Using Soil Attributes to Inform Silvicultural Prescriptions and Carbon Storage Objectives

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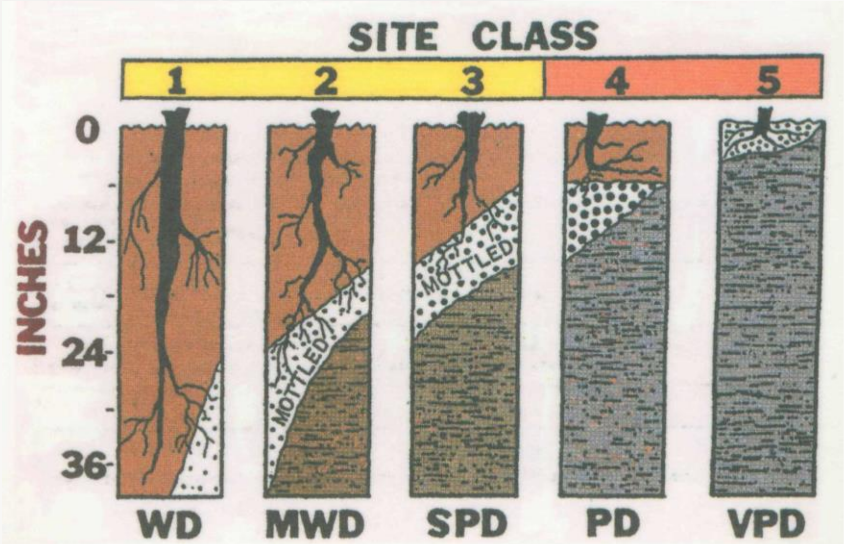
Soil – Production Relationships

- Soils are important factors in timber production
  - Drainage, nutrition, structure, parent material
- Growth and quality of individual tree species
  - Softwood v. hardwood sites
- Indices
  - Briggs' site class



Briggs 1994

Habitat Mapping

- Bill Leak, U.S. Forest Service, 1970s-1980s
  - Habitat: areas within climatic – mineralogical zones which support a distinct successional sequence (i.e., climax forest)
  - Based on drainage, mineral soil characteristics, and parent material
  - Used to determine which species to favor for most production for least effort

Go to "Treesearch" website, enter keywords "habitat mapping" and author "Leak"

U.S. Forest Service

Habitat Mapping

- Marinus Westveld, U.S. Forest Service
- 1920s-1930s
  - Spruce types: spruce swamp, spruce flat, spruce-hardwoods, spruce slope, and old-field spruce
- 1950s
  - Site types: climax forest type
  - Based on organic and mineral soil characteristics, topographic position, and ground vegetation
  - Used to determine composition and structure goals for silviculture

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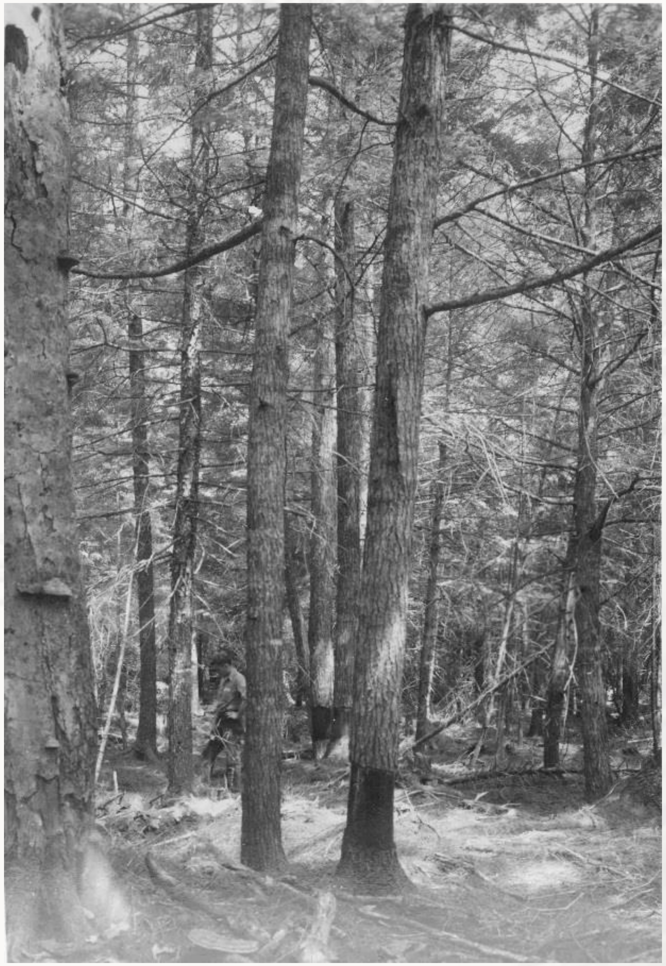
Go to "Treesearch" website, enter author "Westveld"

