

Mastication as a fuels treatment: Short-term ecological implications of mulching the forest

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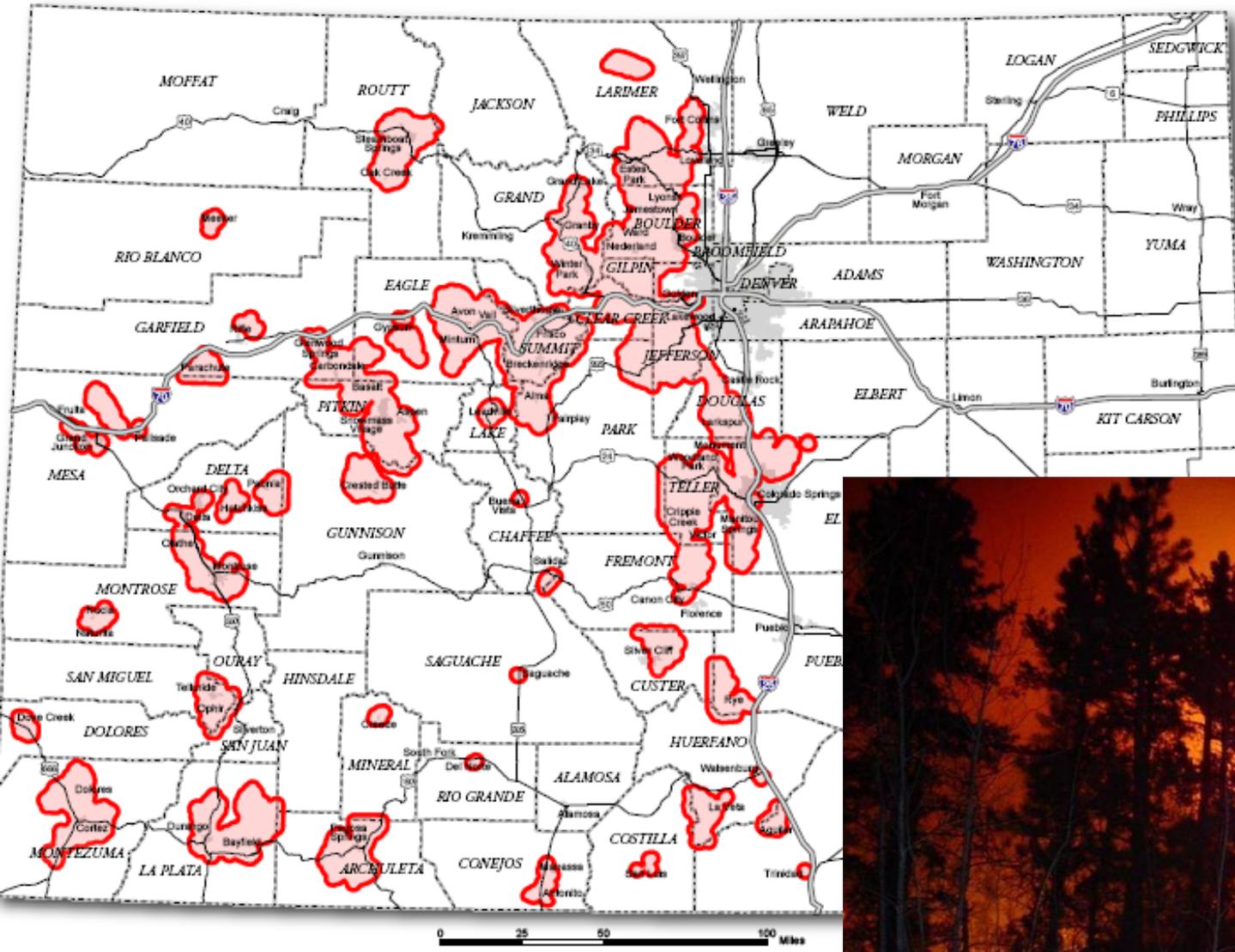
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Interface Areas of High Wildfire Risk in Colorado



Reduce stand density and ladder fuels



What is it?

- Grinding or chipping trees (usually smaller diameter) in place and scattering the wood



Mulching treatments redistribute the standing biomass from the vertical to the horizontal



Widespread Application

- Over 100,000 hectares treated from 2005 to 2011 across the Western U.S.
- No ecological analog – effects unknown



A photograph of a forest floor covered in mulch, with a white string and a yellow marker in the foreground. The background shows a dense forest of tall, thin trees. The text "What are the ecological impacts of mulching treatments?" is overlaid in yellow.

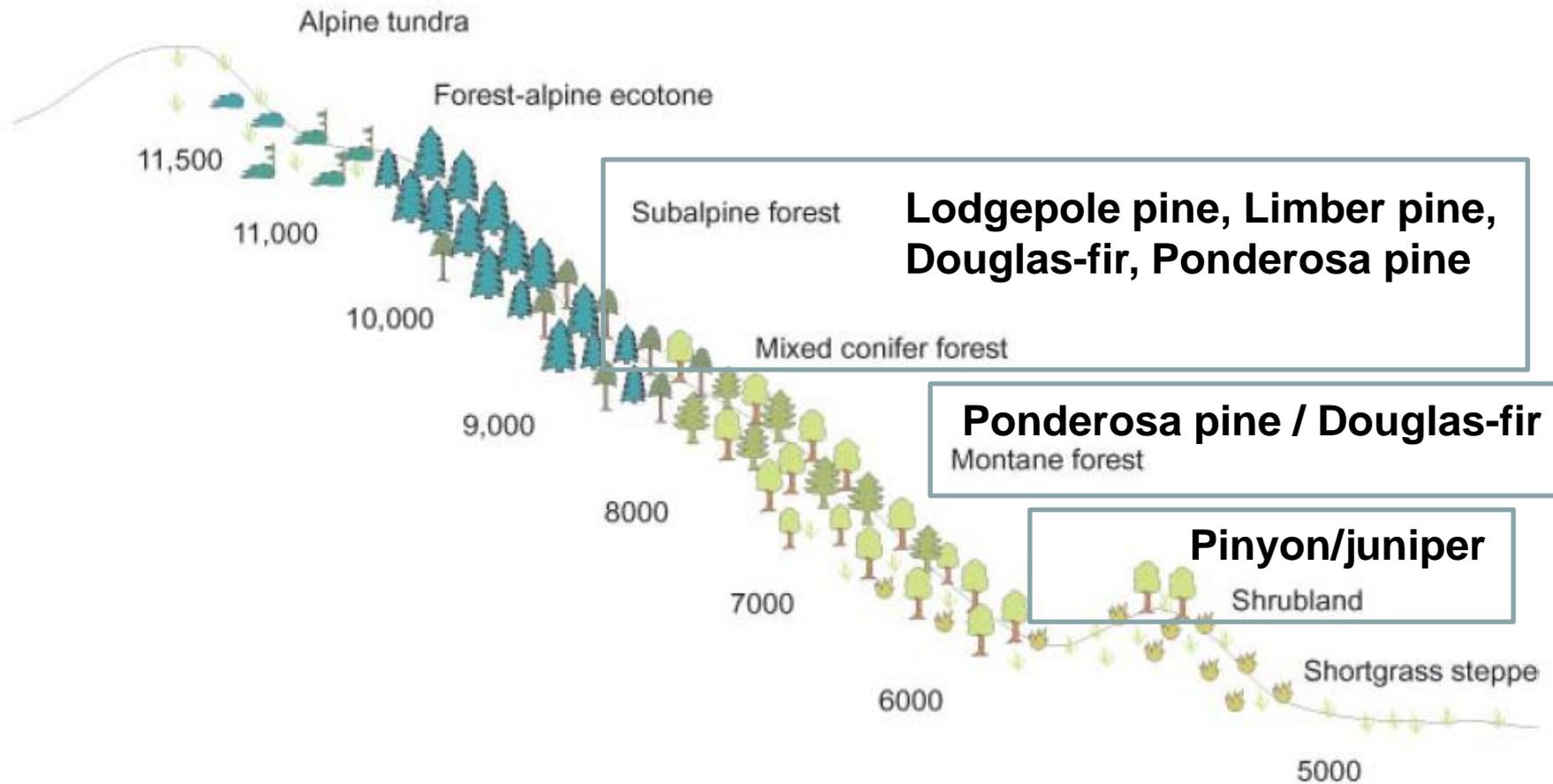
What are the ecological impacts of mulching treatments?

