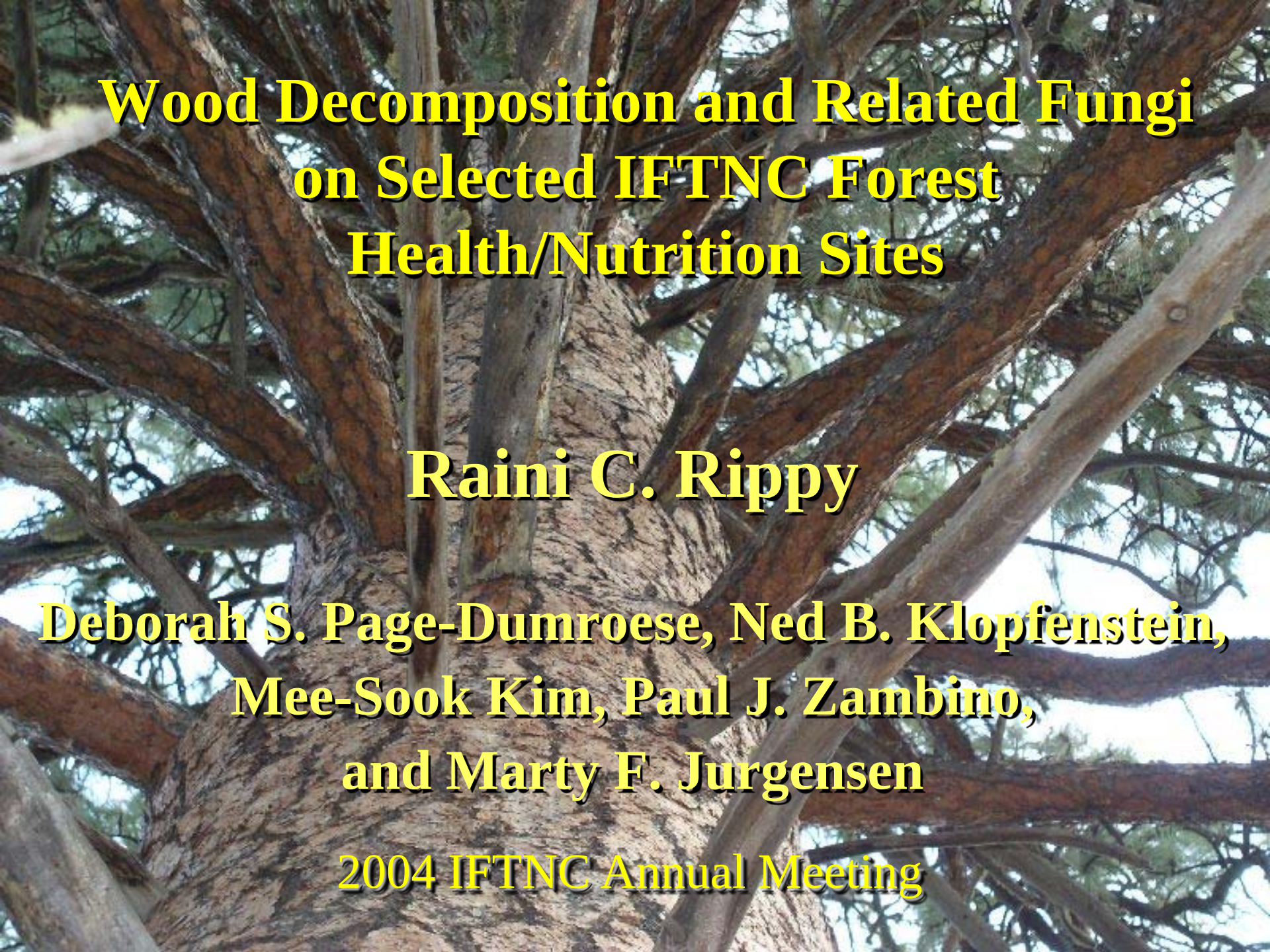

Wood Decomposition and Related Fungi on Selected IFTNC Forest Health/Nutrition Sites

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Outline

- Decomposition
- Fungi and nutrient cycling
- Stake study
- Preliminary results
- Conclusion

Decomposition

- Breakdown of organic materials through biological, physical, and chemical processes
- Primary mechanism by which organic matter and nutrients are returned to forest soils
- Woody debris provides a long-term source of organic matter and nitrogen important in maintaining site productivity

Factors Controlling Decomposition

- Temperature
- Moisture
- O_2 and CO_2 concentrations
- Substrate quality
- Size of substrate
- Decomposer organisms

Decomposer Organisms

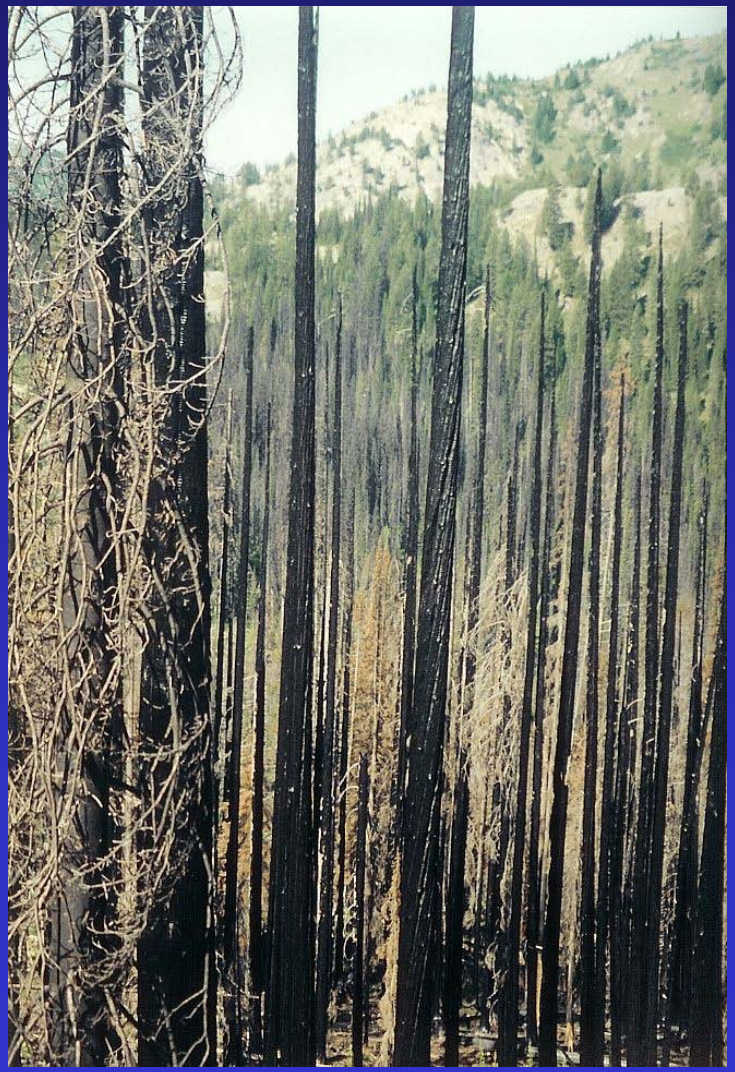
- Break down plant residues and recycle carbon
- Create decay products (white, brown, cubical, and stringy)
- Capture and retain nutrients that might be leached from root zone
- Form chemical and physical components, such as aggregates, involved in maintenance of structure and fertility in forest soils
- Release mineral nutrients in organic matter for use by other organisms
- Fungi comprise 60-90% of microbial biomass in forest soils

