Effects of Fire in Whitebark Pine Communities of the Alpine-Treeline Ecotone

C. Alina Cansler[1] and Don McKenzie [2]

Whitebark Pine Ecosystem Foundation meeting

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[1] University of Washington, Seattle, WA, USA

[2] USFS Pacific Northwest Wildland Fire Science Lab, Seattle, WA, USA

Alpine Treeline Ecotones

"Highest-elevation belt that contains tree species, consisting of a mosaic of individual trees, tree clumps, and meadows that extend from closed forest to alpine (treeless) vegetation" (Rochefort et al. 1994)

Alpine Treeline Ecotones

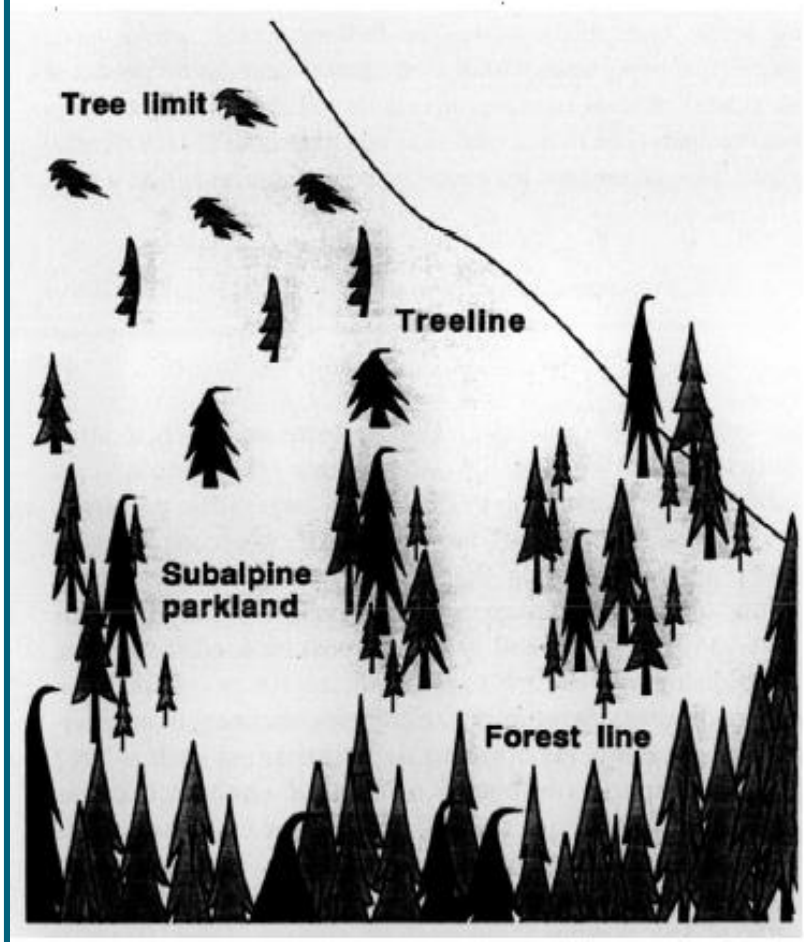


Figure 1 Diagrammatic representation of sub-alpine conifer distribution. A mosaic of trees and meadows dominates the ecotone between the continuous forest below and the treeless alpine above.

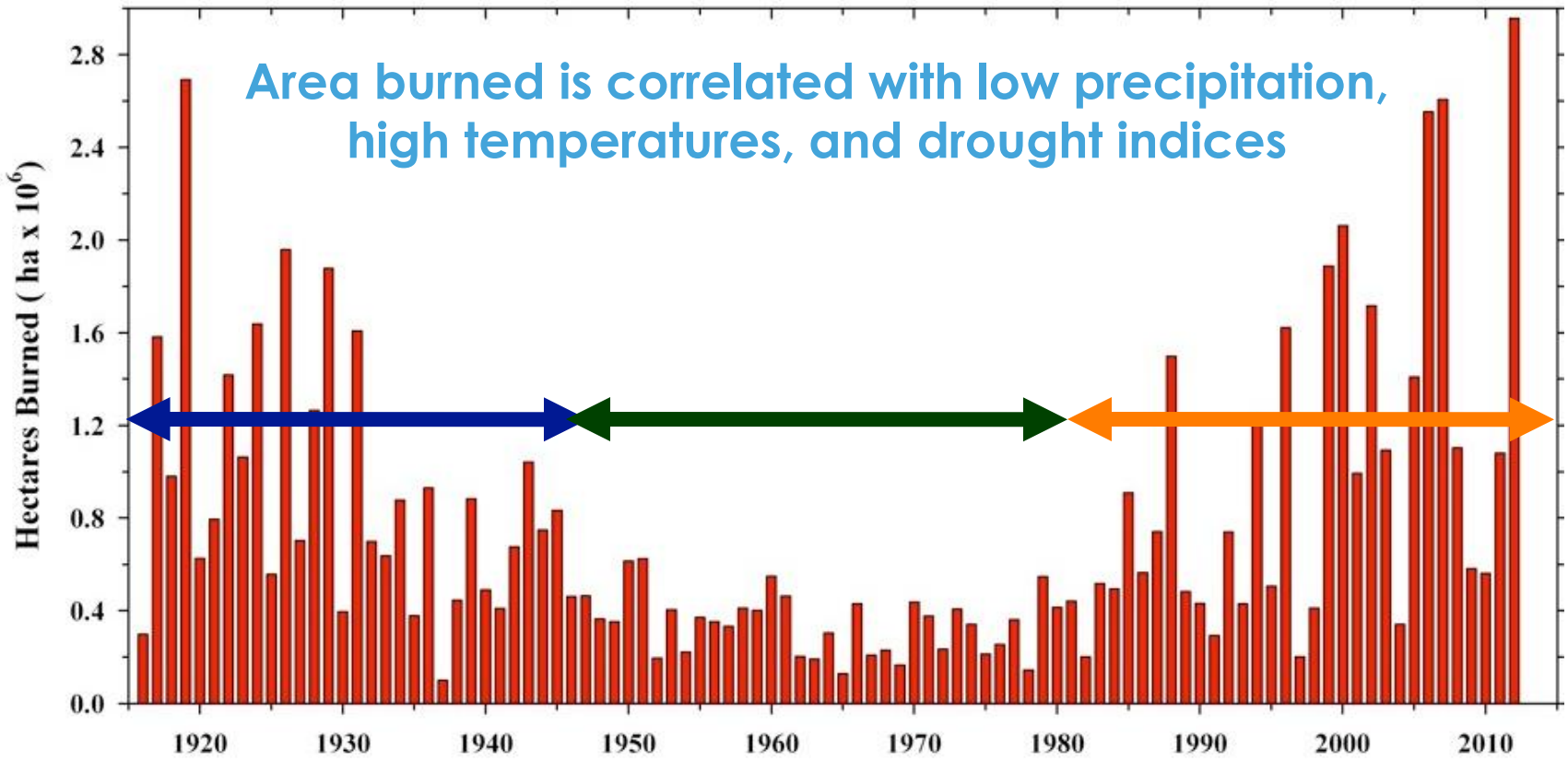
<u>Overarching question</u>:

How does fire impact different parts of the alpine treeline ecotone, from continuous forest, through subalpine parkland, to alpine areas?

<u>For this talk</u>:

Emphasize specific observations and results related to Whitebark pine.