Outline

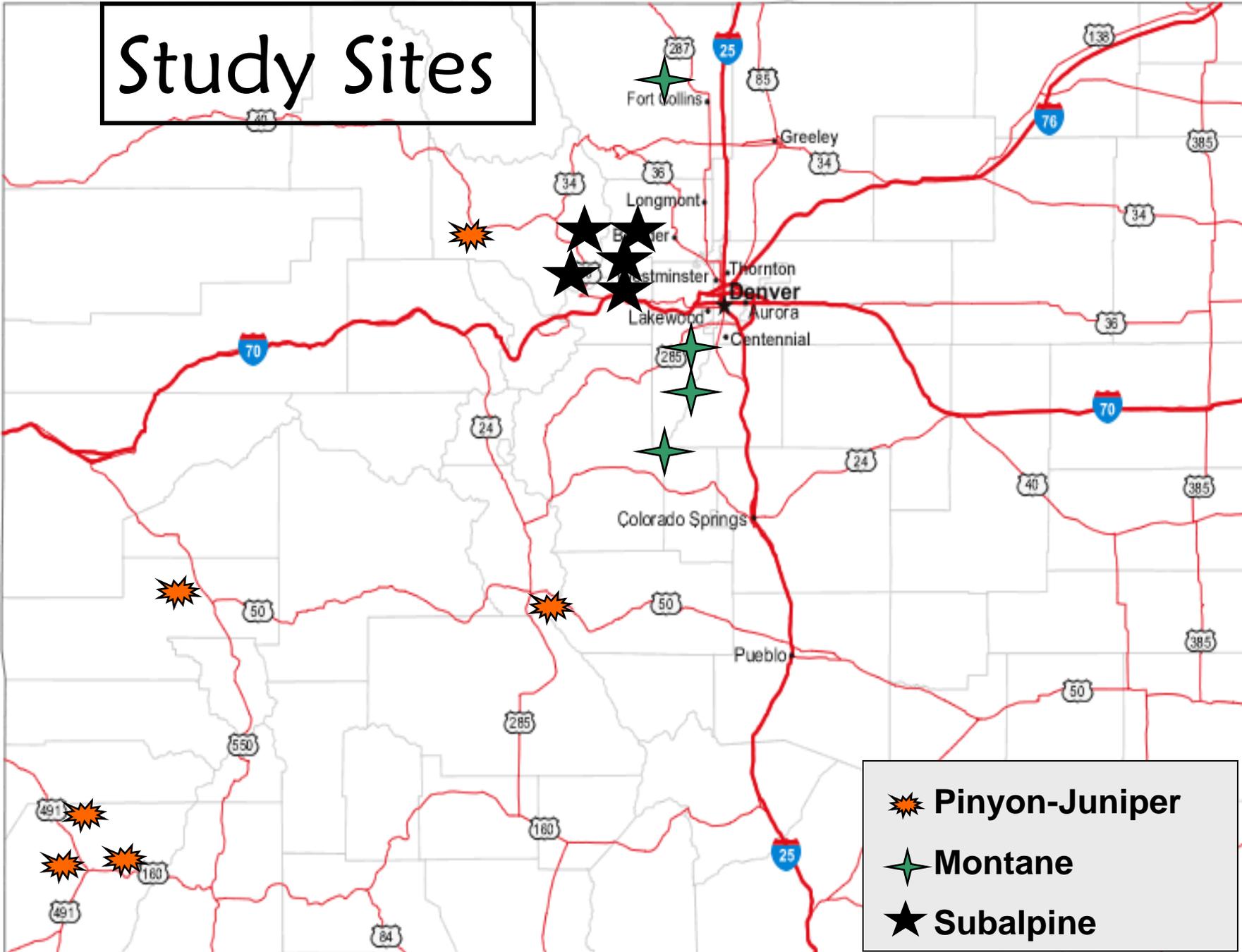
- Operational-scale
 - Fuels
 - Vegetation
 - Soils and Nitrogen
- Mulch depth experiment



Colorado Vegetation



Study Sites



 Pinyon-Juniper

 Montane

 Subalpine



Interstate Highways



US Highways

0

100 KM

100 Miles

© geology.com

Methods – Operational-scale

- Paired mulched and untreated sites
- Sampled 2 to 4 years after treatment
- 3 50 m transects per study area
- 25 1 m² quadrats per transect



Tree density reduction

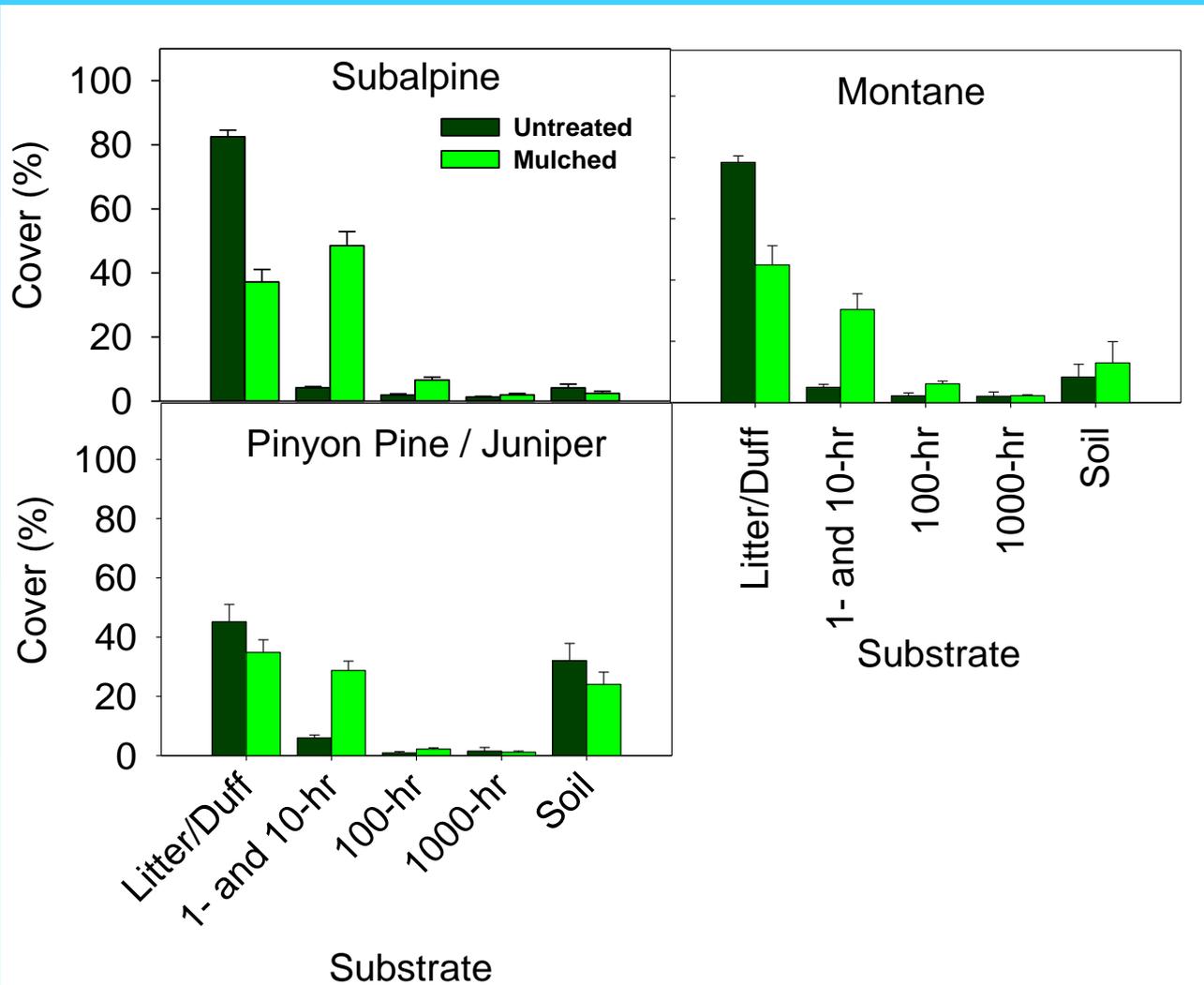
Ecosystem	Untreated avg BA (m²/ha)	Mulched avg BA (m²/ha)	Avg Basal area reduction
Subalpine	38.6	8.0	79%
Montane	26.8	11.2	58%
Pinyon- Juniper	22.0	9.5	57%