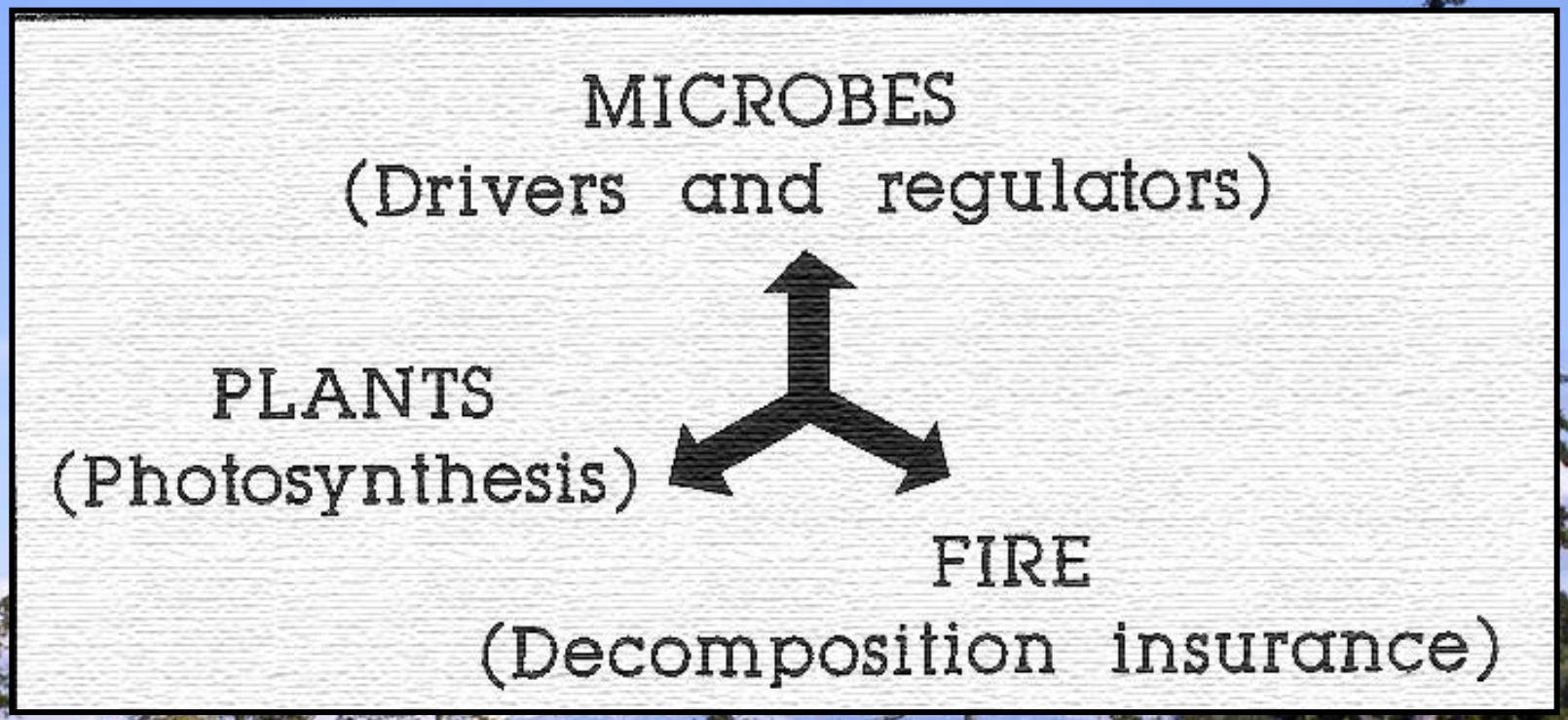
Nutrient Cycling

- In organic soils, the nutrient pool is largely derived from the mineralization of plant litter by microbial activity.
- Fungi are the dominant decomposers in aerobic environments.
- Basidiomycetes (white and brown rots) are the most important forest floor dwelling fungi in recycling carbon stored in wood.
  - Fungi causing brown rot can be the major agents of carbon and mineral nutrient release from wood in coniferous forests.

