Northern Hardwood Forest

Managing for its Magic Sauce

Duff & Retained Organic Matter

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Northern Hardwood Forest Definition

NHF
NHF Natural Community
Maple - Birch - Beech - (Ash & Pine)
Matrix Forest
Outmoded concepts – Climax forest, succession to maple

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Spatial Scale – Natural Community

Small Patch

- Less than 50 acres
- Embedded in another natural community for viability
- Distinct physical (& chemical) features
- 5% of landscape
- Much of the biodiversity
- Cliffs, acidic bogs, vernal pools

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Spatial Scale – Natural Community

Large Patch

- 50 to 1000 acres
- Usually on dominant environmental condition or disturbance – shallow water inundation, fire
- 20% of the landscape
- These are the areas people often associate with special wildlife or plants – marsh & ducks, floodplain forests
- Ecological parameters & careful management allows resource extraction

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Spatial Scale – Matrix Community

Matrix Forest

- 1,000s to millions of acres – dominates landscape
- Shaped by climate and geology – and now humans as its where we live
- Disturbance driven – small gap
- 75% of the landscape
- Species are “generalists” with broad ecological tolerances
- Northern Hardwoods, Spruce NH, Spruce-Fir forests
- Temperate climate produces immense amounts of wood

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What Makes NHF Unique?

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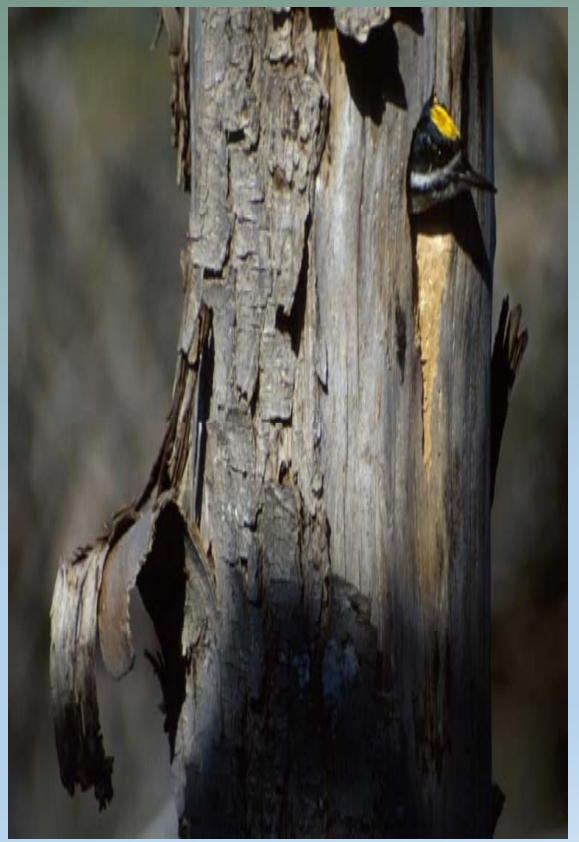
Retained Organic Matter
aka Coarse Woody Debris

- 20% birds, 30% mammals, 45% amphibians, 50-60% of reptiles use CWD directly
- Nearly every forest bird is tied to insects that are part of the detrital cycle
- 99% of energy in a tree ends up in detrital cycle



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Retained Organic Matter
Other Values

- Trapping downslope movement of soil
- Storing moisture in forest floor ecosystem – highly diameter related
- Legacy feature after disturbance
- Insects and fungi – volume & diameter
- Seedling bed – yellow birch

