Thinning During Stand Understory Reinitiation Phase

BLM/ODF Thinning Session
Silver Falls State Park
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Understory Reinitiation

- Characteristics of understory reinitiation stage
- Understory response
    - Herbs and shrubs
    - Tree regeneration
        - Advanced regeneration
        - Planted seedlings
        - New germinants
- Growth response of residual trees
- Summary

Stages of Stand Development
Carey and others 1999

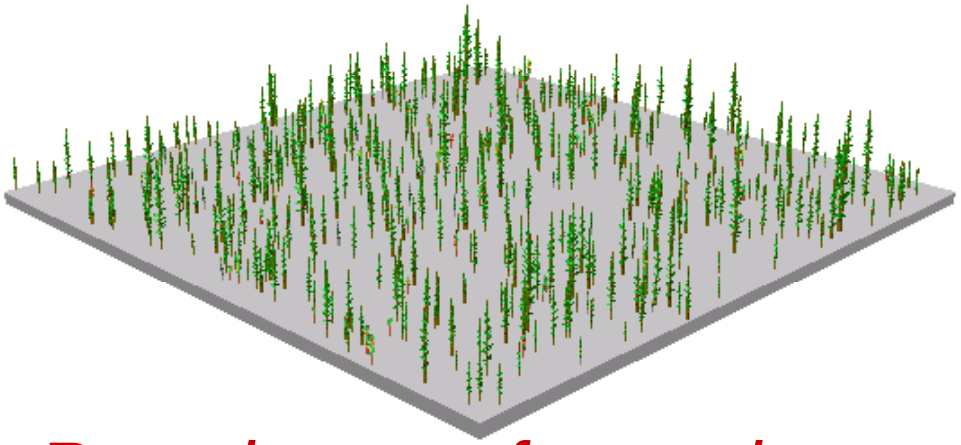
Stage of Development		**Brief Description**
Stand Initiation	SI	Open with regeneration
Exclusion Structure	ES	Canopy closure and Self-thinning
Understory Reinitiation	**UR**	**Understory plants become established**
Developed Understory	DU	Trees in understory
Biologically / Niche Diverse	BD ND	Becoming complex (CWD and snags)
Fully Functional / Old-Growth	FF OG	Complex structure attained

PLOT390 ALL SPECIES Age: 14

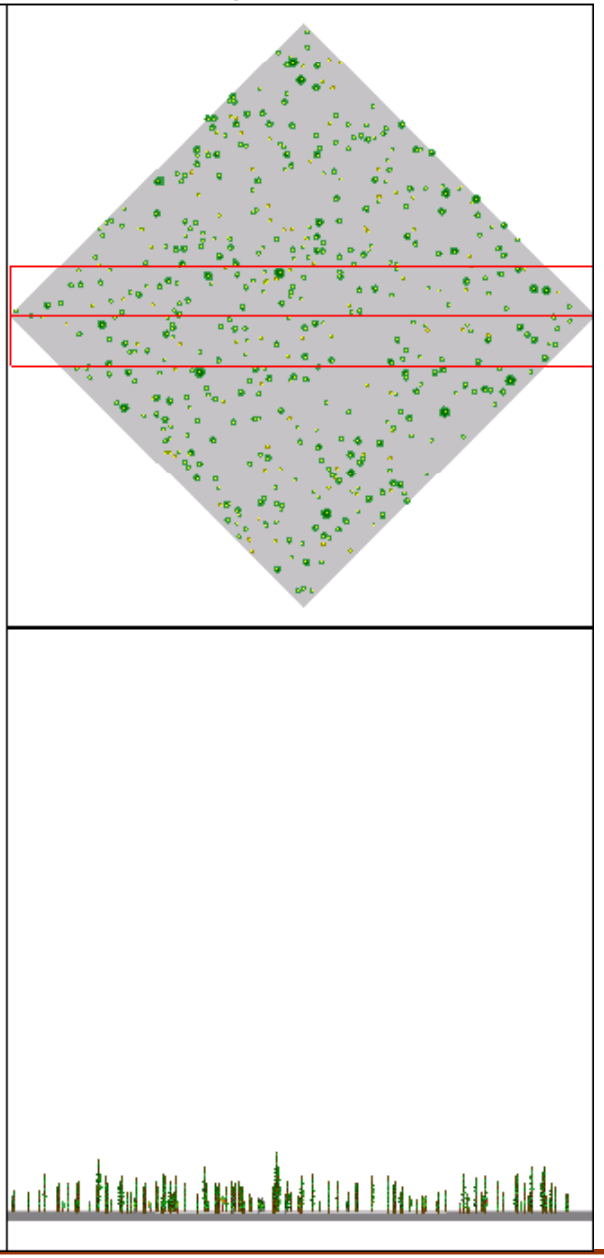
plot390

- Stand developmental stages
  - Stand initiation

    (Recruitment of new plants into newly disturbed area)



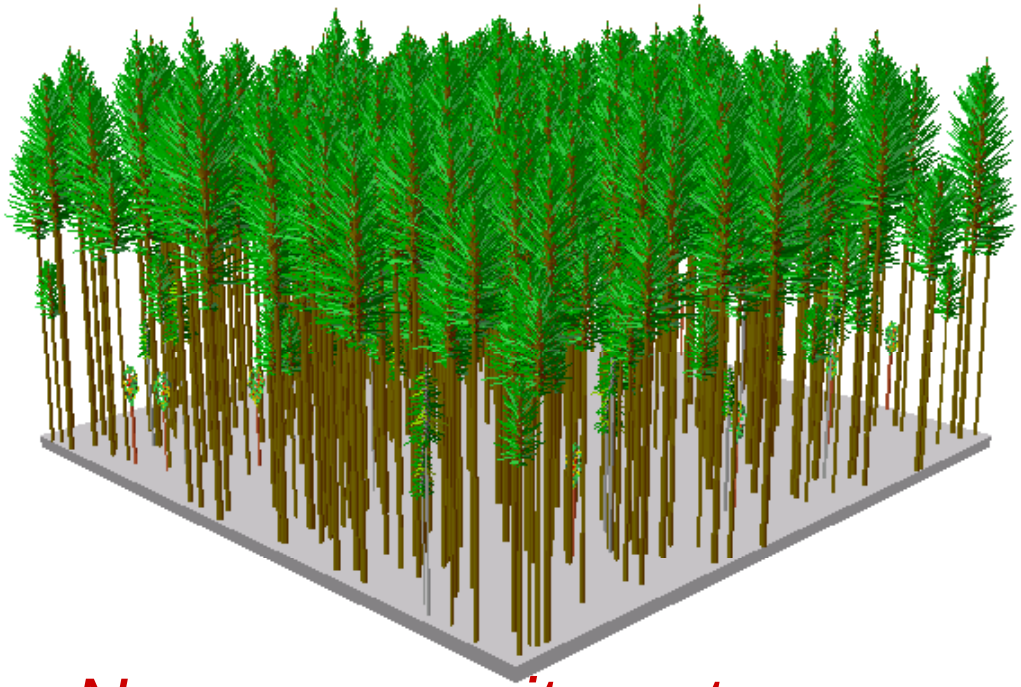
- Recruitment of new plants into freshly disturbed area

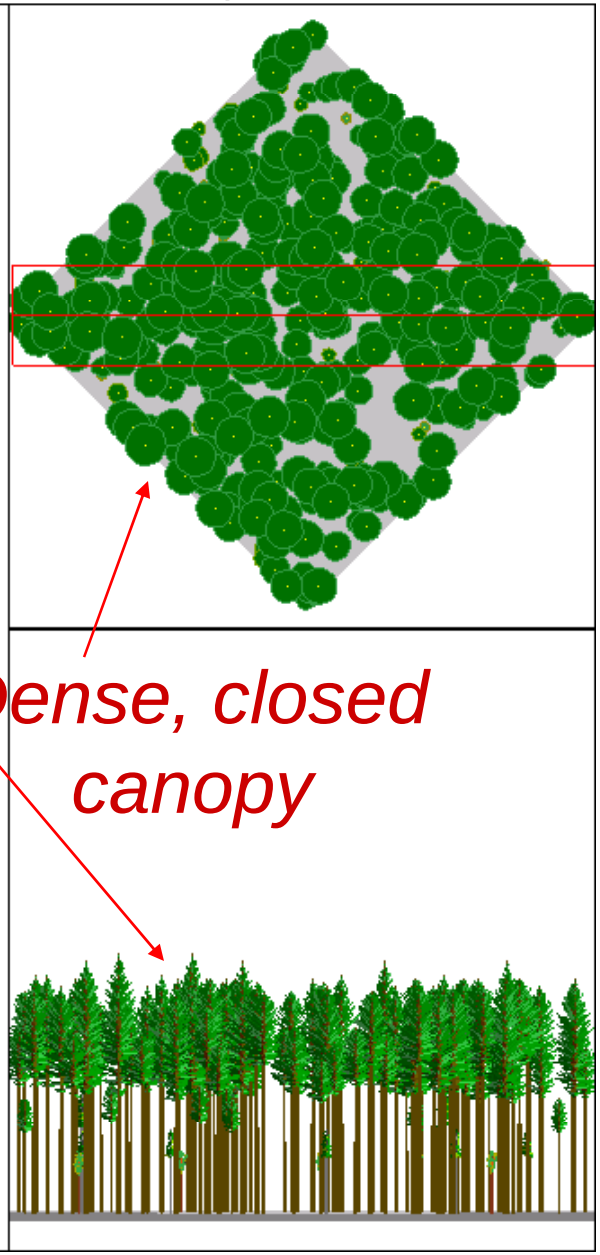


PLOT390 ALL SPECIES Age: 64

plot390b

- Stand developmental stages
  - Stem exclusion





Dense, closed canopy

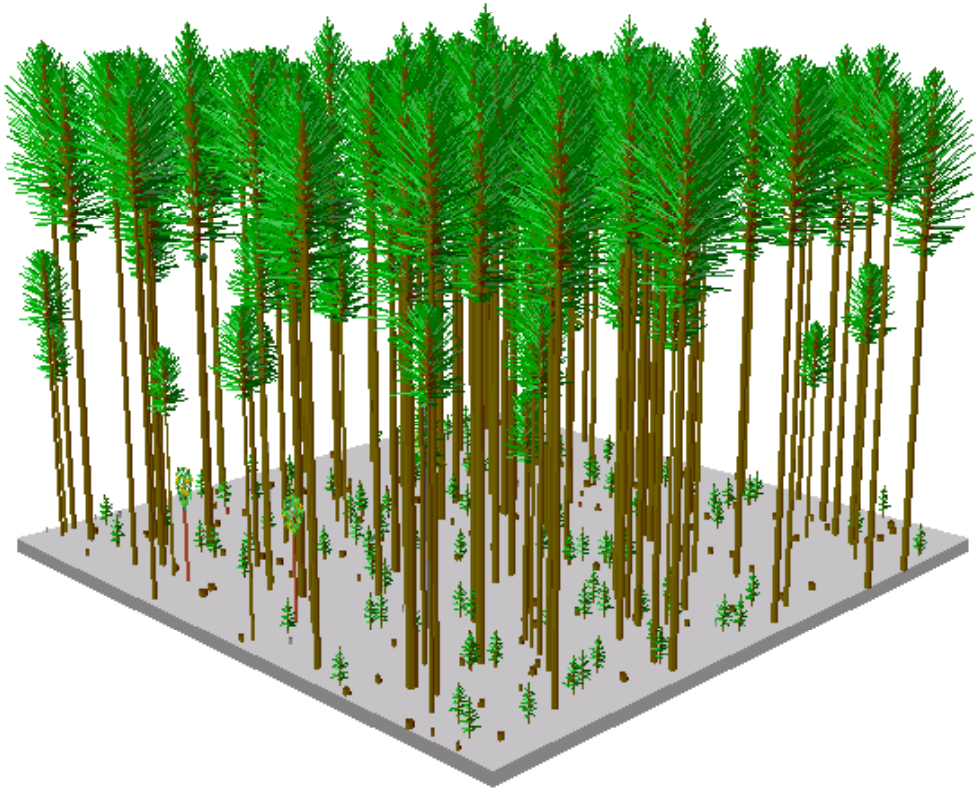
- No new recruitment

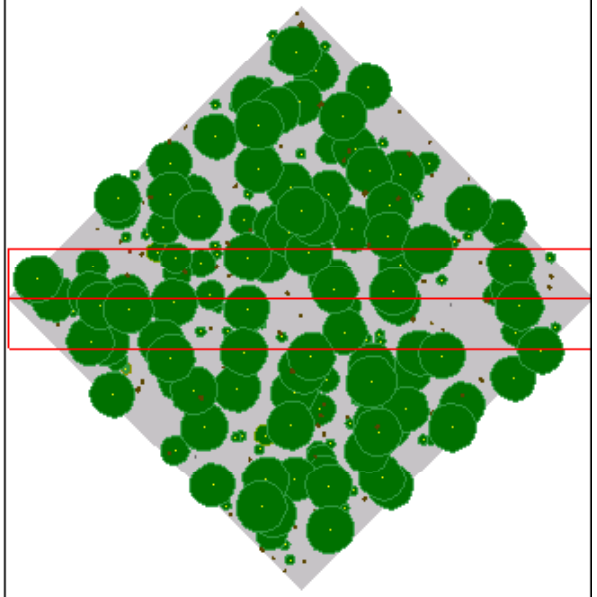
- Density induced mortality

PLOT390 ALL SPECIES Age: 89

plot390c

- Stand developmental stages
  - Understory re-initiation

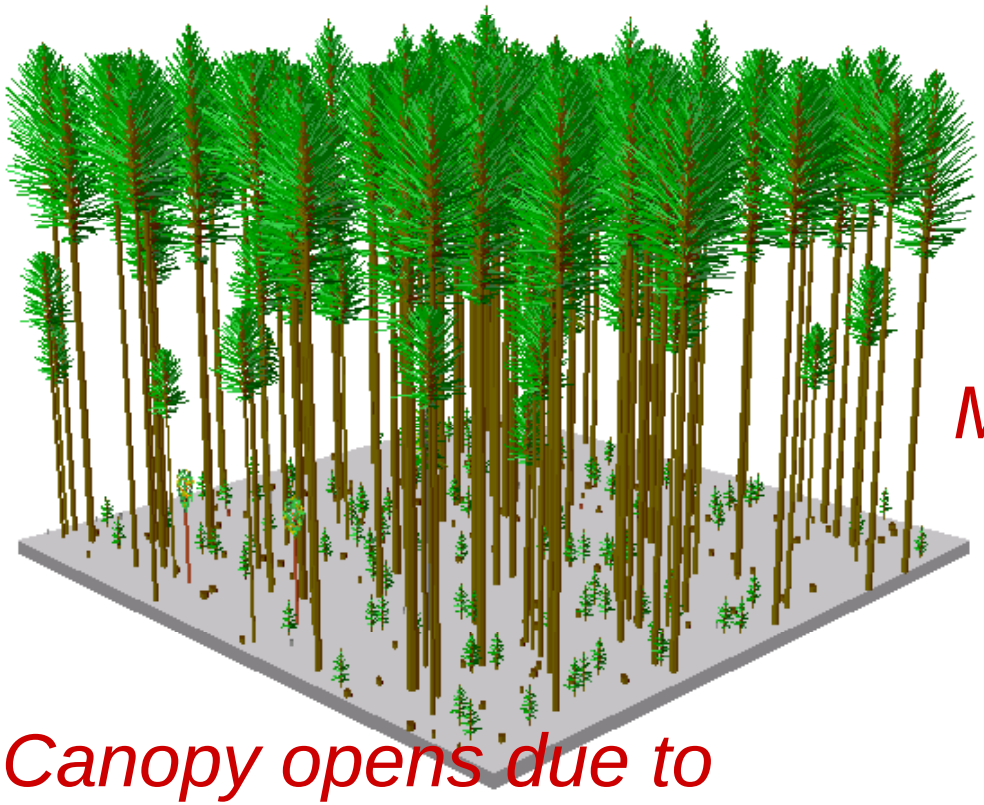


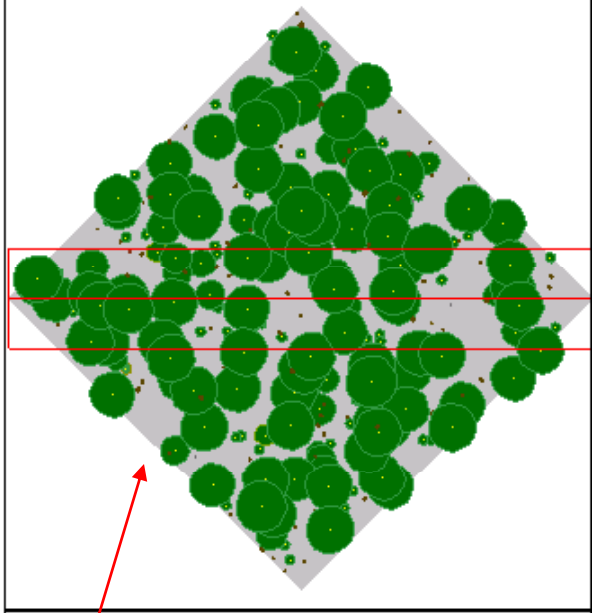


PLOT390 ALL SPECIES Age: 89

plot390c

- Stand developmental stages
  - Understory re-initiation

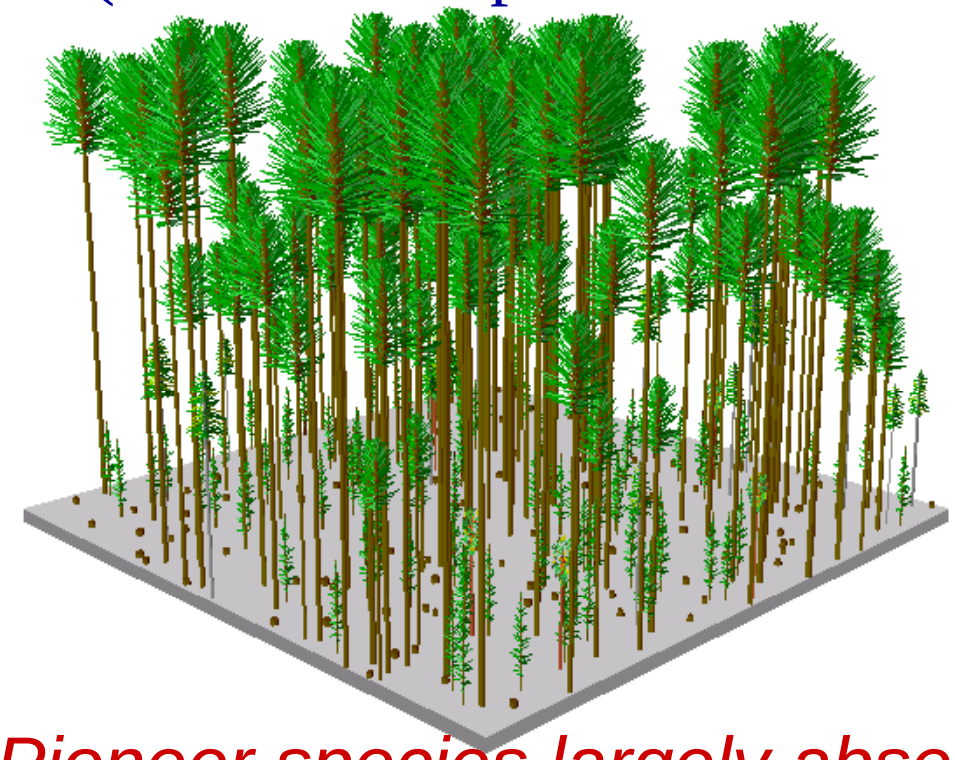




More open canopy

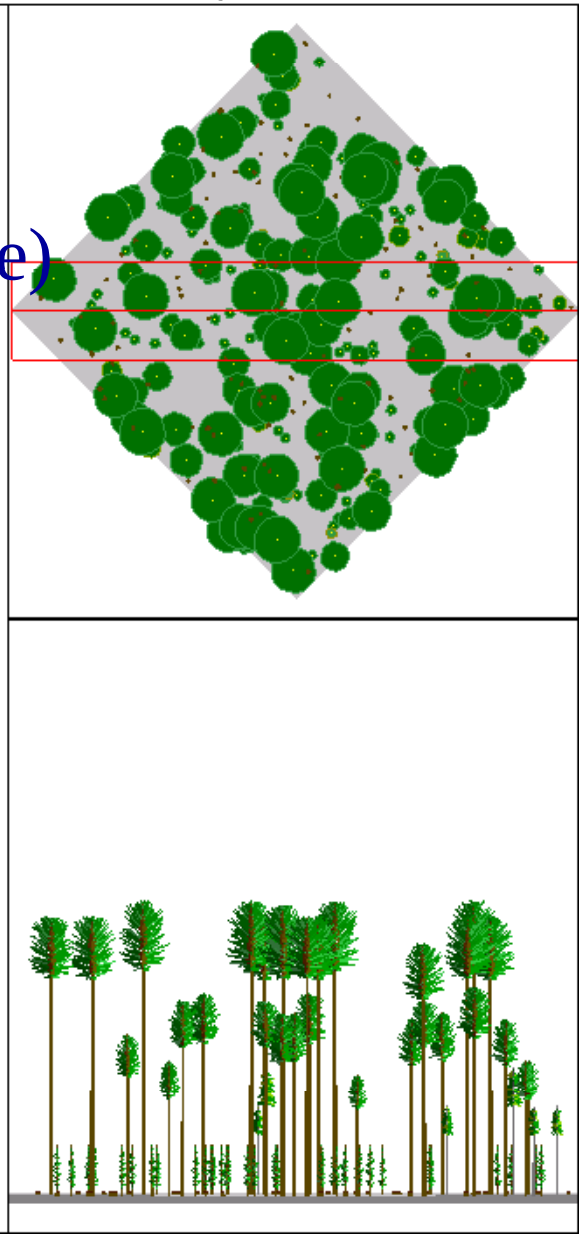
- Canopy opens due to physical abrasion and death of larger trees

- Stand developmental stages
  - Old growth
  - (stand development vs. structure)



