Operational Research Highlights

Timothy B. Harrington, PNW Research Station,
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1. Douglas-fir thinning and fertilizer responses on a droughty site

Reference: Miller et al. 2016

⬅ Thinned

Non-thinned ➡

Fertilizer application ➡

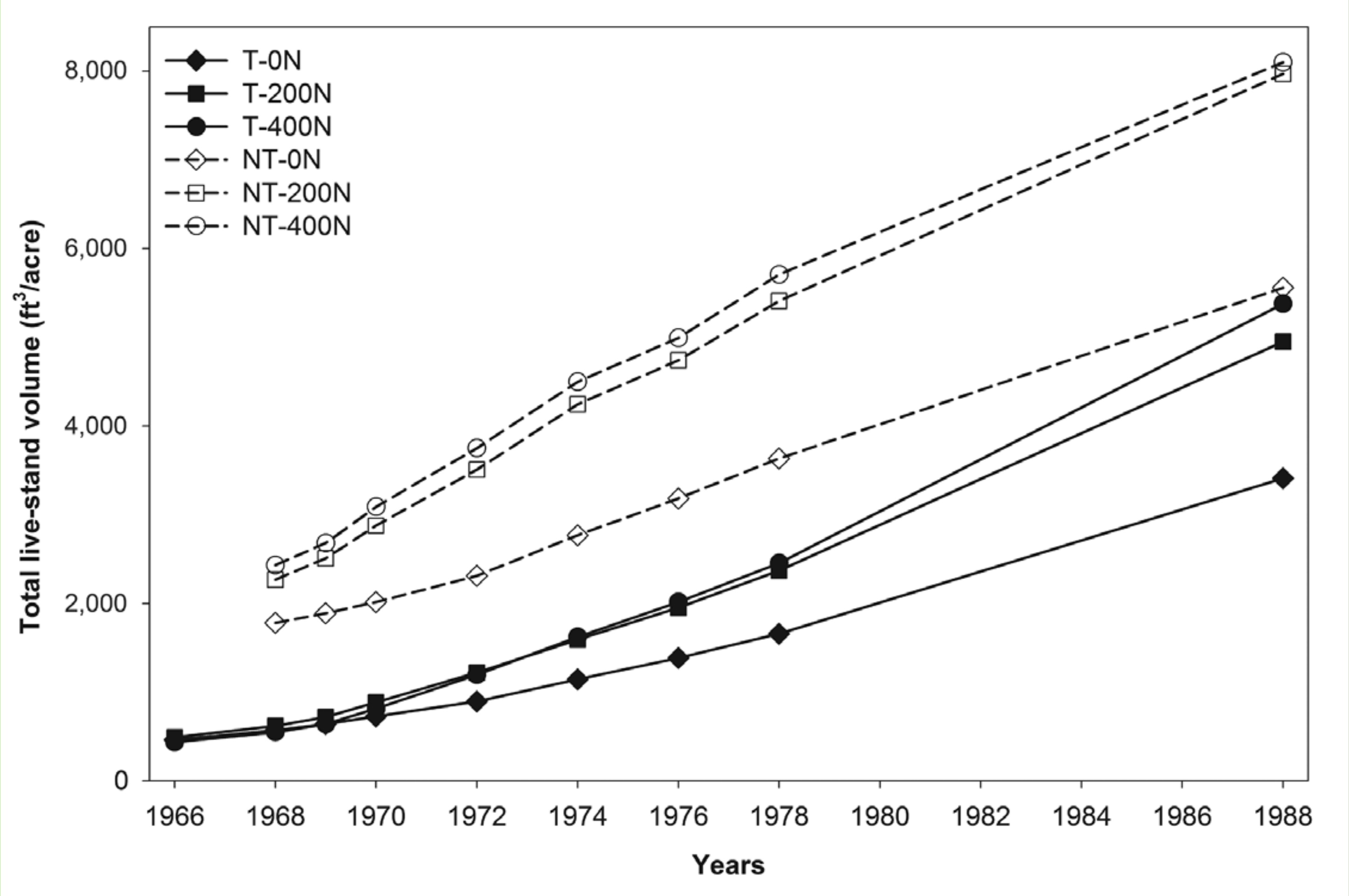
Stand volume

Thinned:

- 40-50% increase from fertilization.
- Accelerating response.

Non-thinned:

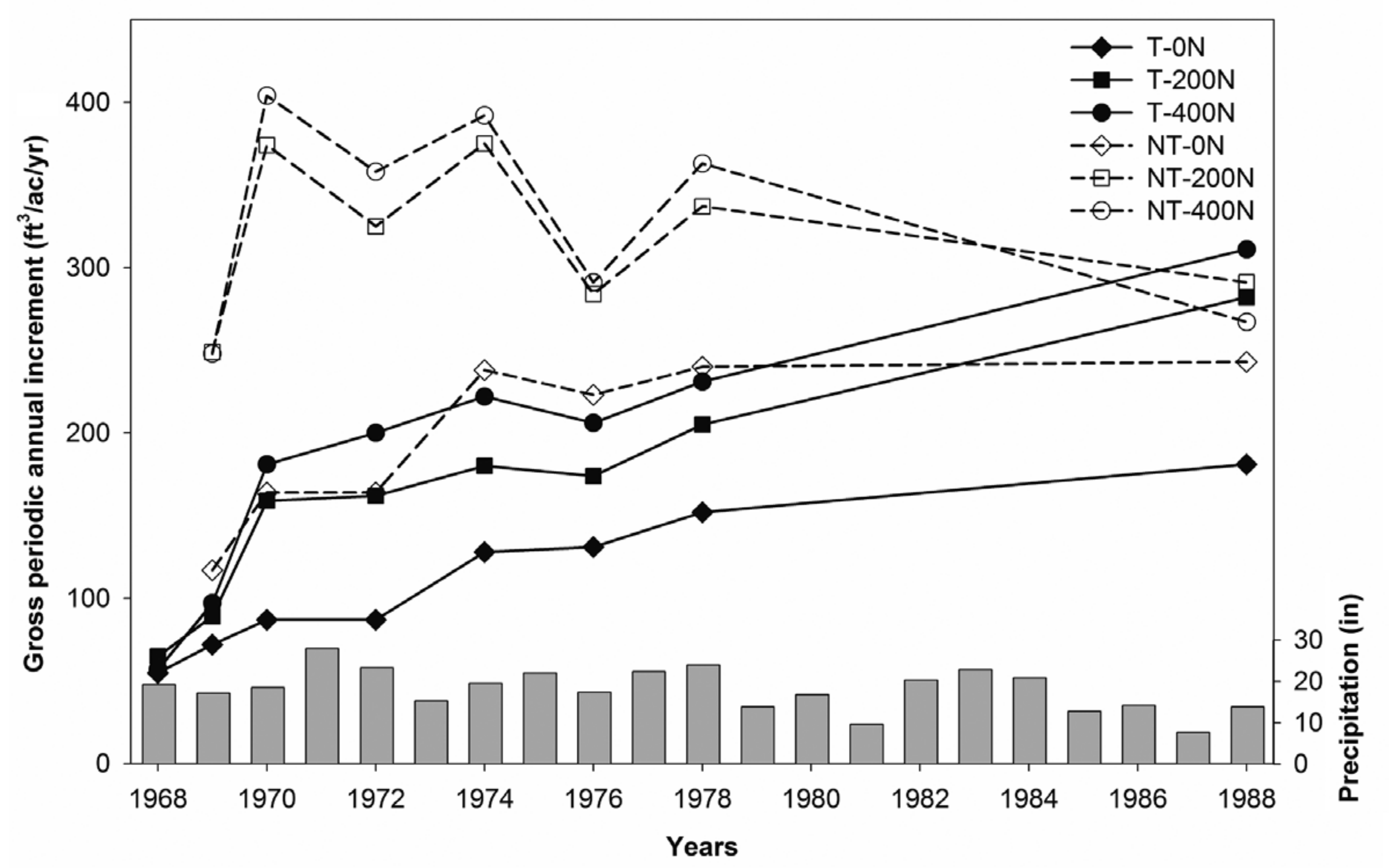
- 30% increase from fertilization.
- Decelerating response.



