

# Impact of Fire Refugia Pattern on Post-fire Forest Recovery in Oregon's Blue Mountains



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Hash Rock Fire, 2000  
Ochoco NF, Oregon

# Pre-settlement dry mixed-conifer forests in the Blue Mountains



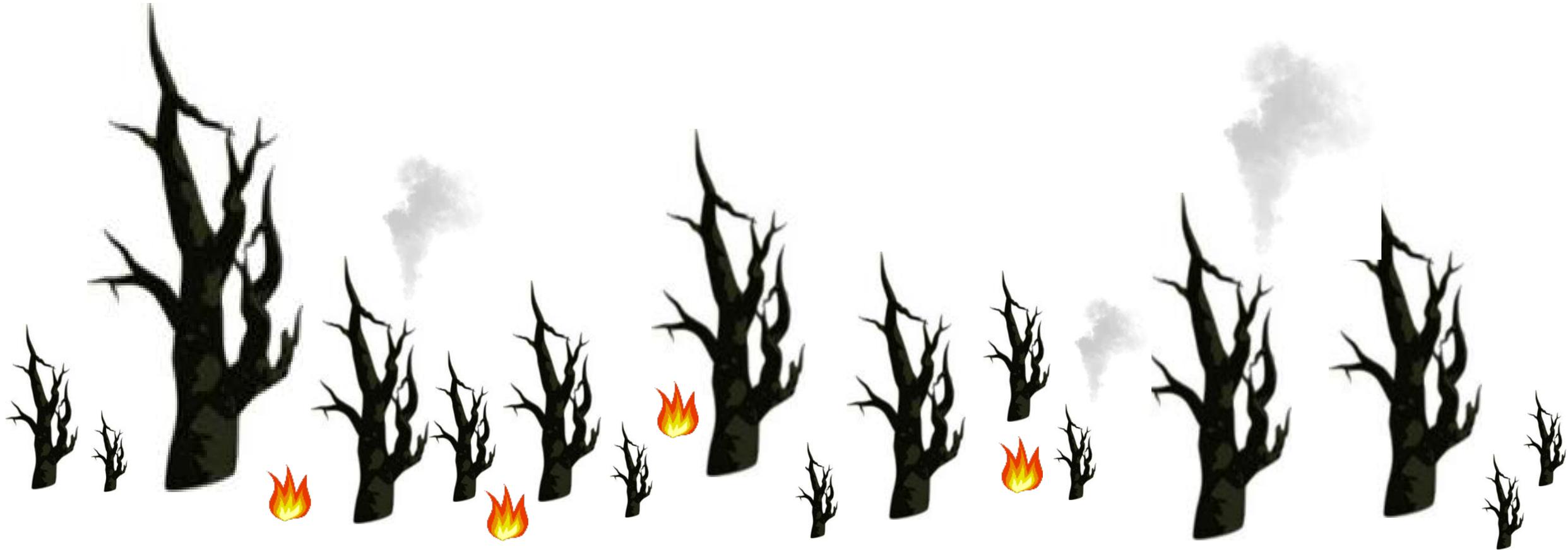
# Historical frequent fire



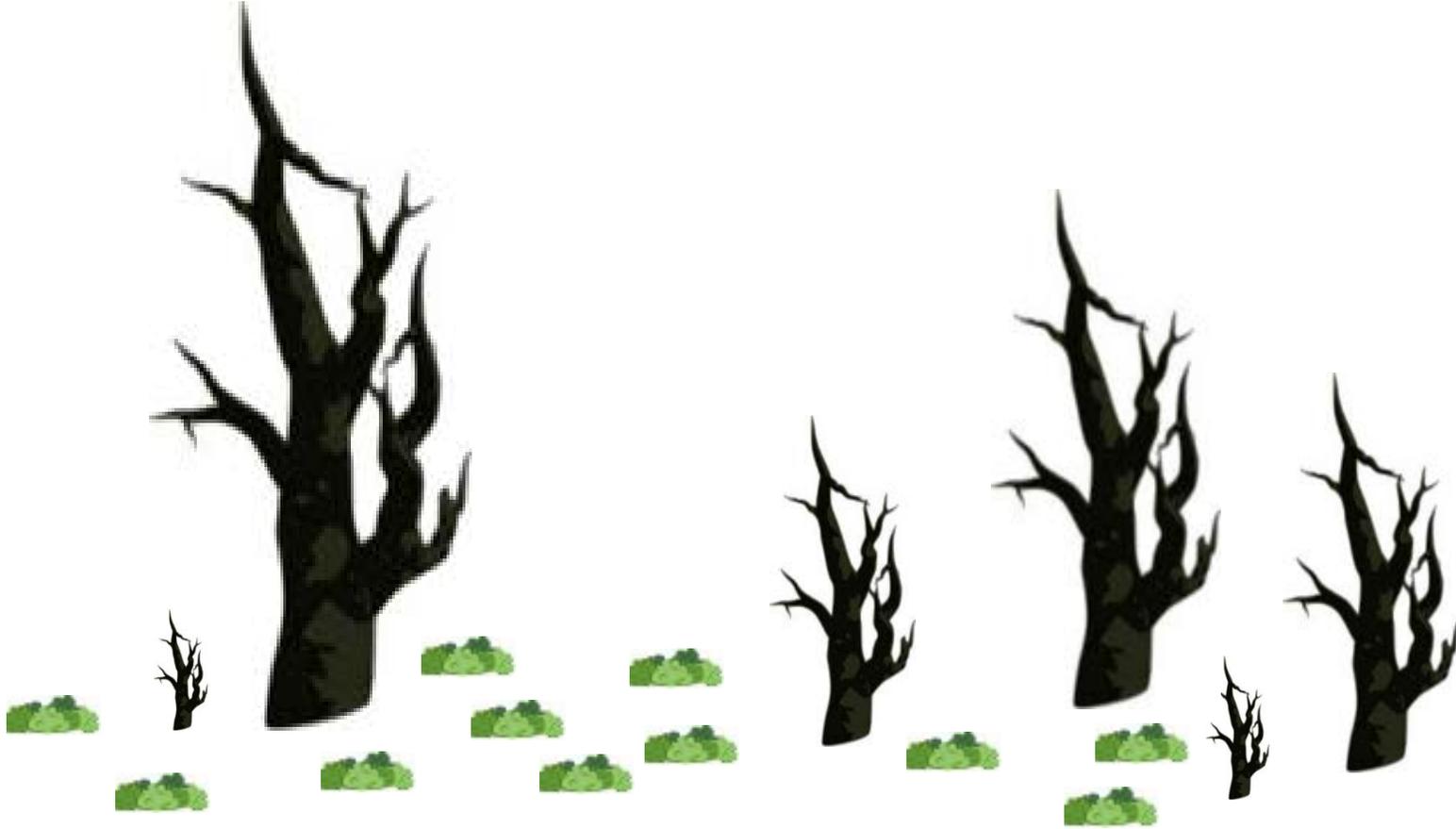
# Grazing, logging, and fire suppression take their toll



# Contemporary high-severity fire effects



# Can forests recover from contemporary high-severity fire effects?



# Objectives and Questions



1. Quantify mixed-conifer seedling regeneration in stand replacement patches in Oregon's Blue Mountains. Are forests recovering following high-severity fire?

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1. Quantify mixed-conifer seedling regeneration in stand replacement patches in Oregon's Blue Mountains. Are forests recovering following high-severity fire?
2. **Identify the key drivers of conifer regeneration. What is the impact of fire refugia pattern on post-fire conifer regeneration?**

# Fire Refugia: A Brief Introduction

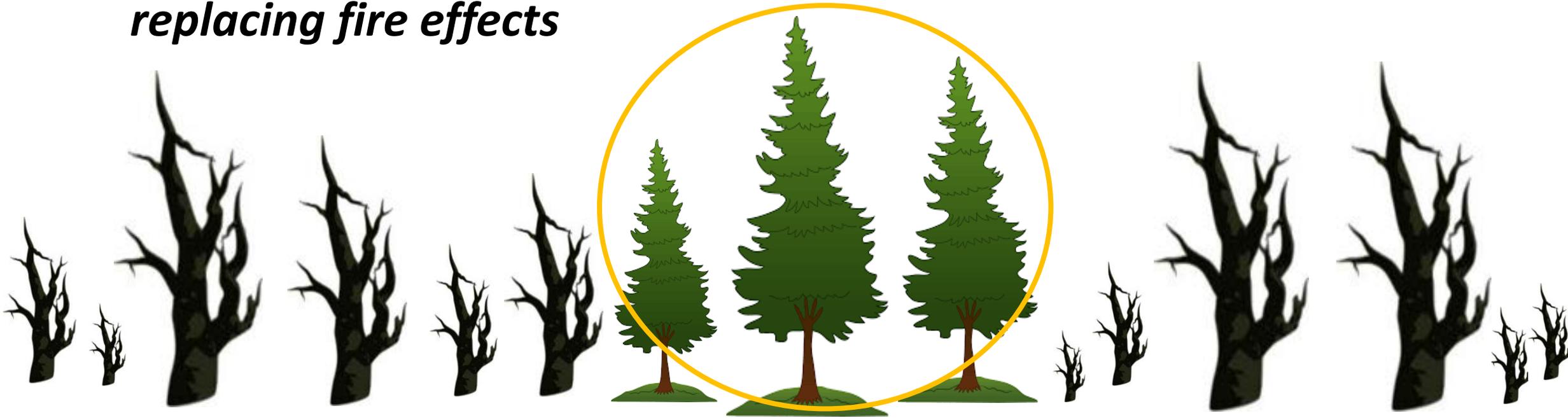


- Areas within fire perimeters that experienced lower severity fire effects than the surrounding landscape