PLOT390 ALL SPECIES Age: 89

plot390d

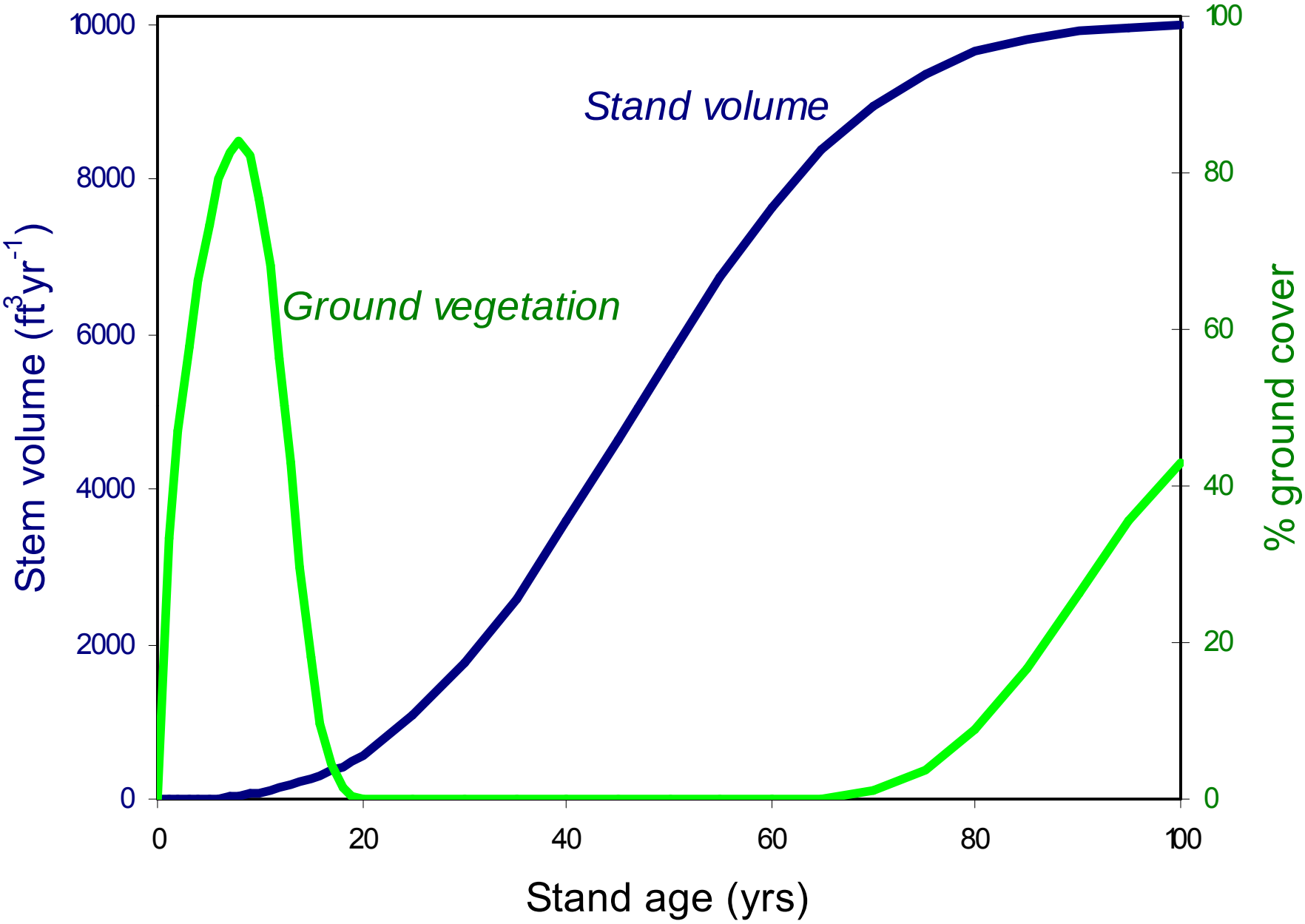


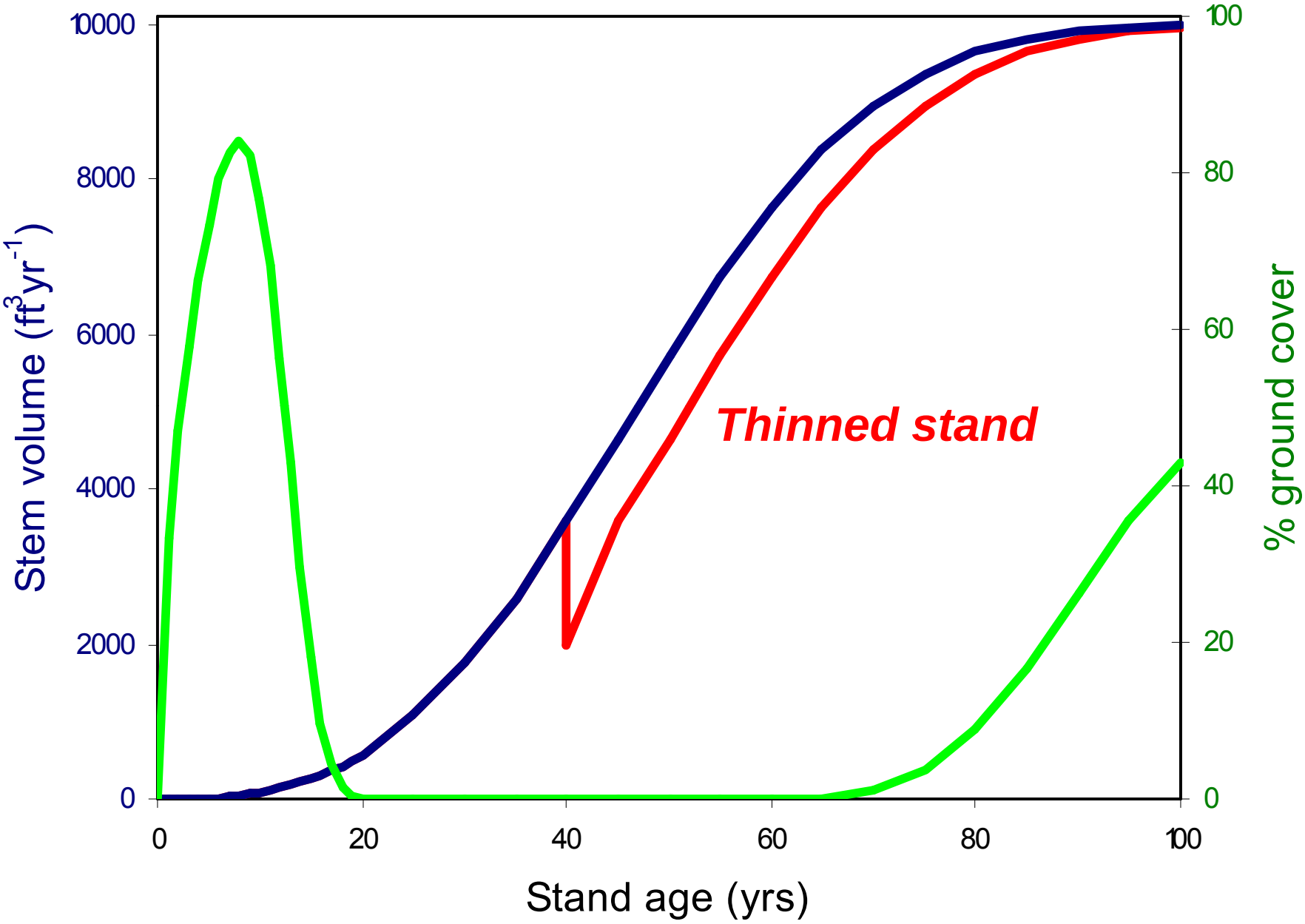
- Pioneer species largely absent

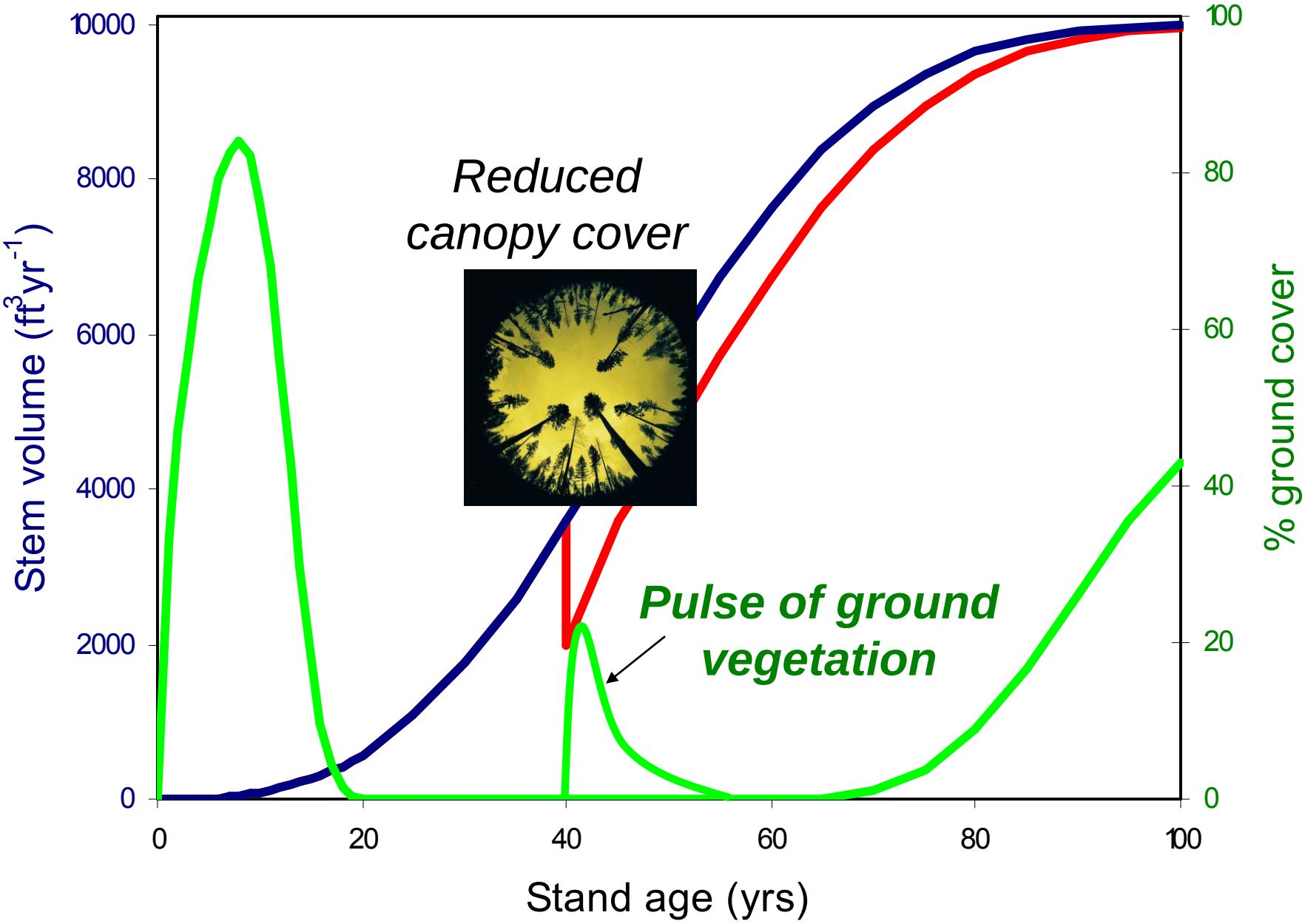
- Continuous regeneration

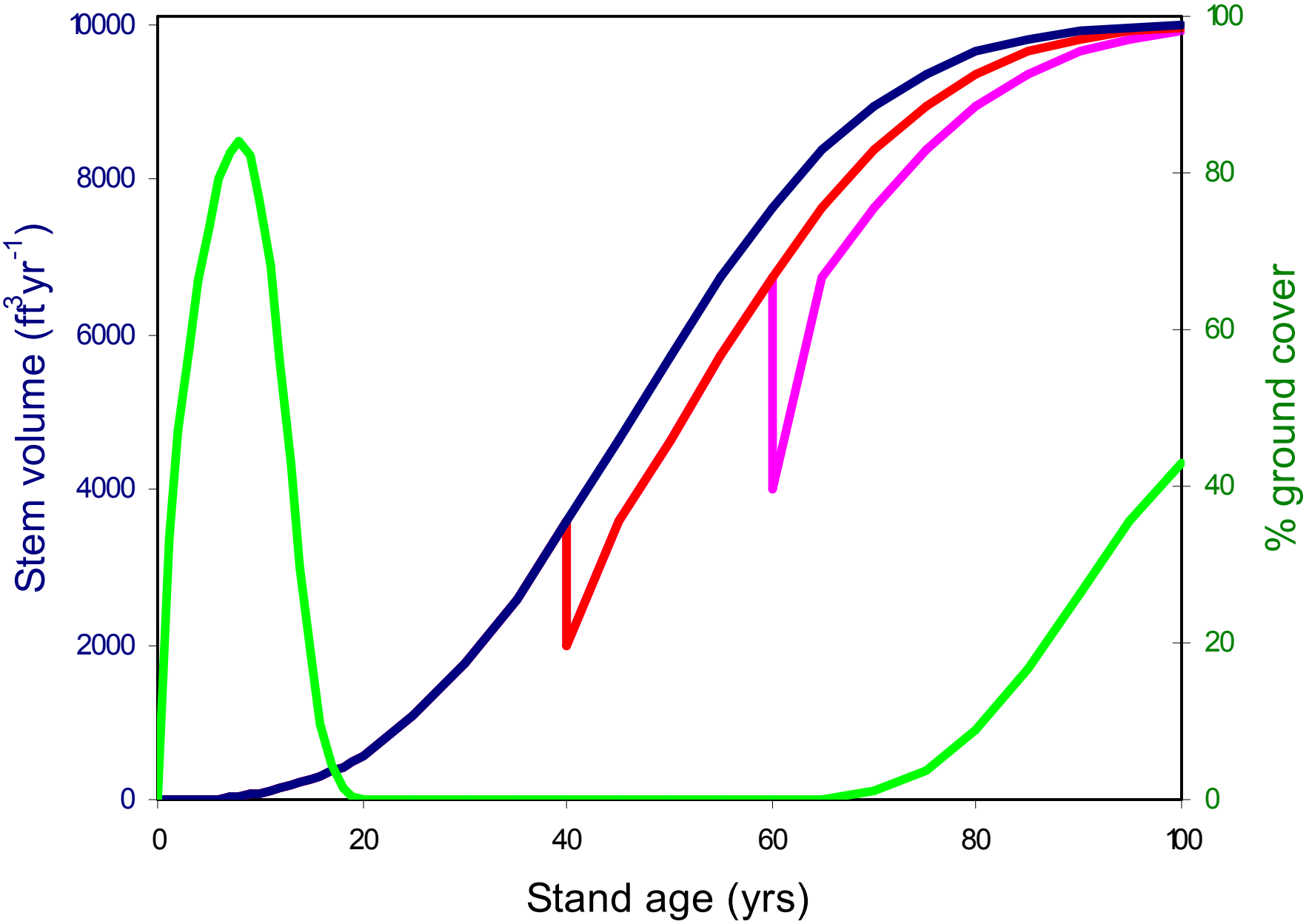
Understory Reinitiation Phase

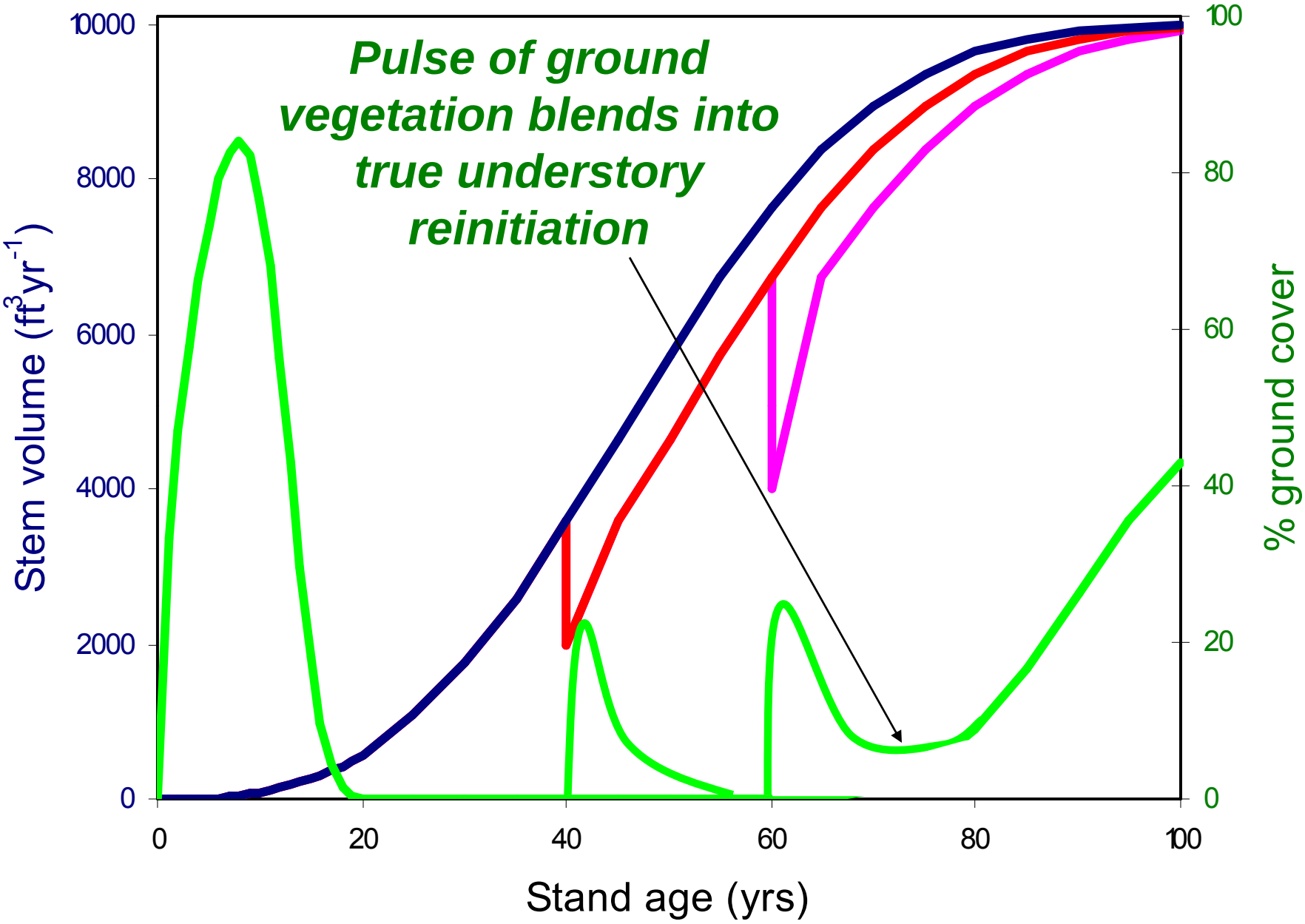
- When does this understory reinitiation phase begin?
  - 60-90 years in full stocked, unmamaged stands
  - Pulses in thinned stands

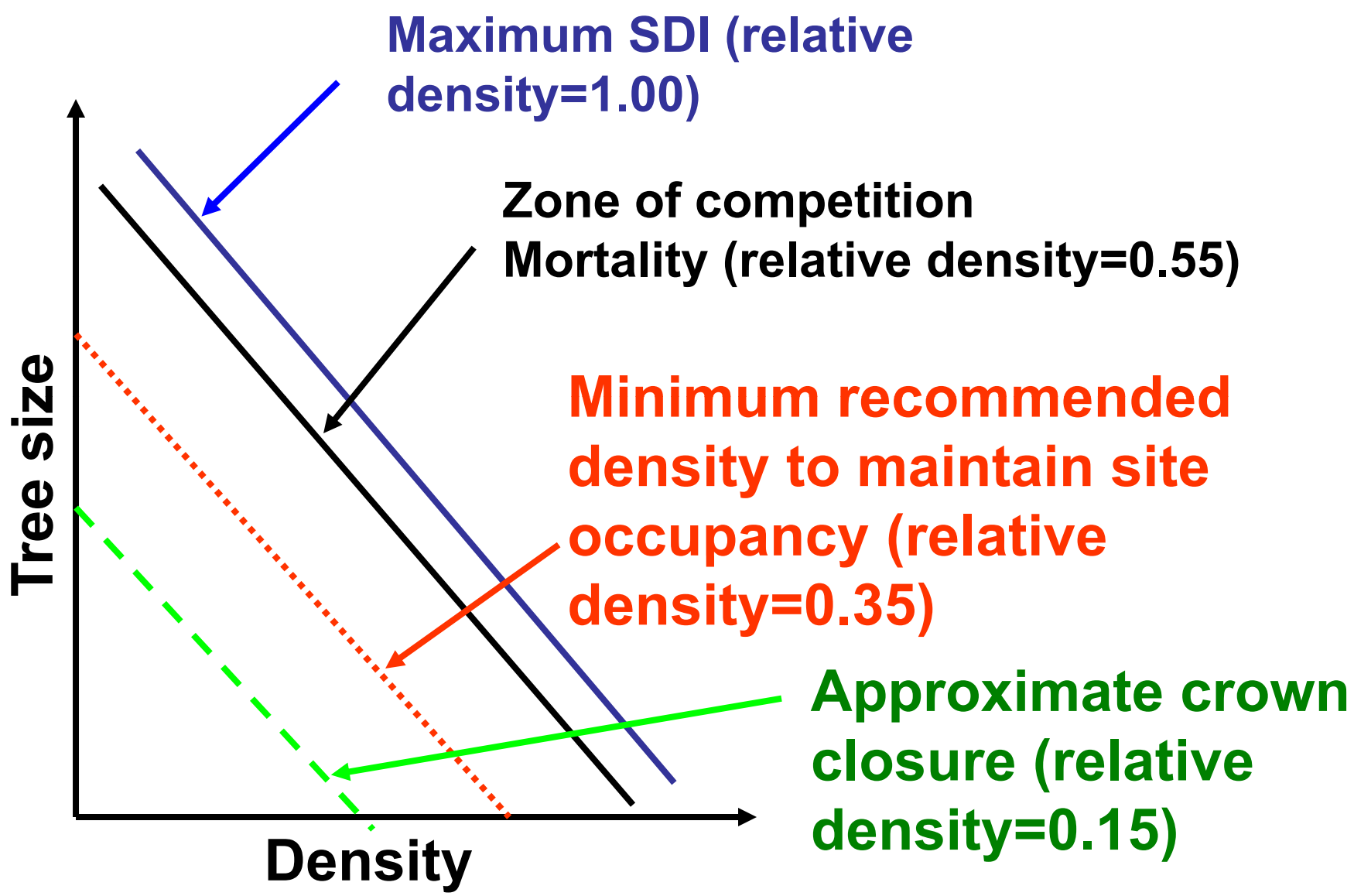

Stand volume
Ground vegetation
Stem volume (ft3yr-1)
% ground cover
Stand age (yrs)
0
2000
4000
6000
8000
10000
0
20
40
60
80
100


10000
8000
6000
4000
2000
0
Stem volume (ft3yr-1)
100
80
60
40
20
0
% ground cover
0
20
40
60
80
100
Stand age (yrs)
Thinned stand


Reduced
canopy cover
Pulse of ground
vegetation
Stem volume (ft3yr-1)
% ground cover
Stand age (yrs)
0
2000
4000
6000
8000
10000
0
20
40
60
80
100


10000
8000
6000
4000
2000
0
Stem volume (ft3yr-1)
100
80
60
40
20
0
% ground cover
0
20
40
60
80
100
Stand age (yrs)


Pulse of ground vegetation blends into true understory reinitiation
Stem volume (ft3yr-1)
% ground cover
Stand age (yrs)
0
2000
4000
6000
8000
10000
0
20
40
60
80
100
0
20
40
60
80
100


Maximum SDI (relative density=1.00)
Zone of competition Mortality (relative density=0.55)
Minimum recommended density to maintain site occupancy (relative density=0.35)
Approximate crown closure (relative density=0.15)
Tree size
Density

Shawnigan Lake, BC
Unthinned plot
2006 (~ total 58 years)
low site quality

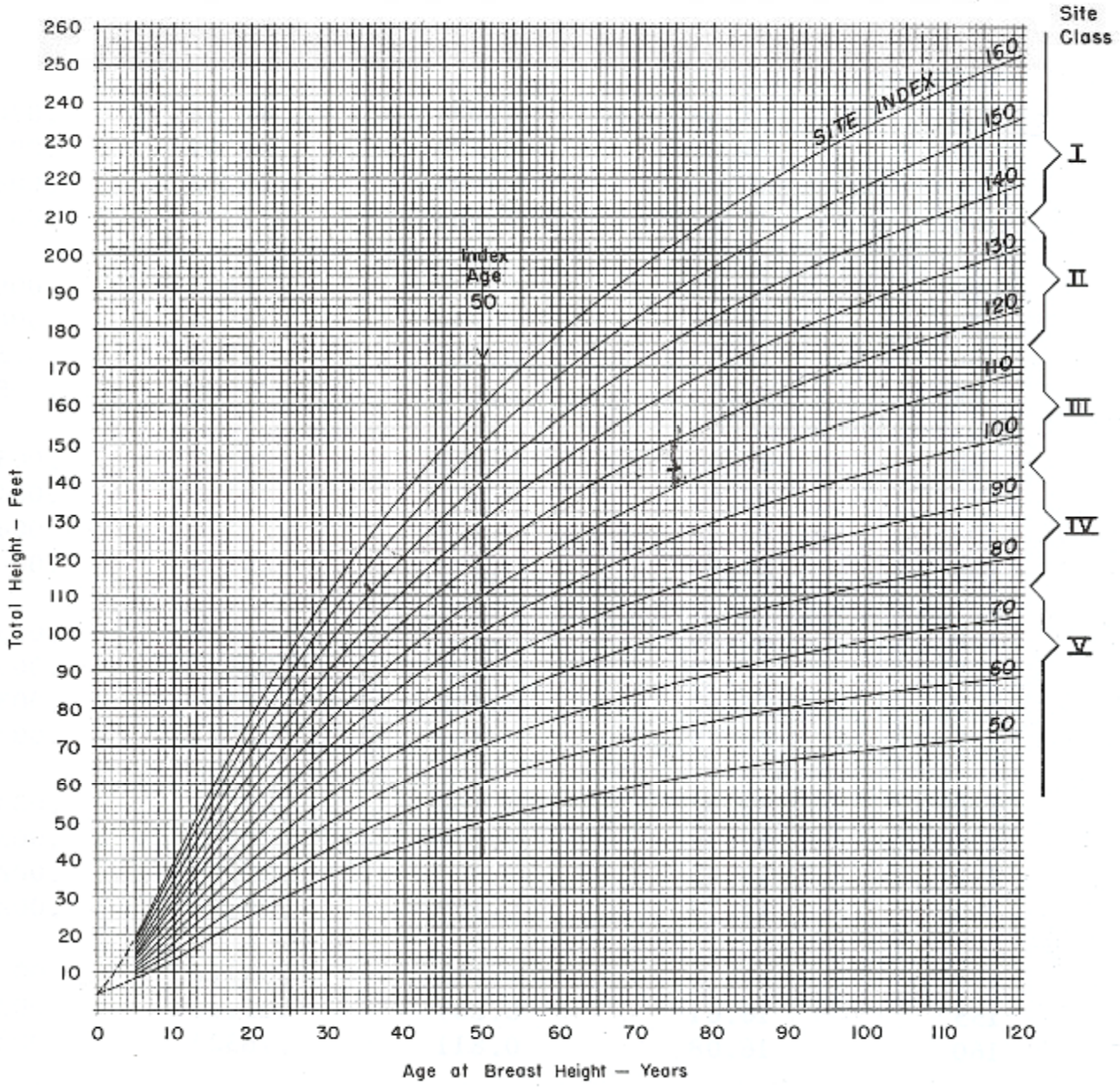
Shawnigan Lake, BC
Unthinned but fertilized
2006 (~ total 58 years)
low site quality

Shawnigan Lake, BC
Thinned plot
2006 (~ total 58 years)
low site quality

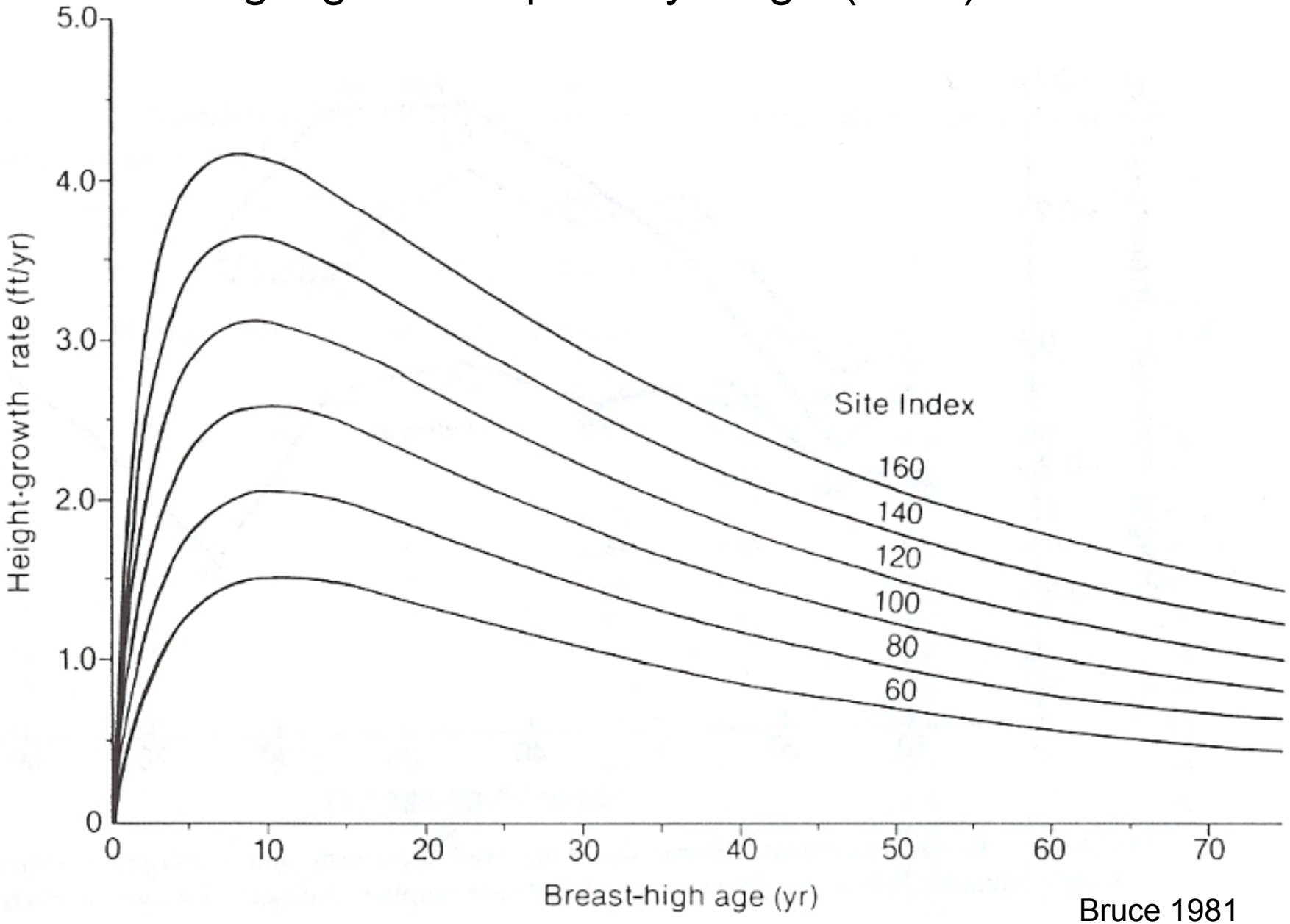
Unthinned

General Characteristics of Understory Reinitiation Phase

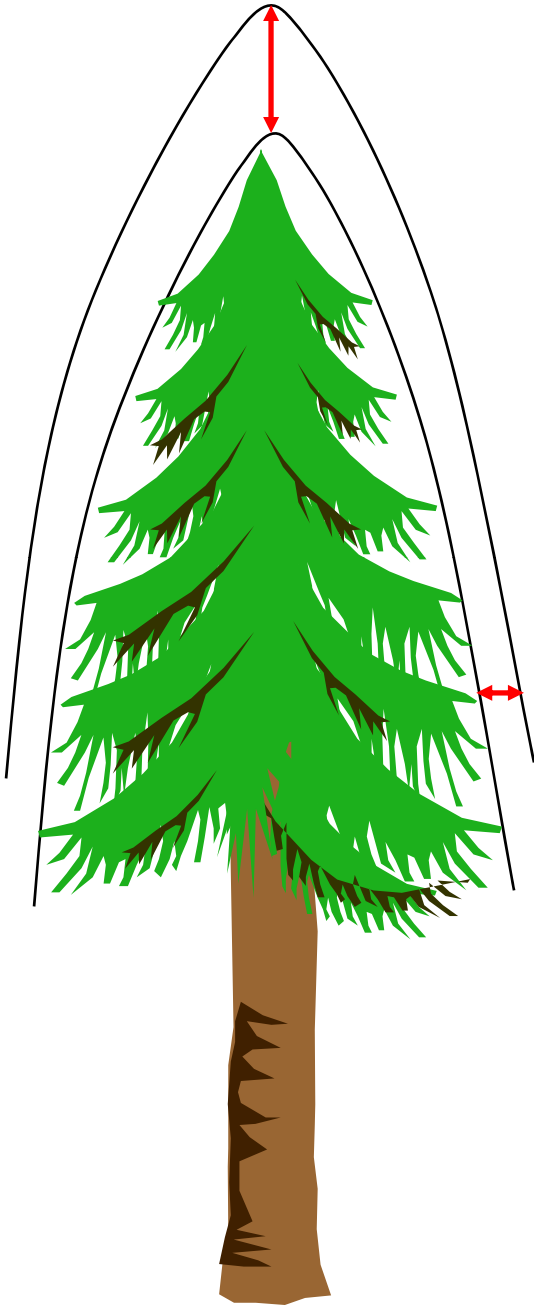
- Death of increasingly larger trees
  - competition (less density dependent?)
  - wind
  - root rot
- Larger canopy holes when trees die (larger crowns)
- More wind sway in taller trees leads to abrasion and crown separation
- Increased light and precipitation throughfall to the forest floor (increased mineralization)
- Establishment of understory plants (trees?)