Key Points

- Species respond differently to soil attributes
- Soil variables (drainage, nutrition, parent material) are determinants of potential composition (climax type)
- But current tree species composition is a poor indicator of site type and growth potential
  - Example: stable versus transitional mixedwoods

Photo courtesy of Nathan Wesely

Transitional Mixedwoods



1956

2008

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Managed Forests

- Species composition, quality, and growth are a function of site and disturbance history

To what degree are northern conifer compositional outcomes a function of site versus silviculture?

Photos courtesy of Phil Hofmeyer

Penobscot Experimental Forest

- 3,800 acres
- U.S. Forest Service
- 1950 to present

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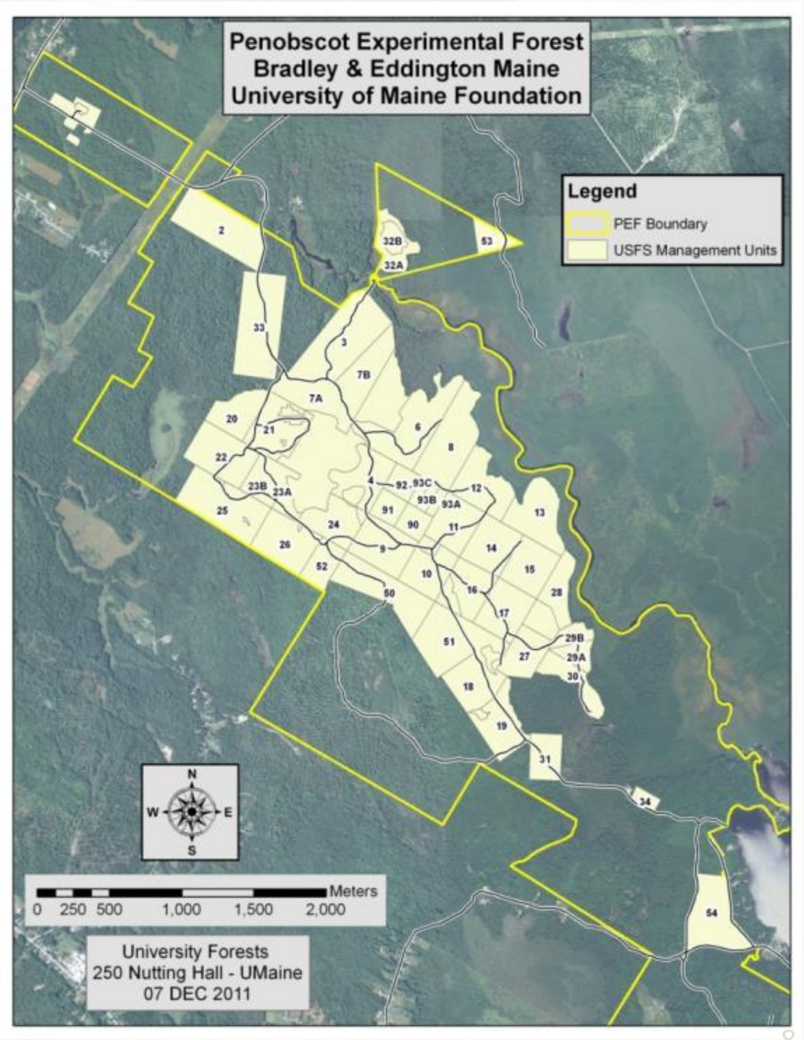