Area burned in 11 Western states, 1916-2012

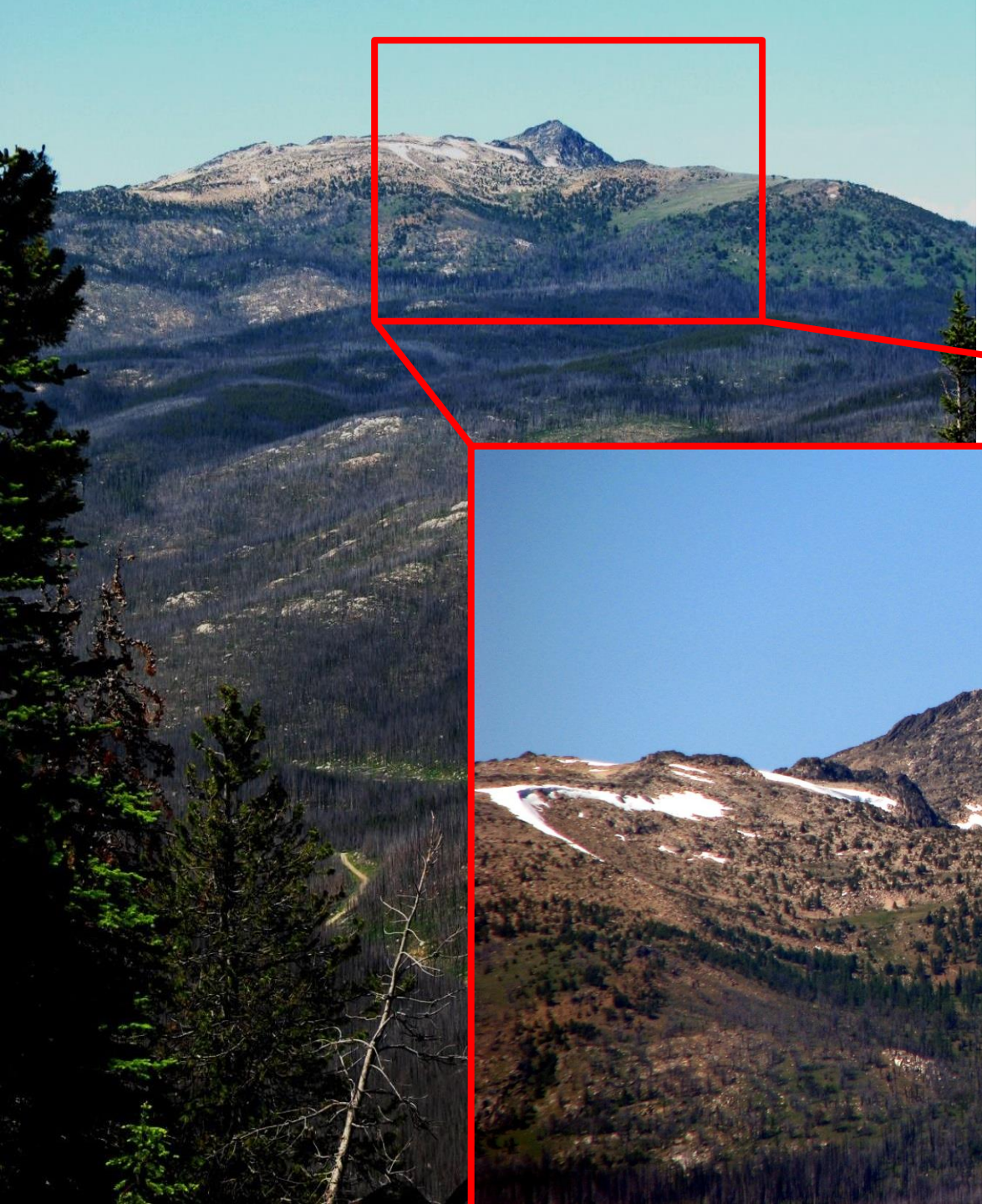


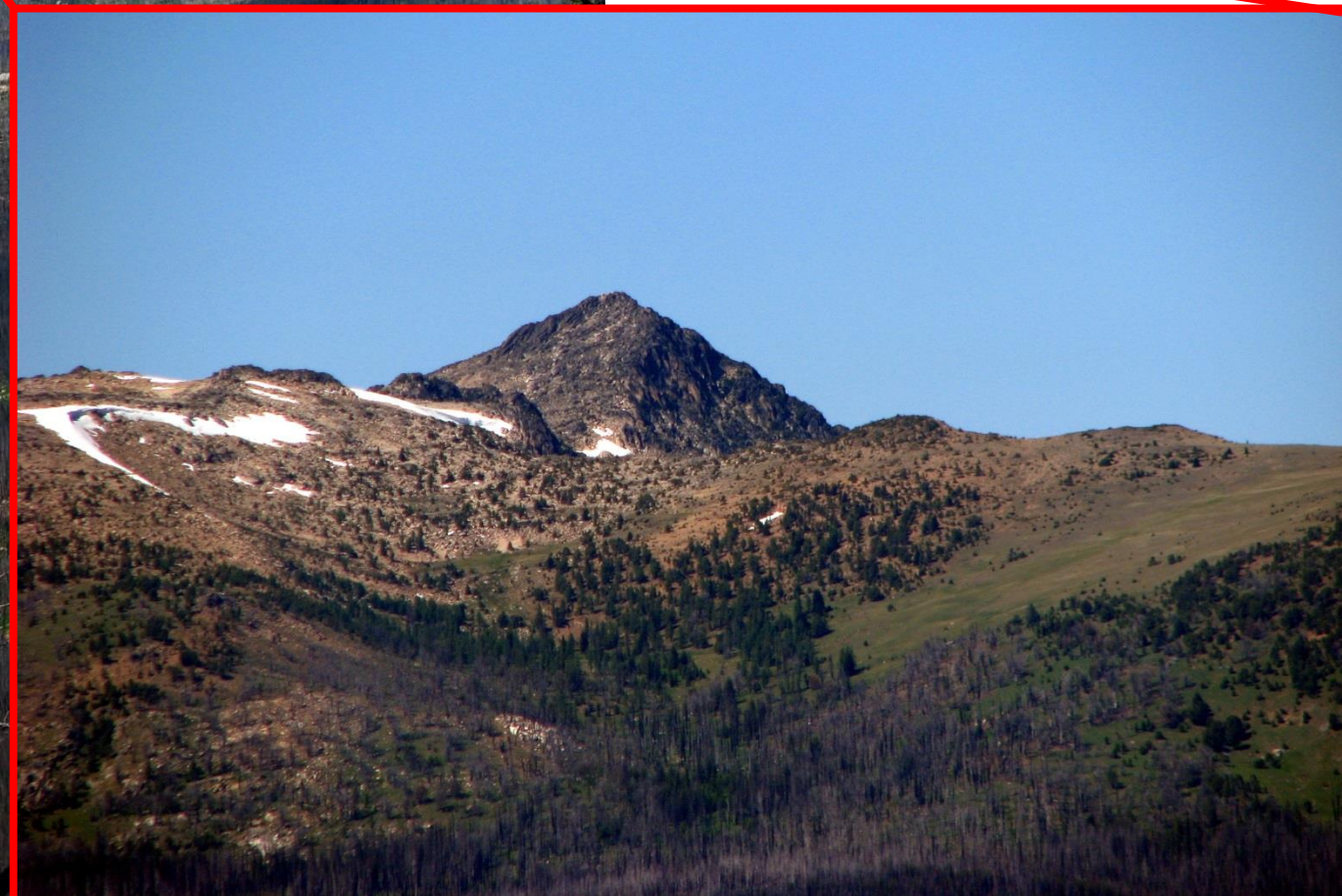
Warm/dry climate

Cool/wet climate & active fire suppression

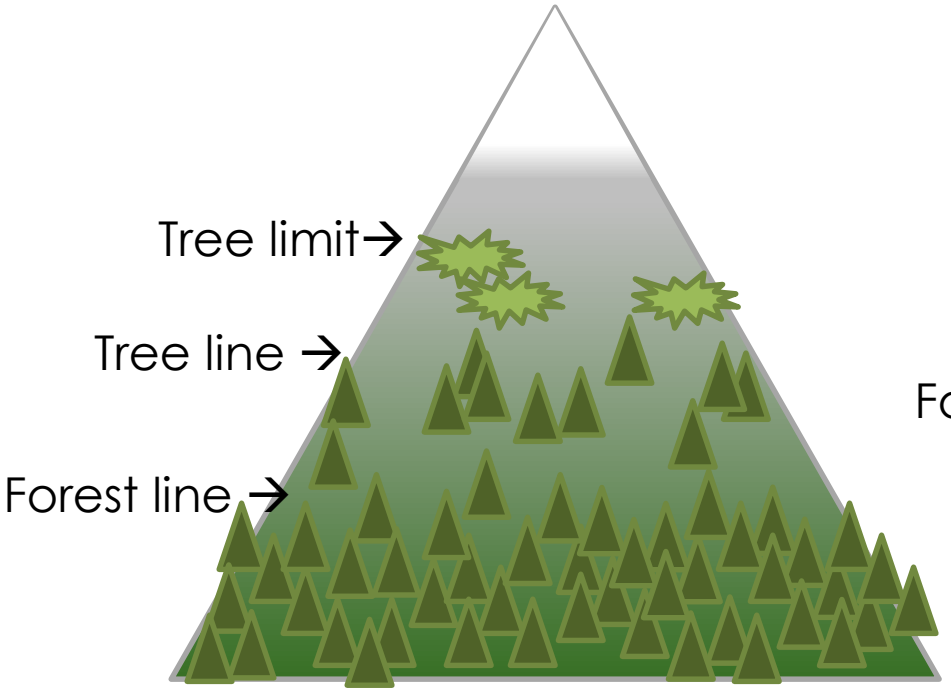
Warm/dry climate Period of fire increase

