

# A Decade of Ecosystem Monitoring: Vegetation and Soil Response to Fire and Management in Mixed Conifer Forests

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# What happens over 10 years?

- ❖ Rate of change depends on soil heating, extent of severity, resiliency of forest ecosystem, etc...

Large wildfires are assessed immediately

- Funding for mitigation or monitoring < 3 years
- Watershed effects often last 5-10 years
- Vegetation effects last 10+ years

How do initial conditions forecast recovery?

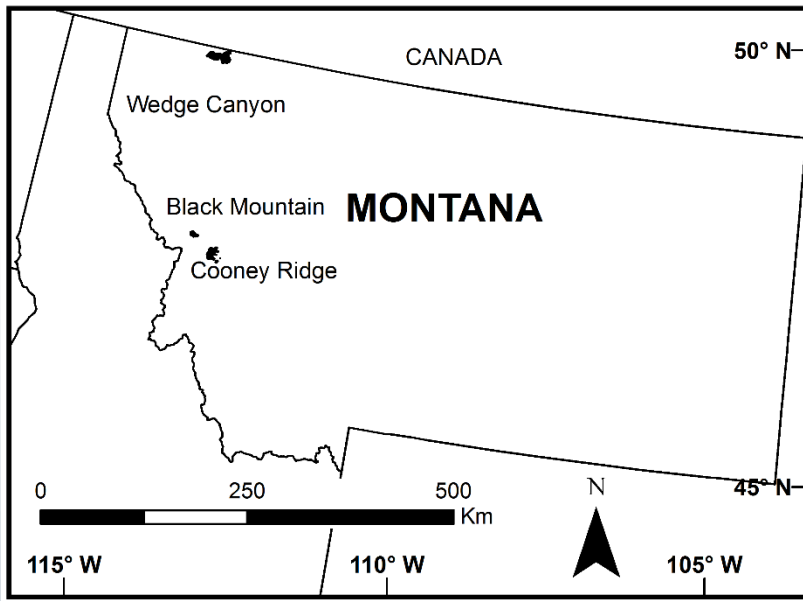
- What indicators are most useful to measure?
  - ❖ Initially, after 1-5 years, after 10 years

# Study sites in Montana – 2003

Full range of soil burn severity

- Indicative of the effects of the effects of the fire on the ground surface

3 mixed-severity wildfires



# Initial conditions

Ground cover



Remotely sensed imagery

- What does this look like from a remote perspective?**
- Aerial hyperspectral (2003)
  - Landsat 5 (2003, 2004, 2007)
  - QuickBird-2 (2007)
  - Landsat 8 (2013)

Vegetation cover and condition

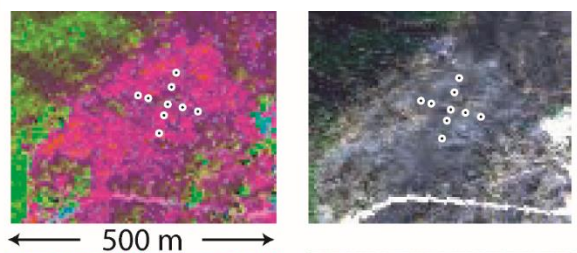


Canopy cover

# High burn severity sites

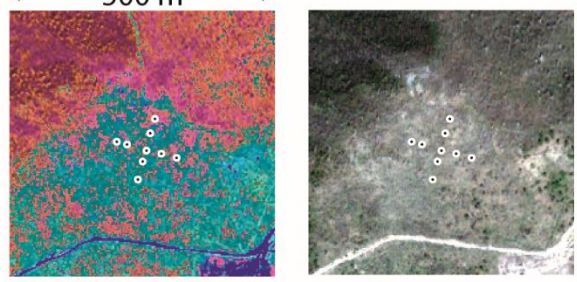
Hyperspectral 2003 90% char, 10% black canopy