Dominant Nutrient Cycling Processes in Inland Northwest Ecosystems

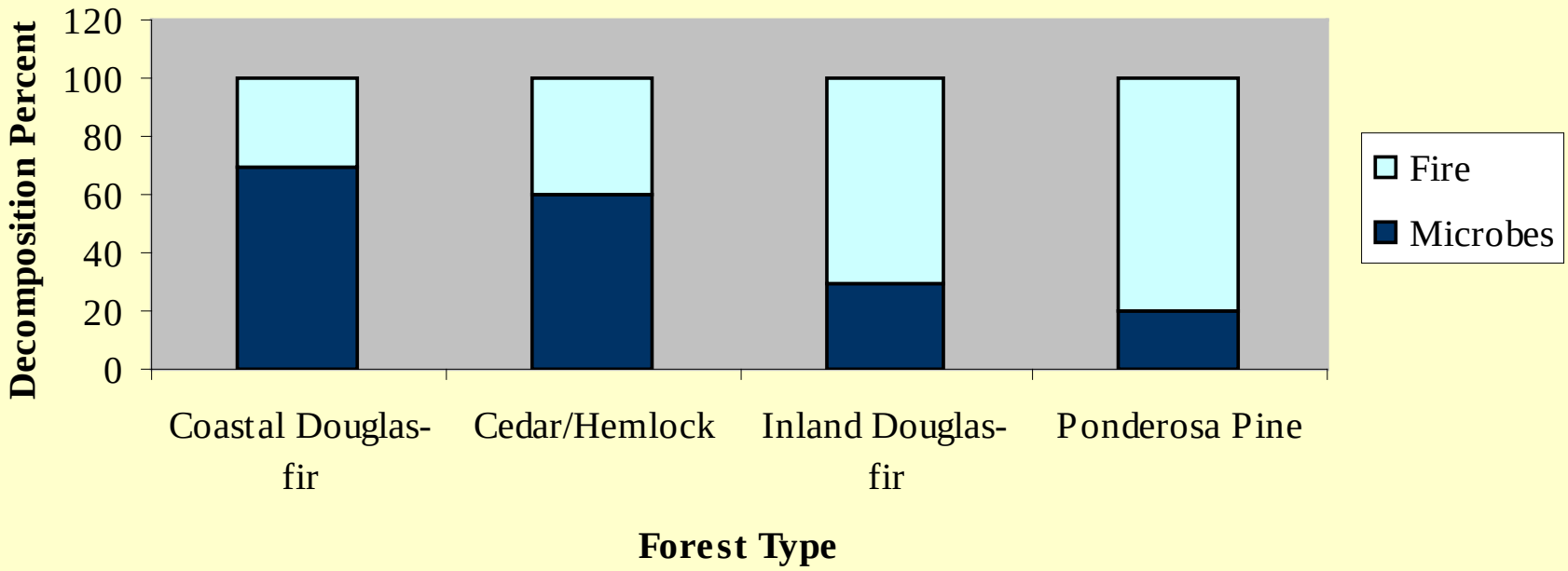
- Fire is the dominant recycling agent in ponderosa pine climax
  - Microbial decomposition limited by moisture
- Microbial decomposition is dominant in cedar-hemlock climax
  - Fire return interval is long





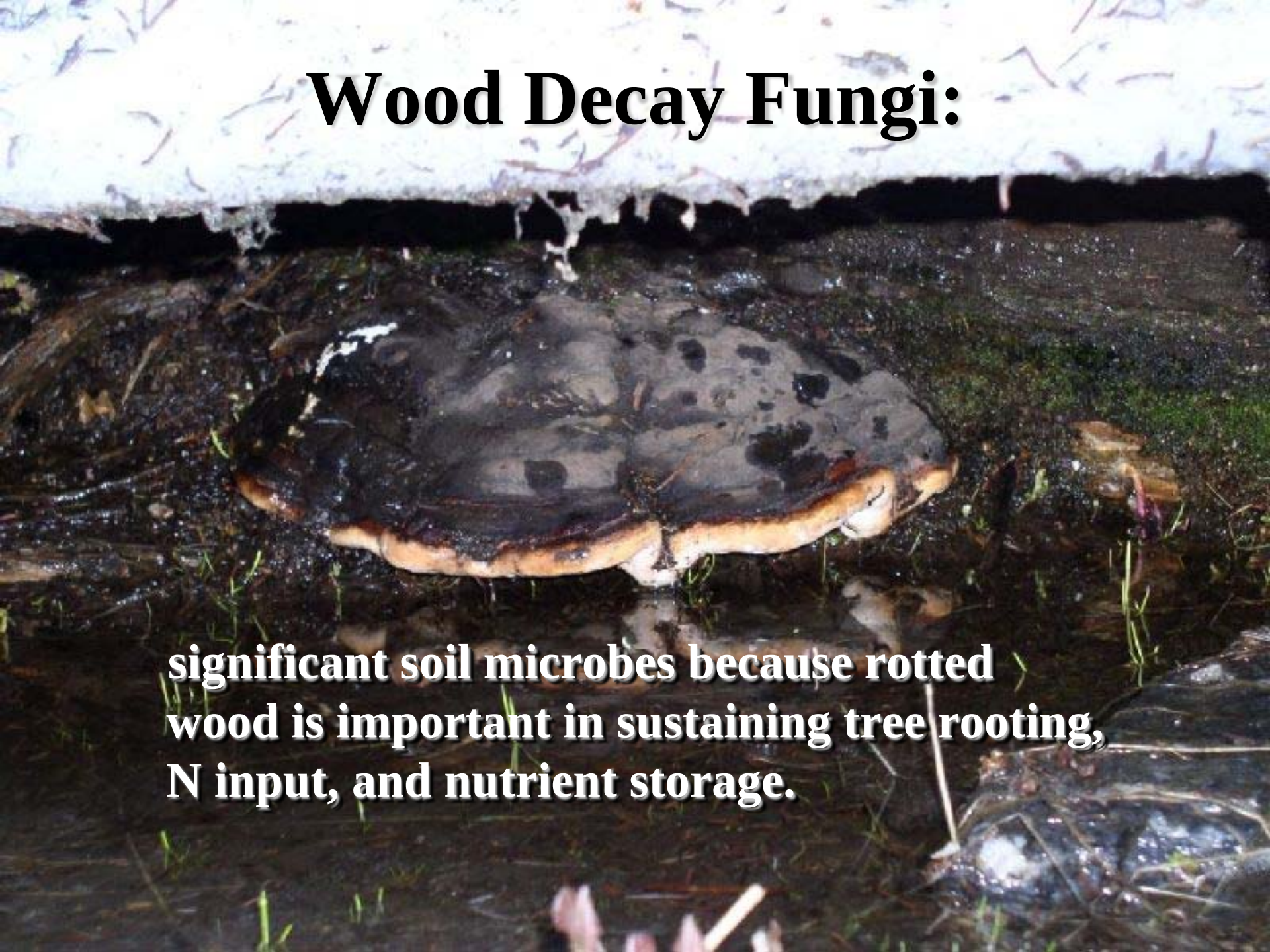
Inland Northwest ecosystems are dominated by three major forces: Plants, Microbes, and Fire (Harvey et al. 1994)

Estimated Relative Decomposition Percent Across Different Ecosystems



adapted from Harvey et al. 1994

Wood Decay Fungi:



significant soil microbes because rotted wood is important in sustaining tree rooting, N input, and nutrient storage.

Wood Stake Study

Background

- Standard-substrate wood stakes were installed on six IFTNC sites to examine effects of:
  - forest fertilization
  - parent material
  - soil moisture
  - soil temperature

on wood decomposition rates and soil fungal communities.

Points to Consider

- Response of wood-decay fungi to soil nutrient changes is not well understood.
- 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.).