Quantify changes to forest floor

- Forest floor coverage
- Fuel loadings
- Fuel size distribution



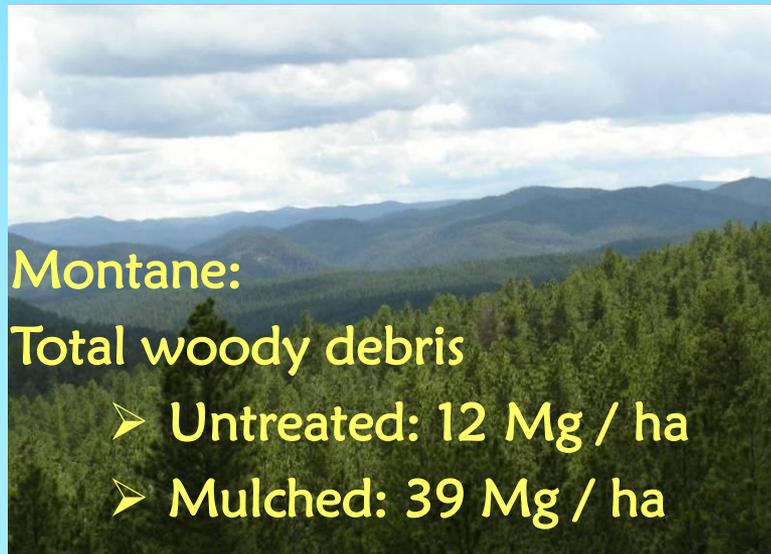
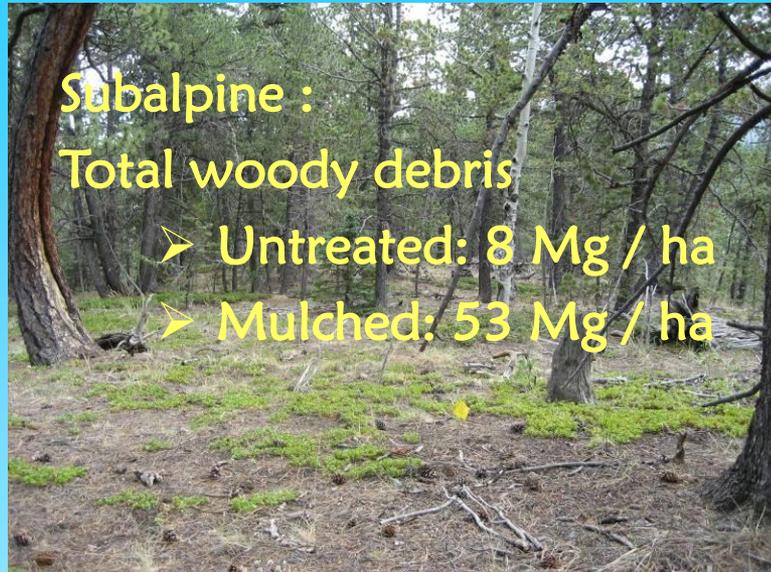
Forest floor coverage altered by mulching treatment



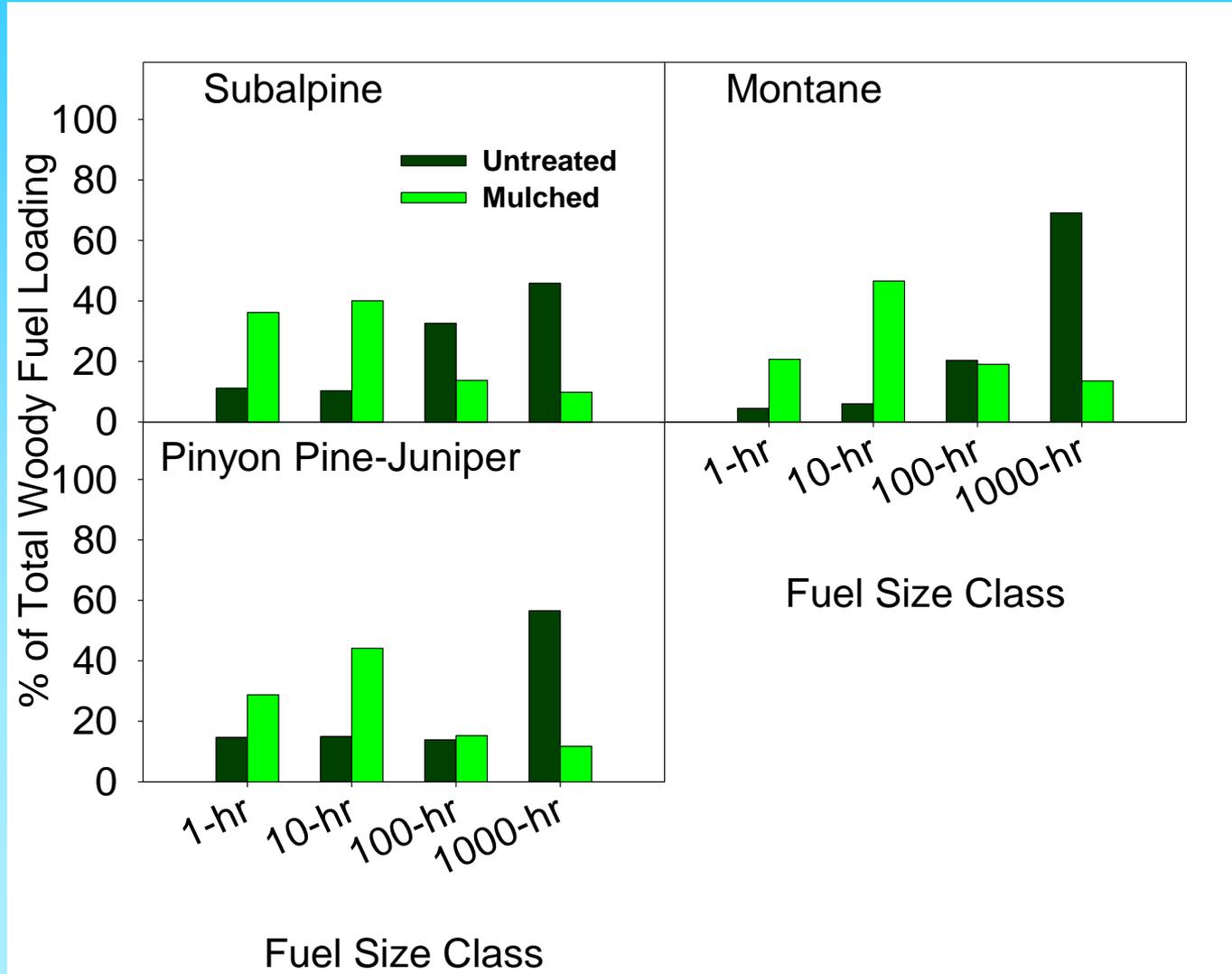
➤ Switch from a needle litter layer to a layer of small pieces of wood

