Wood-decomposing Fungi on Selected IFTNC Forest Health/Nutrition Sites

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(Cooperative project between the USDA Forest Service - RMRS, IFTNC, and Michigan Technological University)

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Outline

I. Introduction

II. Background

III. Forest Fertilization Stake Study

IV. Conclusion

Importance of Soil Microbes

- Mineralize nutrients in plant remains
- Create decay products (white, brown, cubical, and stringy)
- Capture and retain nutrients that might be leached from root zone
- Form chemical and physical components involved in maintenance of structure and fertility in forest soils

Note: The largest proportion of fungal biomass is located belowground.

Wood Decay Fungi

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

Three Major Roles of Decay Fungi

- Break down plant residues and recycle carbon
- Release mineral nutrients in organic matter for use by other organisms
- Help form soil aggregates

Factors Controlling Decomposition

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

Wood-decay Fungi

- 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.).

Background

- Wood stakes were first installed on Long-Term Soil Productivity (LTSP) plots in different regions of the U.S. by the USDA Forest Service.
- To date, stakes have been installed in:
  - United States: Idaho, Washington, Oregon, California, Montana, Colorado, South Carolina, Hawaii
  - International sites: Finland, Switzerland, Canada, Poland
- Study was designed to evaluate management impacts on belowground processes.

Forest Fertilization Stake Study

Parallel project to the original LTSP decomposition study to evaluate management impacts on belowground productivity.

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.
- Determine impact of forest management activities (fertilization) and environmental factors on wood decomposition in and on the forest floor and mineral soil.

Wood Stake Study

- Wood stakes were installed on six IFTNC sites to examine effects of:

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

on wood decomposition rates.

Wood stake study continued

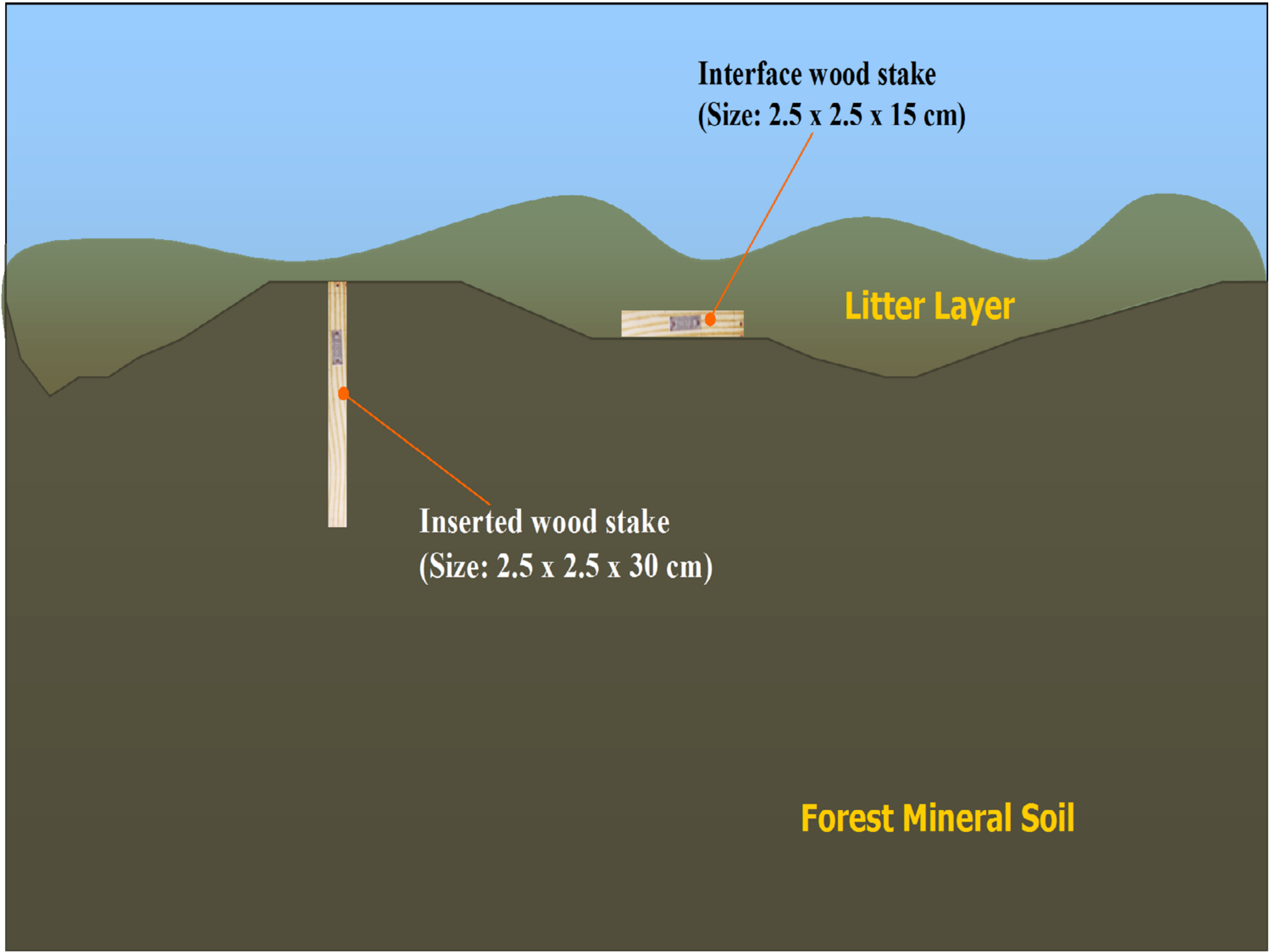
- Stakes are made from from softwood and hardwood trees:
  - Loblolly pine *(Pinus taeda)*
  - Douglas-fir (*Pseudotsuga menziesii)*
  - Aspen *(Populus tremuloides)*