- Char
- Green
- Soil



QuickBird 2007

- NPV
- Green
- Soil



Landsat 8 2013 85% GV +NPV, <10% canopy

- NPV
- Green
- Soil



MESMA

True color

High burn severity - CR1

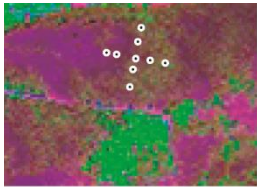


# Moderate burn severity

Hyperspectral  
2003

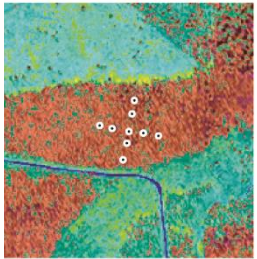
70% char, 40% brown canopy

Char  
Green  
Soil



QuickBird  
2007

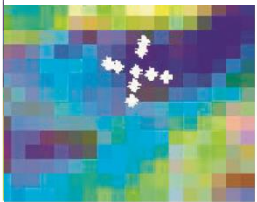
NPV  
Green  
Soil



Landsat 8  
2013

99% GV + NPV, 25% black canopy

NPV  
Green  
Soil



MESMA

True color

Moderate burn severity - CR5

- Highly heterogeneous sites
  - Characterized by patchy brown canopy

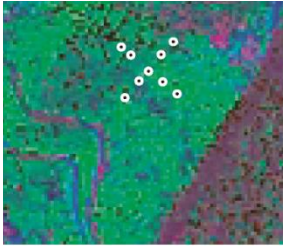


# Low burn severity

Hyperspectral  
2003

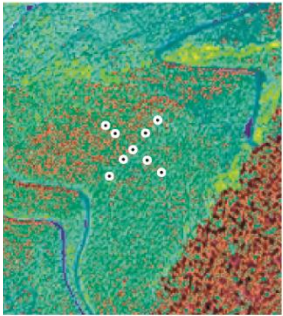
50% char, 50% green canopy

- Char
- Green
- Soil



QuickBird  
2007

- NPV
- Green
- Soil



Landsat 8  
2013

99% GV +NPV, 55% green canopy

- NPV
- Green
- Soil



MESMA

True color

Low burn severity - CR2



# Landscape Scale

- Rate of vegetation response is high in the first year, slows over time





# 10-year ecosystem response

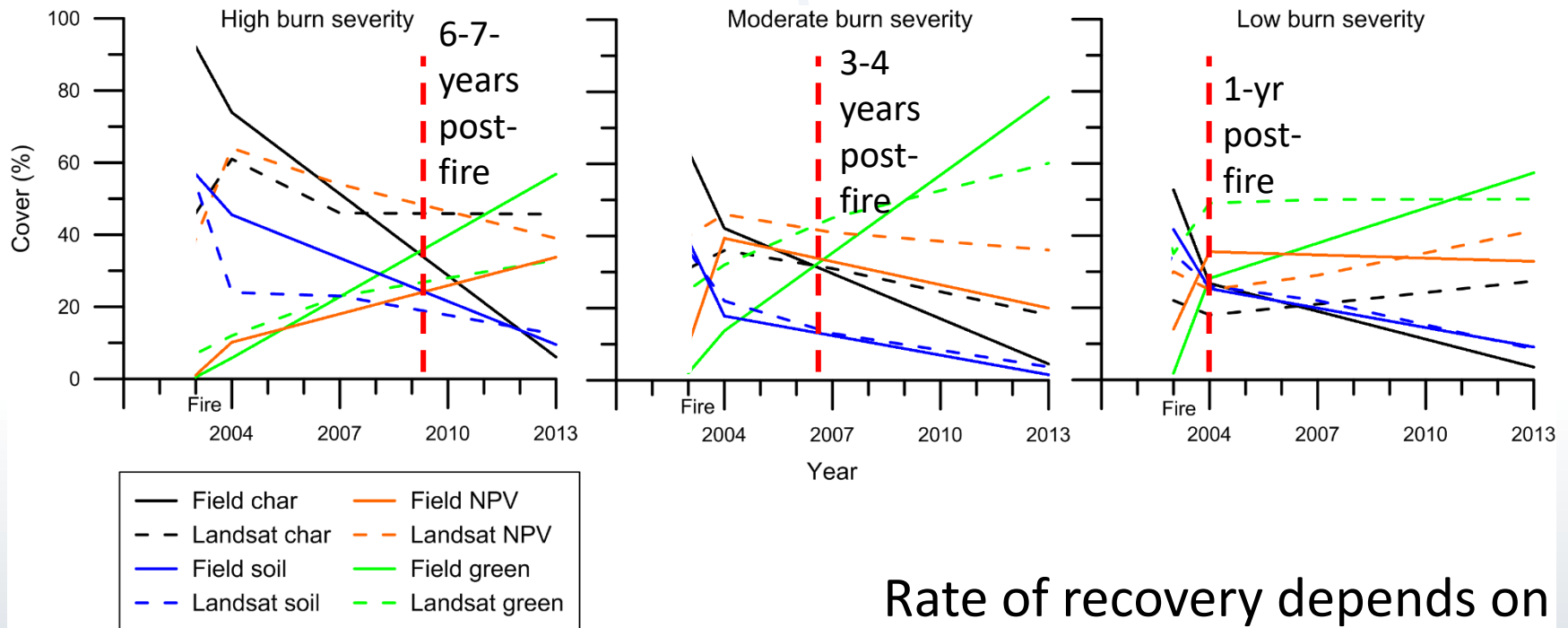


- Abundant understory vegetation
- Slowly recovering canopy

# Recovery Trends

Initially sites are dominated by char and soil

– At what point does organic cover replace inorganics?



Rate of recovery depends on initial condition

# Vegetation Highlights

- ❖ Char, soil, NPV and GV cover are mappable and scalable
  - ❖ High resolution imagery better represents heterogeneity
  - ❖ Temporal resolution of Landsat is unmatched
- ❖ Field and remote measures indicated a similar degree of vegetation response after 10 years
- ❖ **Important to evaluate how other fires in other regions and vegetation types compare**
- ❖ **How do post-fire activities affect recovery?**

# BAER Overview

Remote Sensing  
Imagery

BAER database  
Publications

Erosion/Hydrology  
Predictions

ERMiT, Peak Flow  
Calculator, WEPP  
Road, WEPP-PEP

Value at Risk Tools

Treatment  
Effectiveness  
Synthesis

BAER

<https://forest.moscowfs.wsu.edu/BAERTOOLS>

Field Guide for Mapping Post-Fire  
Soil Burn Severity



Erosion Risk Management  
Tool (ERMiT) User Manual  
(version 2006.01.18)



New Procedure for Sampling Infiltration  
Assess Post-fire Soil Water Repellency



Post-Fire Treatment  
Effectiveness for  
Hillslope Stabilization



Assessing Post-Fire  
Values-at-Risk With a  
New Calculation Tool



# Evaluate the Values at Risk

- Cost of treatment versus the value of the resource needing protection
- Overwhelming management factor for erosion mitigation is ground cover

## Treatment Costs

- ✓ Various rainfall intensities and amounts
- ✓ Remains functional for >1 year
- ✓ Traps sediment