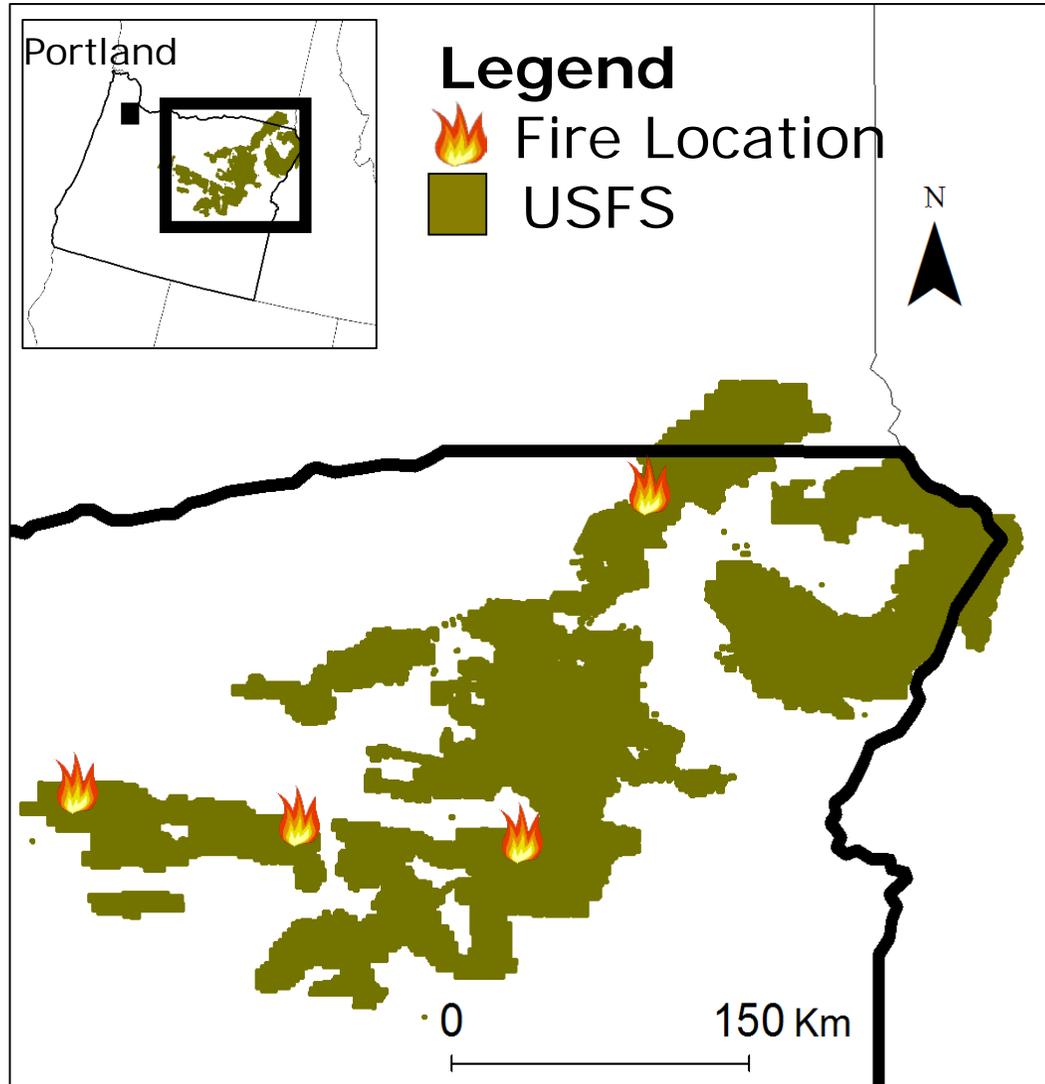
# Fire Refugia: A Brief Introduction

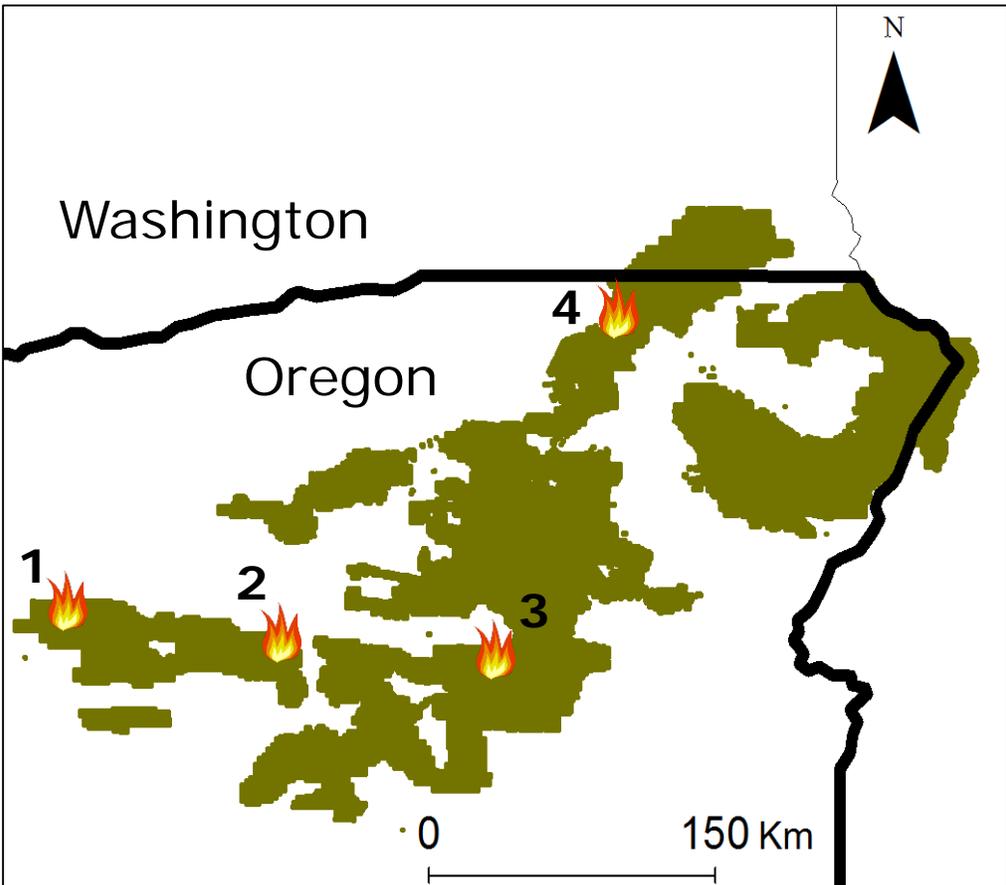
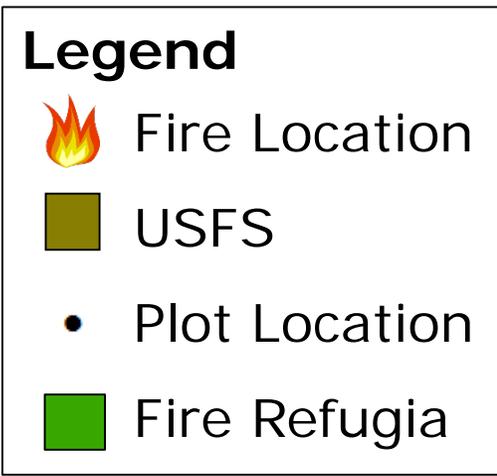
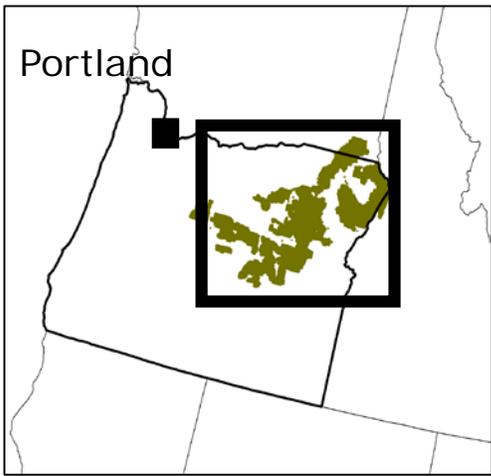


- Areas within fire perimeters that experienced lower severity fire effects than the surrounding landscape
- For purposes of this study, fire refugia are defined specifically as ***patches of surviving forest that did not experience stand-replacing fire effects***

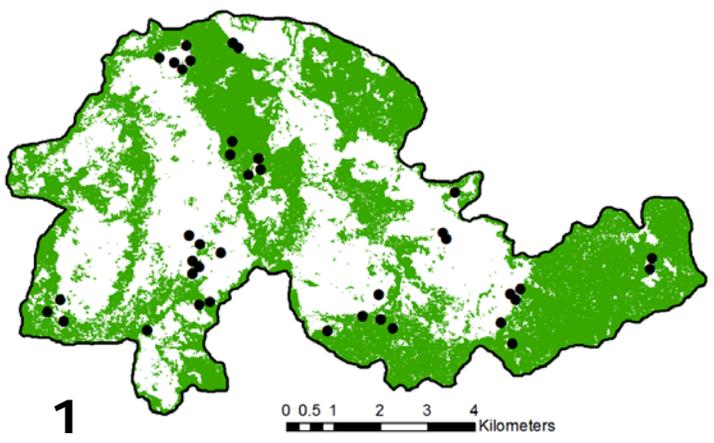


# The Blue Mountains

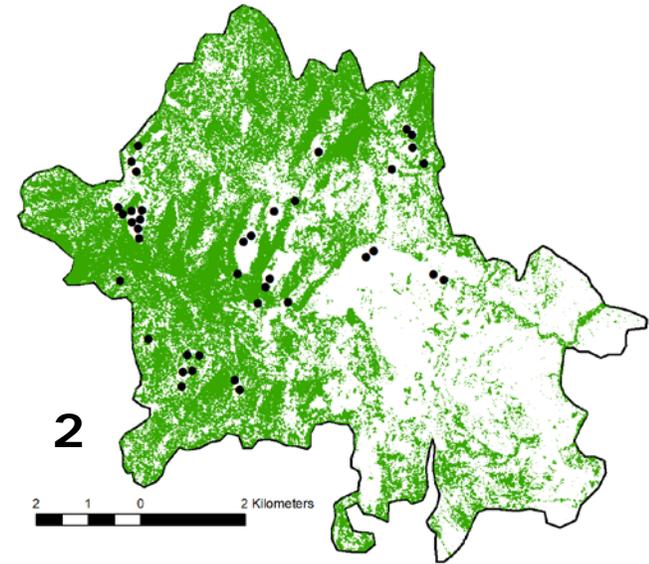




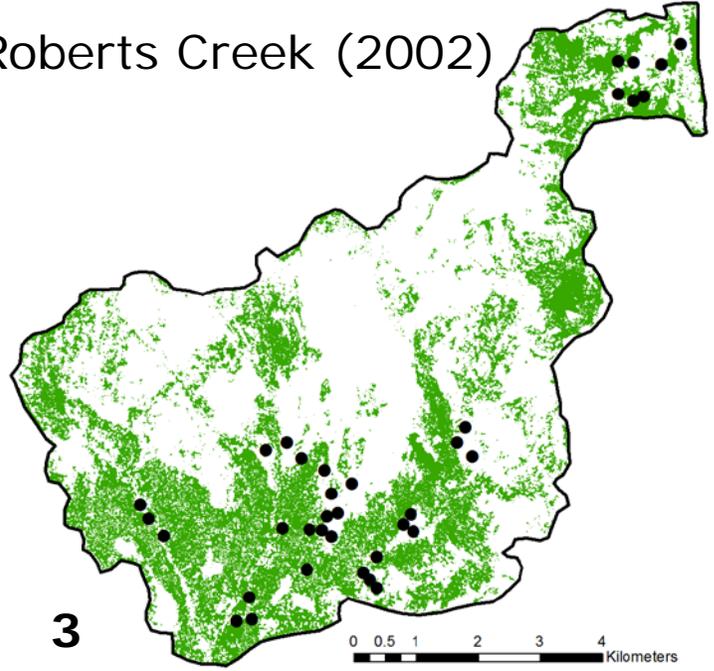
Hash Rock (2000)



747 (2002)



Roberts Creek (2002)



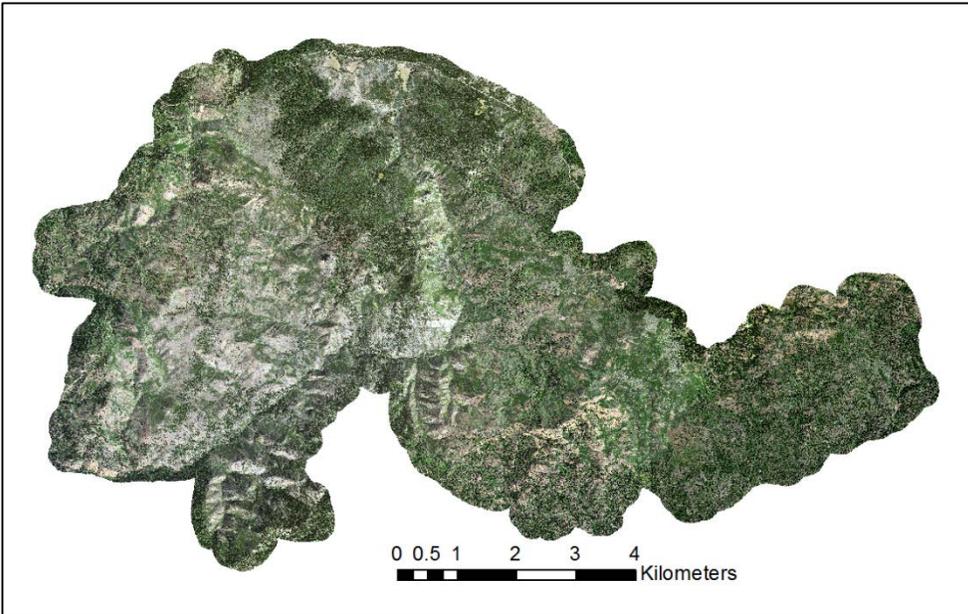
Burnt Cabin (2005)



