Effects of Nutrition Treatments on Soil Fungi, Subsequent Decay, and Breakdown of Soil Wood on Forest Health Sites

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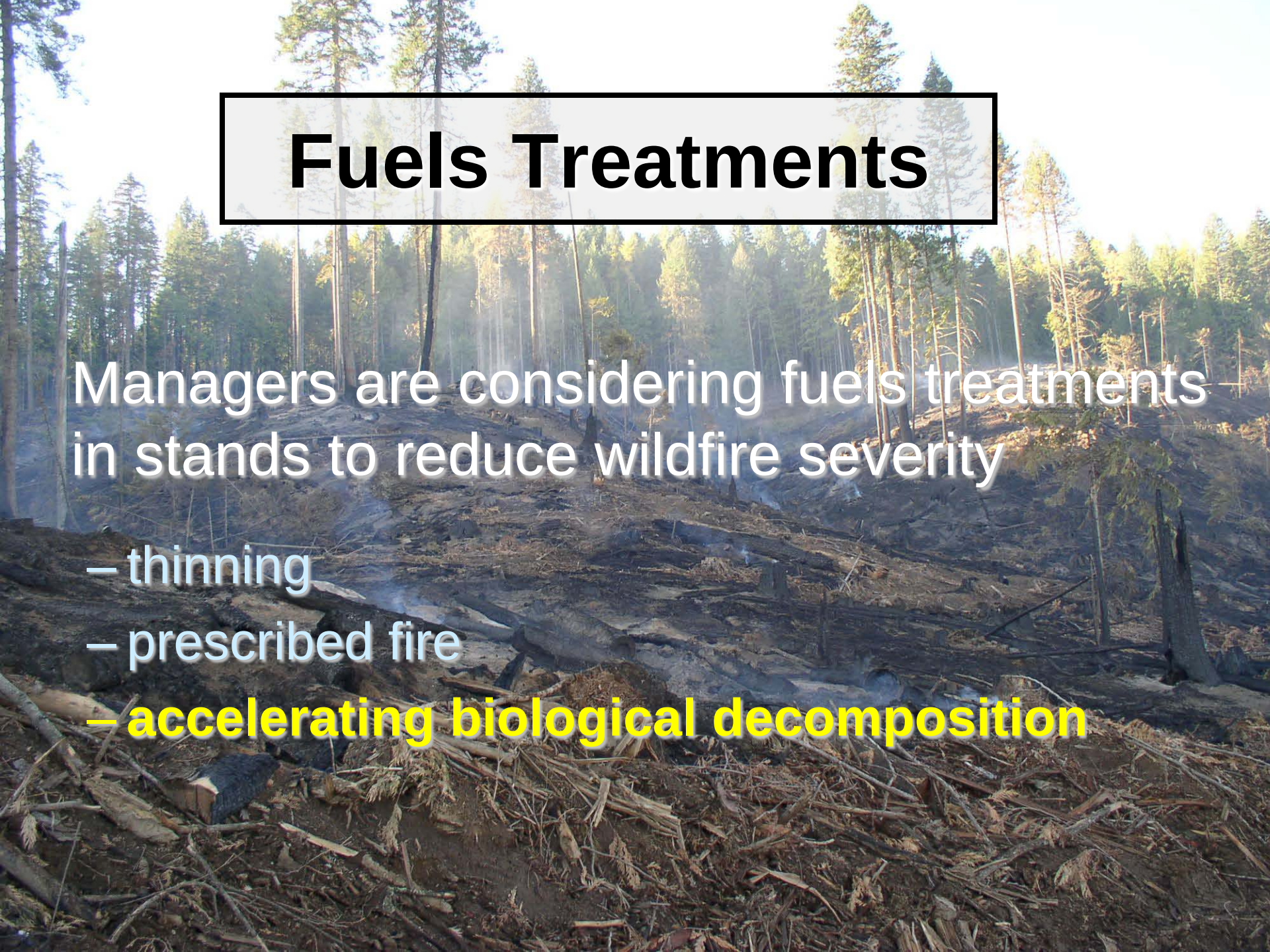
Forest Conditions

- Shifts in tree species composition
- Higher density of trees
- Increases in insect and disease damage

Forest Management Challenges

- Fire exclusion and selective timber harvesting have resulted in heavy accumulations of fuels
- Stands are at greater risk for severe wildfires
- Soils at risk for damage from fire and other management practices



Fuels Treatments

Managers are considering fuels treatments in stands to reduce wildfire severity

- thinning
- prescribed fire
- **accelerating biological decomposition**

Management Concerns

- Reduced long-term productivity
- Disrupted nutrient cycling
- Changes in soil properties
- Changes in tree species composition
- **Changes in fungal communities**

Management Implications

Timber harvesting, grazing, fire, and application of fertilizers, herbicides, and pesticides can:

-reduce soil organic matter levels
-change soil temperature and moisture
-change soil pH

These practices can negatively effect distribution and diversity of fungi

Points to Consider

- Fertilization can impact the fungal distribution and the rate at which fungi decompose organic matter
- Decomposition processes can influence fuel loads, carbon sequestration, and other microbial processes (e.g., nutrient cycling, root disease, etc.)
- Response of wood-decay fungi to soil nutrient changes is not well understood