- Stake sizes
  - (2.5 x 2.5 x 30 cm) = insertion stakes
  - (2.5 x 2.5 x 15 cm) = surface stakes

New aspen insertion stakes

Why not use all local species?

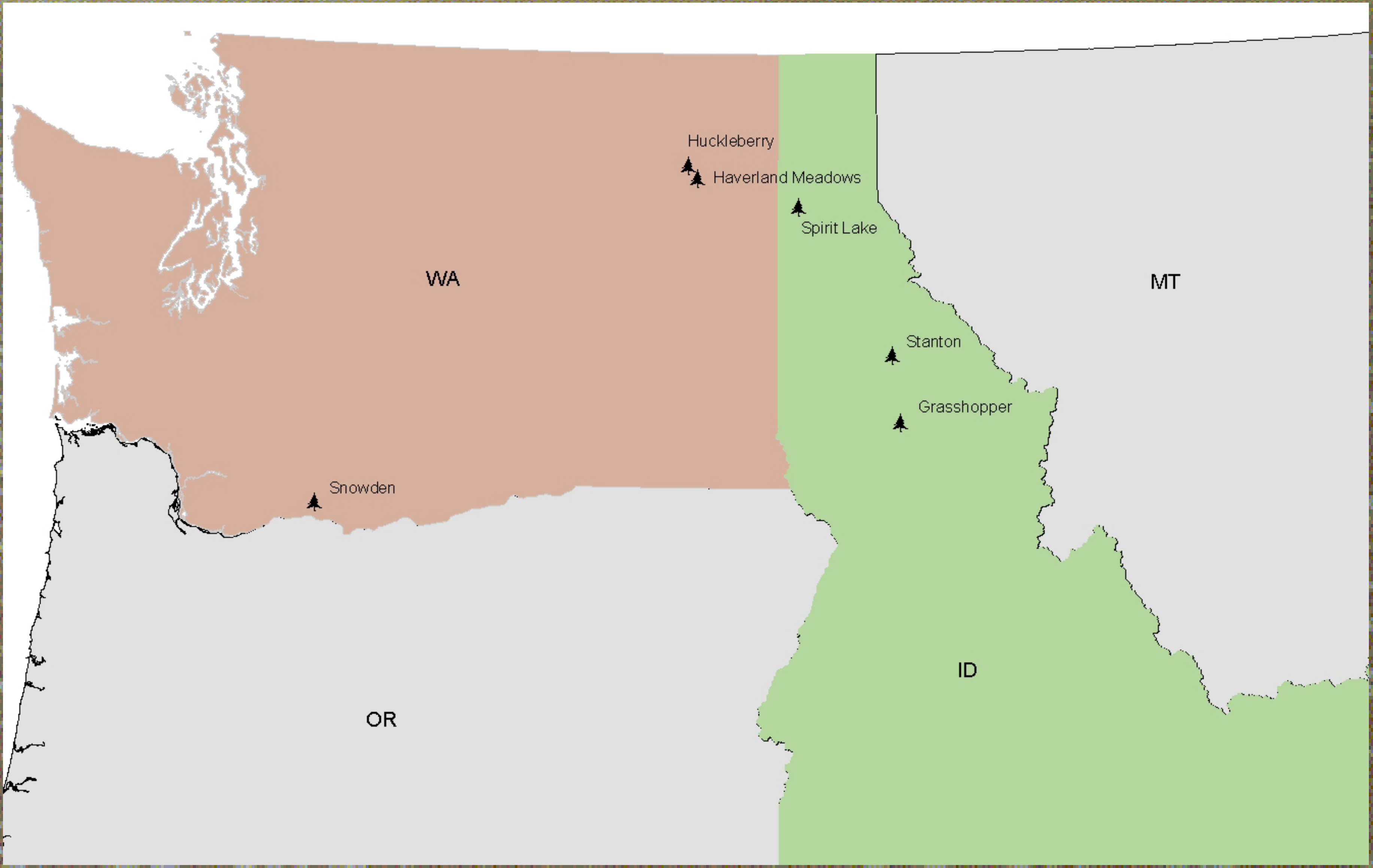
- Use of “standard” organic materials (loblolly pine and aspen) allows comparisons between sites.
  - Quality of the organic material is held constant, while providing a range in lignin and cellulose contents.