➤ In Pinyon pine, a decrease in soil cover

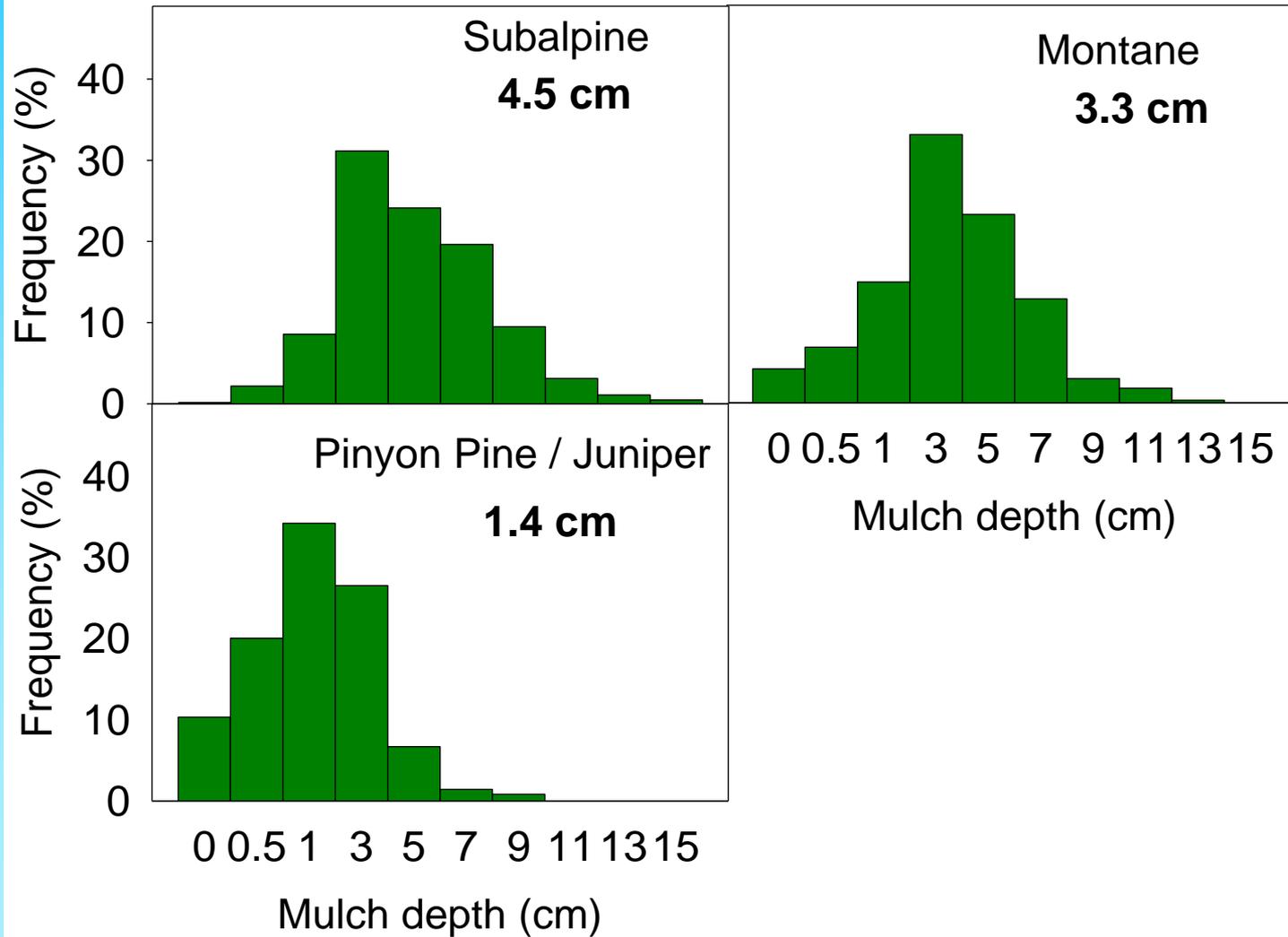
Surface fuel loads 3 to 6 times greater in mulched areas