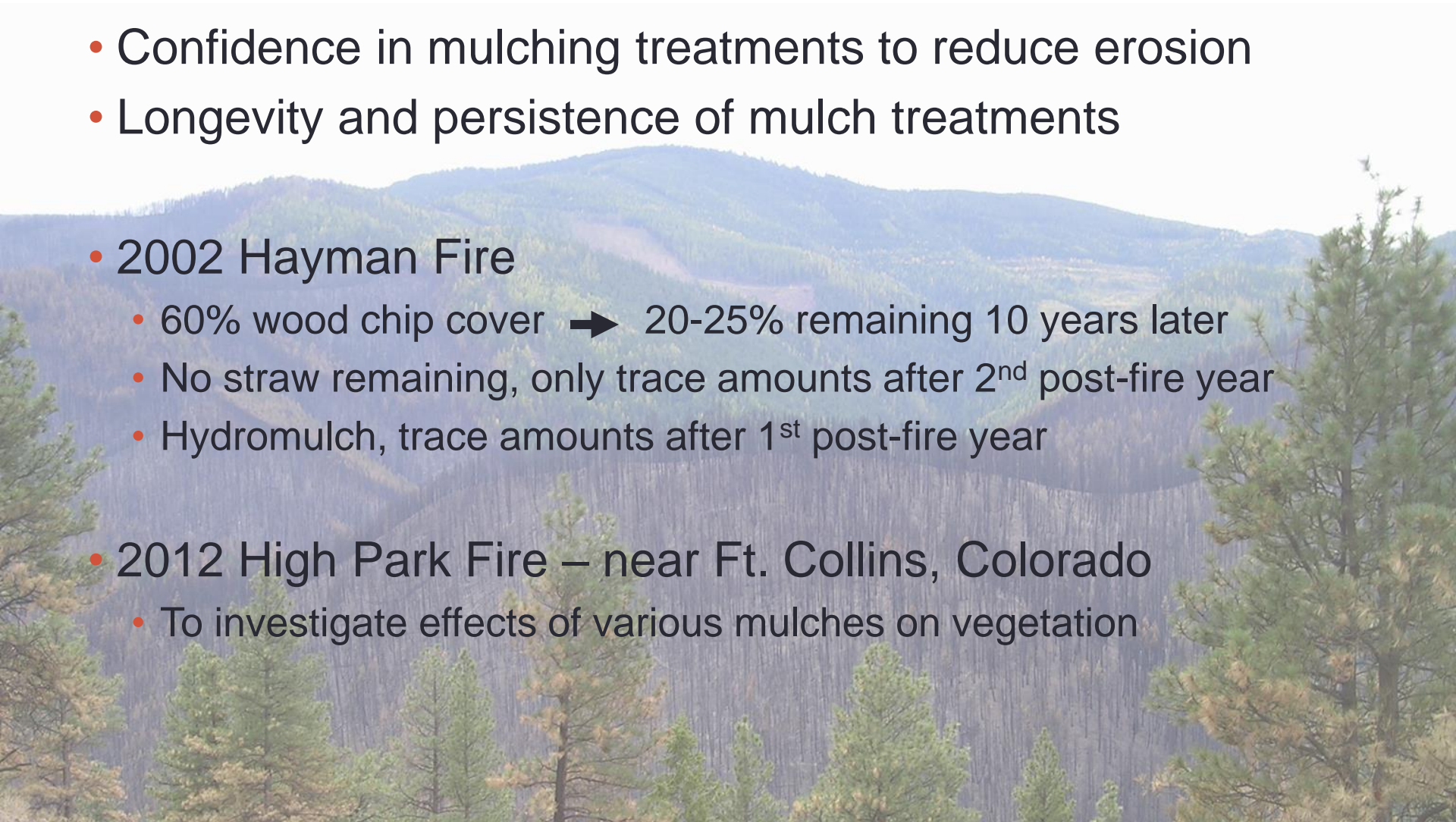
	Treatment	~Cost/acre
1	Aerial Seeding	\$ 20 - 50
2	Agricultural Straw	\$ 500-1200
3	Wood Shreds	\$ 1,700 – 2,300
4	Wood Strands	\$ 2,500 – 3,500
5	Hydromulch	\$ 3,000



