Uneven-Aged Silviculture Research on the Penobscot Experimental Forest

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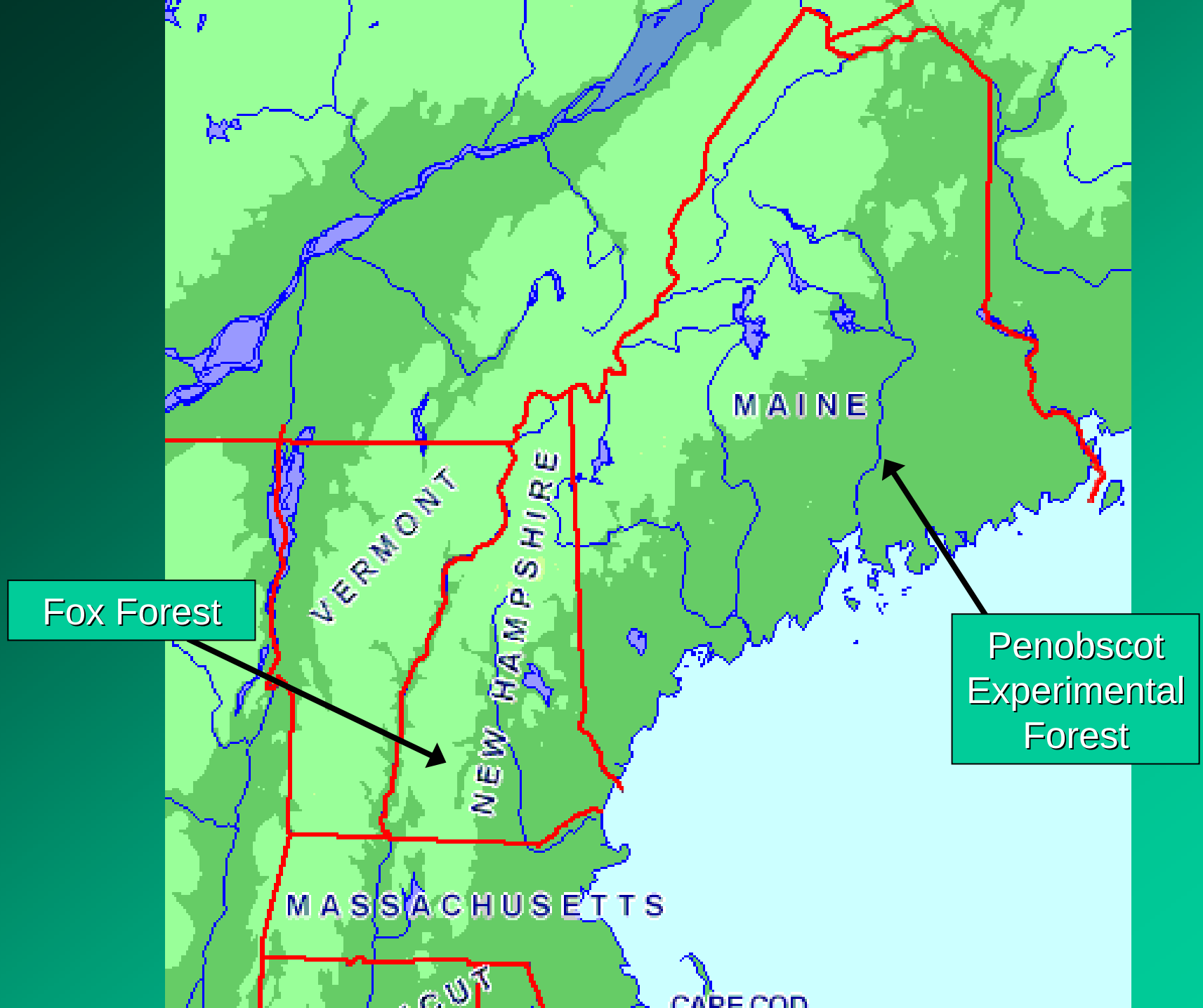
Penobscot Experimental Forest

- 4,000+ acre forest
- Located in central Maine
- Owned by University of Maine
- USDA Forest Service
  - Long-term silviculture experiment
  - 50+ years of research