Gross PAI

Thinned: increasing growth; increasing fertilizer response.

Non-thinned: decreasing growth; decreasing fertilizer response.



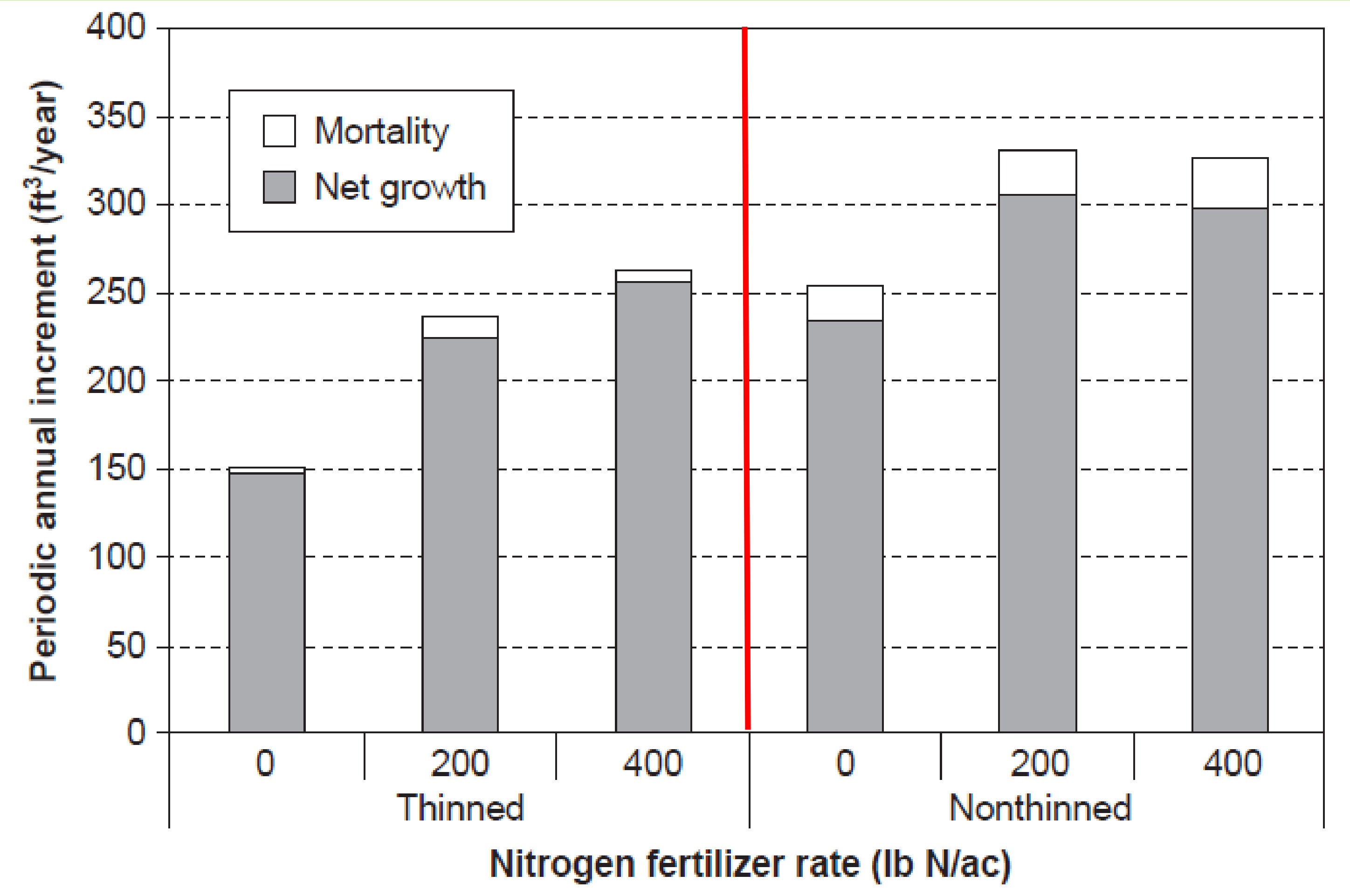
Mortality & Net PAI

Thinned:

- No effect of fertilization on mortality.

Non-thinned:

- Increased volume mortality from fertilization.