Silvicultural Treatments
1950 to present

Variants of:

- Shelterwood
- Single-tree selection
- Diameter-limit
- Commercial clearcutting

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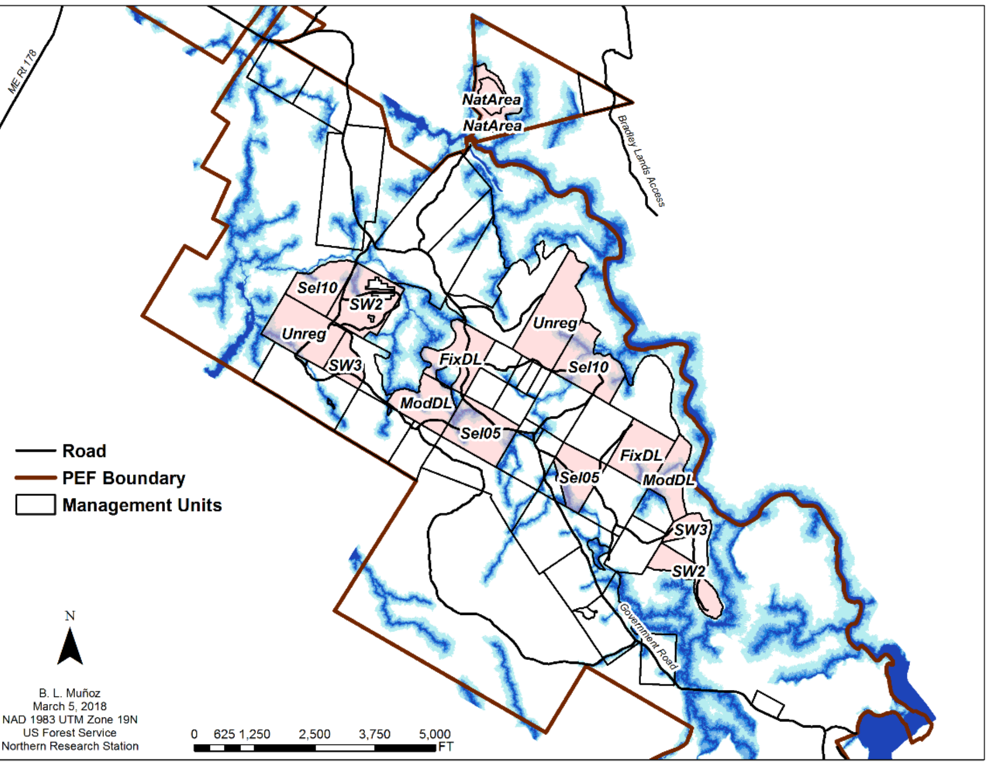
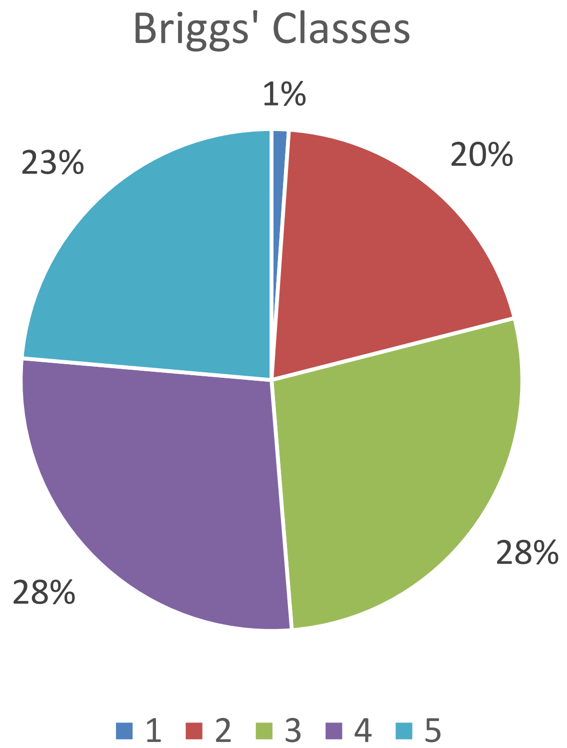
Soils