Origin of the PEF

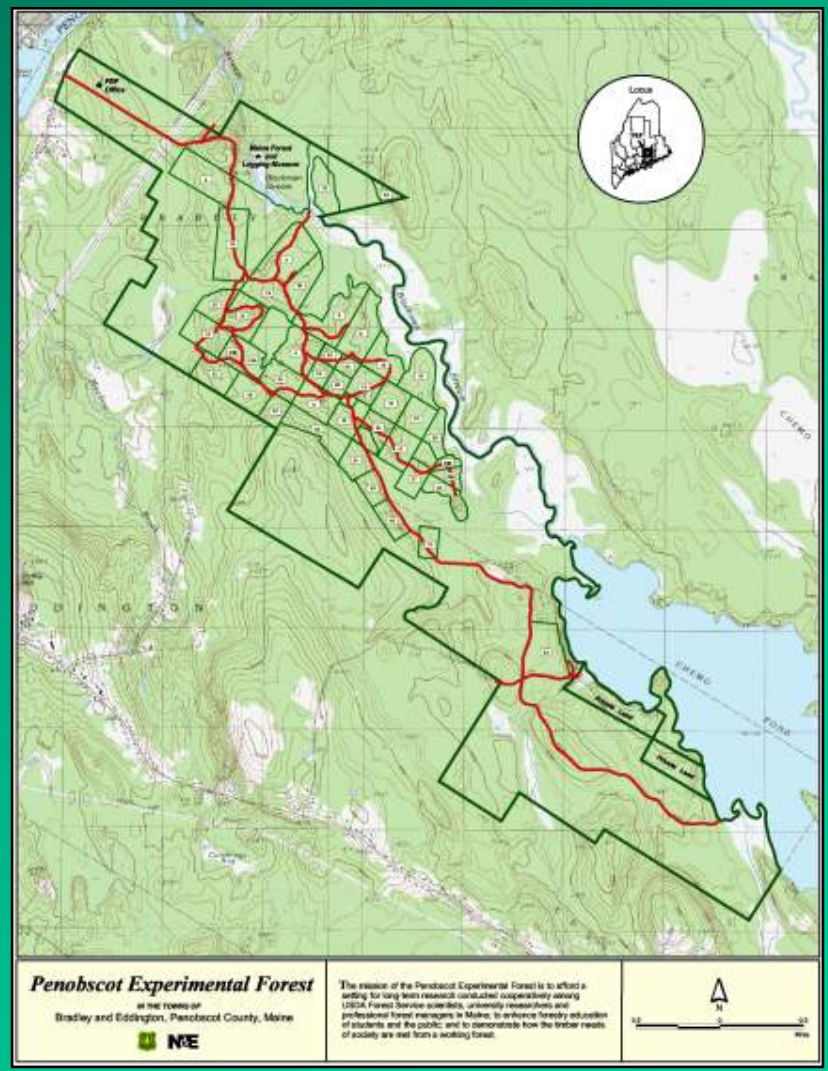

MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CAPE COD
Fox Forest
Penobscot Experimental Forest

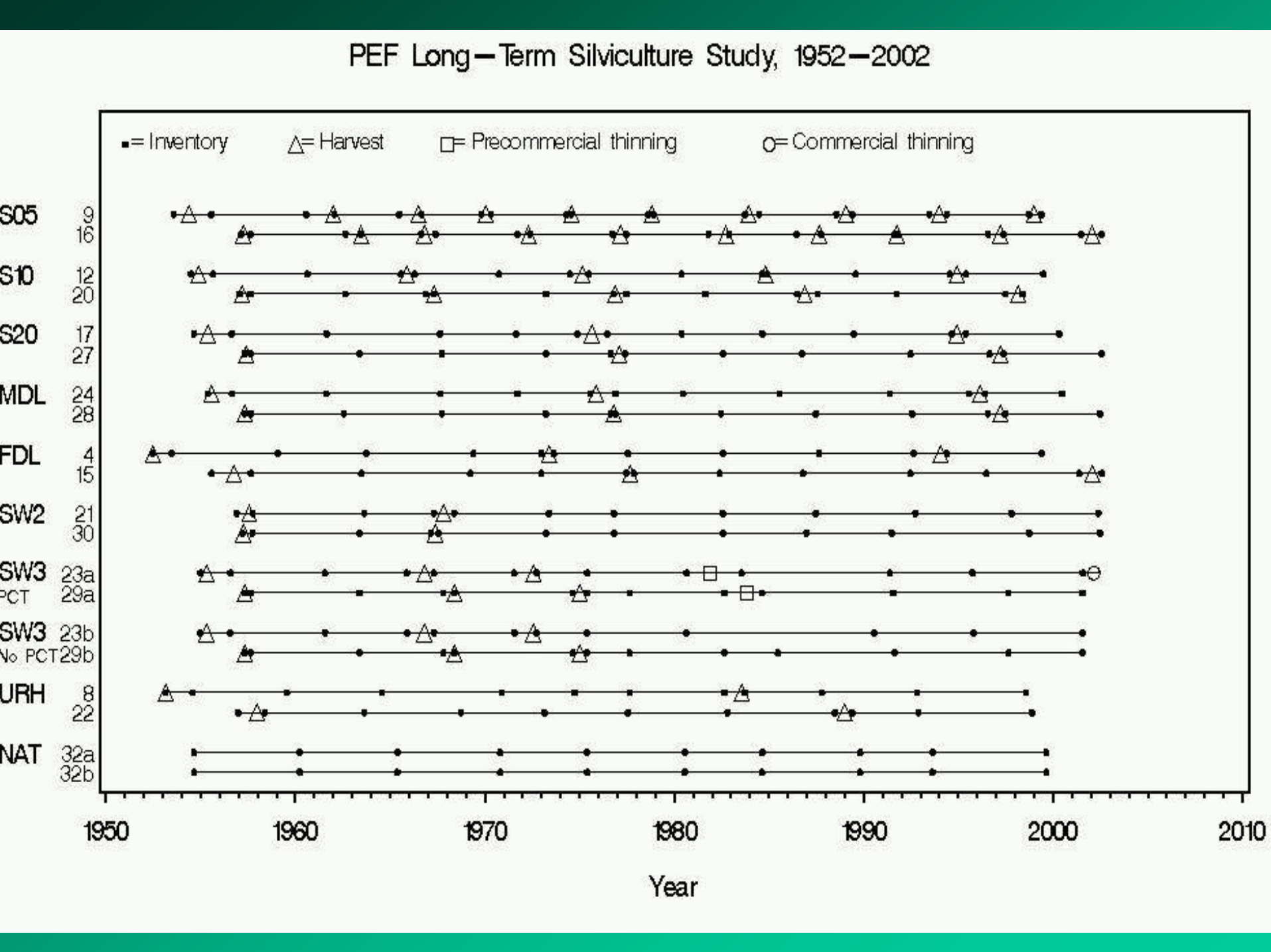
Northern Conifer Forest

- Spruce
  - Red, White, and Black
- Balsam fir
- Eastern hemlock
- Northern white-cedar
- Eastern white pine
- Hardwoods
  - Maple, Birch, and Aspen