Wood Stake Study

Study Objectives

- Determine effects of soil properties on wood decomposition rates
- Evaluate fungal among sites on different wood species
- Evaluate impact of fertilization and environmental factors on wood decomposition in the forest floor and mineral soil
- Examine wood in contact with soil as a potential inoculum source for pathogens

Wood Stake Study

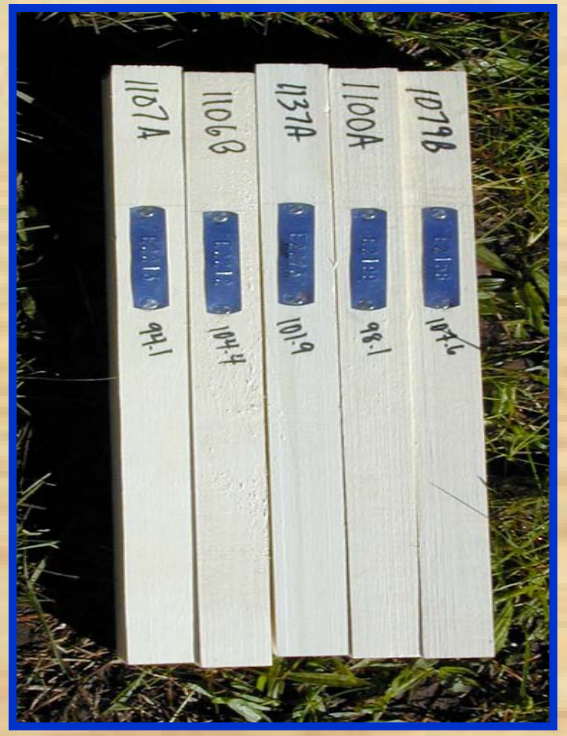
Standard substrate wood stakes were installed on six sites to examine effects of:

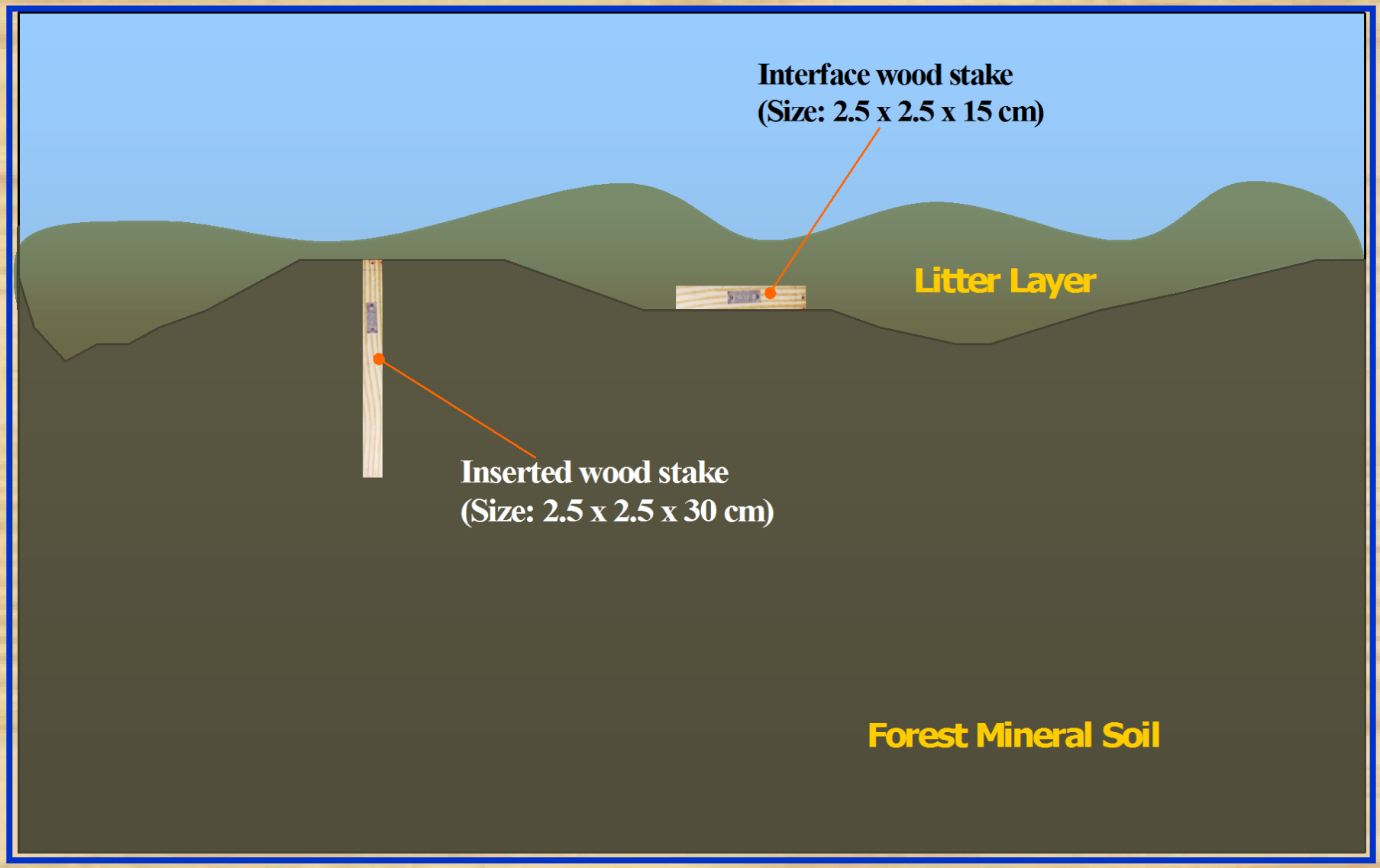
- forest fertilization
- parent rock material
- soil moisture
- soil temperature