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 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



Four Treatments

- N (300 lb/acre)
- K (170 lb/acre)
- N+K (300 + 170 lb/acre)
- Control (unfertilized)

Stake Installation

- Two subplots were installed on each of the four selected treatments.
- Soil moisture and temperature data collectors were placed on one subplot in the control at depths of 10 cm and 5 cm, respectively.
  - CO_2 tubes were installed on one subplot at each treatment for soil gas collection.

Stake Installation Continued

- 25 stakes (2.5 x 2.5 x 30 cm) of each species were inserted into the mineral soil of each subplot. *(DF only placed at Spirit Lake,ID, and Grasshopper, ID)*
  - 2800 insertion stakes total across sites
- 25 stakes (2.5 x 2.5 x 15 cm) of each species were placed on top of forest floor and 25 more were installed at forest floor/mineral soil interface at each subplot.
  - 4800 surface stakes total across sites

Stake insertion at Installation 338 Snowden, WA, April 2002.

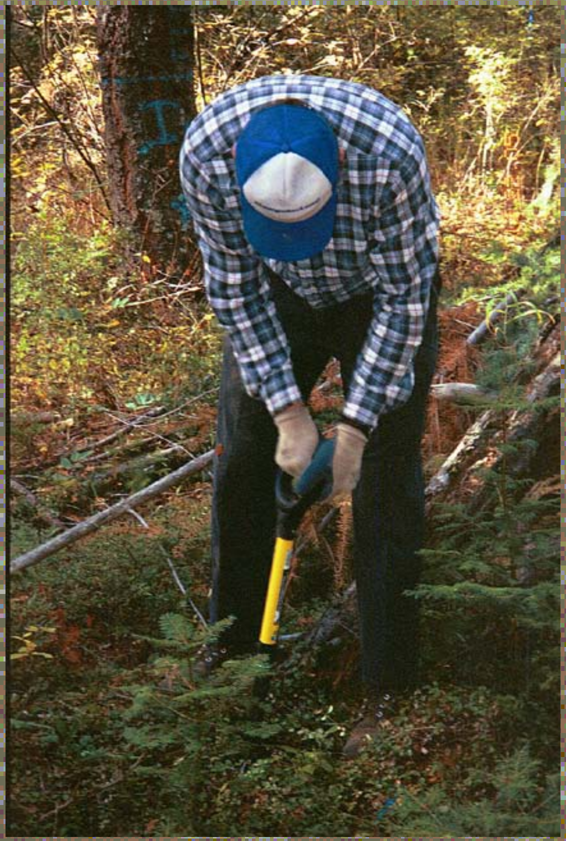
Surface stakes at Snowden, WA, April 2002.

Sampling Design

- All subplots on all treatments will be sampled
  - twice a year (spring & fall)

- One stake of each species from each row
  - insertion and interface stakes
    - surface stakes from the top of the forest floor will not be used for fungal isolations

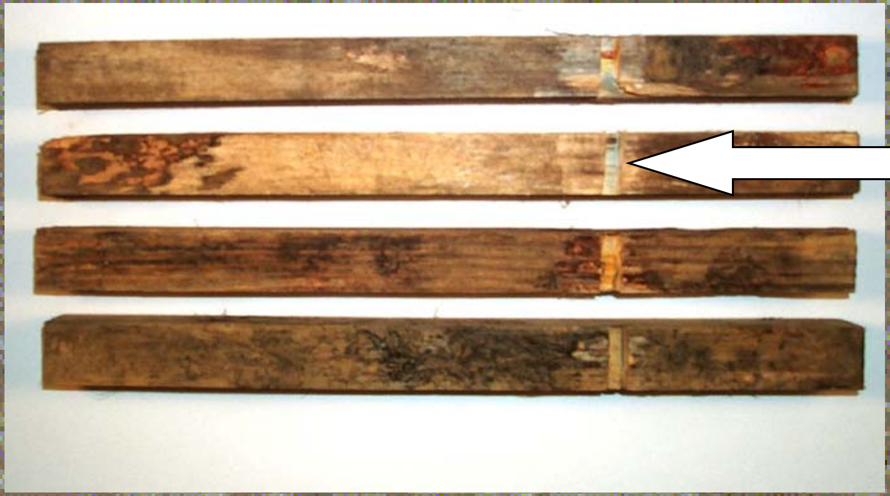
Installation 336 Spirit Lake, ID, stake extraction, October 2002.