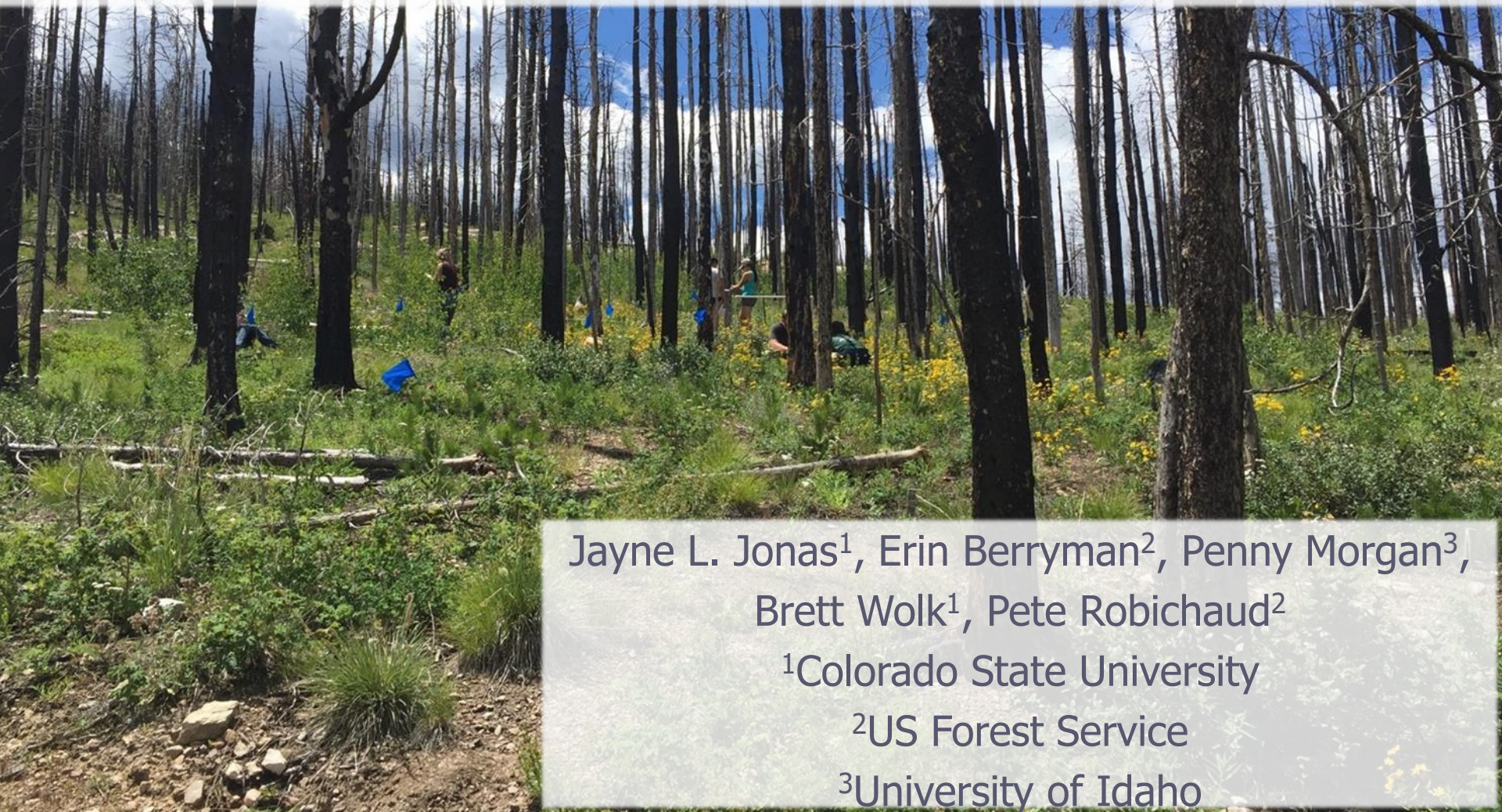
Hillslope Treatments

# Longer term mulching effects – what do we know?

- Confidence in mulching treatments to reduce erosion
- Longevity and persistence of mulch treatments
- 2002 Hayman Fire
  - 60% wood chip cover → 20-25% remaining 10 years later
  - No straw remaining, only trace amounts after 2<sup>nd</sup> post-fire year
  - Hydromulch, trace amounts after 1<sup>st</sup> post-fire year
- 2012 High Park Fire – near Ft. Collins, Colorado
  - To investigate effects of various mulches on vegetation



# ECOSYSTEM RESPONSES TO POST-FIRE MULCH TREATMENTS IN A LODGEPOLE PINE FOREST



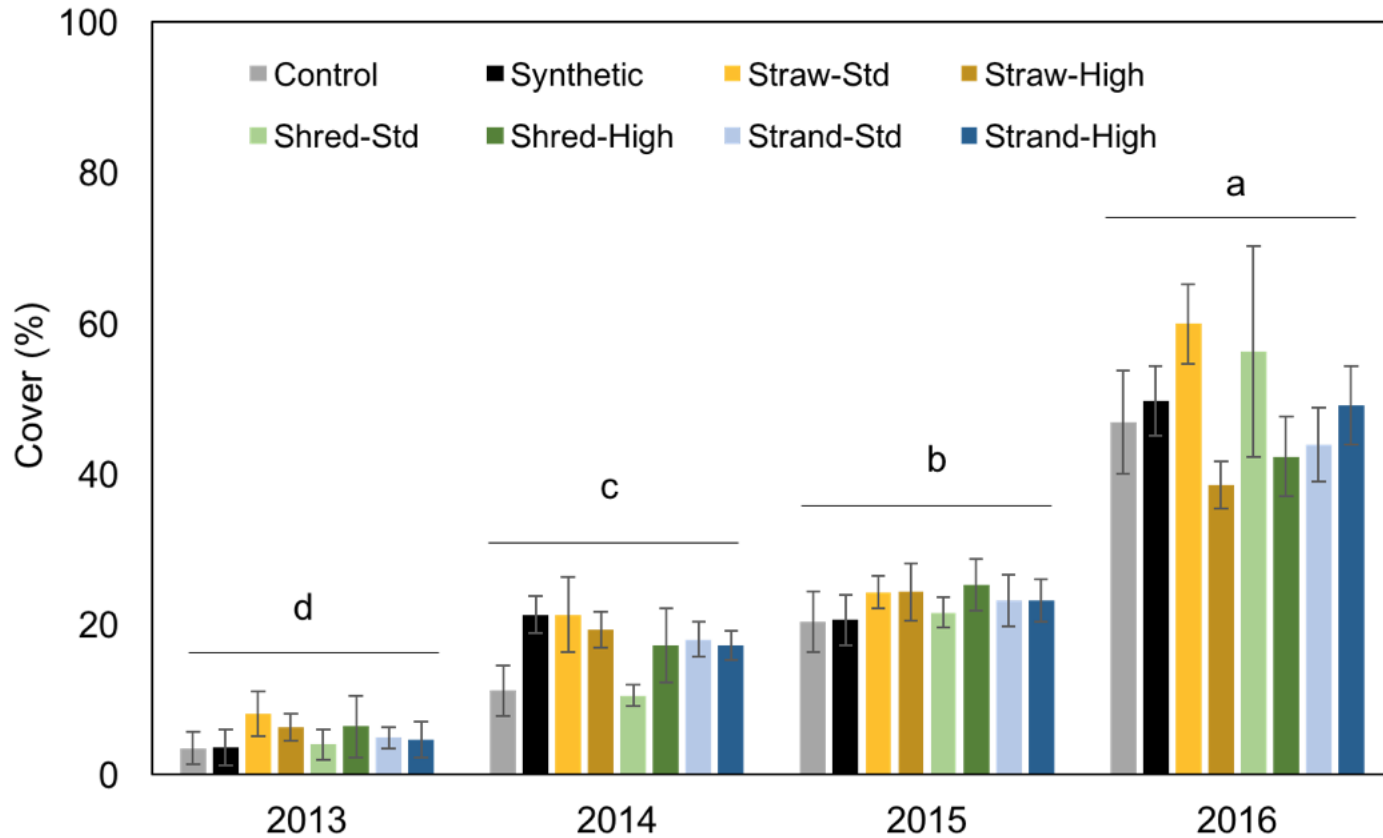
Jayne L. Jonas<sup>1</sup>, Erin Berryman<sup>2</sup>, Penny Morgan<sup>3</sup>,  
Brett Wolk<sup>1</sup>, Pete Robichaud<sup>2</sup>