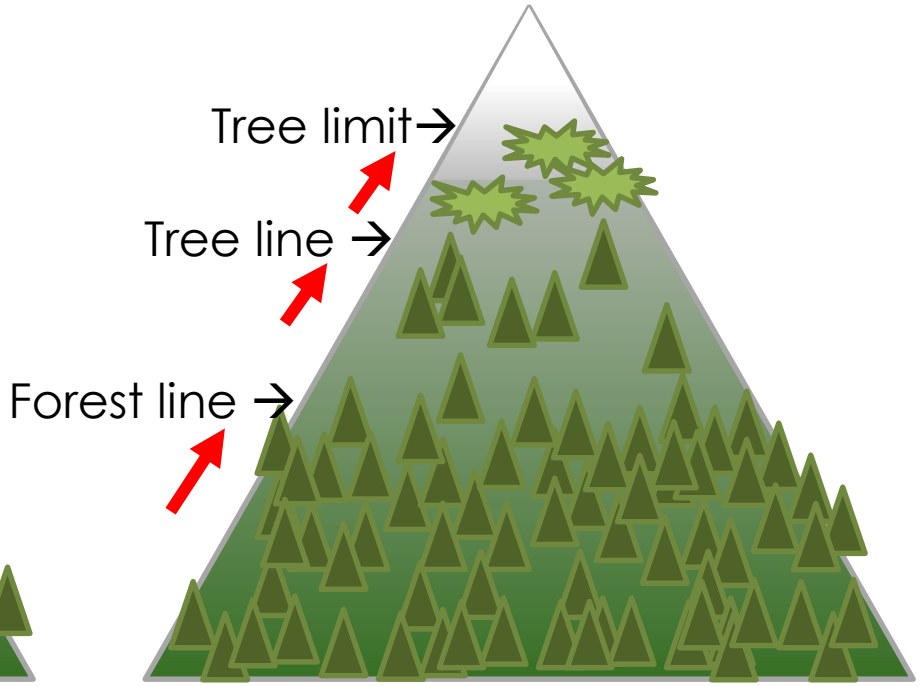
Are climate-driven changes in fire regimes impacting alpine treeline ecotones?



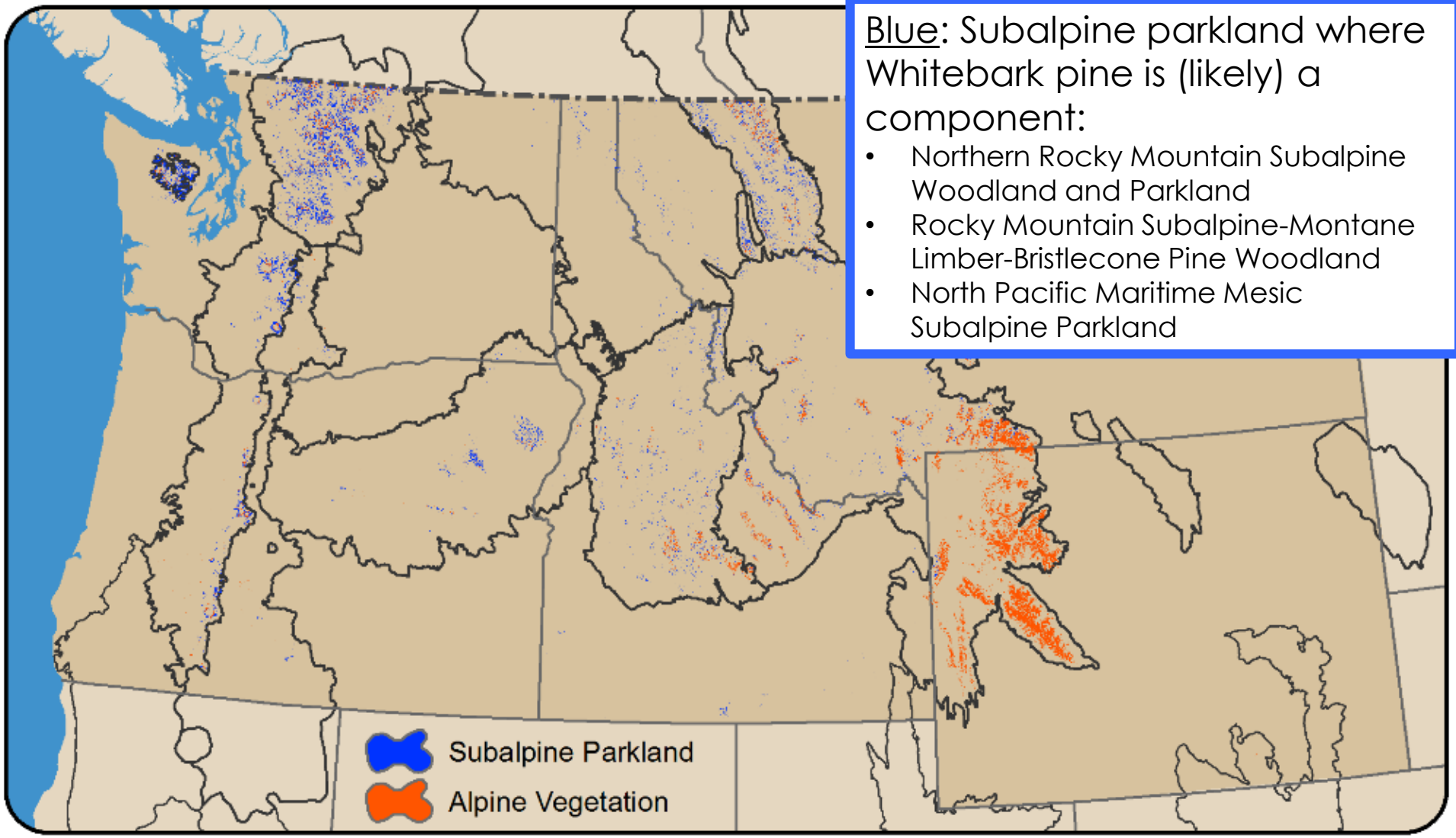


Could increased fire counteract impacts of climate change on treelines?