on wood decomposition rates

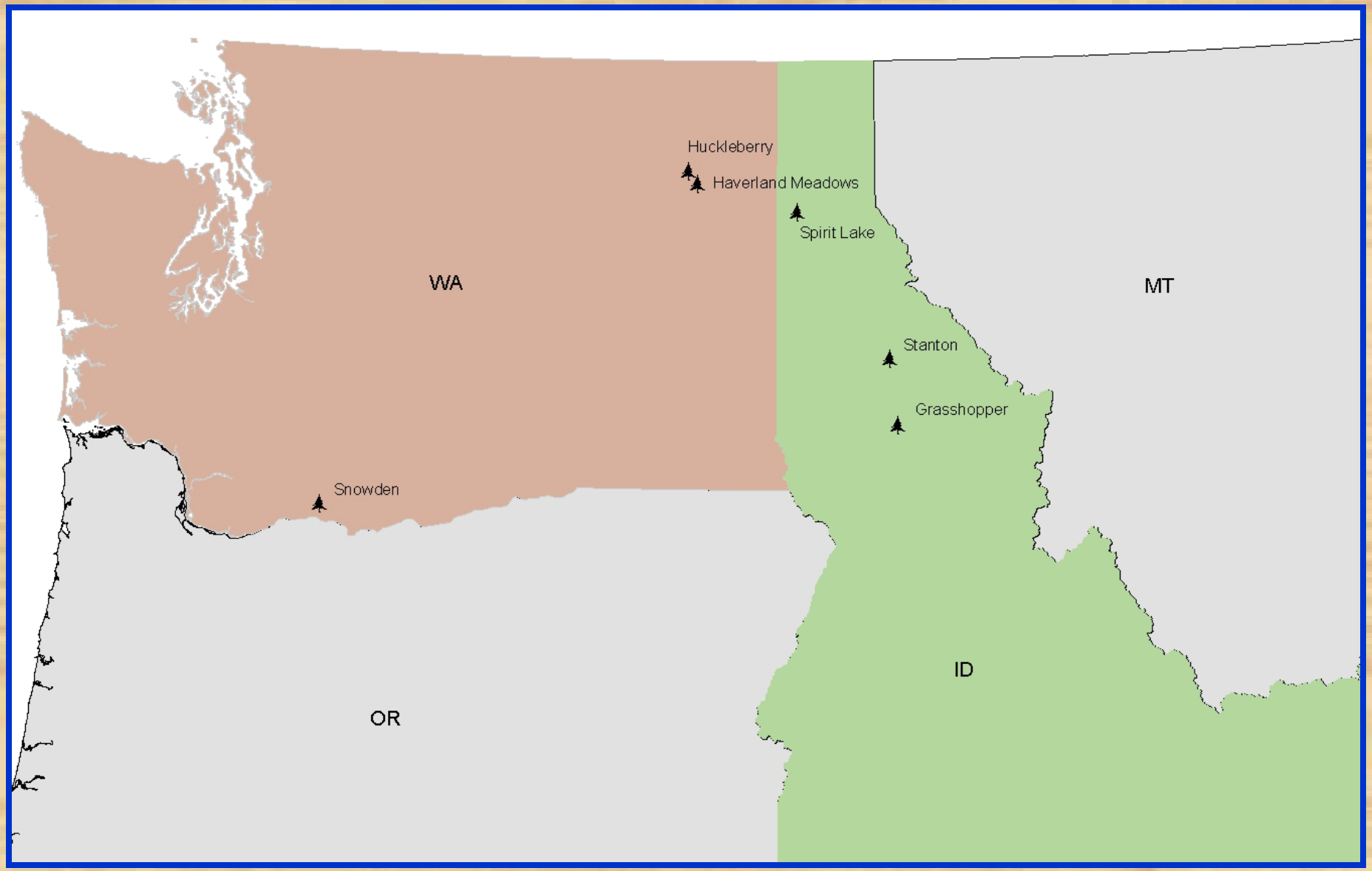
Methods

- Wood stakes were installed across all sites
  - Loblolly pine (Pinus taeda)
  - Douglas-fir (Pseudotsuga menziesii)
  - Aspen (Populus tremuloides)
- Four treatments:
  - N (336.3 kg/ha)
  - K (190.5 kg/ha)
  - N + K (336.3 kg/ha + 190.5 kg/ha)
  - Control (unfertilized)