Economic analysis

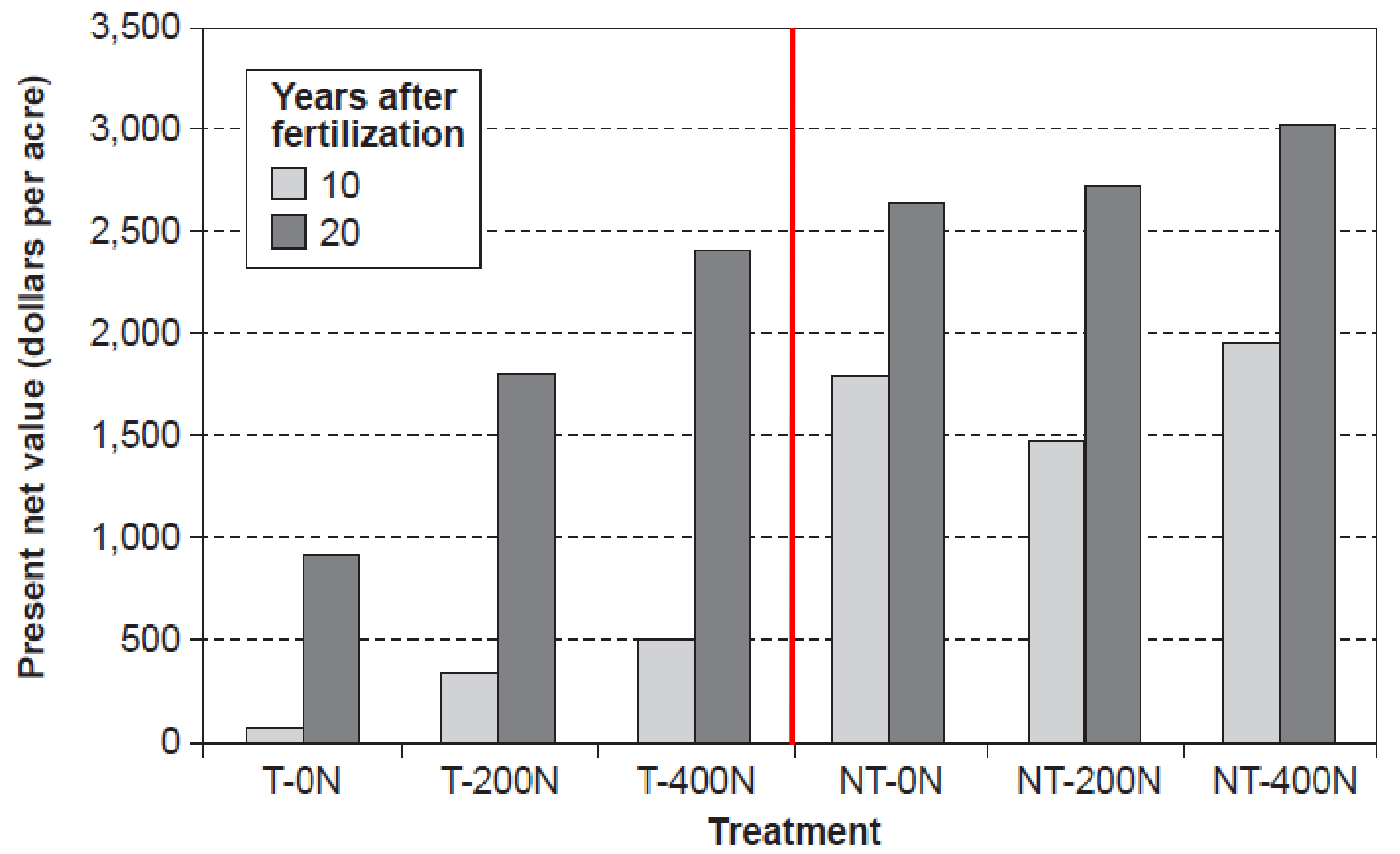
Thinned:

- Greater PNV when harvested 20 years after fertilization.
- Greater PNV from fertilization but no difference between 200N and 400N.

Non-thinned:

- Greater PNV when harvested 20 years after fertilization.
- No effect of fertilization on PNV.

T vs. NT: thinning reduced PNV of non-fertilized plots.



Assumptions of the economic analysis: merchantable volume estimate; 2008 product values; PCT=$60/acre (1963); $100 & $190/acre for 200N and 400N treatments, respectively; all costs and revenues standardized for 2014 dollars; no real change in wood product prices; did not account for logging/hauling costs or alternative investments; 5% discount rate. Thanks to Chuck Chambers & Jim Hotvedt!

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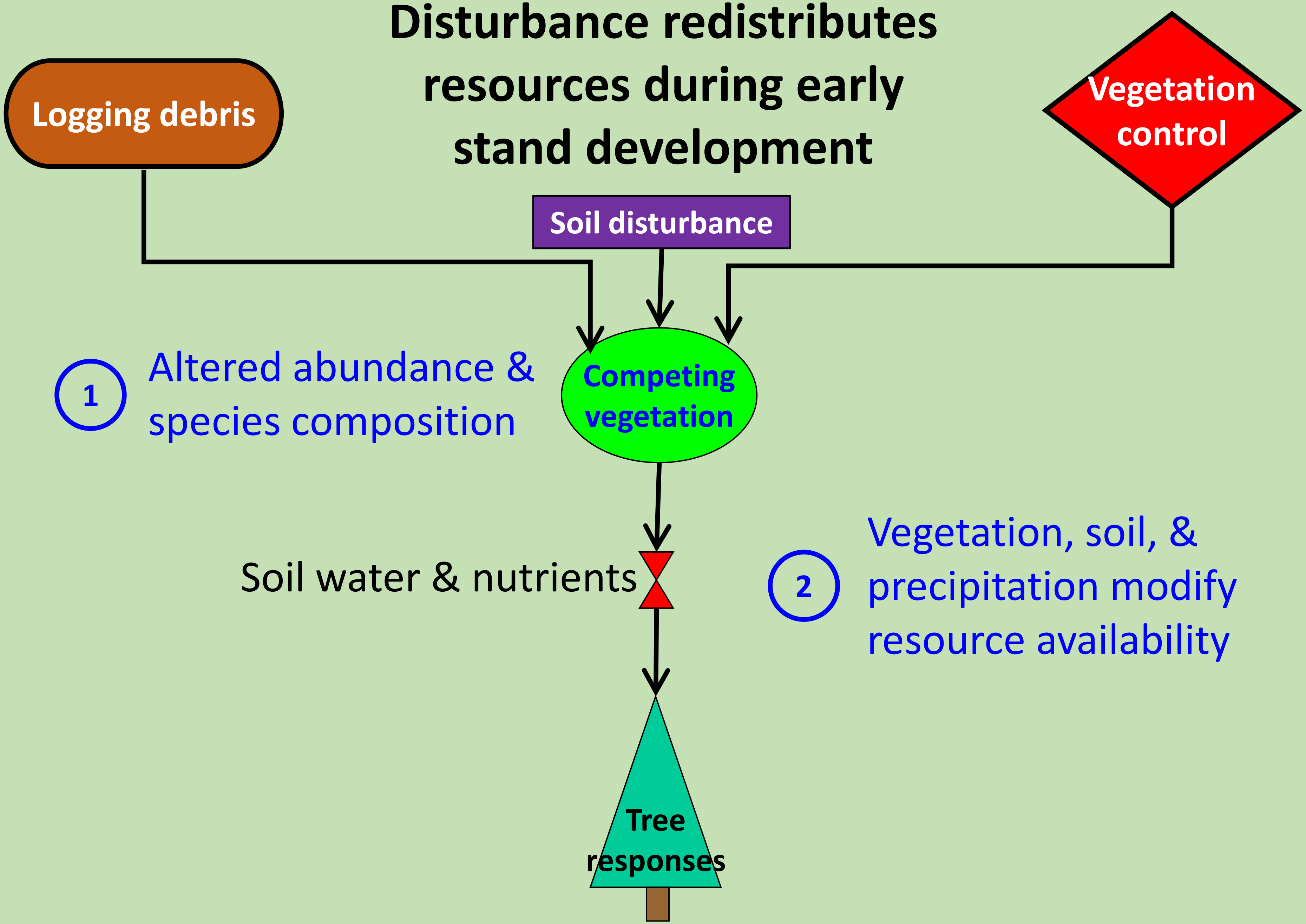
2. Preventing the development of recalcitrant plant communities

References: Harrington & Schoenholtz 2010; Harrington et al. 2018; Peter & Harrington 2018