- Glacial till and lacustrine deposits
  - Range from well to moderately well drained loams and stony loams, to poorly to very poorly drained silt and silty clay loams



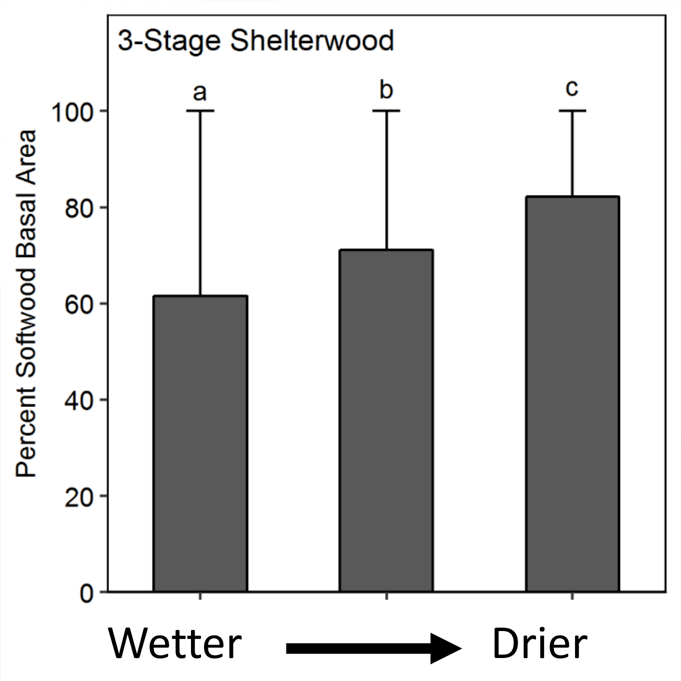


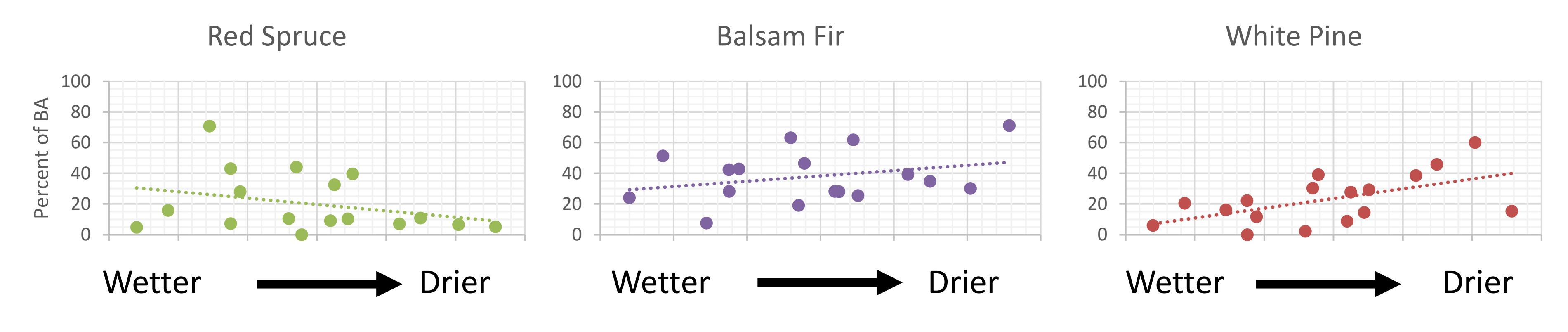
Effect of Silviculture

- Across all sites, commercial clearcutting resulted in lower softwood abundance than any other treatment
- For other treatments, softwood abundance is a function of silviculture and depth to water
  - On wetter sites, proportion of softwoods is similar across treatments
  - On drier sites, proportion of softwoods decreases with increasing intensity of harvest