1 and 10 hr fuels contribute >70 % of total load in mulch treatments

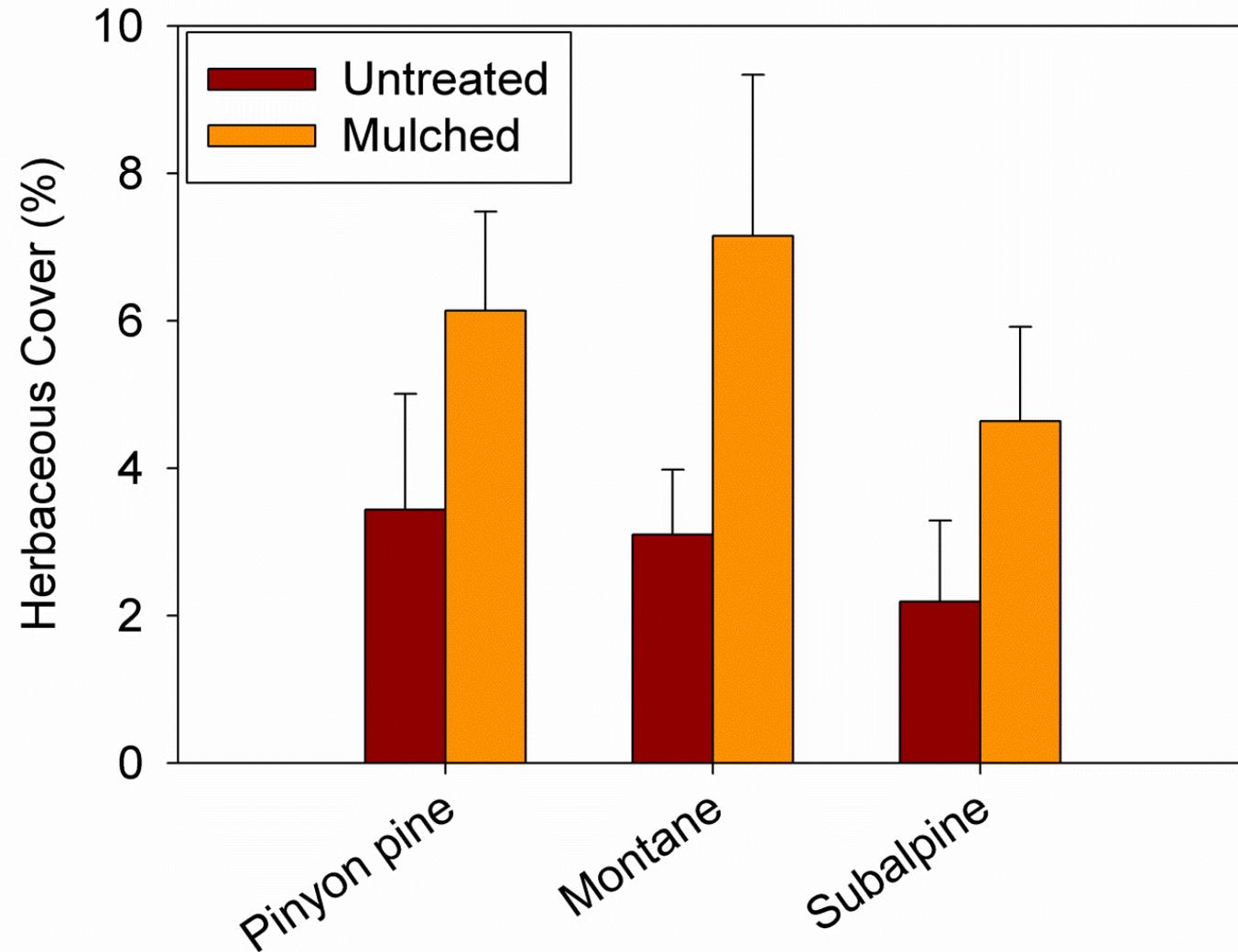


Distribution of mulch depth across treatments





Average herbaceous cover increased but variability high



➤ Results
2 to 4
years
post-
treatment

Exotics across the ecosystems

2 to 4 years post-treatment

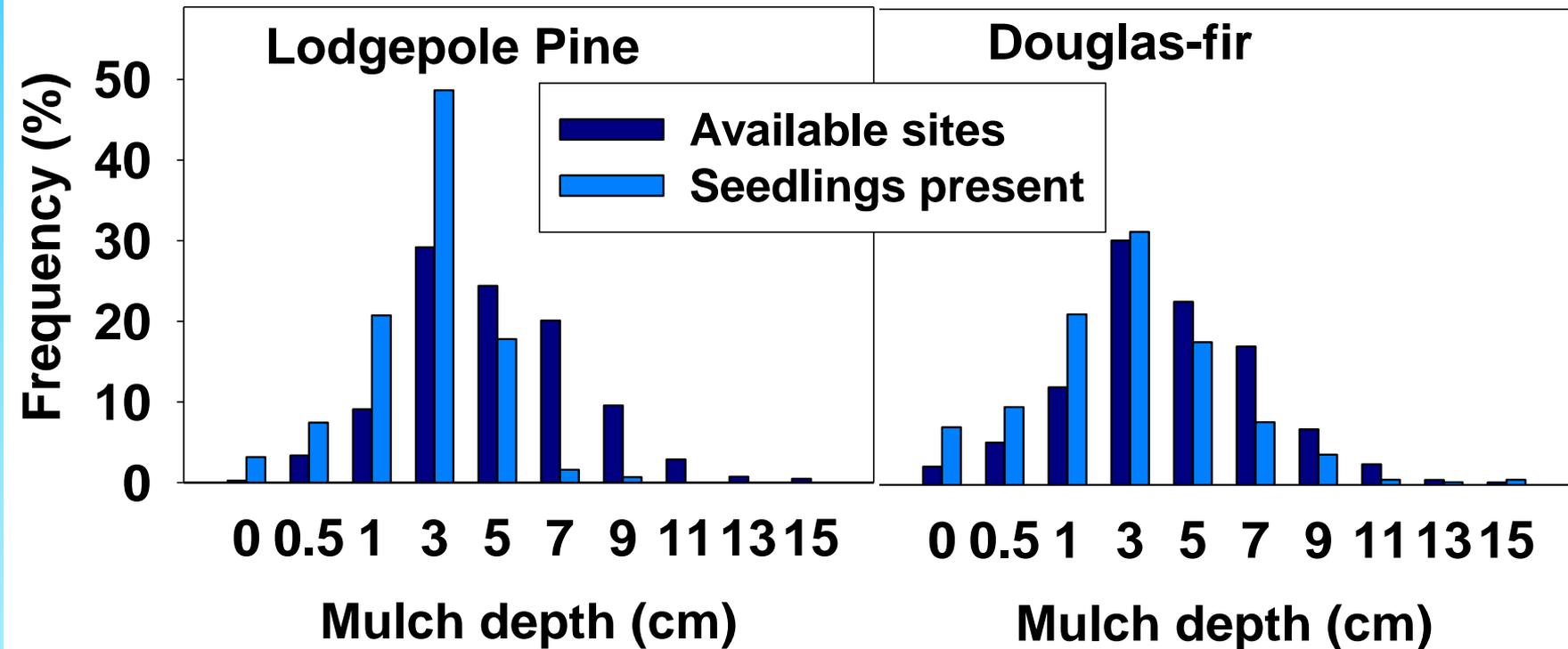
Ecosystem	Untreated	Mulched
Subalpine	<ul style="list-style-type: none"> ▪ essentially absent 	<ul style="list-style-type: none"> ▪ 6 species ▪ Canada thistle most common
Montane	<ul style="list-style-type: none"> ▪ essentially absent 	<ul style="list-style-type: none"> ▪ 11 species ▪ Canada thistle, prickly lettuce, mullein, dandelion common
Pinyon-Juniper	<ul style="list-style-type: none"> ▪ 6 species 	<ul style="list-style-type: none"> ▪ 16 species ▪ cheatgrass at essentially the same sites



