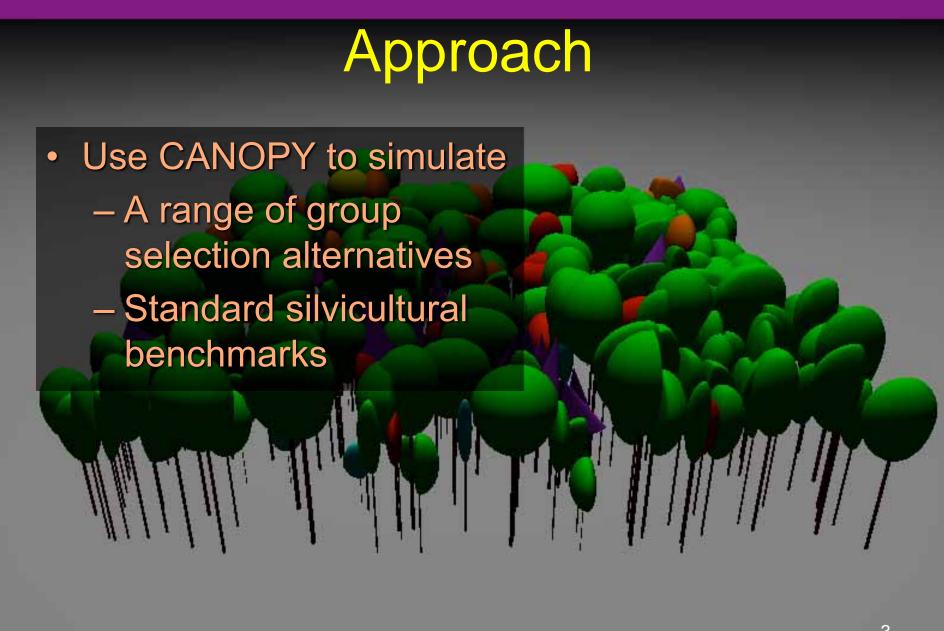
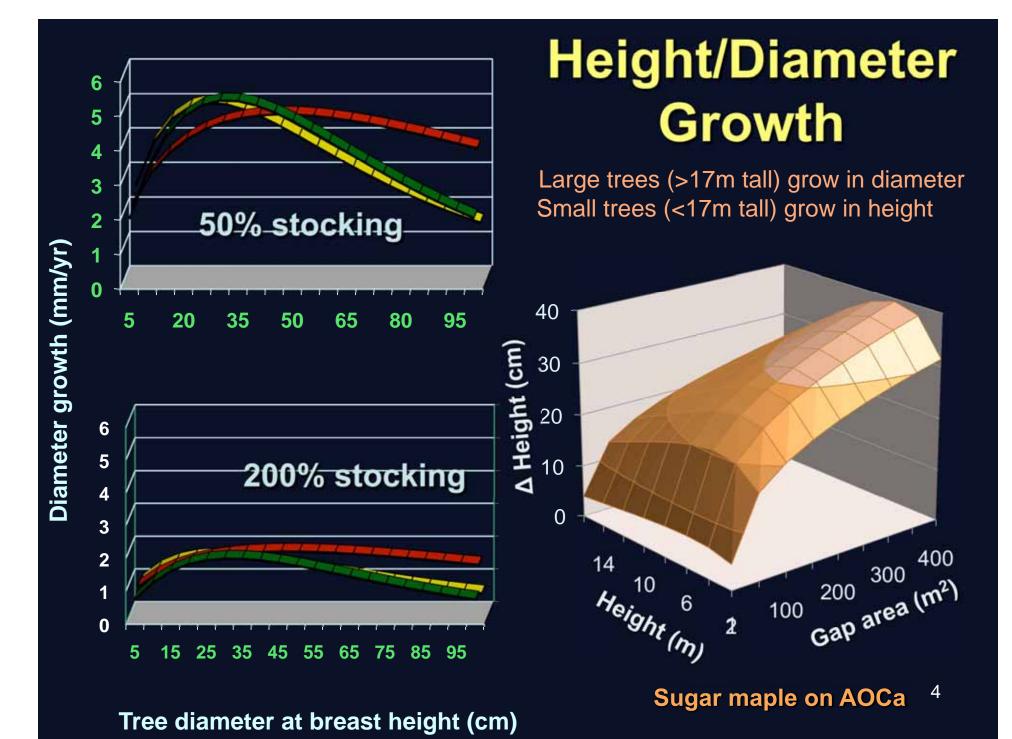
Long term effects of alternative group selection harvesting designs on stand production