# Fire Refugia Pattern



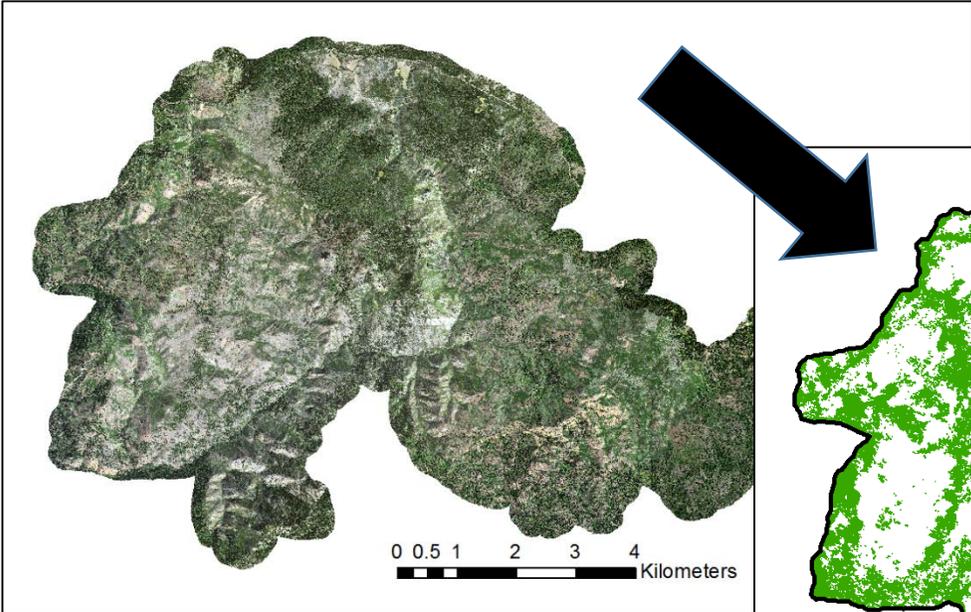
1 meter aerial imagery



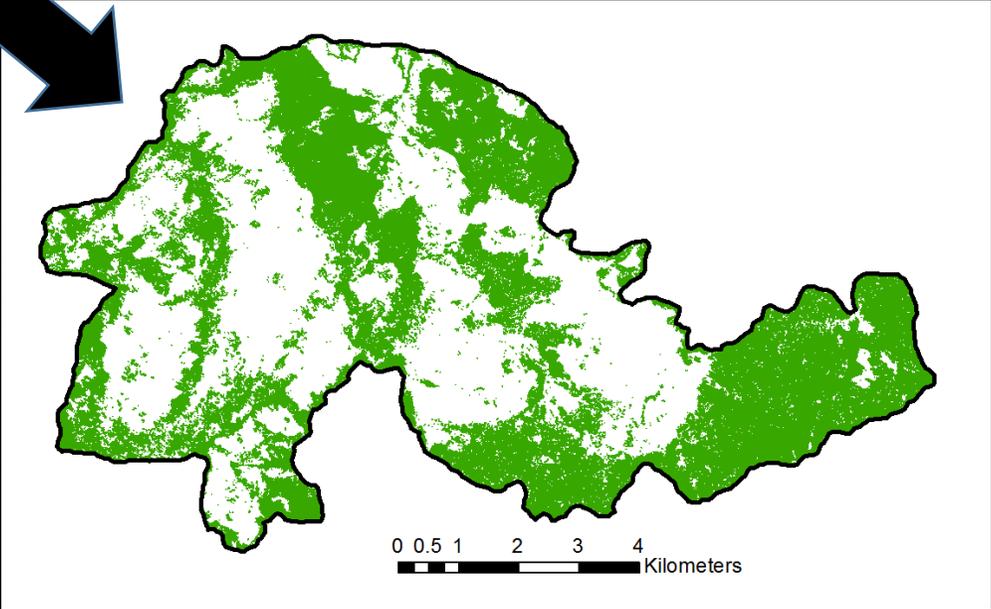
# Fire Refugia Pattern



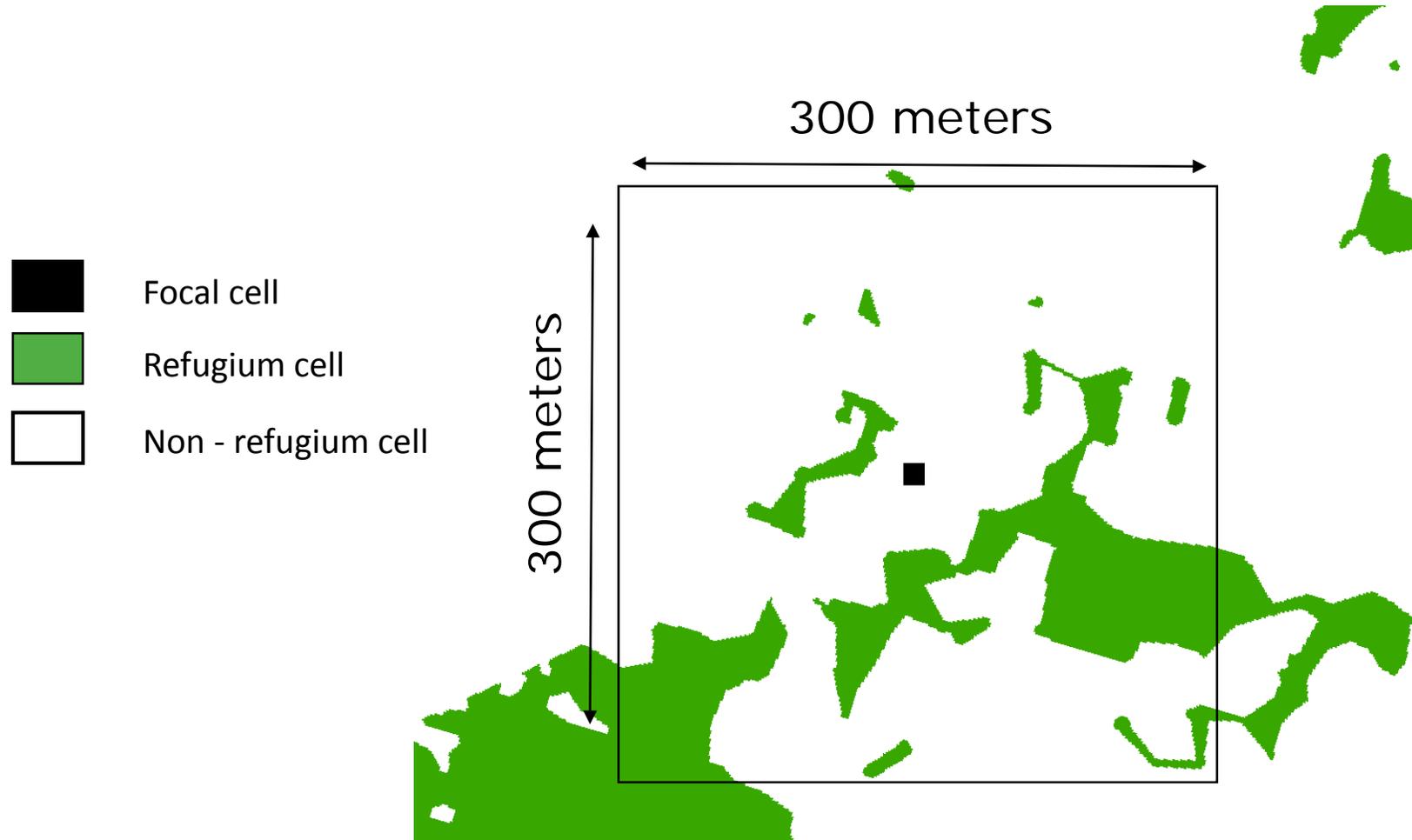
1 meter aerial imagery



1 meter maps of fire refugia



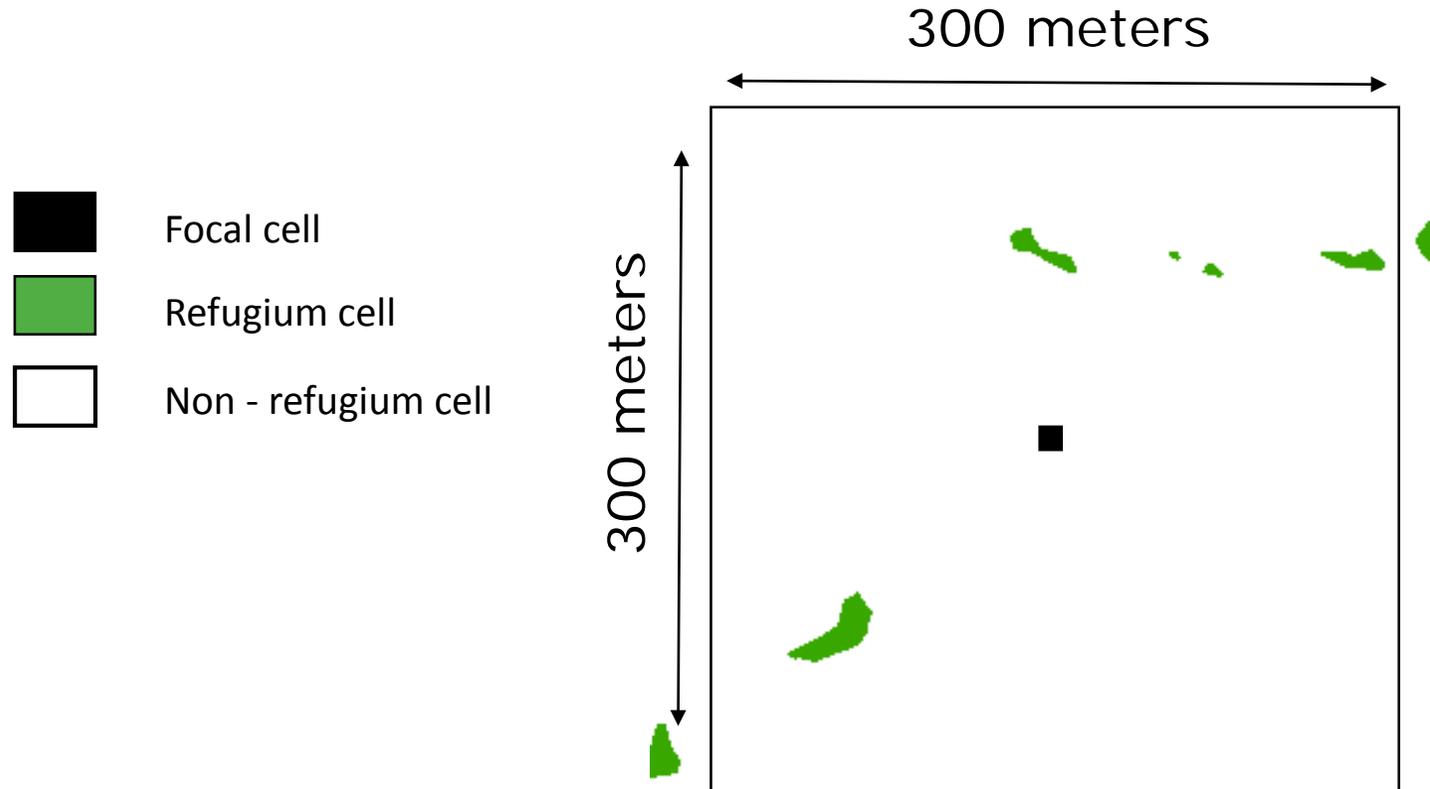
# Landscape Fire Refugia Density



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## Low fire refugia density (~50)



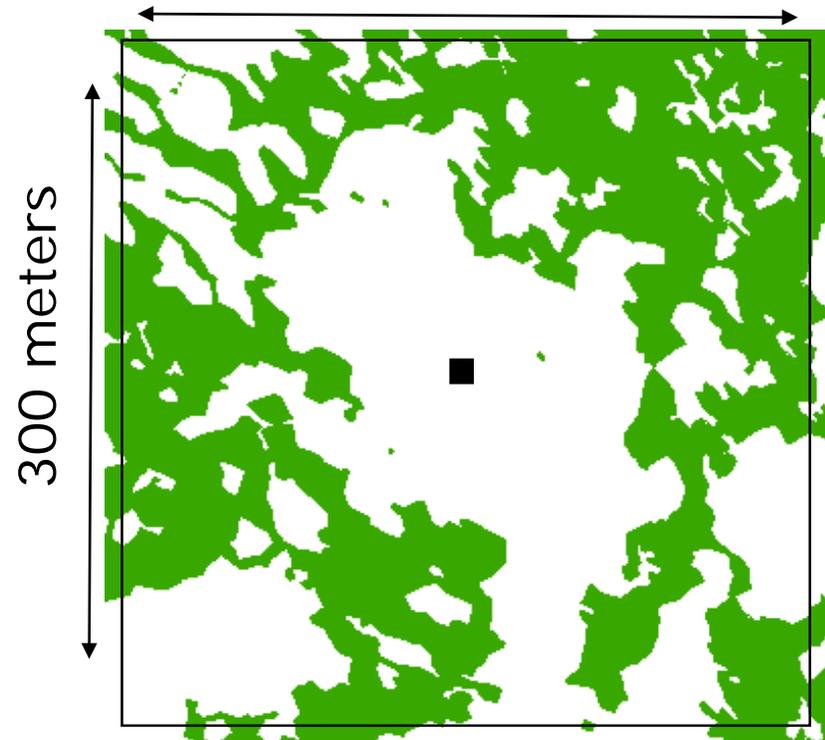
# Landscape Fire Refugia Density



## High fire refugia density (~600)

300 meters

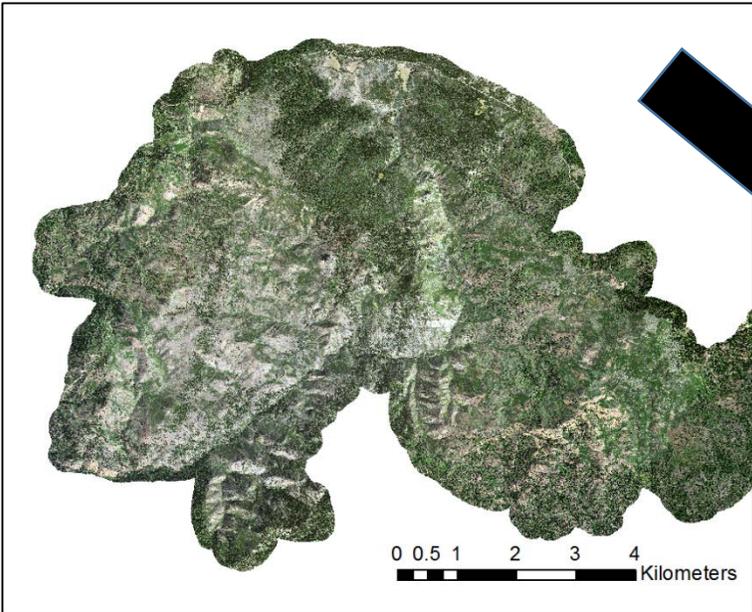
-  Focal cell
-  Refugium cell
-  Non - refugium cell