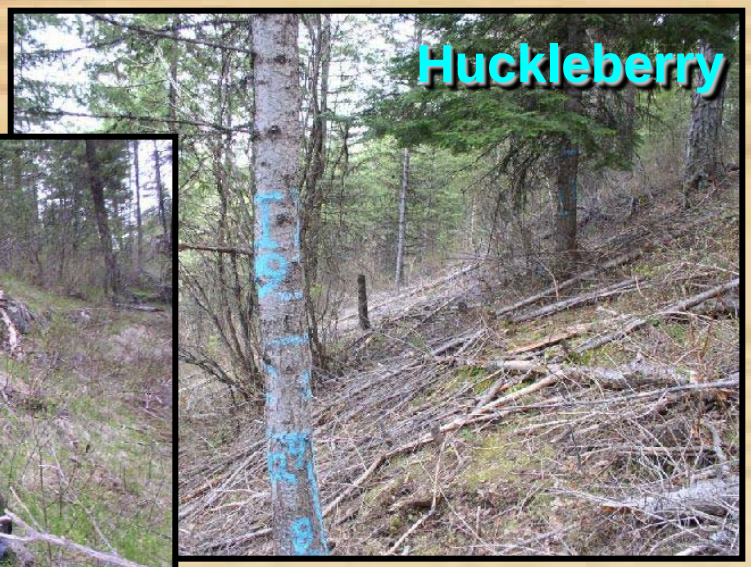



Interface wood stake
(Size: 2.5 x 2.5 x 15 cm)
Litter Layer
Inserted wood stake
(Size: 2.5 x 2.5 x 30 cm)
Forest Mineral Soil

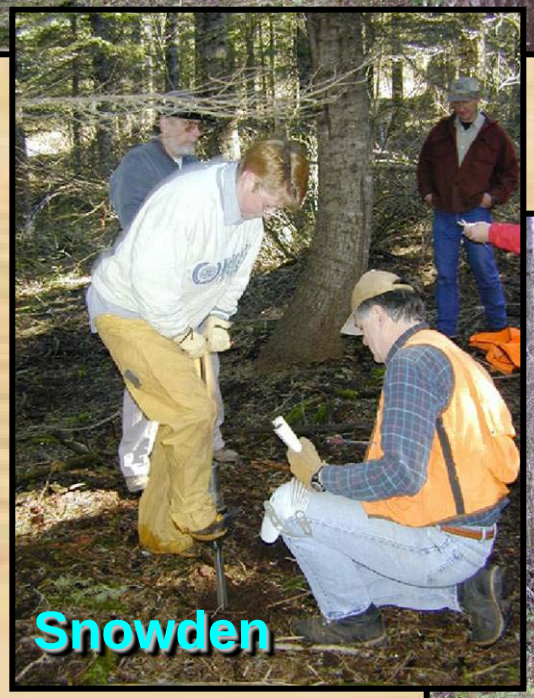
IFTNC Forest Health/Decomposition Sites




Grasshopper


Huckleberry


Haverland

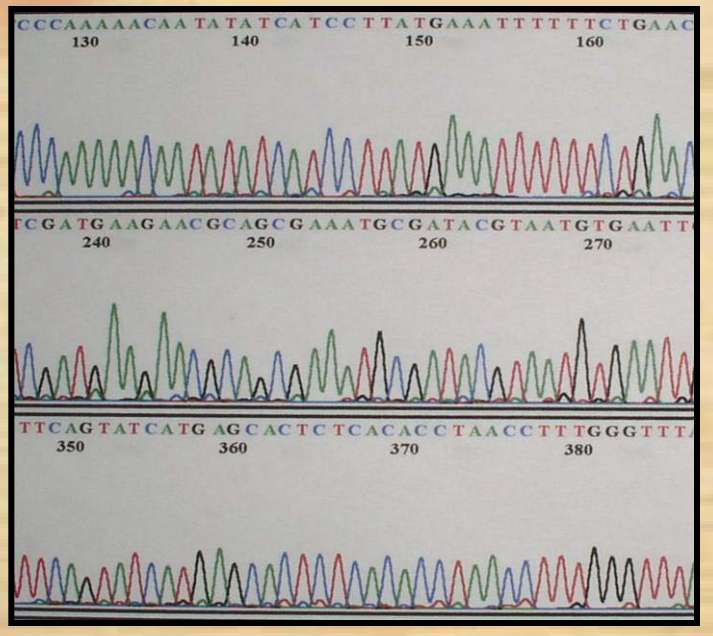

Snowden


Spirit Lake


Stanton

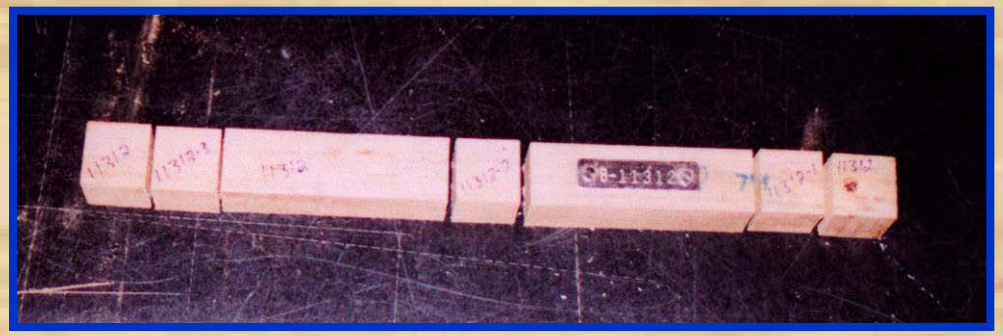
Identification of Fungi

- rDNA ITS sequencing
- Morphological characterization



Mechanical Testing

- Stakes from the field were matched back up with their uninserted control stakes
- Mechanical tests (compression parallel to grain and weight loss) were performed



Soil Sampling

- Soils cores were collected to a depth of 10-cm in spring of 2005
- Analyses to be conducted:
  - bulk density
  - pH
  - C:N ratio
  - % organic matter