Study Objectives

- Determine effects of soil chemical and physical properties on wood decomposition rates and fungal species diversity.
- Examine fungal diversity relating to rate and degree of wood decomposition under varying soil moisture, temperature, and nutrient conditions over time.
- Determine impact of forest management activities (fertilization) and environmental factors on wood decomposition in the forest floor and mineral soil.

- A total of 2800 mineral soil and 4800 surface / interface stakes (loblolly pine, aspen, and Douglas-fir) installed across all six sites.
  - Use of “standard” organic materials (loblolly pine, aspen, and Douglas-fir) allows comparisons between sites.
  - Quality of the organic material is held constant, while providing a range in lignin and cellulose contents.
- Four treatments:
  - N (300 lb/acre)
  - K (170 lb/acre)
  - N+K (300 + 170 lb/acre)
  - Control (unfertilized)

IFTNC Forest Health Sites

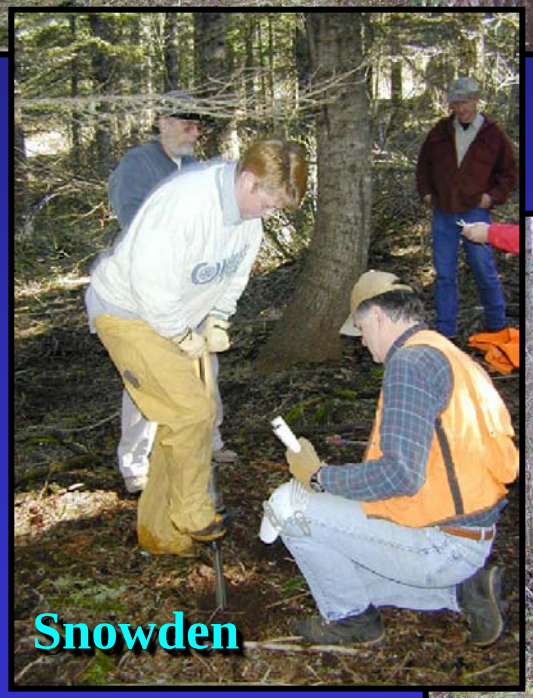
Installation	Parent Material	Habitat Type
• 336 Spirit Lake	Glacial till	THPL/PAMY
• 338 Snowden	Basalt	ABGR/ACCI
• 341 Grasshopper	Granite	THPL/ASCA
• 354 Huckleberry	Metasedimentary	ABGR/CLUN
• 355 Stanton	Metasedimentary	THPL/ASCA
• 362 Haverland	Granite	ABGR/PAMY