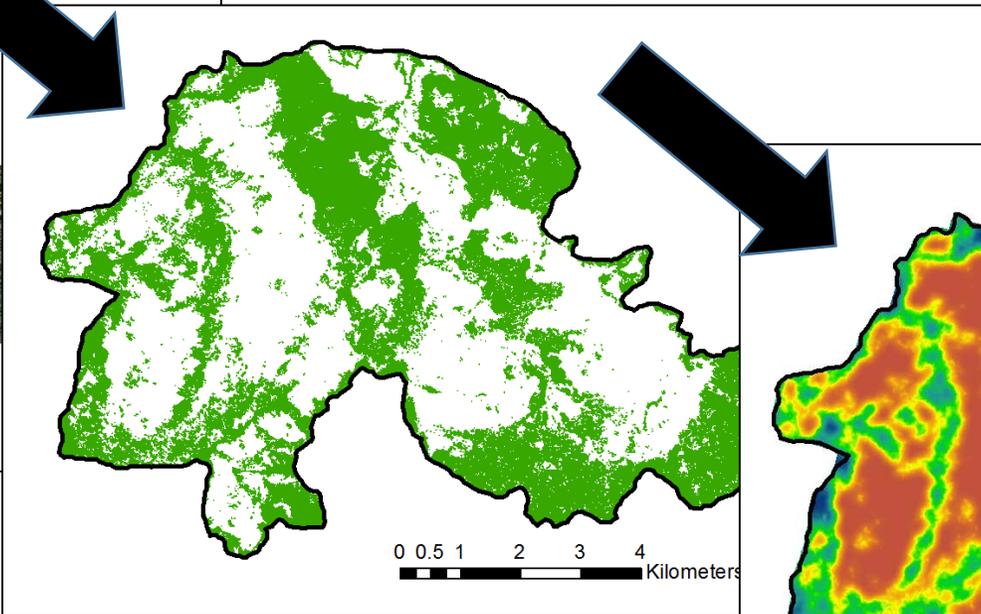
# Landscape Fire Refugia Density



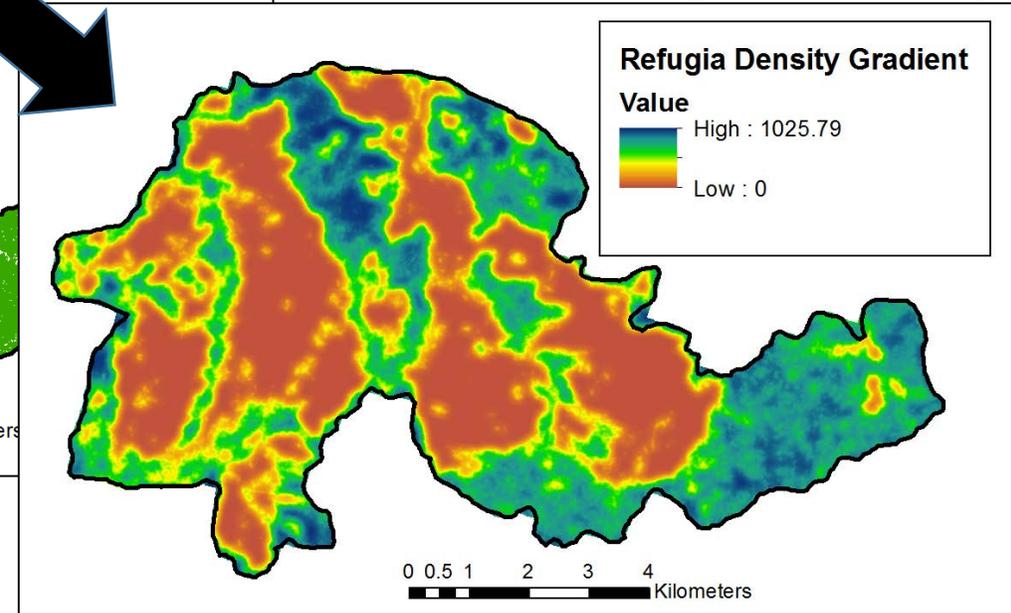
1 meter aerial imagery



1 meter maps of fire refugia



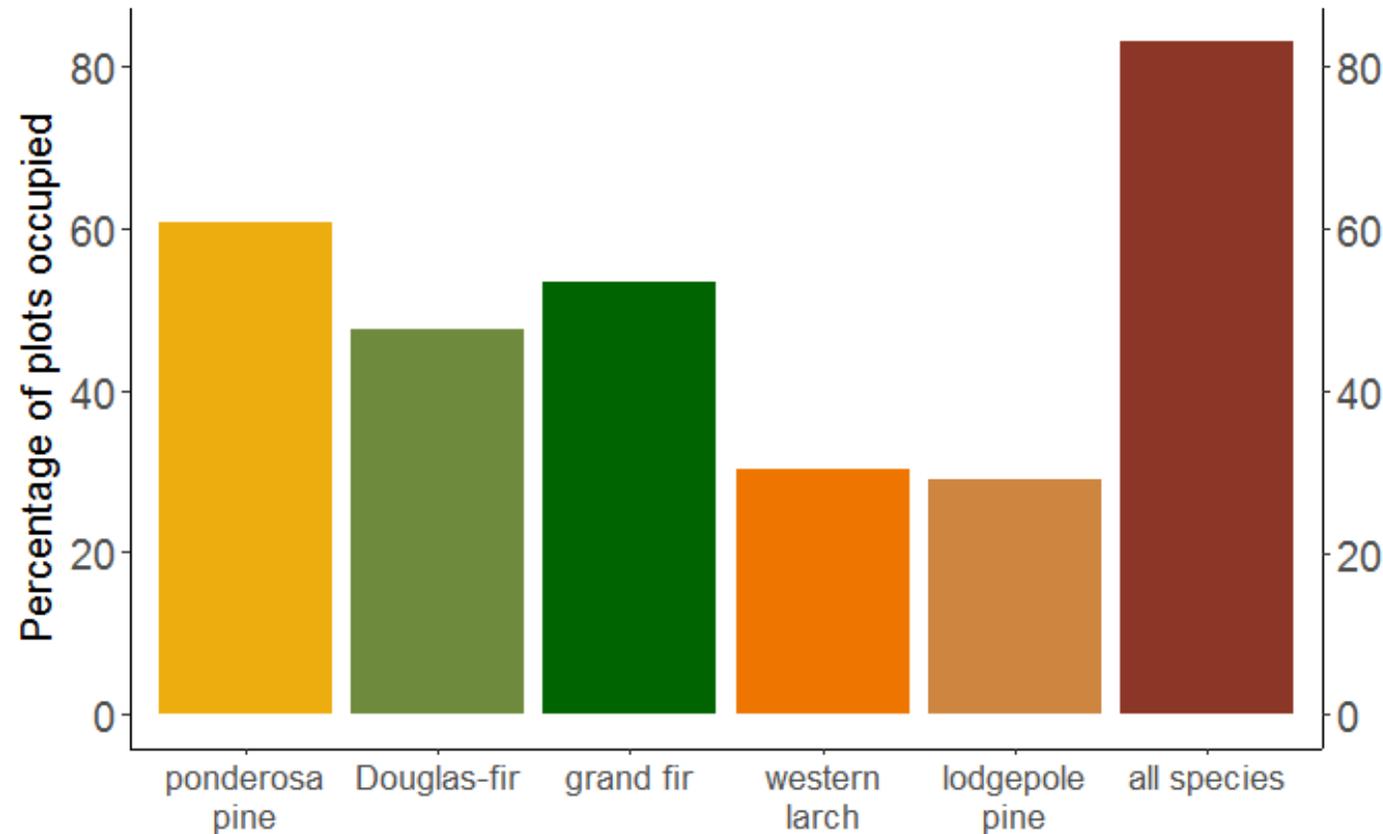
1 meter maps of fire refugia density



# Forest is returning to stand replacement patches



**Conifer seedlings present in 83% of plots**



# Significant variability in seedling densities



Dense regeneration



# Significant variability in seedling densities



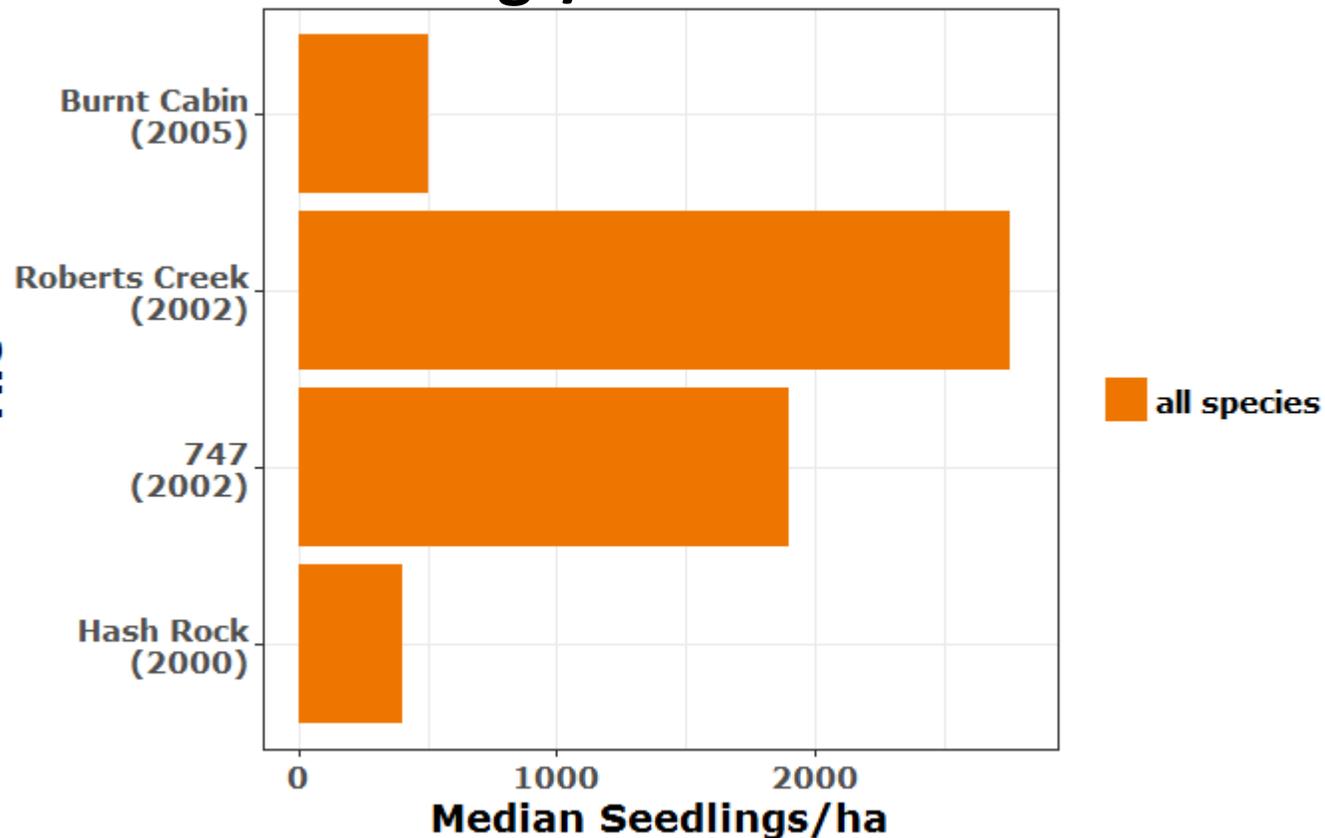
Sparse, or absent  
regeneration



# Resilience to high-severity fire effects evident 12-17 years post-fire



**Median densities were greater than 400 seedlings/ha for all fires**



# Drivers of post-fire forest recovery



2. Identify the key drivers of post-fire conifer seedling regeneration. What is the impact of landscape patterns of fire refugia on conifer regeneration in stand replacement patches?

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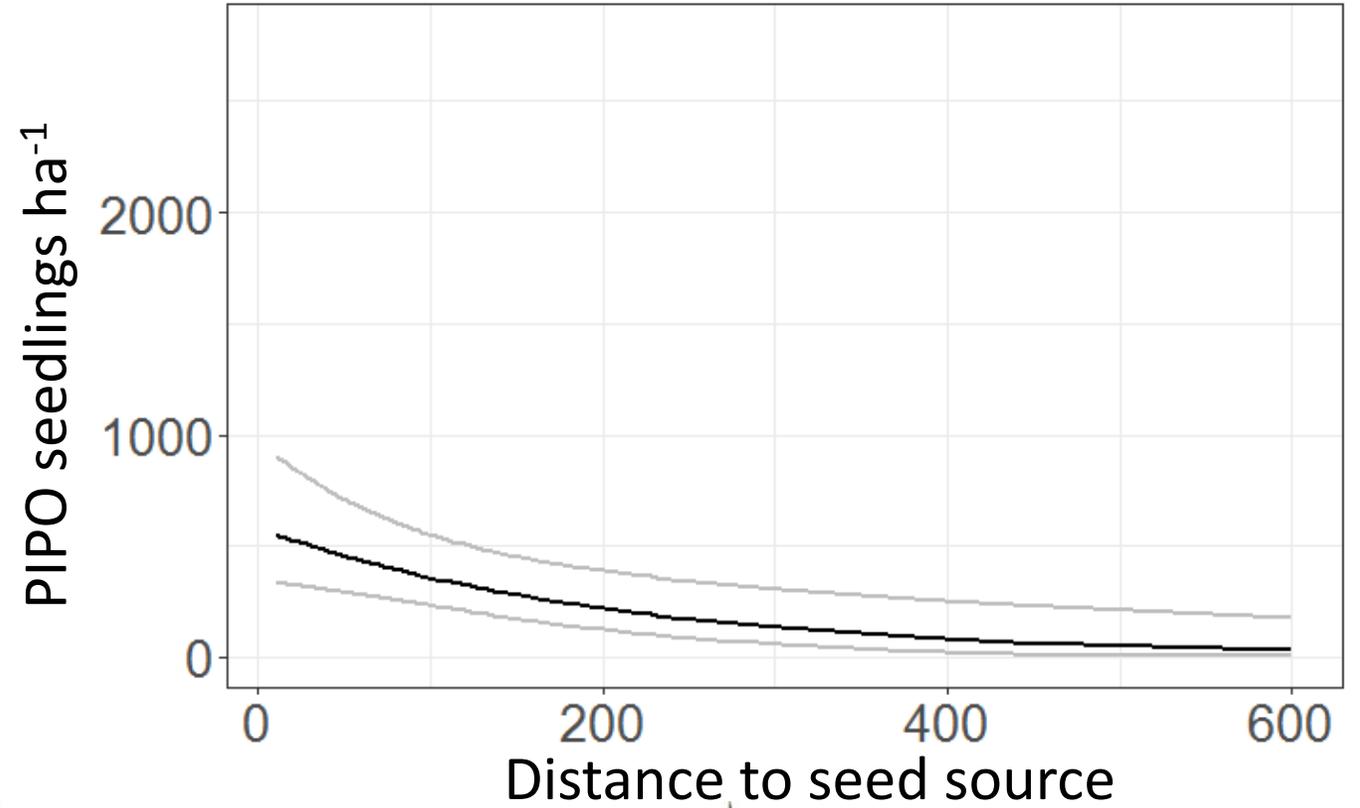
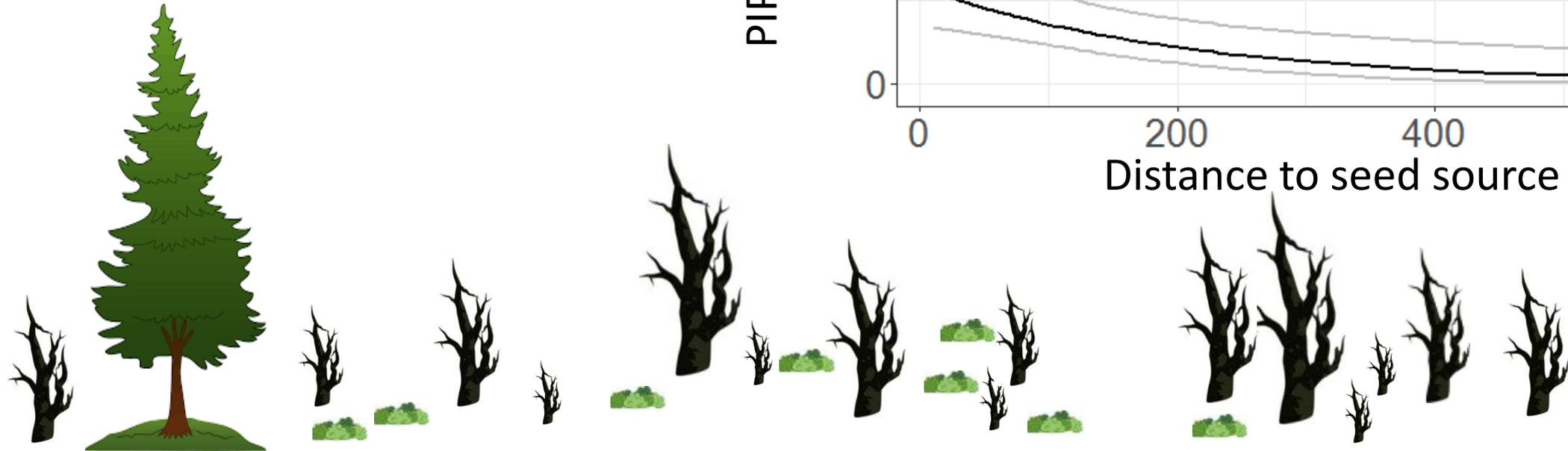
Site Characteristics
Heat load
Climatic moisture deficit
Elevation
Fire severity (dNBR)
<b>Shrub cover</b>