Disturbance redistributes resources during early stand development



Logging debris

Soil disturbance

Vegetation control

① Altered abundance & species composition

Competing vegetation

Soil water & nutrients

② Vegetation, soil, & precipitation modify resource availability

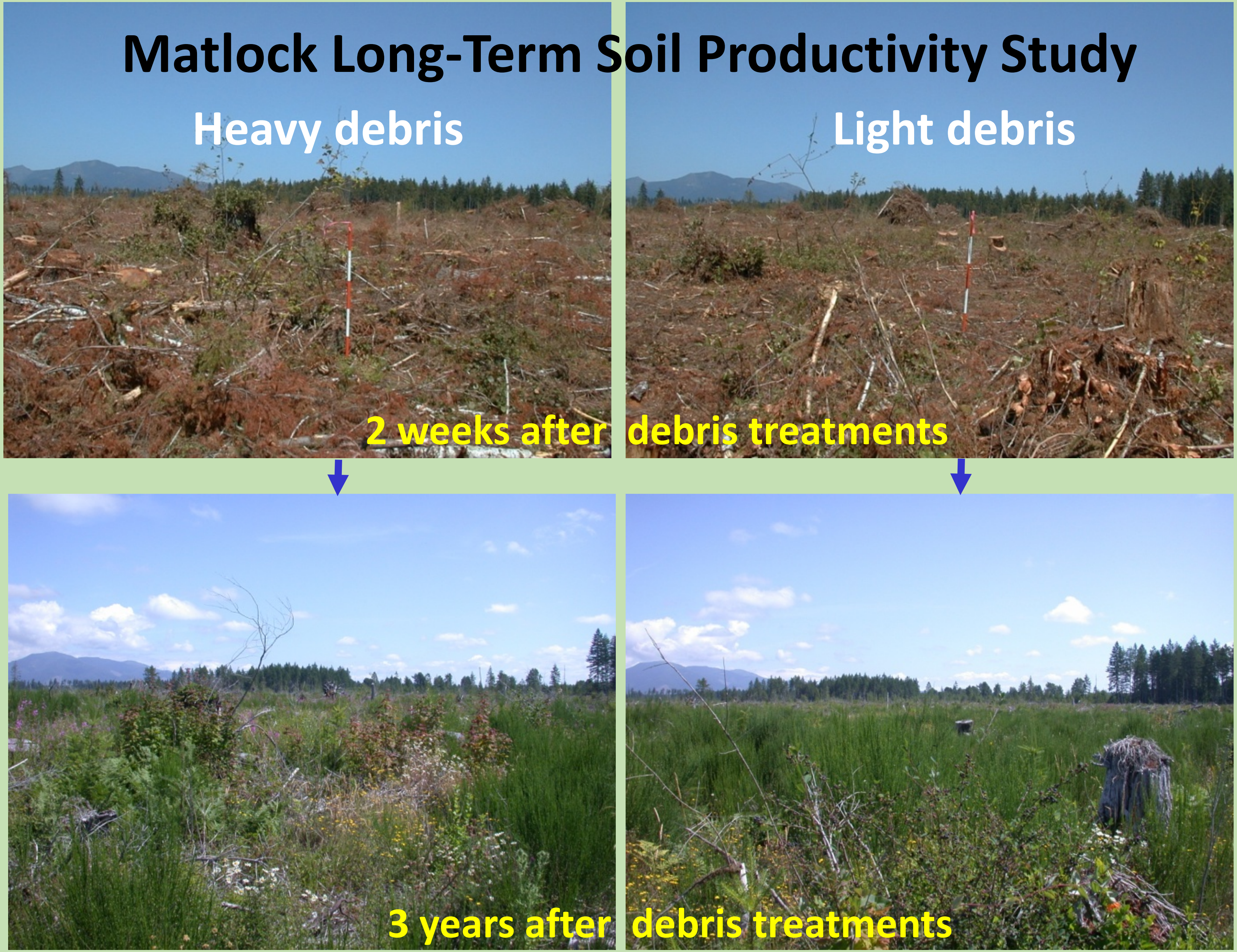
Tree responses

Logging debris treatments

Heavy debris: 9 tons/acre

Light debris: 4 tons/acre

Matlock Long-Term Soil Productivity Study