In the modern era (1984-2012), are fires impacting treeline areas?



Blue: Subalpine parkland where Whitebark pine is (likely) a component:

- Northern Rocky Mountain Subalpine Woodland and Parkland
- Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
- North Pacific Maritime Mesic Subalpine Parkland

Cansler, C.A., McKenzie, D., Halpern, C. 2016. Area burned in alpine treeline ecotones reflects region-wide trends. *In press* at *International Journal of Wildland Fire*.

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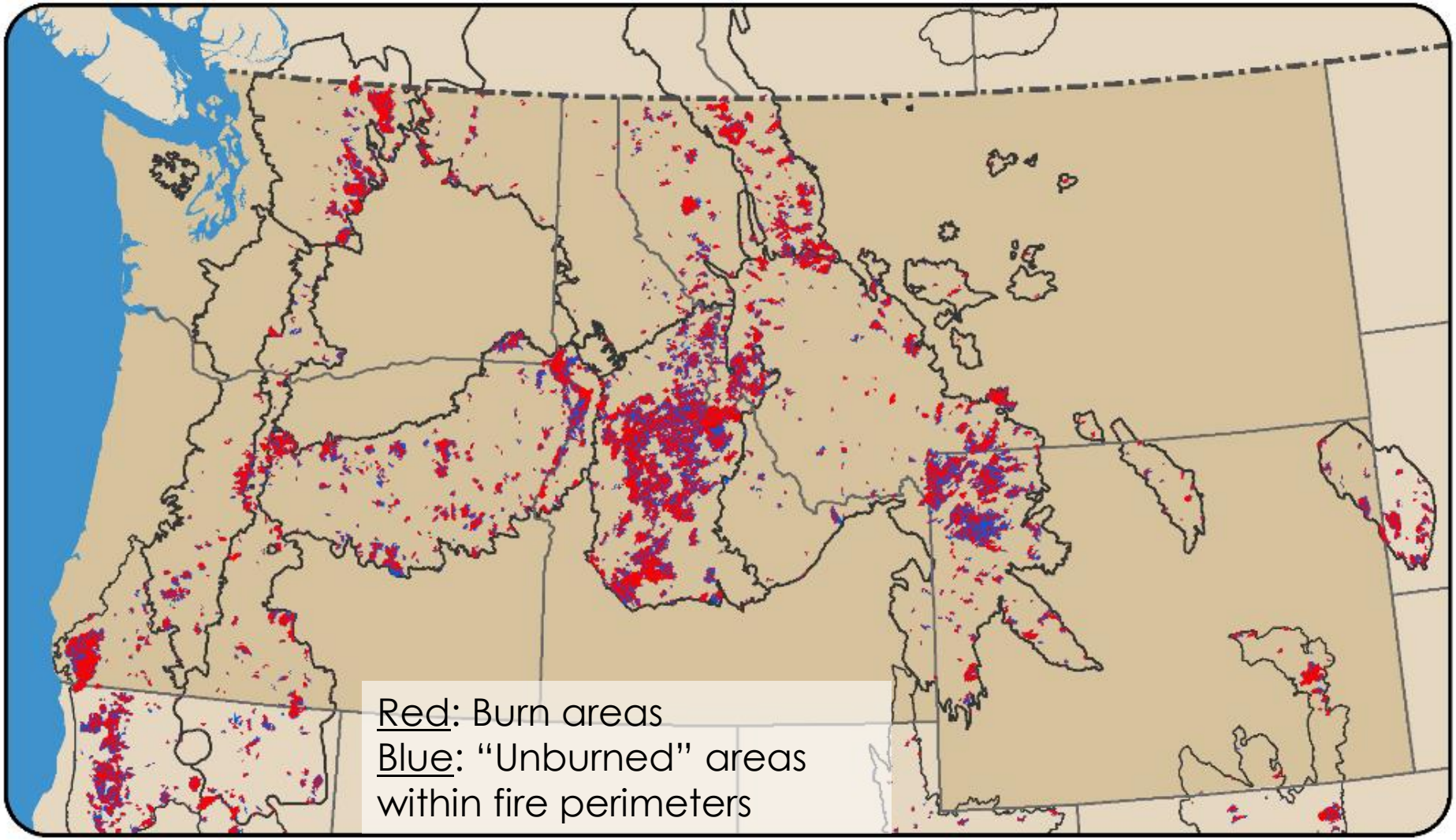
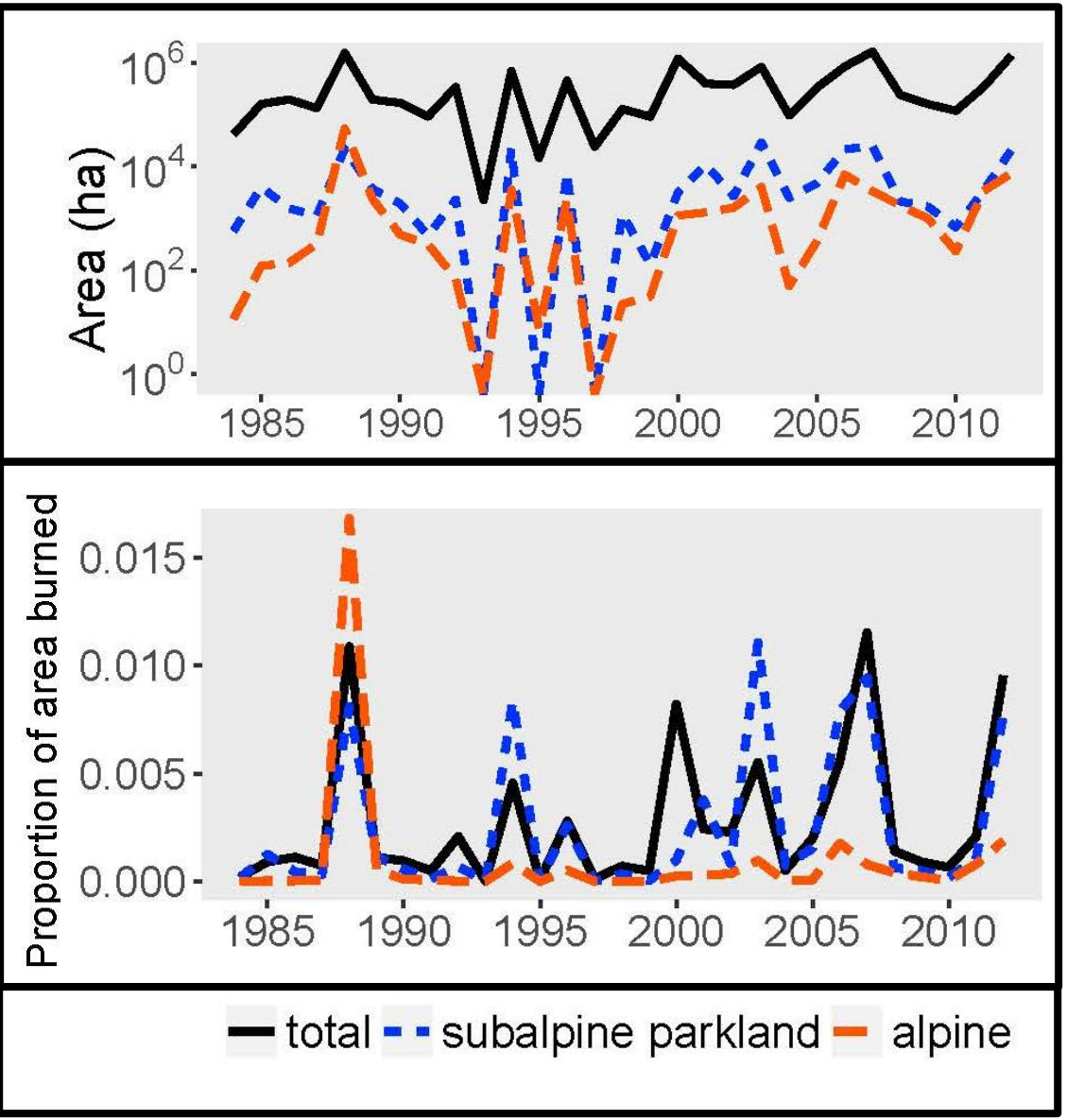