Results

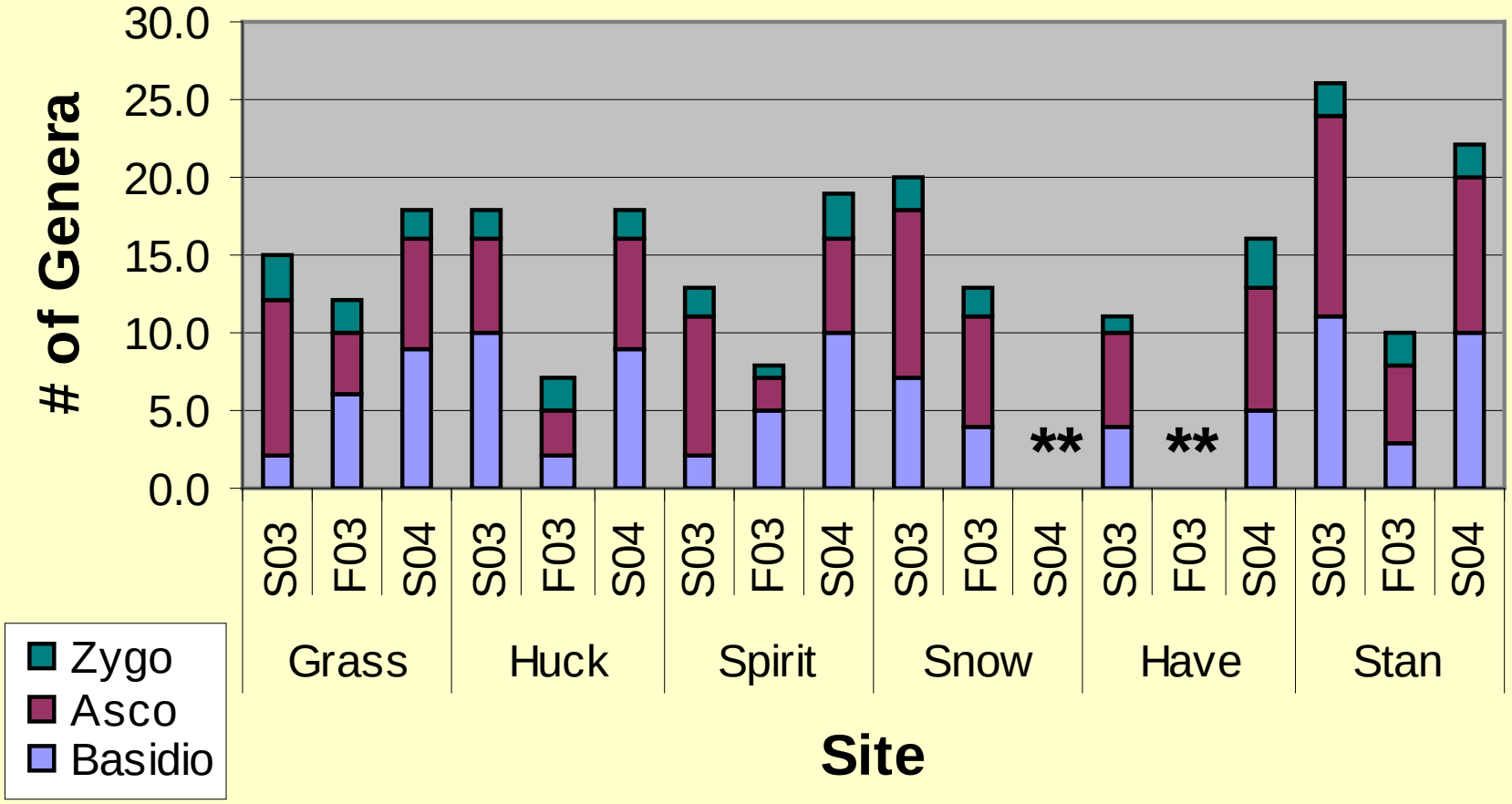
- Total number of stakes sampled = 3089
- Total number of isolates identified to date = 1239
  - based on ITS sequencing
- *Trichoderma* and *Umbelopsis* were most common genera isolated
- More isolates and genera were recovered in spring extractions than fall extractions
- Total basidiomycete, ascomycete, and deuteromycete isolates increased over time
- Total zygomycete isolates decreased over time