<sup>1</sup>Colorado State University

<sup>2</sup>US Forest Service

<sup>3</sup>University of Idaho

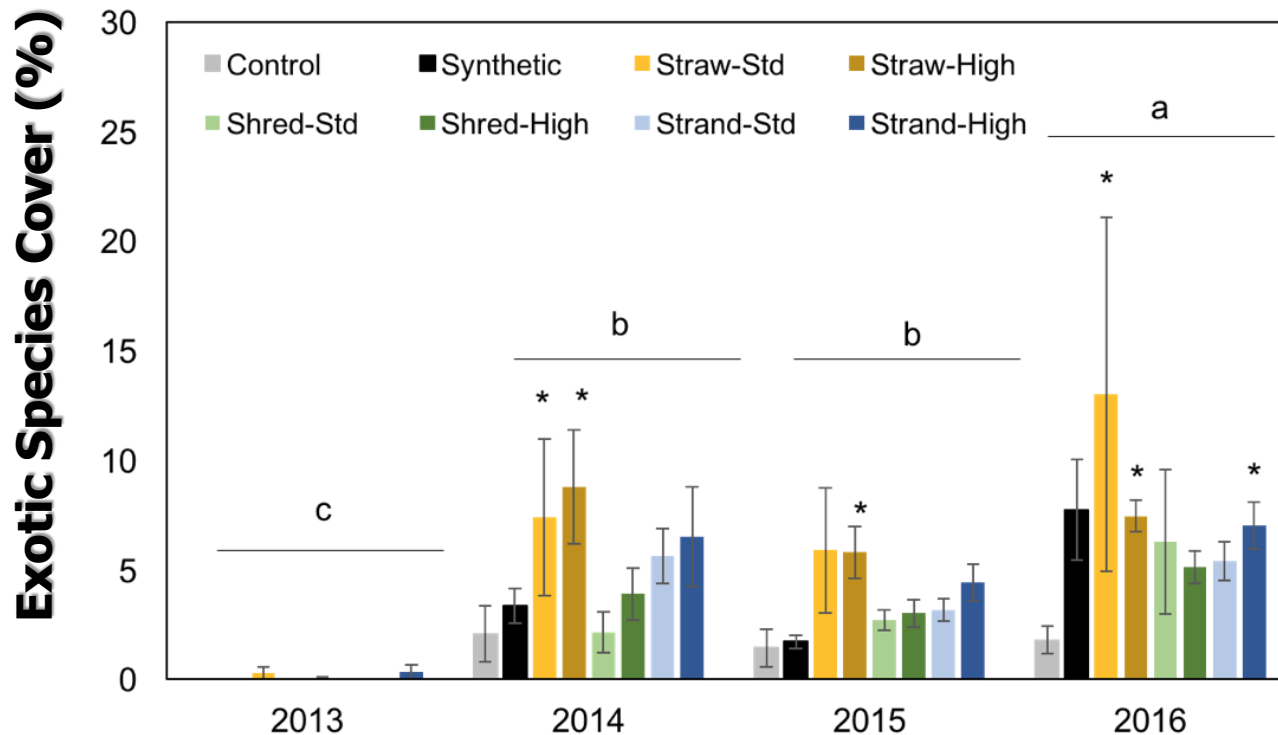
# Understory total plant cover increased over time in all treatments