C. Halpin, C.G. Lorimer, J.J. Hanson, B. Palik

Objectives

- To assess group selection's impact on
 - Stand-level volume production
 - Stand-level growing space efficiency
 - Tree-level volume production
 - Tree-level growing space efficiency

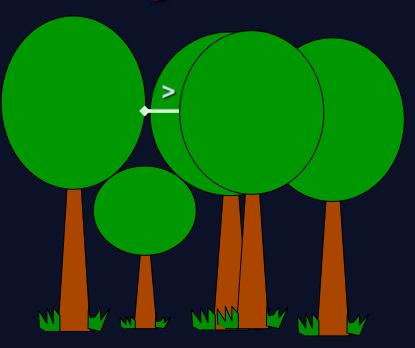




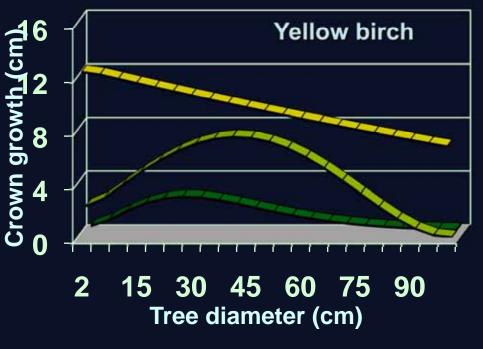
Crown growth

Crown radii can grow N, S, E, W

- 1. Exposed and facing gap
- 2. Exposed and not facing gap
- 3. Shaded
- 4. Touching



- Exposed and facing gap
- Exposed and not facing gap
- Shaded (150% stocking)

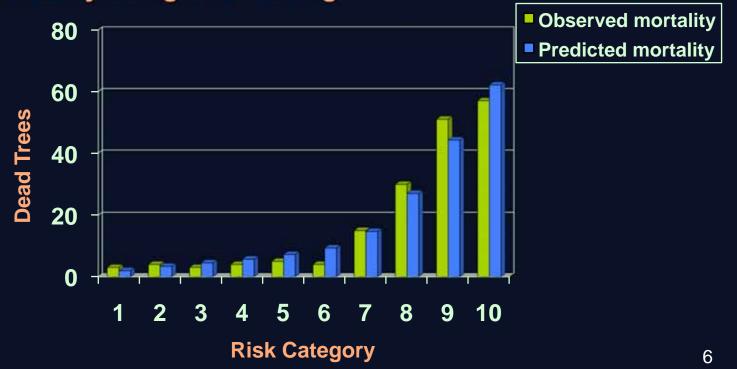


Mortality

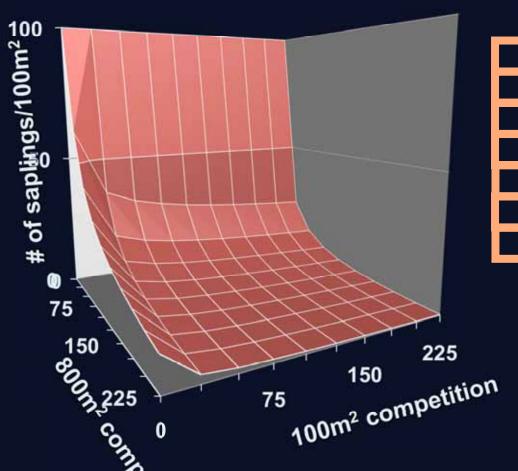
Mortality is stochastic

Annual probabilities of mortality given by a Logistic function of diameter and stocking

