Boreal mixedwood forests: Linking early performance of white spruce with future yield

Victor Lieffers, Zhili Feng and Ken Stadt

Regulatory Instruments

- Establishment and Performance Surveys
- Stocking
- Minimum Height
- Free-to-grow assessment
- Focus on 10 m^2 plots

Topics

- Stocking
- Mortality
- Competition
- FTG standards

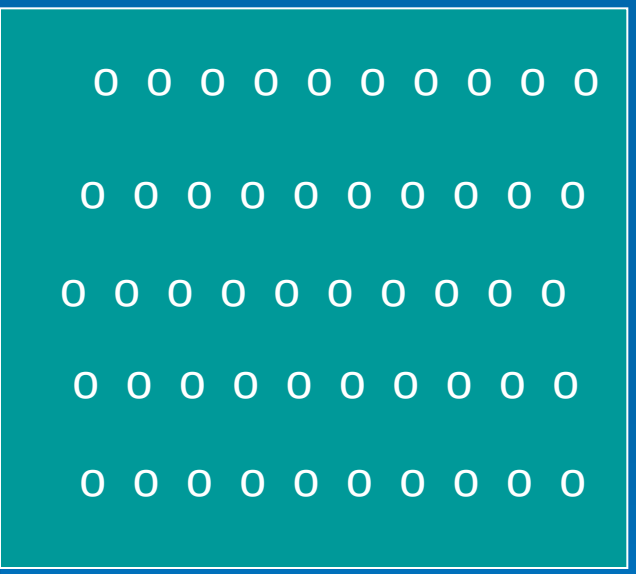
The Data

- Stand Dynamics Systems – Juvenile PSPs
- Mature mixedwood PSPs
- Data from operational Establishment and Performance Surveys

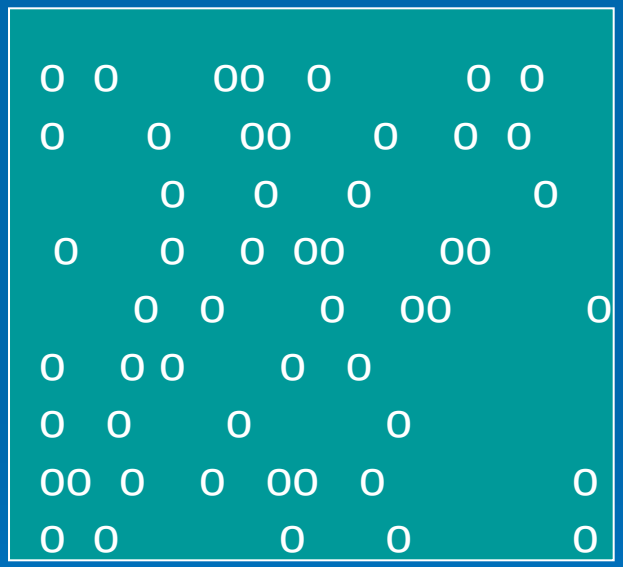
Stocking

Morisita Index of Dispersion

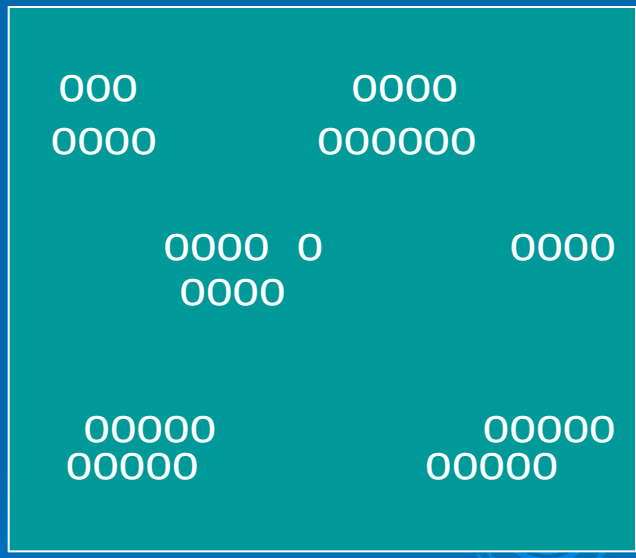
- Regular
- Random
- Clumped



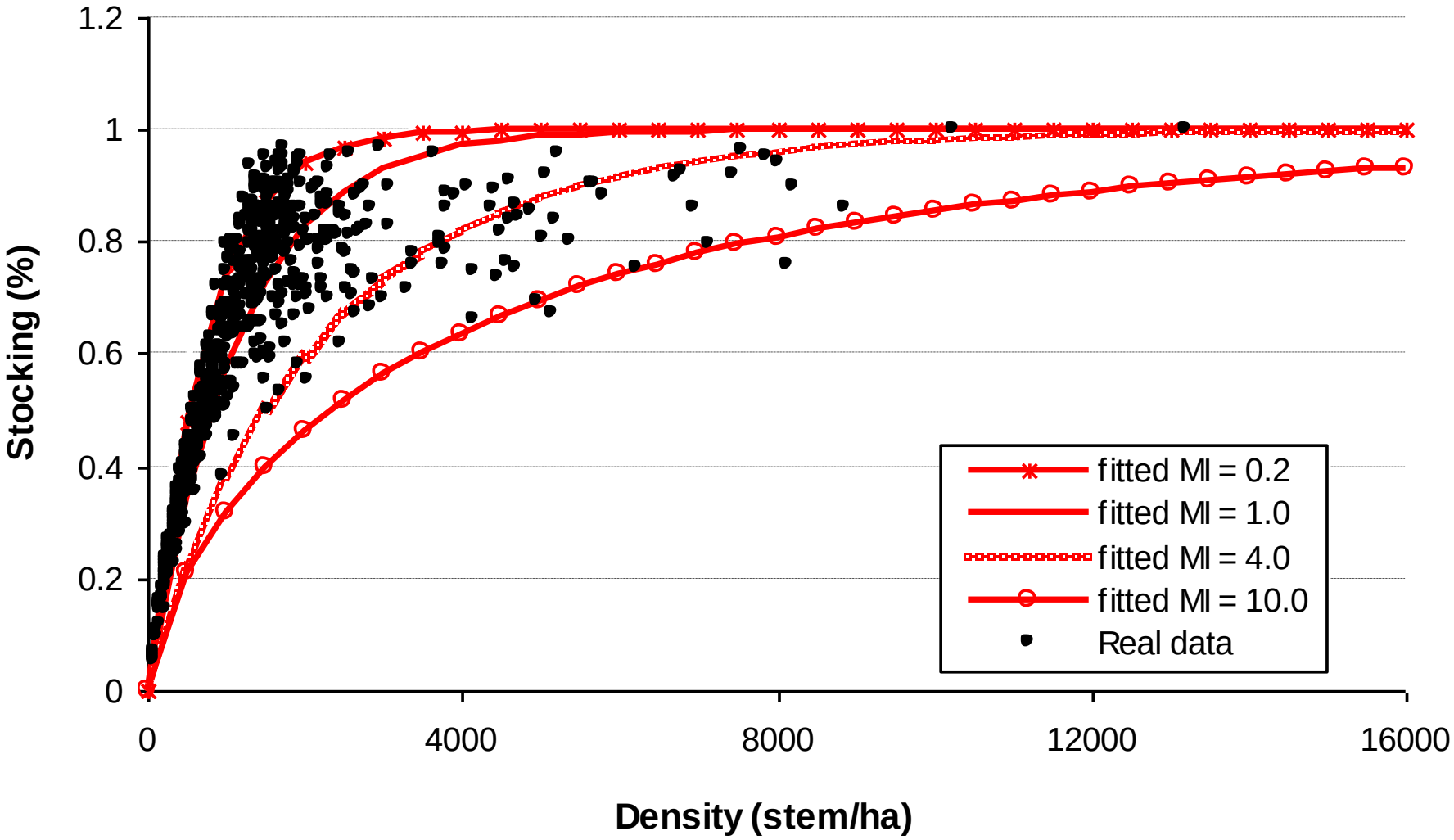
MI ~ 0



MI = 1



MI > 10

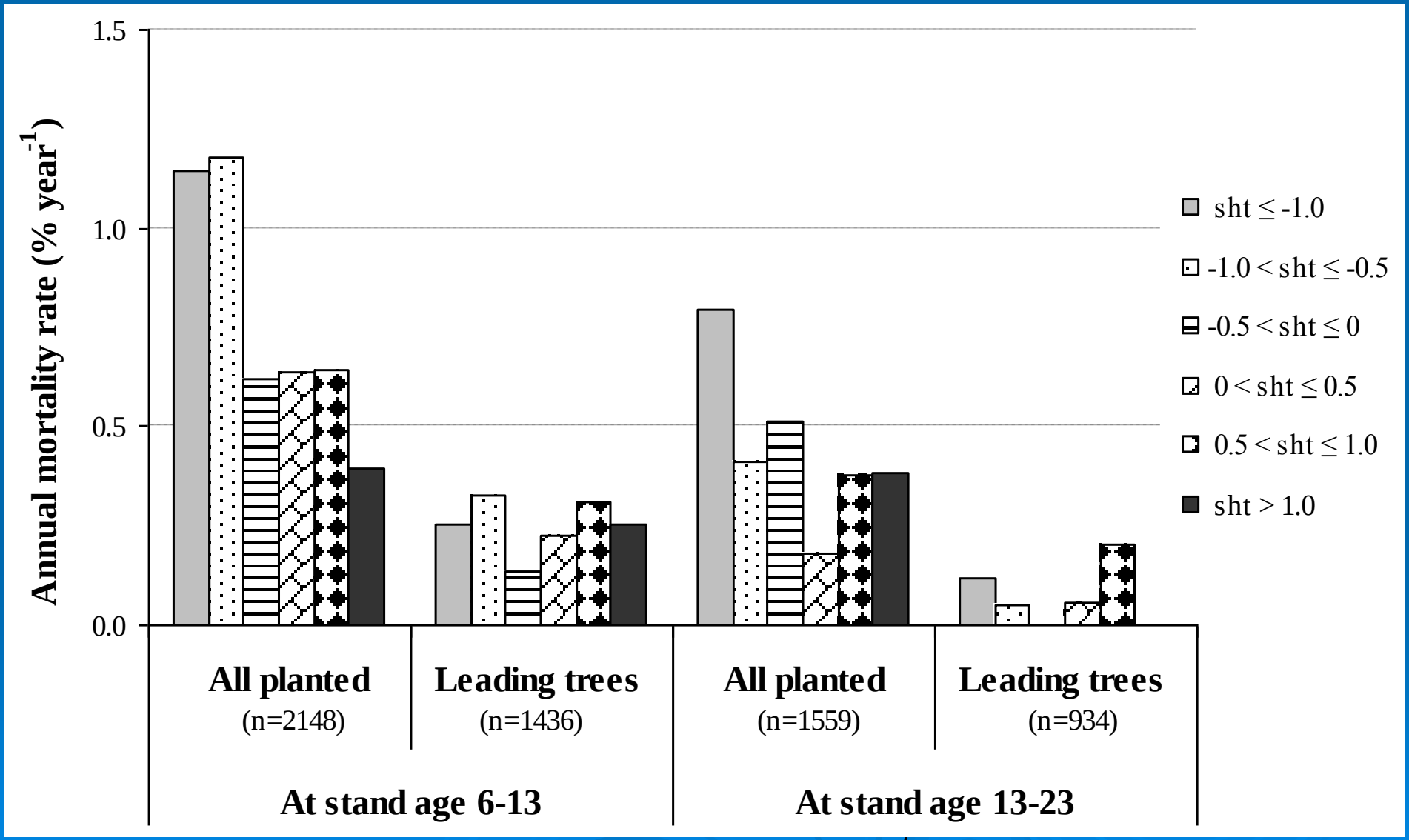

1.2
1
0.8
0.6
0.4
0.2
0
Stocking (%)
0
4000
8000
12000
16000
Density (stem/ha)
fitted MI = 0.2
fitted MI = 1.0
fitted MI = 4.0
fitted MI = 10.0
Real data

a1 = 1.7273,
a2 = 0.7608,
a3 = 1.0582,
a4 = 0.0353
n = 620,
P < 0.001,
R^2 = 0.97,
RMSE = 0.070).