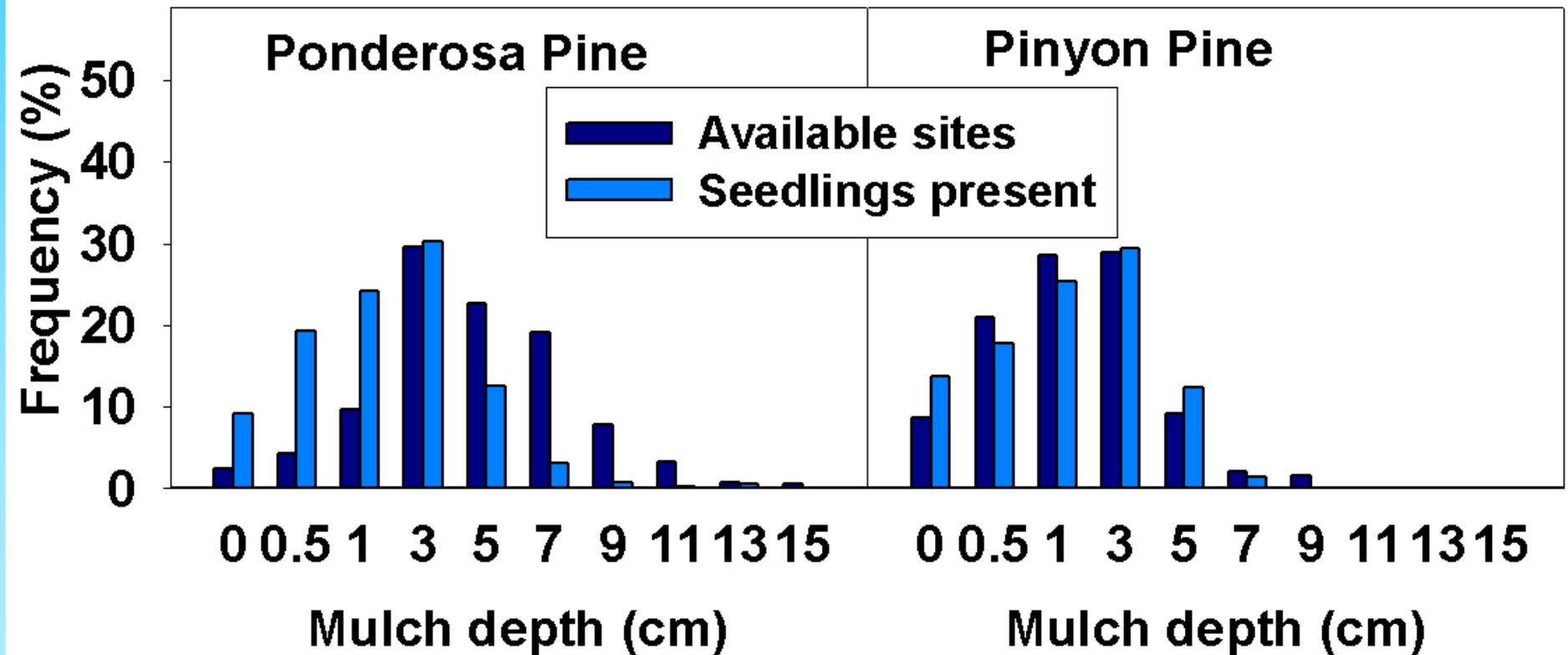


Species preferences for mulch depth

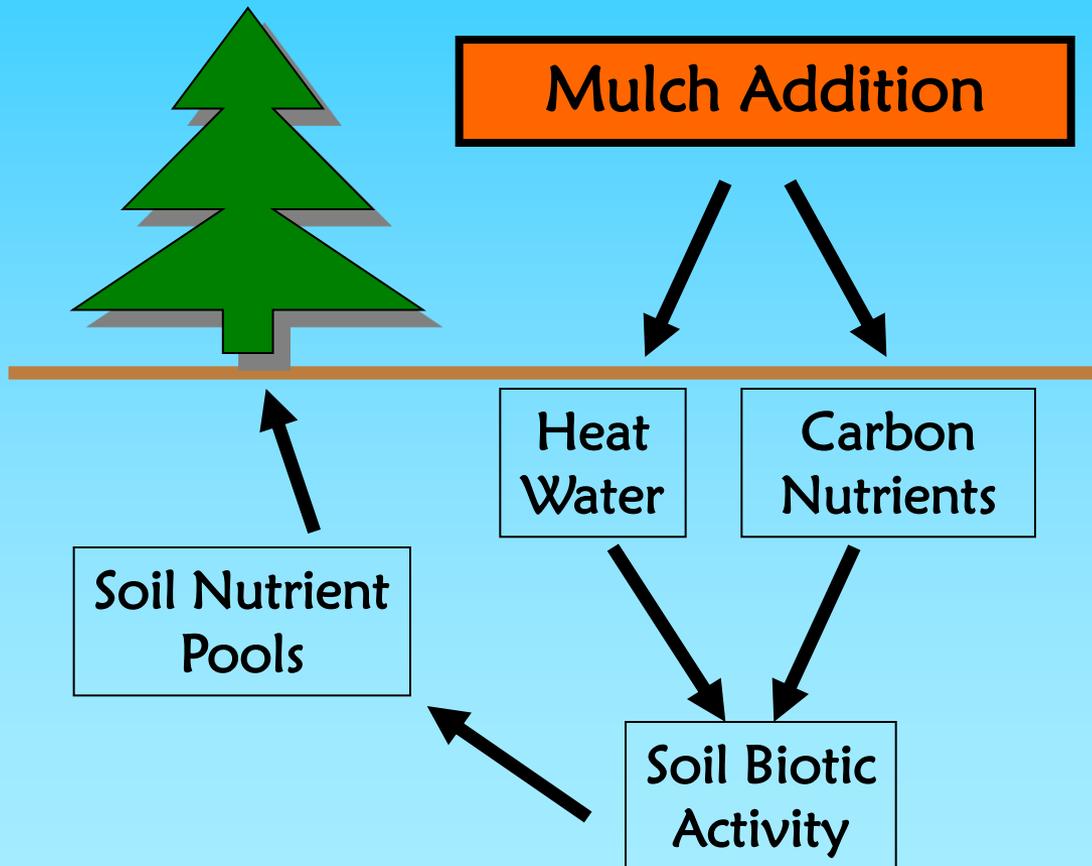
6 to 8 years post-treatment



Species preferences for mulch depth *6 to 8 years post-treatment*



Mulching = Physical + Biological Effects



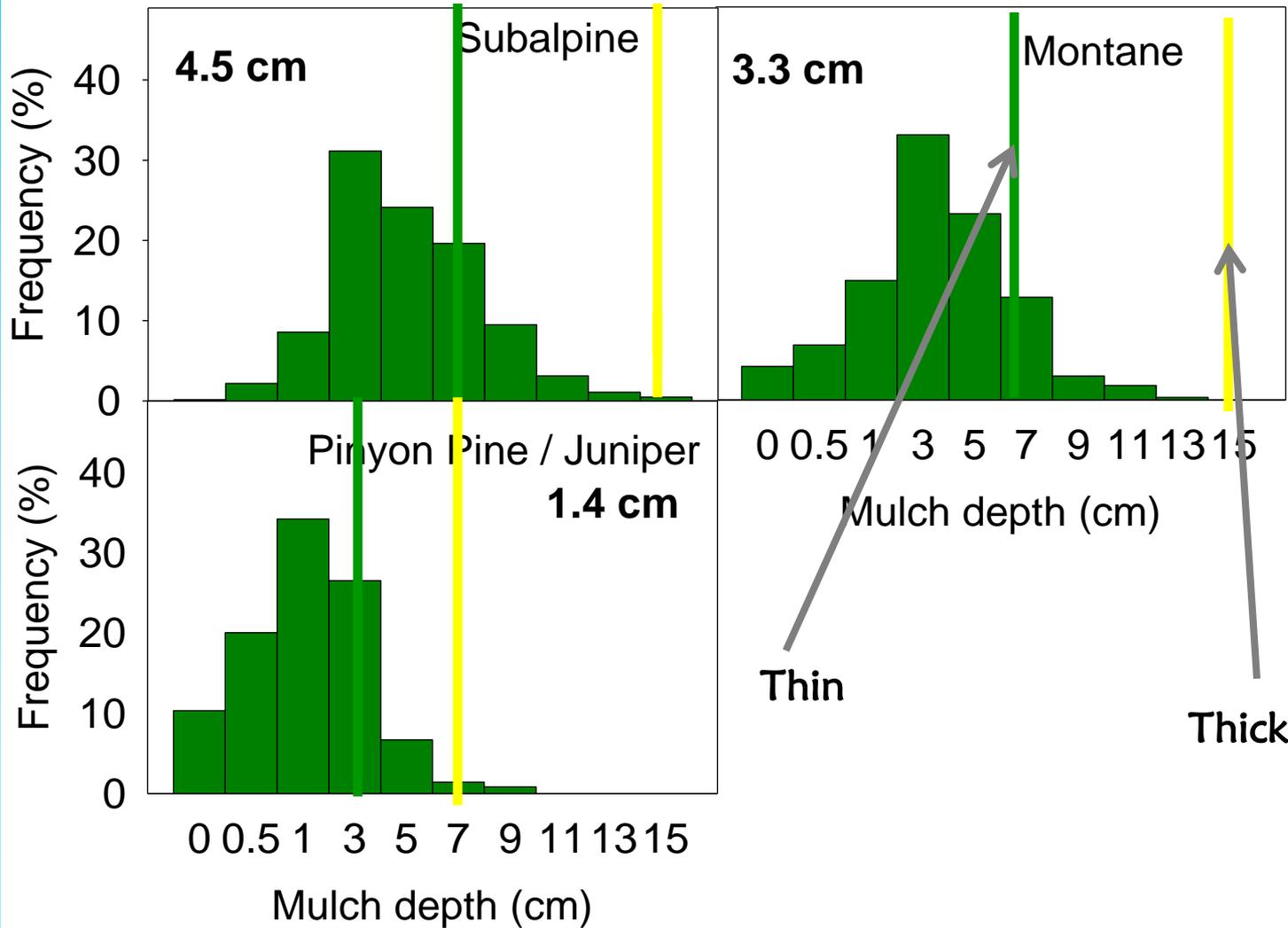
Mulch Effect on Soil N – *Operational scale 2 to 4 years post-treatment*

Forest Type	Total IER Nitrogen	
	Untreated	Mulched
Subalpine	1.04 (0.11)	1.51* (0.19)
Montane	0.96 (0.10)	1.46* (0.15)
Pinyon-Juniper	0.98 (0.10)	0.98 (0.09)
<i>Two-way Anova, Main Effects</i>		
	<i>F</i>	<i>p</i>
Treatment	8.26	0.004
Forest Type	0.26	0.774
Treatment x Forest Type	2.12	0.121

*Data are mean (SE); * denotes p < 0.05*

- IER-N was about 50% higher in mulched areas in subalpine and montane forests
- Mulching increased IER-N at two pinyon-juniper sites, but had no effect at the other four sites.

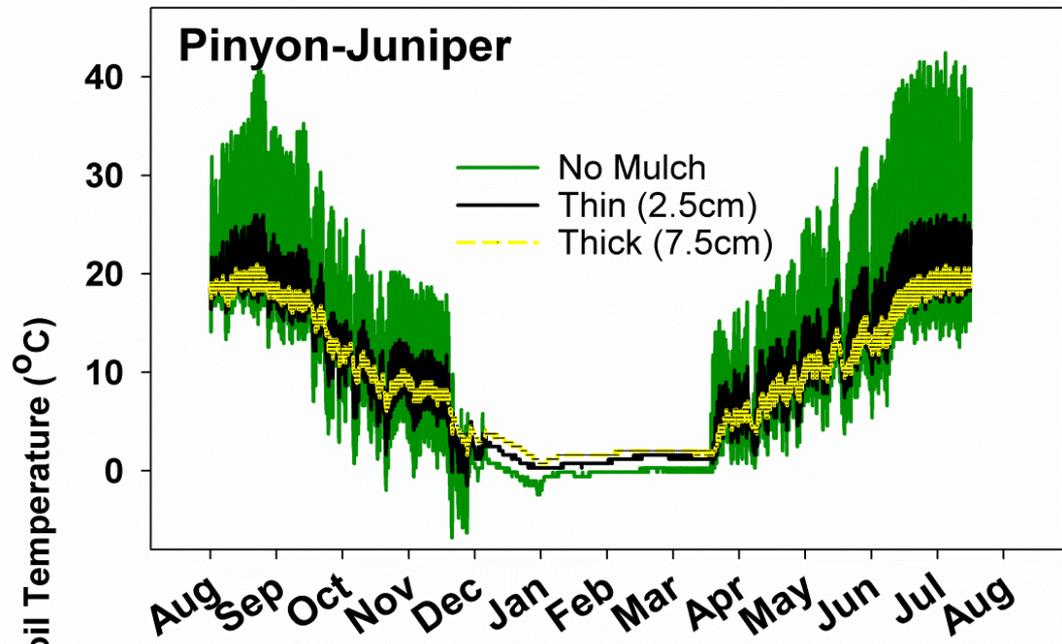
Mulch depth experimental plots



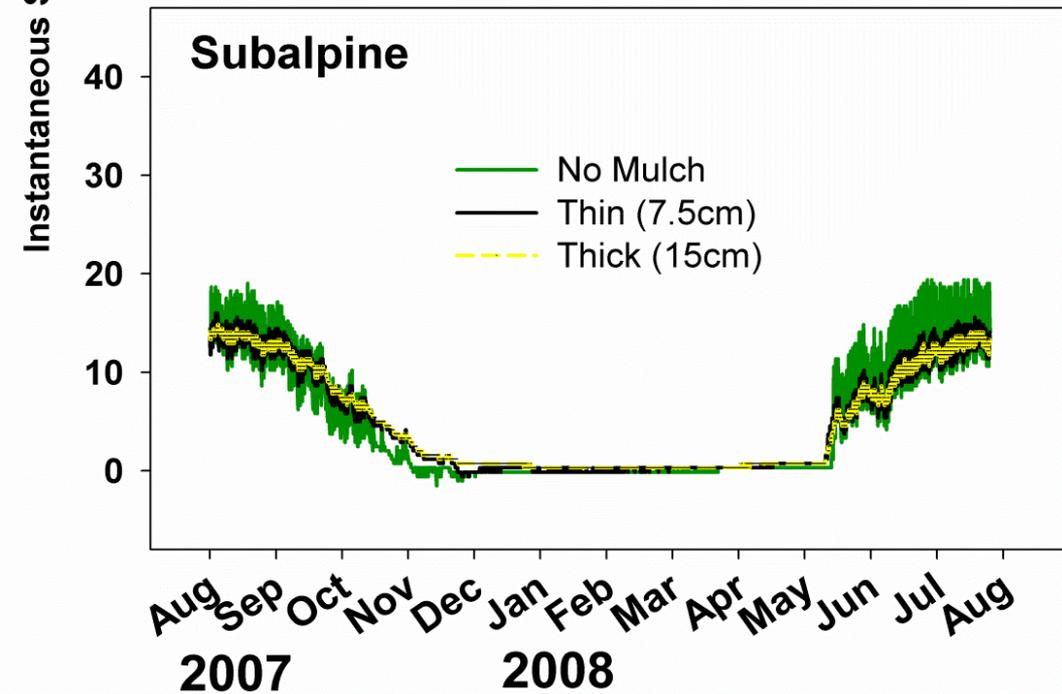
Mulch was rarely deeper (e.g., <20% of time) than the *Thin Mulch* beds and only reached the depth of *Thick* beds in few plots.