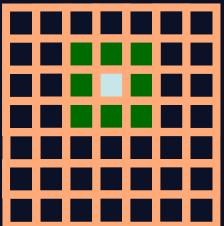
Function follows a U-shaped trend with diameter, and predicts higher mortality at higher stocking



Recruitment



The number of 2-6 cm trees expected in each 100m² area is predicted



- 100m² stocking
- 800m² stocking

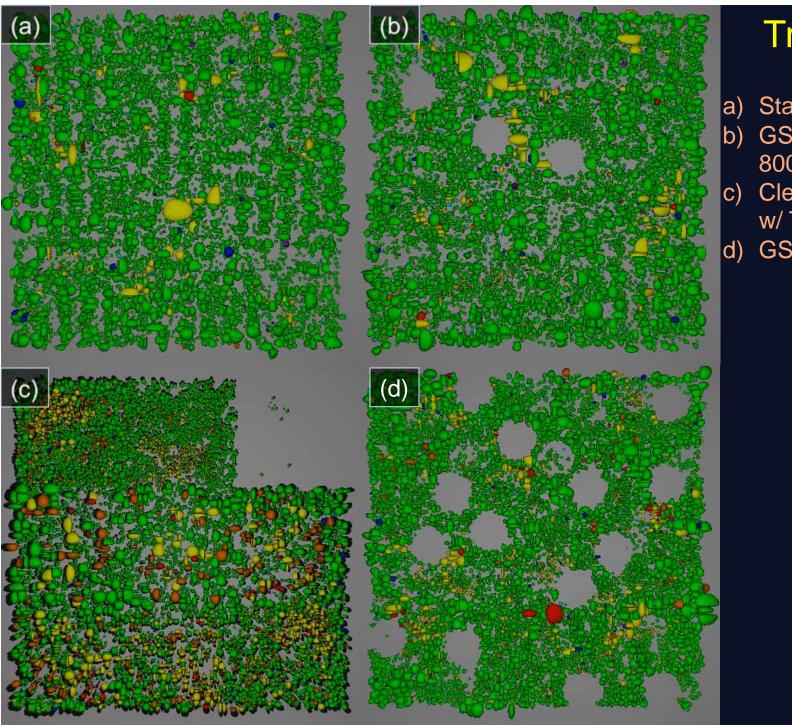
New saplings are added if there is a deficit

Species of new saplings is influenced by overstory composition

Validation

Comparing CANOPY simulations of standard single-tree selection against NH-25 field data for the same treatment:

	CANOPY Prediction	NH-25 Measurement	%Diff
Survivor Growth (m²/ha/yr)	0.35	0.32	9.3%
Mortality (m ² /ha/yr)	0.11	0.10	10.0%
Harvest Rate (m³/ha/yr)	4.58	4.42	3.6%



Treatments

- a) Standard STS
- o) GS+STS 800m², 3%
- c) Clearcutting w/ Thinning
- d) GS 800m², 120yr