Study Design

- 10 treatments
  - 2 stand replicates
  - Permanent plot network
    - Semi-random
- Limitations
  - Compartments
  - Within-treatment variability
  - Control




PEF Long–Term Silviculture Study, 1952–2002
▪= Inventory
△= Harvest
□= Precommercial thinning
○= Commercial thinning
S05 9 16
S10 12 20
S20 17 27
MDL 24 28
FDL 4 15
SW2 21 30
SW3 PCT 23a 29a
SW3 No PCT 23b 29b
URH 8 22
NAT 32a 32b
1950
1960
1970
1980
1990
2000
2010
Year

Data Collection

- nested 1/5-, 1/20-, and 1/50-acre CFI plots
  - 15% sample
- trees > 0.5 in. dbh
  - numbered
  - species
  - dbh
  - condition
- 5-year remeasurement

Regeneration Data

- milacre plots
- seedlings 0.5 ft. to 0.5 in. dbh
  - species
  - height class

Uneven-Aged Treatments

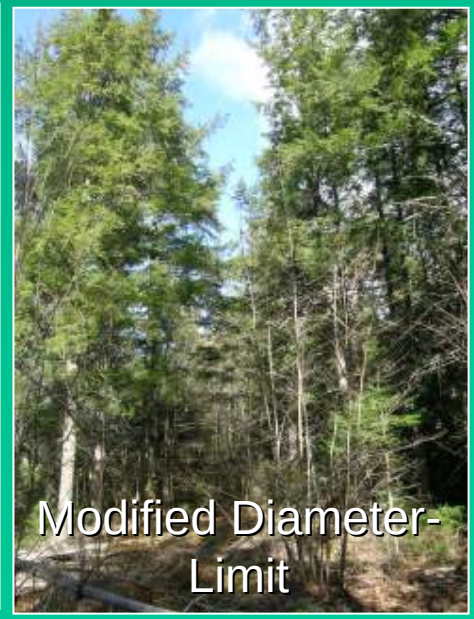
- Selection
  - 5-year
  - 10-year
  - 20-year

Selection Cutting (5-Yr)

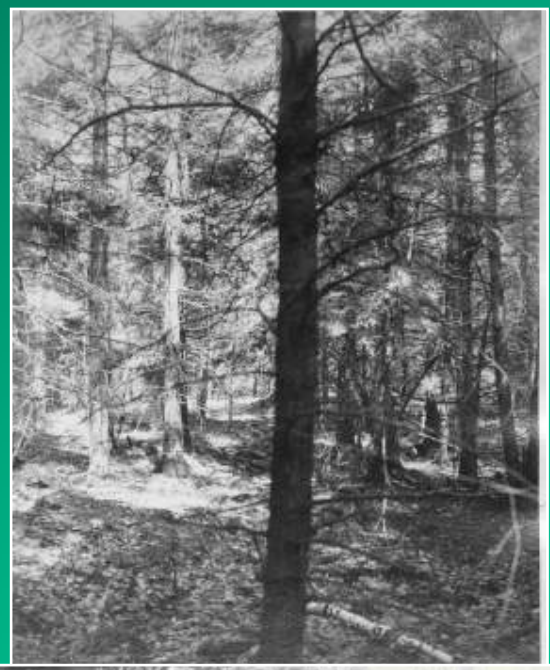
Selection Cutting (20-Yr)

- Diameter-Limit
  - Fixed diameter-limit
  - Modified diameter-limit

Fixed Diameter-Limit


Modified Diameter-Limit

Pre-treatment Conditions



Selection Treatment
BD*q* Method

- Define residual structure using
  - Basal area
  - Maximum diameter
  - *q*-factor
    - mathematical
    - ratio of trees in each class to the next larger class is a constant (*q*)

Structural Goals

Cutting cycle	Residual BA ft^2/ac	Maximum dbh (in)	q-factor (1 in. classes)
5	115	19	1.4
10	100	18	1.4
20	80	16	1.4