IFTNC Forest Health/Decomposition Sites


Grasshopper


Haverland


Huckleberry

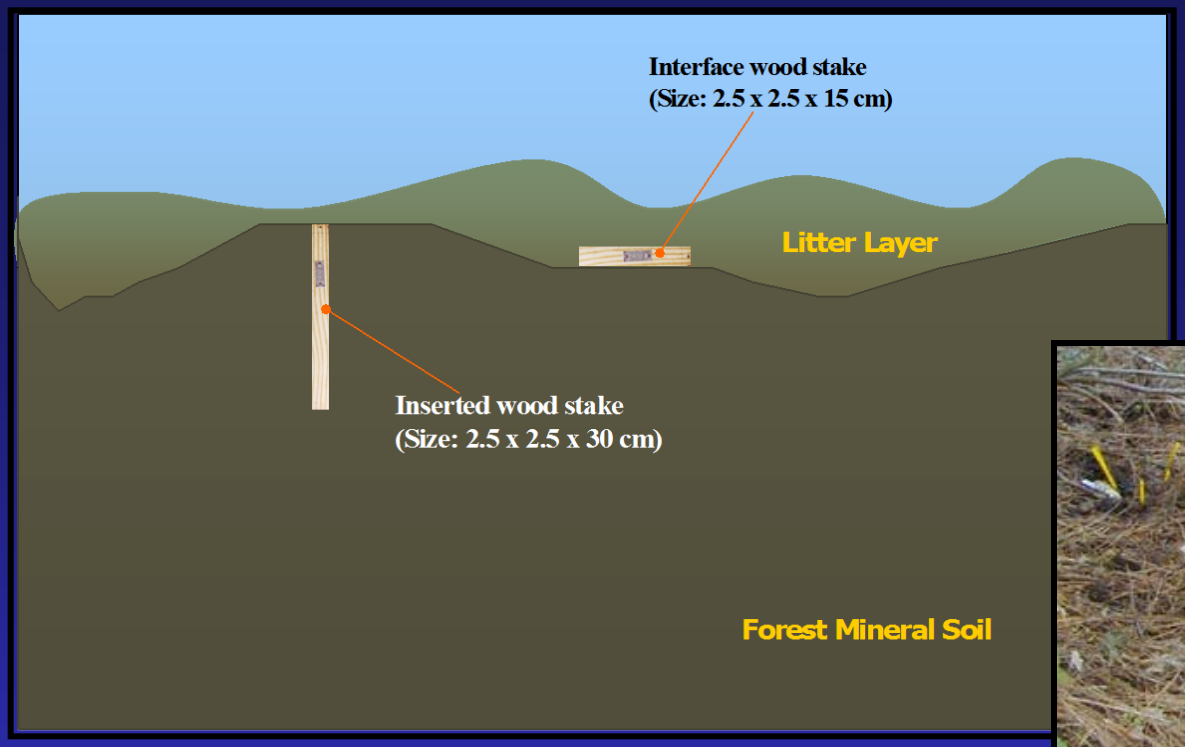

Snowden


Spirit Lake


Stanton

Stake Insertion

30 cm stakes inserted into mineral soil



Surface and interface stakes

Mineral soil stakes

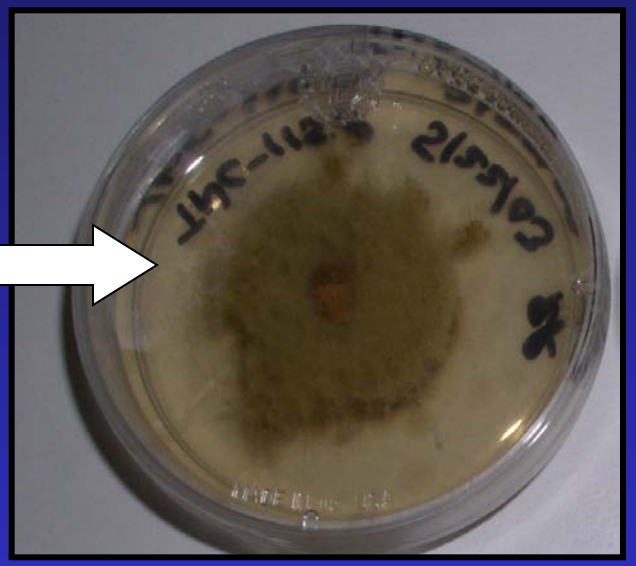
Mineral soil stake extraction

Surface stake extraction

Decay range of stakes

Isolation of Fungi

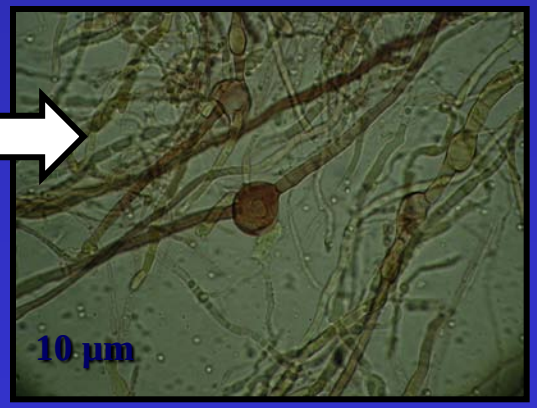
Samples from insertion stakes taken at 10-cm depth



Interface stakes were sampled at one location 3 cm from the end

Identification of Fungi

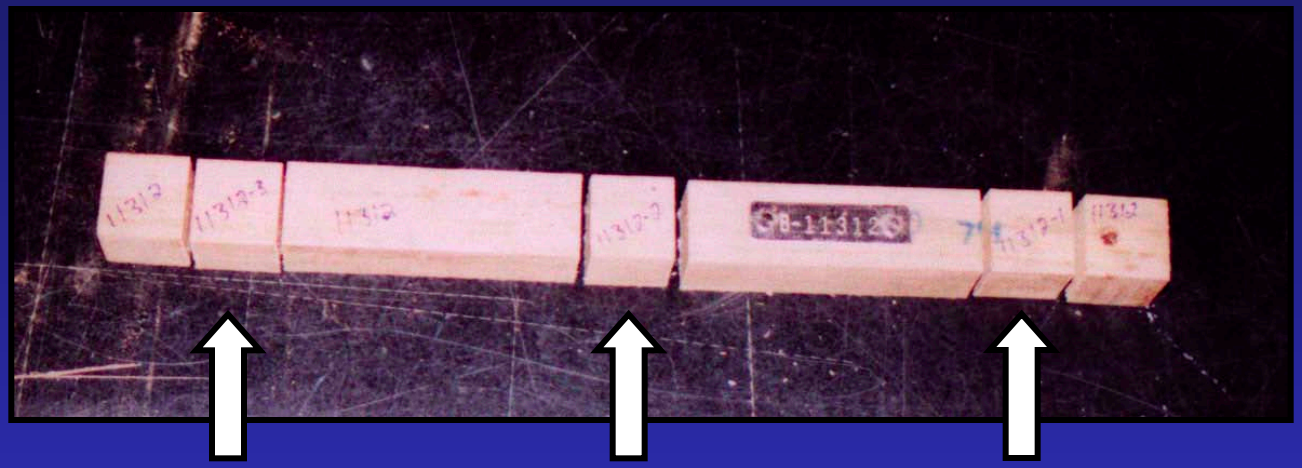
- Use both DNA analysis and morphological examination under the microscope.
  - DNA analysis provides information for fungal identification within a few days.
  - Verify identification of taxonomic characteristics by morphological examination.



Mechanical and Chemical Testing

- Stakes from the field are matched back up with their uninserted control stakes.
- Mechanical tests (compression parallel to grain) are performed at Michigan Technological University.
  - Weight loss is also evaluated at a standard moisture content.
- Chemical tests are performed at the USDA-FS Forest Products Laboratory in Madison, WI, and the USDA-FS Rocky Mountain Research Station in Moscow, ID.

Mechanical Tests



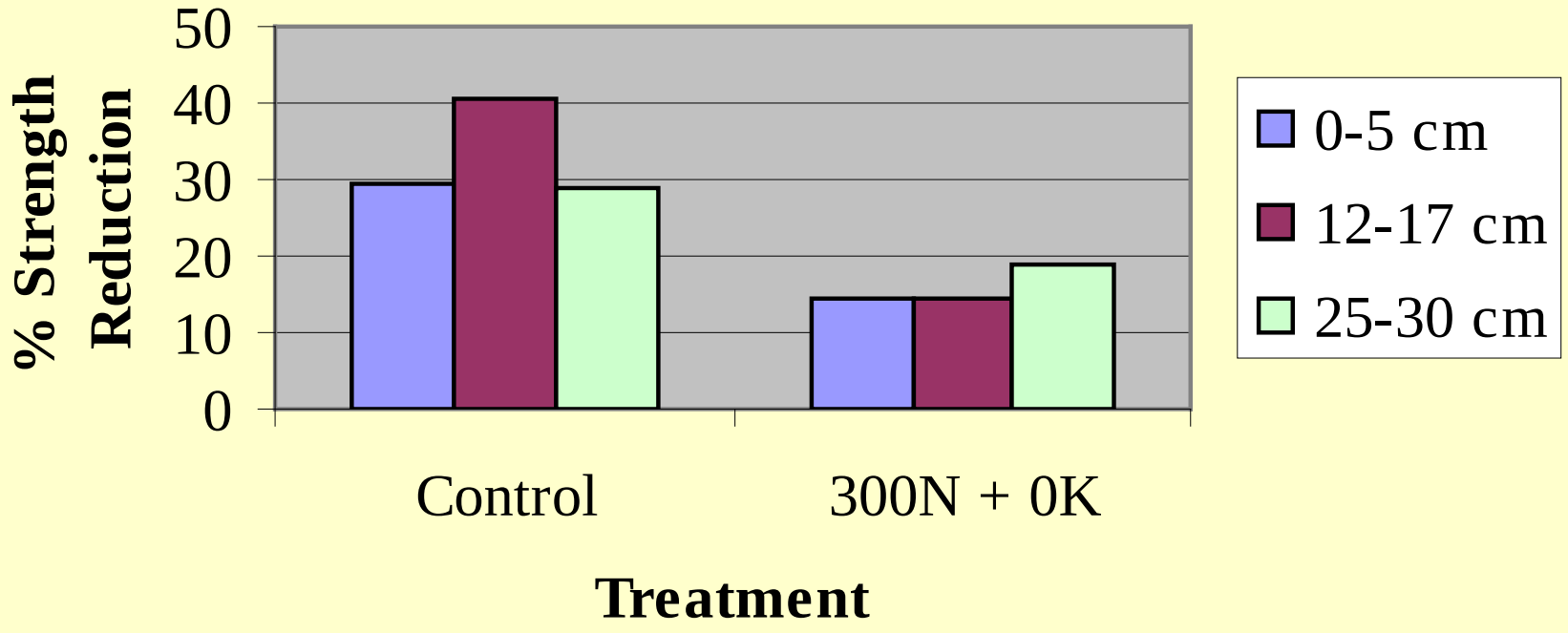
Compression tests are performed at three locations on the mineral soil stakes and one location in the middle of the surface stakes.