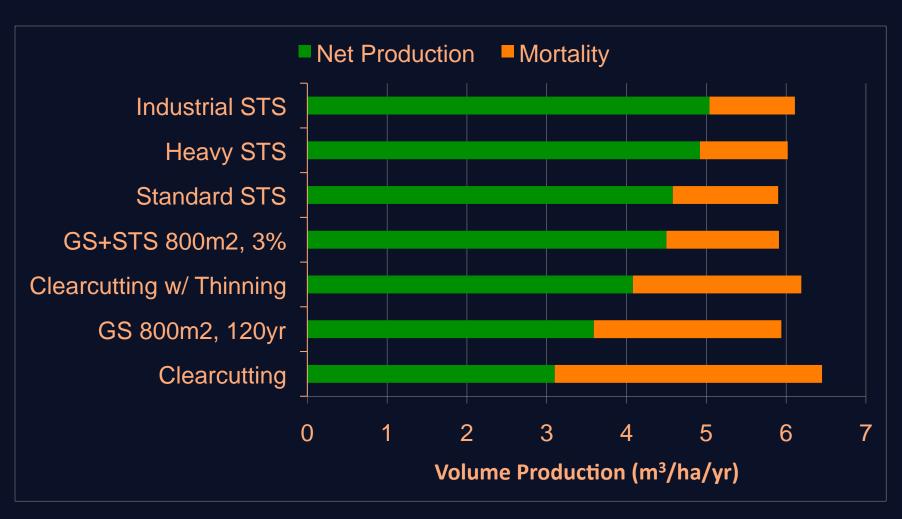
Methods

- Simulated 10 reps of each treatment
- Used last 150 years of simulation to compute annualized volumetric yield and mortality
- Life-cycle inventory for individual trees
 - A cohort of trees is tracked from birth to death
 - 5-year volume increments are used to compute yield and efficiency averaged by size class

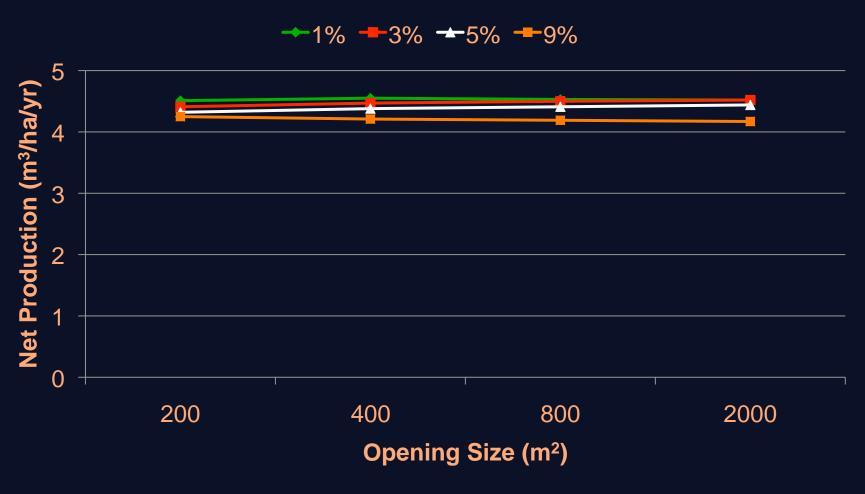
Hypotheses

- H1: Group size and the percentage of the stand occupied by groups will not affect net production rate
- H2: Under group selection alone, net production will decline as rotation age increases
- H3: Increases in sapling/pole GSE will not increase stand-level production markedly because the sapling/pole component produces only a small fraction of the total