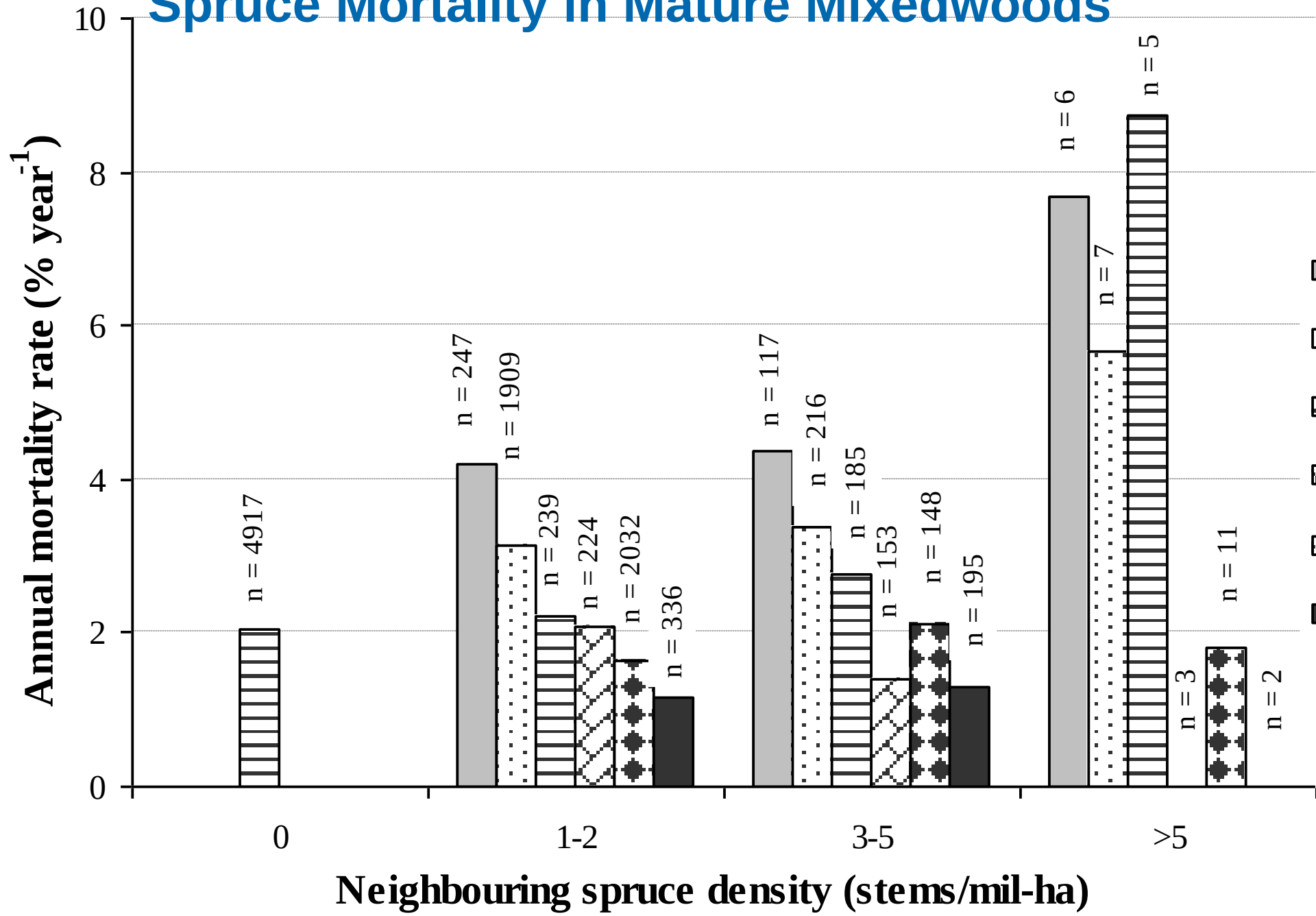
$$S = 1 - e^{-\left(\frac{a_1 \cdot A \cdot D}{(1+MI)^{a_2}}\right)^{a_3 - a_4 \cdot MI}}$$

Mortality of Spruce

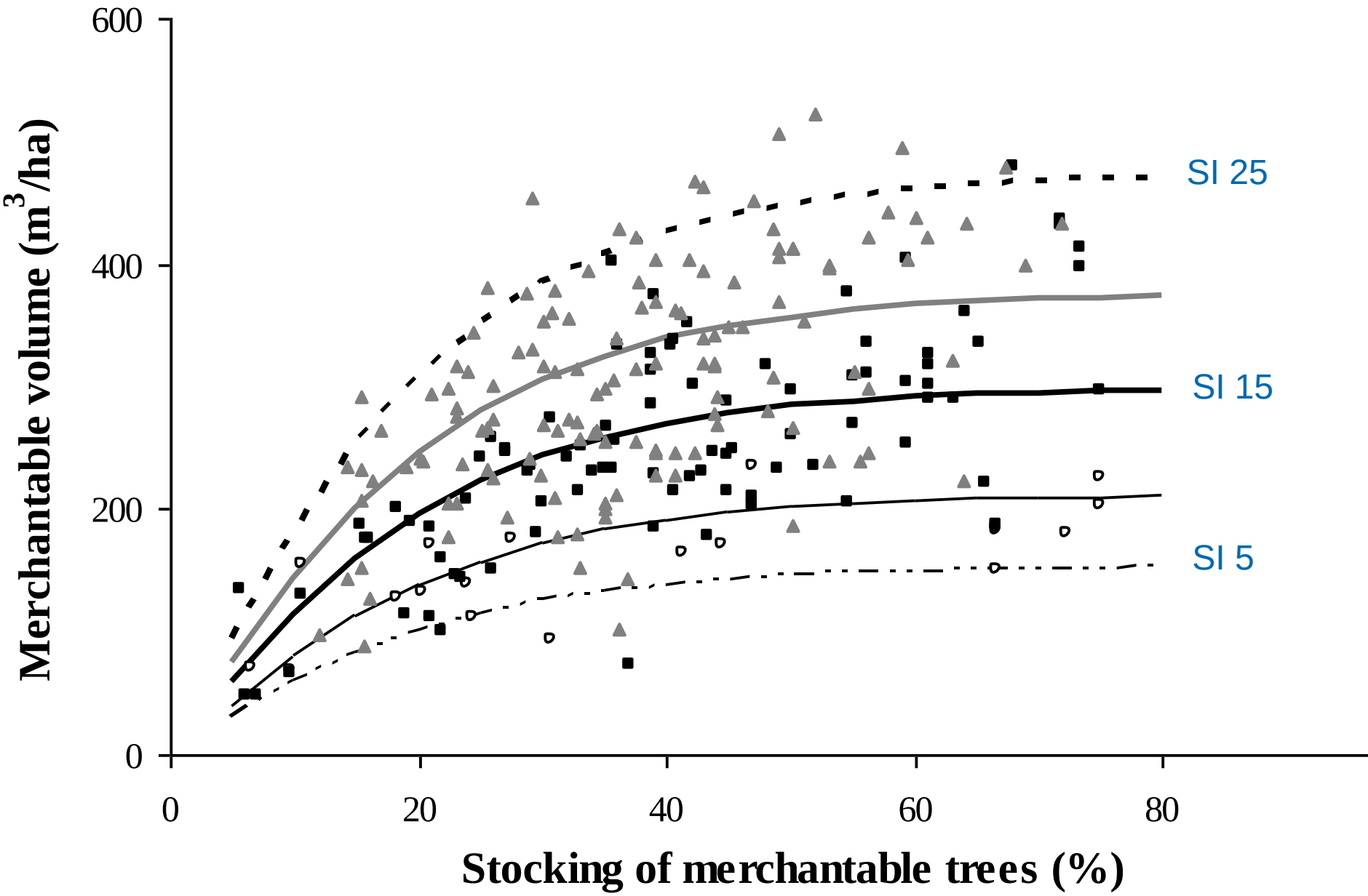
Juvenile stands



Spruce Mortality in Mature Mixedwoods



Mature PSPs


600
400
200
0
0
20
40
60
80
Merchantable volume (m3/ha)
Stocking of merchantable trees (%)
SI 25
SI 15
SI 5