Marking Guidelines

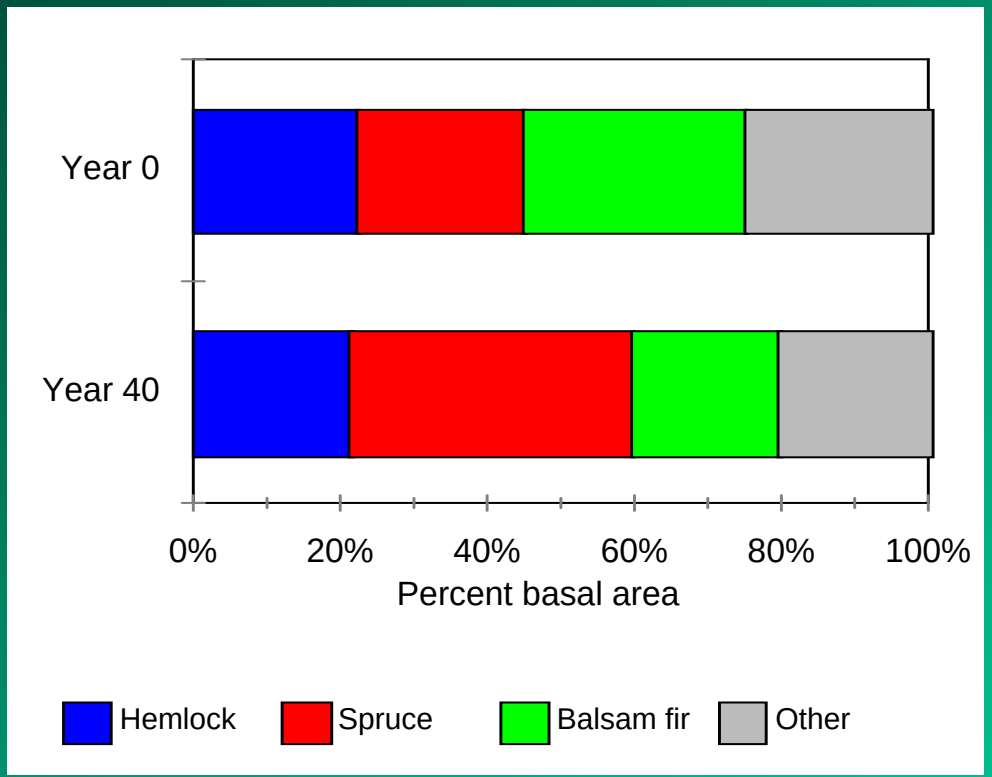
- Remove
  - cull trees
  - high risk trees
  - undesirable species
  - trees at financial maturity
- Release crop trees
- Create regeneration openings

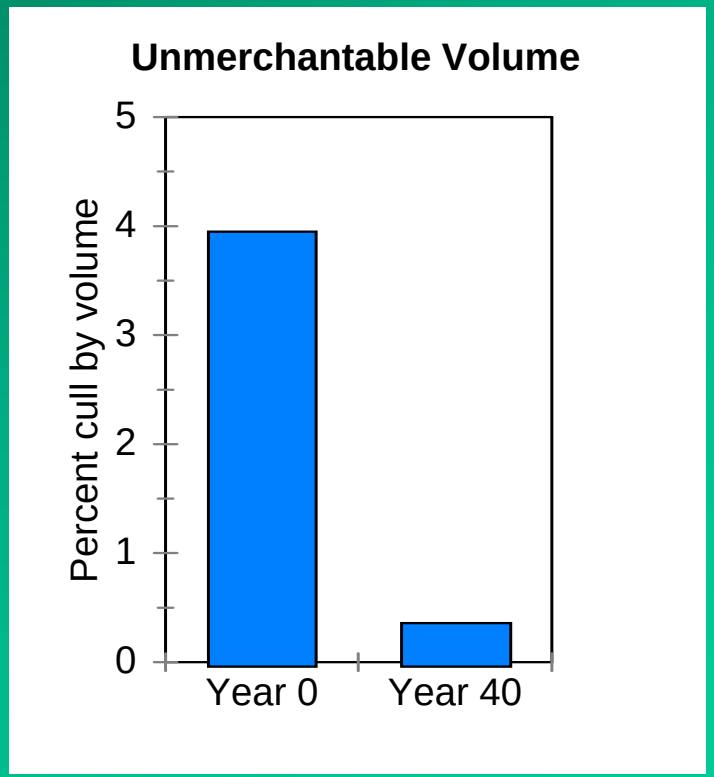
Species Preference

• Spruce spp.	35 - 55 (% BA)
• Balsam fir	15 - 25
• Hemlock	15 - 25
• White pine	5 - 10
• Paper birch	5 - 10
• Cedar	5 - 10
• Other	5 - 10

Selection Cutting

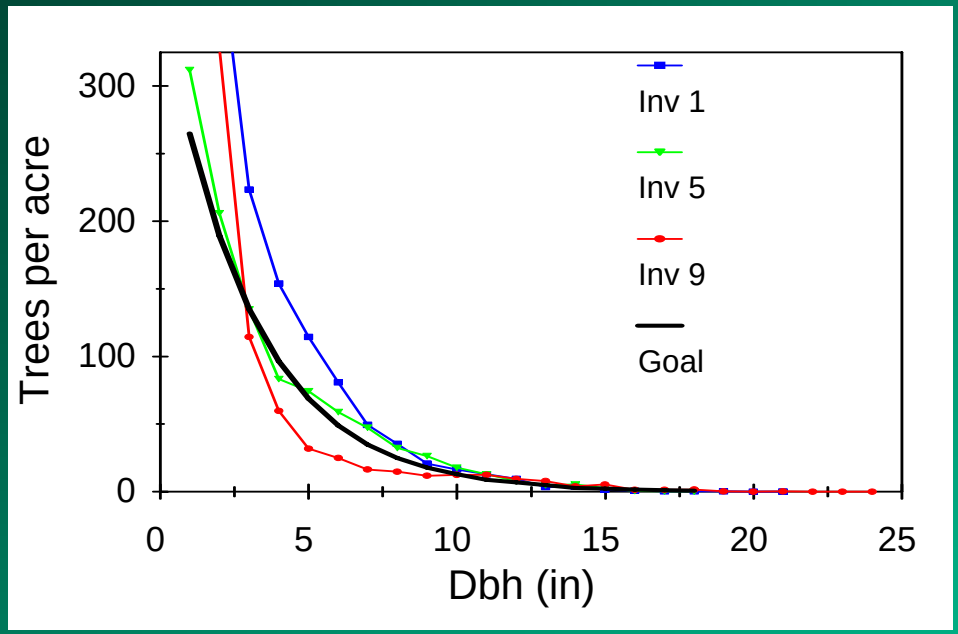
- Species composition and quality improved