- Exception:
  - Uniform shelterwood

Example





Site and Silviculture

- Interactions between soils, silviculture, and species silvics
  - Forest composition and production
- Match species objectives to site potential
- Working forest
  - Current composition affected by management
  - Important to consider soils in setting goals

Site Quality & C Dynamics

Research on the PEF

PEF Natural Area

32A - Scantic

32B - Danforth

32A - Scantic

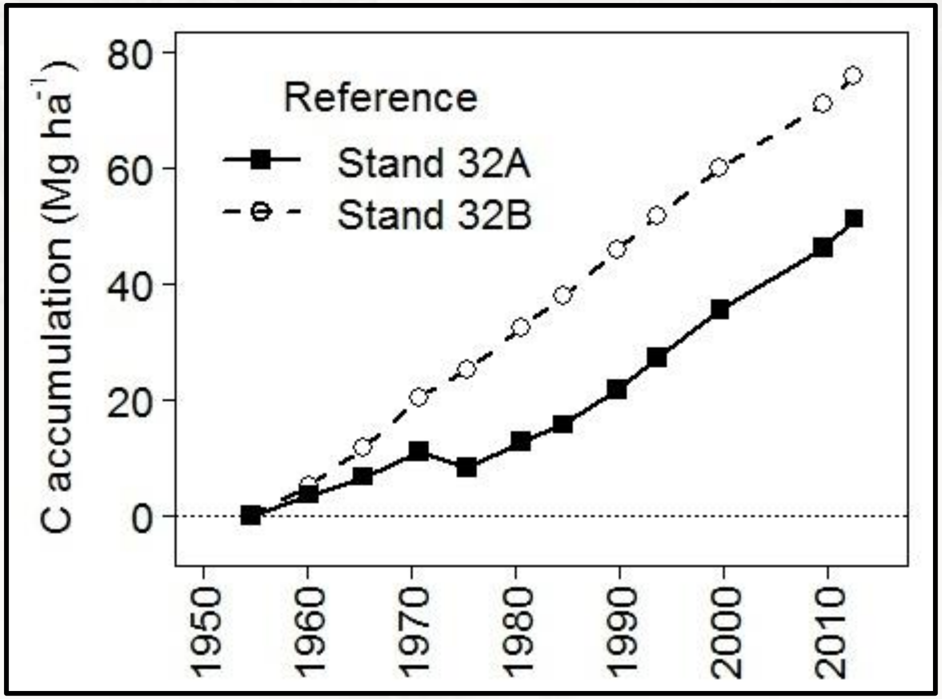
70.0 (9.5) **51.7 (19.9)** **71.7 (7.5)** **90.0 (9.1)**