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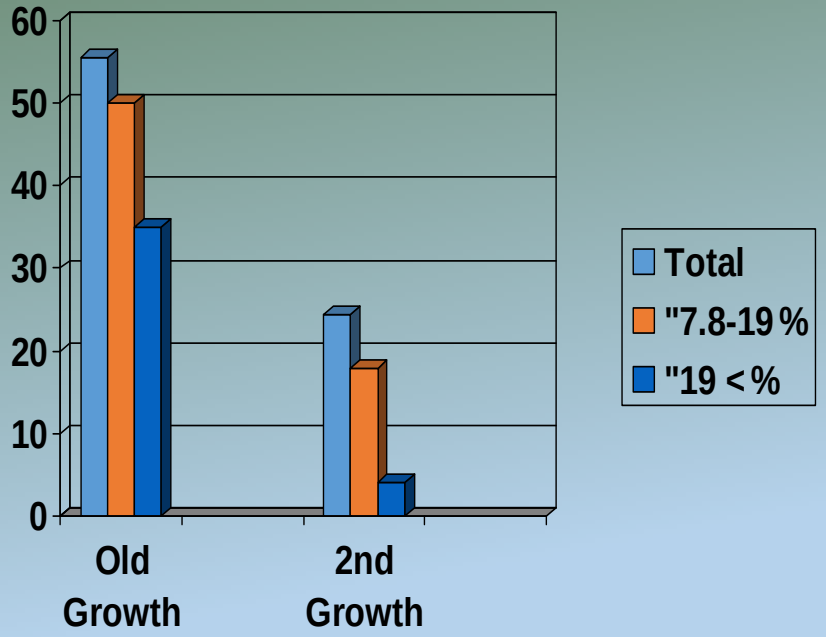
Size and Distribution matter

- ½ volume in managed forests
- Greatest loss in large diameter (1/10 vol)
- 70 year decay rate (conservative) and water storage
- Bats & Birds



Based on McGee et al. 1999

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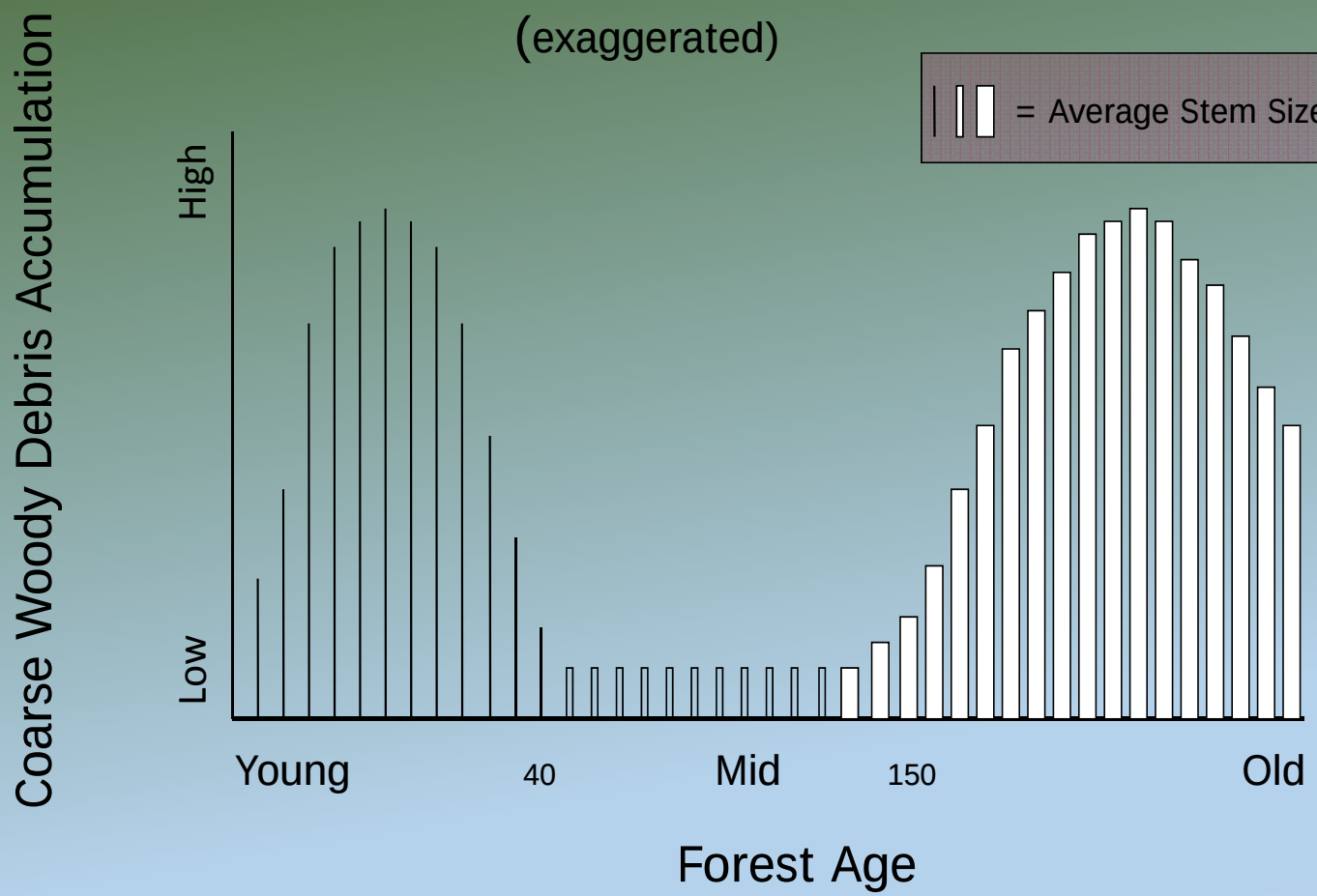
Coarse Woody Debris Inputs by Age