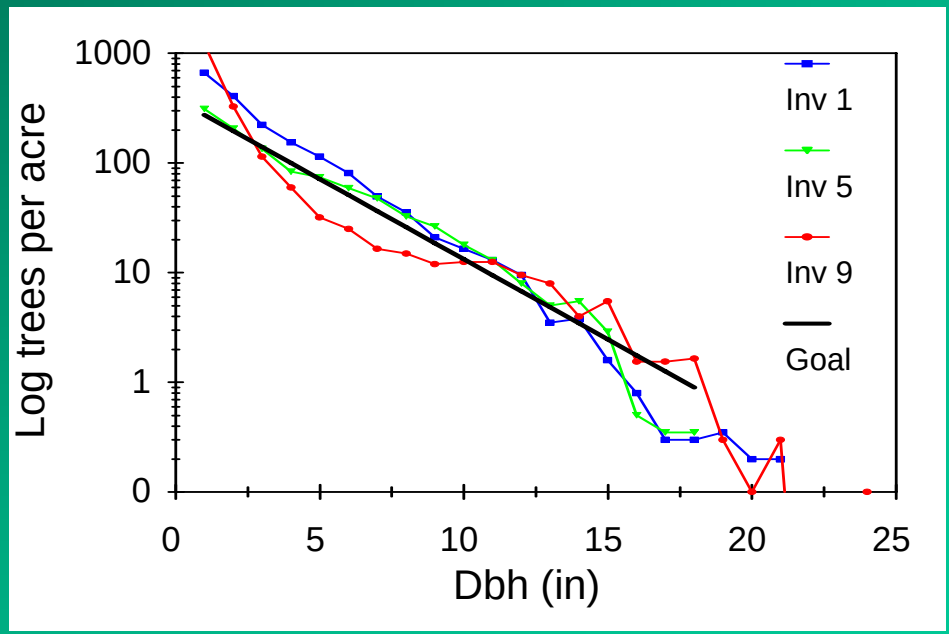




Example: 10-year Cutting Cycle

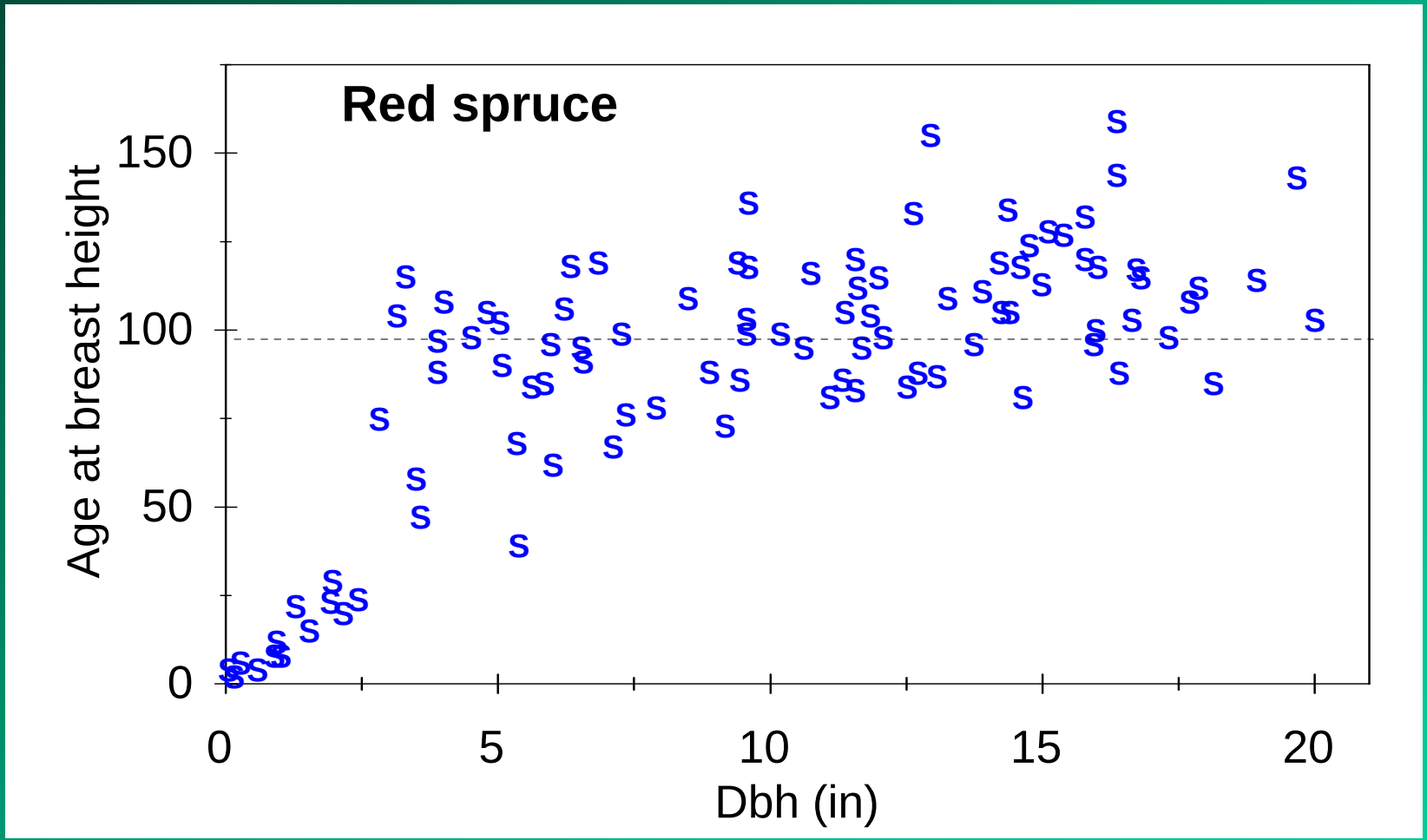
- Tree size diversity is great, though diameter distributions are unbalanced