Treatment:  $p=0.37$   
Year:  $p<0.0001$   
Year\*Treatment:  $p=0.22$



# Wheat straw associated with higher exotic species establishment



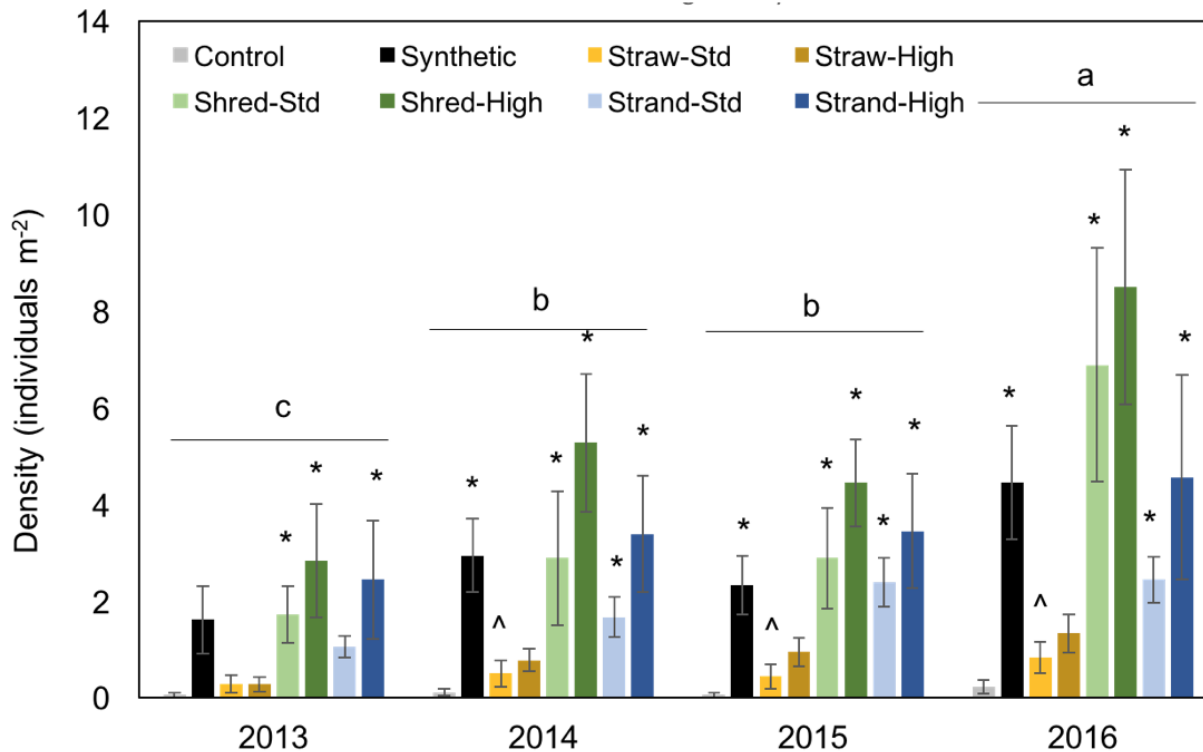
Treatment  
Year  
Year\*Treatment

$p < 0.0001$   
 $p = 0.003$   
 $p = 0.12$

Cheatgrass and Mullein

# Wheat straw associated with lower pine seedling establishment

Pine Seedling



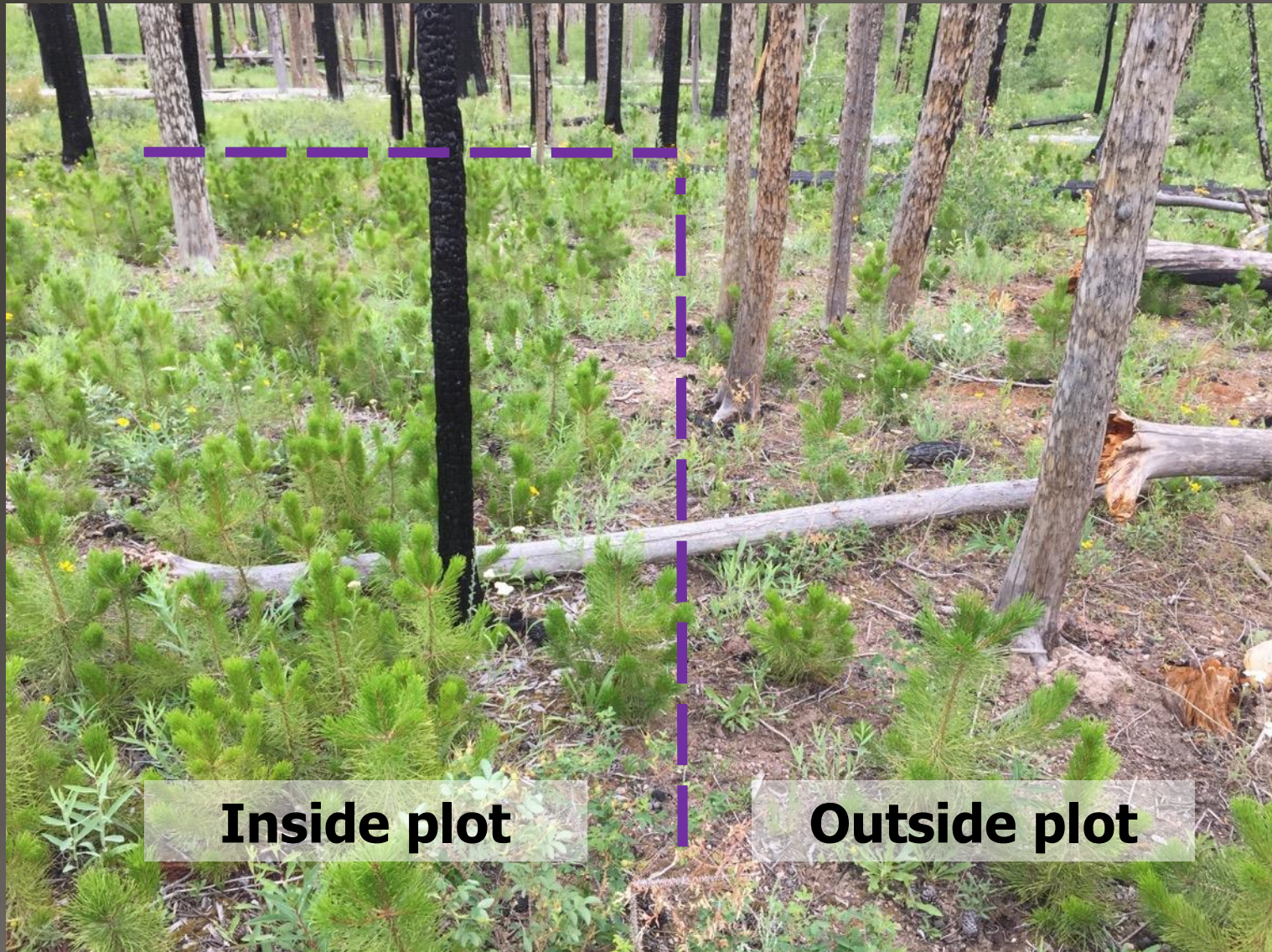
\*differs from unmulched control  
 ^differs from synthetic mulch

Treatment  
 Year  
 Year\*Treatment

$p < 0.0001$   
 $p < 0.0001$   
 $p = 0.37$

Nitrogen Immobilization

# Wood mulches had highest pine seedling establishment



# Does mulch affect post-fire plant community development?

- Few effects on understory plant cover 4-years post-fire
  - Plant cover steadily increased each year
  - Wheat straw introduced exotic species
- Wood-based mulches promoted pine seedling establishment
  - Wheat straw and unmulched controls had lowest seedling densities
- Little evidence for mulch impacting plant community recovery via nitrogen immobilization
  - Likely wood mulches improve soil abiotic conditions (soil moisture) for plant and tree seedlings



# Salvage Logging Research



# Post-fire Salvage Logging

## Justification:

- **Recoup economic loss**
- **Reduce fuel loads**
- **Increase safety** (e.g., road corridors)