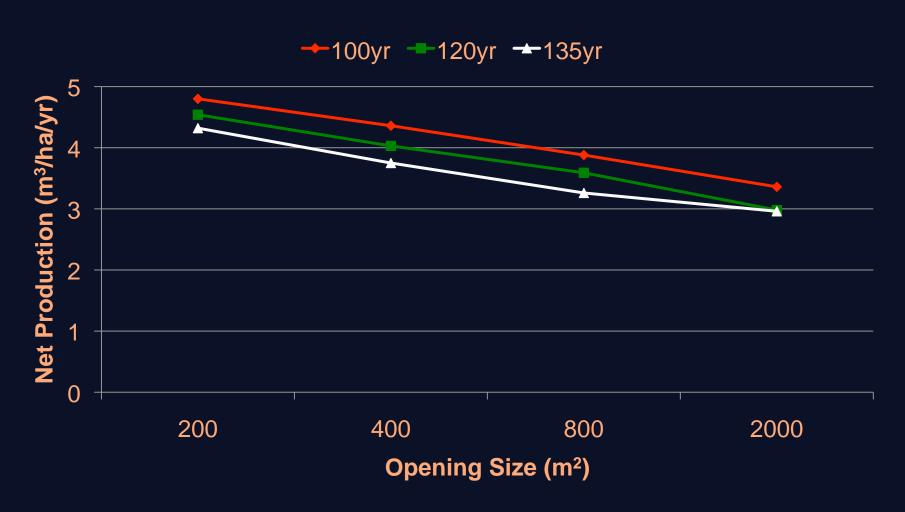
Stand-level Production



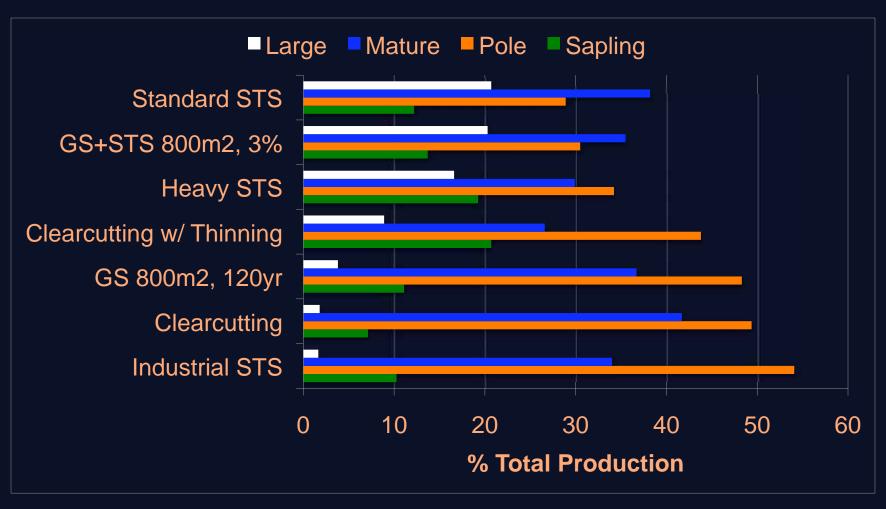
Group Selection with Single-tree Cutting between groups