Mulch depth experiment





➤ Soil temperature extremes moderated by mulch

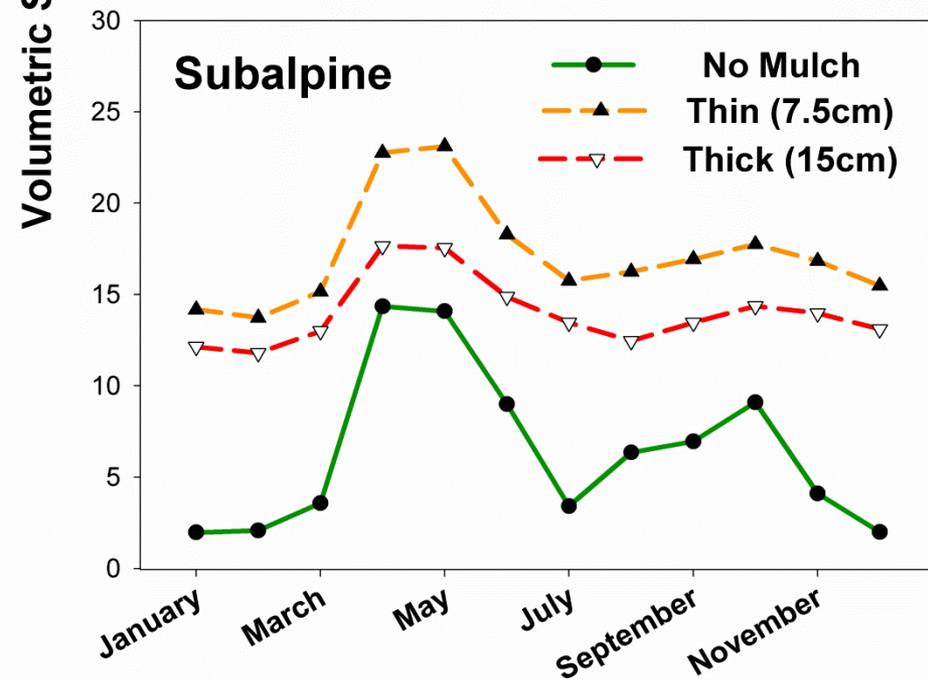
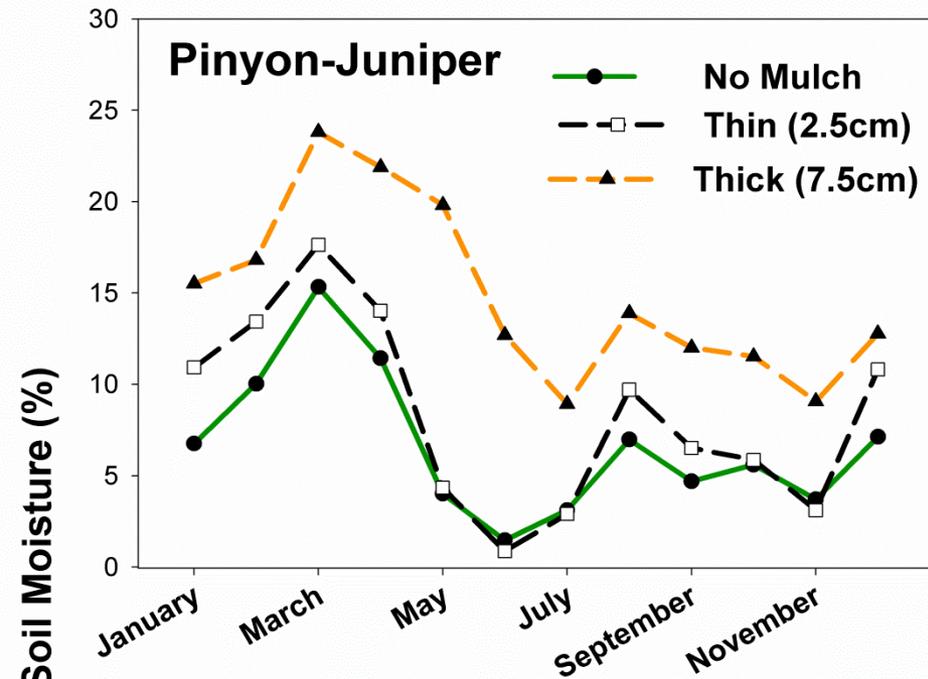