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Minimum Retained Organic Matter

Dated, these will evolve

- 5 logs/acre >/= 20” 16’ long
- 10 logs/acre >/= 14” 16’ long
- Even distribution
- Stream buffers

No one cared until C sequestration issues – 20% of biomass in NE

Length and diameter will be important – whole tree harvest a threat

Nutrient cycling – leafs quick, logs a legacy and increase over time

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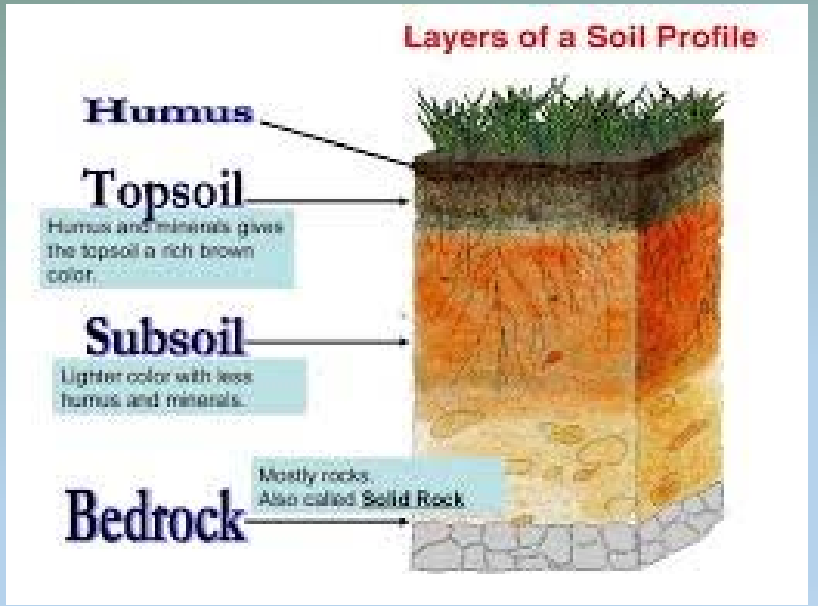
Get this right and everything else falls into place

Soil – What is it?

Traditional view - 1936

- Weathering & accumulated unconsolidated material
- Proportion of sand, silt and clay
- Organics
- Primary focus is impacts on human use



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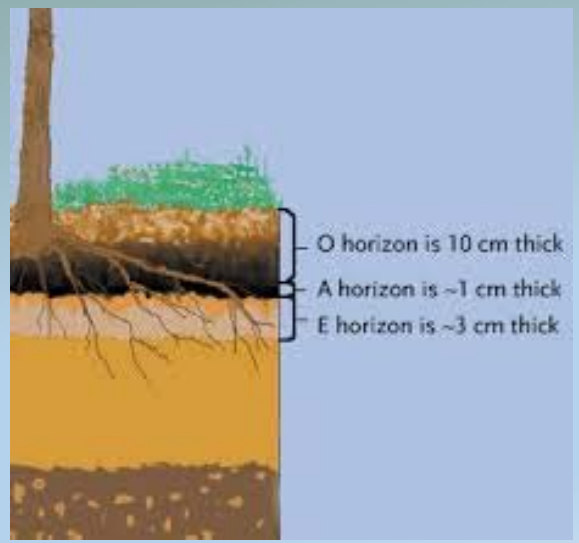
Soil – What is it?