$$Volume = a_1 \cdot (1 - e^{-a_2 \cdot stock^{a_3}}) \cdot SI^{a_4}$$

a_1 = 49.4616

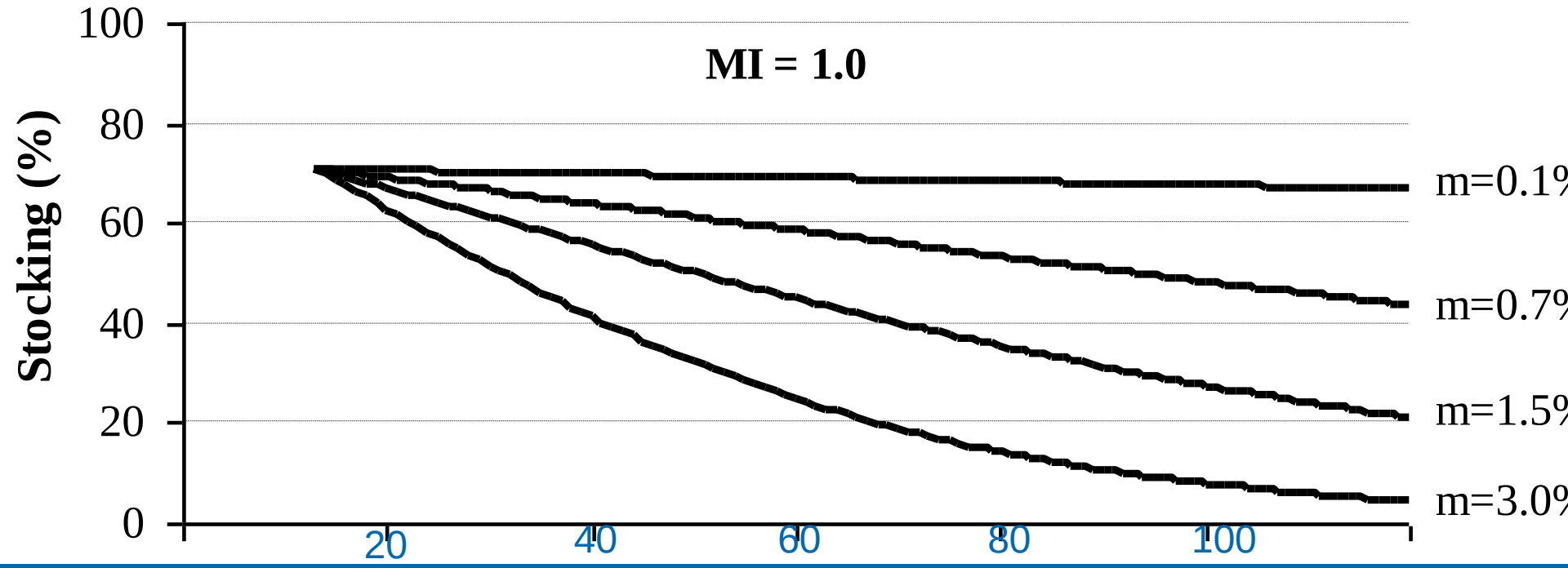
a_2 = 5.6478

a_3 = 1.1324

a_4 = 0.7017

R^2 = 0.5404

MSE = 66.34

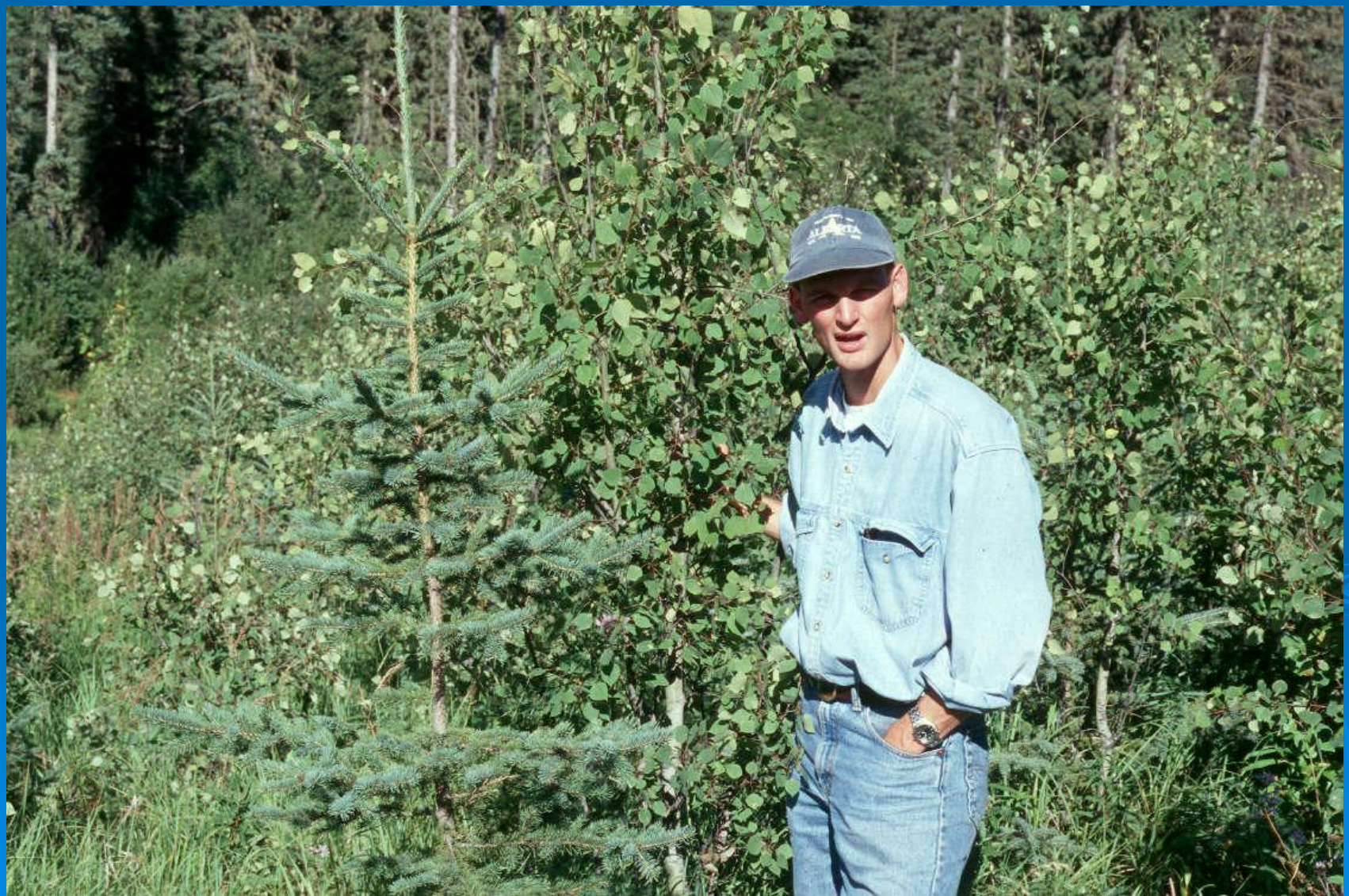

MI = 1.0
Stocking (%)
100
80
60
40
20
0
20
40
60
80
100
m=0.1%
m=0.7%
m=1.5%
m=3.0%
Stand Age

Conclusions

- Stocking is defined by stem density and spatial dispersion
- Leading trees that were small or large had no difference in mortality
- Full volume of Sw can be attained by 30-40% stocking at maturity
- Mortality over the life of stand is uncertain but very important

Free-to-Grow Standard

Competition index placed in regulation



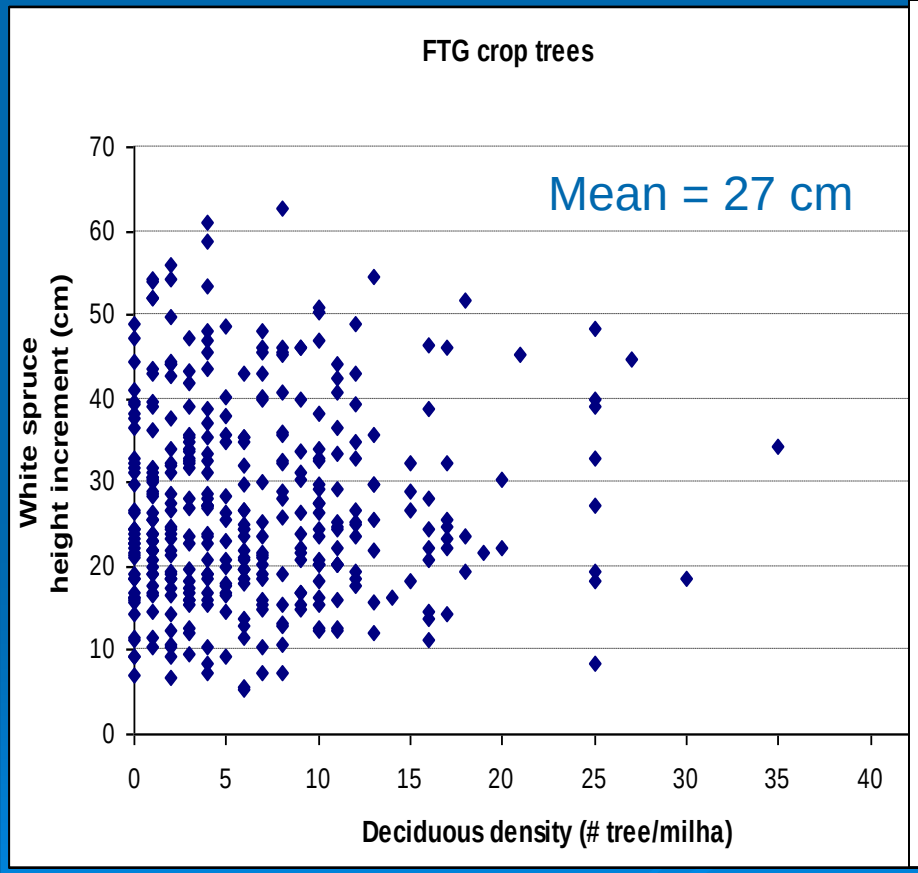
Free-To-Grow Standard

A FTG tree is usually big

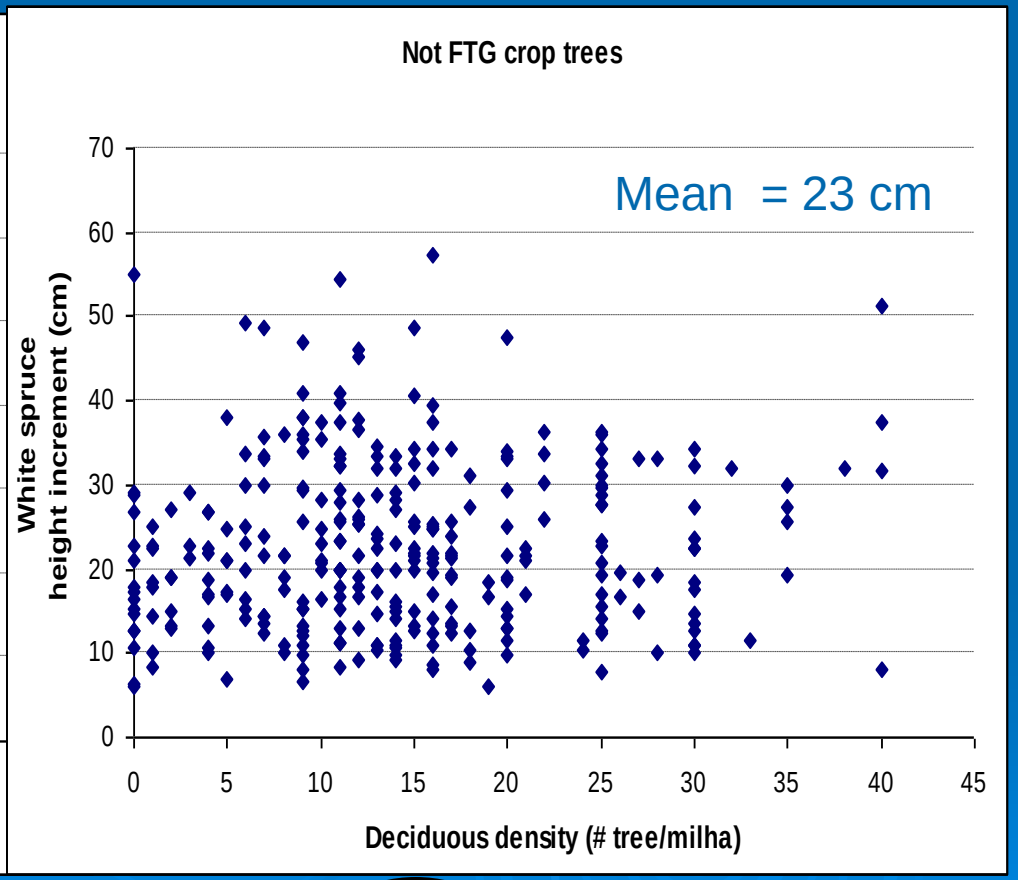
Trees designated FTG usually are bigger and faster growing

FTG (mixedwood standard - 49 stands)

FTG

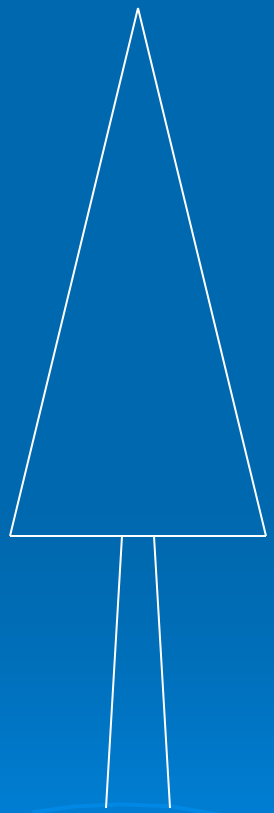


Not FTG



We must be careful if we include the size of the subject in the competition model.

Why do big trees grow fast?