## Concerns:

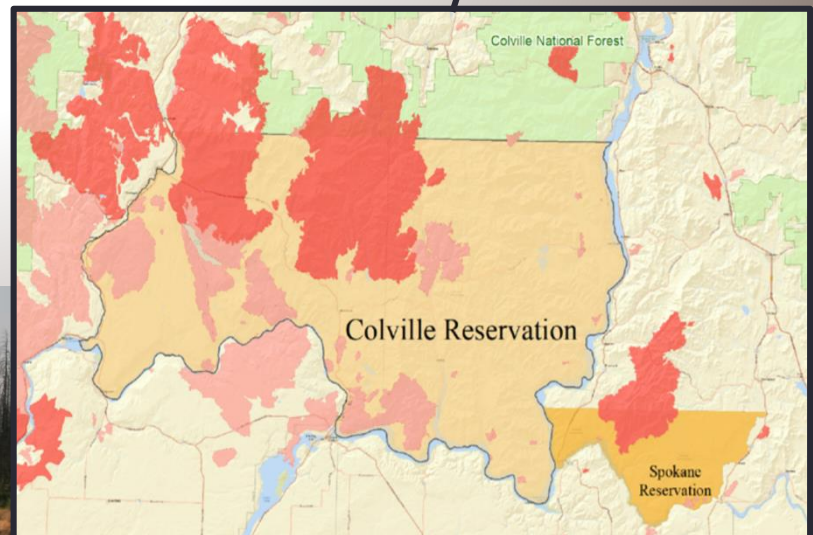
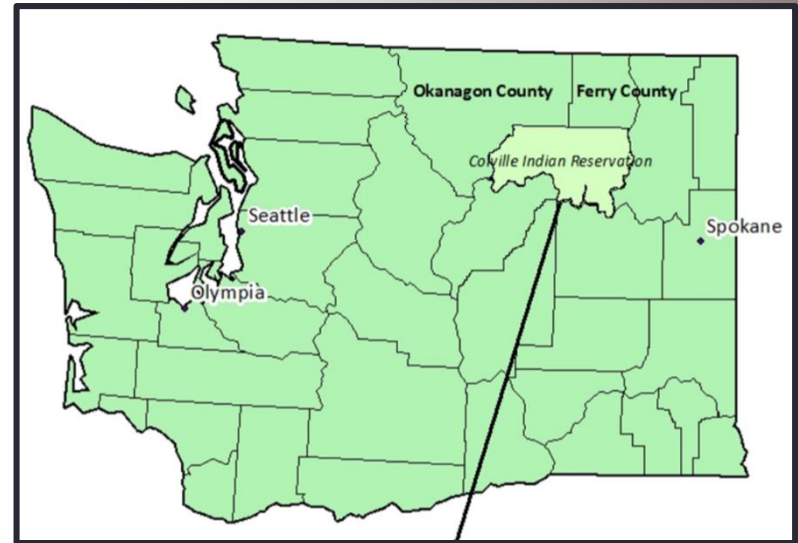
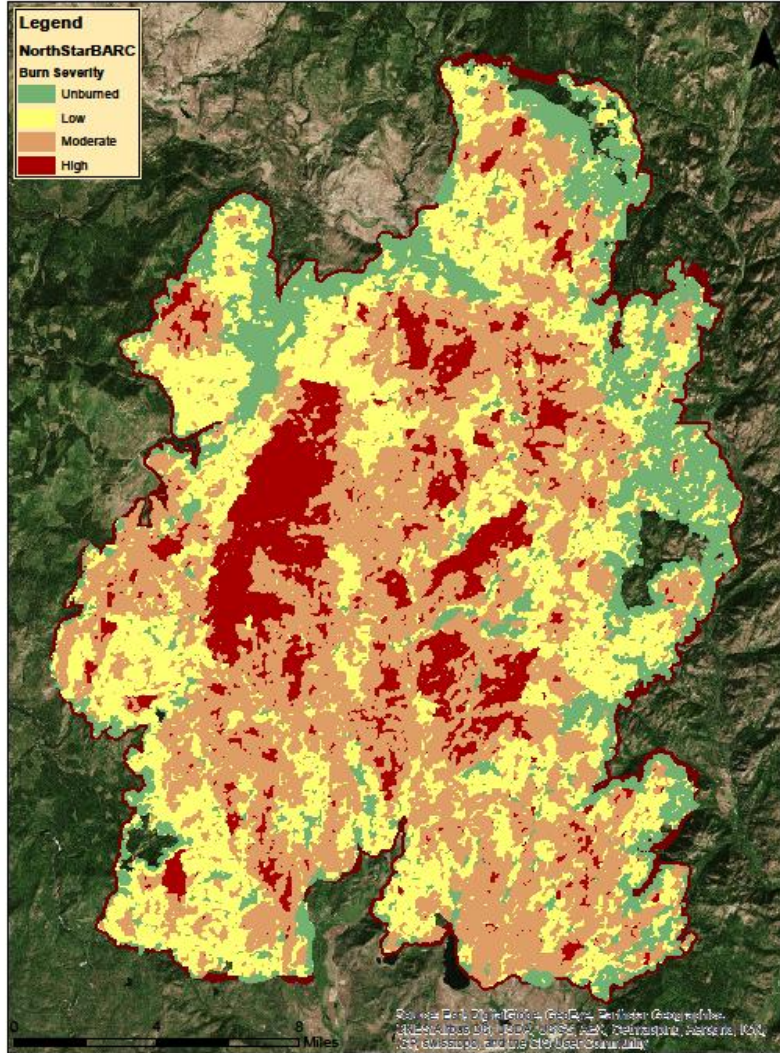
- **Compounded disturbance**
- **Altered soils**
- **Increased runoff and erosion**
- **Loss of water storage**