Chemical Tests

- Wood segments used in compression tests are ground and analyzed for:
  - Carbohydrates
  - Lignin
  - Carbon
  - Nitrogen
  - Phosphorus
  - Cations (Ca, Mg, K)
- Carbon isotope analysis is being performed at the University of Idaho.

Results

Average Aspen Decomposition After One Year By Soil Depth at Snowden, WA

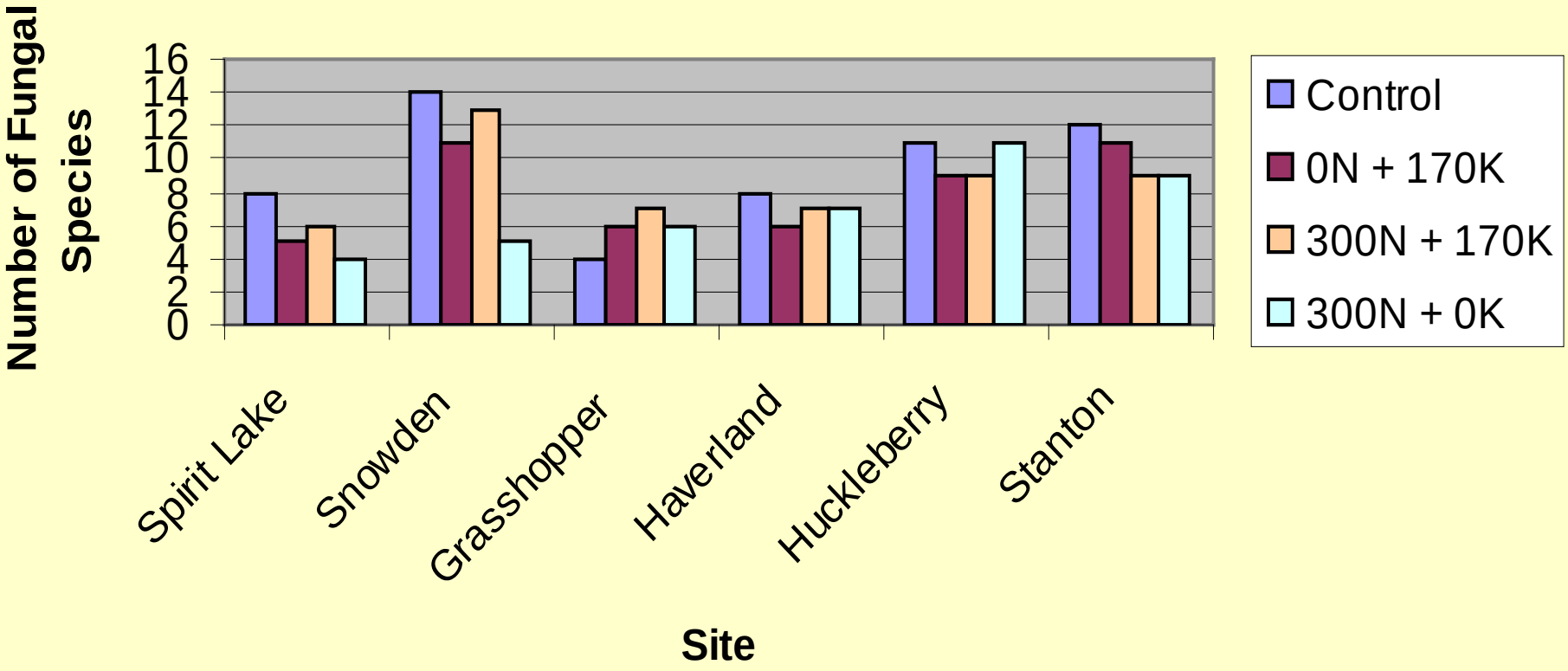


Fungal Genera Identified to Date

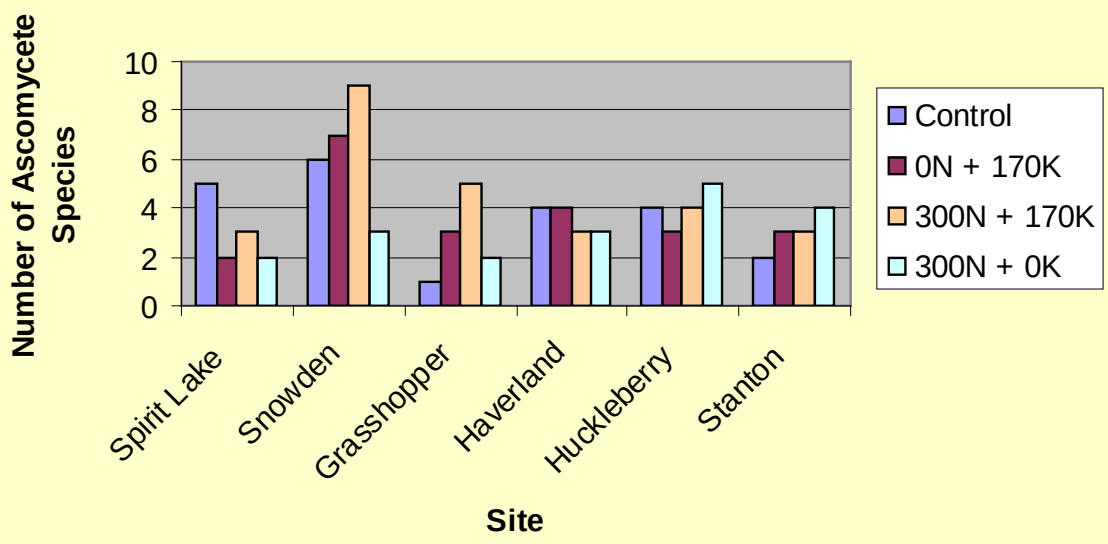
Basidiomycete		Ascomycete		Zygomycete
Agrocybe	*Rhizoctonia*	*Alternaria*	*Leptodontidium*	*Mortierella*
Ceriporiopsis	*Sistotrema*	*Aureobasidium*	*Leptosphaeria*	*Mucor*
Clavulina	*Sistotremastrum*	*Cladosporium*	*Leptosphaerulina*	*Thamnidium*
Coniophora	*Stereum*	*Colletotrichum*	*Nectria*	*Umbelopsis*
Coprinus	*Tephrocybe*	*Cordyceps*	*Neonectria*	
Cylindrobasidium	*Trichosporon*	*Cylindrocarpon*	*Penicillium*	
Gymnopilus	*Truncatella*	*Drechslera*	*Phoma*	
Lentinellus	*Vararia*	*Embellisia*	*Poculum*	
Lyophyllum		*Epicoccum*	*Podospora*	
Mycena		*Eupenicillium*	*Pseudogymnoascus*	
Peniophora		*Fusarium*	*Tetracladium*	
Phanerochaete		*Gibberella*	*Thysanophora*	
Polyporus		*Hypocrea*	*Trichoderma*	
Poria		*Lecythophora*	*Ulocladium*	