Fire Refugia Pattern
Minimum distance to seed source
Median distance to seed source
<b>Mean distance to seed source</b>
<b>Landscape fire refugia density (RD)</b>
Mean distance + RD

# Local and landscape fire refugia patterns drive regeneration

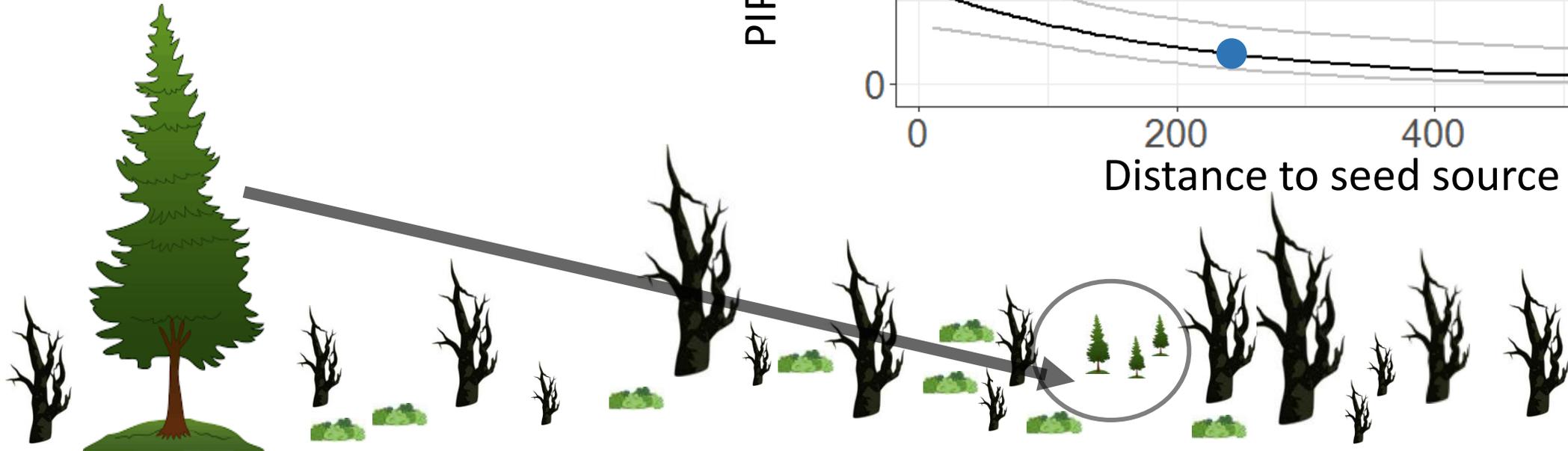
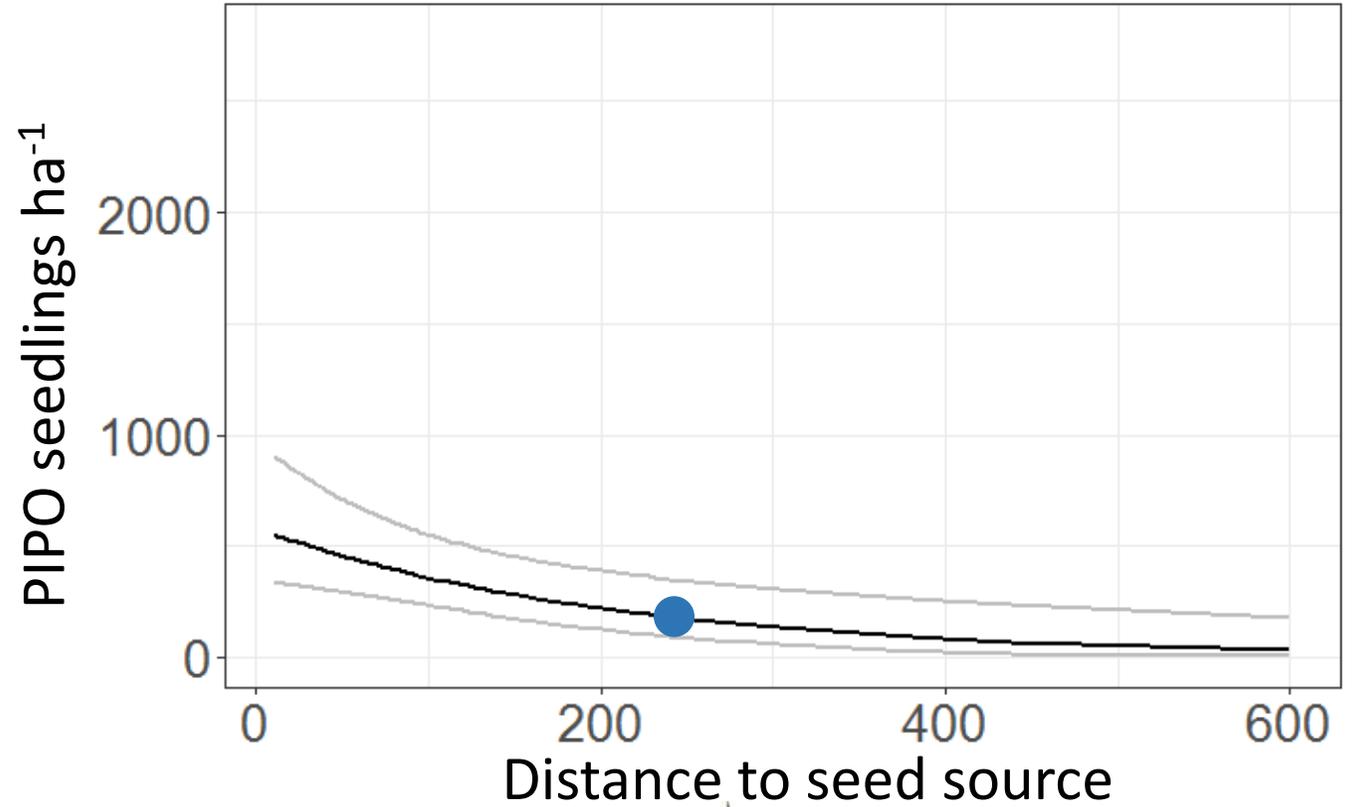


# Local and landscape fire refugia patterns drive regeneration



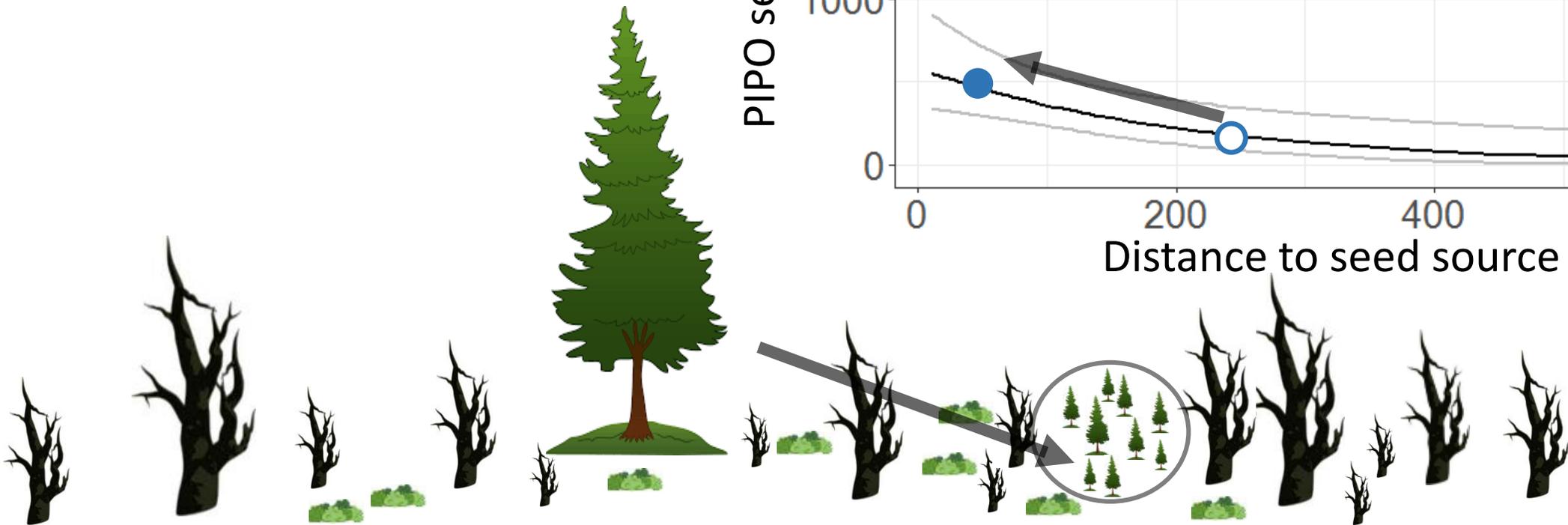
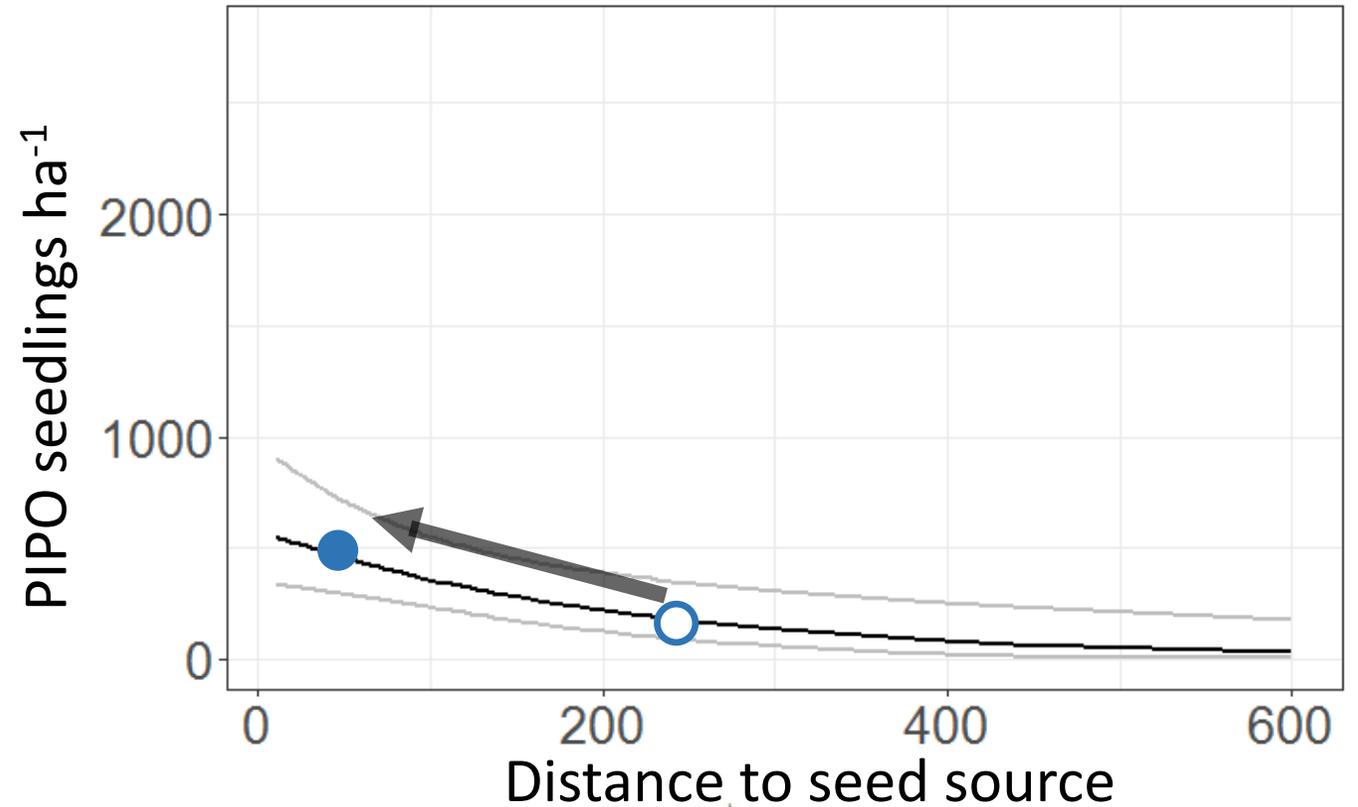
# Local and landscape fire refugia patterns drive regeneration

Decreasing distance to seed source from 250m to 50m...