Modern view forests - 1996

- Rhizosphere – space near fine roots
- Global carbon exchange cycles – soil is largest carbon pool
- Nutrient cycles
- Glomalin = humus, discovered in 1996
- **Mycorrhizal fungi** – this changes everything



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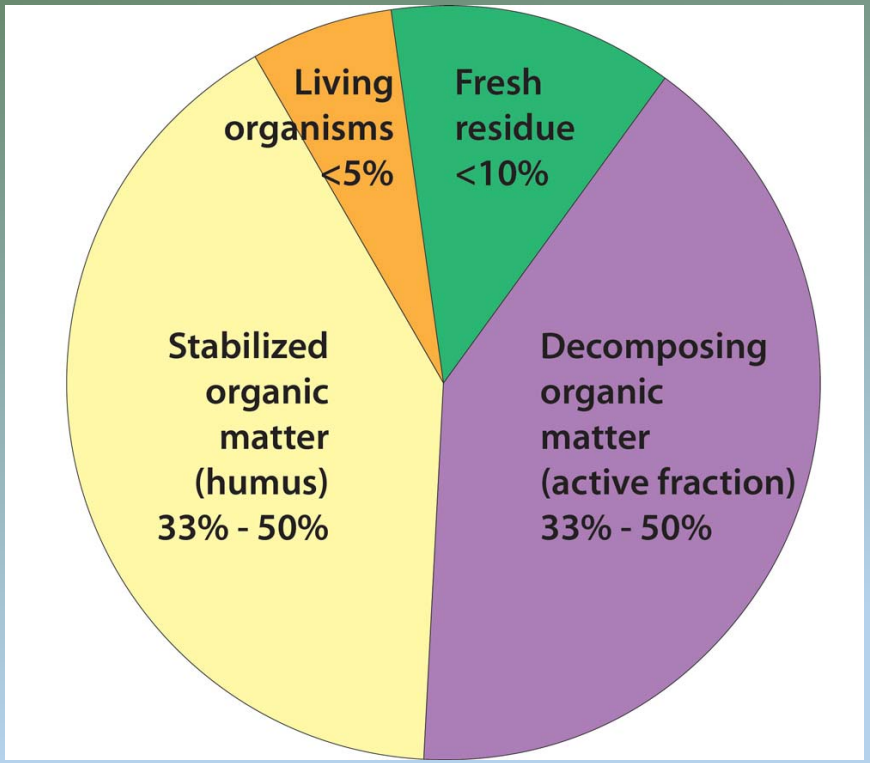
Soil – What is it?



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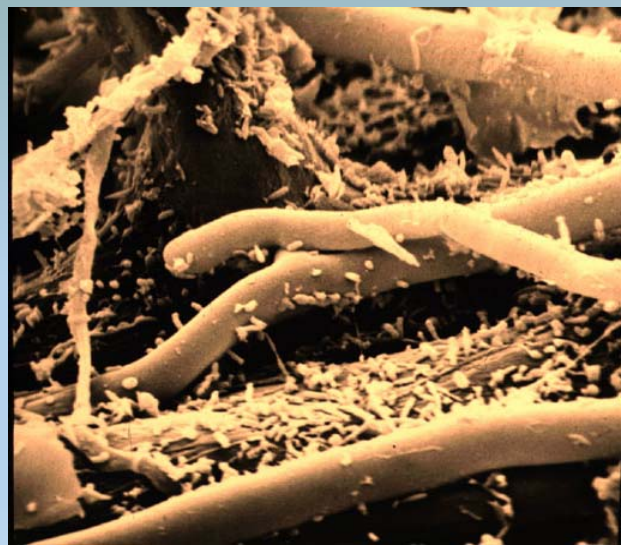
Rhizosphere