Note: Identification is based on preliminary DNA analysis

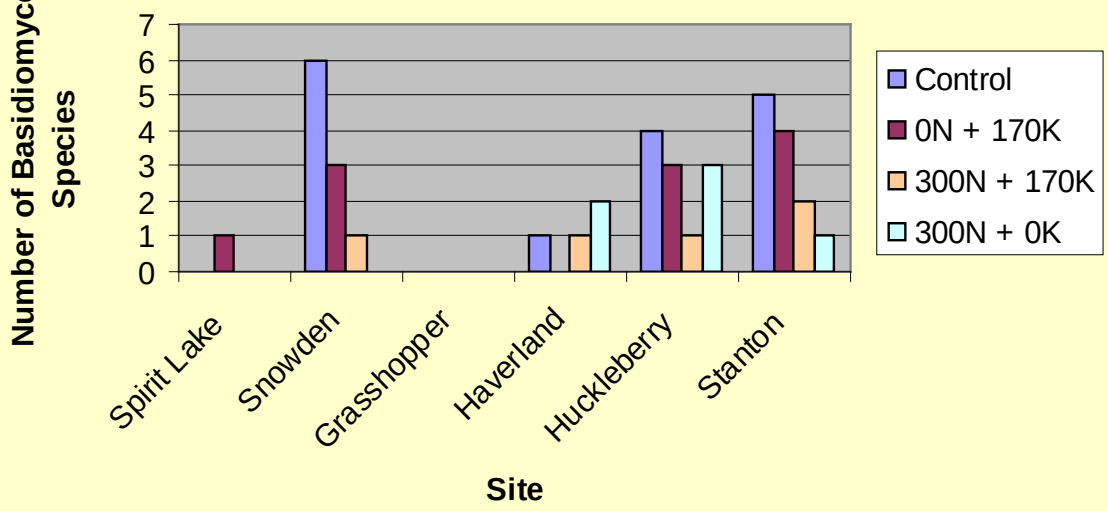
Distribution of Fungal Species from Spring 2003 Stake Extractions