Cansler, C.A., McKenzie, D., Halpern, C. 2016. Area burned in alpine treeline ecotones reflects region-wide trends. *In press* at *International Journal of Wildland Fire*.

Subalpine parkland burns slightly less than the broader landscape & alpine burns much less.



Area burned (ha)		
Subalpine parkland	Alpine vegetation	Total area
55,137	27,510	5,015,686

Proportion burned		
Subalpine parkland	Alpine vegetation	Total area
0.070	0.027	0.080

Fire rotation (years)		
Subalpine parkland	Alpine vegetation	Total area
412	1,083	364

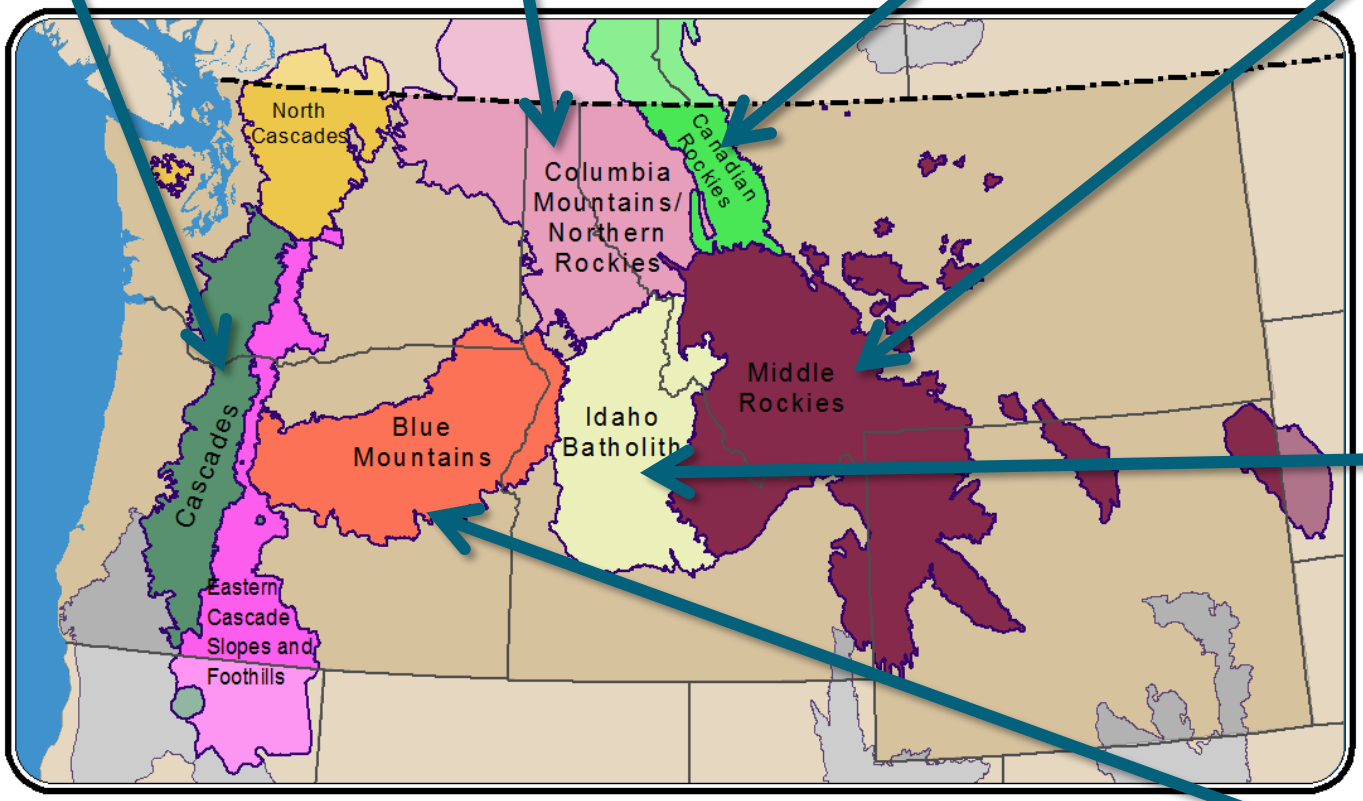
In four ecoregions subalpine parkland burned more than the broader landscape.

