than reduce, **heterogeneity**

Conditions prior to the initial fires influenced reburn severity

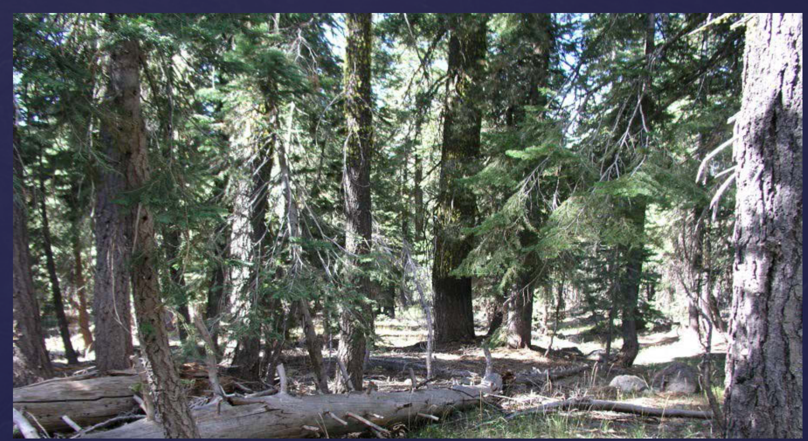


- < 15 % of landscape had burned in 100 years prior to 2000 Storrie Fire
- Dense stands of small trees, high fuel loads

Pre-fire conditions



Basal Area threshold used as indicator of unhealthy pine forest conditions



Clue to past conditions

Restoration considerations

Post-fire restoration begins in unburned forests!

- Reduce stand density → may reduce the density of post-fire snags and risk of high severity reburn.
- Moderate fire behavior BEFORE the first fire and the reburn

Once an area burns…

Identify areas with (undesirably) high densities of snags and shrub cover

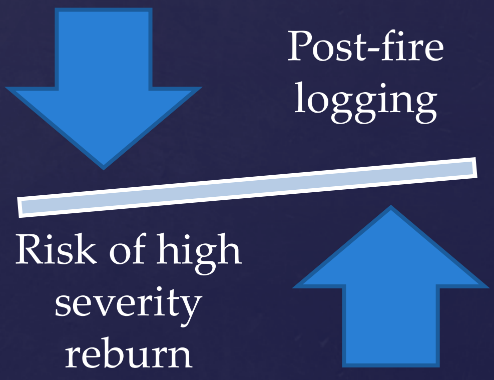
- Selective thinning
- Mastication
- Prescribed Fire
- Follow-up treatments to reduce surface fuels
  (i.e. broadcast burning; piling and burning)

Important considerations…….

- Potential negative impacts of post-fire logging vs. risk of future high severity fire

- Shift perspective from short-term (economic recovery) to long-term (fire resilience)
  - Smaller snags
  - Retention of species/structures for wildlife

- Passive Management



Summary

- Risk of future high severity fire may be higher in areas that have already burned at high to moderate severity, especially in areas that have a high density of standing snags and regenerating shrubs.
- This risk can be mitigated through management, both prior to and after an initial fire.
- Post-fire management actions should be tailored to fire severity and long-term management objectives, with a focus on enhancing resilience to future reburns
- *Results from our study suggest that fire may be reinforcing rather than restoring the altered conditions in the Sierra Nevada.*

Acknowledgements

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