Most Common Fungal Genera Identified to Date

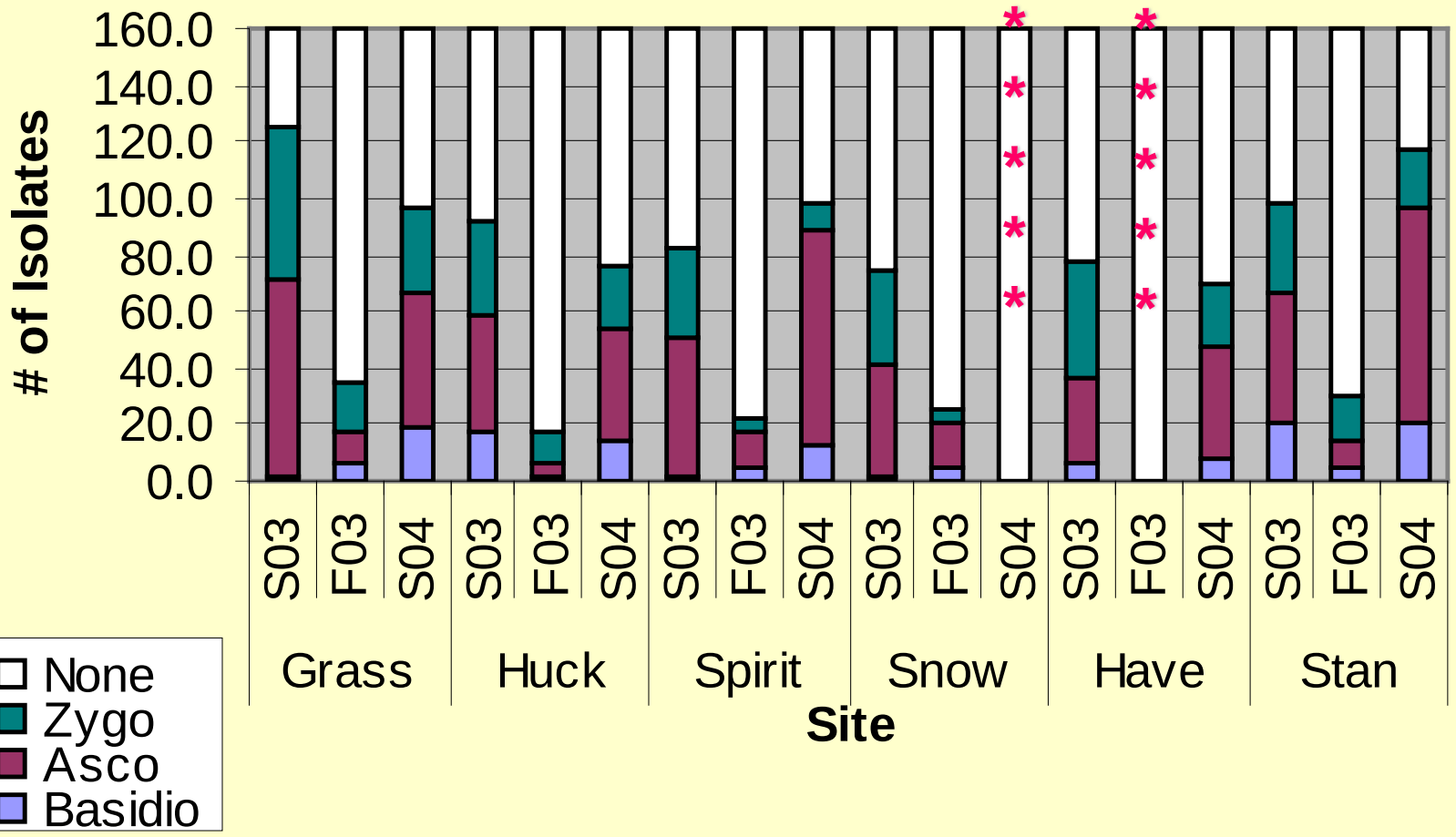
Basidiomycetes	Ascomycetes	Zygomycetes
Sistotrema	*Trichoderma*	*Umbelopsis*
Coniophora	*Hypocrea*	*Mucor*
Vararia	*Lecythophora*	*Mortierella*
Ceriporiopsis	*Fusarium*	
Phanerochaete	*Gibberella*	

Note: Preliminary identification is based on ITS sequencing

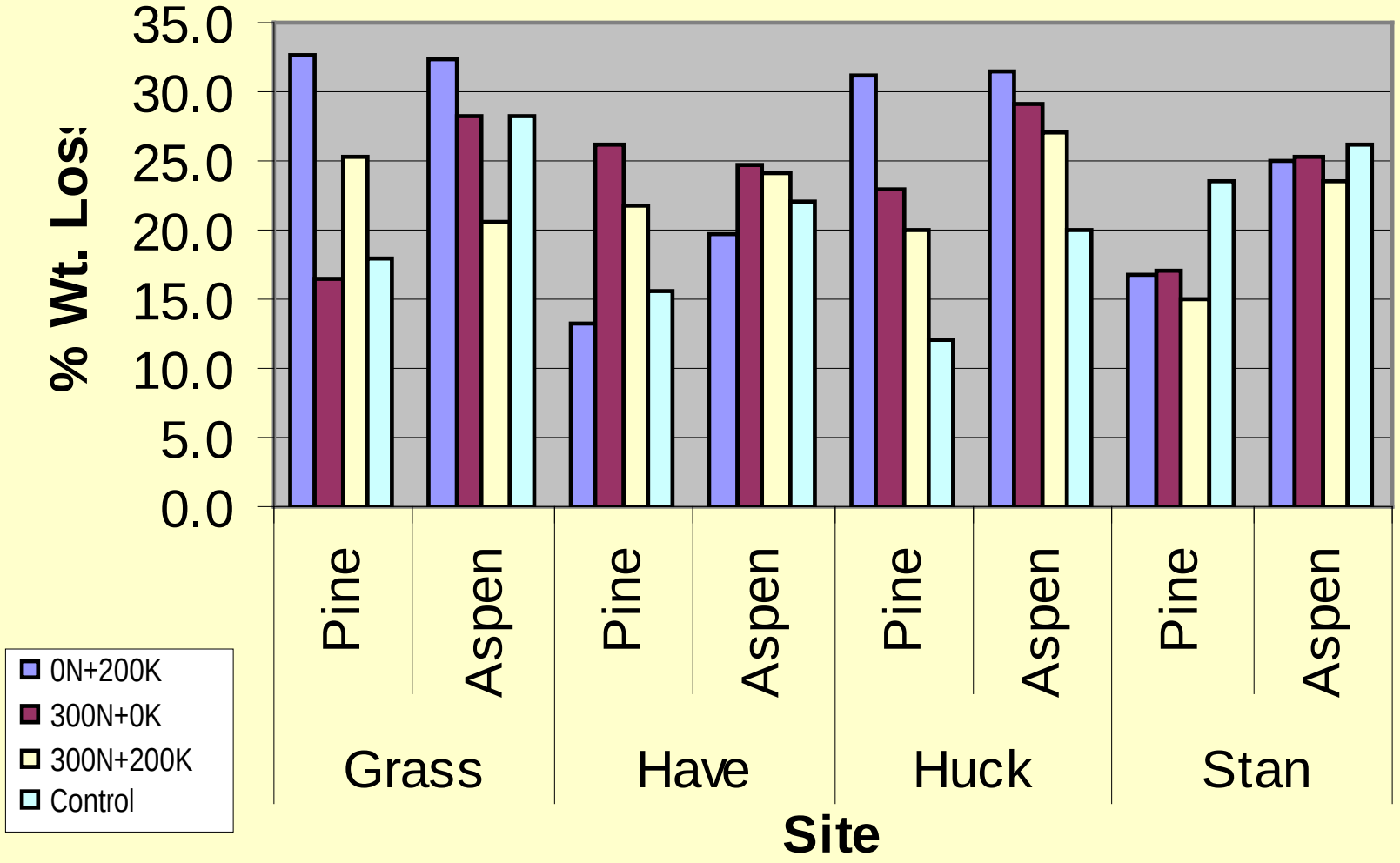
Number of Fungal Genera Isolated by Season