Heavy debris

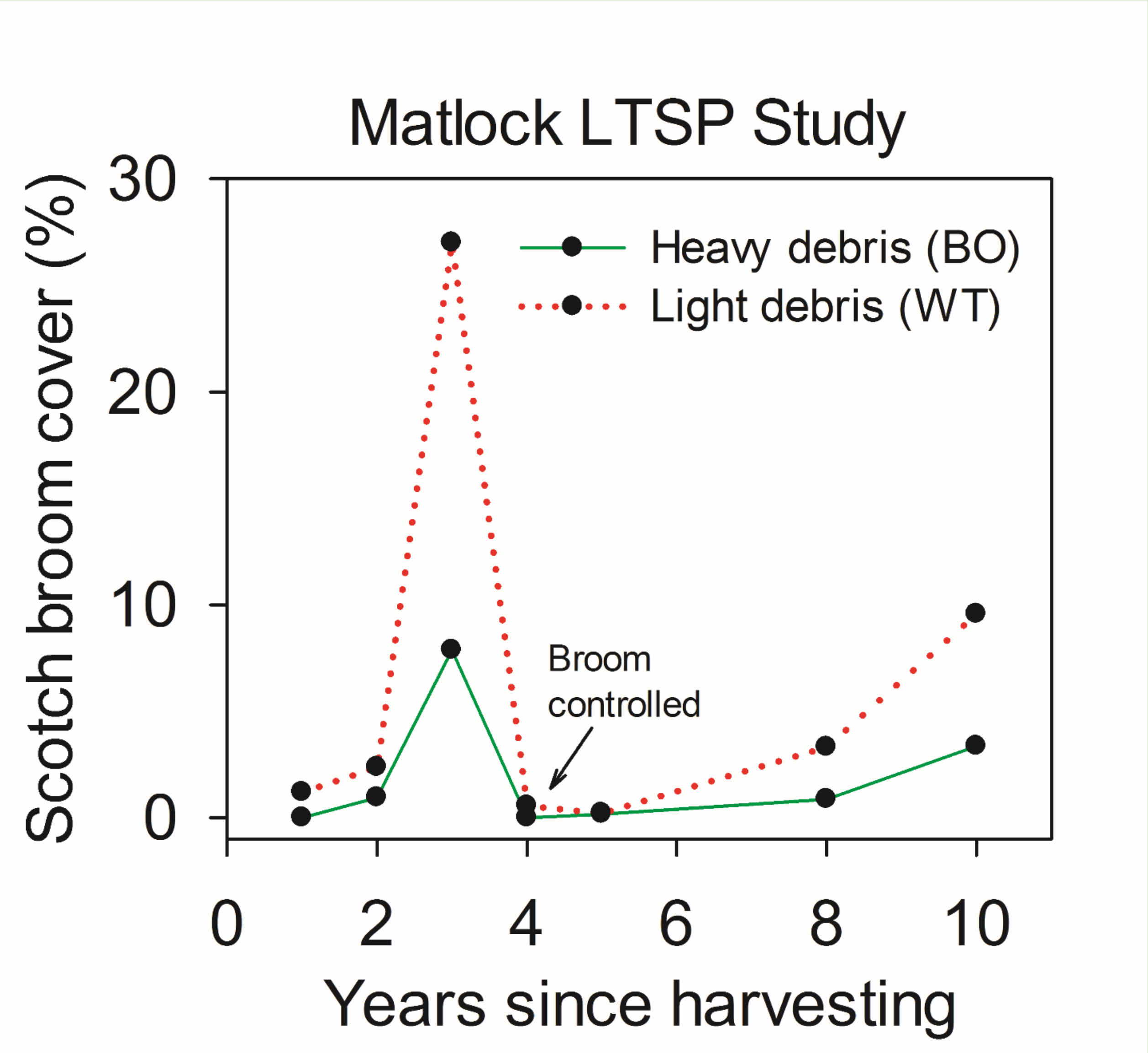
Light debris

2 weeks after debris treatments

3 years after debris treatments

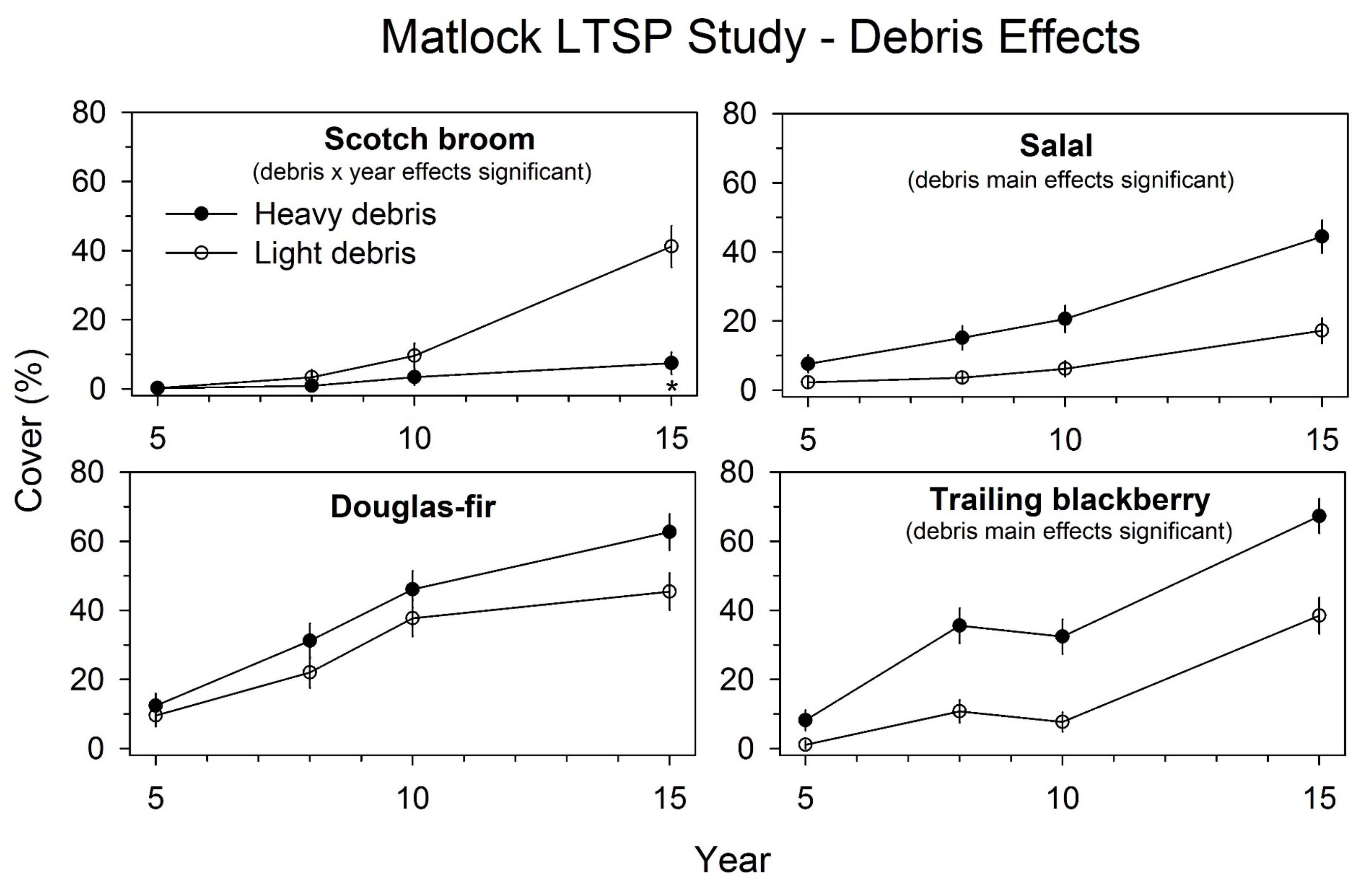
Surprising course of vegetation development

- Year 4: attempted to eliminate Scotch broom to prevent loss of study.
- By year 10, broom recovery was clearly dependent on the original logging debris treatments.
- Follow-up measurements were taken in year 15 (2018)…