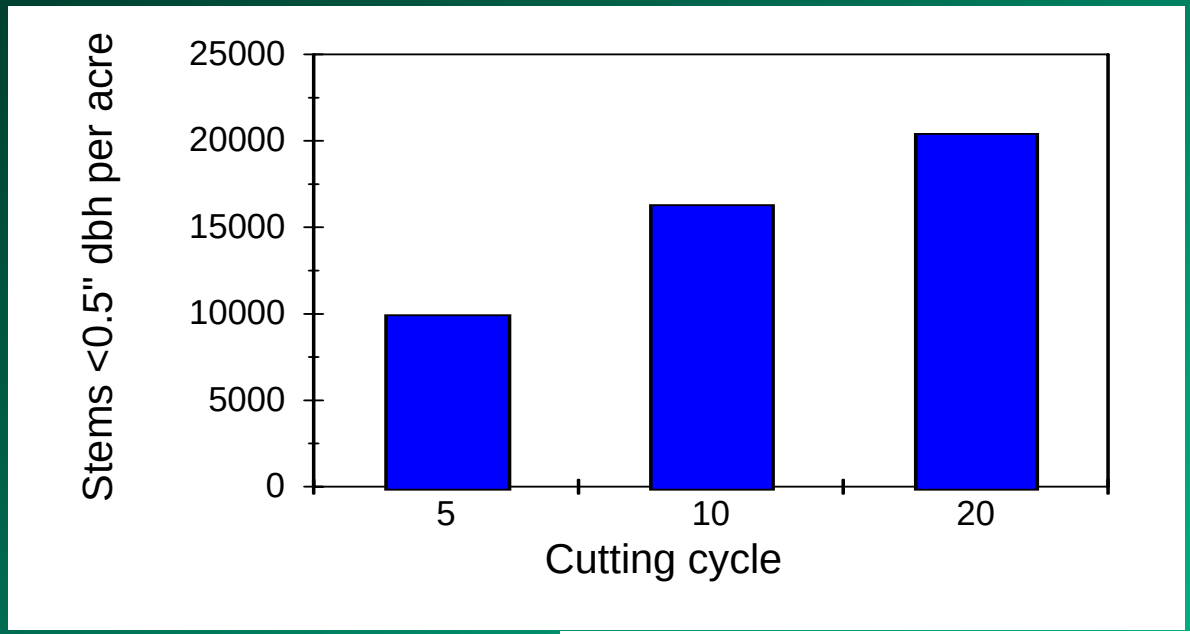
Example: 10-year Cutting Cycle

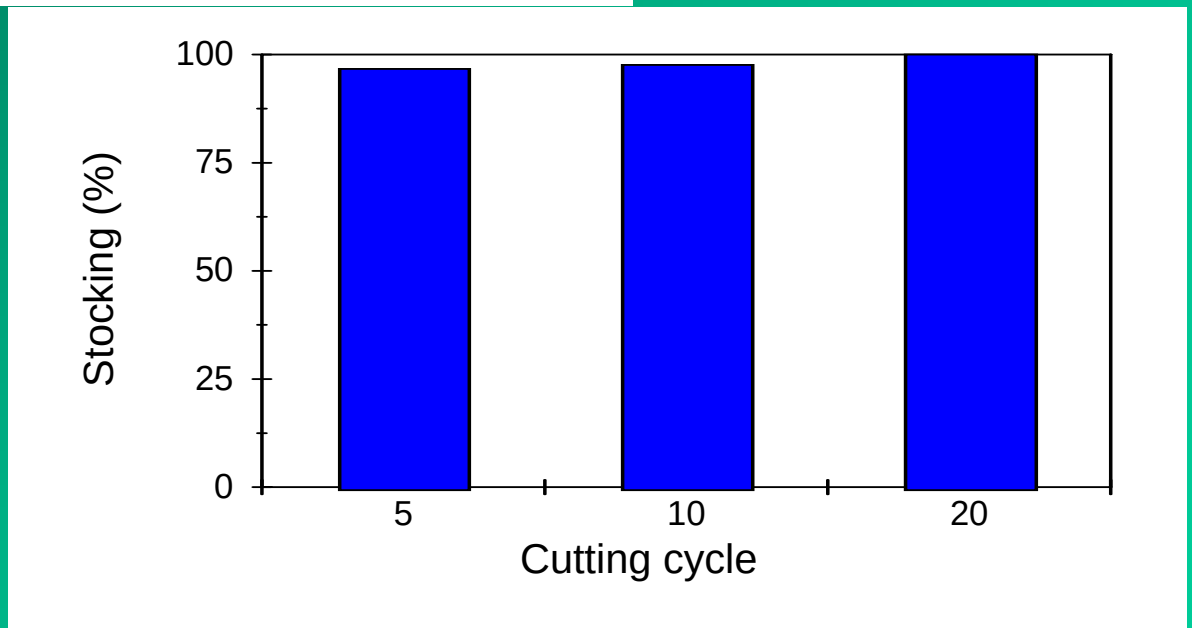
- Age - size relationships are weak
  - Many small trees are very old