Low competition

Superior microsite

Superior genetics

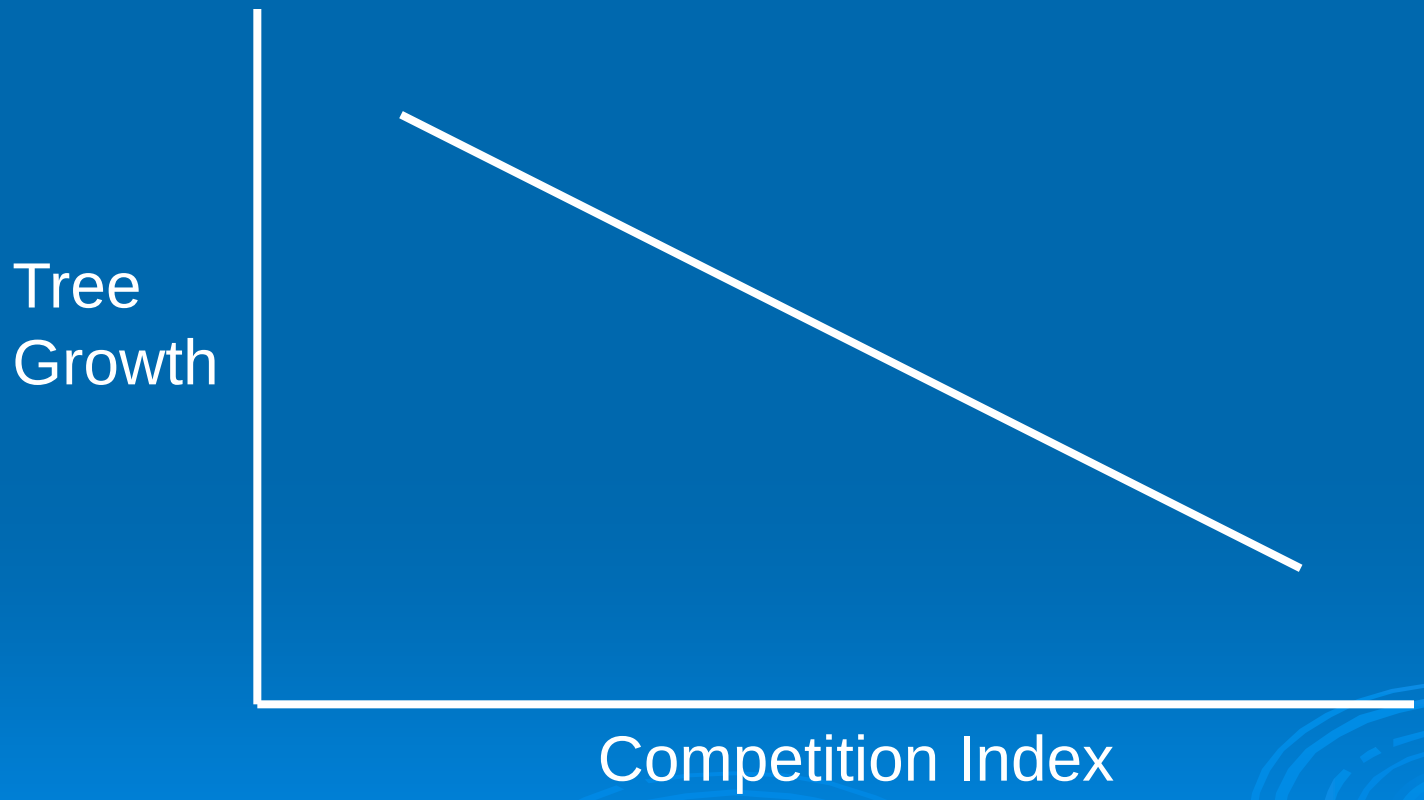
Few insects/diseases

Superior mycorrhizae

Free-to-Grow Criterion

- Does not isolate effects of competition from other factors affecting growth.