- 10,000s of species of bacteria, fungi, nematodes, protozoa, algae, viruses, arthropods, and others
- Now considered **one of the most complex ecosystems on earth**, with complex web of predators and decomposers
- All grouped around fine roots
- Fine roots make up 33% of all net primary productivity (think growth) by plants
- Rhizosphere fed by root exudates – **40% of tree's photosynthate**



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Mycorrhizal Fungi

Basic Biology

- Arbuscular mycorrhizae - penetrates fines roots – 80% of all plants – maples
- Ectomycorrhizae – does not penetrate roots – 2% of plants – birch, beech, oak, pine
- MF Biomass equals biomass of fine roots
- 50% +/- of the carbon in soil & litter
- Mushrooms = fruiting bodies

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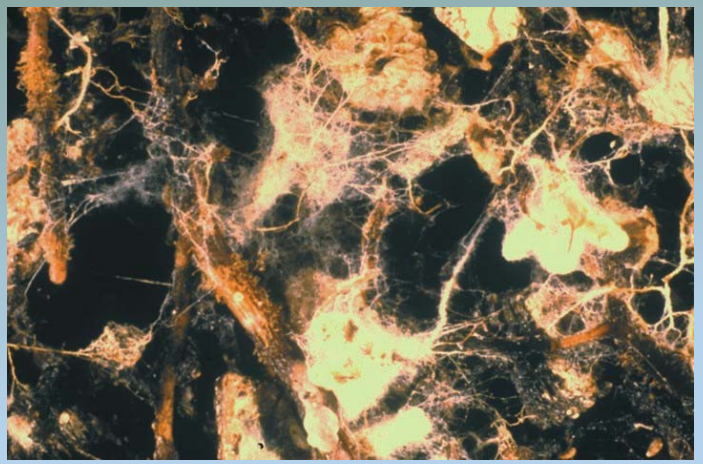
Mycorrhizal Fungi

Functional Role

- Expand reach of 1000s miles of fine roots 100X
- Constantly probing soil
- Vastly increases uptake of nutrients and water
- Antibiotic protection of root
- Excrete enzymes and hormones



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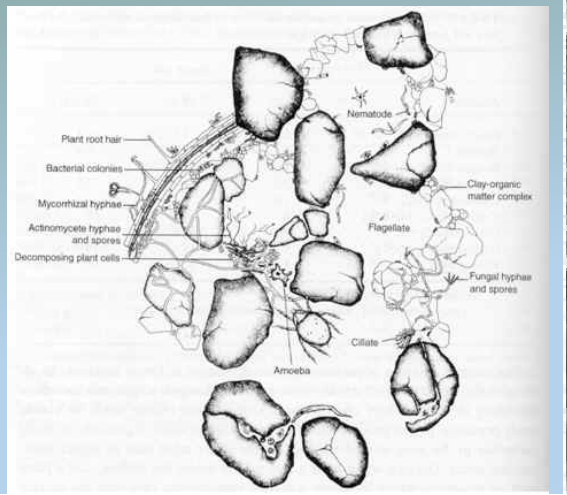
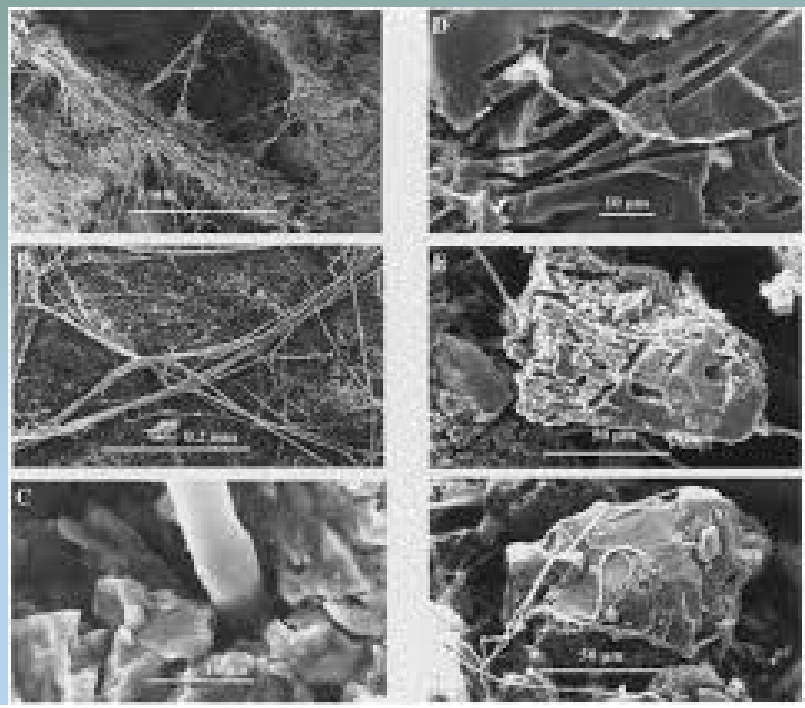
Mycorrhizal Fungi