32B - Danforth

64.6 (14.2) **54.2 (10.8)** **43.8 (15.8)** **37.5 (14.4)**

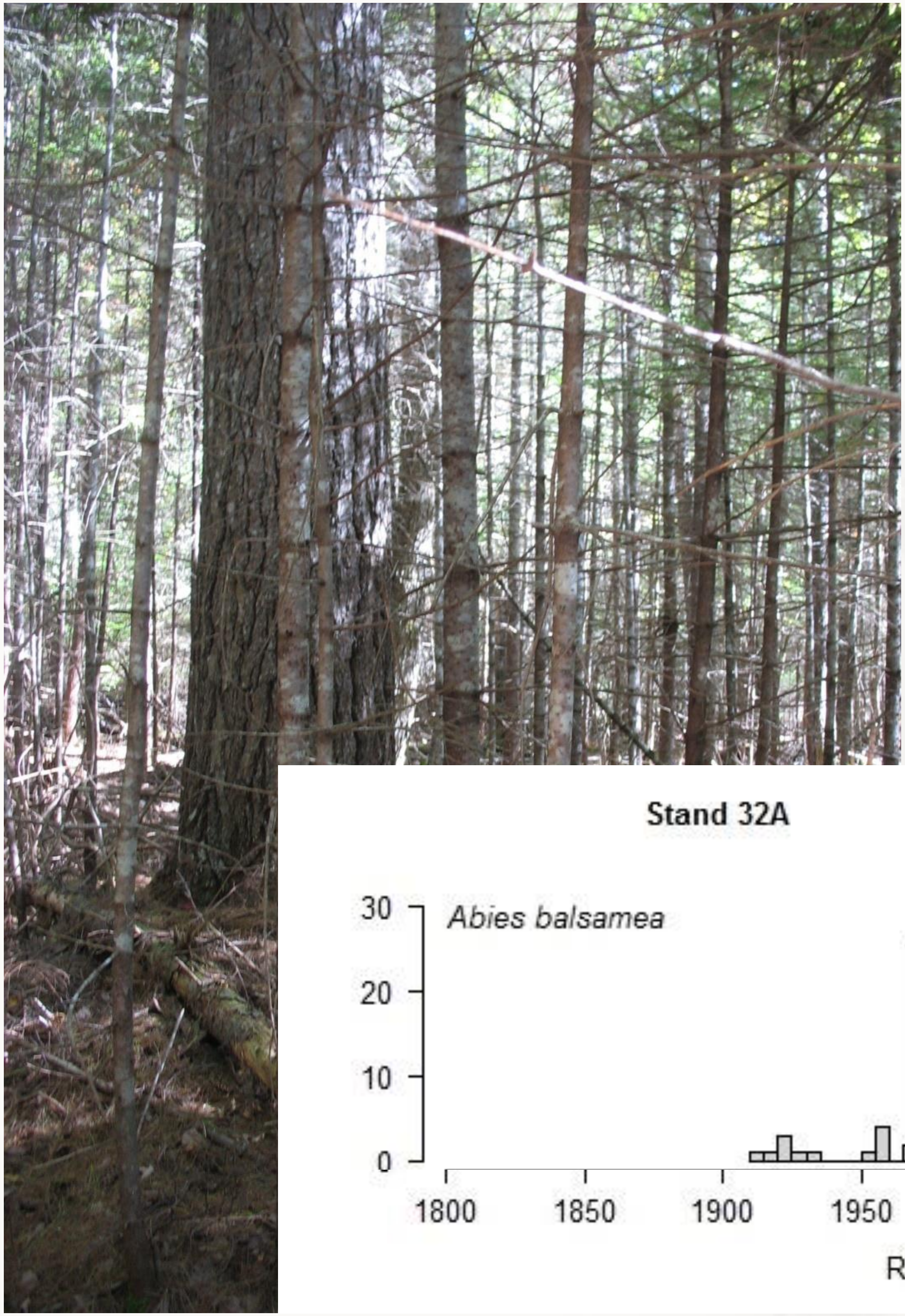
C accumulation

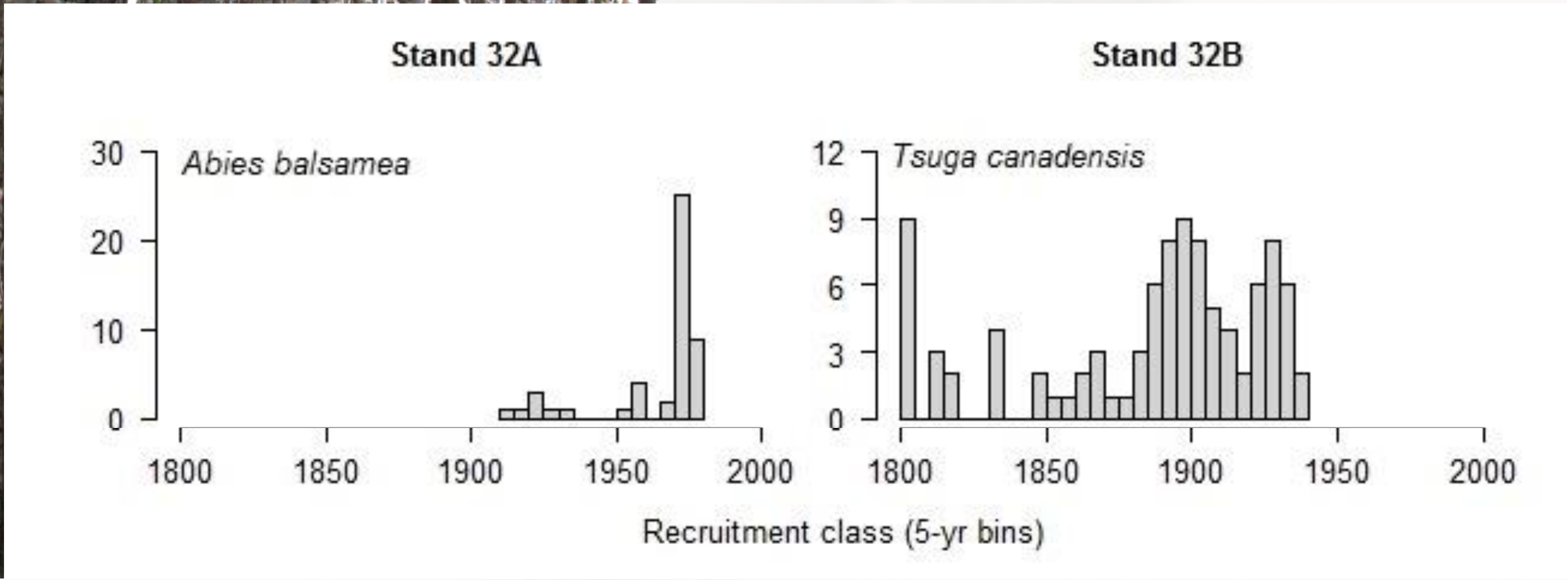
- Cumulative sum of net changes in aboveground live tree and dead wood C stocks over time.