➤ Maximum and average summer temperatures lowered as mulch depth increased

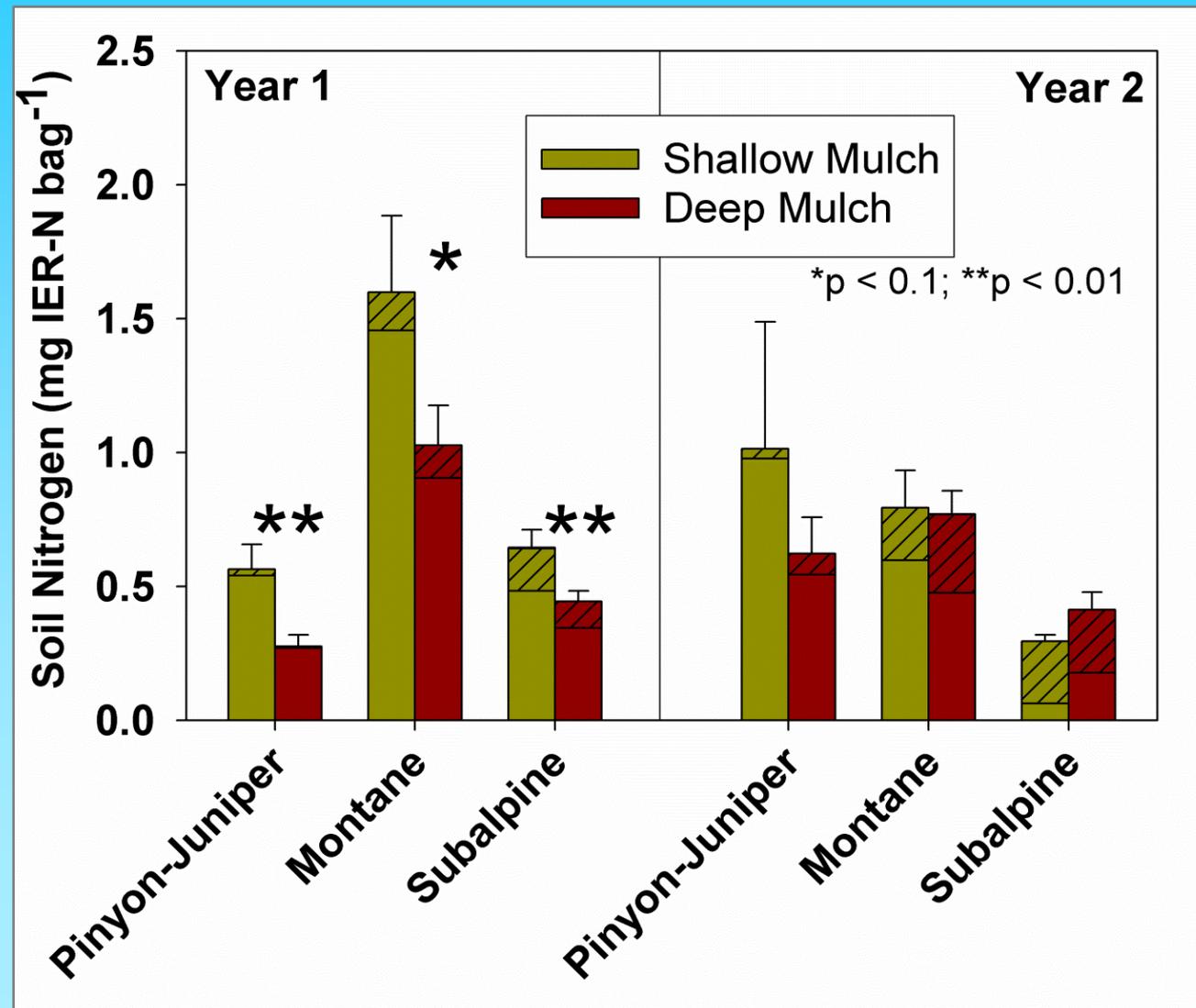
➤ Soil moisture greater in deeper mulch

➤ In PJ, effect not as large in thin mulch

➤ Soil moisture in subalpine remains high throughout the growing season

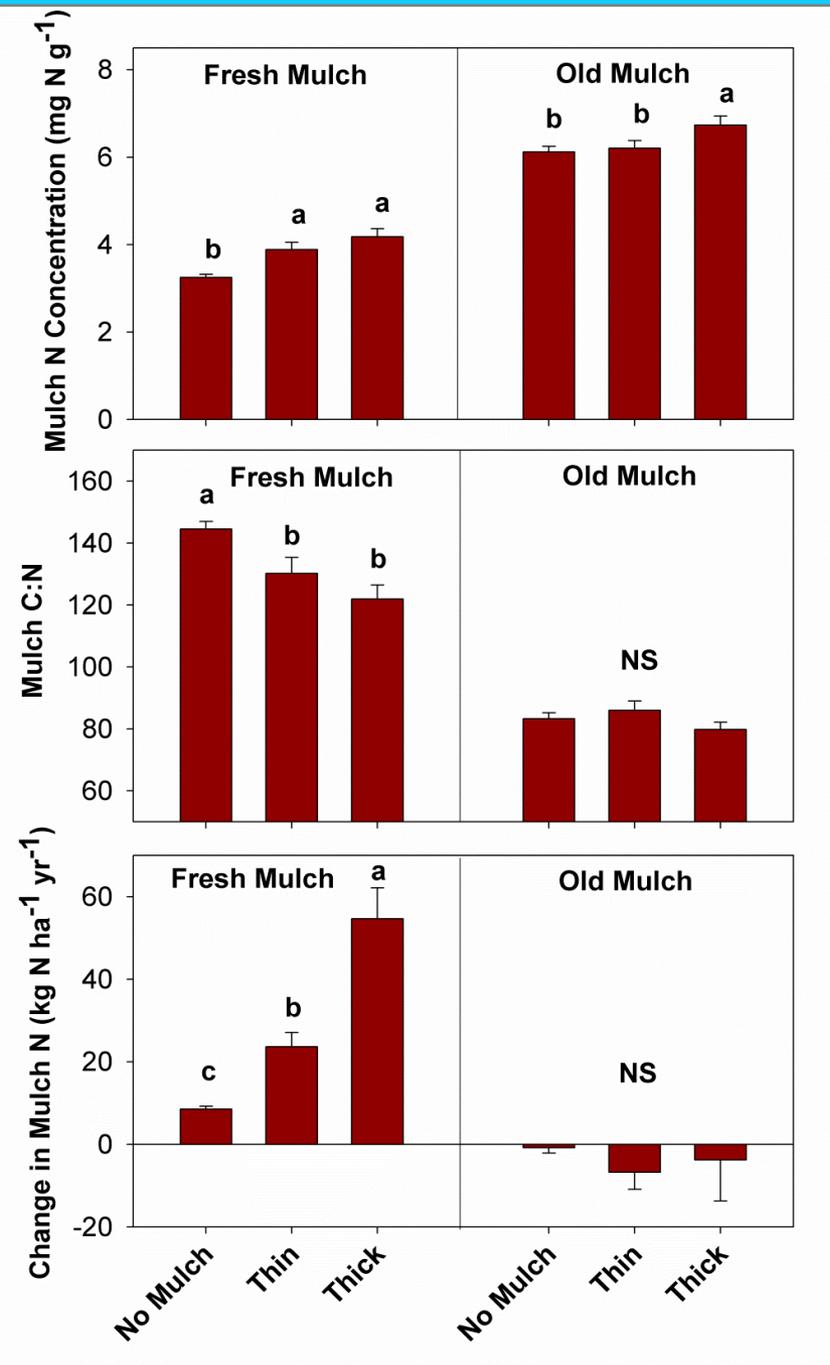


Mulch Effect on Soil N - *Depth*



➤ Plant available soil N was reduced under heavily-mulched plots the first year, but the effect did not persist





After 2 years:

➤ Greater change in N Conc was observed in thick mulch beds and for fresh material.

➤ Fresh mulch immobilized N and effects increased with depth.

➤ Five year old mulch released N regardless of depth

Take home messages: Fuels

- About 3 to 6 times more surface fuel in mulched areas
 - Mostly concentrated in the smaller fuel size classes instead of the 1000-hr fuel size classes
- Mulch deposition was patchy, creating variability in mulch depth across sites, with many areas only receiving 1.5 to 4.5 cm of mulch

Take home messages: Vegetation

- Herbaceous cover increase in the mulched areas
- Exotic species cover was not high, but were more often observed in treated plots: **may increase with time.**
- Tree Seedlings were able to establish in depths up to 7 cm, but preferentially established in depths less than 3 to 4 cm

Take Home Messages - Soil

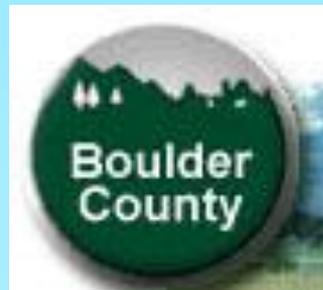
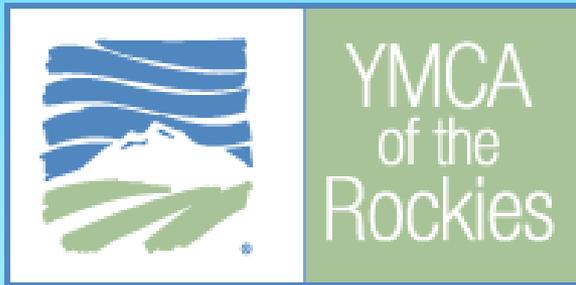
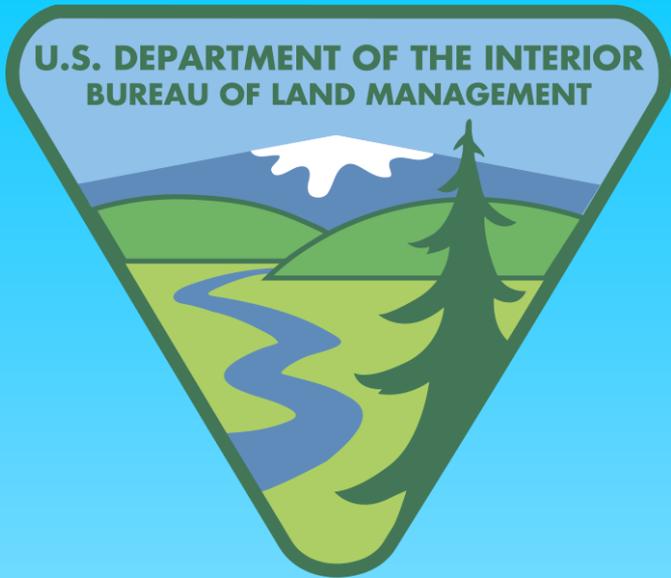
- Soil temperature and moisture
 - Increased moisture
 - Moderated extreme temperatures during summer
 - Cooler average temperatures during summer

Take Home Messages - Nitrogen

- Effects on Soil N – Operational level
 - Increased by 50% in Subalpine and Montane ecosystems
 - Neutral in Pinyon/Juniper ecosystem
- Threshold Mulch Depth Effect on Soil N
 - Deep mulch had negative effects initially, but nitrogen immobilization did not persist
 - However, deep mulch was **rare** at the operational-scale

Future work

- Long-term effects
 - Continued monitoring of plant and soil N
 - Tree growth
 - Test influence of mulch depth on seed germination, soil N, and seedling growth



Questions?

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