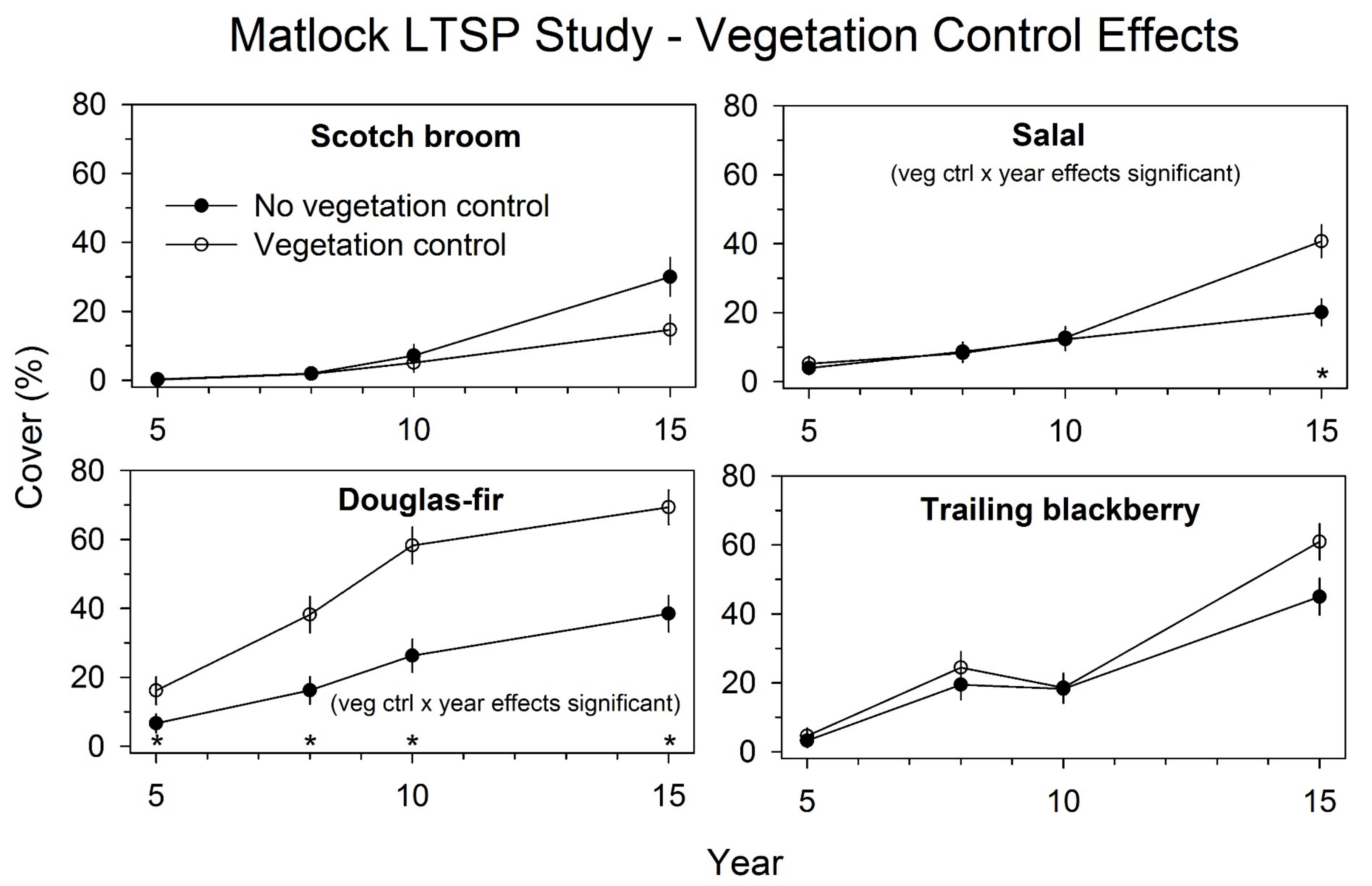
Debris effects

- Cover of Scotch broom was less in heavy debris.
- Cover of salal and trailing blackberry was greater in heavy debris ("trellising").
- Douglas-fir beginning to respond to heavy debris.



Veg. ctrl. effects

- 5 years of herbicide treatments had less effect on vegetation than the one-time debris treatment.
- Douglas-fir cover increased with vegetation control.



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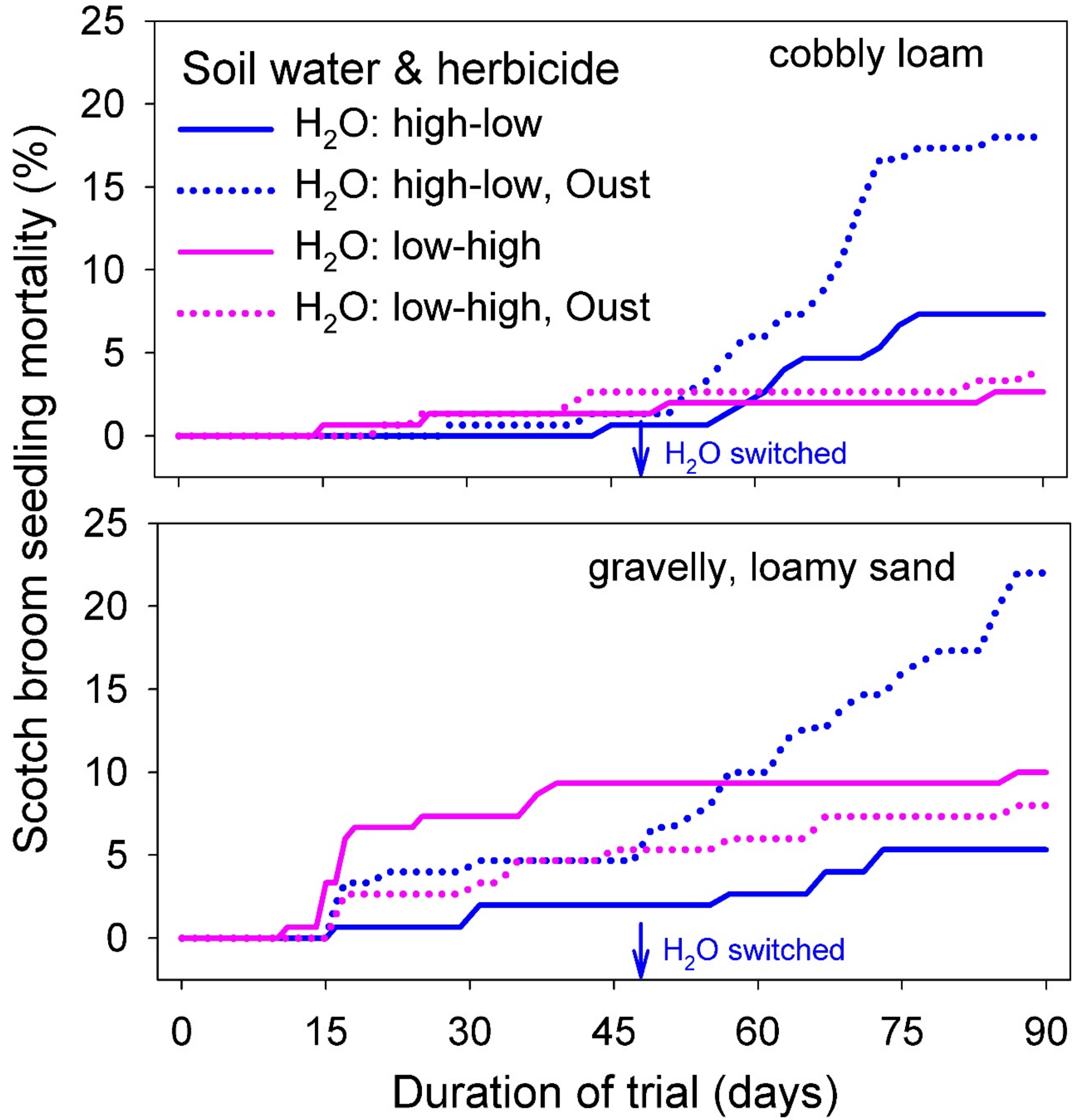
3. Methods for controlling Scotch broom

References: Harrington 2009; Harrington 2014; Peter & Harrington 2018

Sulfonylurea herbicides

- Oust® or Escort® herbicides cause little direct mortality of Scotch broom seedlings.
- What about environmental stress?
- In a growth chamber experiment, combining Oust® with soil drought accelerated broom mortality.