Emerging Functional Roles?

- Soil structure/aggregation – binding
- Glomalin – protein - 30% of soil carbon – humus – 7-42 years to degrade
- Movement of material between trees, even of differing species
- Mining calcium and moving it to specific trees
- Communication?





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Mycorrhizal Fungi

Emerging Functional Roles?

What we know

- Soil aggregation is associated with MF and increases soil productivity
- Glomalin is associated with AMF and soil aggregation
- Dissolving calcium from acidic apatite is largely by EcMF
- Radioactive gas provided to leaves results in radioactivity within hours in distant trees
- There are direct linkages of AMF between different tree species and nutrients are moved
- Maple trees **actively** move calcium to the soils under them
- Fine root hairs actively form and disappear in a time frame of hours and days to probe soil
- A tree under insect attach mobilizes protective chemicals, and then other nearby trees mobilize protective chemicals even though they are not being attached

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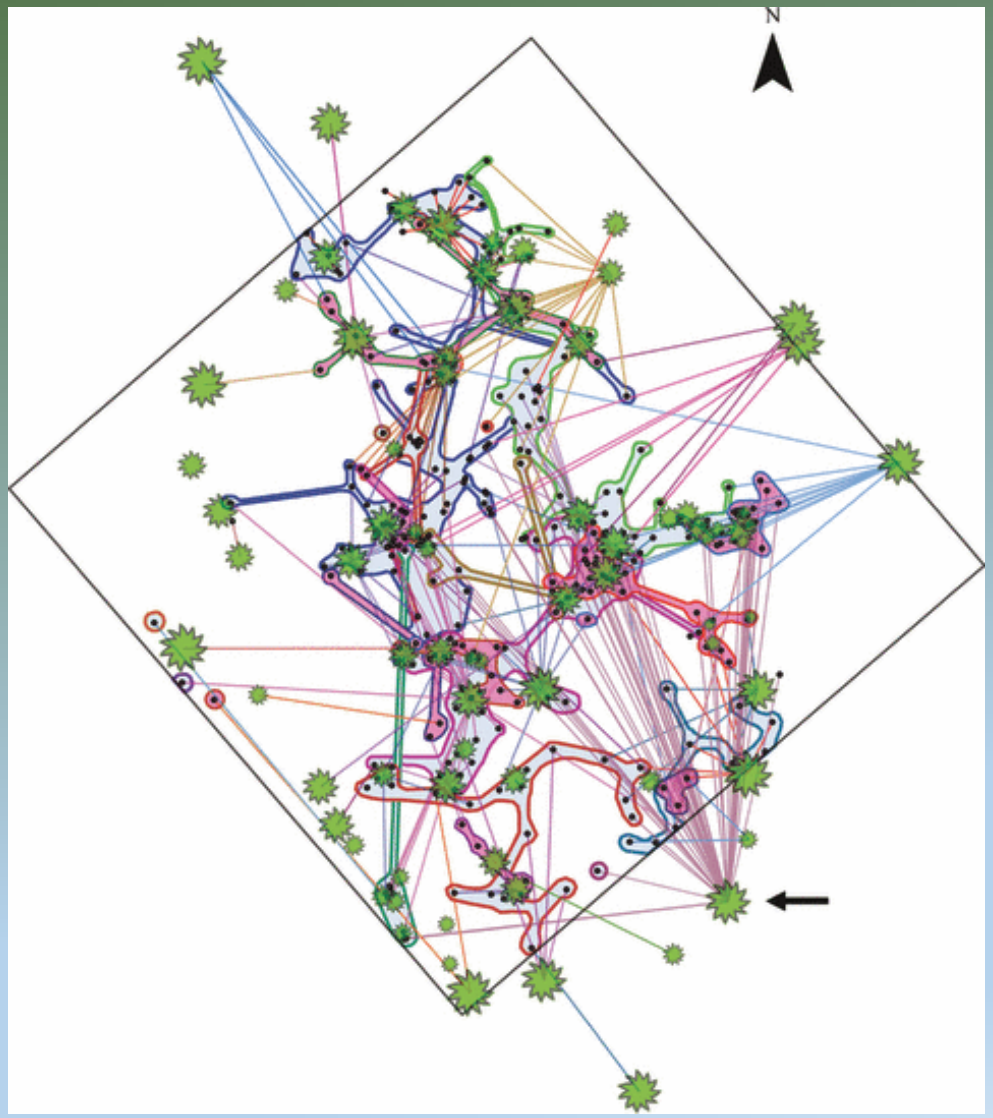
Mycorrhizal Fungi Network