# 2015 North Star Fire, WA

70,000 ha (171,000 ac) burned

North Star Fire, Colville Reservation, WA



# North Star Salvage Treatments

Burned, but not logged



Skid Trails with slash treatment



Skid Trails with no treatment





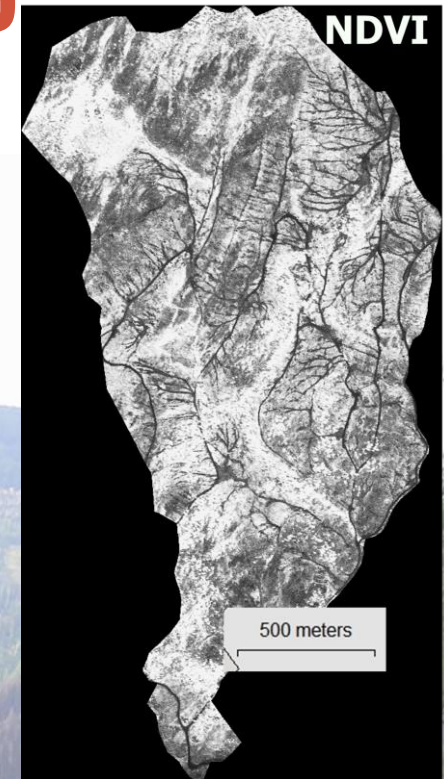
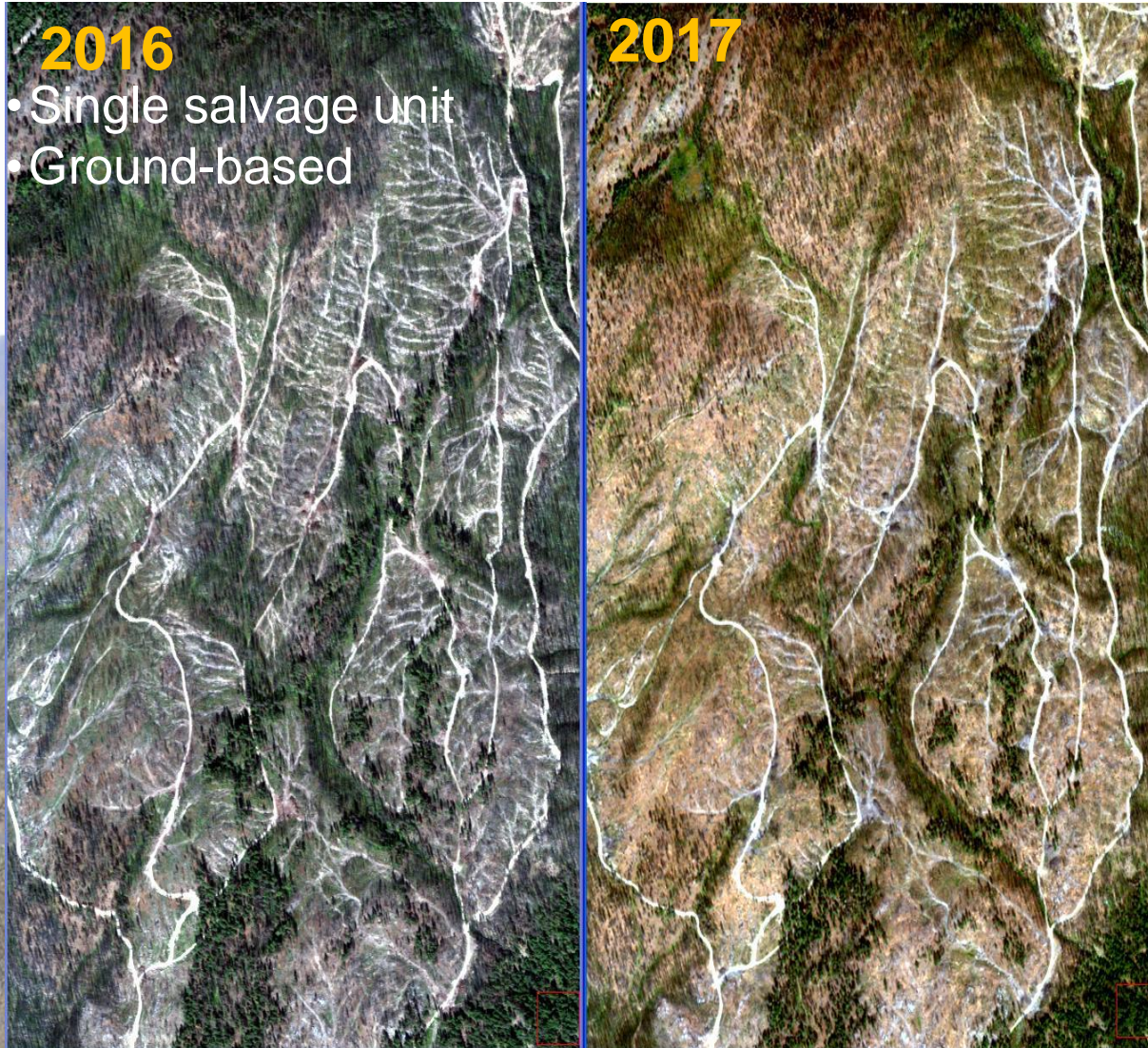
# North Star Rills Soil Erosion



- Large sized slash on skid trails significantly reduces erosion and runoff velocity
  - 1 year and 2 years post fire
- Vegetative recovery
  - Good growing conditions
  - Decreased exposed mineral soil in year 1 and year 2 in both skid and control treatments



# Monitoring Salvage Logging



**Relationship between soil cover and NDVI is:**

- **More negative where disturbance is greater**
- **Stronger where disturbance is greater**

# Direction from here ->

- Relationship is strongest where disturbance (soil) is highest
- Fine-tune relationship between soil and NDVI
- Explore NBR, other indices



**Questions?**