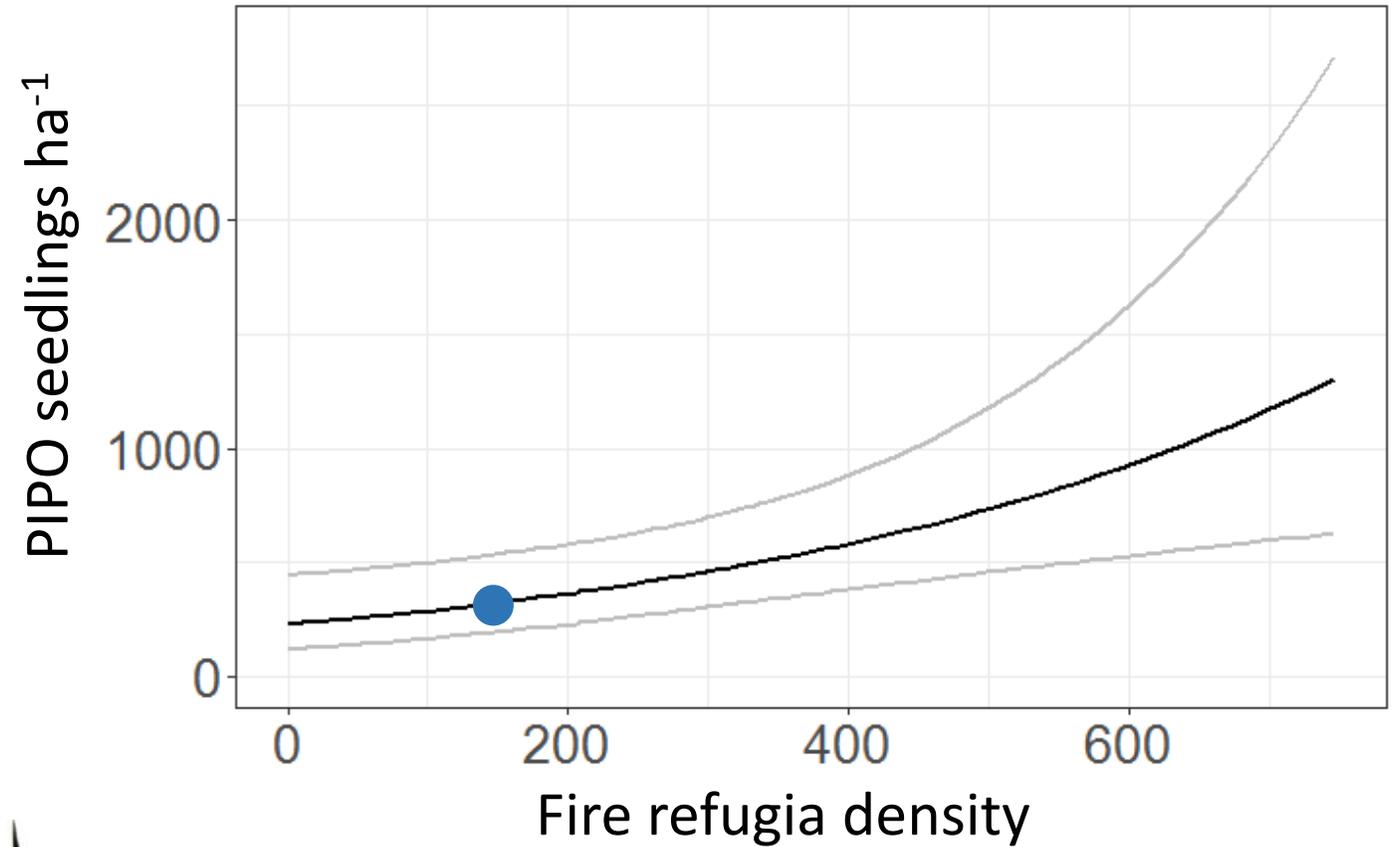
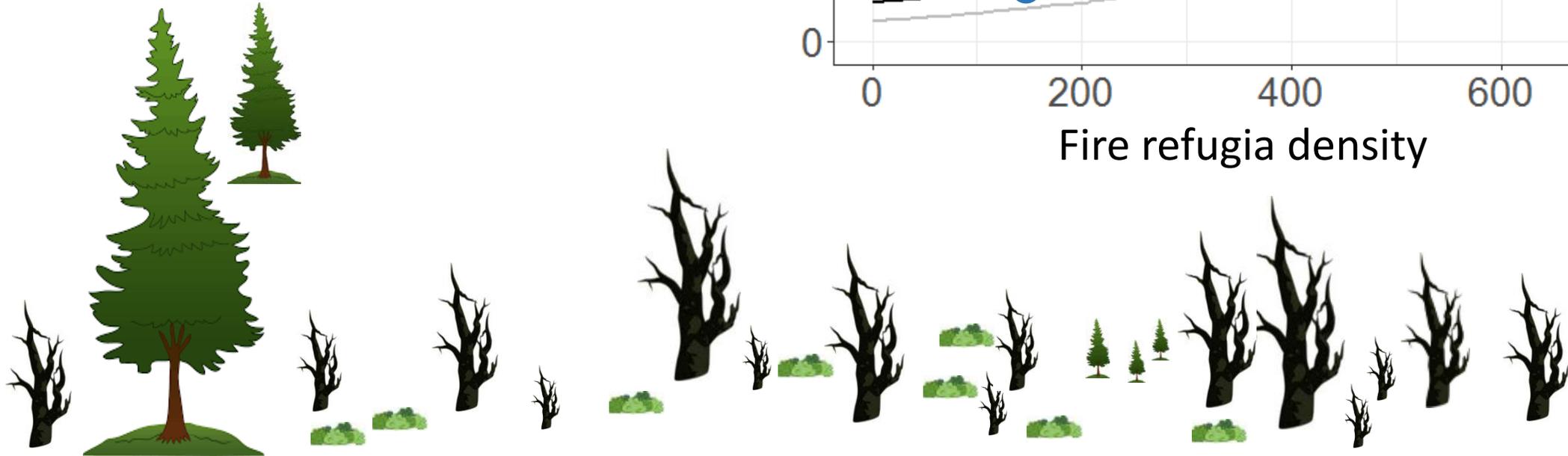
# Local and landscape fire refugia patterns drive regeneration

...nearly triples predicted  
PIPO seedling density (170 –  
450 seedlings  $\text{ha}^{-1}$ )



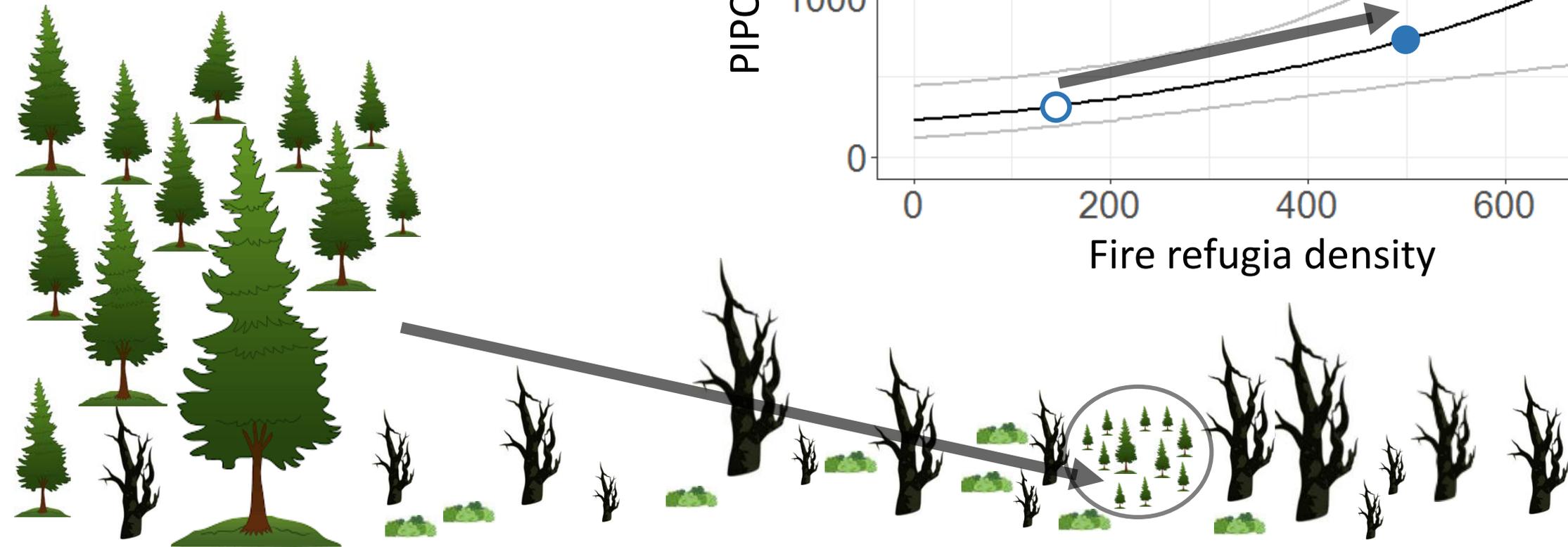
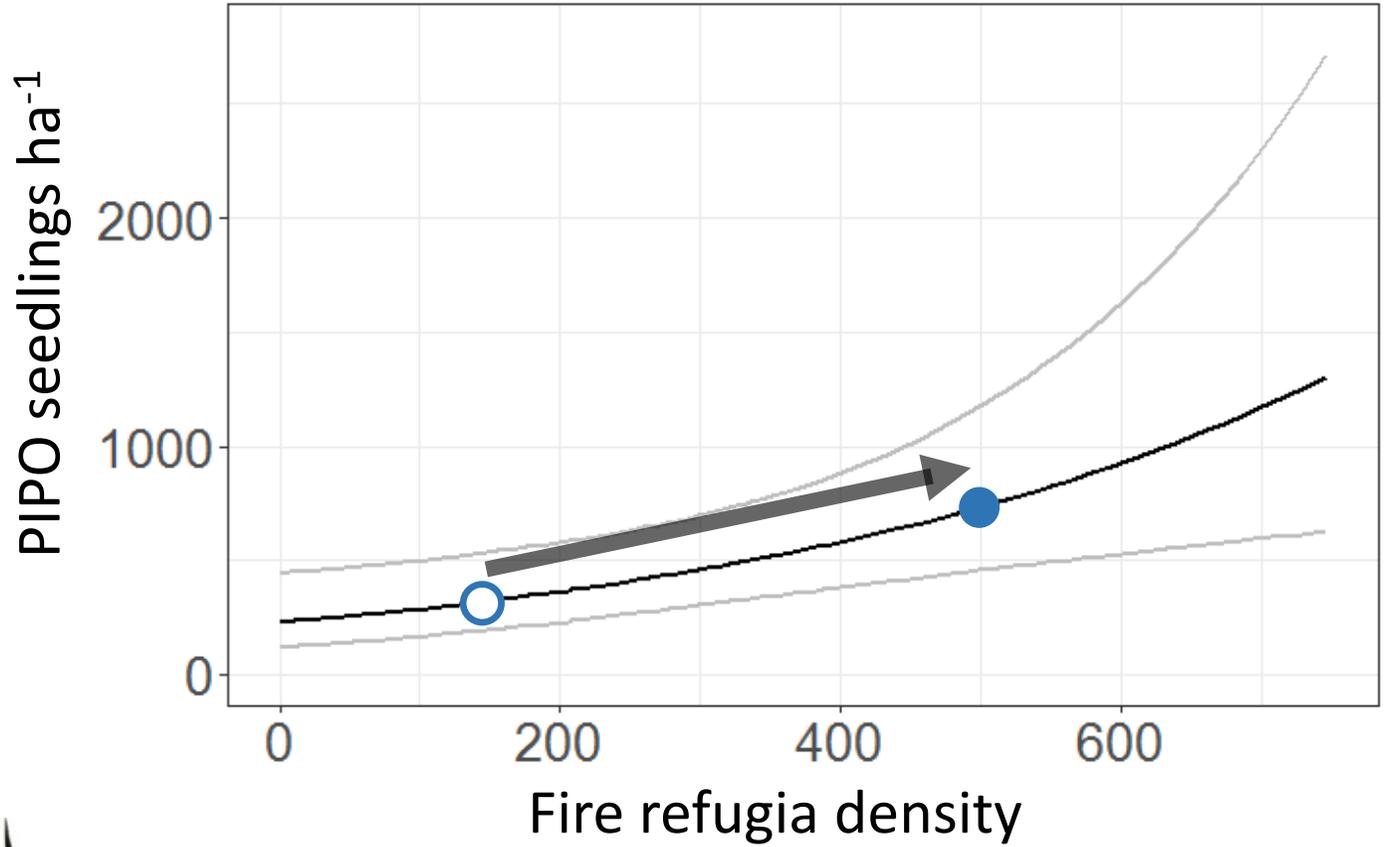
# Local and landscape fire refugia patterns drive regeneration

Increasing fire refugia density from 150 to 500...



# Local and landscape fire refugia patterns drive regeneration

...increases predicted seeding densities by 130%  
(325 – 750 seedlings  $\text{ha}^{-1}$ )



# A shrub dominated post-fire landscape



# A shrub dominated post-fire landscape



Average shrub cover = 54%

40% of seedlings overtopped by shrubs

No significant relationship between shrub cover and regen.