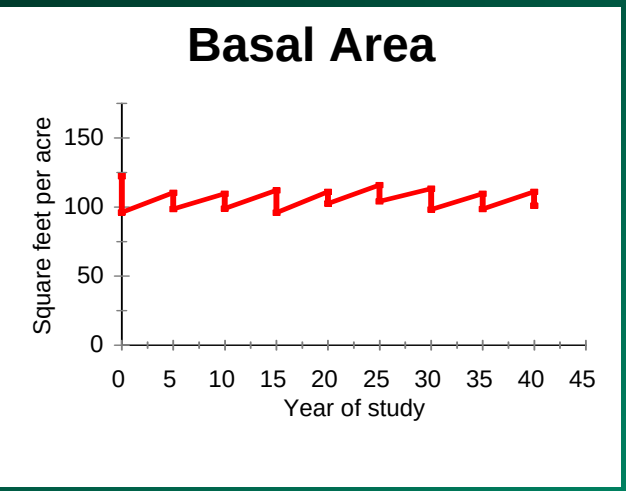
Example: Red spruce, 5-Year Selection Stand

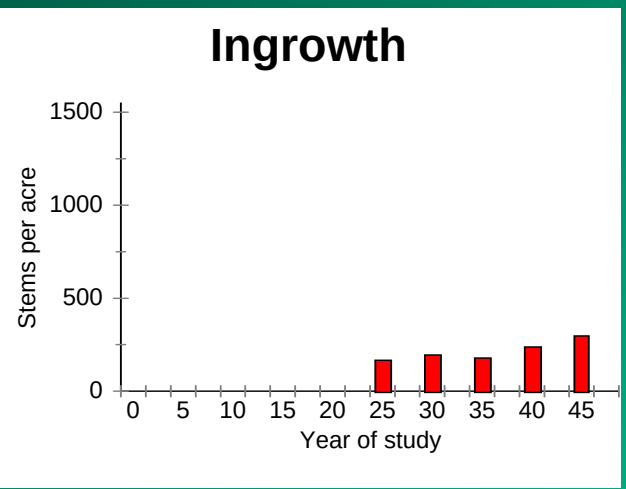
- Regeneration is abundant



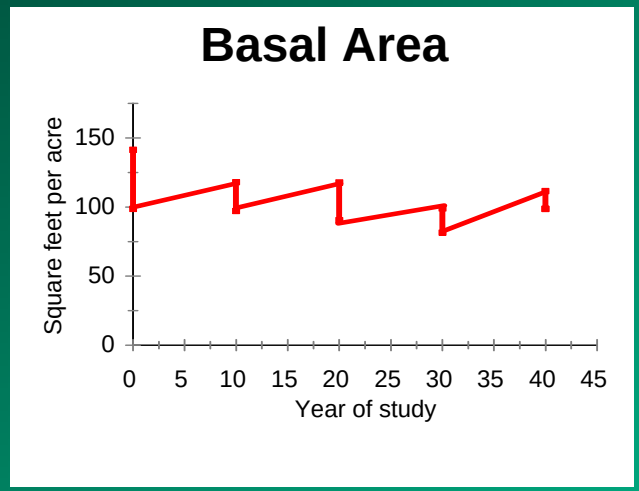


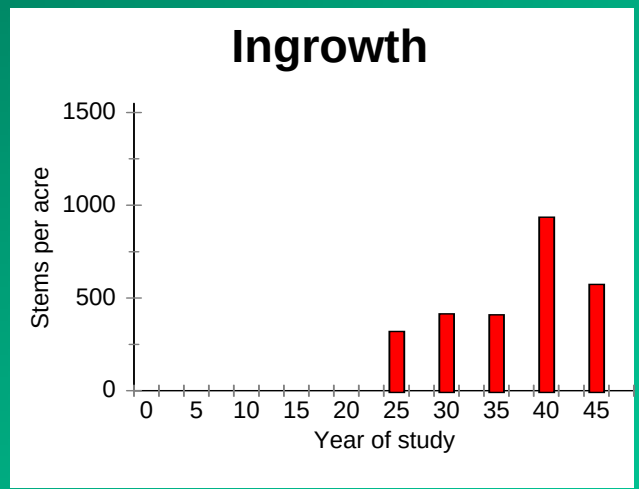
SC05



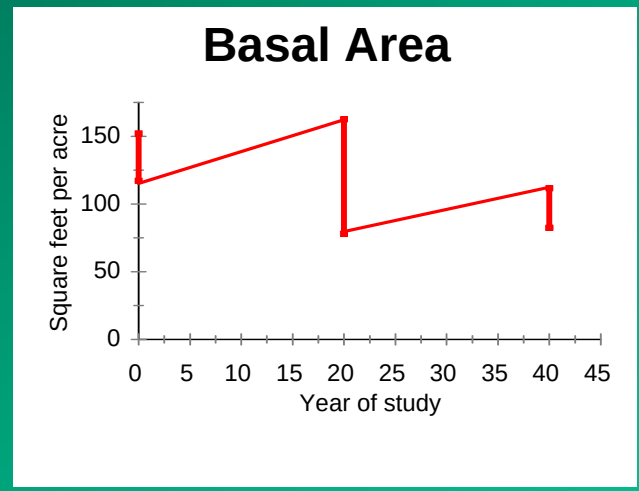


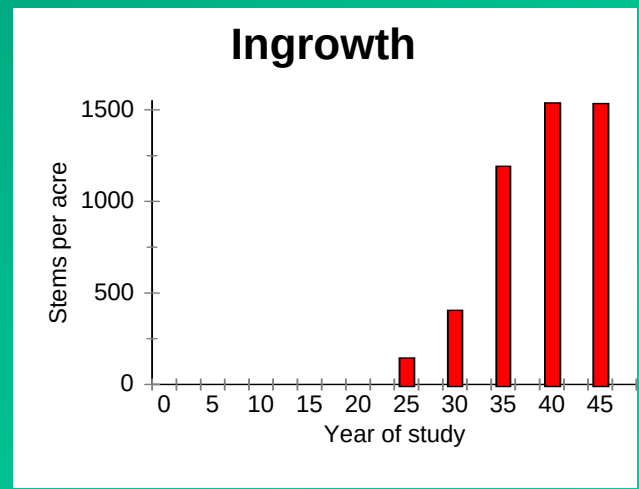
SC10



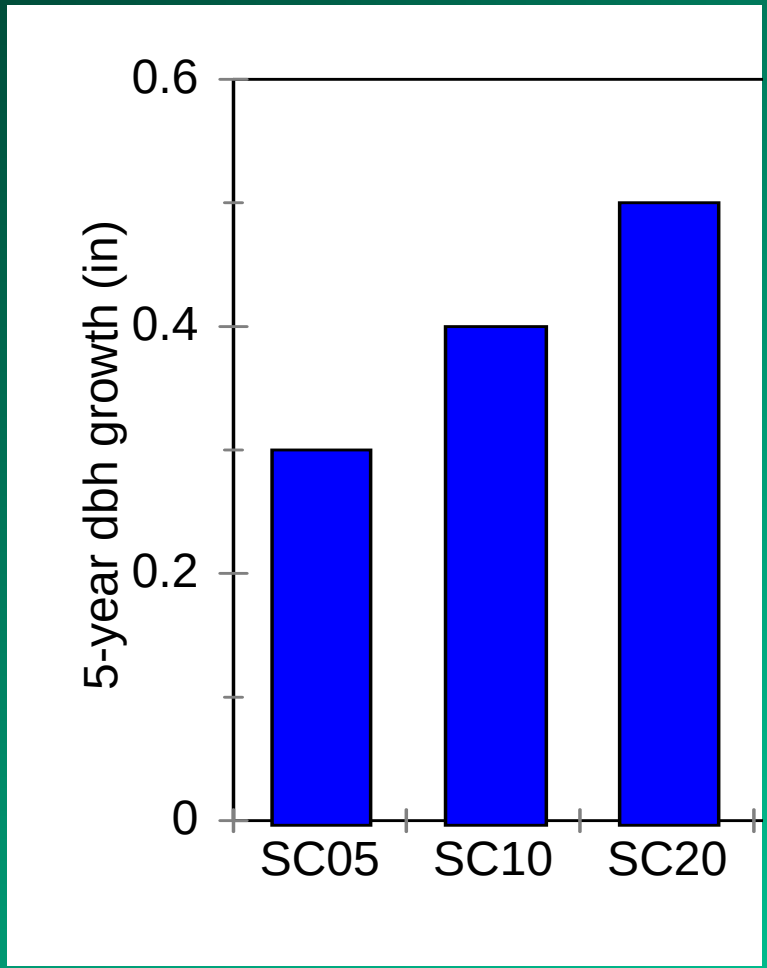


SC20





5-Year Average Growth Rates of New Saplings



Average annual growth rates of new saplings are less than 0.1 inches in diameter per year!

- Sapling ingrowth mortality is high

This is what happened to new saplings over 25 years:

Treatment	Mortality	Saplings	Poletimber
SC05	76%	23%	1%
SC10	53%	47%	<1%
SC20	34%	62%	4%
MDL	41%	56%	3%
FDL	46%	52%	3%
Mean	50%	48%	2%

All Partial Cuts Are Not the Same…

- Fixed diameter-limit cutting resulted in less sawtimber growth and volume, less regeneration, less residual value, and more cull than selection cutting

Modified Diameter-limit Cutting

- Volume, percent cull, and species composition were not differentiated from selection after 45 years

Highlights

- Establishing and releasing regeneration beneath the canopy is important
- Selection cutting maintains diversity of tree ages, sizes, and species
- Component species should be considered individually
- Repeated fixed diameter-limit cuts with and no tending is degrading
- Modified diameter-limit cuts may have potential (need more study…)

In Summary

- Research has shown uneven-aged silviculture with a combination of single-tree and small group removals to be effective in northern conifers
- Though structures are somewhat unbalanced, the stands appear to be robust

The Bottom Line

Treatments that remove low vigor, poor quality trees and undesirable species across all size classes, maintain a diversity of tree sizes and ages, and create openings to establish and release regeneration are likely to be successful in northern conifer stands.