Cascades
Parkland: 3.8%
Regional: 3.0%

Columbia Mountains
Parkland : 3.8%
Regional: 1.8%

Canadian Rockies
Parkland : 8.1%
Regional: 5.6%

Middle Rockies
Parkland: 8.0%
Regional: 7.2%



Idaho Batholith
Parkland: 22%
Regional: 29%

Blue Mountains
Alpine: 18.5%
Regional: 10.9%

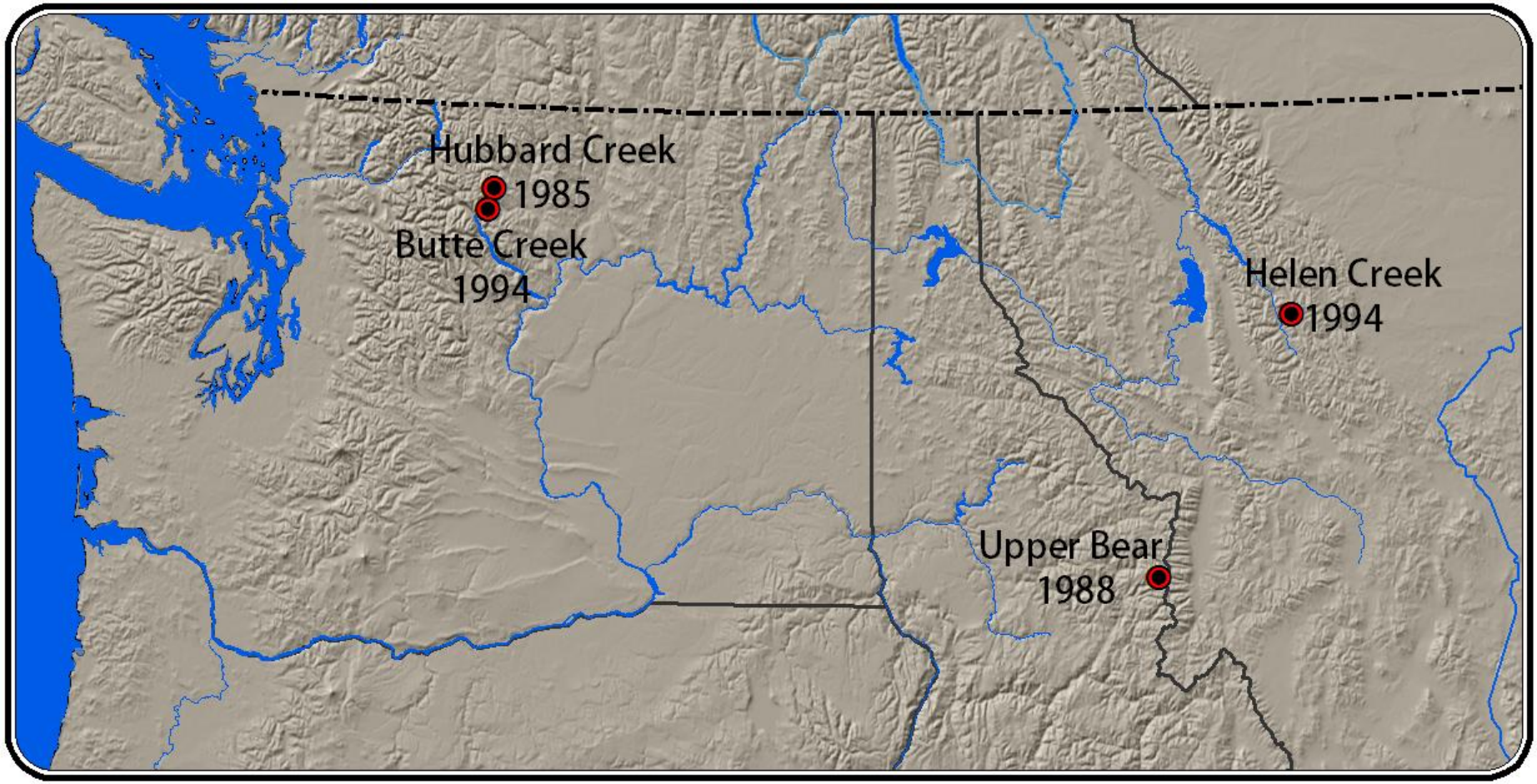
Fire regimes in subalpine forests may be more responsive to climate change

<u>Possible causes:</u>

- CLIMATE
  - Elevation dependent warming
  - Local increase in fuel connectivity (*e.g.,* infilling of meadows)
  - Increases in flammability of adjacent subalpine or other forest types
- FIRE MANAGEMENT
  - Increasing contagion following fire exclusion
  - Increasing wildland fire use
  - Reduced area burned at low elevations

Research sites

Four burned alpine treeline ecotones in the Northern Cascade Range or Northern Rocky Mountains



Research sites

531 field plots sampled

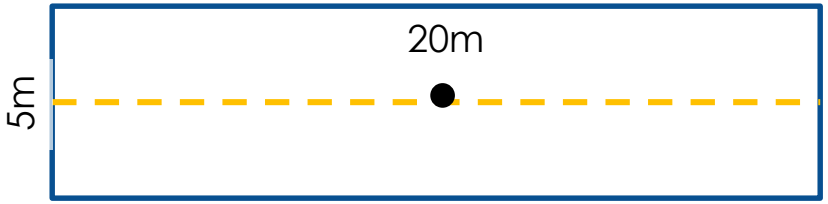
Fire	Year	Location	Elevation range (m)	Dominant tree species	Field plots
Hubbard Creek	1985	Northern Cascade Range (WA)	2150-2460	*Abies lasiocarpa, Larix lyallii, Picea engelmannii*	99
Upper Bear	1988	Bitterroot Mountains (ID)	2050-2390	*Abies lasiocarpa, Pinus albicaulis, Pinus contorta subsp. latifolia*	92
Helen Creek	1994	Bob Marshall Wilderness (MT)	1850-2400	*Abies lasiocarpa, Pinus albicaulis, Picea engelmannii*	189
Butte Creek	1994	Northern Cascade Range (WA)	1850-2255	*Abies lasiocarpa, Pinus albicaulis, Larix lyallii*	151

Field Plot Sampling Design

Stratified sample by burn/unburned and amount forest cover

Macro-plots (5x20 m; 0.01 ha)

1. Canopy-cover structural classes
2. **Burn severity class**
3. **Overstory trees (>1.4m height)**
4. **Seedling trees**



1. How did the fire change *overstory tree density and size structure*?
2. How did fire change tree species composition of *overstory trees*?
3. Which species are most abundant as seedlings after fire?

Reconstructed pre-fire conditions

DEAD BEFORE FIRE: **Bole of larger trees deeply charred** **ALIVE BEFORE FIRE:** **Bole of smaller trees not charred**	**DEAD & DOWN BEFORE FIRE:** **Bole of log deeply charred** **ALIVE BEFORE FIRE:** **Bole not charred on standing trees**	**ALIVE AFTER FIRE / RECENT MORTALITY:** **Bark and fine branches still present** **Frass in beetle galleries**

Fire severity

How did the fire change overstory tree density and size structure?

Overstory size classes	DBH range
A	<5 cm
B	≥5 cm to <10 cm
C	≥10 cm to <20 cm
D	≥20 cm to <40 cm
E	≥40 cm

- Were smaller or larger trees more likely to be killed by fire?
- Was total mortality or mortality among size classes influenced by pre-fire structure?
- Was mortality among size classes influenced by fire severity?

How did the fire change overstory tree density and size structure and how was that change moderated by pre-fire conditions?

- Trees assigned to a size class
- Conducted an NMDS ordination on density by size class, to understand the main ways size structure varied

Overstory size classes	DBH range
A	<5 cm
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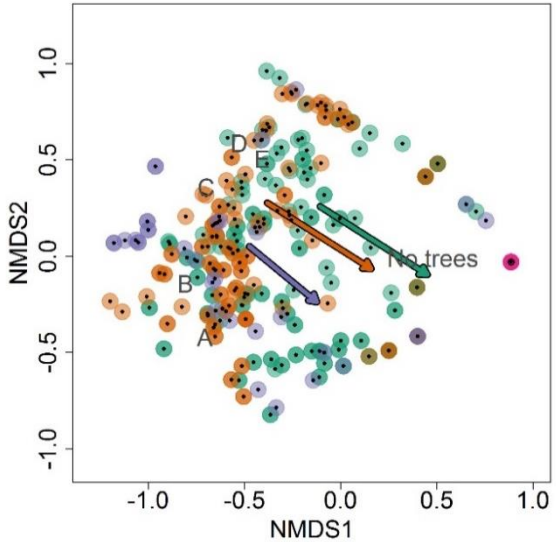
E	≥40 cm

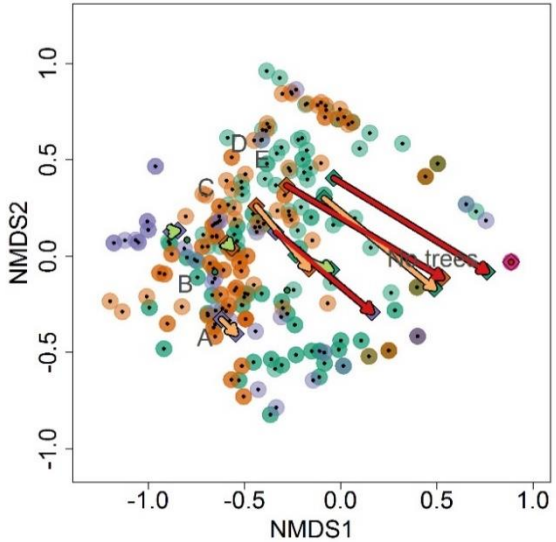
How did the fire change overstory tree density and size structure and how was that change moderated by pre-fire conditions?