Sulfonylurea herbicides stunt broom seedling morphology

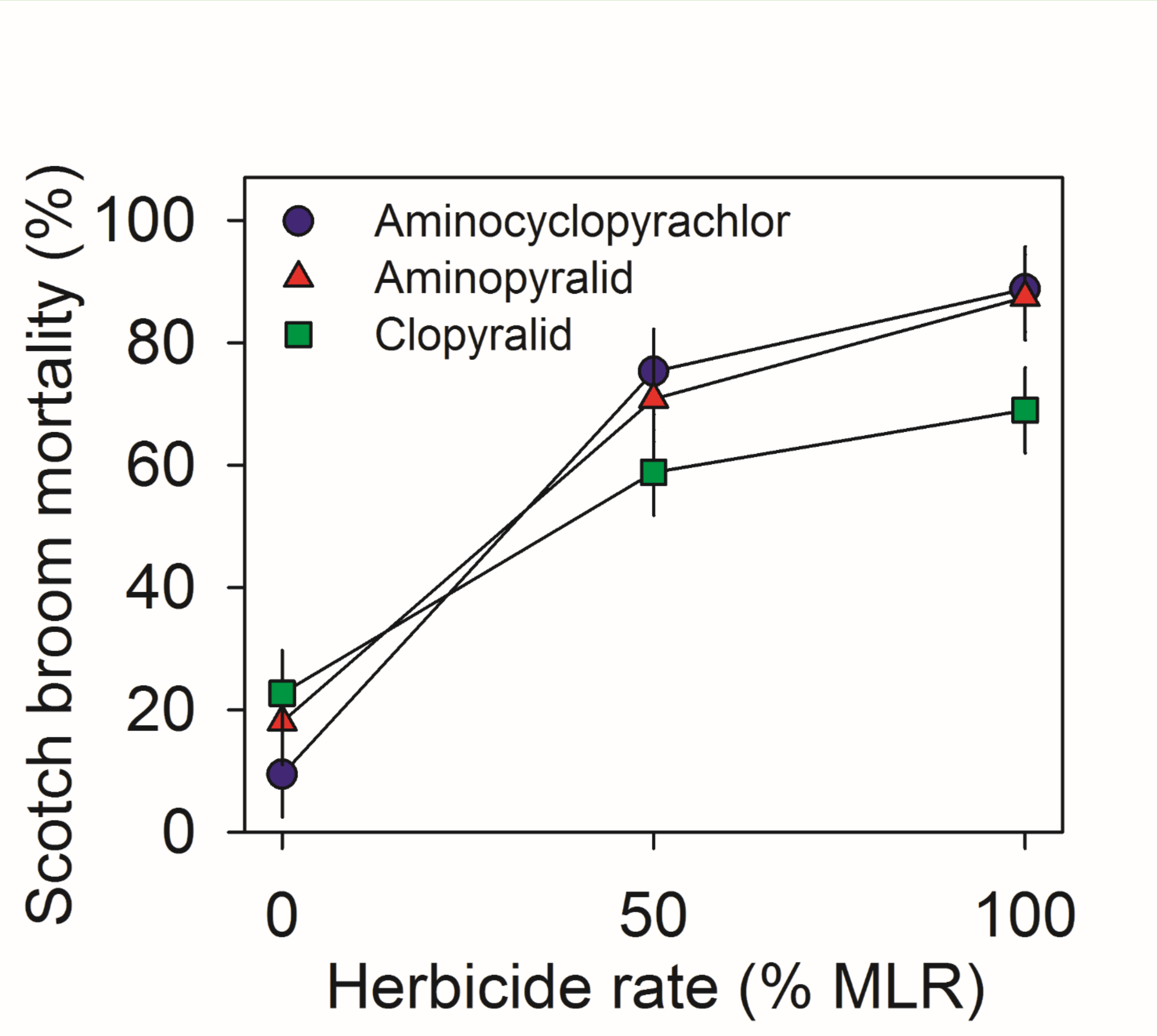
Non-treated seedlings @ 90 days

Sulfometuron-treated seedlings

Metsulfuron-treated seedlings

Synthetic auxin herbicides

- Soil-active herbicides having a mode of activity similar to auxin.
- Kill up to 90% of Scotch broom seedlings as they emerge from the soil surface.
- Moderate rates also effective; clopyralid somewhat less effective.



MLR = maximum labeled rate

Synthetic auxin herbicide effects on broom seedlings at 14 days

Non-treated check

Aminocyclopyrachlor

Aminopyralid

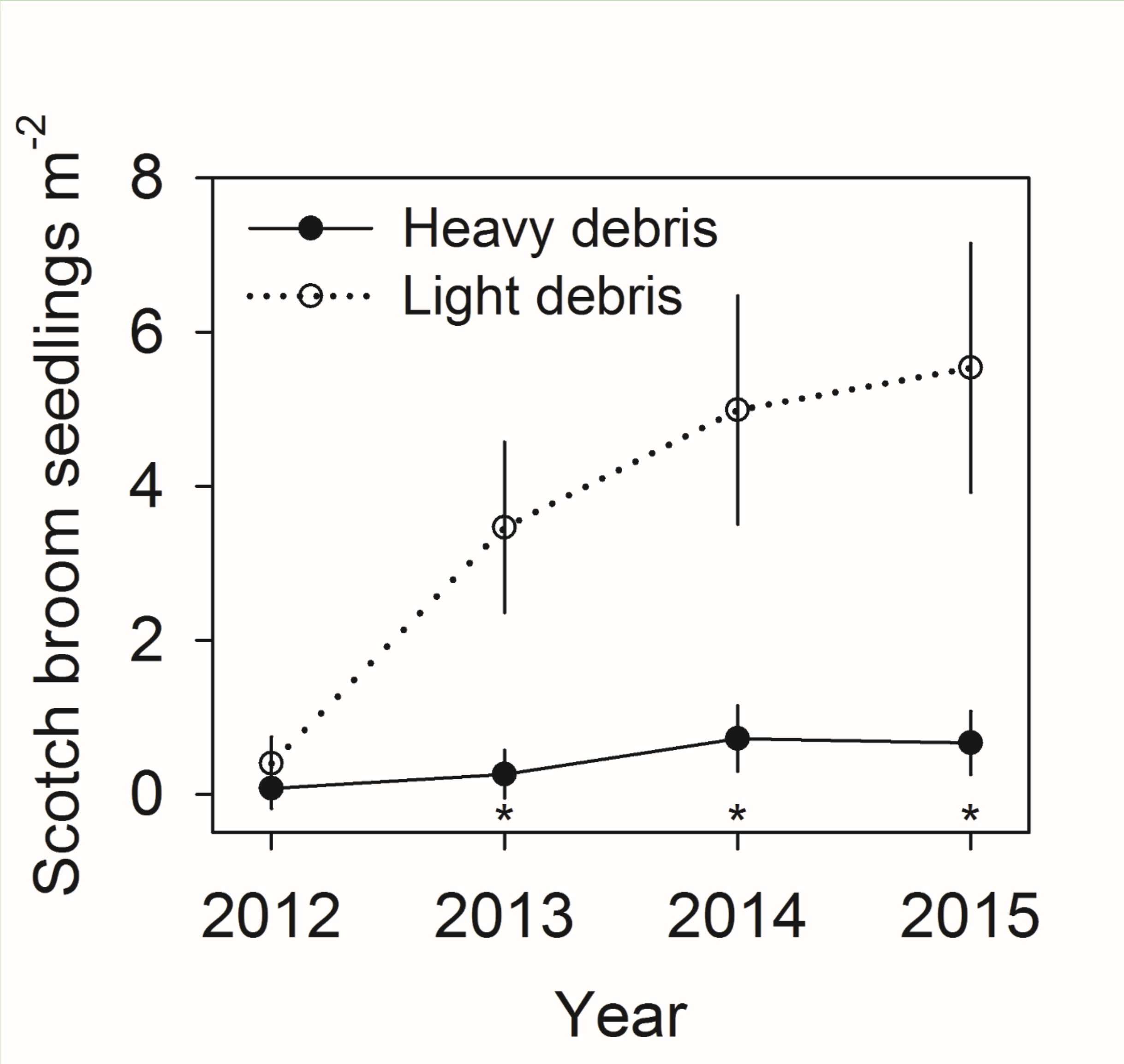
Clopyralid

Cost/efficacy comparisons among herbicides

Herbicide	**Herbicide rate**	**Herbicide cost**	**Broom seedling mortality**	**Cost per unit mortality**
	% max	$/acre	%	$ per %
Aminocyclopyrachlor	50	23	75	0.31
	100	47	89	0.52
Aminopyralid	50	10	71	0.13
	100	19	87	0.22
Clopyralid	50	13	59	0.22
	100	27	69	0.39