Installation 336 Spirit Lake surface stake extraction, October 2002.

Spirit Lake, March 2003

Isolation of Fungi



Samples from insertions stakes taken at 10-cm depth.

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

Pine

Range in stages of decay in stakes extracted at the same time from the same site.

Aspen

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.

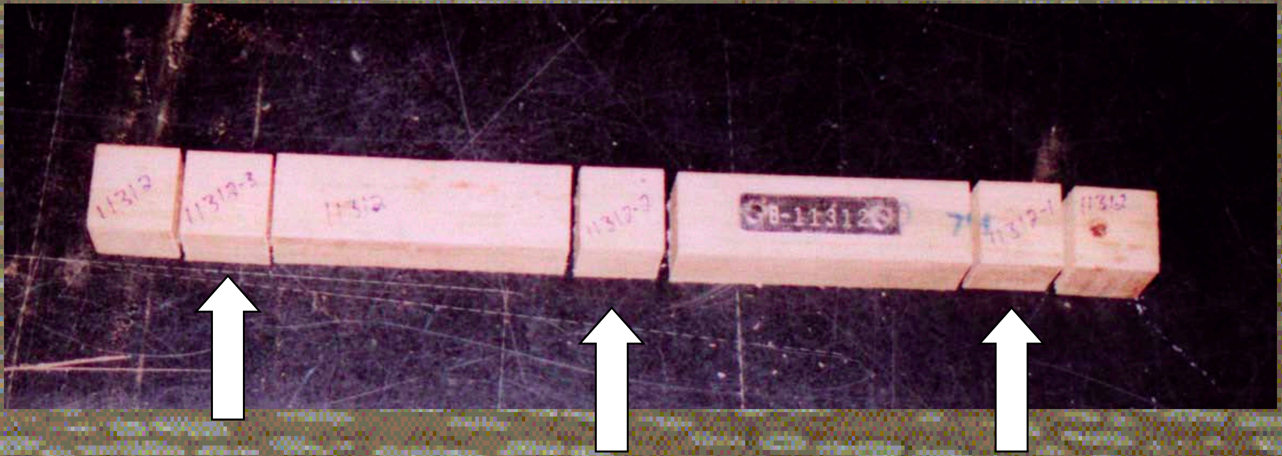
Mechanical and Chemical Testing

- 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 will be performed at the University of Idaho.

Preliminary Results

- Stakes were extracted from Snowden and Spirit Lake last fall.
  - Stakes were also extracted at Spirit Lake in March 2003.
- Basidiomycete, ascomycete, and zygomycete fungi were isolated.

Preliminary Results Continued

Spirit Lake, ID 2002

Fungal Class

- Basidiomycetes = 4 species
- Ascomycetes = 10 species
- Zygomycetes = 5 species (largest number of isolates)

- Highest diversity of species on control plot (12), followed by 0N + 170K (9), 300N + 0K (7), and 300N + 170K (5).

Preliminary Results Continued

Spirit Lake, ID 2003

Fungal Class

- Basidiomycetes = 0 species
- Ascomycetes = 7 species
- Zygomycetes = 5 species (largest number of isolates)

- Highest diversity of species on control plot (8), followed by 300N + 170K (6), 0N + 170K (5), and 300N + 0K (4).

Preliminary Results Continued

Snowden, WA 2002

Fungal Class

- Basidiomycetes = 3 species
- Ascomycetes = 14 species
- Zygomycetes = 3 species (largest number of isolates)

- Highest diversity of species on control plot (12), followed by 0N + 170K (9), 300N + 170K (6), and 300N + 0K (5).

Summary of Preliminary Results

- Control plots and ‘potassium only’ plots had the highest fungal diversity.
  - More basidomycetes present on these plots.
- Nitrogen plots had the lowest fungal diversity, but the largest groups of fungi.
  - Mostly zygomycetes and ascomycetes on these plots.
- Chemical and mechanical tests are in progress.
  - Will compare decomposition of stakes between species, depth, treatment, site, and fungal isolates.

Conclusion

- Use of a standard decomposition substrate allows evaluation of the effects of management on fungal succession and 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.

Conclusion Continued

- Knowledge of the interactions of fungi, decomposition, and soil properties is essential in determining appropriate management practices.
- Appropriate management practices can:
  - reduce surface fuels
  - maintain nutrients
  - sequester carbon

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