Site Class
SITE INDEX
160
150
140
130
120
110
100
90
80
70
60
50
I
II
III
IV
V
Index Age 50
Total Height – Feet
Age at Breast Height — Years
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
120

Height growth implied by King's (1966) site curves

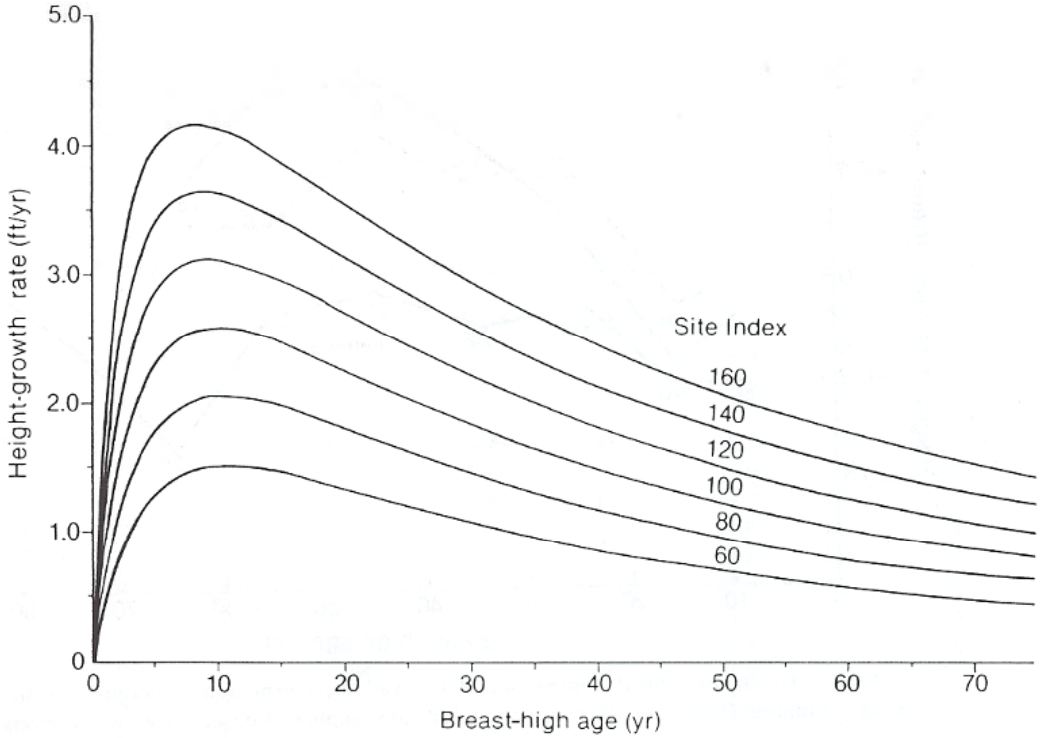


Bruce 1981



Crown radial growth is proportional to height growth

Lower height growth potential → Lower potential for radial expansion of crown



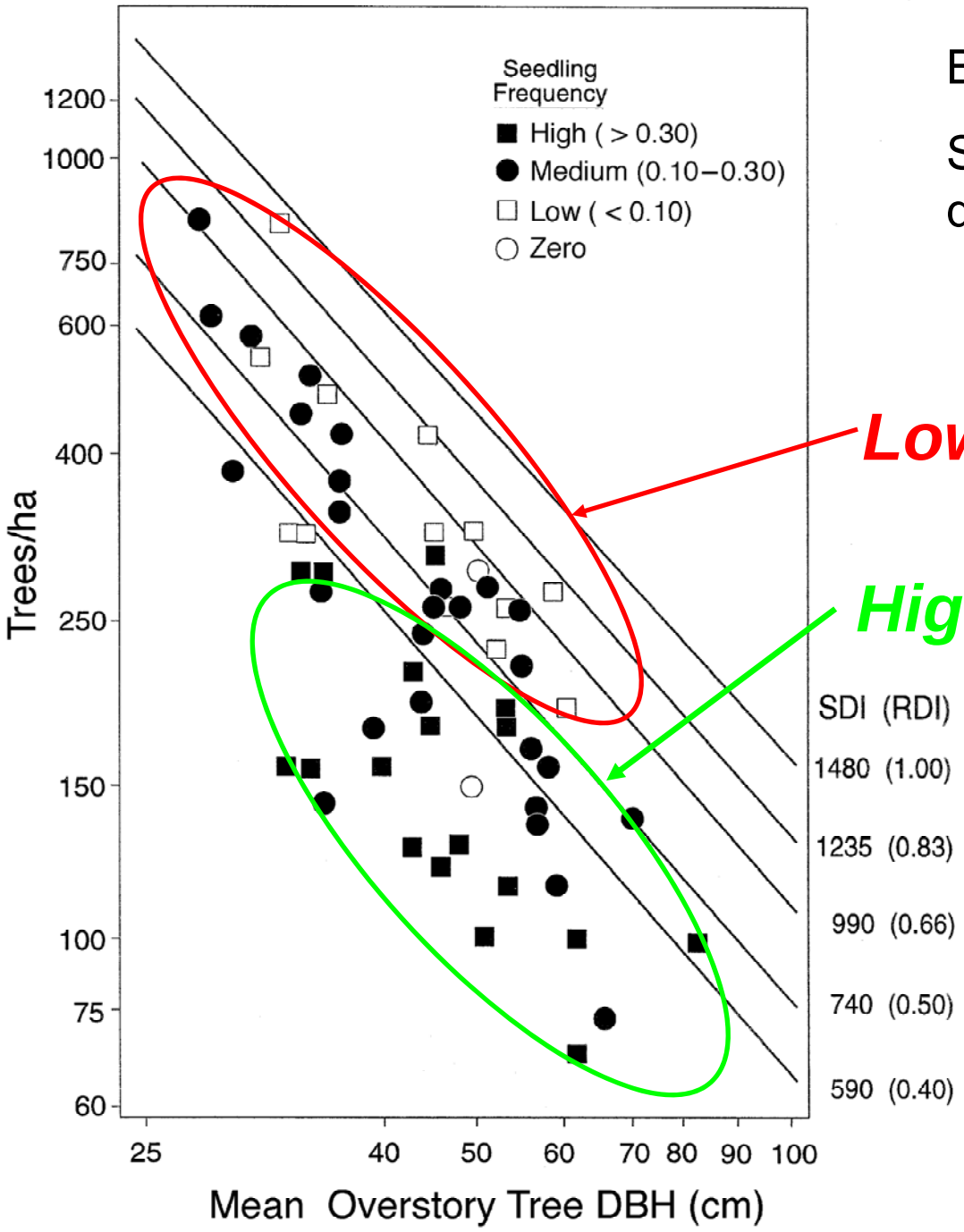
Understory Reinitiation

- Characteristics of understory reinitiation stage
- **Understory response**
  - Herbs and shrubs
  - Tree regeneration
    - Advanced regeneration
    - Planted seedlings
    - New germinants
- Growth response of residual trees
- Summary

Western Oregon Stands 50- to 120-years-old

(Bailey and Tappeiner 1998)

	Average Seedlings/ha
Young Unthinned (n=32)	233
Young Thinned (n=32)	1433
Old-growth (n=20)	1010

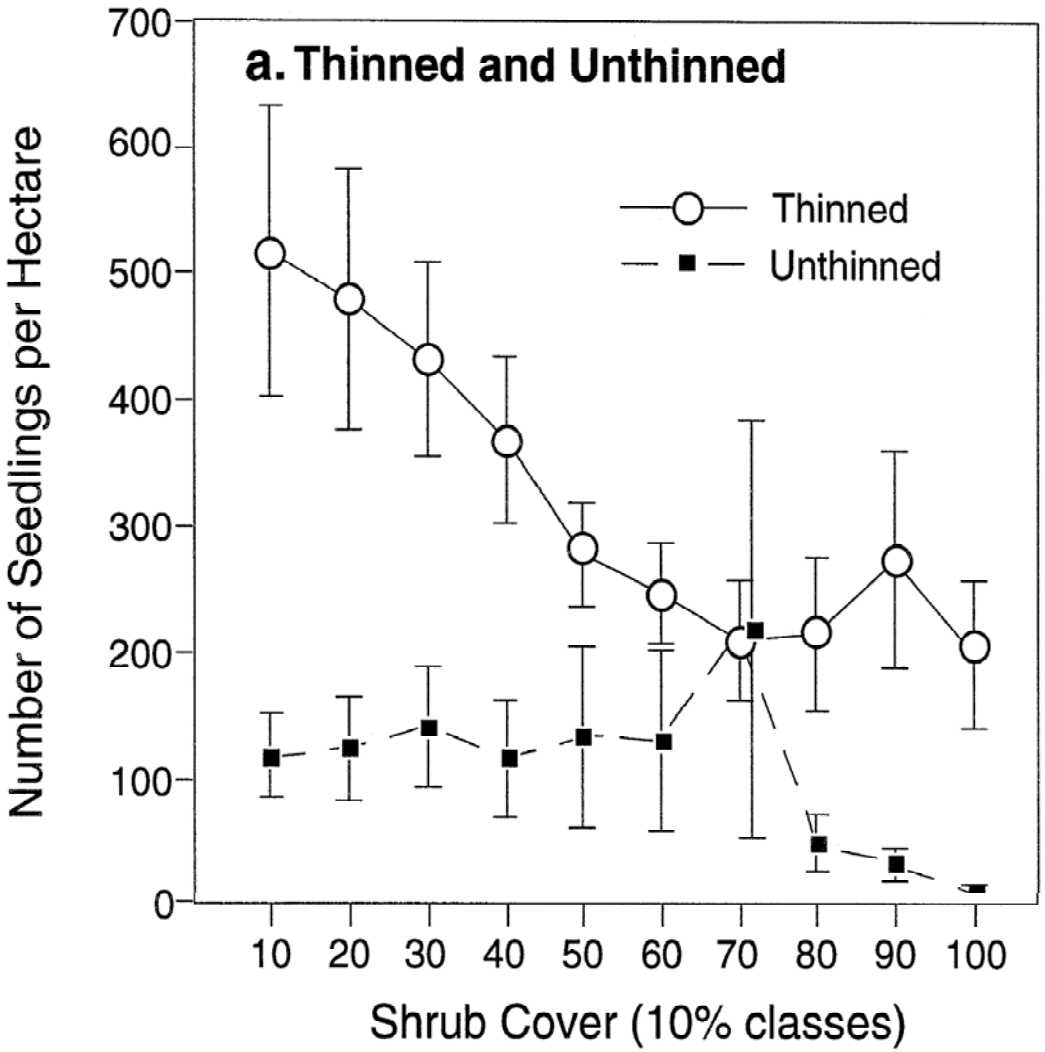


Bailey and Tappeiner 1998

Stand density management diagram

Low seedling frequency

High seedling frequency



Bailey and Tappeiner 1998

Interaction of stand density and shrub cover

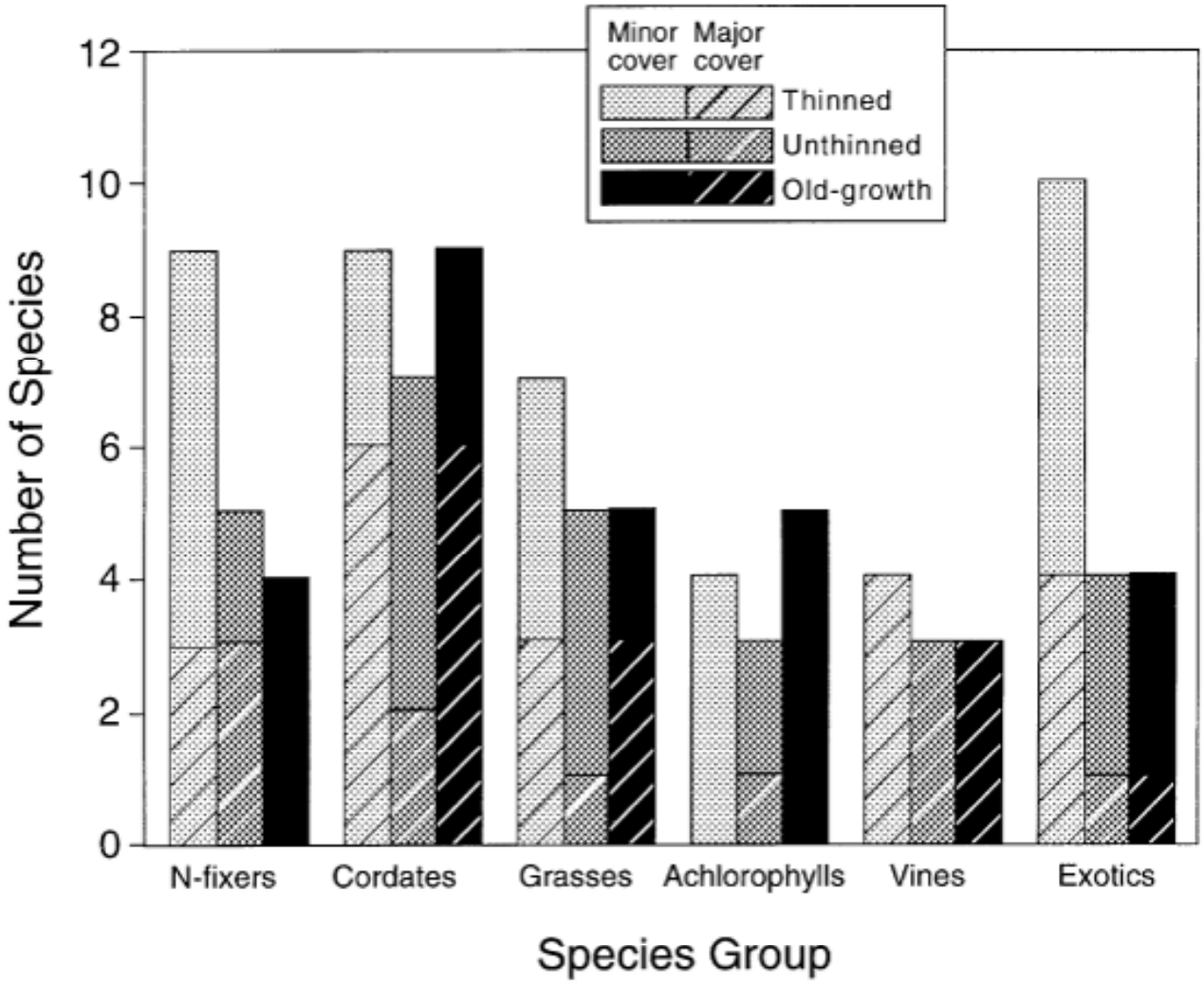


Fig. 3. Species richness (number of species) by stand-type for the six species groups. Major cover corresponds to individual species cover that averaged $\geq 1\%$ across 10 1 m^2 subsamples at any point in any stand; minor cover was <1%.

Bailey et al. 1998

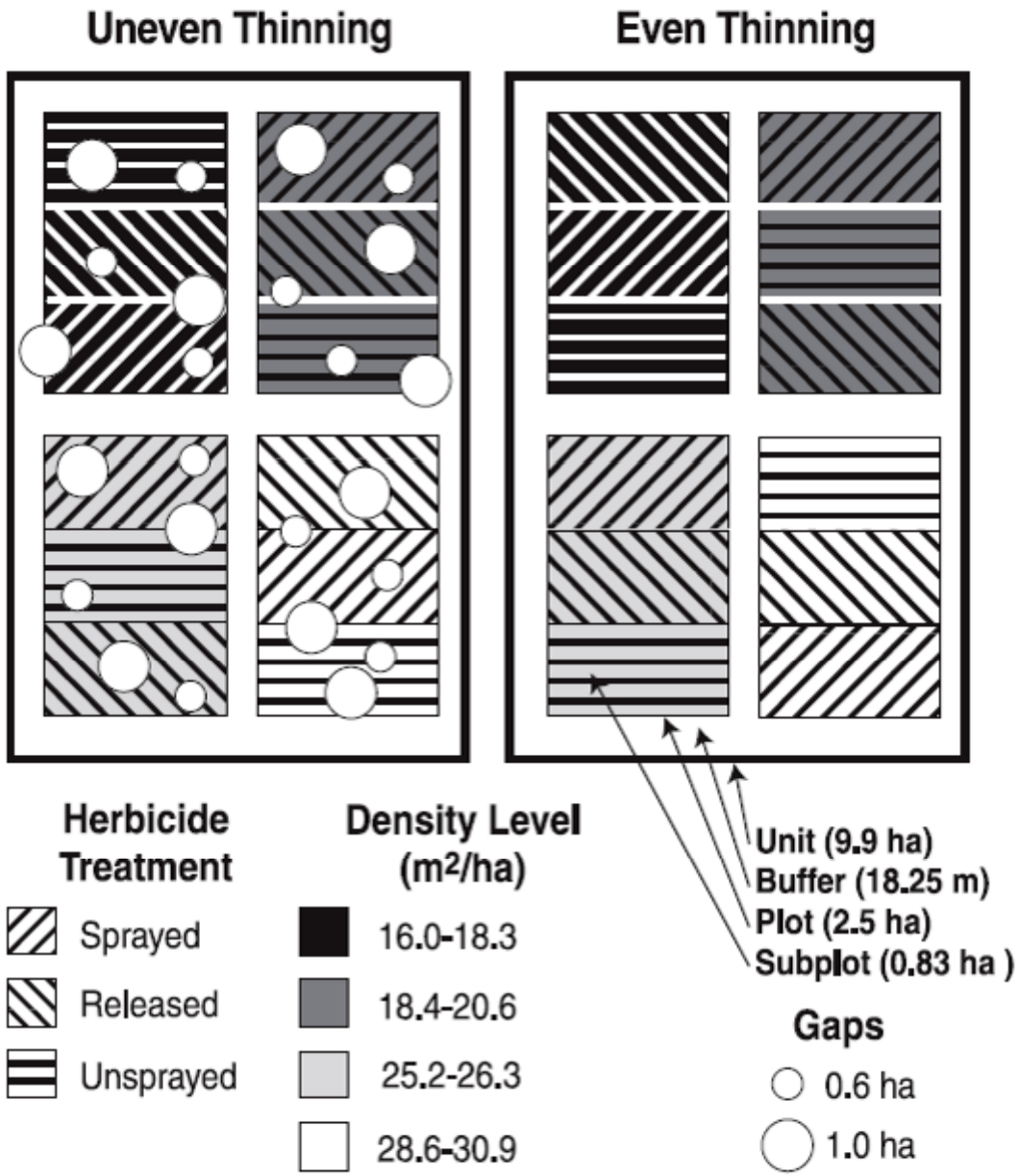
Brandeis et al. 2001

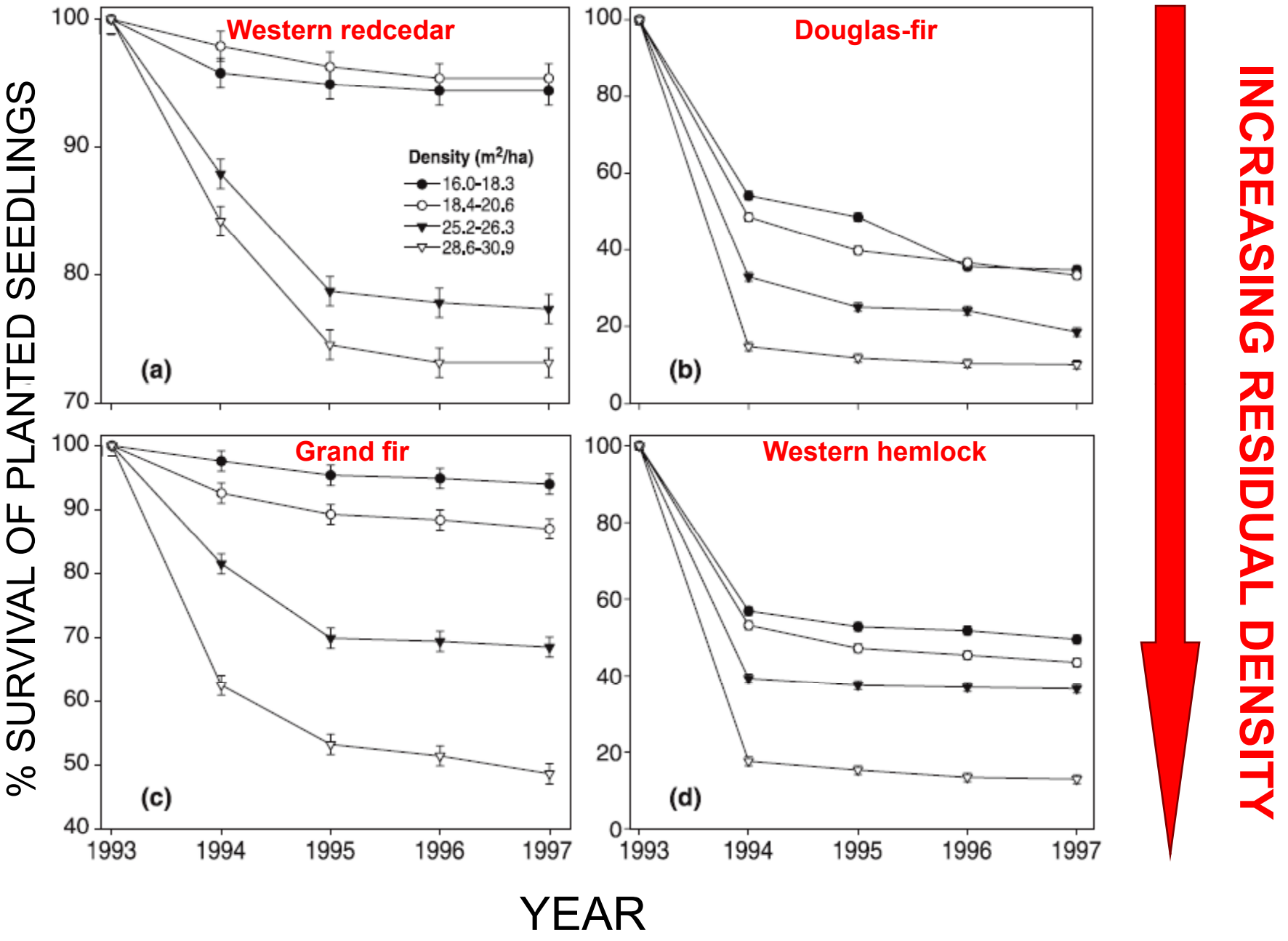
Thinning study on McDonald Forest, OSU:

Four residual densities

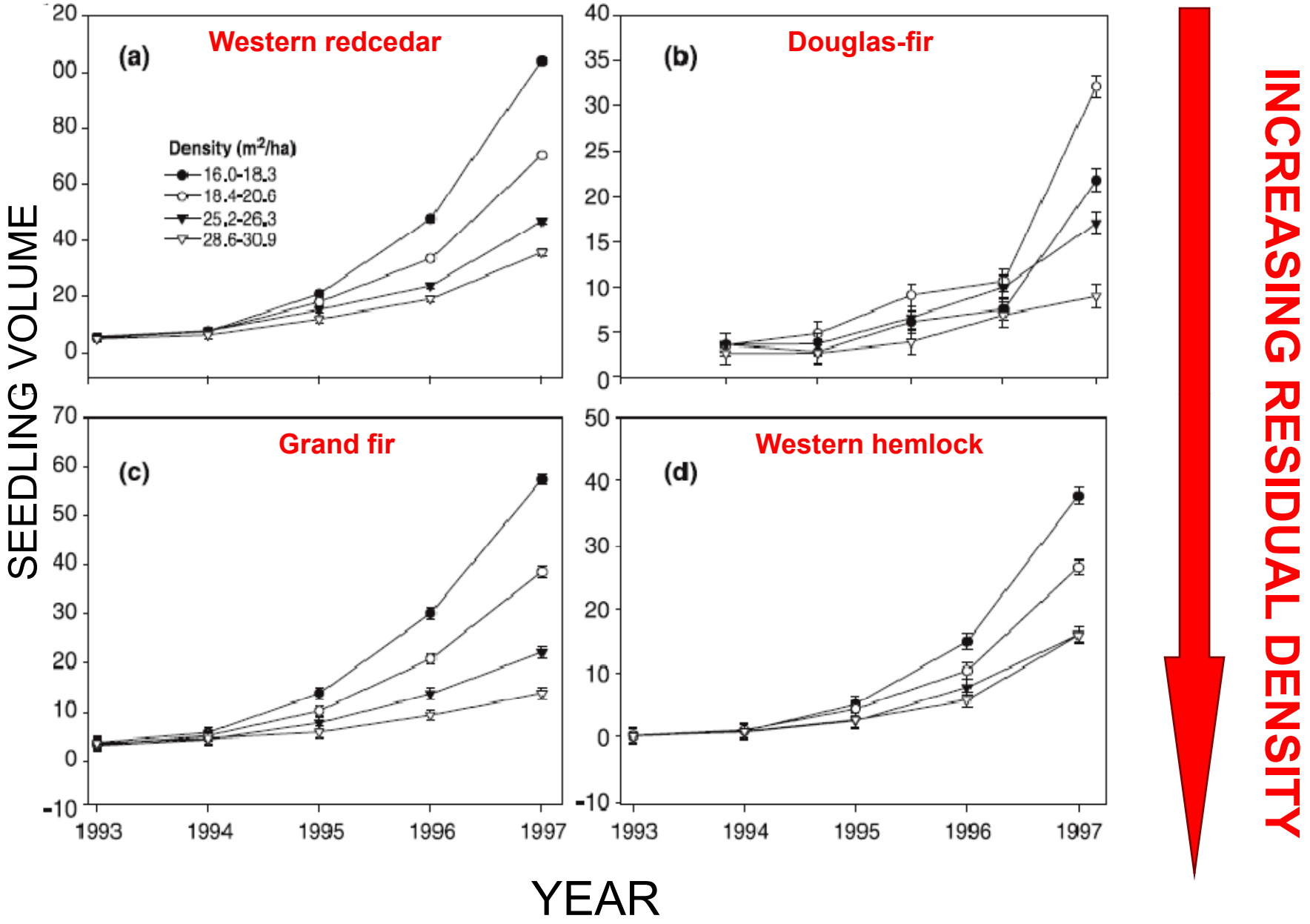
Two thinning patterns

Three competing vegetation treatments





Brandeis et al. 2001



Brandeis et al. 2001

Competing vegetation treated

No competing vegetation control

Hoskins levels-of-growing-stock study in Douglas-fir

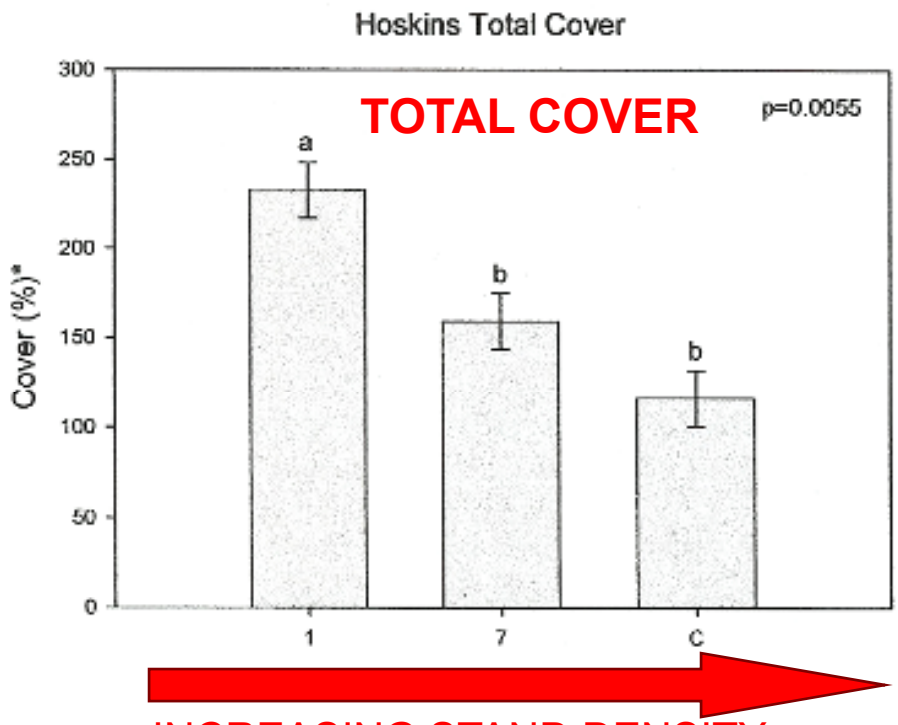
- 20 yrs old in 1963

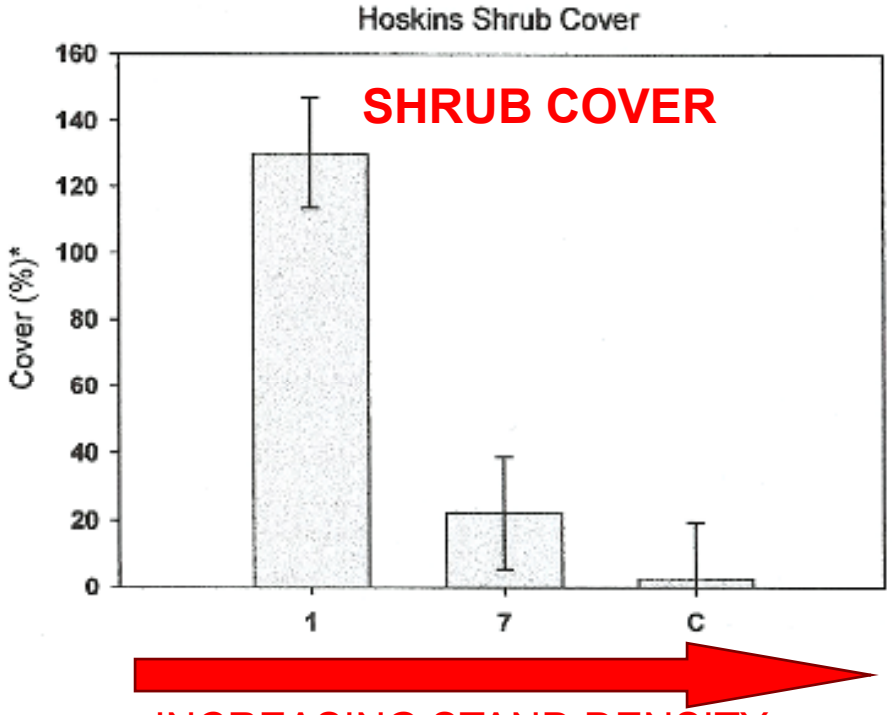
- Thinned 1966, 1970 1973, 1975, 1979, 1983

- Vegetation survey in 1997 (age 54 yrs) : 38 yrs since first thinning, 21 yrs since last thinning

Hoskins LOGS Control Plot
1995 about 50 years old
1993: 377 tpa (from 1718)
297.5 ft^2/ac
85.5 RD

Hoskins LOGS Heavy Thin (T-1) Plot
1995 about 50 years old
1993: 52 tpa
136.4 ft^2/ac
29.0 RD





INCREASING STAND DENSITY

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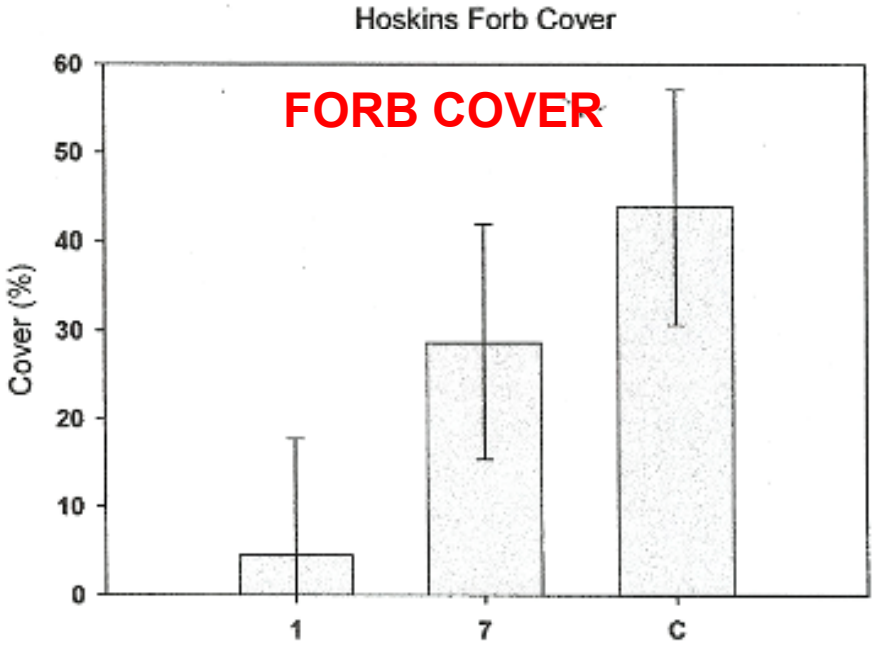
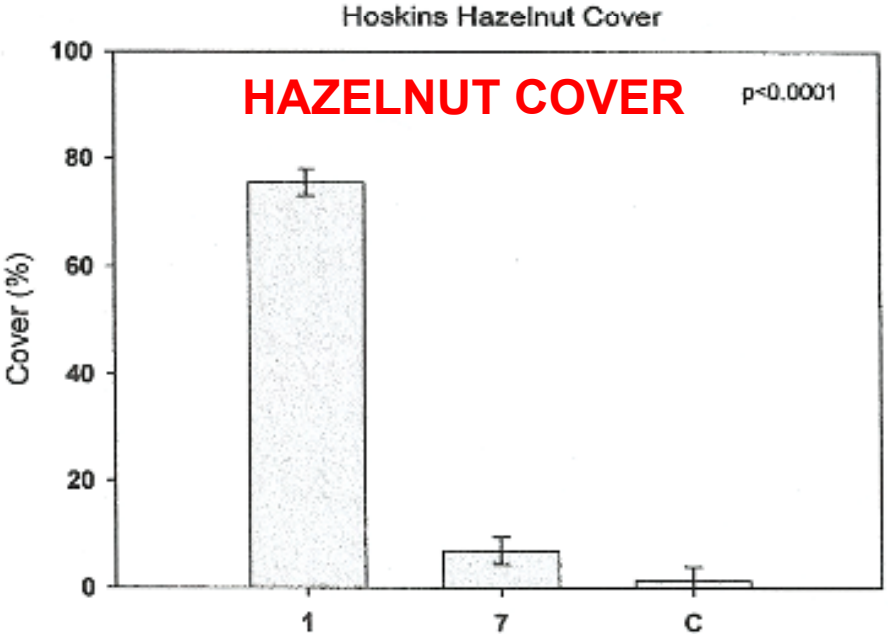
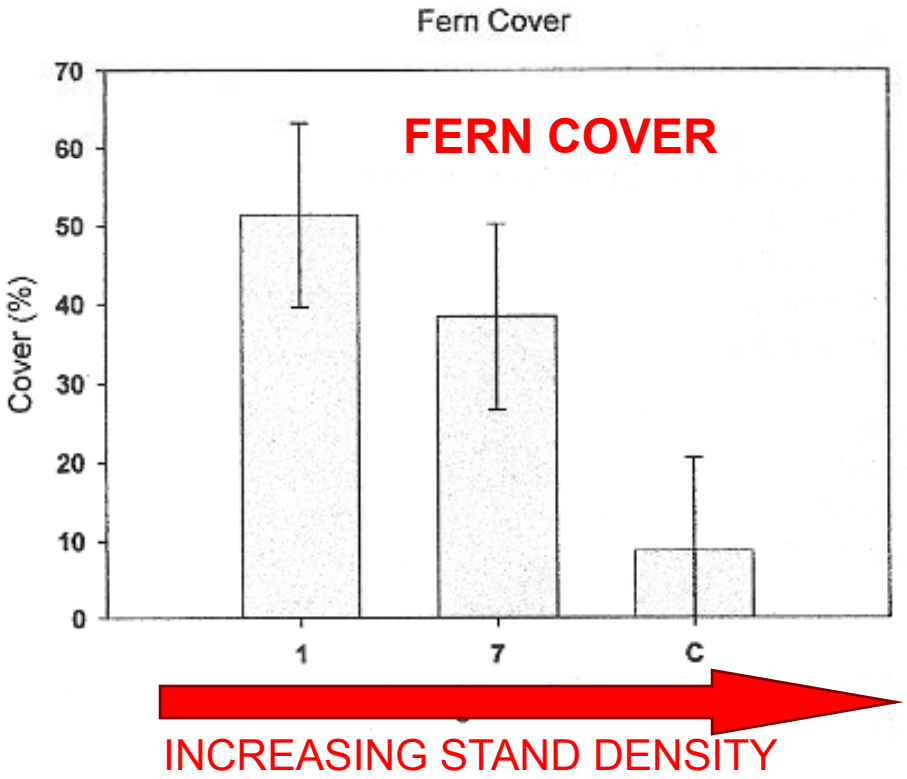
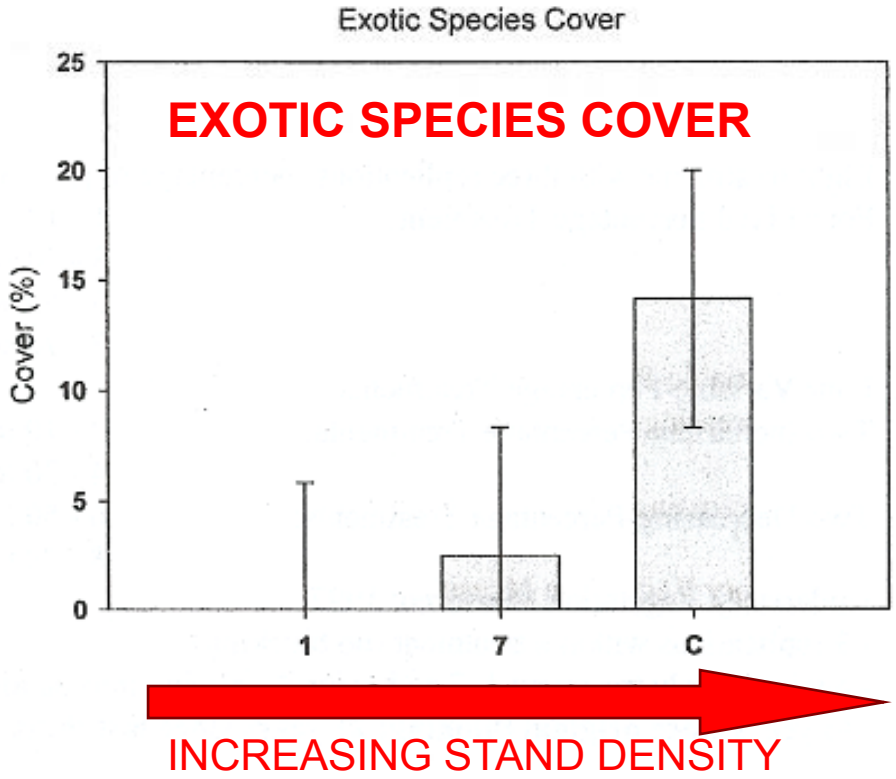





Fern Cover
FERN COVER
Cover (%)
70
60
50
40
30
20
10
0
1
7
C
INCREASING STAND DENSITY


Exotic Species Cover
EXOTIC SPECIES COVER
Cover (%)
25
20
15
10
5
0
1
7
C
INCREASING STAND DENSITY

Green-tree Retention Under the Northwest Forest Plan

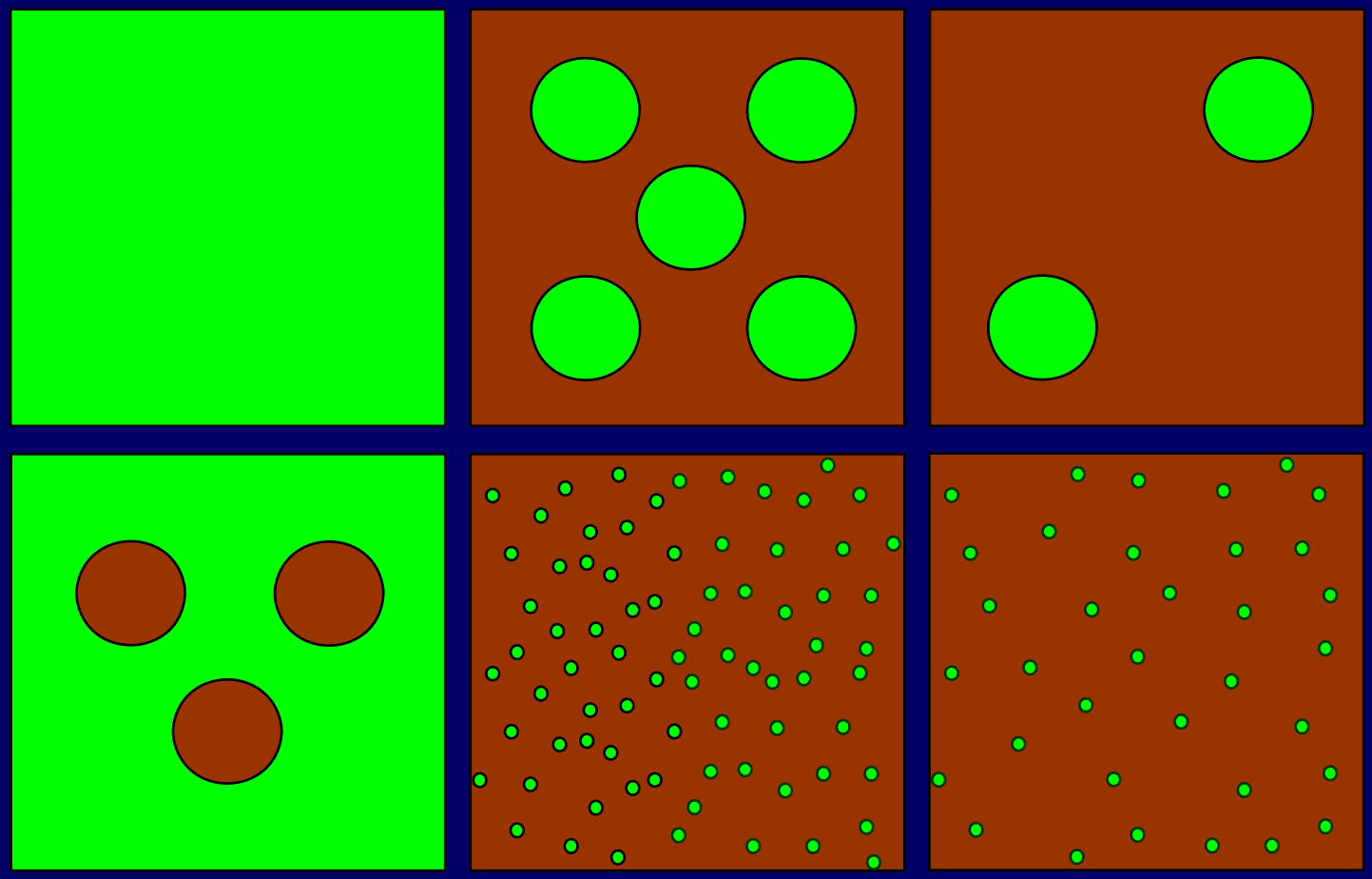
- 15% of each harvest unit
  - 70% intact patches (aggregates) 0.2-1.0 ha
  - 30% dispersed trees / small clumps
- Largest, oldest decadent trees & snags
- Retained indefinitely
- Ecological value largely untested – professional judgments
- Uncertain impacts on growth and yield

DEMO
Demonstration of Ecosystem Management Options

- First large-scale, replicated experiment to study the effects of variable-retention harvests in mature Douglas-fir forests.
- Research questions in DEMO:
  - How does the level of green-tree retention affect ecological attributes, microclimate, growth and yield, and public perceptions of visual quality?
  - At a given level of retention, do effects vary with the pattern of residual trees?
  - How do responses vary over time?

Six treatments

defined by level and pattern of basal area retention



Relevance of DEMO to thinning at Understory Reinitiation?

- Most of the stands were in Understory reinitiation phase at time of treatment
- Dispersed treatments focus on generating and sustaining more complex structures (two stories)
- Complexity in stand structure is often the major objective for thinning during the Understory Reinitiation phase