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Mycorrhizal Killer Threats

- Clearcuts
- Garlic Mustard
- Wild Boar
- Earthworms

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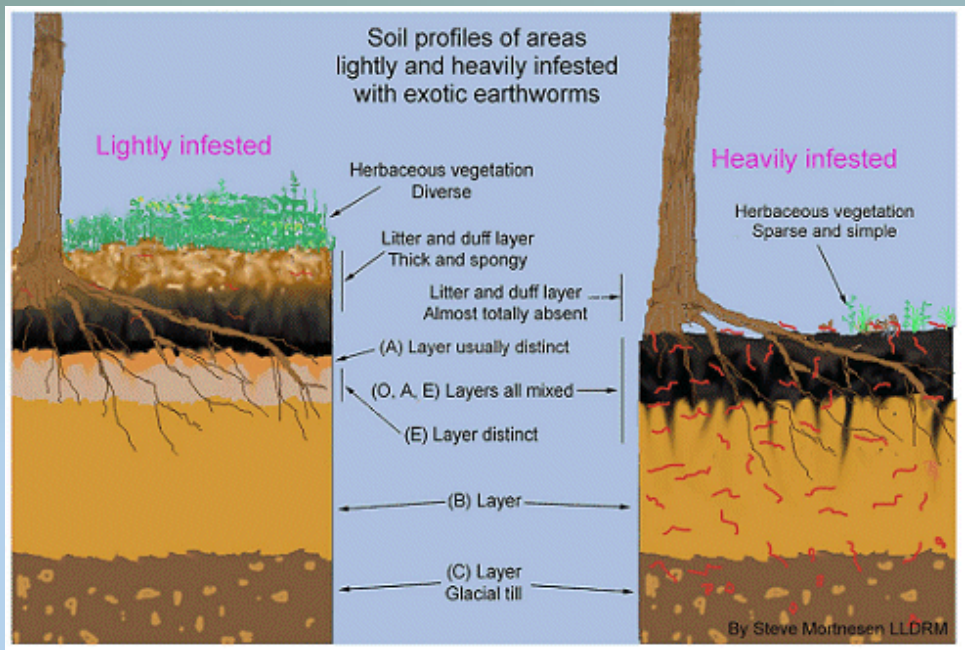
Earthworms – Invasive Species