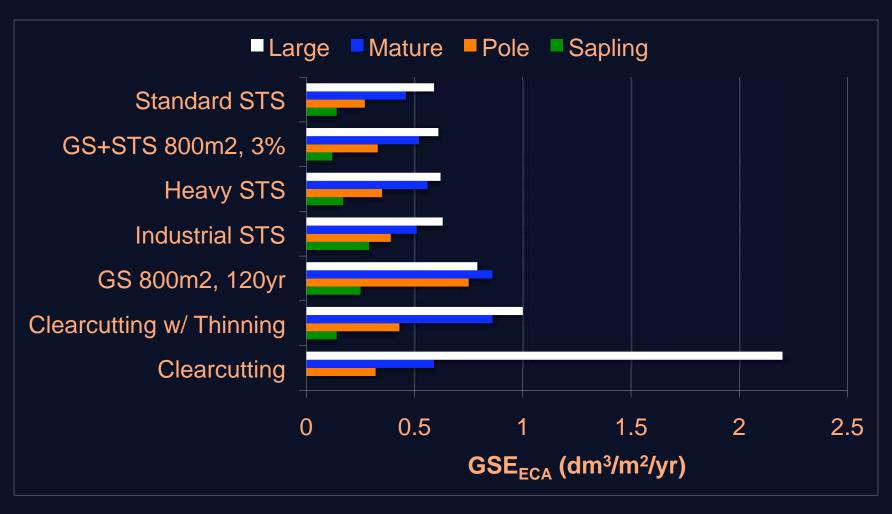
Group Selection Alone



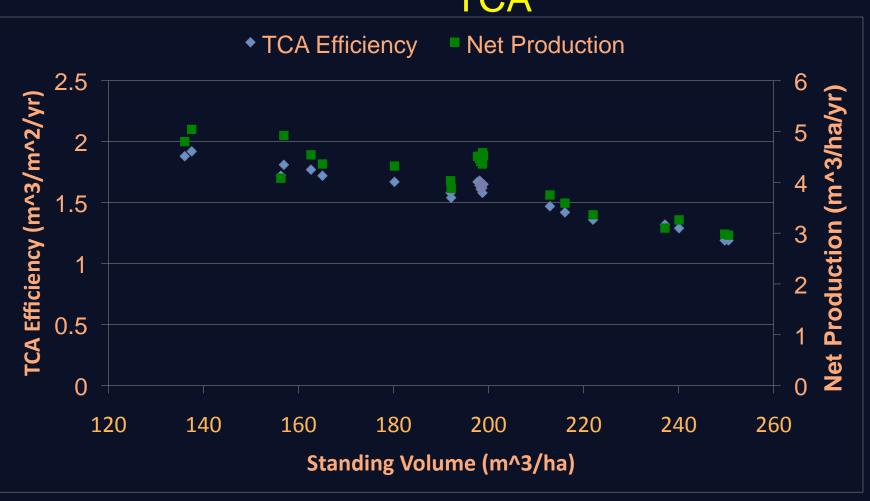
Relative volume produced by trees in each size class



Lifetime Average GSE_{ECA}



Production and Stand-level GSE_{TCA}



Relative Production of Clearcutting and Standard STS



Evaluation of Hypotheses

- H1: Group sized/extent does not affect net production
 - Supported by data
- H2: Under group selection alone, net production will decline as rotation age increases
 - Supported by data
- H3: Increases in sapling/pole GSE will not increase stand-level production markedly because the sapling/ pole component produces only a small fraction of the total
 - NOT supported by data

Concluding Remarks

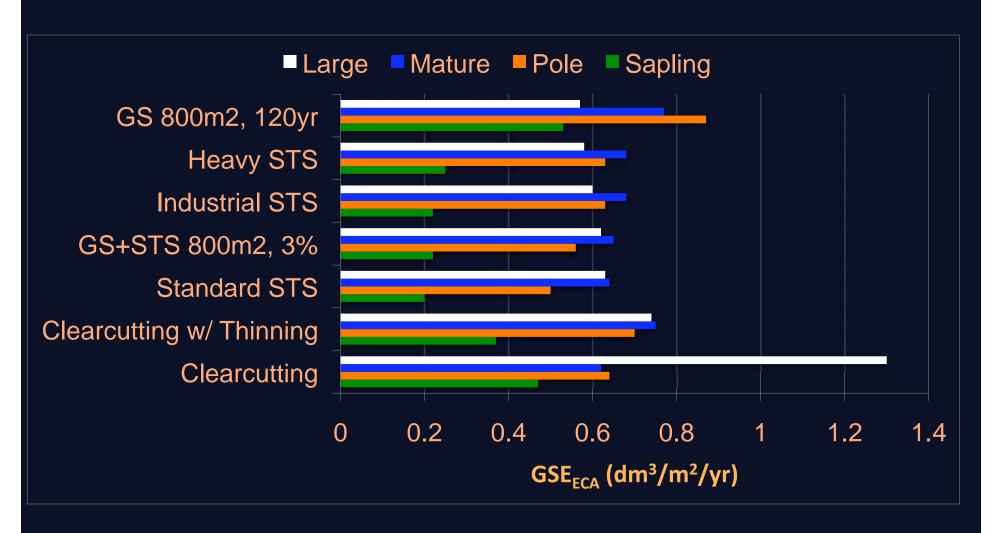
- Paradox of efficiency vs yield
 - Clearcutting without thinning is less productive than STS because of unsalvaged mortality
 - Clearcutting with thinning is very similar in production to STS despite clear GSE advantages
 - GSE advantage is mitigated by lower site occupancy

Questions?