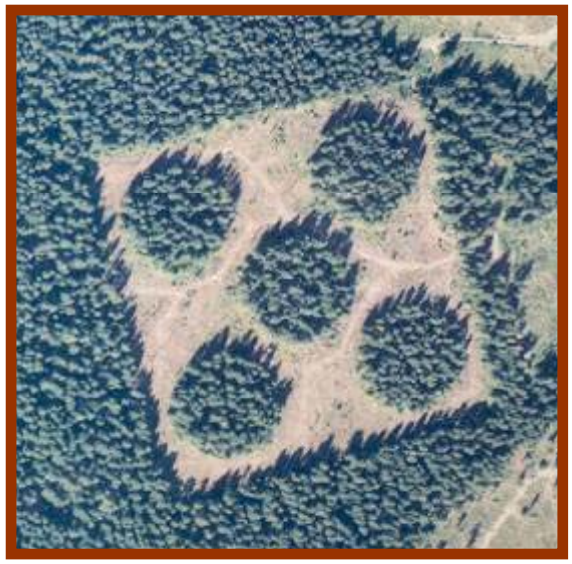
100%

40%D

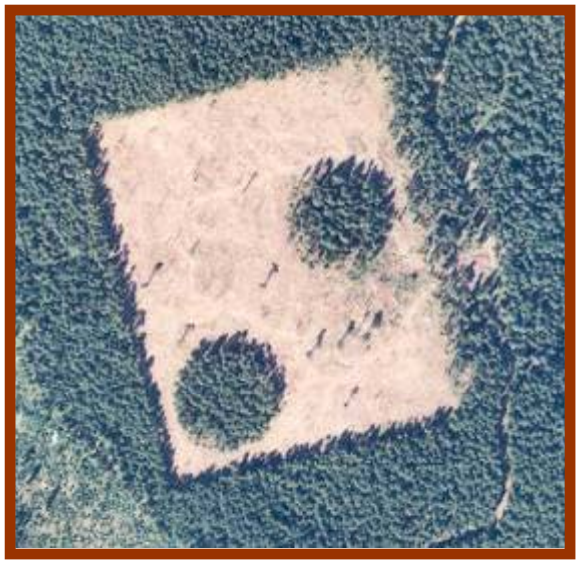
15%D

75%A

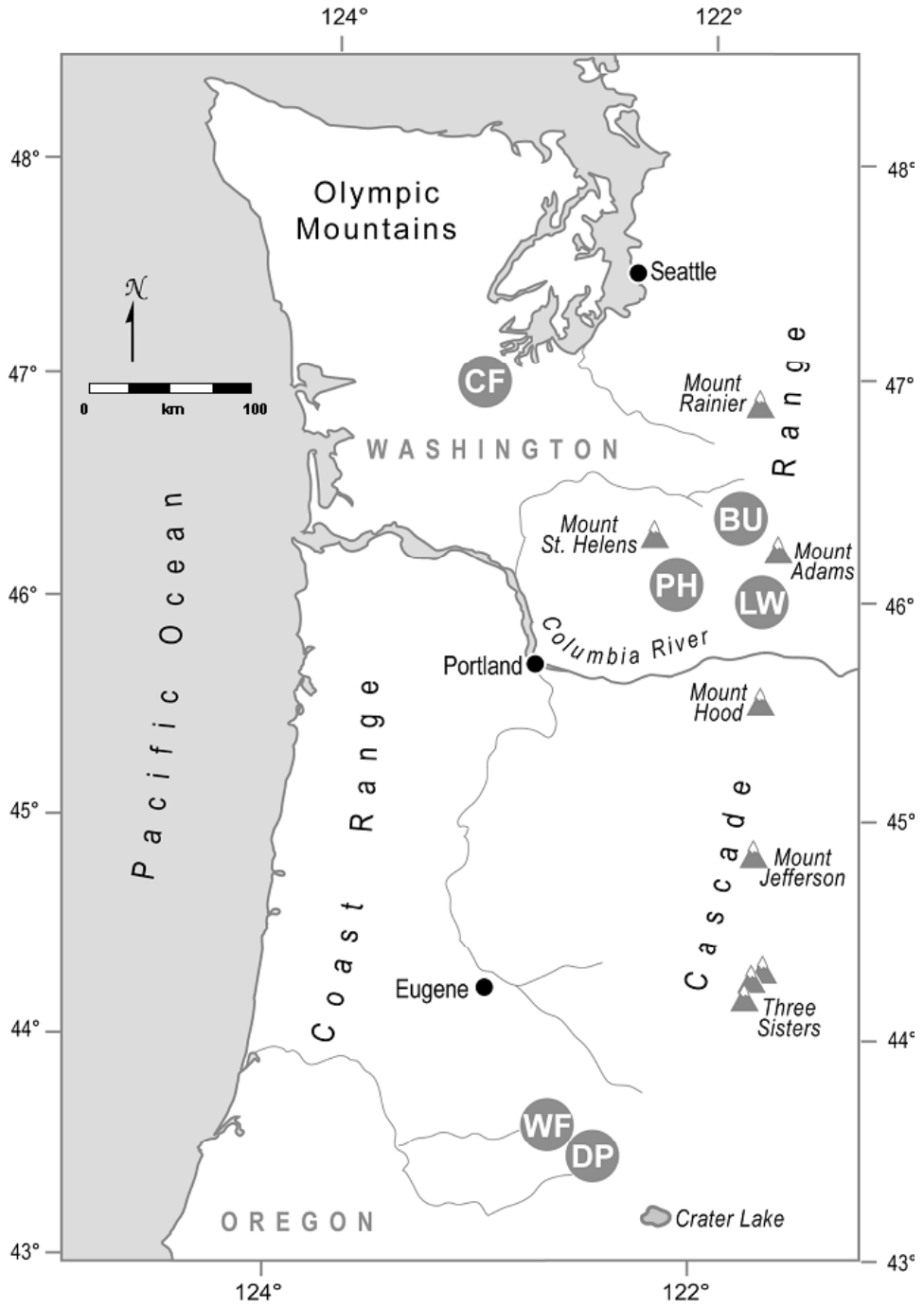
40%A



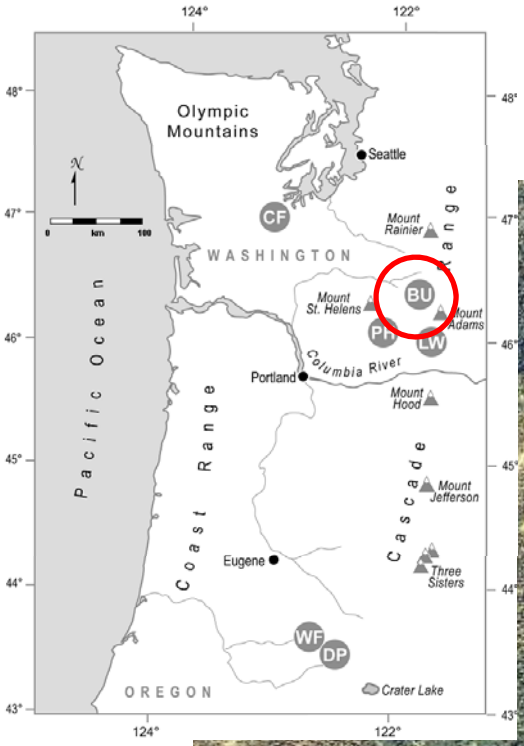
15%A

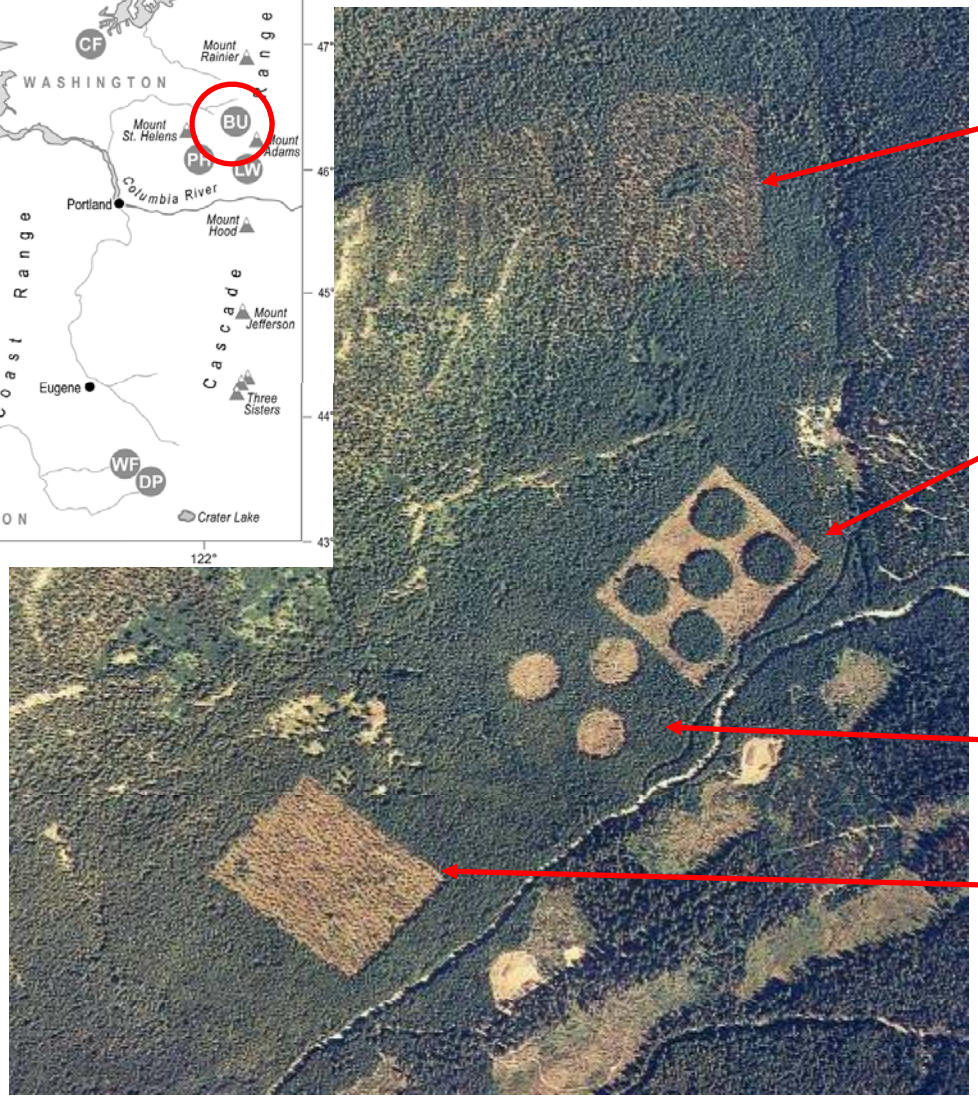


DEMO treatments implemented at 6 locations (blocks) in SW Washington and SW Oregon



Butte – DEMO block on Gifford Pinchot N.F.



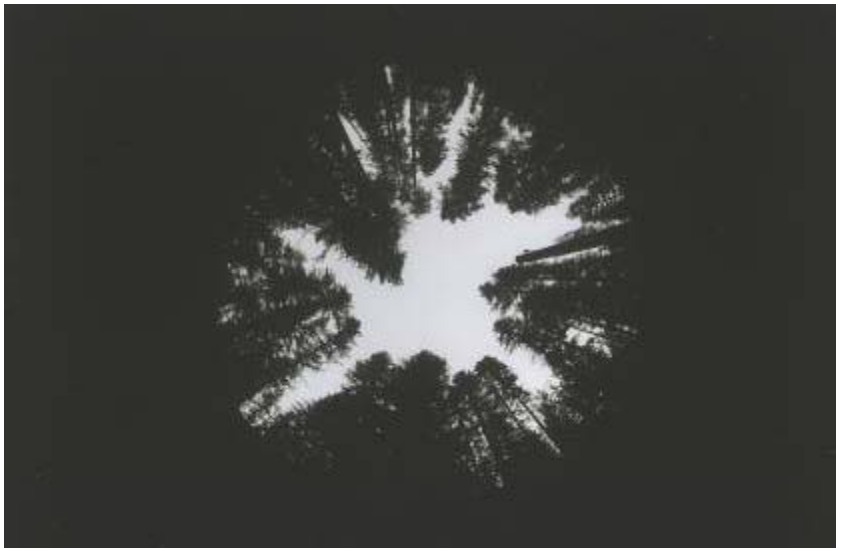


40% dispersed

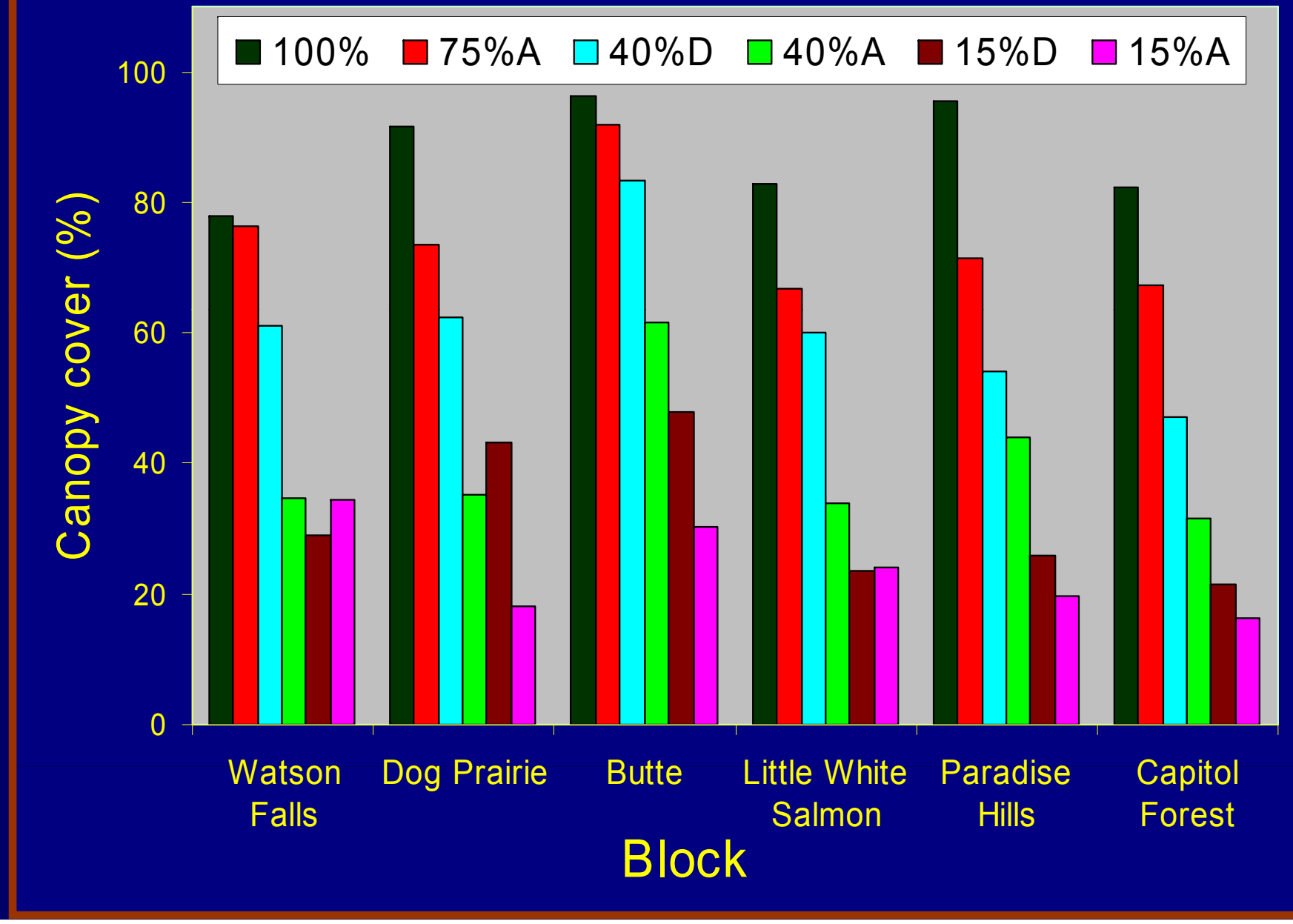
40% aggregated

75% aggregated

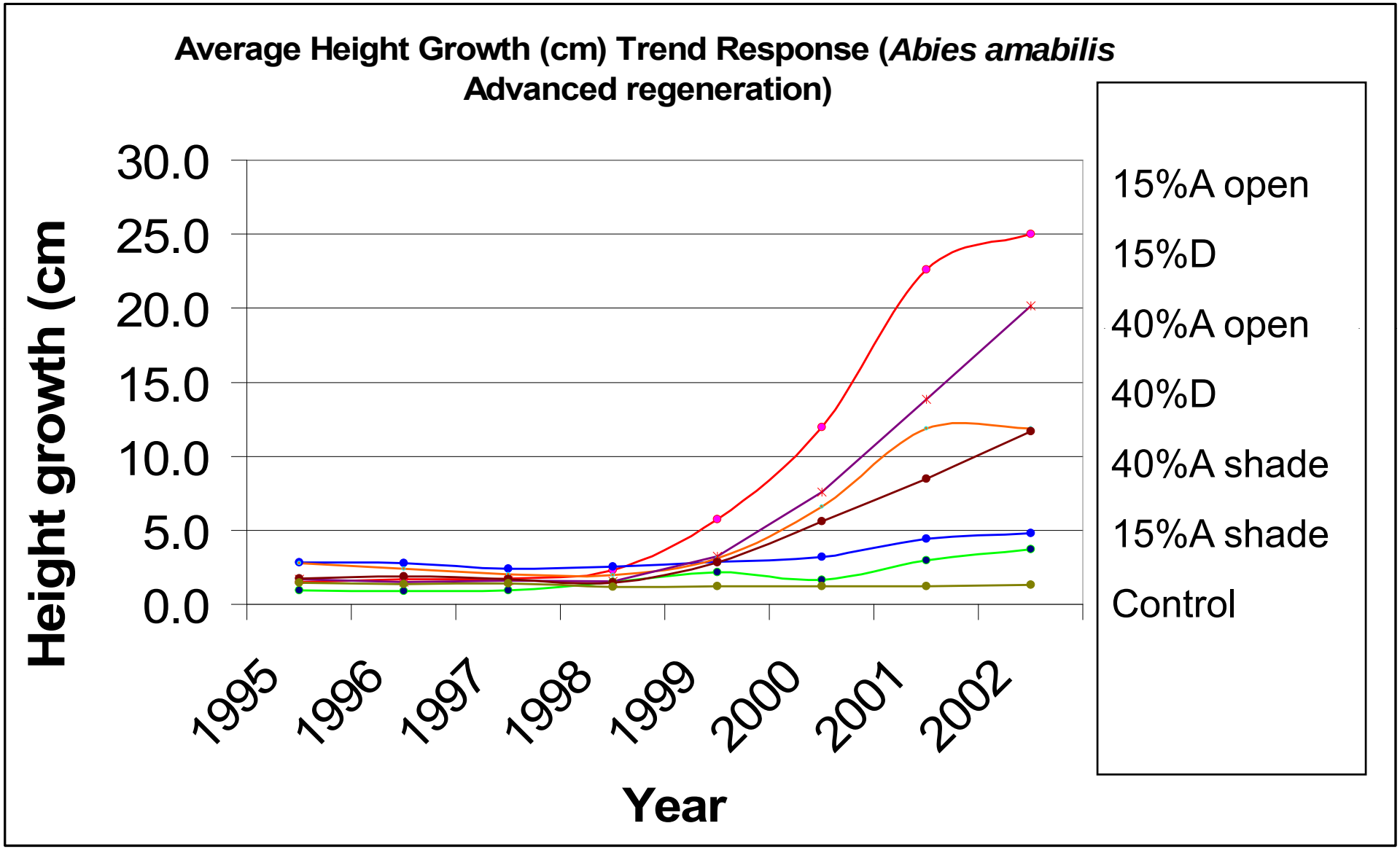
15% dispersed



Dispersed canopy cover > aggregated canopy cover



DEMO advanced regeneration study



DEMO Watson Falls block
Douglas-fir

Adjacent understory

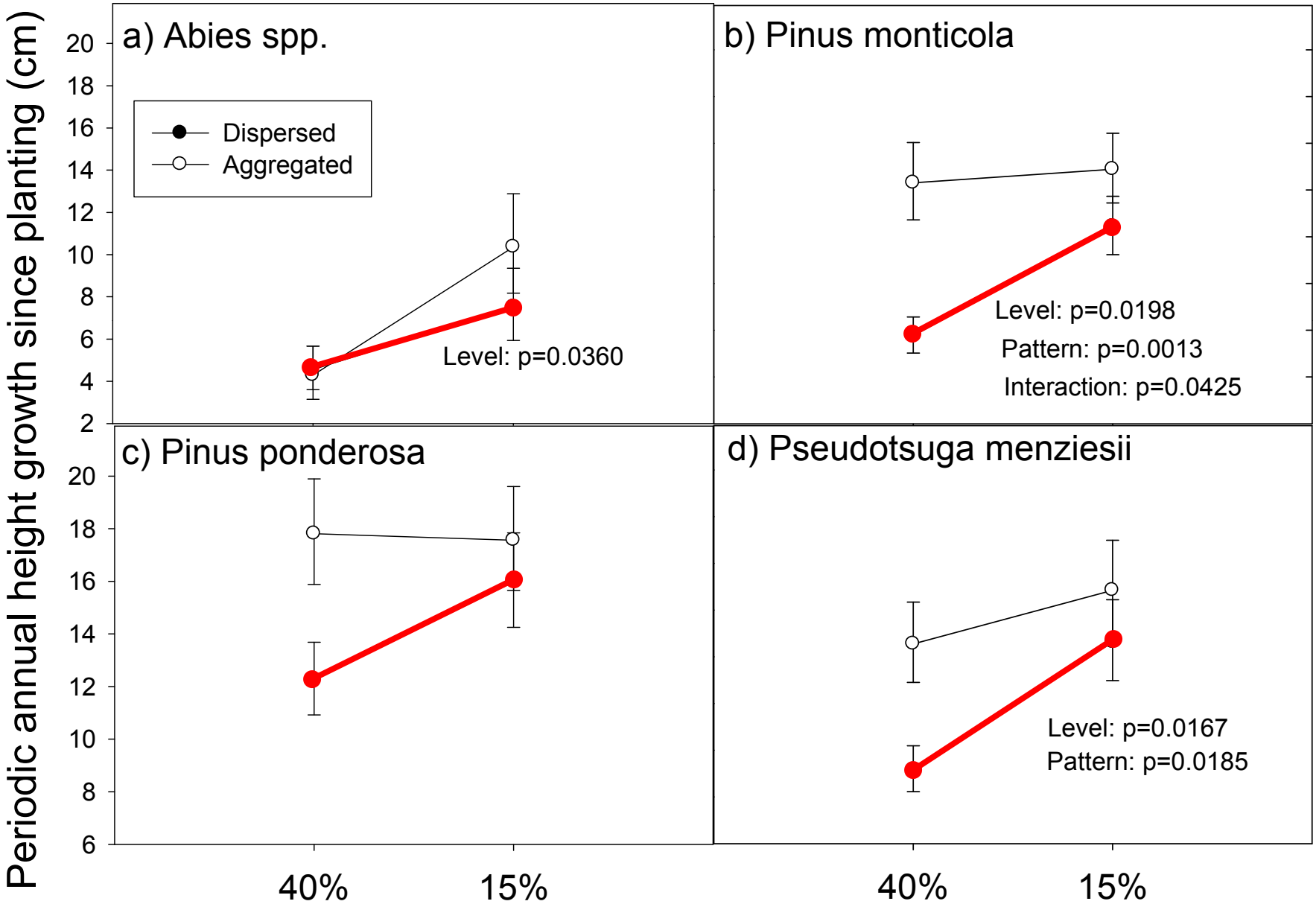
Overstory removed

DEMO Watson Falls block
White fir (*Abies concolor*)

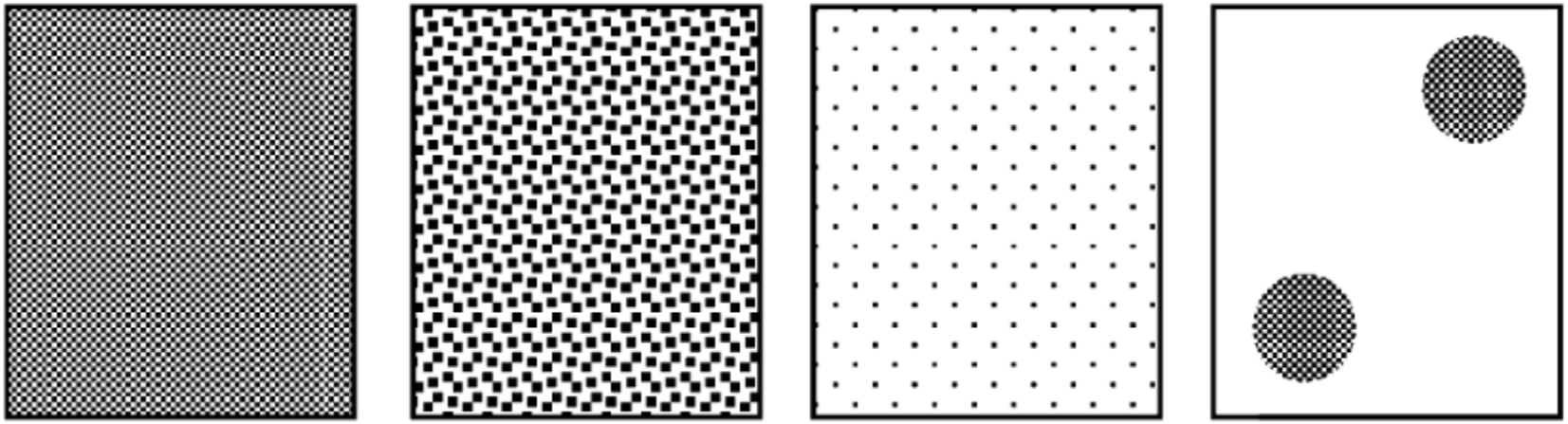
DEMO Watson Falls block
15% dispersed retention
5 yrs after treatment