Axis 1: From high to low total tree density

Axis 2: From high density of small (<10 cm) trees to high density of larger (>10 cm)trees

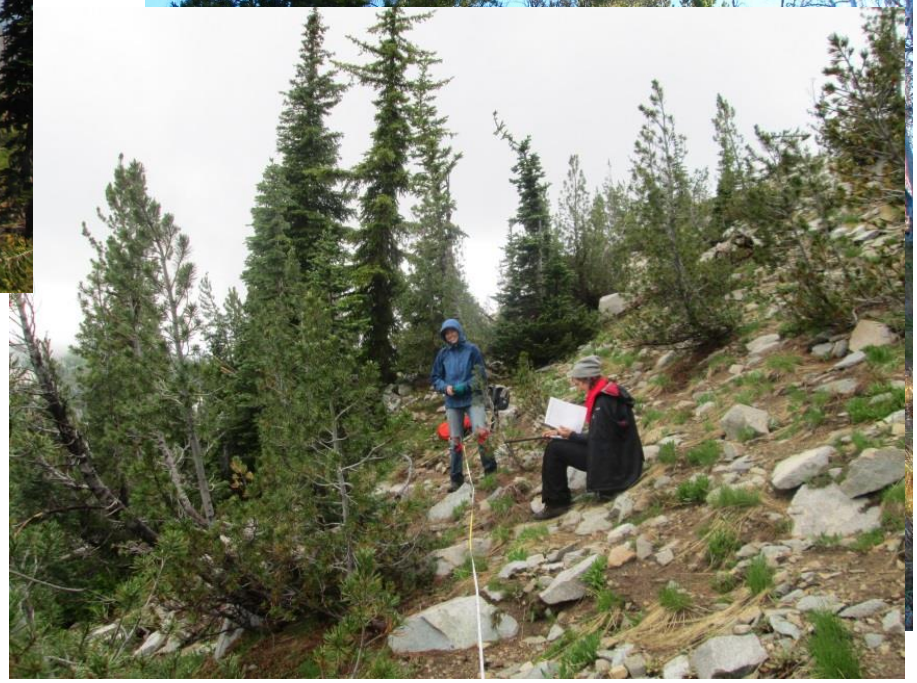
1. Were smaller or larger trees more likely to be killed by fire?
   → Larger trees: greater reductions in tree density in larger size classes.



2. Was total mortality or mortality among size classes influenced by pre-fire structure?
   → No.

3. Was mortality among size classes influenced by fire severity?
   → Yes, at 3 of the sites. Not at Hubbard Creek in the North Cascades.

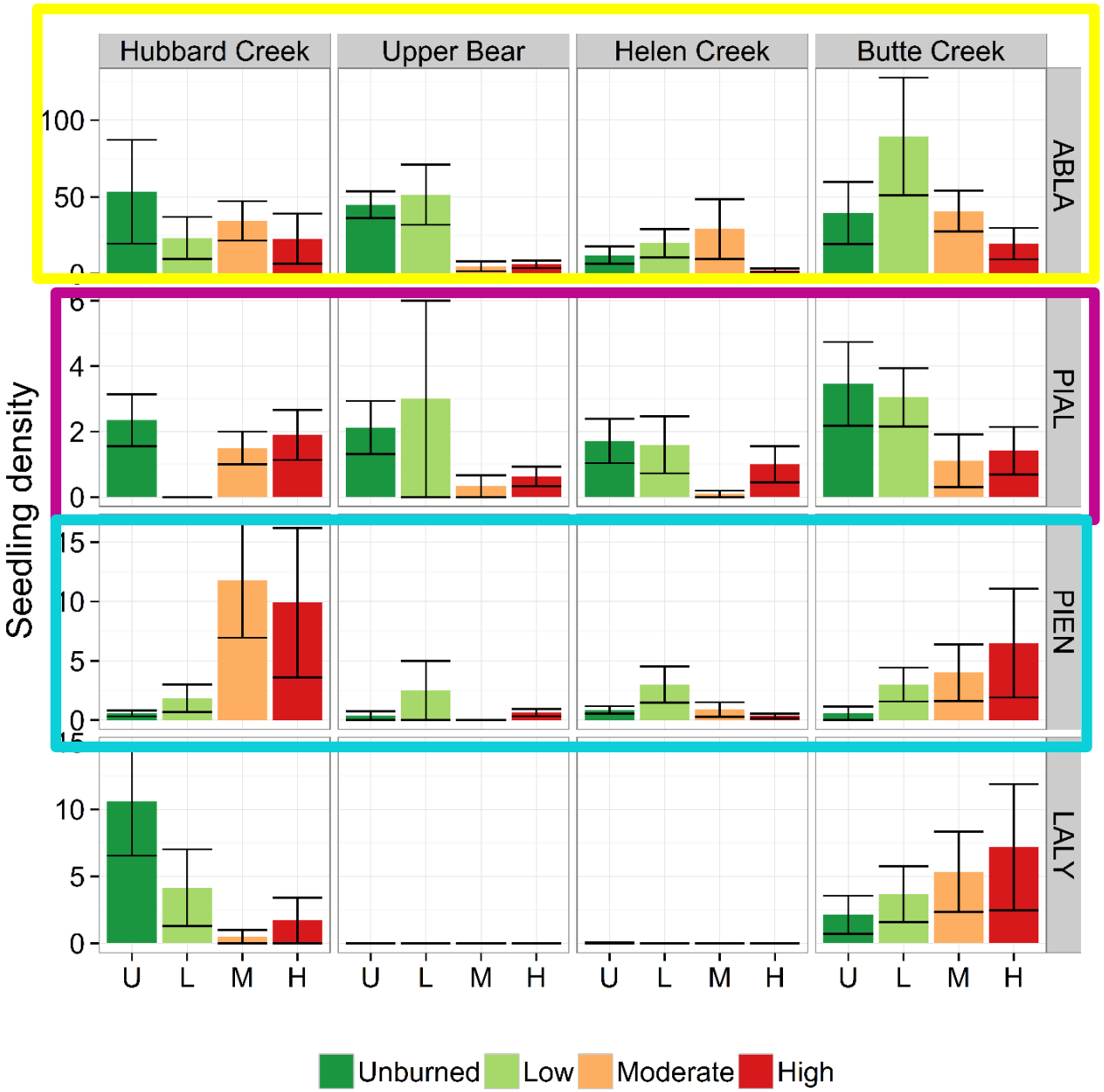
How did the fire change overstory tree-species composition?