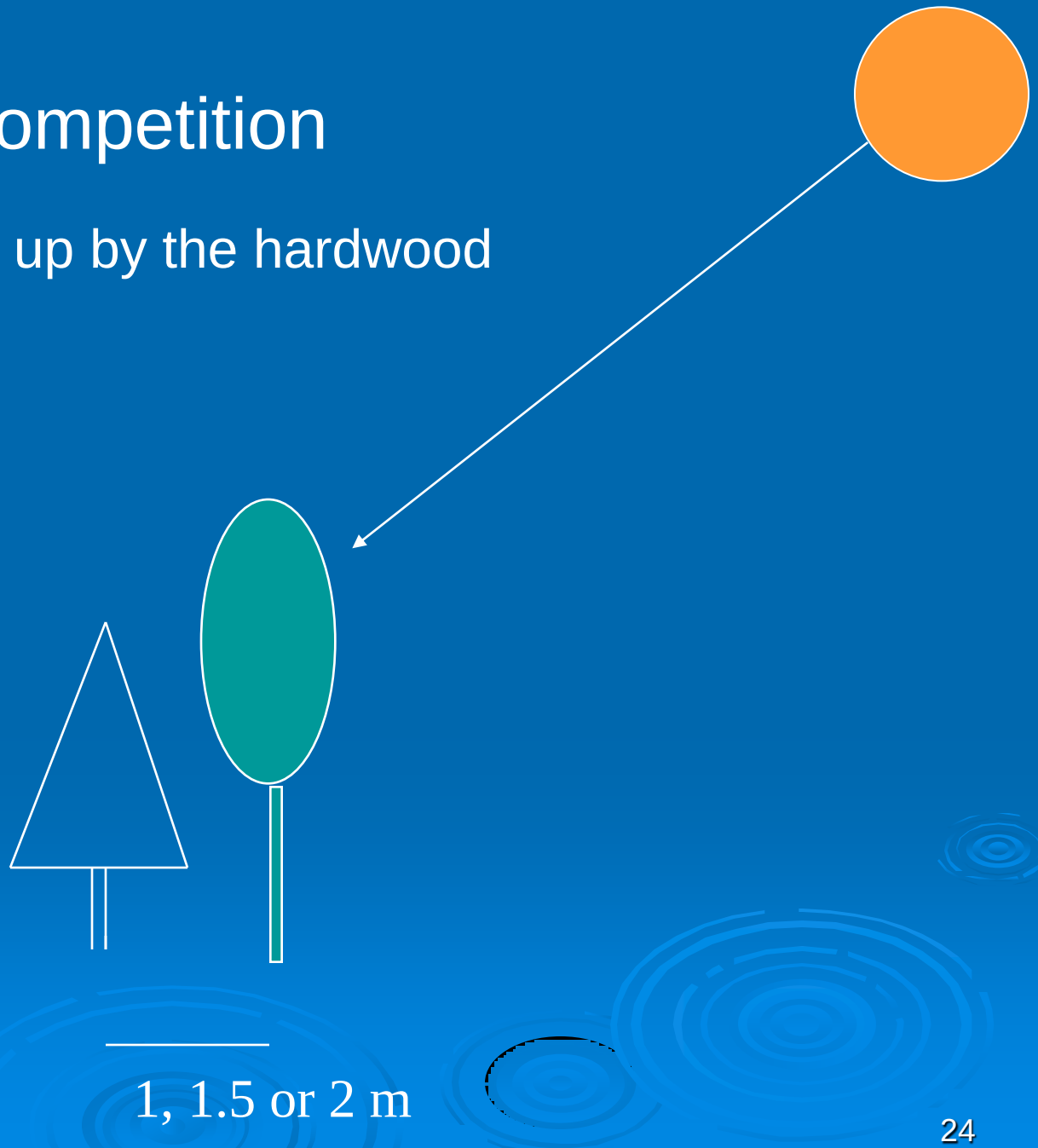
How to judge a competition index



Asymmetric Competition

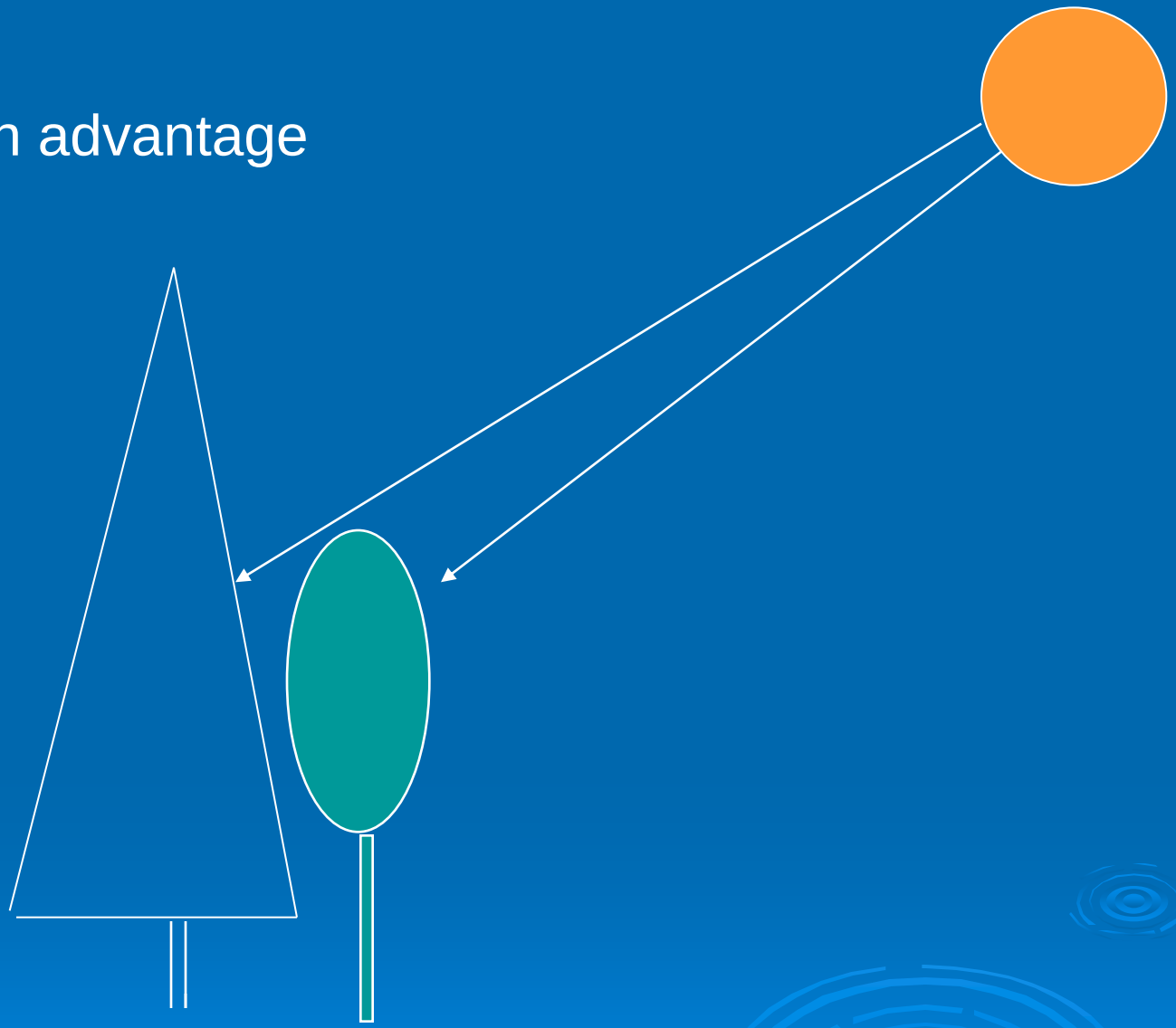
Light is intercepted up by the hardwood

Non- FTG

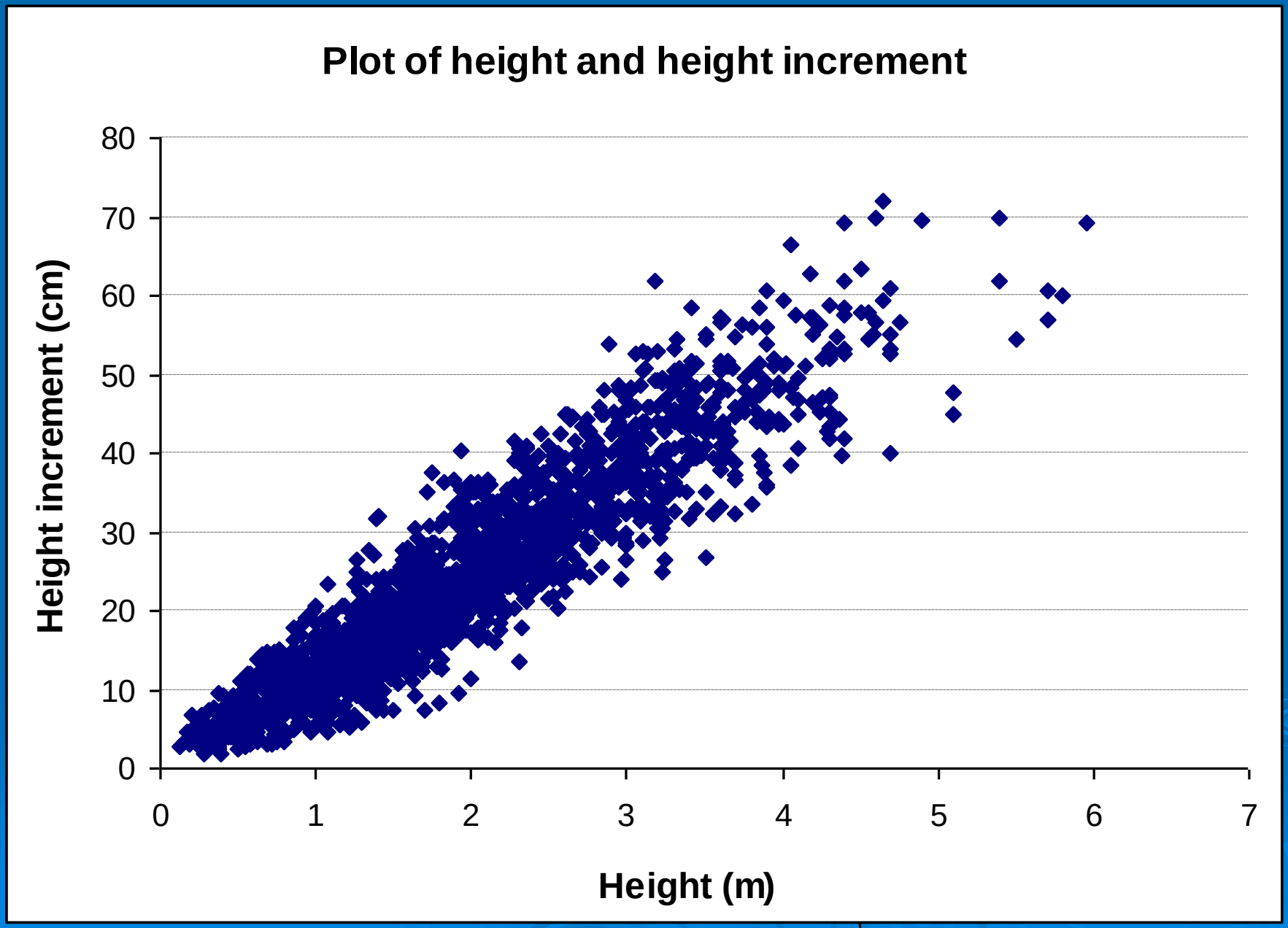


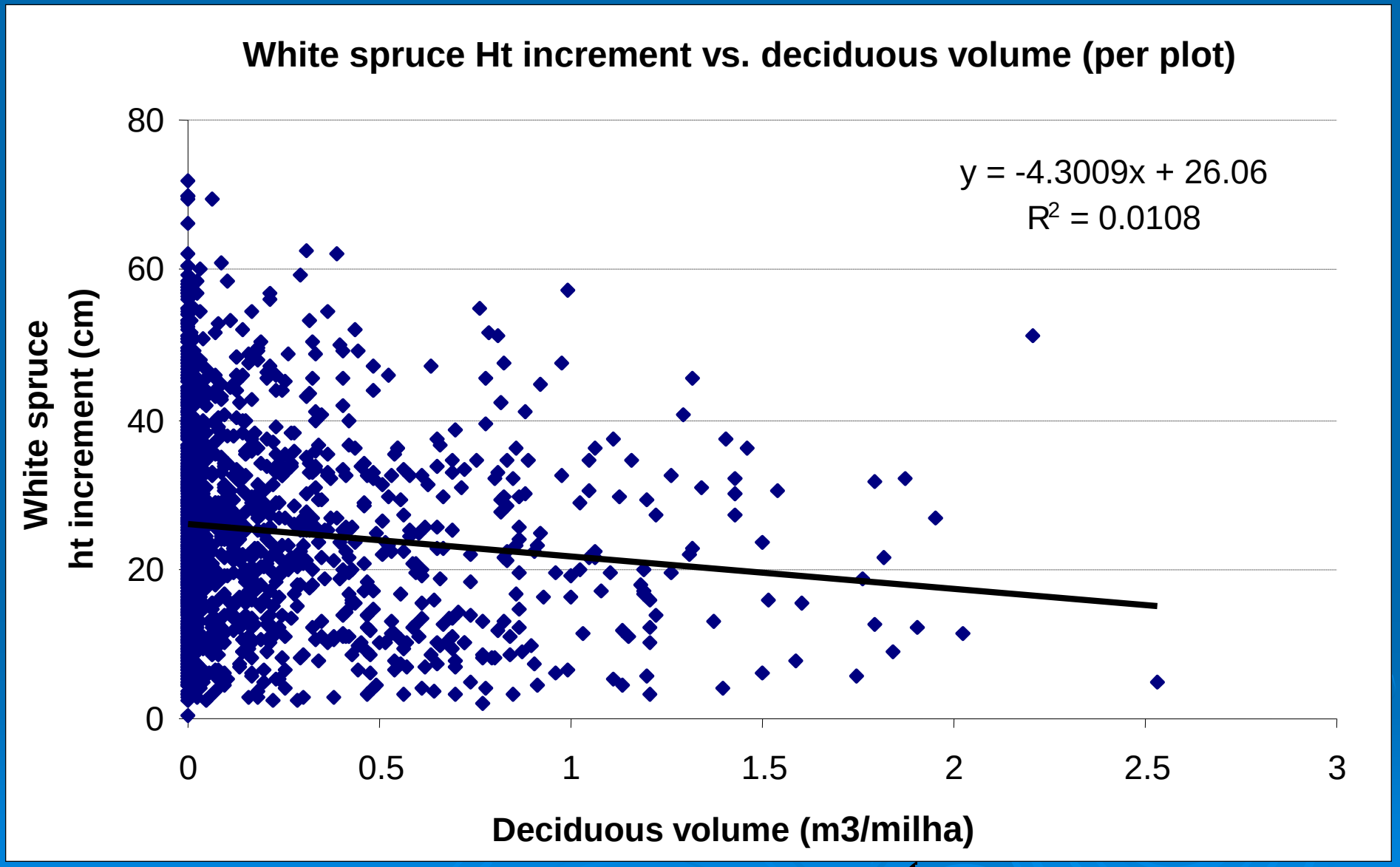
FTG Spruce

Large spruce has an advantage over a small spruce



1, 1.5 or 2 m

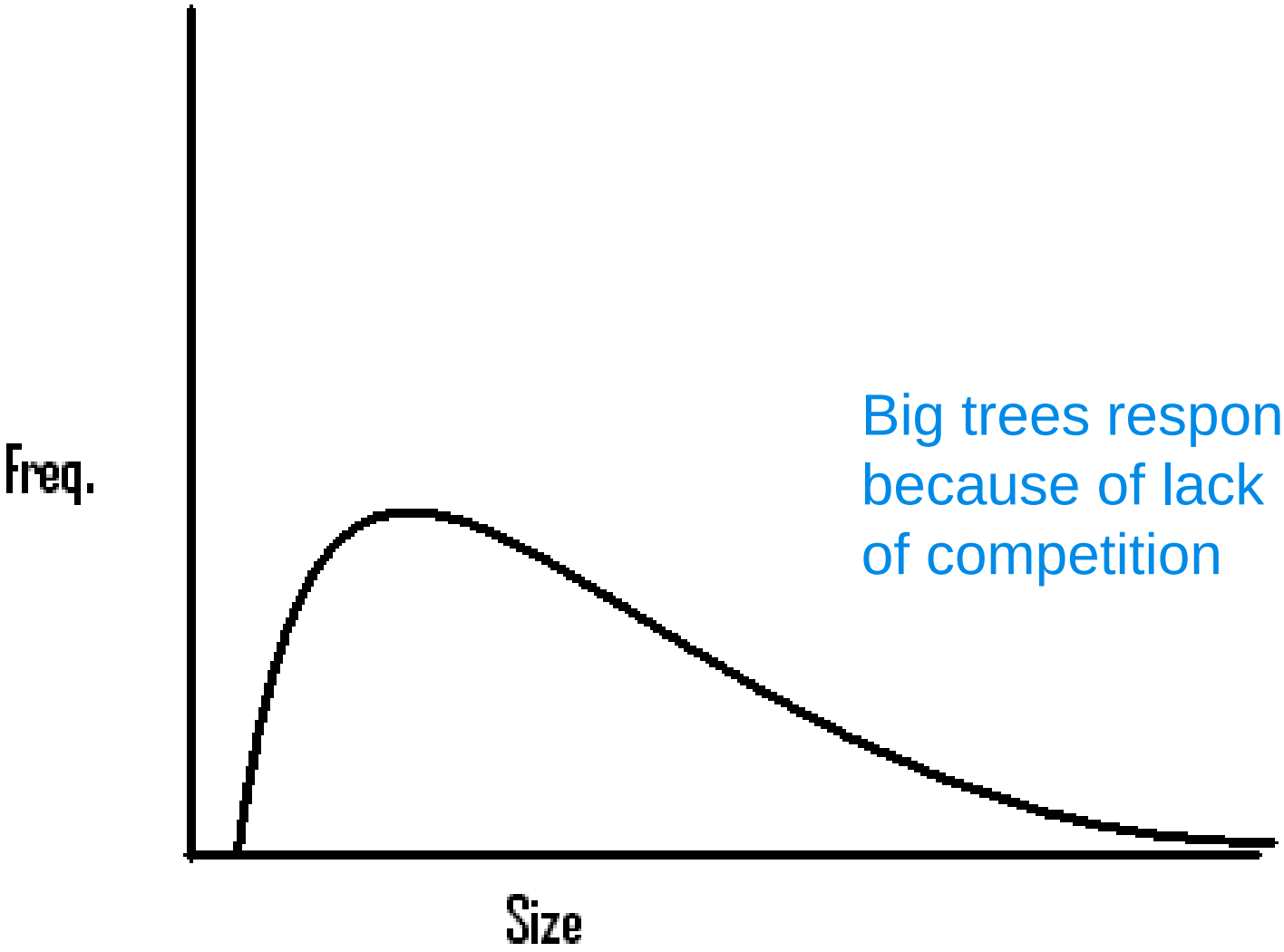

Plot of height and height increment
Height increment (cm)
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
Height (m)


White spruce Ht increment vs. deciduous volume (per plot)
y = -4.3009x + 26.06
R2 = 0.0108
White spruce ht increment (cm)
Deciduous volume (m3/milha)
0
20
40
60
80
0
0.5
1
1.5
2
2.5
3