DEMO Watson Falls block
15% dispersed retention
5 yrs after treatment

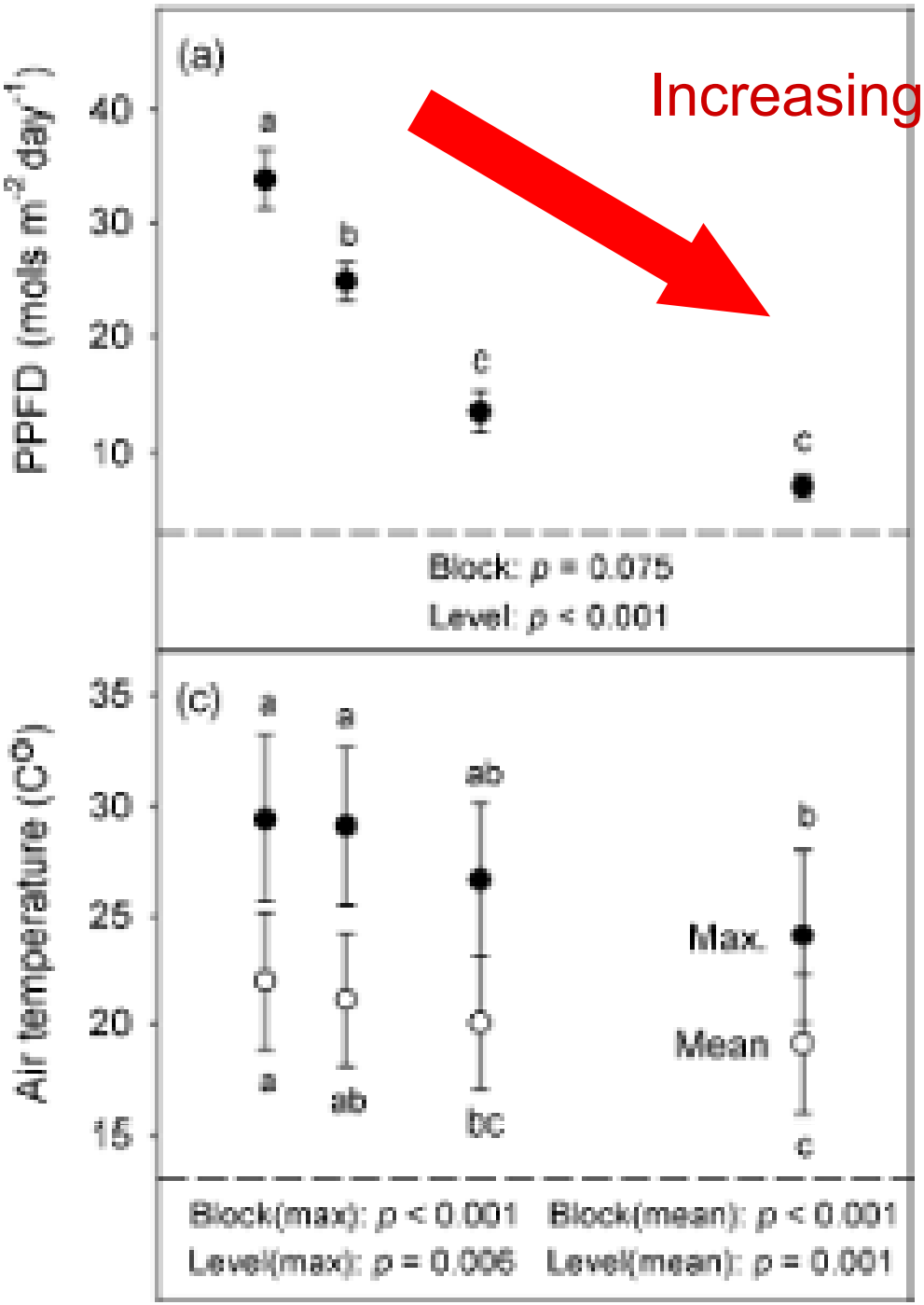
Performance of planted seedling on DEMO



Microclimate under differing retention levels in DEMO



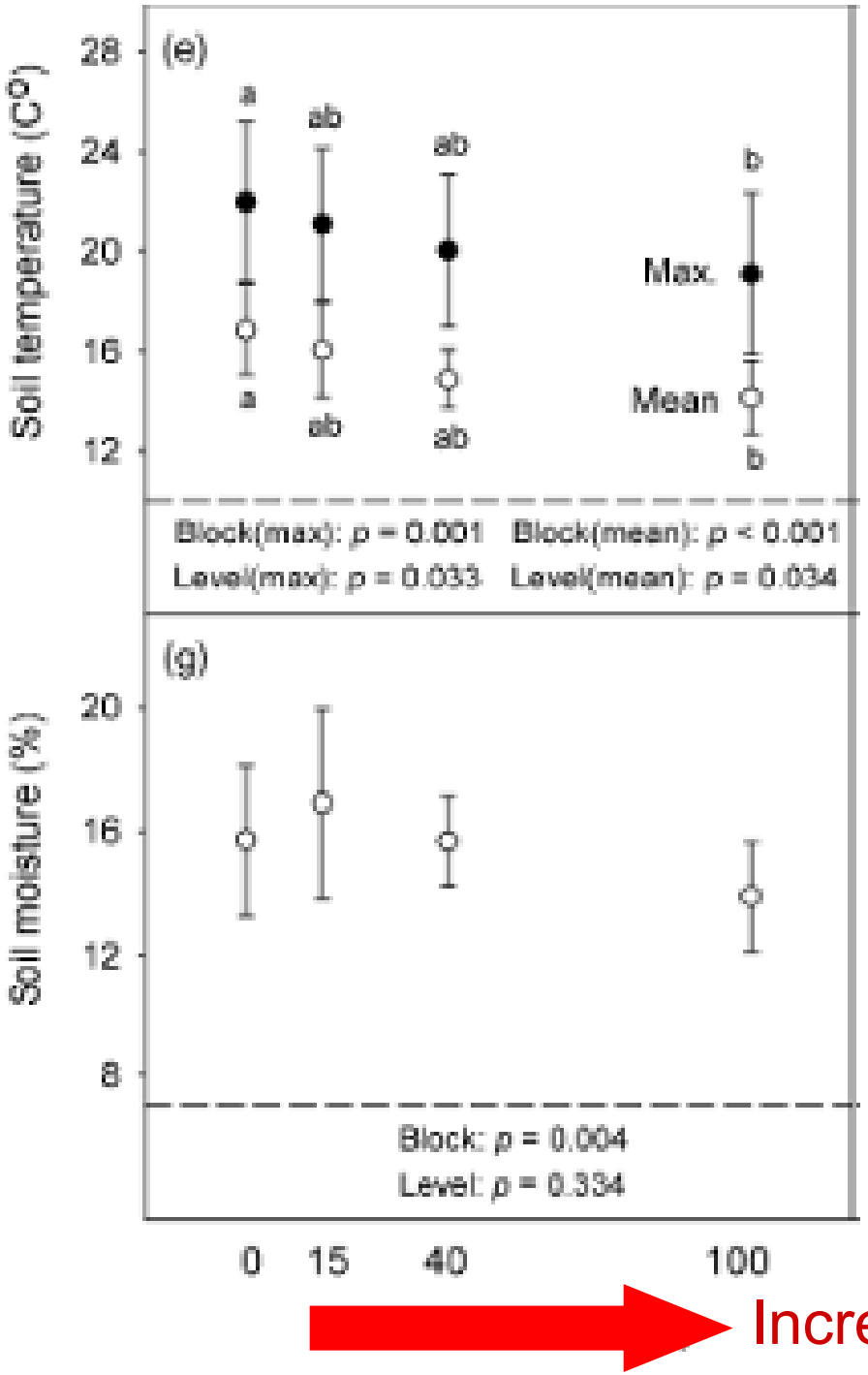
Heithecker and Halpern 2006



Increasing residual density

LIGHT

AIR TEMPERATURE



SOIL TEMPERATURE

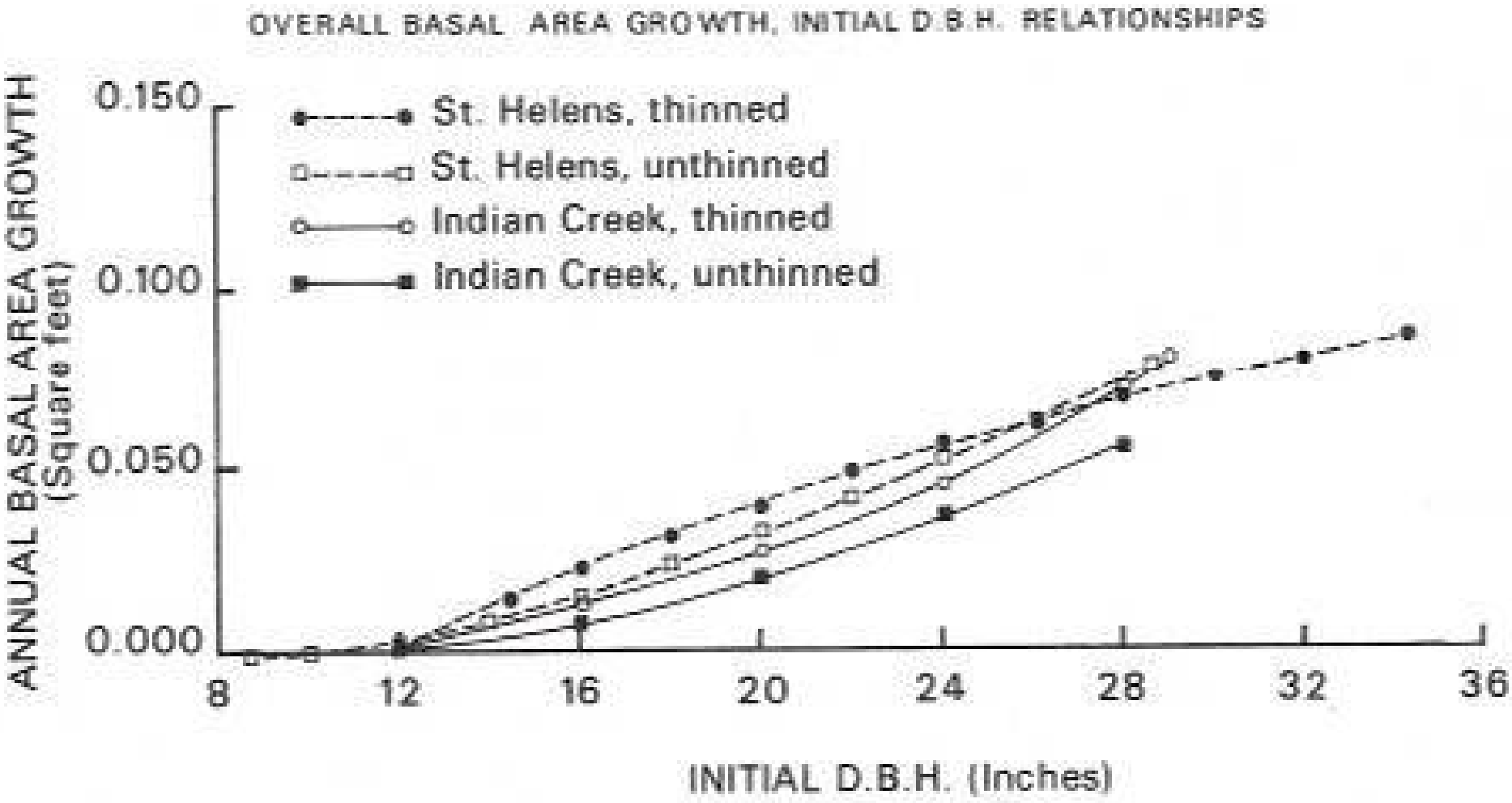
SOIL MOISTURE

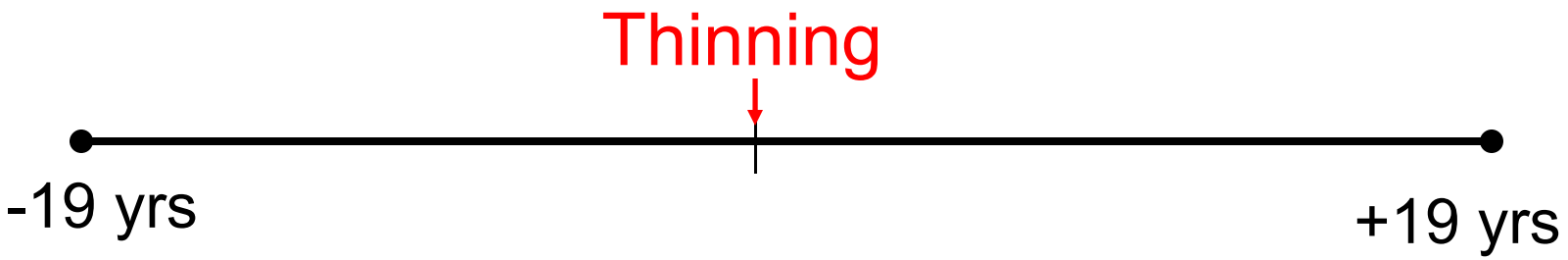
Understory Reinitiation

- Characteristics of understory reinitiation stage
- Understory response
    - Herbs and shrubs
    - Tree regeneration
        - Advanced regeneration
        - Planted seedlings
        - New germinants
- **Growth response of residual trees**
- Summary

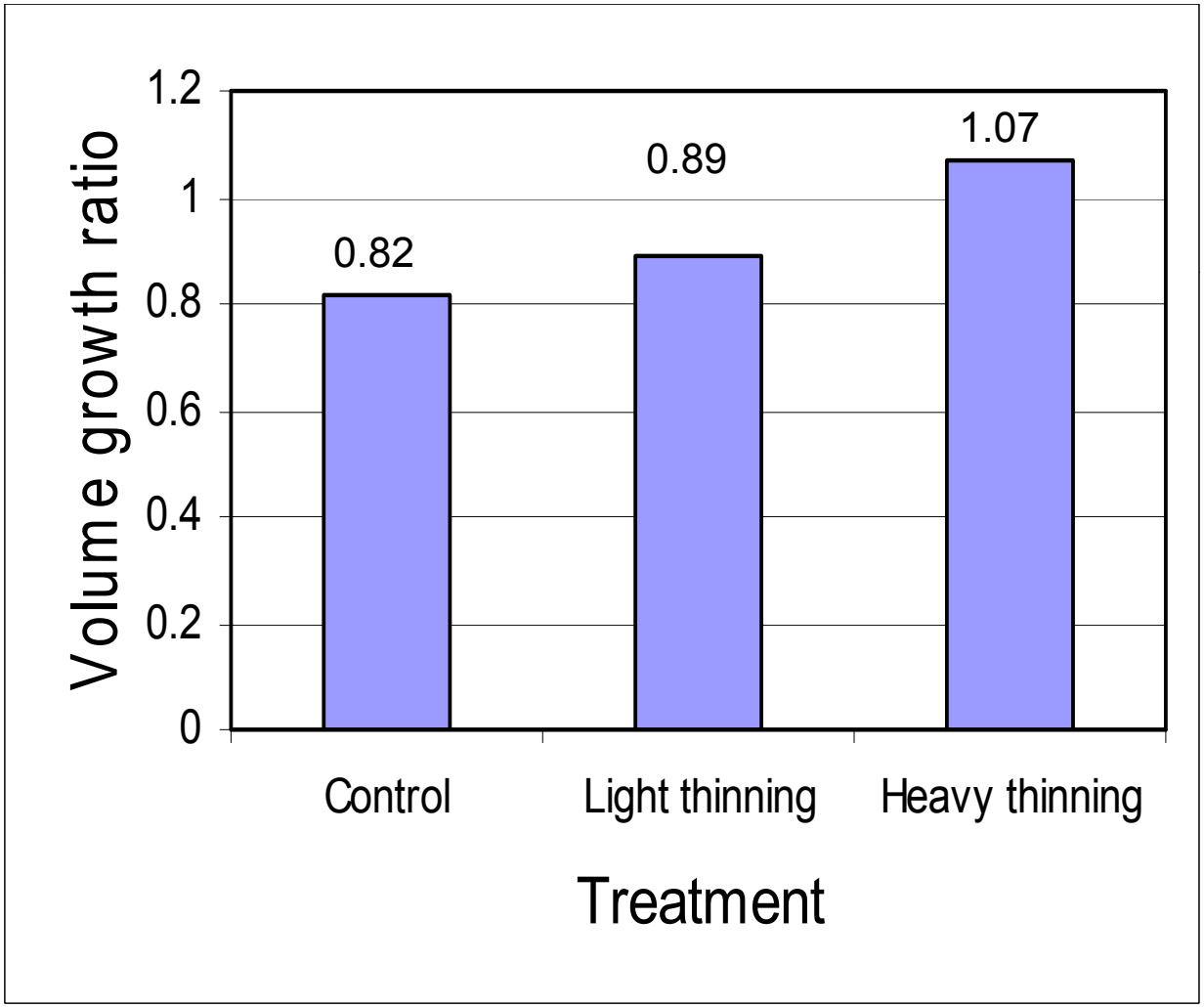
- Older trees can respond to release
  - Williamson and Price (1971)
  - Williamson (1982)
  - Roberts and Harrington (in press)
  - DEMO

- Older trees can respond to release
  - Williamson and Price (1971)
    - Indian Creek 77 years old
    - St. Helens 68 years old



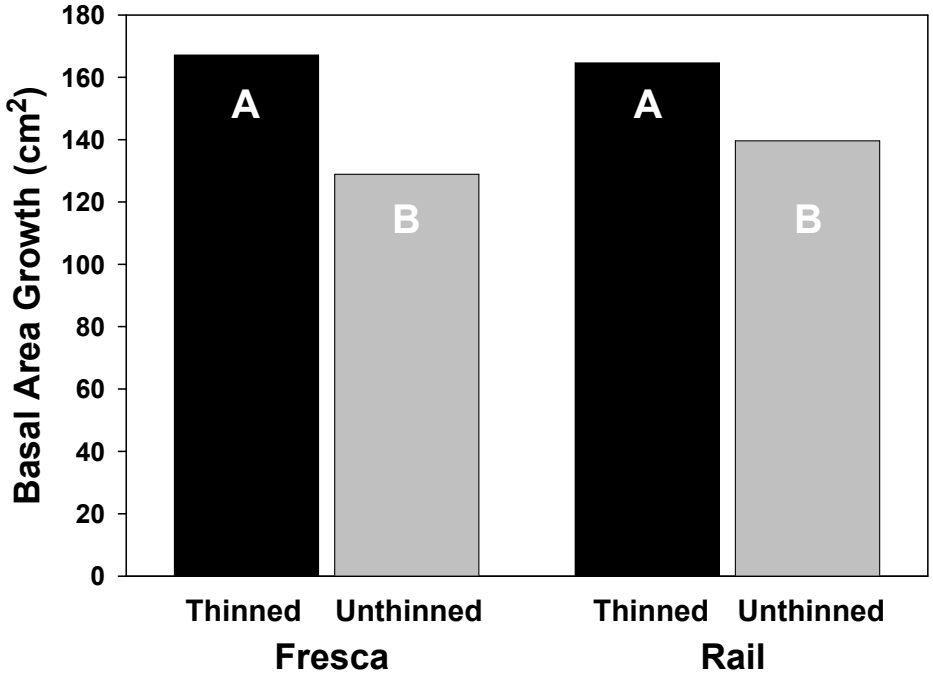


- Williamson (1982)
- 110 years old
- Ratio of 19-yr volume growth after thinning to 19-yr volume growth just prior to thinning for individual trees ($\Delta V_{+19}/\Delta V_{-19}$)



Expected Results from Thinning in Older Stands

- Older trees can respond to release
  - Roberts and Harrington (in press)
    - 65 years old
    - 5-year post thinning

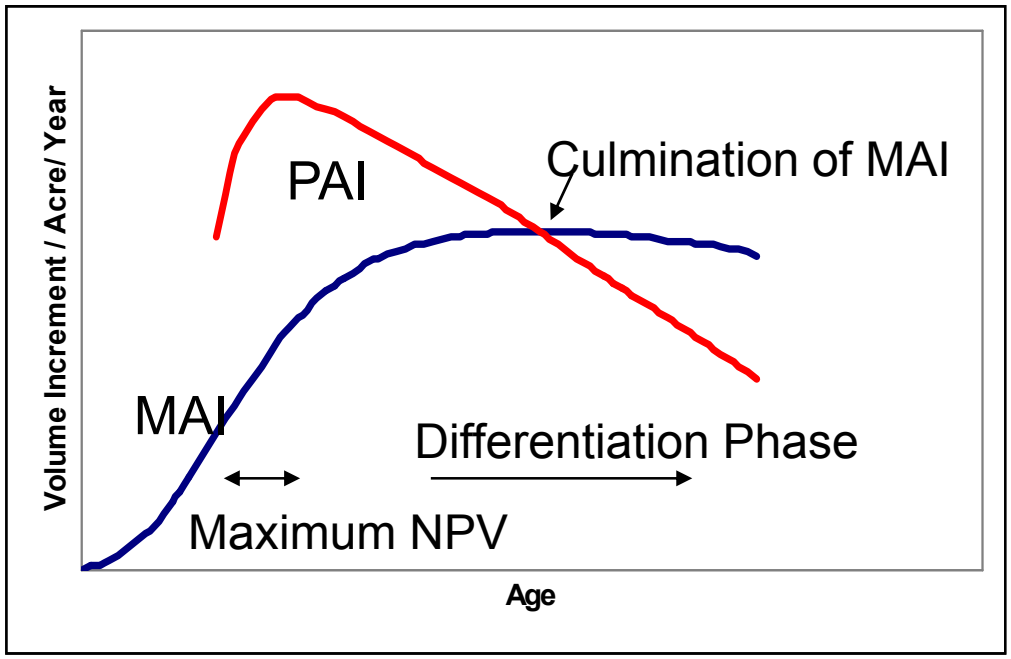


Expected Results from Thinning in Older Stands

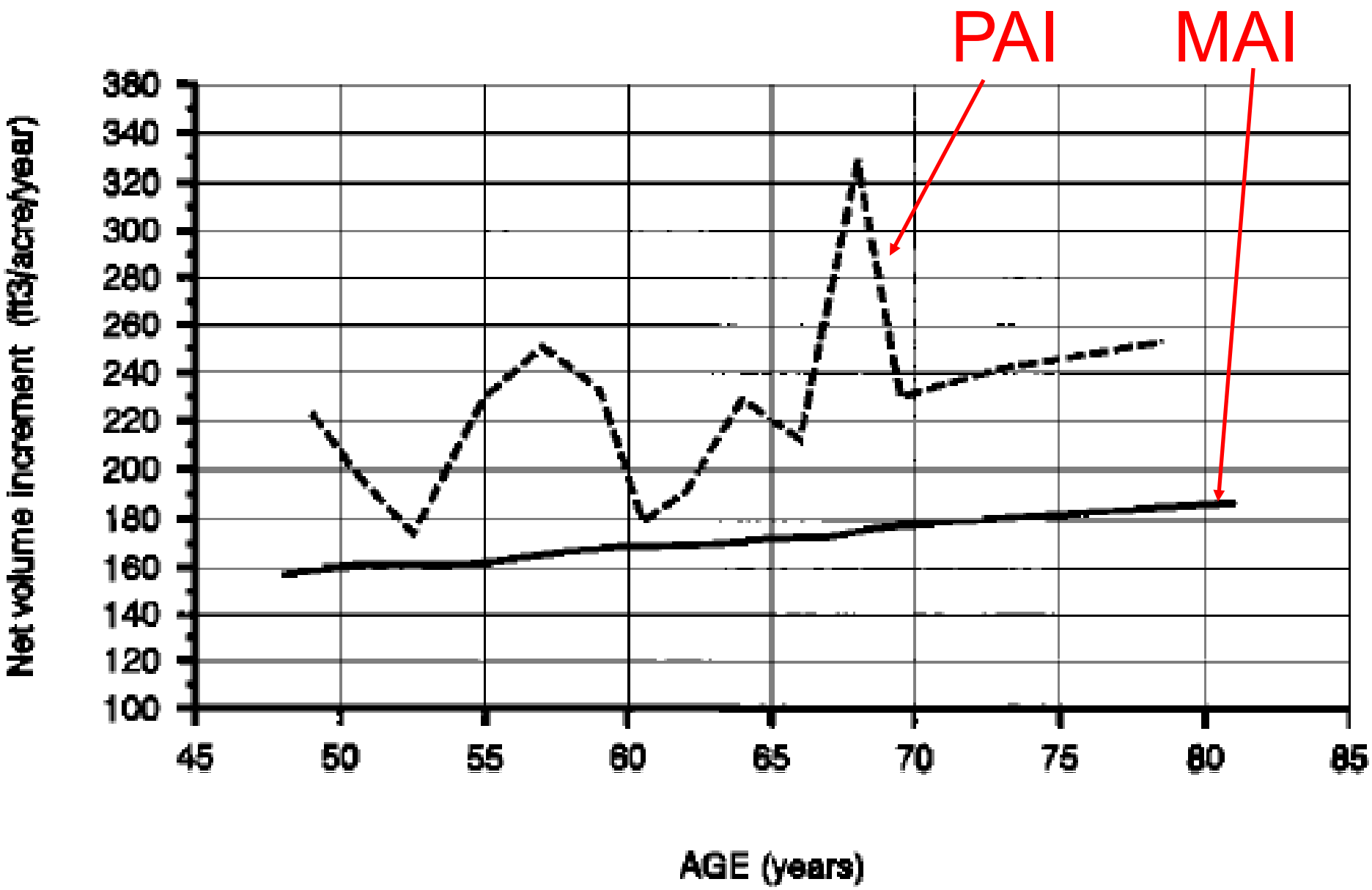
- Reduction in volume production depends on
  - holding period (rotation)
  - thinning intensity
  - vigor
  - site
  - etc.

Expected Results from Thinning in Older Stands

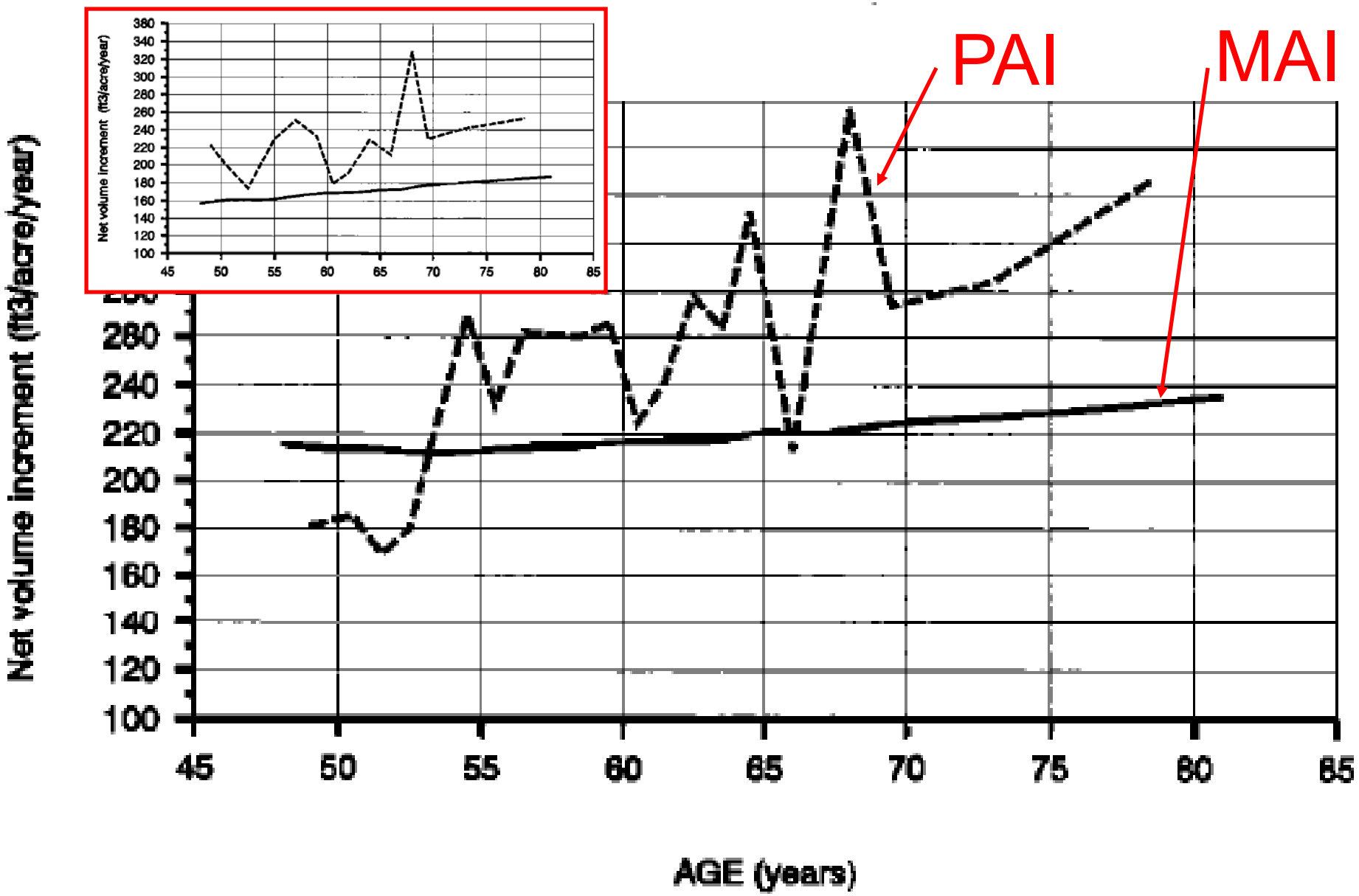
- Appears to delay CMAI (Curtis 1995)
  - CMAI >75-80 years (Curtis 1994, 1995)
    - lower and later on lower sites
    - later for merchantable volume



Cubic volume increment, unthinned Douglas-fir



Cubic volume increment, thinned Douglas-fir



Board foot volume increment same plots

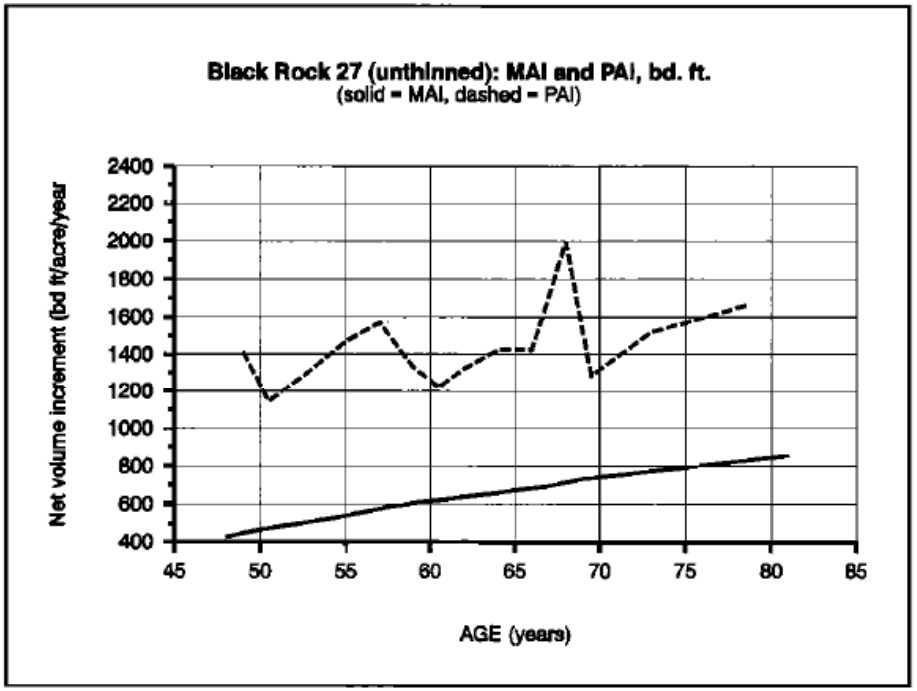


Figure 9. Observed mean annual increment and periodic annual increment in board feet on Black Rock plot 27 (no thinning), site III+ (medium).