Total Number of Isolates by Season



Weight Loss (%) Summary for Mineral Soil Stakes Extracted after 2 Years by Substrate



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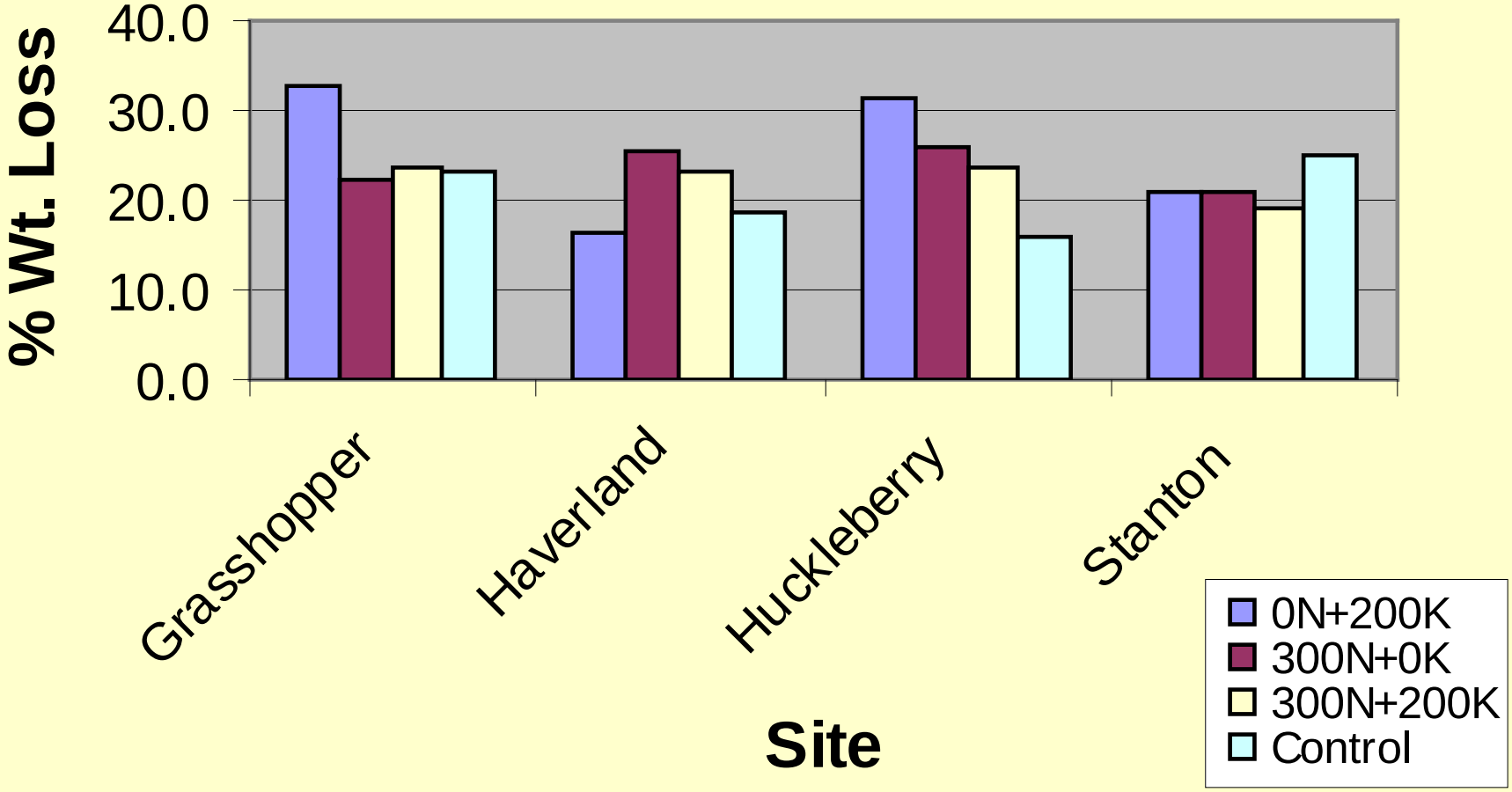