- Introduced from Europe in ship ballast
- No native equivalent in NA – NHF evolved in post glacial context
- Voracious predator of rhizosphere
- Prior reputation is based on a restorer of damaged soil structure



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Earthworms – Invasive Species

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Forest Carbon

Northern Hardwood Forest (NHF) Carbon

- Forest floor (9-18%); Trees & Roots (31-41% of which 16% can be roots); Soil (41-59%)
- M. fungi 50-70% of soil C; glomalin 30% (research ongoing)
- Carbon density in NHF trees second only to Oak/Hickory
- New England portion of NHF total carbon =/> Pacific NW Doug/Fir
  - NW trees higher so tree C greater, NE soil C higher, acre for acre NHF total 33% less

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Northern Hardwood Forests could play huge large role in global C sequestration – most intact large temperate broadleaf forest in the world.

Climate Change Threats

Increase in Invasives

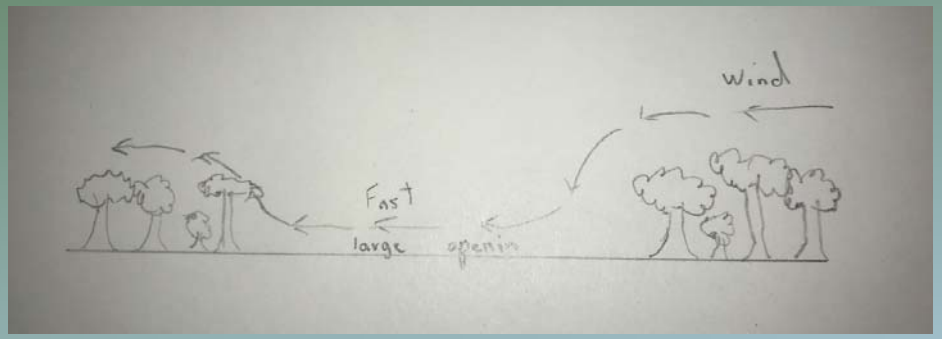
- Often synergistic with worms
- Can outcompete stressed native plants

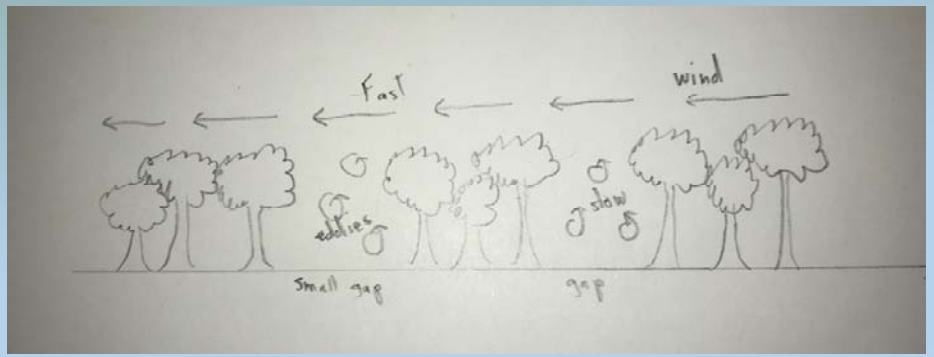
Increase in Pests

- Disruption of Mycorrhizal network
- Increase harvest stress from salvage

Increase in Wind

- Wind-throw increases
- Keep openings small





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Climate Change - Snow

Northern Hardwoods most robust where snow deepest

Climate change predicts less snow and greater number of freeze thaw cycles

Freezing kills MF and fine roots – most likely through mechanical action not depth of freezing

Releases nitrates, not taken up by biologically active soil, but now runs of with snowmelt into streams

Small group selection gaps will drop and keep more snow

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Climate Change Resilience

- Maximize carbon sequestration, starting with soil health
- Management to minimize stress on the forest
- No clearcuts, no whole tree harvest
- Retain large organic matter – snags & downed logs
- Best would be let forest grow for next 40 yrs, but if one harvests use small group selection to mimic natural gaps
- 1/10 acre and less – 75 feet diameter circle

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Open for Discussion

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