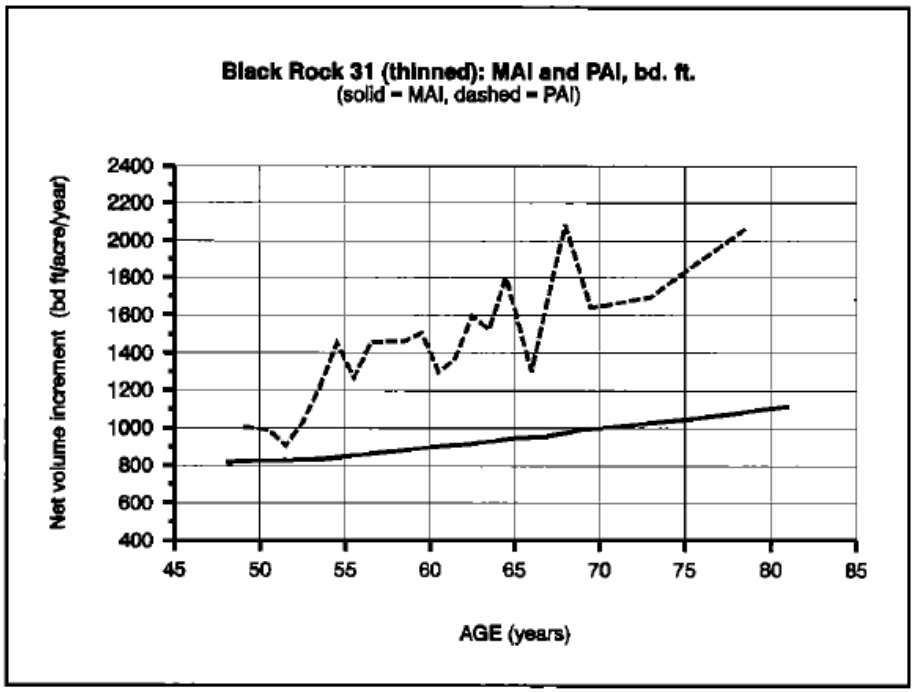
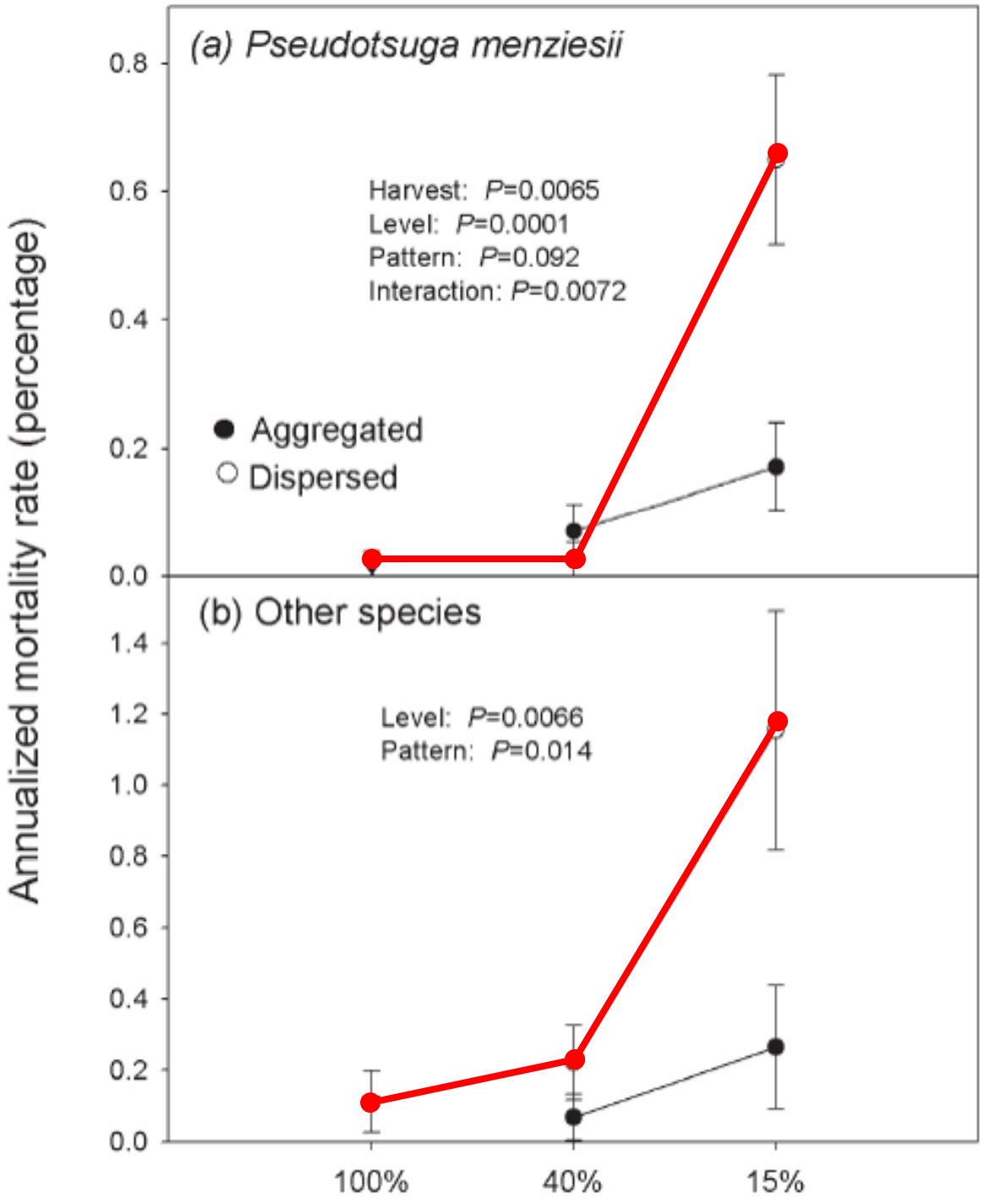


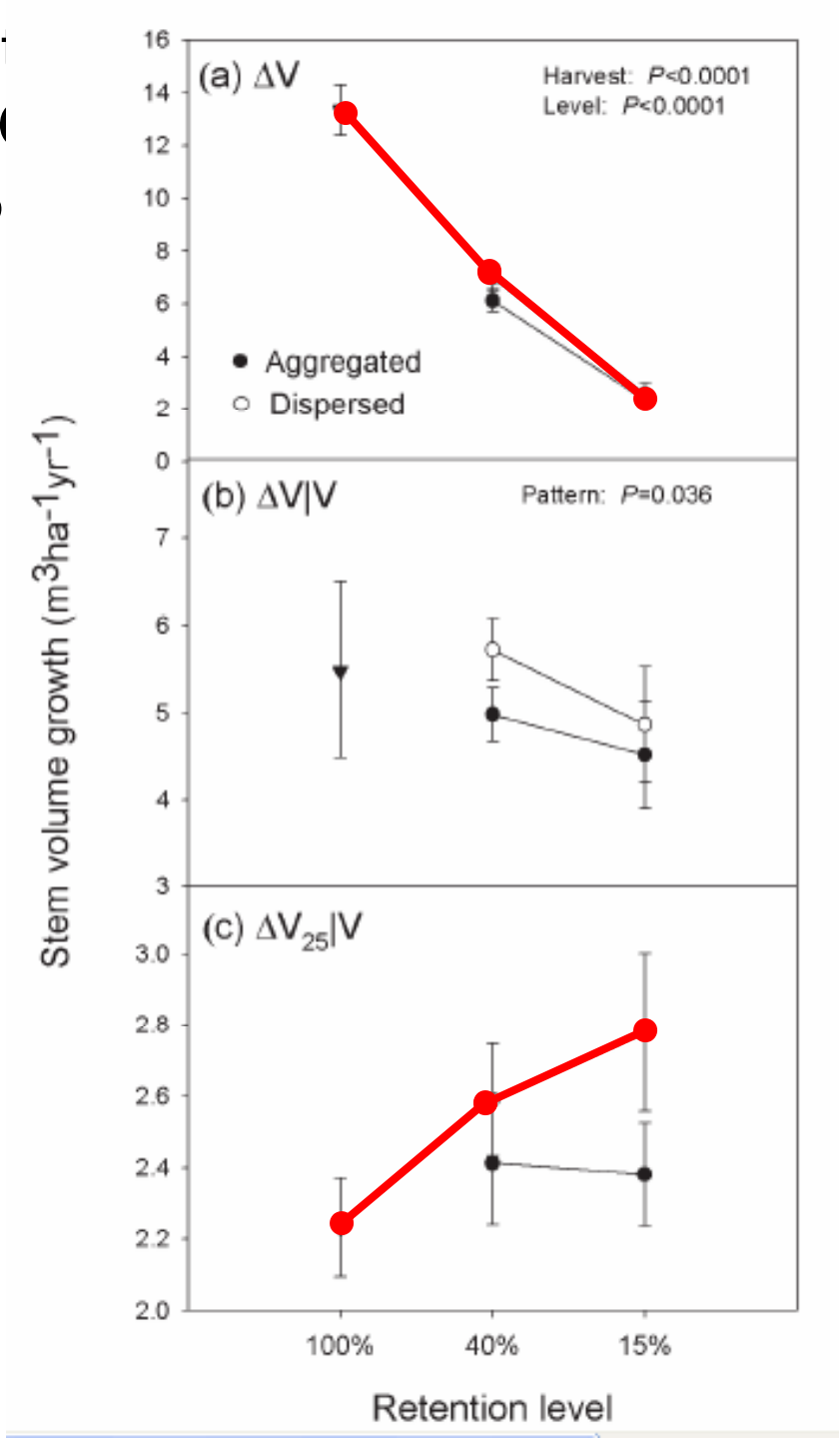
Figure 12. Observed mean annual increment and periodic annual increment in board feet Scribner on Black Rock plot 31 (very heavy thinning), site II (good).



Residual overstory mortality in DEMO study

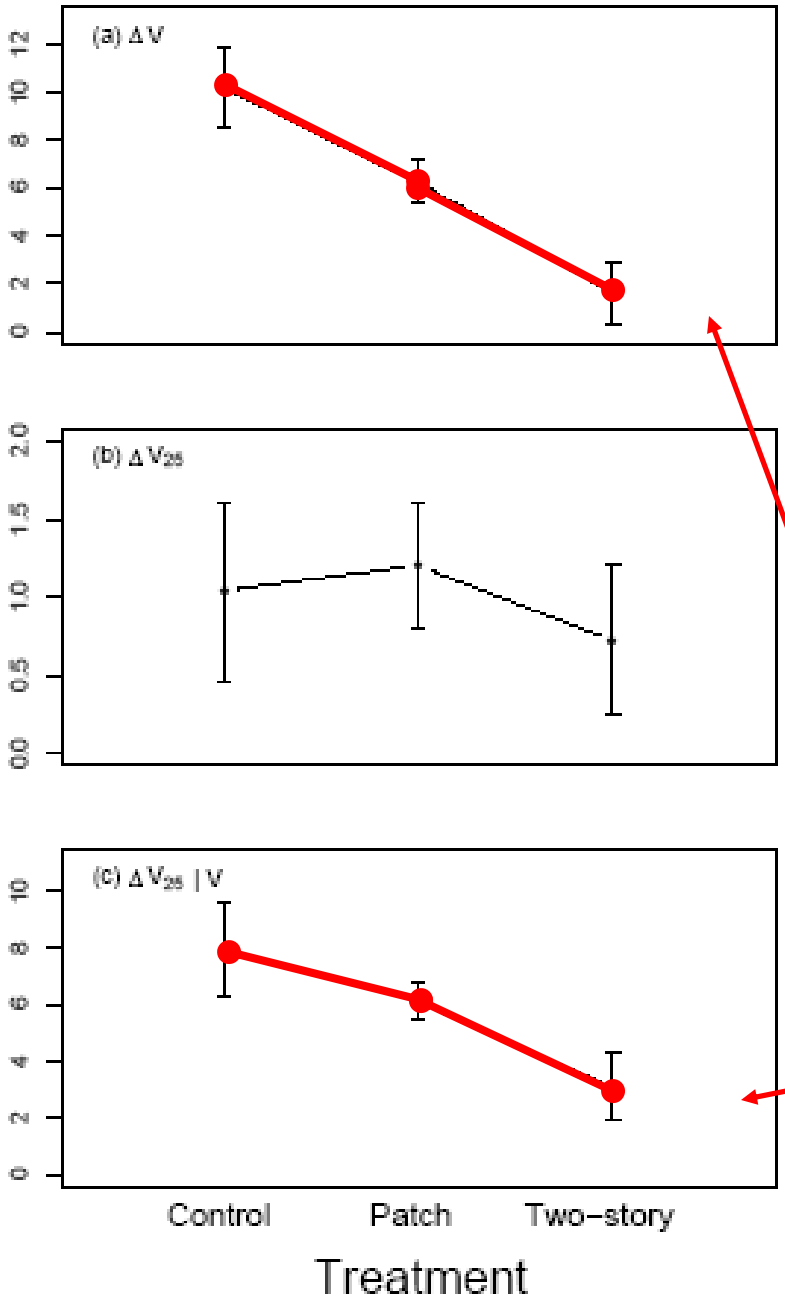
Low retention level leads to heavier mortality rate

Residual overs
growth in DEM
study (4- and 5
growth)



growth proportional to growing stock

growth efficiency (%) of largest 25 trees/ha may be starting to increase



BUT, in another study (CFIRP, McDonald Forest)

Growth trend 14 years after treatment:

-same for total

- opposite for largest 25 tph

Expected Results from Thinning in Older Stands

- Older trees can respond to release
  - Top Candidates
    - vigorous stands
    - lower densities
    - good crown ratios
  - Challenges
    - denser stands
    - at risk of windthow and snowbreakage
    - impacts of disease (root rot)

Uprooting

Wind damage under 15% dispersed retention at DEMO Watson Falls block

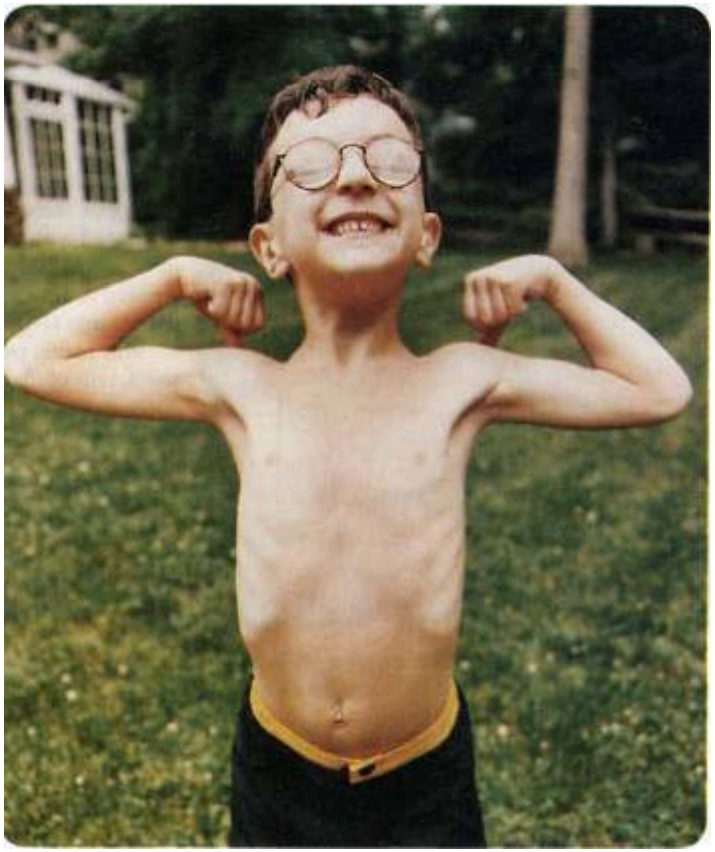
Stem breakage

Expected Results from Thinning in Older Stands

- Older trees can respond to release
- Generally reduces volume production
- Appears to delay CMAI
- Extending rotations
  - reduce classic PNV
  - might increase other values

Potential Advantages of Longer Rotations (Curtis 1995)

- Reduced land area in regeneration and early development stages
  - Reduced visual impacts
  - Reduced regeneration costs
- Larger trees and higher value wood (?)
- Higher quality wildlife habitat for some species
- Greater range of ages and structures across landscape
- Hydrological and long-term productivity benefits
- Increased carbon storage from larger growing stock
- Higher employment
- Increased tax revenues



Do we have the strength to continue?

Uniform thinning can increase understory development and diversity … however it may not last without heavy thinnings and/or repeated thinnings.

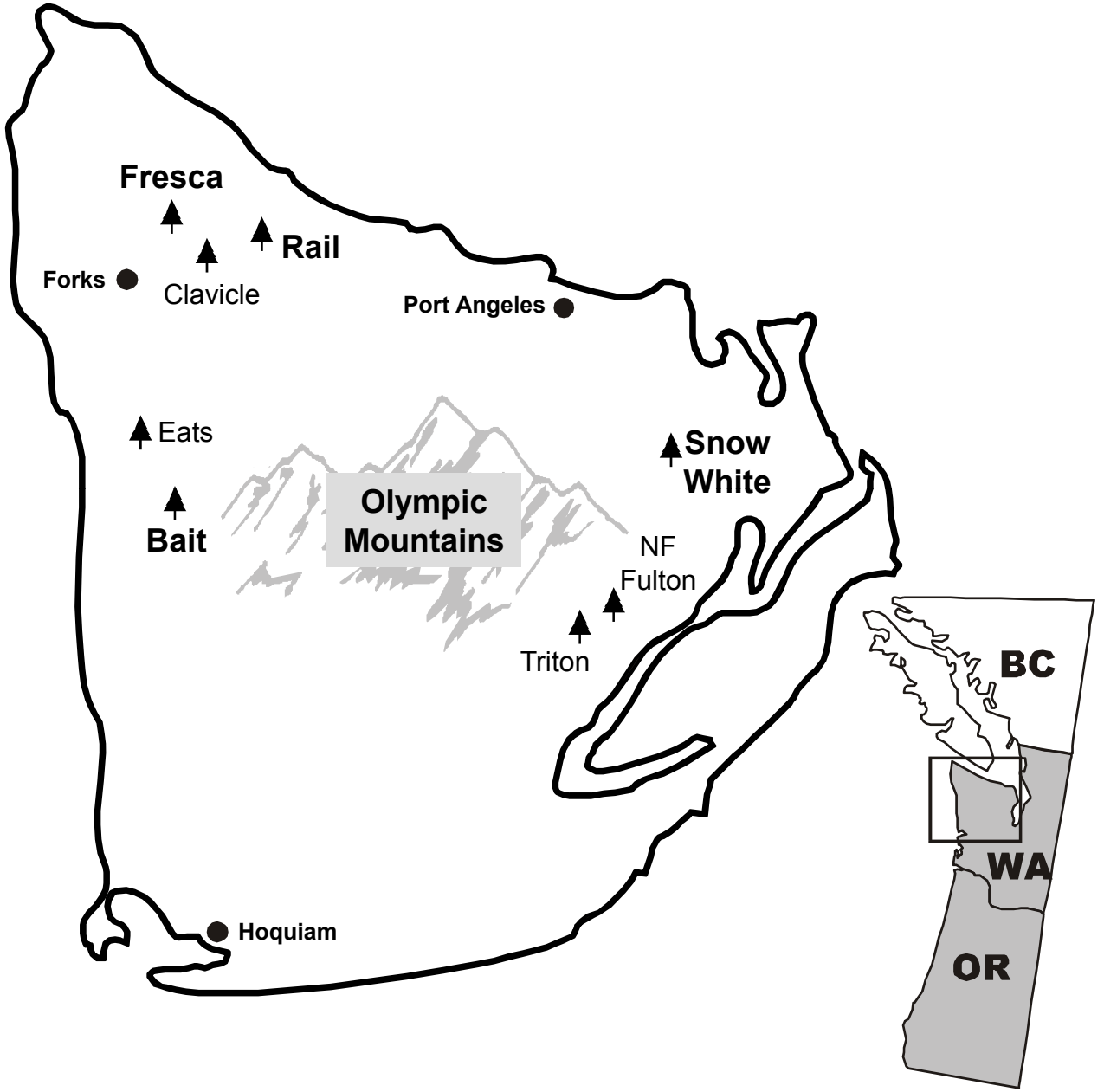
One alternative that could reduce reliance on heavy and frequent thinnings and provide more structural diversity is by using gaps and variable density thinning.

Black Rock Gap

Results from Variable Density Thinning

Olympic Habitat Development Study
Connie Harrington

Olympia Forestry Science Laboratory
PNW Research Station


Fresca
Rail
Forks
Clavicle
Port Angeles
Eats
Snow
White
Olympic
Mountains
Bait
NF
Fulton
Triton
Hoquiam
BC
WA
OR

Initial Stand conditions

- 35 to 70 year-old primarily coniferous stands
- Major species:
  - Douglas-fir
  - western hemlock
  - Sitka spruce
- Other common species:
  - Redcedar
  - silver (amabalis) fir
  - red alder
- 2 blocks commercially thinned in past
- 3 blocks were planted, 5 naturally seeded

Study Implementation

8 original blocks set up in 1994

7 timber sales sold

6 units have been thinned

- First 2 blocks completed 1997-98
- Second 2 blocks completed 1999-00
- 1 block thinned in multiple years with different logging systems
- 1 block completed in 2003

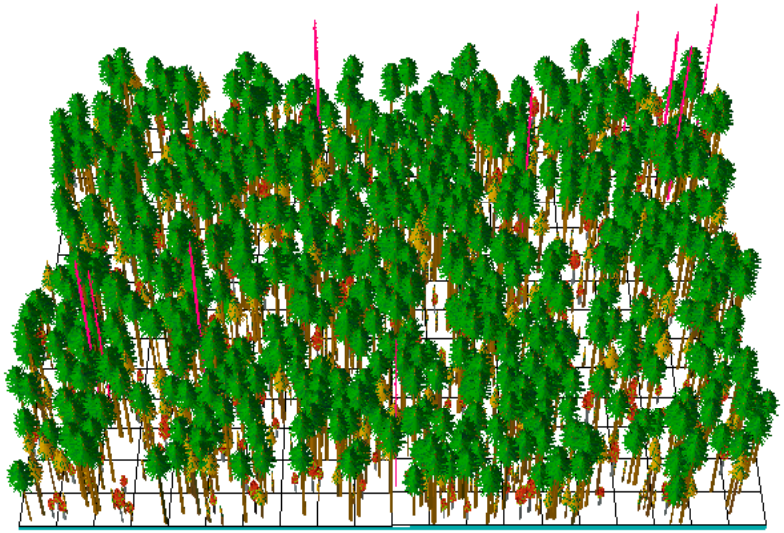
Skips and Gaps

Skips (10% of area)

- 0.3 – 0.6 ha
- Look for largest snags to protect
- Keep at least 20 m from gaps

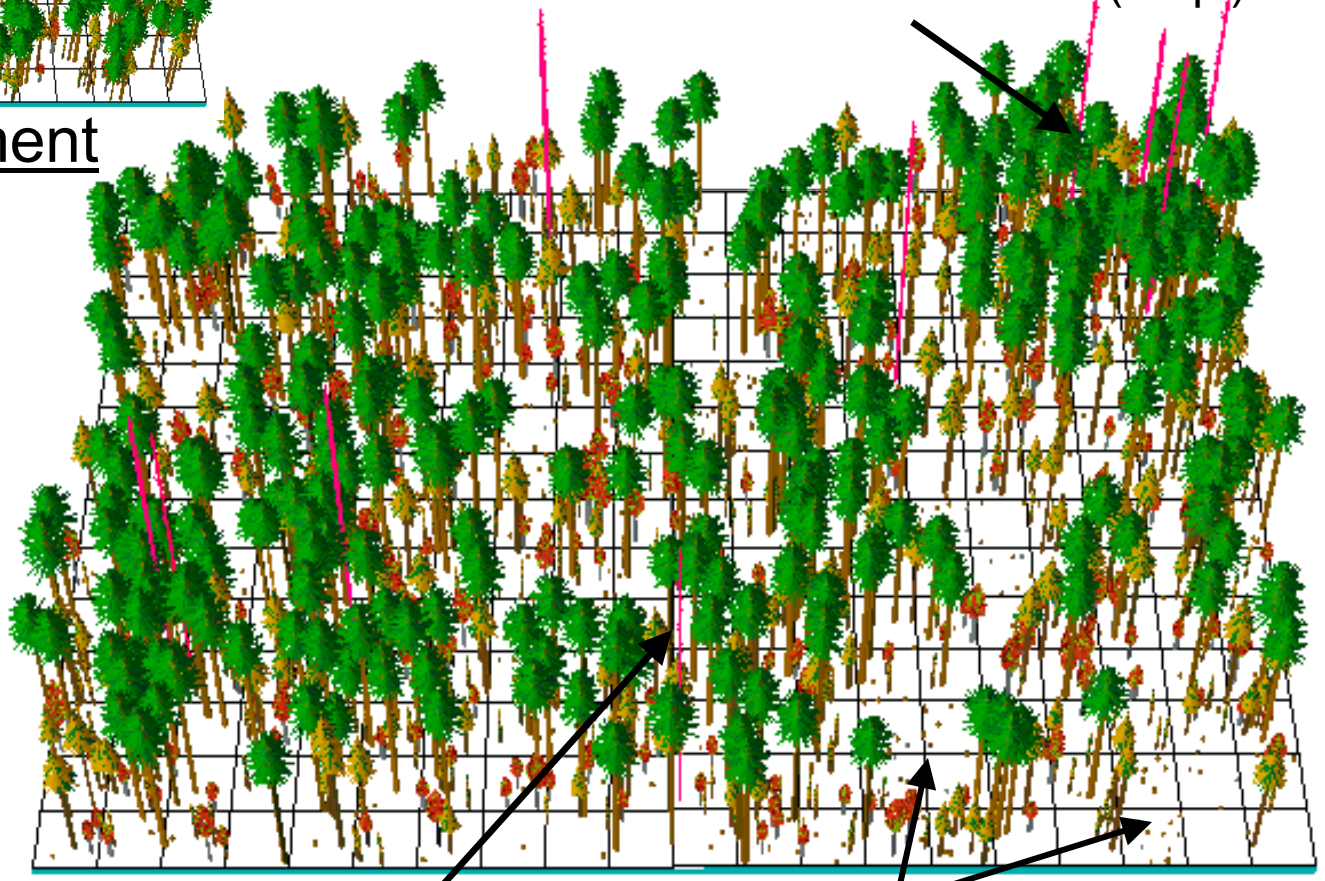
Gaps (15% of area)