Discussion

- Two of the most common basidiomycete genera cause brown rots
- Most common basidiomycete isolated is still unidentified
- Only one pathogen was isolated from one stake over the course of the study

Discussion

- Other studies that evaluated fungal communities were:
  - based on fruiting bodies
  - utilized DNA extraction only
  - examined large debris with bark intact
- This study used both molecular and culture techniques

Carbon Sequestration

- Global climate change
- Forests may be able to remove and store more C from atmosphere
- Wildfires release carbon sequestered in soil
- Decomposition data can be used to determine C sequestration

Ongoing Research

- Morphological characterization of fungi
- Statistical analysis
- Stake weight loss
- Soil analyses

Limitations of Study

- IFTNC plots were not originally designed for this research
- Wood stakes did not have bark and were kiln dried
- Only one small piece of wood was used for fungal isolation per stake

Summary

- Soil organisms are important to ecosystem sustainability
- Influence of parent material on fungal communities needs further investigation
- Important functions of soil fungi include nutrient cycling, nitrogen fixation, protecting trees against soil pathogens, contributing to soil structure, and improving soil moisture holding capacity

Tools Available for Managers

- Species and population structure of fungi can be identified quickly using molecular tools
- Ability to identify forest fungi will help studies determine effects of management on these fungi
- Decomposition data can be used to help account for carbon credits

Conclusion

- Ecological roles of many fungal species are still poorly understood
- Therefore, it is difficult to develop management objectives that address both timber production and maintenance of fungal communities important in forested ecosystems
- Further research is needed to examine effects of forest management on fungal communities and subsequent soil sustainability

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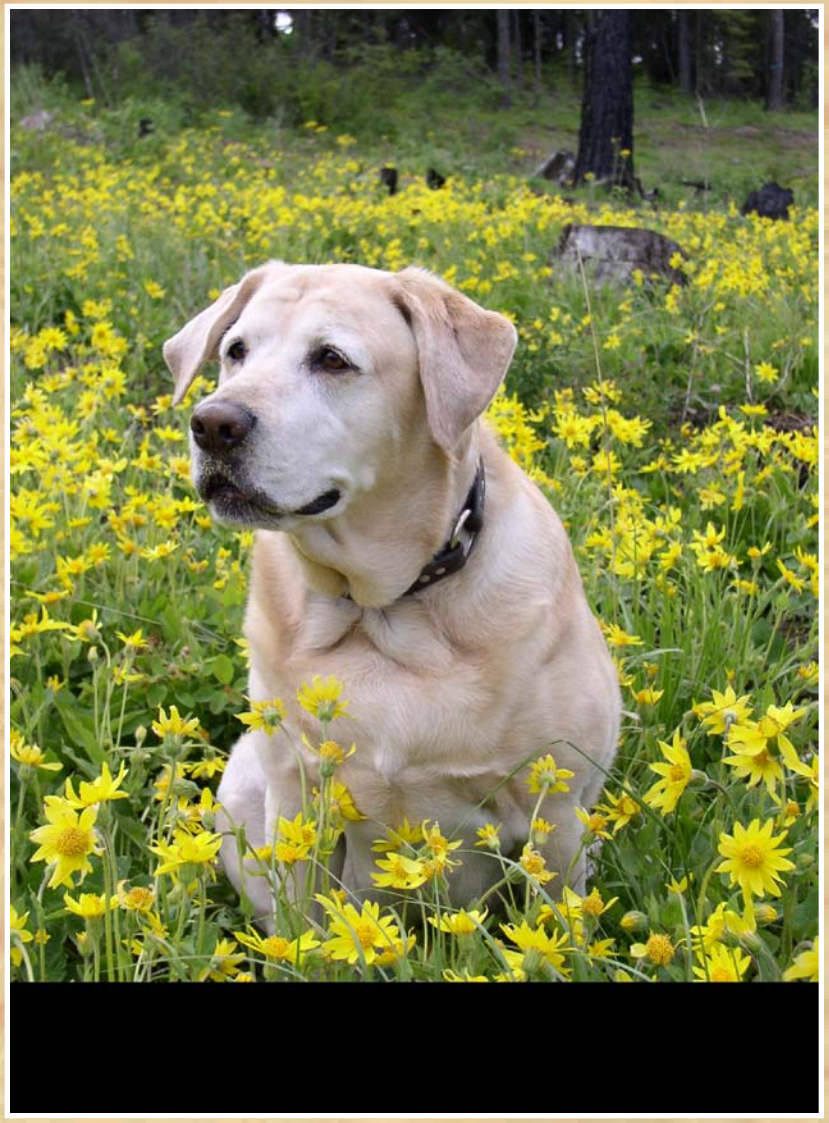

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