# Key Points



- Evidence that dry mixed-conifer forests are resilient to contemporary fire effects in the Blue Mountains

# Key Points



- Evidence that dry mixed-conifer forests in the Blue Mountains are resilient to contemporary fire effects
- Local and landscape fire refugia pattern are key drivers of forest resilience and recovery

# Acknowledgements



## **Krawchuk LCSRG Lab**

Garrett Meigs

Anna Talucci

Claire Tortorelli

## **Field Crew**

Claire Tortorelli

Jean McCalmont

Julie VanSant

## **Fire Refugia Working Group**

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Ellen Whitman

Ryan Walker

Marc Parisien

Carol Miller

Jonathan Coop

Geneva Chong

Garrett Meigs



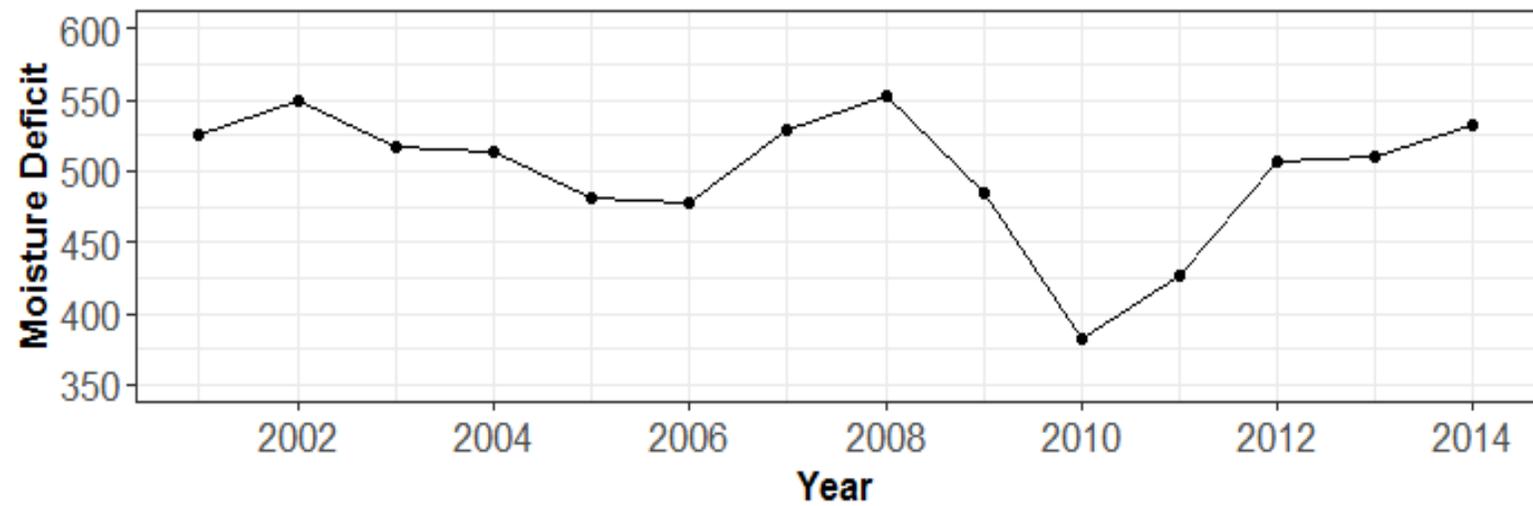
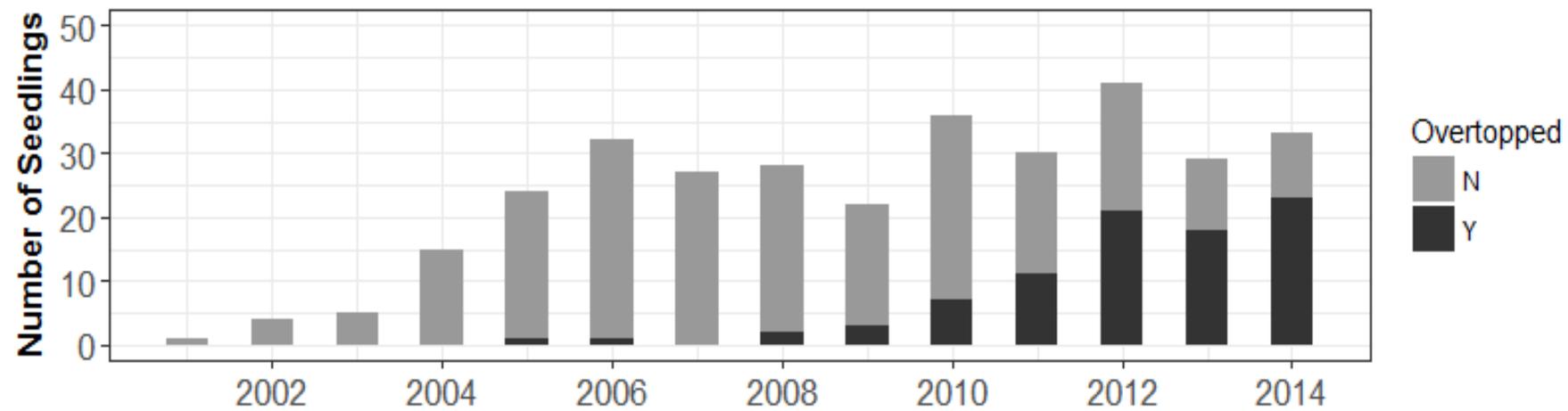
# Questions?

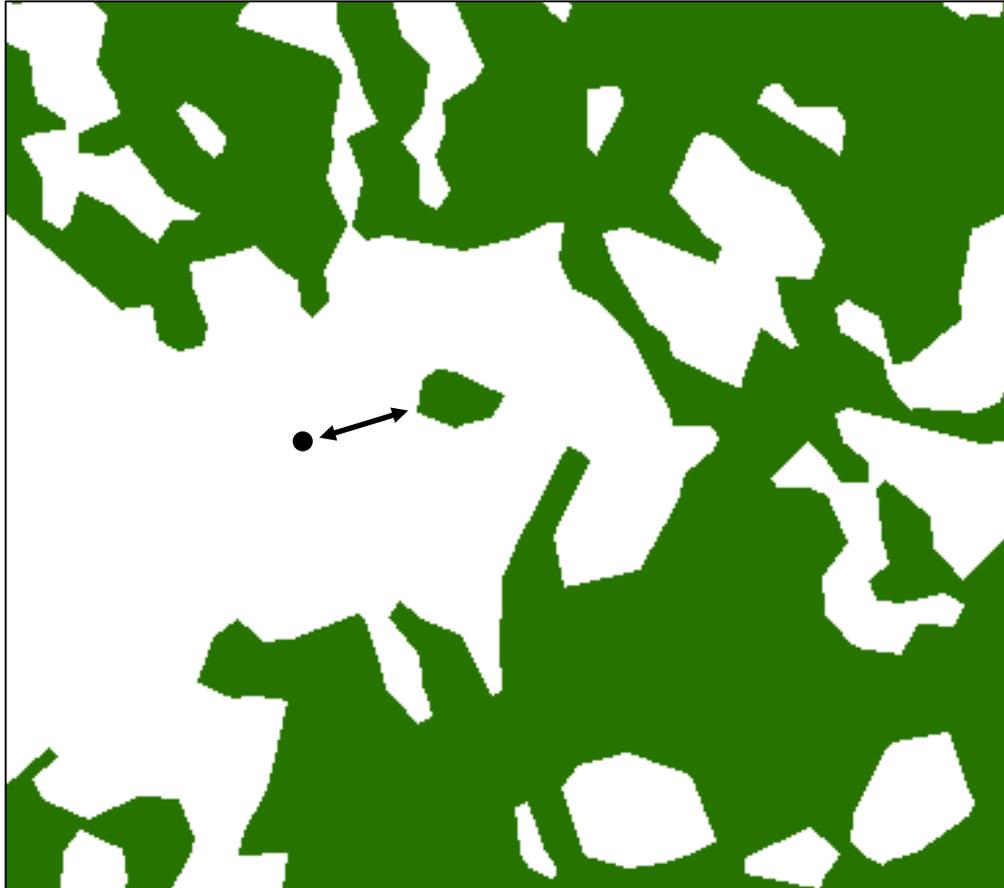


Desolation Fire, 2017

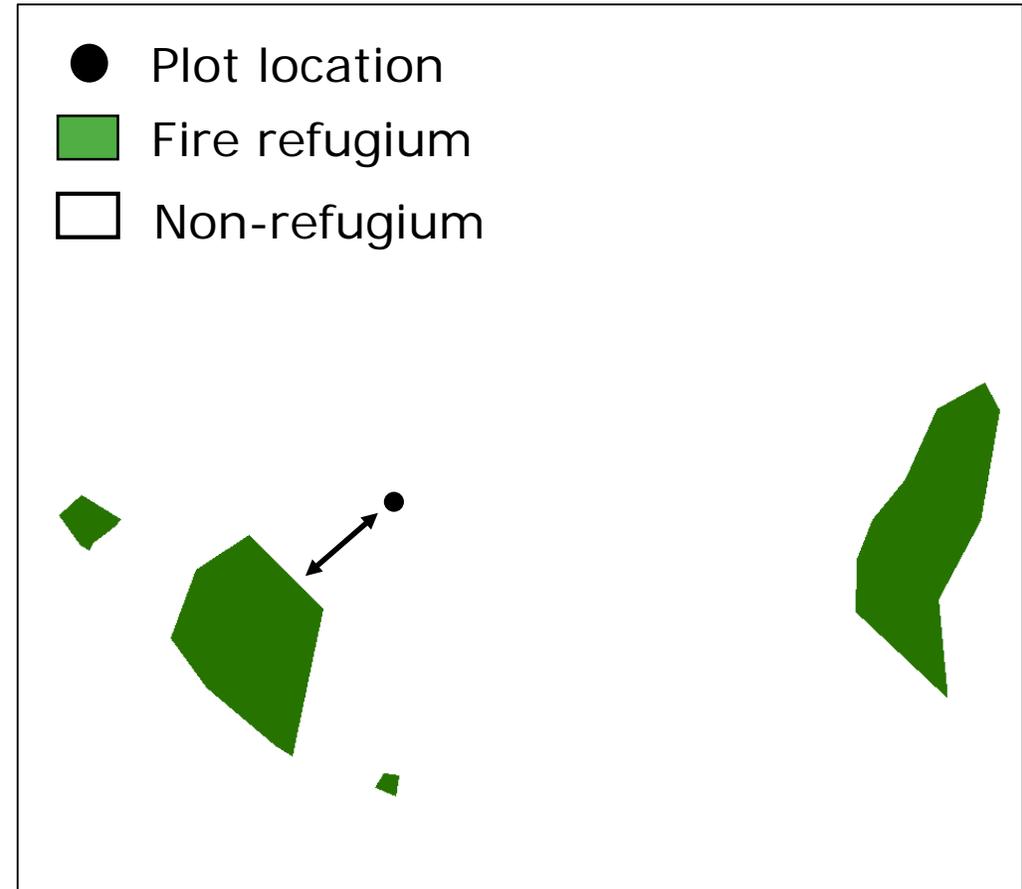
Photo: [inciweb.nwcg.gov](http://inciweb.nwcg.gov)