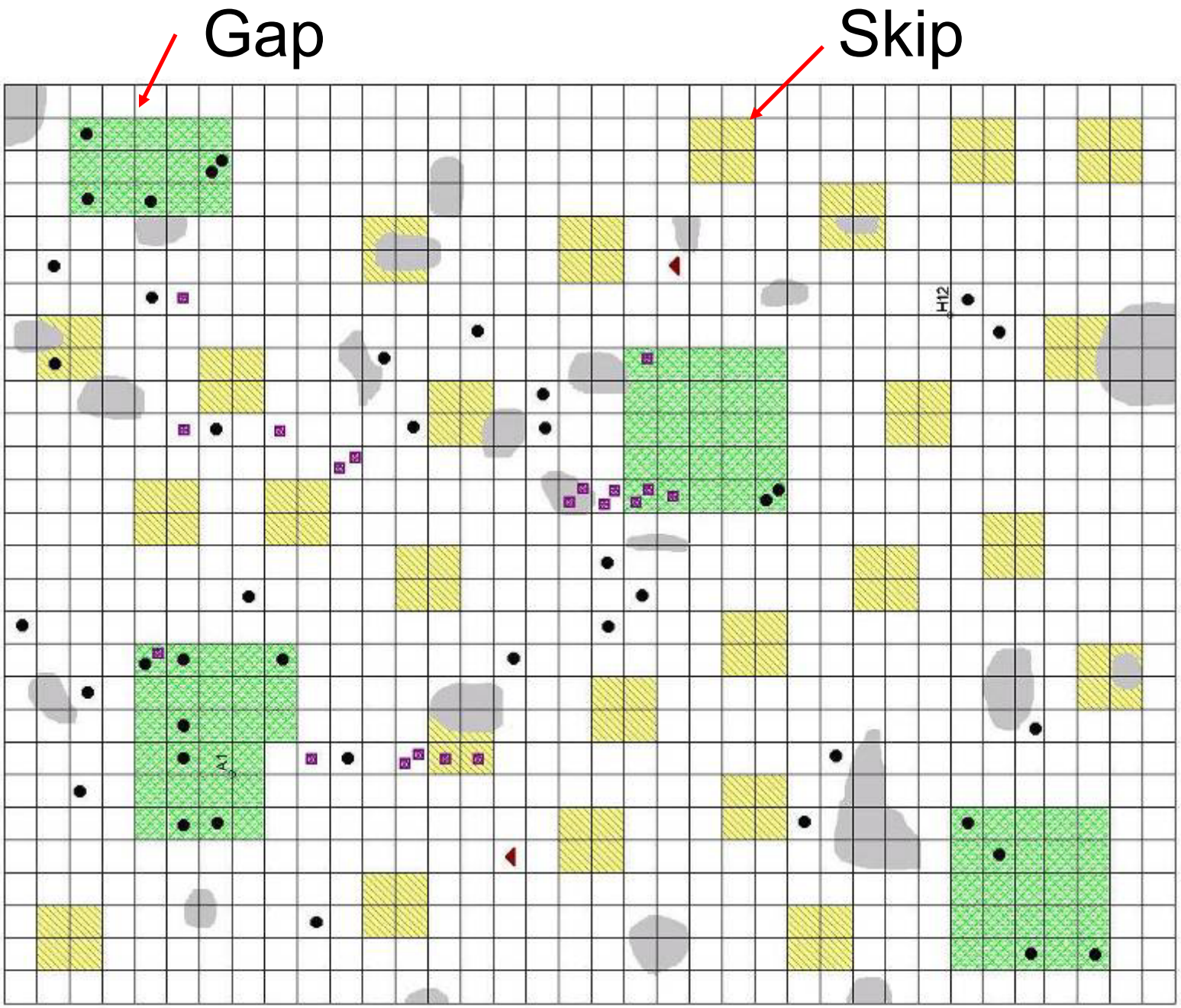
- 20 x 20 m (or slightly larger if enlarging previous gap)
- Do not cut “preference species” in gaps

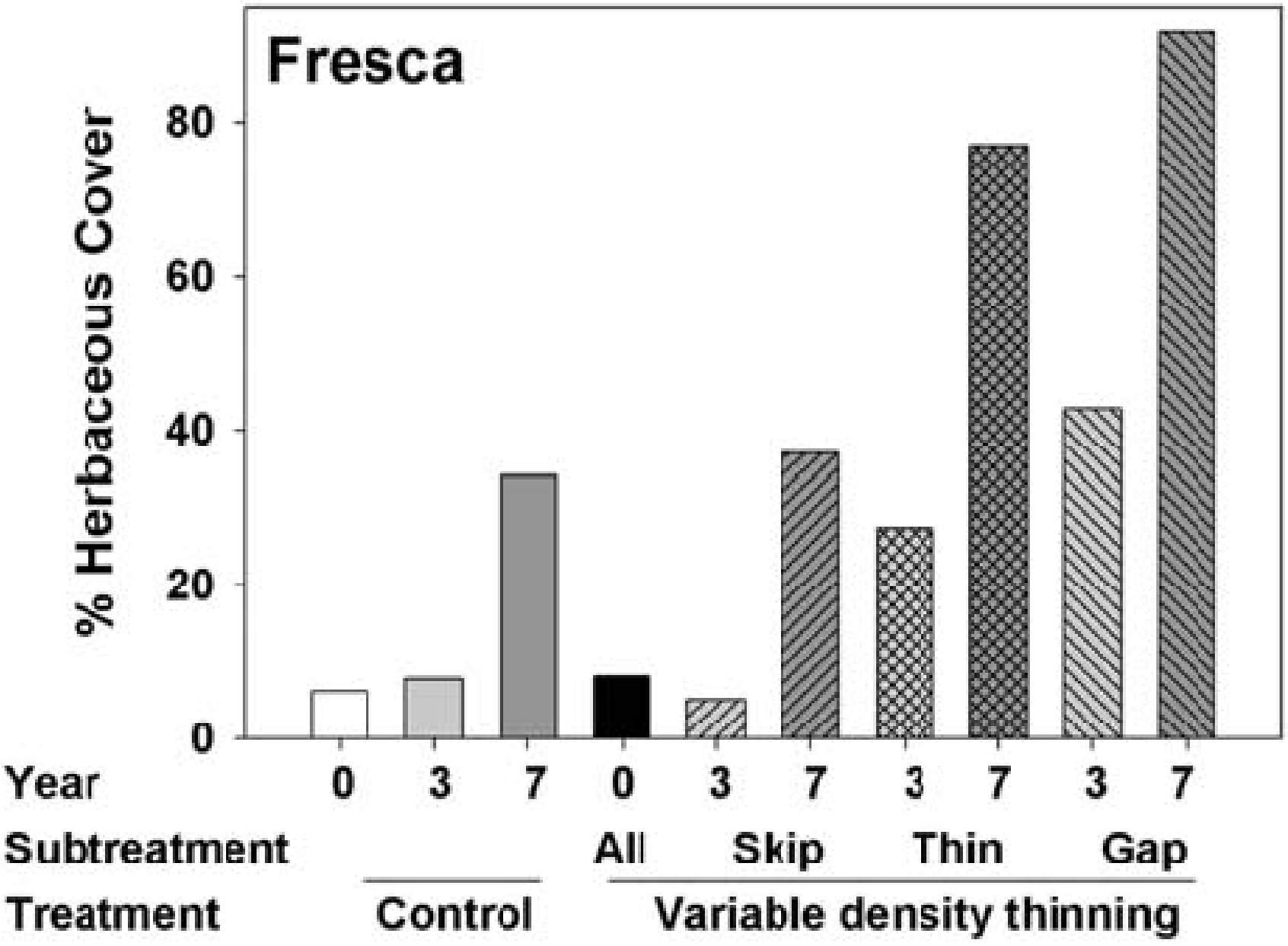


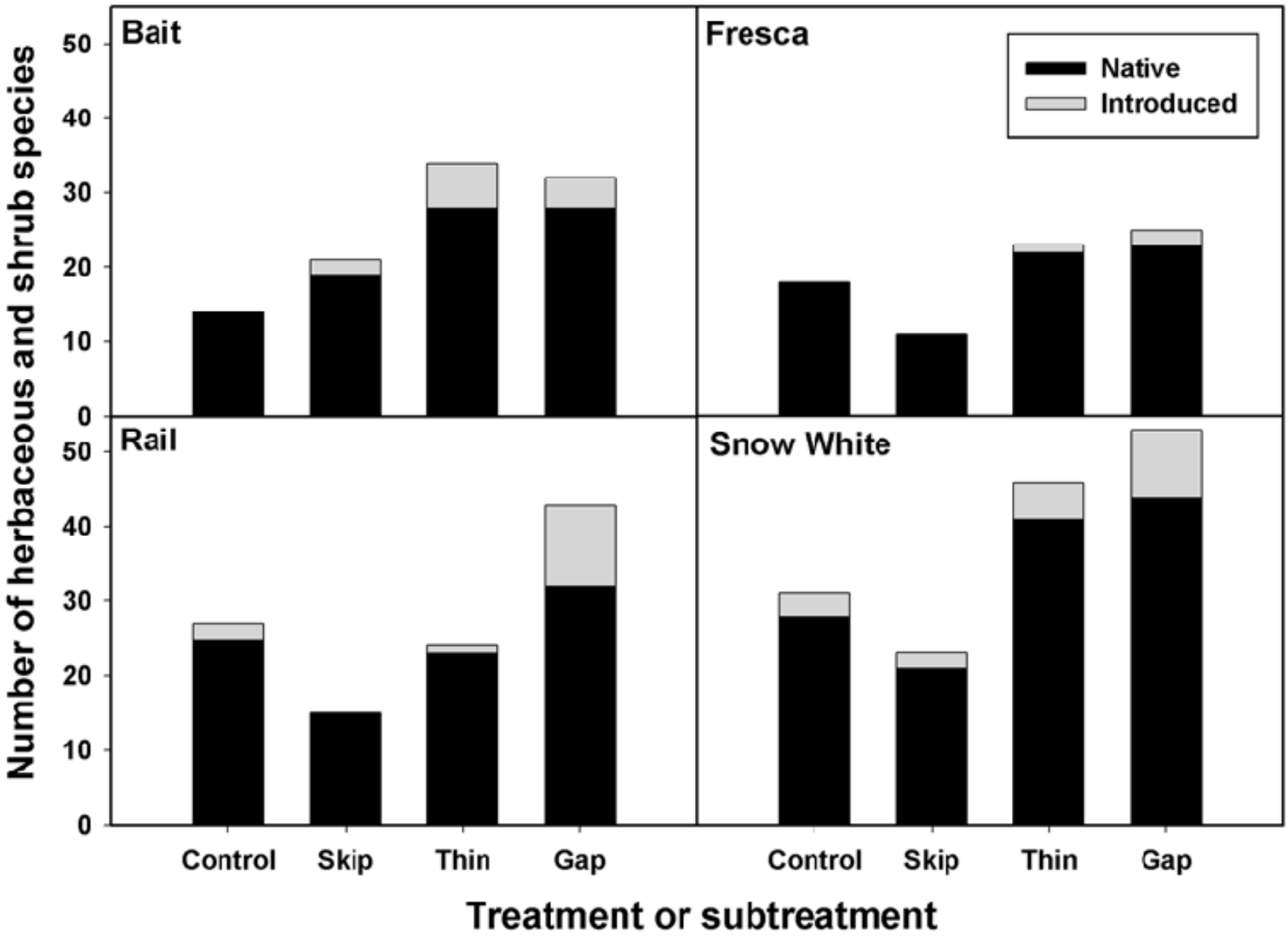
Prior to Treatment

Post Treatment

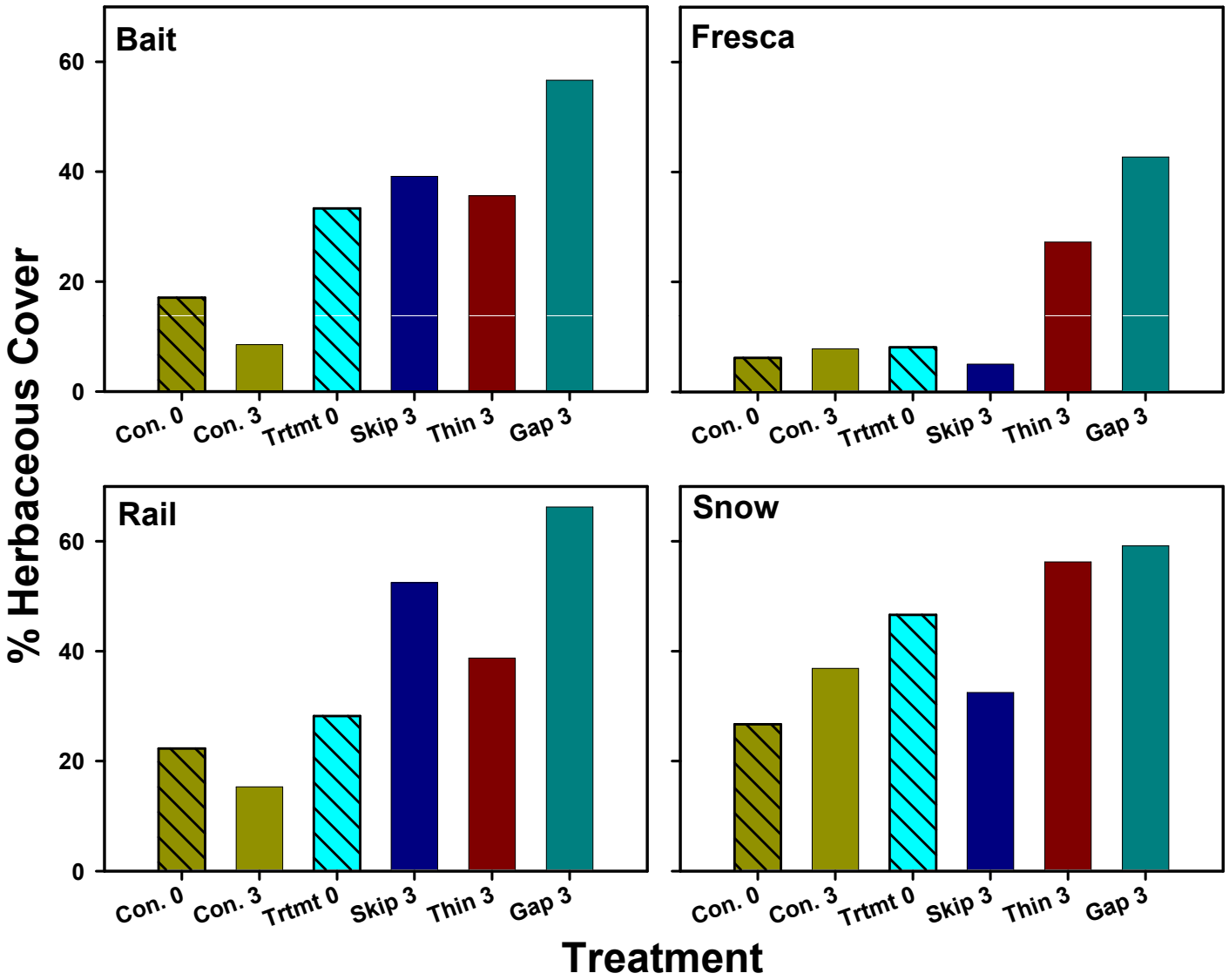



Gap
Skip
H12
A1

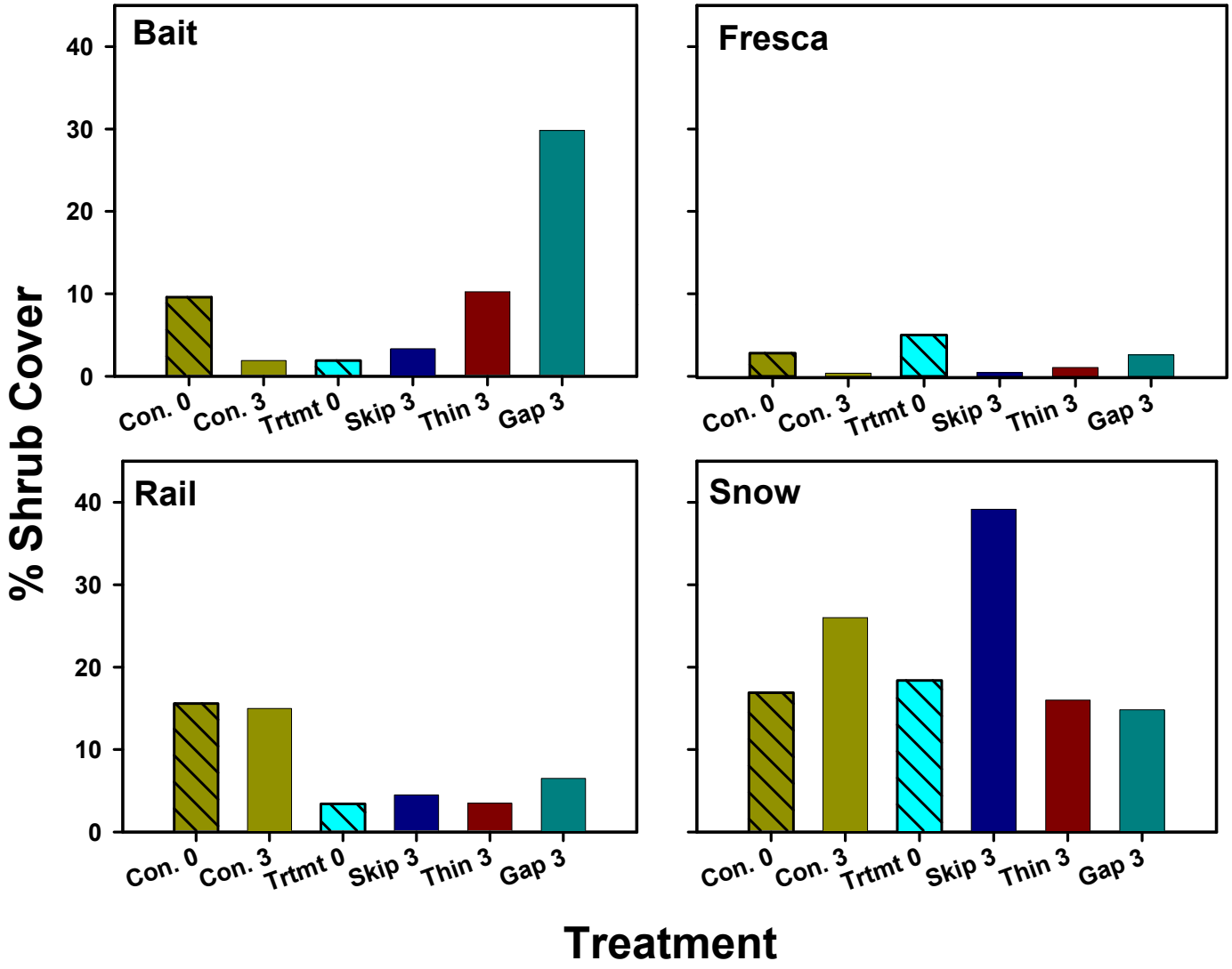

Fresca
% Herbaceous Cover
80
60
40
20
0
Year
0
3
7
0
3
7
3
7
3
7
Subtreatment
All
Skip
Thin
Gap
Treatment
Control
Variable density thinning


Bait
Fresca
Rail
Snow White
Native
Introduced
Number of herbaceous and shrub species
0
10
20
30
40
50
Control
Skip
Thin
Gap
Treatment or subtreatment

Change in % Herbaceous Cover

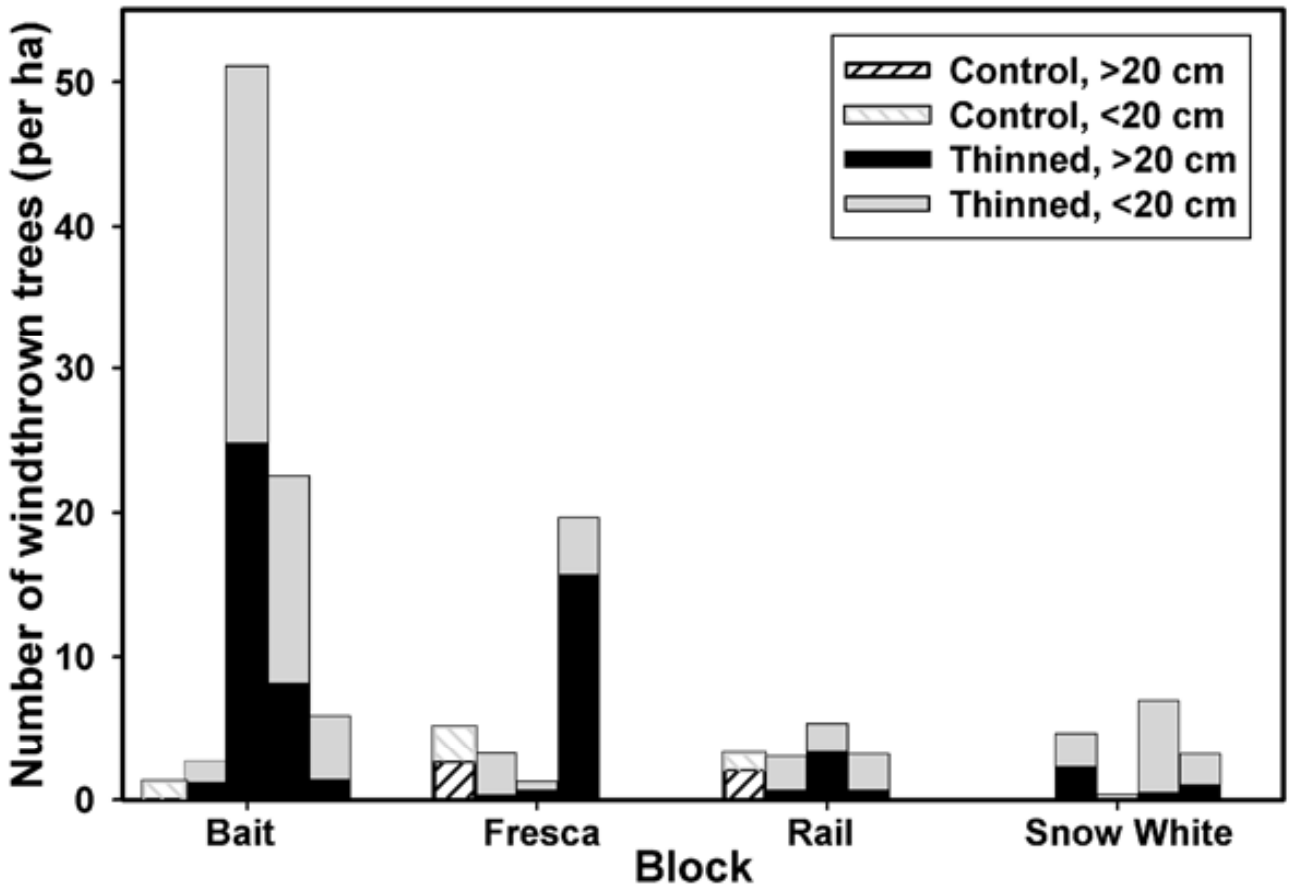


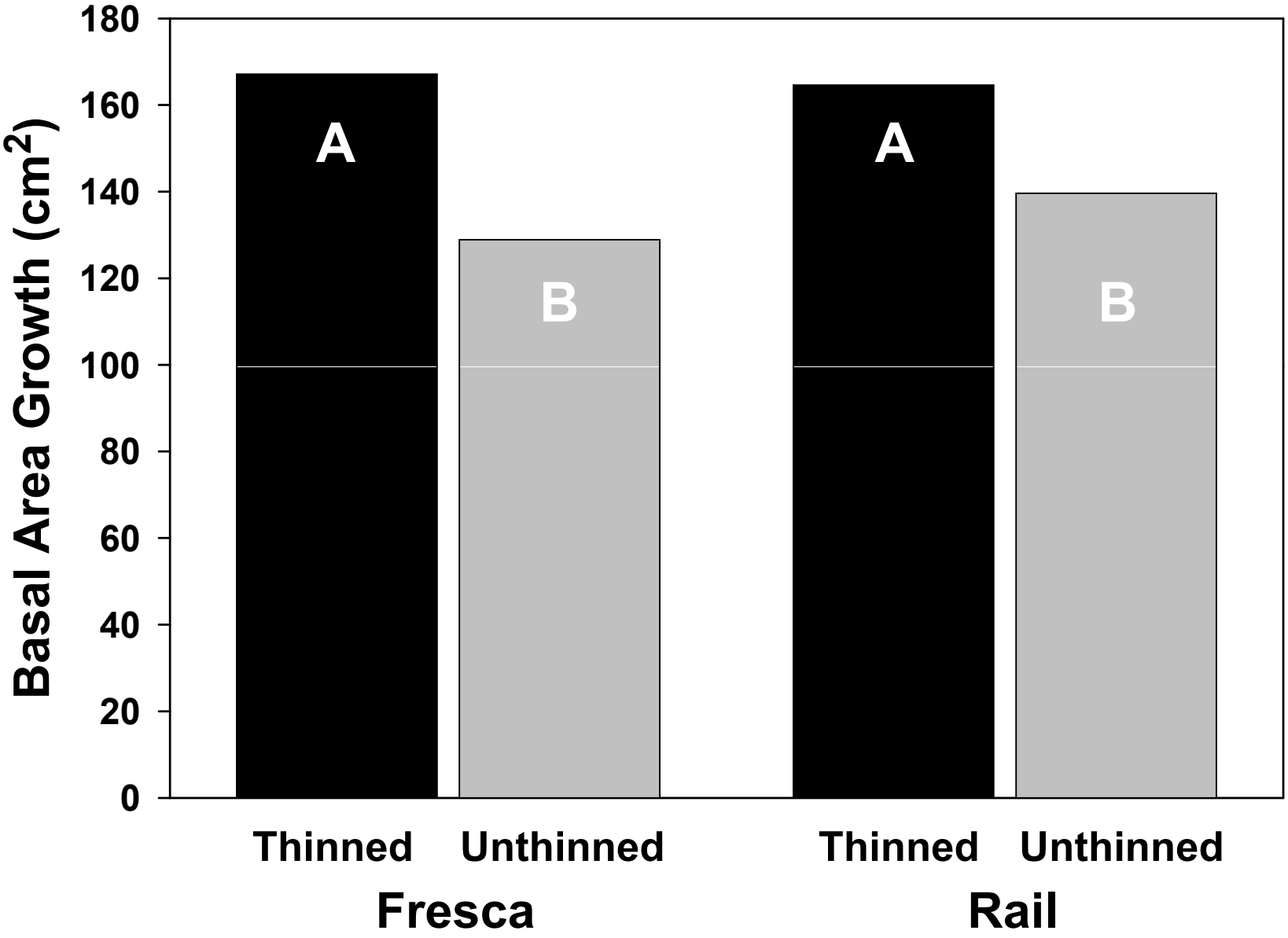
Change in % Shrub Cover



Understory development

- Initial conditions influenced 3-yr results
- Results differed across sites
- Thinning and gap creation
  - increased % cover of herb spp.
  - increased # of herb spp.
  - increased # of non-native spp.
  - reduced % cover of moss


Number of windthrown trees (per ha)
0
10
20
30
40
50
Bait
Fresca
Rail
Snow White
Block
Control, >20 cm
Control, <20 cm
Thinned, >20 cm
Thinned, <20 cm


Basal Area Growth (cm2)
180
160
140
120
100
80
60
40
20
0
A
B
A
B
Thinned
Unthinned
Thinned
Unthinned
Fresca
Rail

Tree growth summary

- Trees responded to thinning
- Tree size-class diversity will increase due to differential responses associated with:
  - species,
  - sub-treatments, and
  - edges
- Differential regeneration across the VDT unit will also increase future structural diversity.

Understory Reinitiation

- Characteristics of understory reinitiation stage
- Understory response
    - Herbs and shrubs
    - Tree regeneration
        - Advanced regeneration
        - Planted seedlings
        - New germinants
- Growth response of residual trees
- Summary

Summary

- Early thinnings more impact
- Late thinnings will ….
  - Probably increase tree growth and understory developement
  - likely reduce volume at final harvest
  - Push for longer rotations (holding period)
- Heavier thinning needed to establish and grow trees in understory
- Repeated thinnings may be needed to keep understory developing (manage it or lose it)
- Variable density thinning may promote development of greatest structural diversity

- Greatest opportunity to influence tree and stand development is in thinning young stands (Curtis and other 1998) – CR expansion is much greater

Thanks for your attention !