Judging Asymmetric Competition

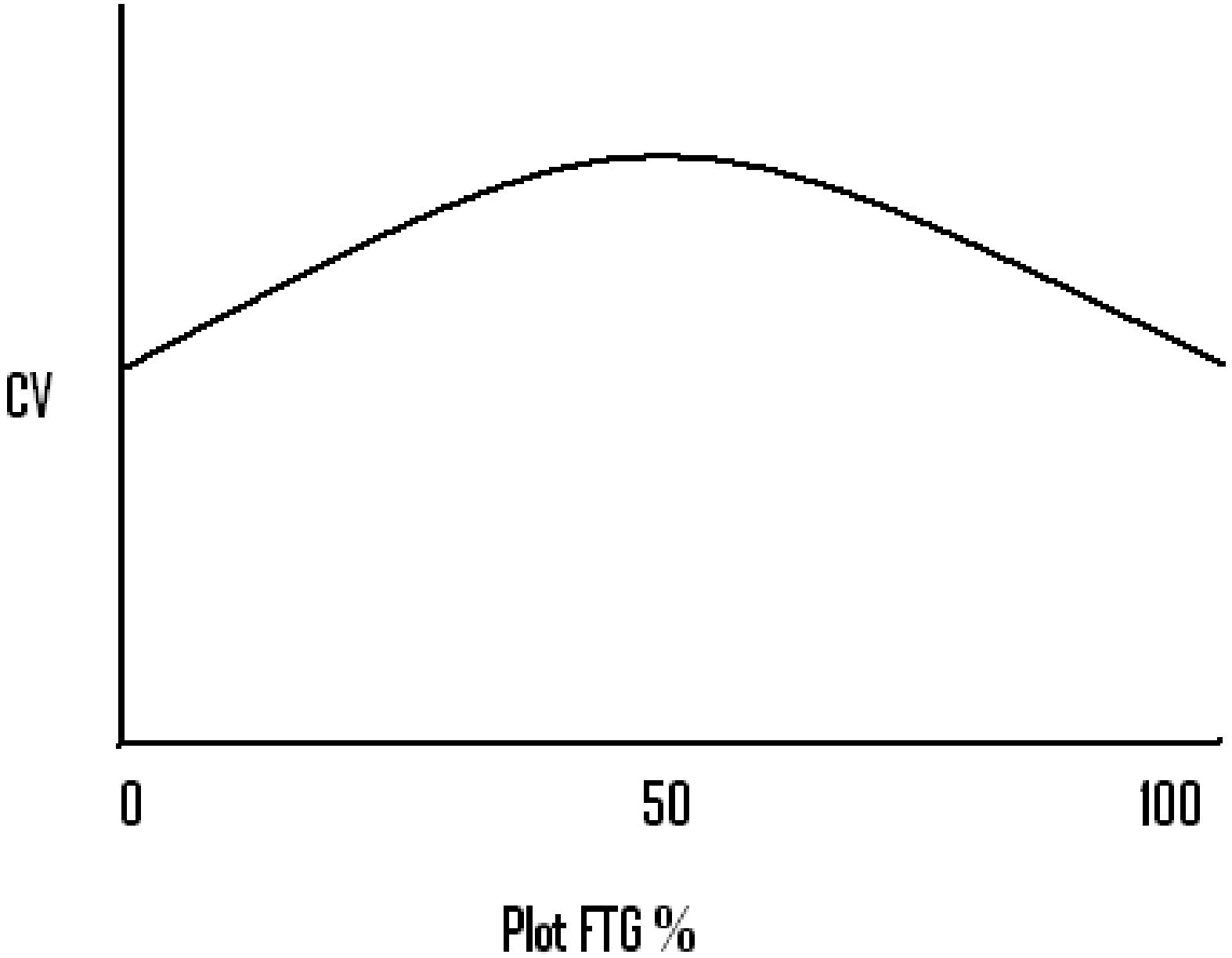
- Unclear with large trees.

Expected size frequency distribution when half of crop trees are FTG

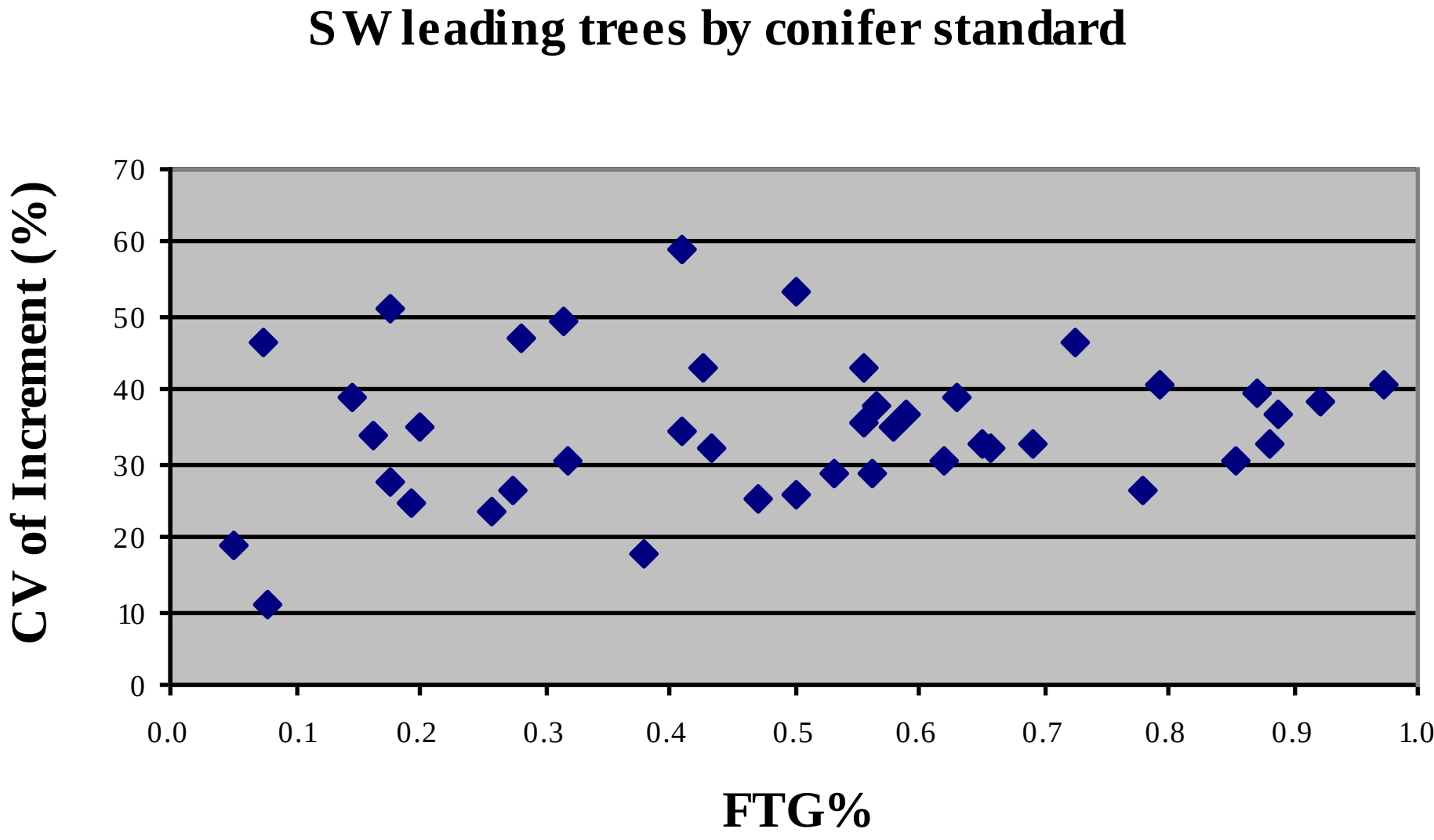


Big trees respond because of lack of competition

Expect greater variation in the distributions of growth of leading trees when 50% of plots FTG



49 stands, 12-13 years old, boreal mixedwoods
Height Increment



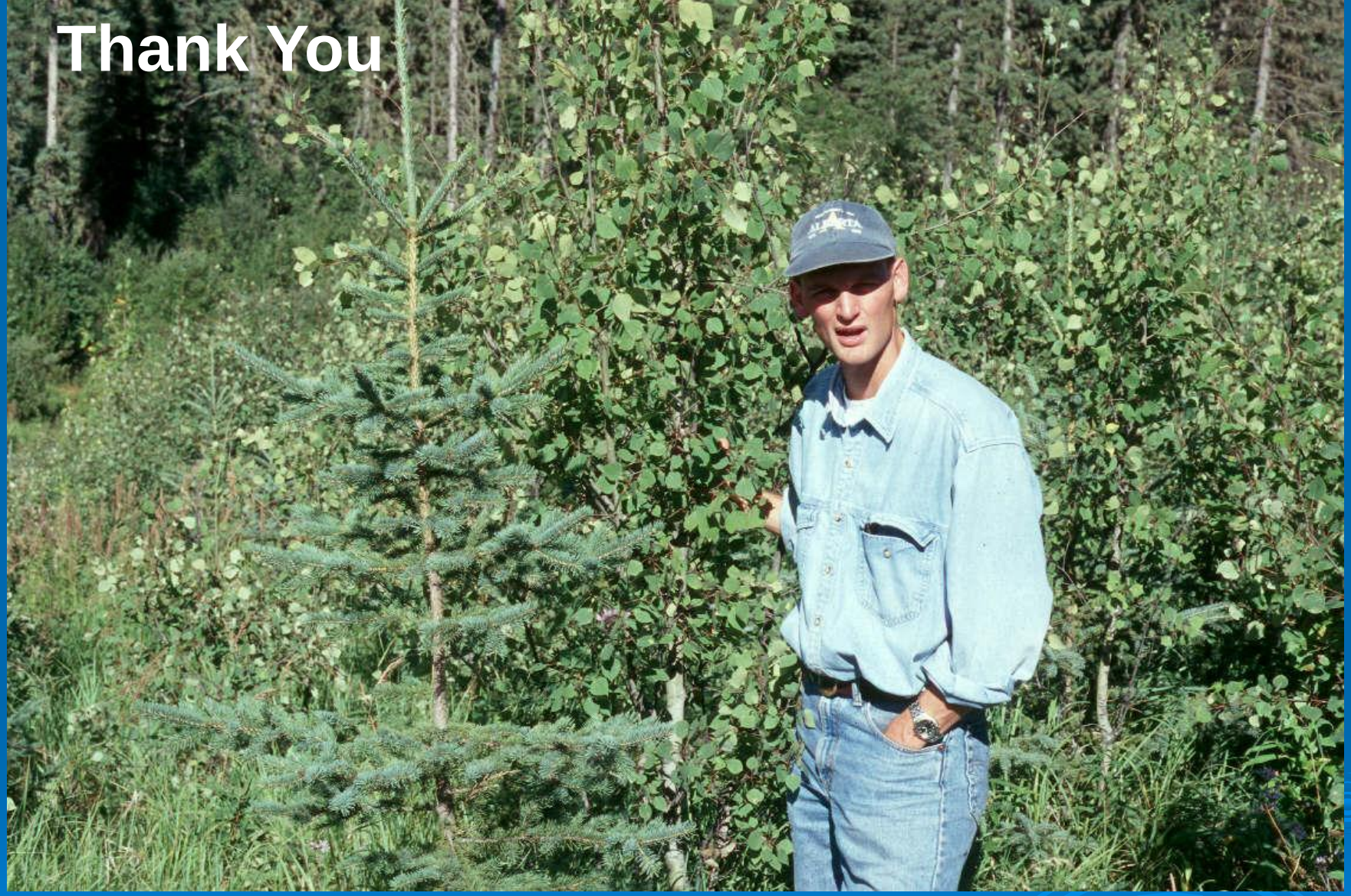
Possible Implications

- No shift in growth frequency distribution with FTG
- FTG standard is not a good measure of competition
- Need other theories to understand asymmetric competition

Why is this Important?