- Rates of C accumulation were fairly similar for stands 32A and 32B despite differences in soil types between stands.



Species composition

- 32A – balsam fir.
- 32B – eastern hemlock.





C in the forest

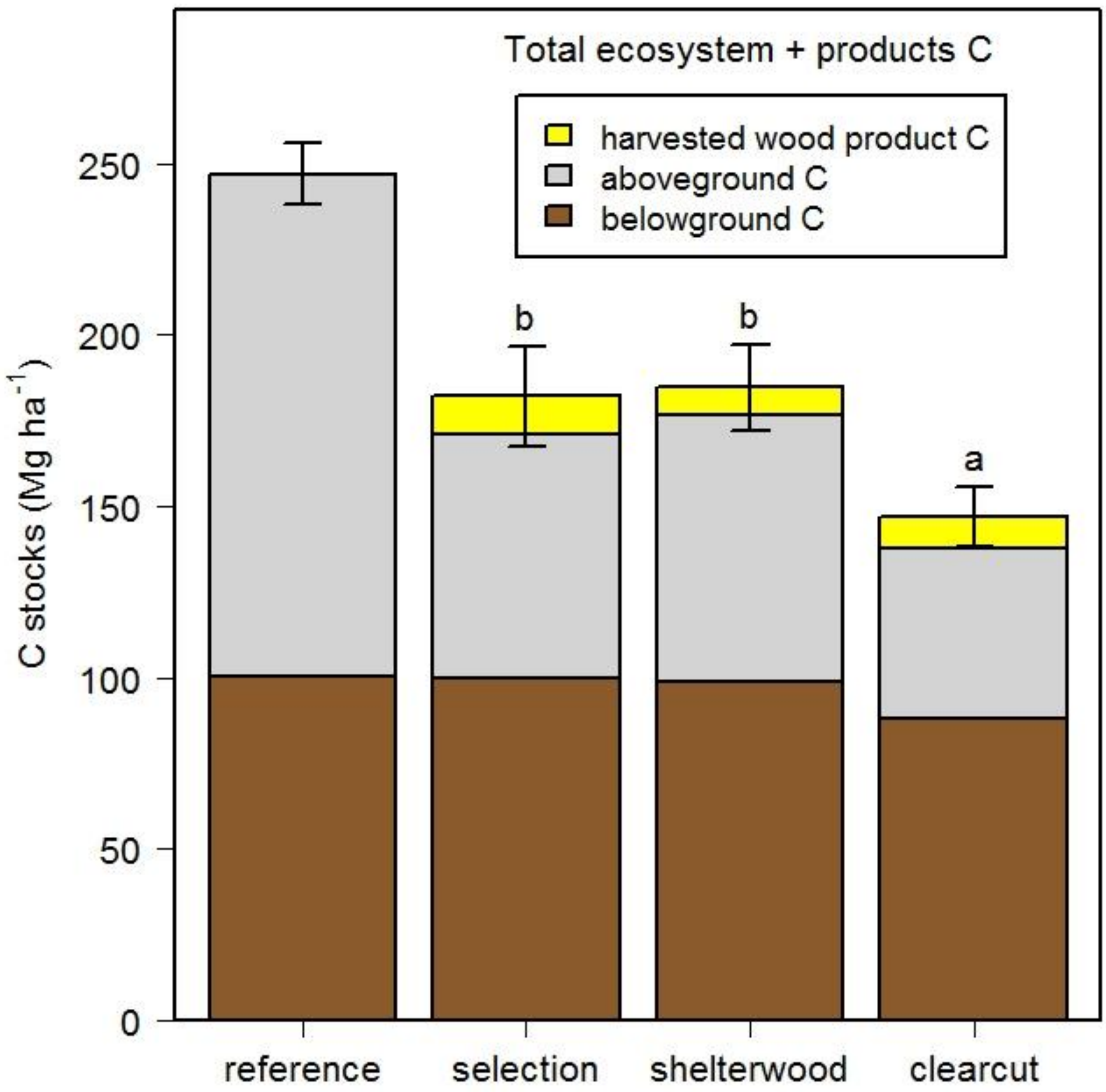
About half of the C stocks are in belowground C pools.