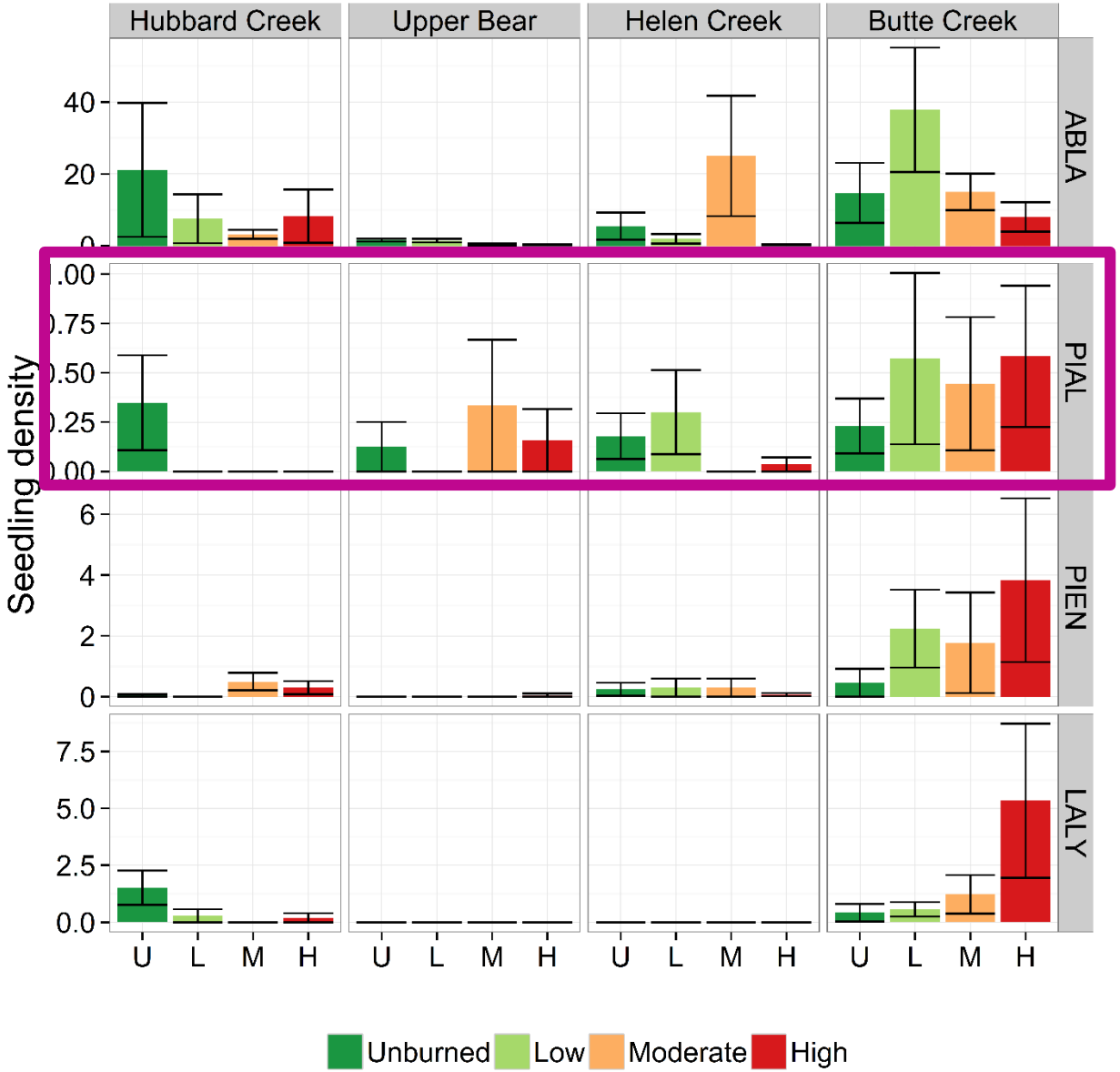
How did the fire change overstory tree-species composition? Mortality in burned plots:

Species	Fire	Mean percent mortality ± S.E.
Pinus albicaulis	Hubbard Creek	**14** ± 14
	Upper Bear	**38** ± 16
	Helen Creek	**81** ± 11
	Butte Creek	**53** ± 11
Abies lasiocarpa	Hubbard Creek	**38** ± 10
	Upper Bear	**64** ± 11
	Helen Creek	**78** ± 6
	Butte Creek	**46** ± 7
Larix lyallii	Hubbard Creek	0
	Upper Bear	0
	Butte Creek	**16** ± 10
Picea engelmannii	Hubbard Creek	**8** ± 6
	Upper Bear	0
	Helen Creek	**71** ± 13
	Butte Creek	**41** ± 14

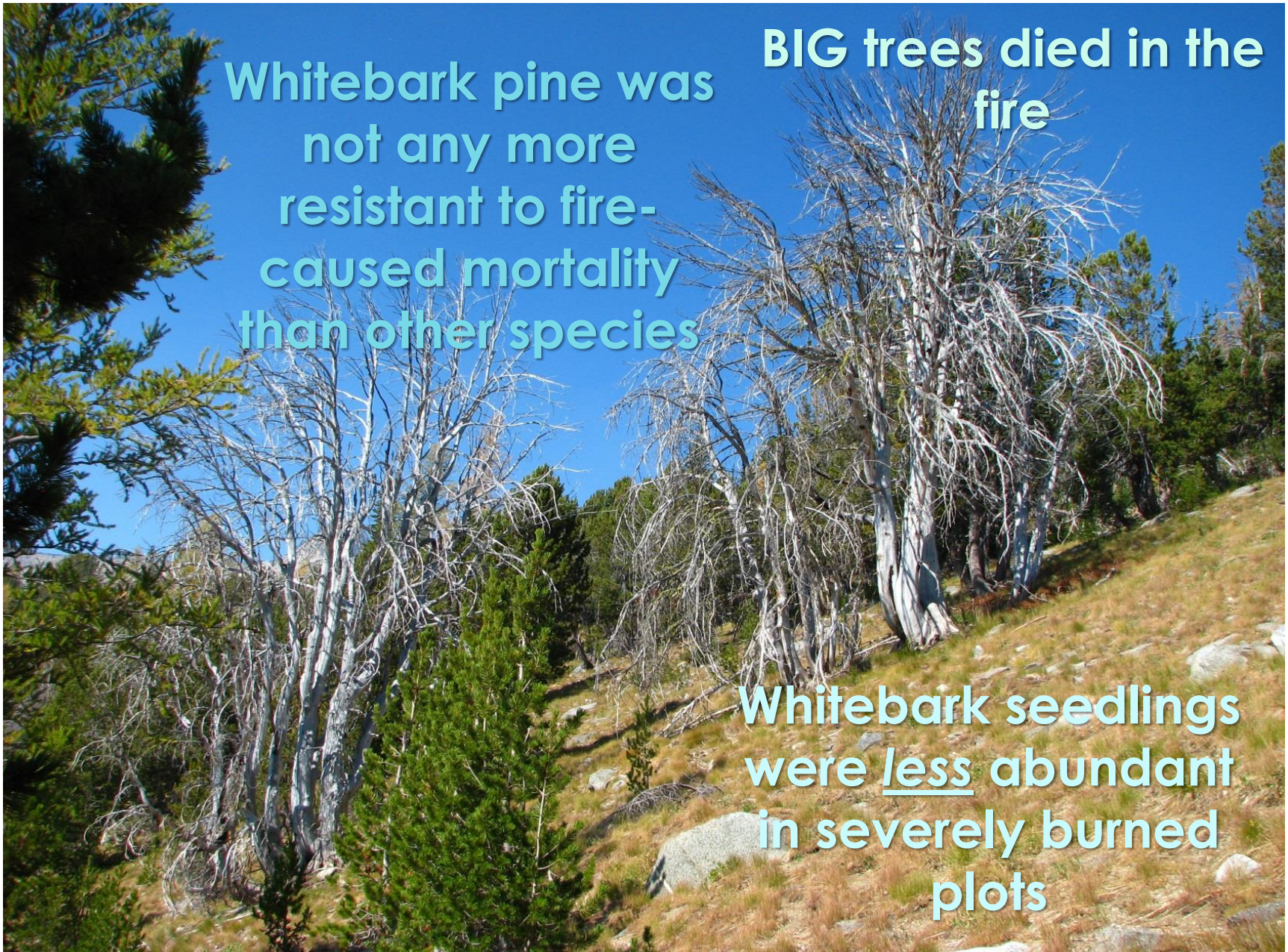
Trees < 1.4 m – where are these burned sites going in the future?



Trees < 0.1 m – where are these burned sites going in the future?



Lessons learned



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