- Silvicultural investments
- Change in forest structure of mixedwoods

Thank You

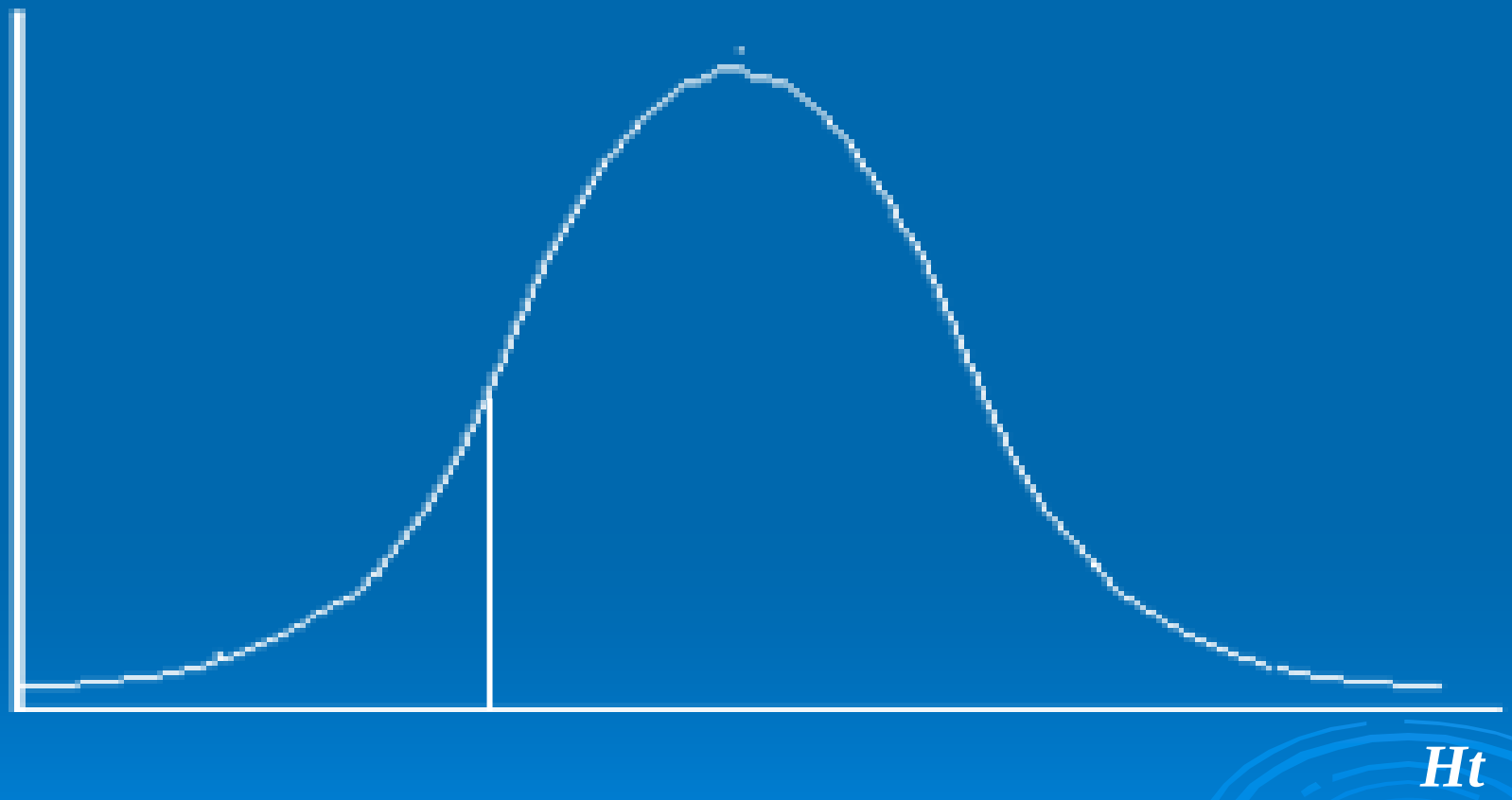


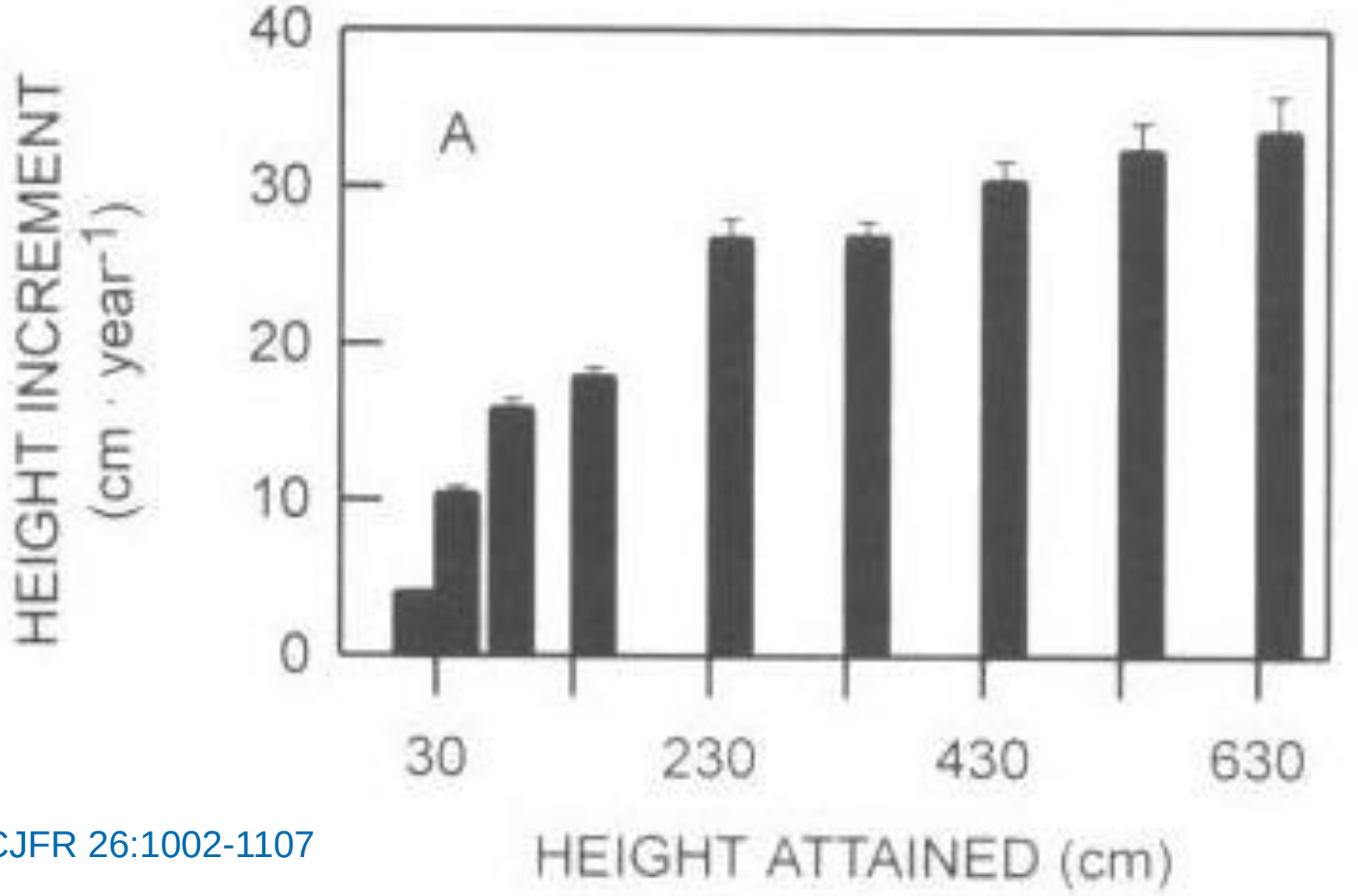
Supporters: Mixedwood Management Association
West Fraser & Weyerhaeuser
NCE-SFM

Further Evidence

- No detectable increase in mortality of spruce (>8 yrs old) in stands with aspen
- Very small loss in height growth of spruce in aspen stands, once spruce is 1m tall.