Potential Production of Clearcutting and Standard STS



GSE_{ECA} within a size class



Relative volume harvested from each size class



Diameter growth equations Canopy and non-gap trees

For each habitat type:

$$In(\Delta Diameter) = A + B*In(Diameter) - C*(Diameter) - D*Stocking$$

1. Calibrate equation using 2/3 of data (Sugar maple example)

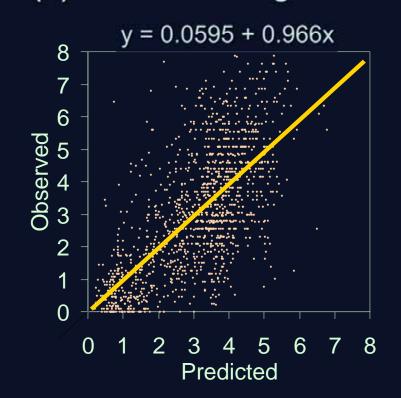
$$ln(\Delta D) = -0.245 + 0.904*ln(D) - 0.028*(D) - 0.008*Stocking R2 = 0.403$$

2. Evaluate equation using reserved 1/3 data

Compare predicted to observed growth using the "Simultaneous F-test":

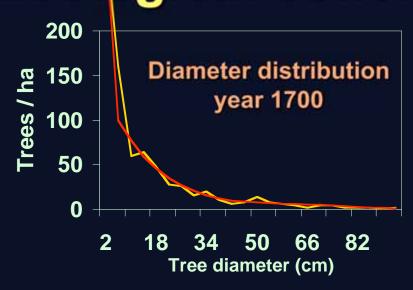
Do predicted = observed?

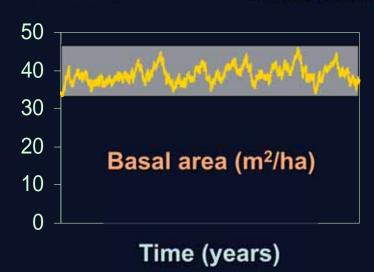
Not significantly different p = 0.305

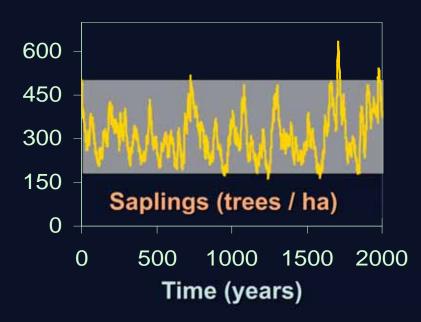


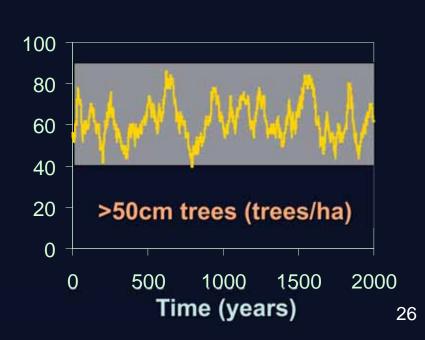
Ecological benchmarks





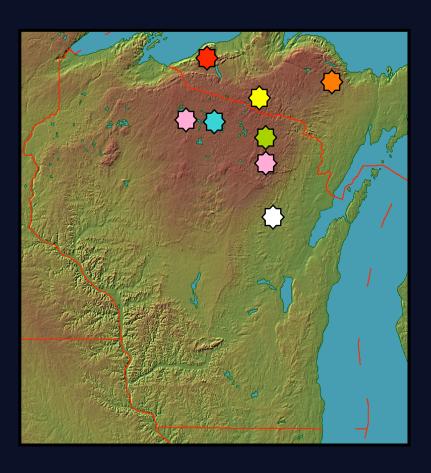






Building a database

Variety of stand conditions



Over 13,000 trees

- Porcupine Mountains: 1981-2004
 Unmanaged late successional / old growth
- Dukes Experimental Forest: 1952-2002 Selection harvests in old forest
- Sylvania Wilderness
 Unmanaged late successional / old growth
- NHAL: 1983-1996 Single-tree selection
- Argonne Exp. Forest: 1951-2001 Selection harvests in young forest
- Chequamegon/Nicolet National Forest Selection harvests
- Menominee Reservation: 1979-1999
 Selection harvest with big trees

27