# Ponderosa pine seedling regeneration is ongoing 12 – 17 years post-fire

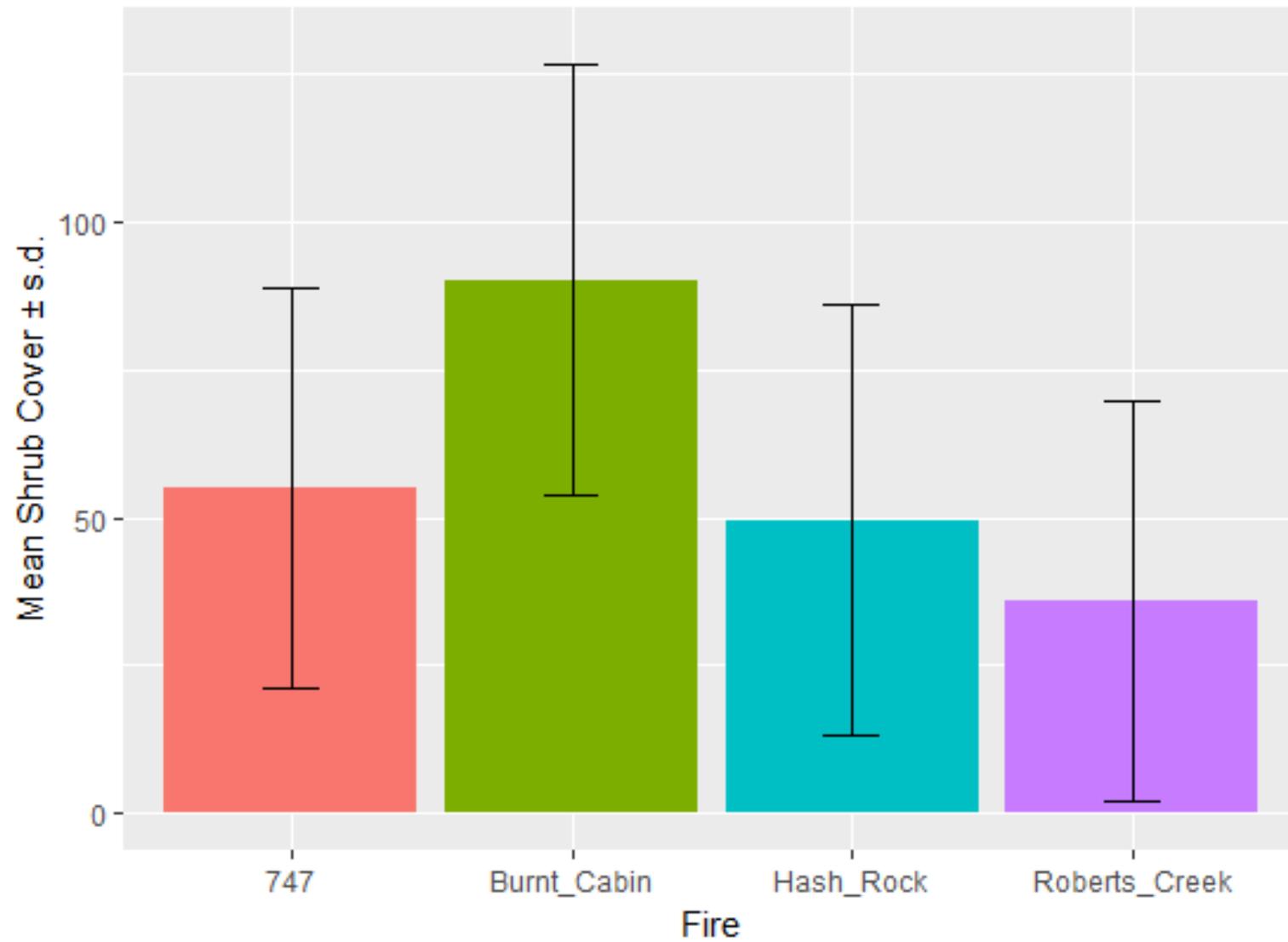


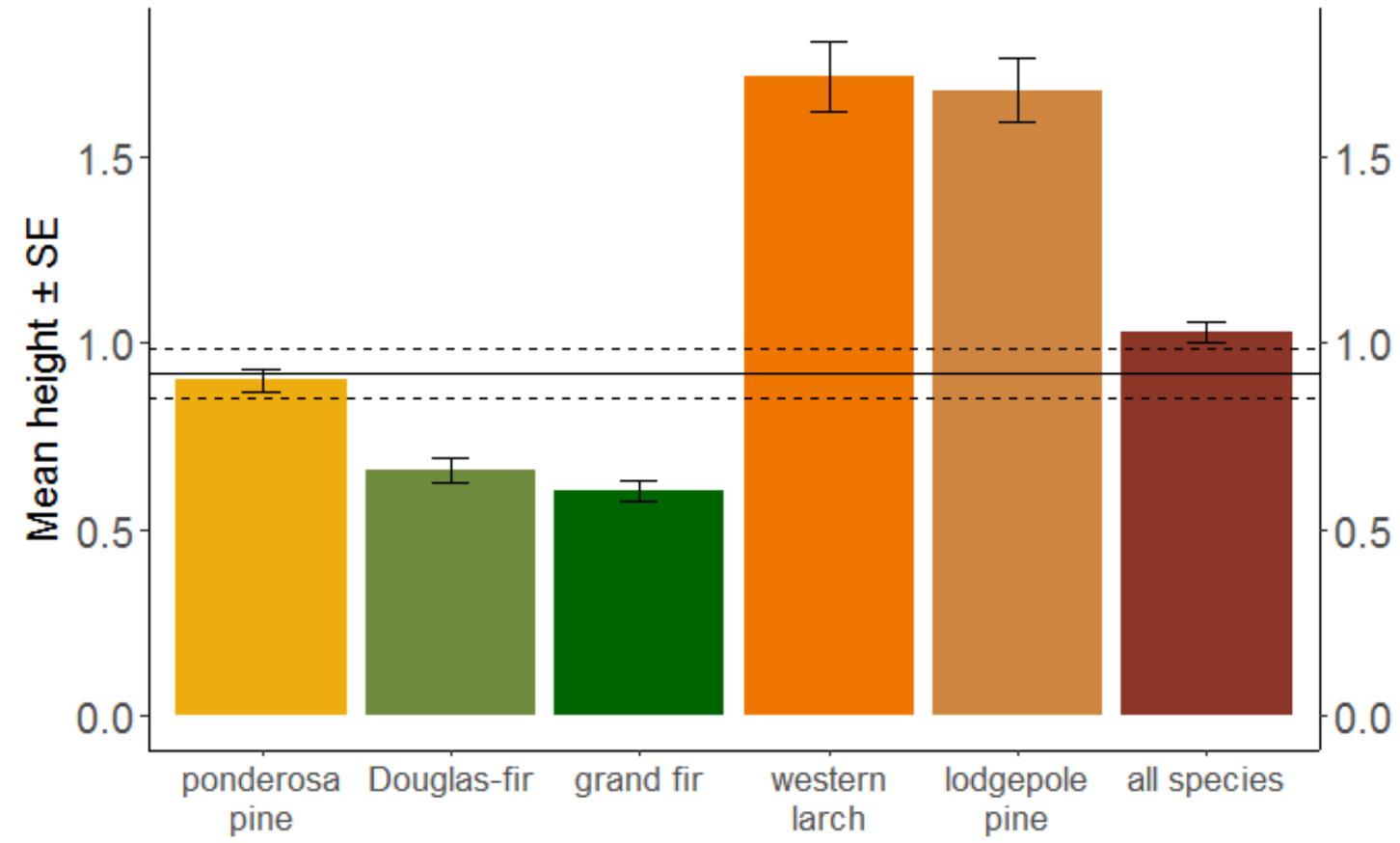


Distance to seed source = 70 meters  
Fire refugia DWD = 90 (25<sup>th</sup> percentile)  
Predicted PIPO seedlings ha<sup>-1</sup> = **280** (95% CI 160 – 500)



Distance to seed source = 70 meters  
Fire refugia DWD = 420 (75<sup>th</sup> percentile)  
Predicted PIPO seedlings ha<sup>-1</sup> = **610** (95% CI 400 – 935)

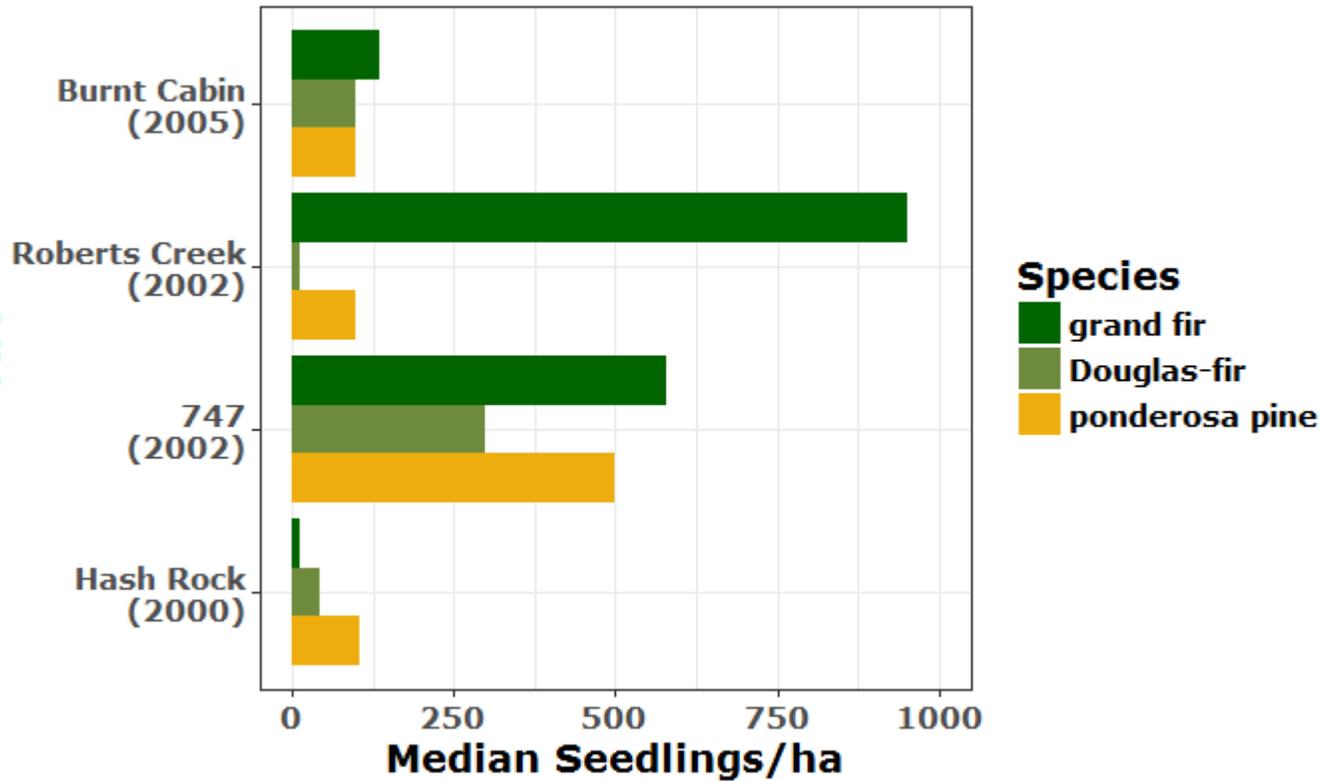




# Resilience to high-severity fire effects evident 12-17 years post-fire



### Conifer Seedling Density



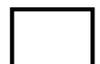


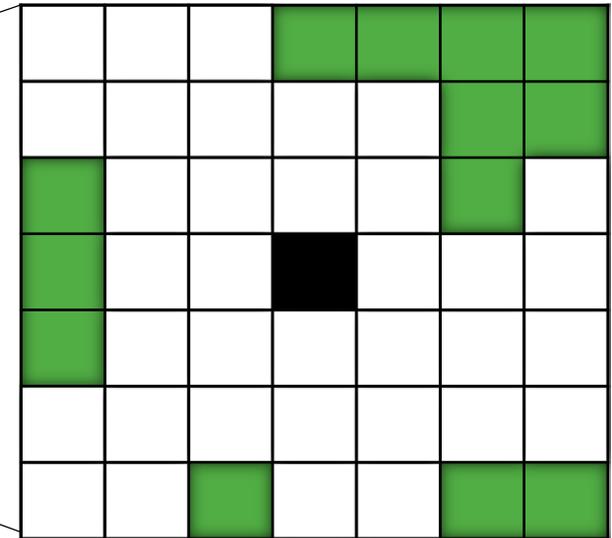
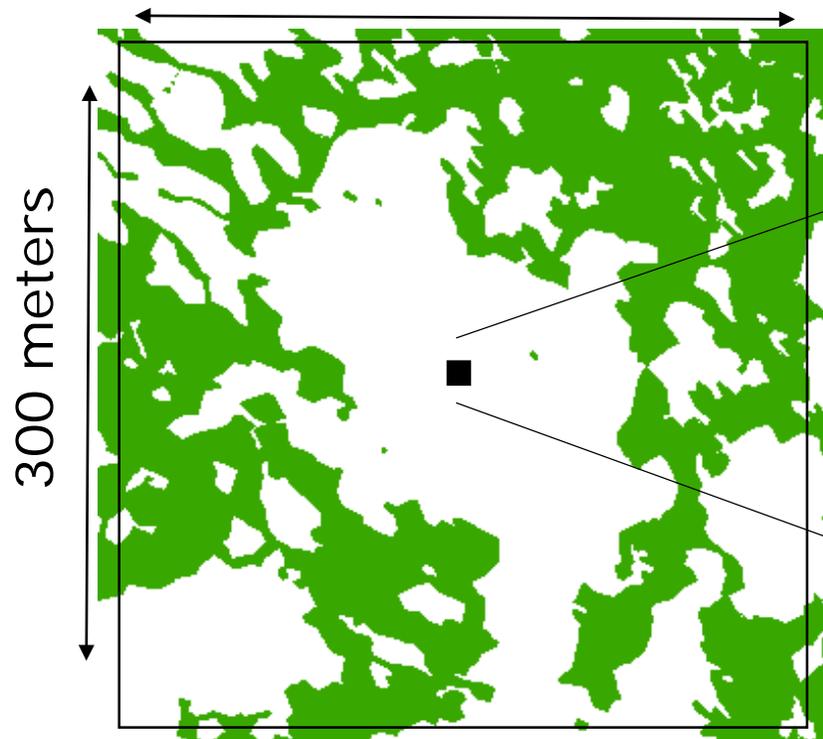
# Landscape Fire Refugia Density



## High refugia density (~600)

300 meters

-  Focal cell
-  Refugium cell
-  Non - refugium cell





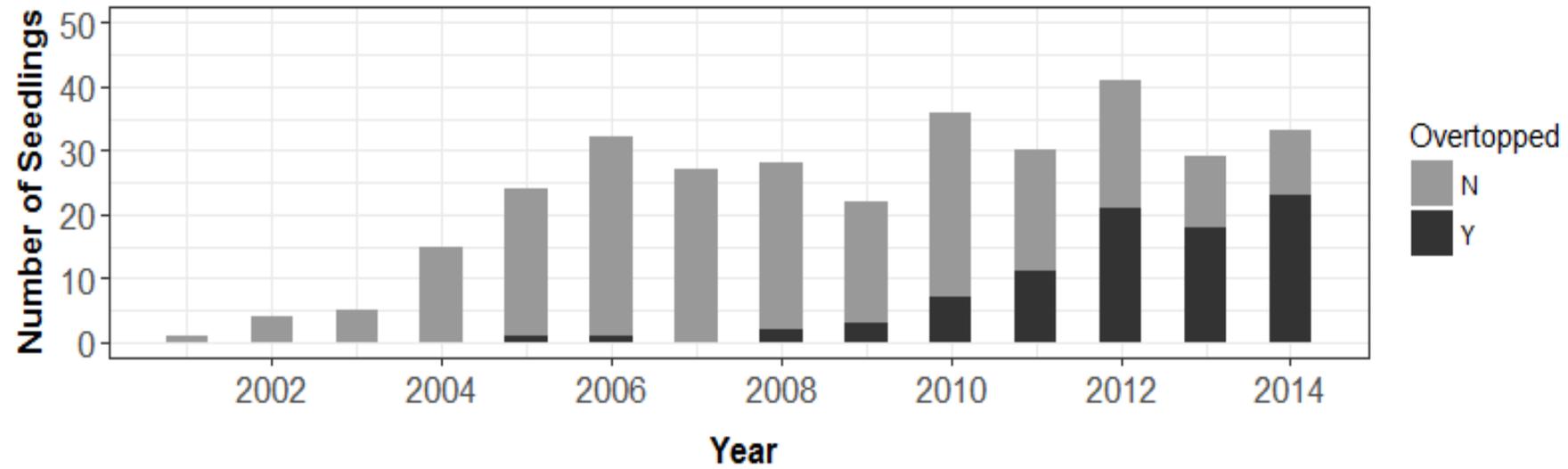
# Objectives and Questions



1. Quantify mixed conifer seedling regeneration in contemporary burn scars in Oregon's Blue Mountains. Are forests recovering following high-severity fire?
2. Identify the drivers of post-fire conifer seedling regeneration. What is the effect of landscape patterns of fire refugia on conifer regeneration in stand replacement patches?
3. **Determine the temporal pattern of ponderosa pine seedling establishment. Is seedling establishment ongoing? And, is establishment related to climate?**

3. Estimate ponderosa pine seedling establishment dates using whorl-counts. Is seedling establishment ongoing 12 – 17 years post-fire?

# Ponderosa pine seedling regeneration is ongoing



# Key Points



- Evidence that dry mixed-conifer forests in the Blue Mountains are resilient to contemporary fire effects
- Both local and landscape fire refugia pattern are key drivers of forest resilience and recovery
- Ponderosa pine regeneration is ongoing 12 – 17 years post-fire.