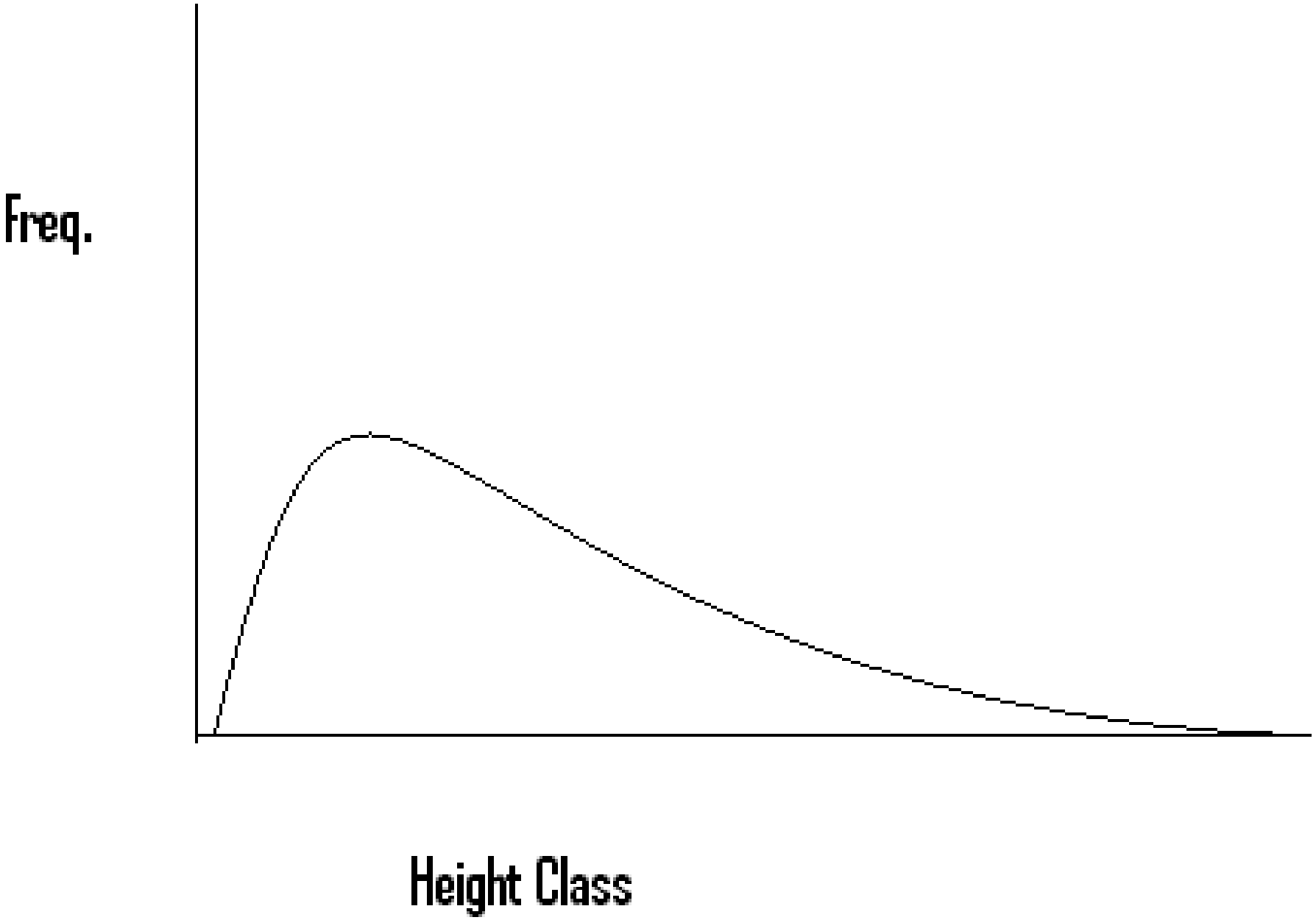
Normal Size – Frequency distribution



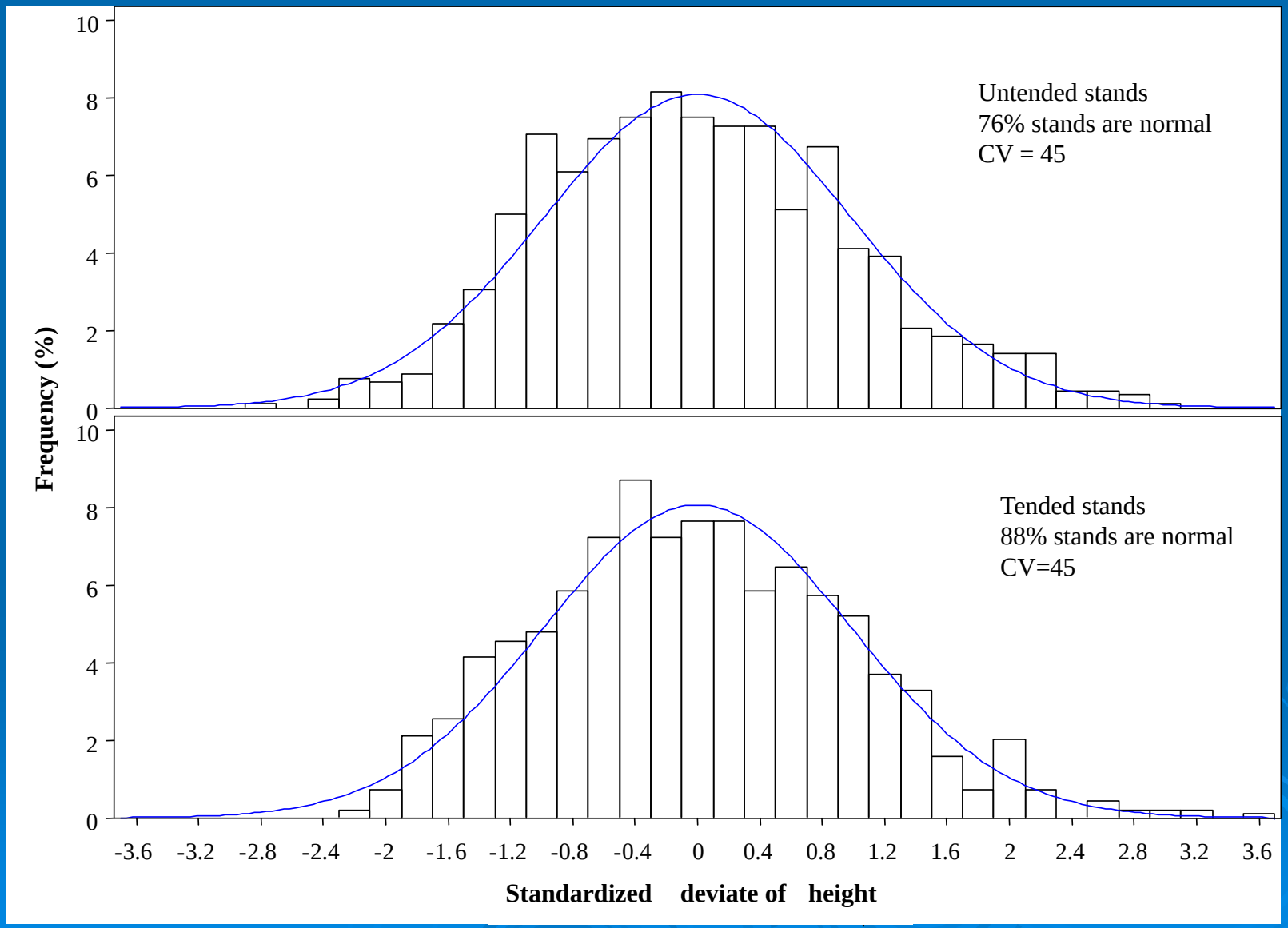


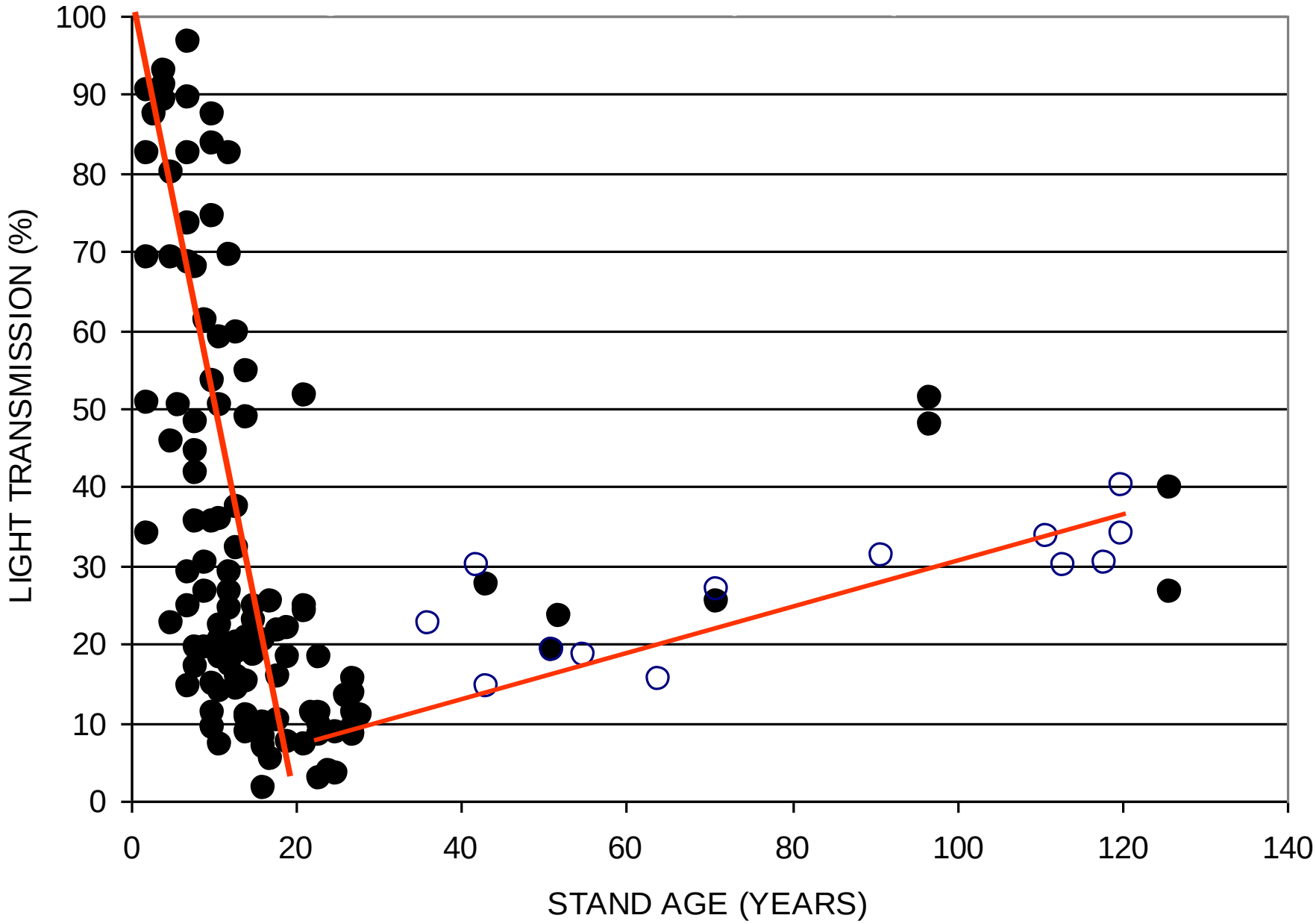
CJFR 26:1002-1107

Distribution with asymmetric competition

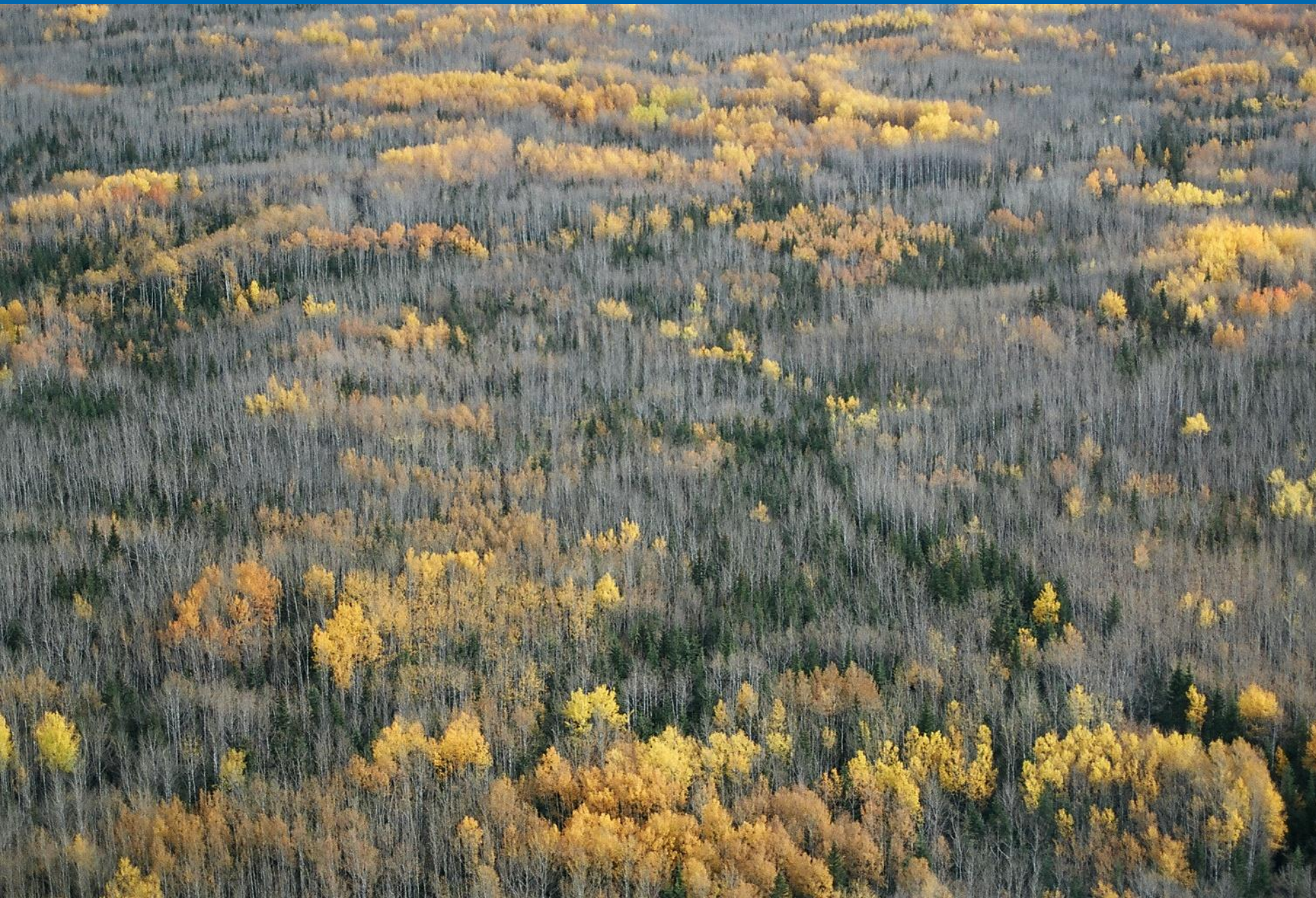


Height normality analysis (leading tree)





2002, For Chronicle 78: 137-145



20 year-old MOF plots

Normal

Burn pile

Annual mortality:

SDS leading trees: 7 dead / 949, M=0.1%

SDS all planted trees: 52 dead/ 1585, M=0.4%

Duffy Plot underplant M = 0.7% after 5-42 yrs

PSP: M = 1% for the average (Yang 2002)

M = 2% for the worst case (Yang 2002)