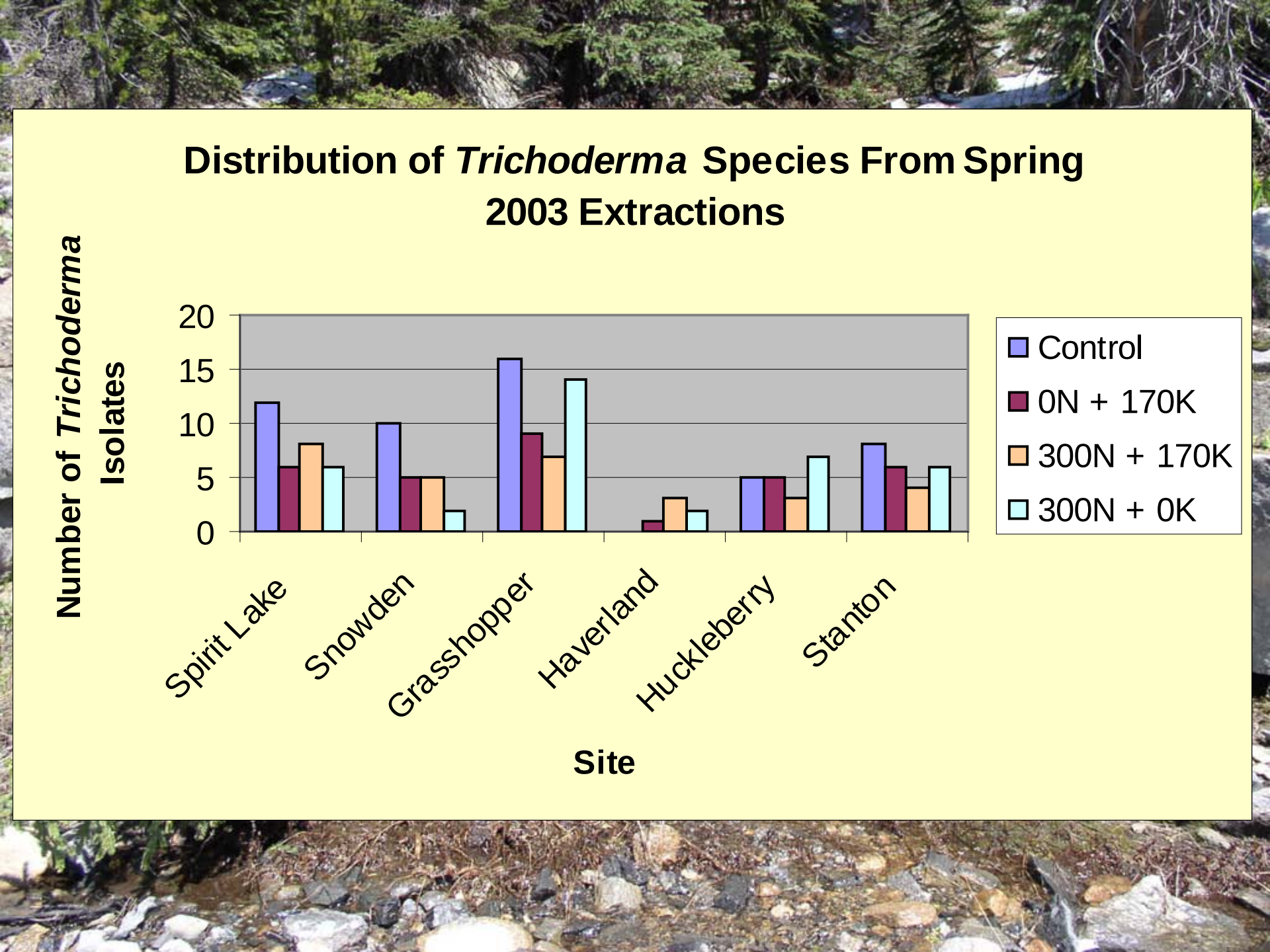


Distribution of Ascomycetes Spring 2003



Distribution of Basidiomycetes Spring 2003




Distribution of *Trichoderma* Species From Spring 2003 Extractions
Number of *Trichoderma* Isolates
20
15
10
5
0
Spirit Lake
Snowden
Grasshopper
Haverland
Huckleberry
Stanton
Site
Control
0N + 170K
300N + 170K
300N + 0K

Summary of Preliminary Results

- Total number of stakes sampled to date = 2223
- Total number of species identified to date = 579
- Total number of fungal isolates to still be identified ~ 600
- Control plots and ‘potassium only’ plots had the highest number of basidomycetes present
- Nitrogen plots had mostly zygomycetes (molds & “sugar fungi”) and ascomycetes (molds, sap-stains & soft-rots) present
- Chemical and mechanical tests are in progress
  - Will compare decomposition of stakes between species, depth, treatment, site, and fungal isolates

Industrial Applications of Forest Fungi

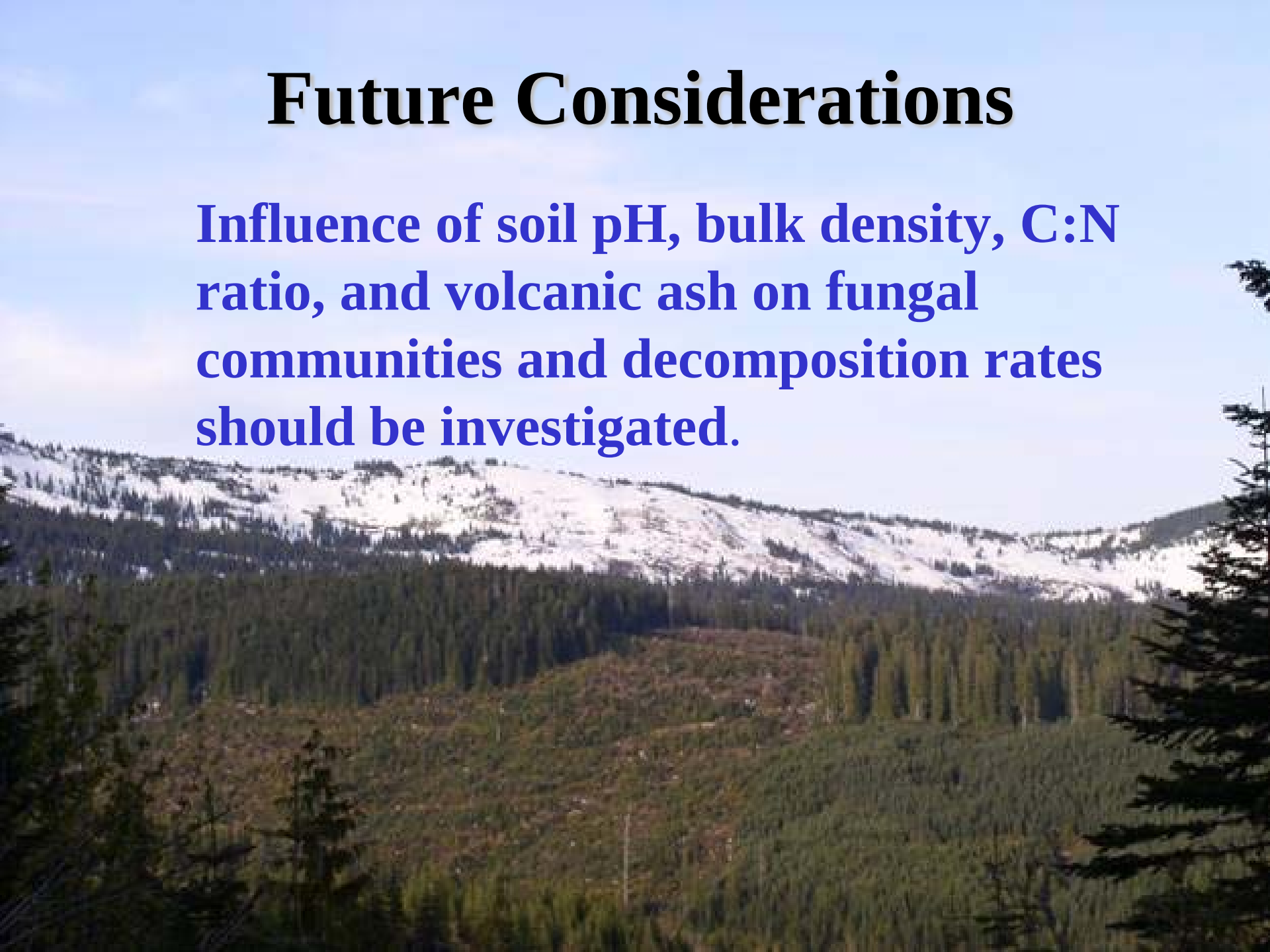
- Biological control
  - Root diseases and wood decay
- Biodegradation
  - Resin acids
  - Wood preservatives
- Biopulping
- Bioremediation

Summary

- Use of a standard decomposition substrate allows evaluation of the effects of management on decomposition rates, fungal succession, and fungal community changes.
- It is important to determine the impacts of forest management on belowground productivity and sustainability across different environments.
  - Including impacts on fungal communities and fungal succession.
- Critical nutrients are sequestered in plant debris and sites can become nutrient limited.
  - This is especially true in the absence of fire and when biological decomposition is limited by temperature and moisture.

Future Considerations

Influence of soil pH, bulk density, C:N ratio, and volcanic ash on fungal communities and decomposition rates should be investigated.



Conclusion

- Knowledge of the interactions of fungi, decomposition, and soil properties is essential in determining appropriate management practices.
- By altering factors known to regulate soil decomposer communities and processes, forest management practices could be used to change soil organic matter decomposition rates in order to reduce surface fuels, maintain nutrients, and sequester carbon.

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