	Stand	
Aggregated C pools	32A	32B
Aboveground ($Mg\ ha^{-1}$)	100.1 (14.1) 87.6-122.6	146.5 (20.2) 128.7-168.7
Belowground ($Mg\ ha^{-1}$)	96.3 (7.6) 86.8-105.7	100.4 (6.6) 96.2-110.3
Total ecosystem ($Mg\ ha^{-1}$)	196.3 (9.6) 185.6-209.4	247.0 (17.7) 226.8-267.3

Site quality and C stocks

The percentage of coarse fragments in the mineral soil was negatively correlated with many C stocks and explained much of the variation in C stocks between stands within treatments.

Treatment	Selection		Clearcut	
Stand	9	16	8	22
Coarse fragments (%)	28.2 (10.9) 17.1-45.9	42.8 (19.8) 15.8-66.8	31.9 (12.4) 20.0-50.7	39.7 (16.8) 18.7-64.1
Aboveground C (Mg ha^{-1})	78.4 (11.0) 60.8-90.3	63.3 (11.7) 48.8-80.1	51.6 (12.7) 40.7-71.5	47.9 (10.7) 39.9-66.0
Total ecosystem C (Mg ha^{-1})	188.5 (24.1) 155.4-218.0	153.1 (34.1) 132.5-213.4	145.3 (17.0) 126.7-169.4	129.9 (20.7) 103.6-151.3


Total ecosystem + products C
harvested wood product C
aboveground C
belowground C
C stocks (Mg ha^{-1})
0
50
100
150
200
250
b
b
a
reference
selection
shelterwood
clearcut

New soil research to inform silviculture

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Partnering to Improve Climate Change Benefits of Working Forests

Assessing and monitoring the influence of forest management practices on soil productivity, carbon storage and conservation in the Acadian Forest Region

Why this project matters

1865 THE UNIVERSITY OF MAINE

About the University of Maine

In the News

Press Release: SFI Conservation Grants Feature Collaboration From 45 Different Groups Across the U.S. and Canada
March 6, 2018

Joshua Puhlick, Marie-Cecile Gruselle, and Ivan Fernandez