Logging debris effects on Scotch broom seedling emergence

- Rapid recruitment of Scotch broom seedlings under light debris; very little under heavy debris.
- Two-thirds of total recruitment occurs in the second year after forest harvesting.
- High density + high growth rates → rapid cover development.
- Long-term control from heavy debris because plant community resists invasion.



Mechanisms: cooler temperatures under debris + vines (trellising) reduce broom germination; shade (and shift to far red light) limits seedling biomass, especially roots.

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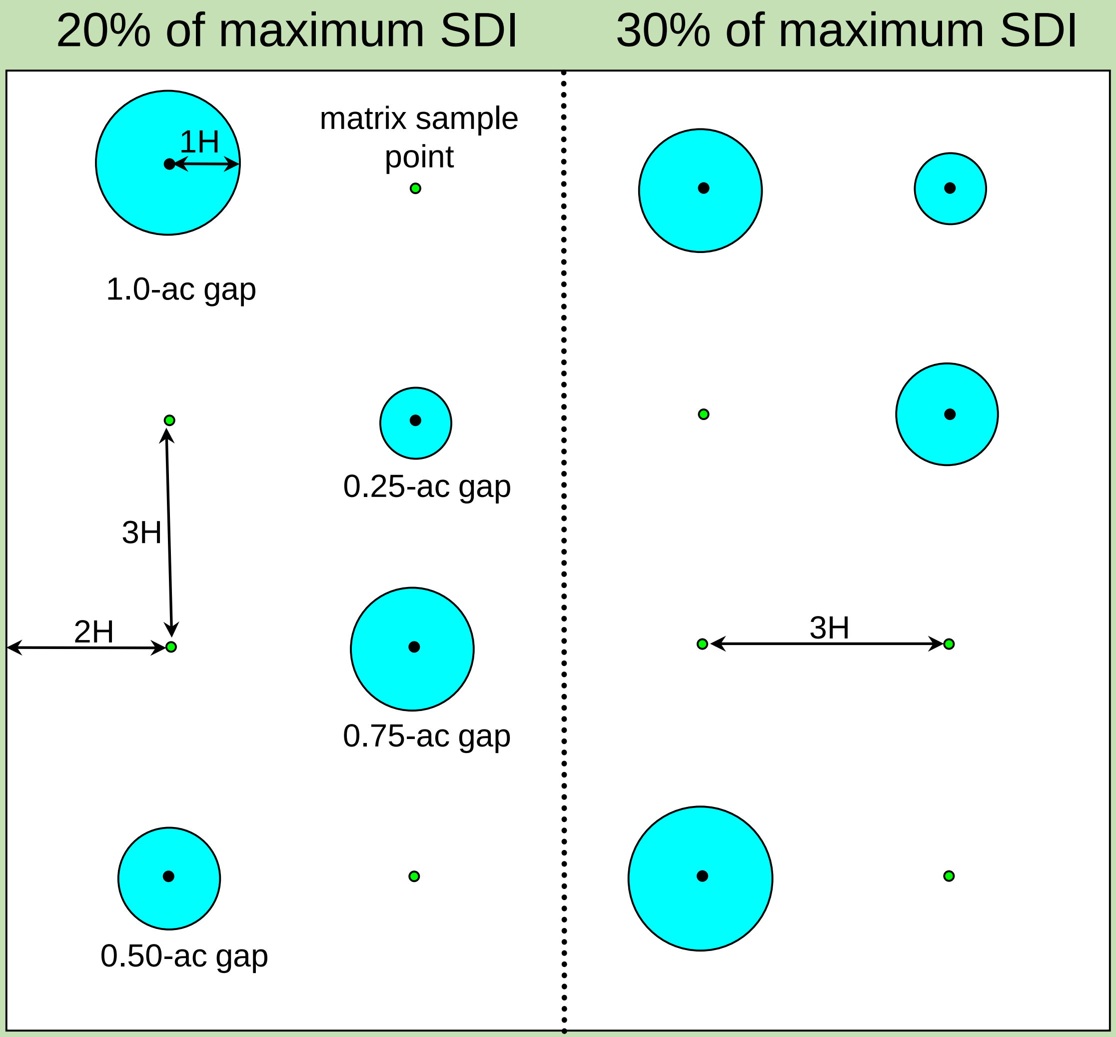
4. Conifer regeneration performance versus opening size

Reference: Harrington & Devine 2018

JBLM Gap Study

Example layout of matrix and gap plots within two thinning intensities

Identify the best conifer species and gap sizes for group selection silviculture at Joint Base Lewis-McChord (JBLM).



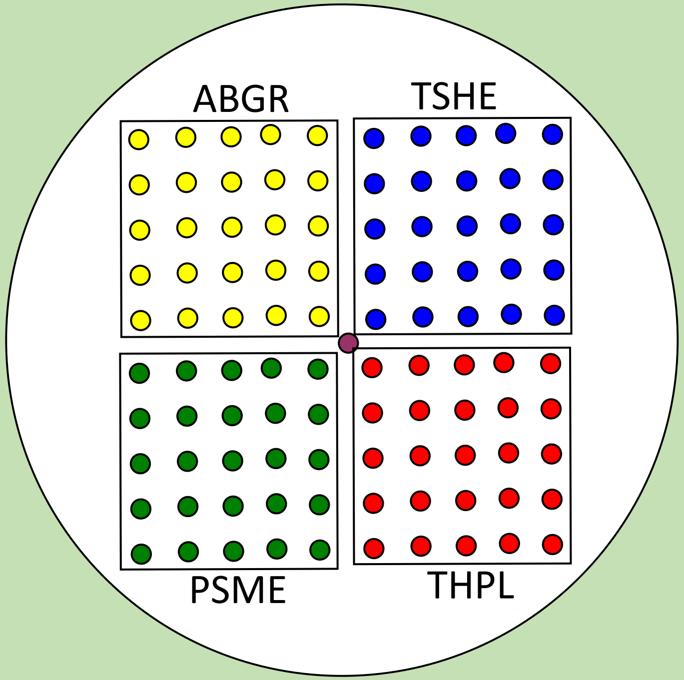
Species tested:

- grand fir
- Douglas-fir
- western redcedar
- western hemlock

Gap sizes tested:

- No gap (matrix)
- 0.25 acre
- 0.5 acre
- 0.75 acre
- 1.0 acre

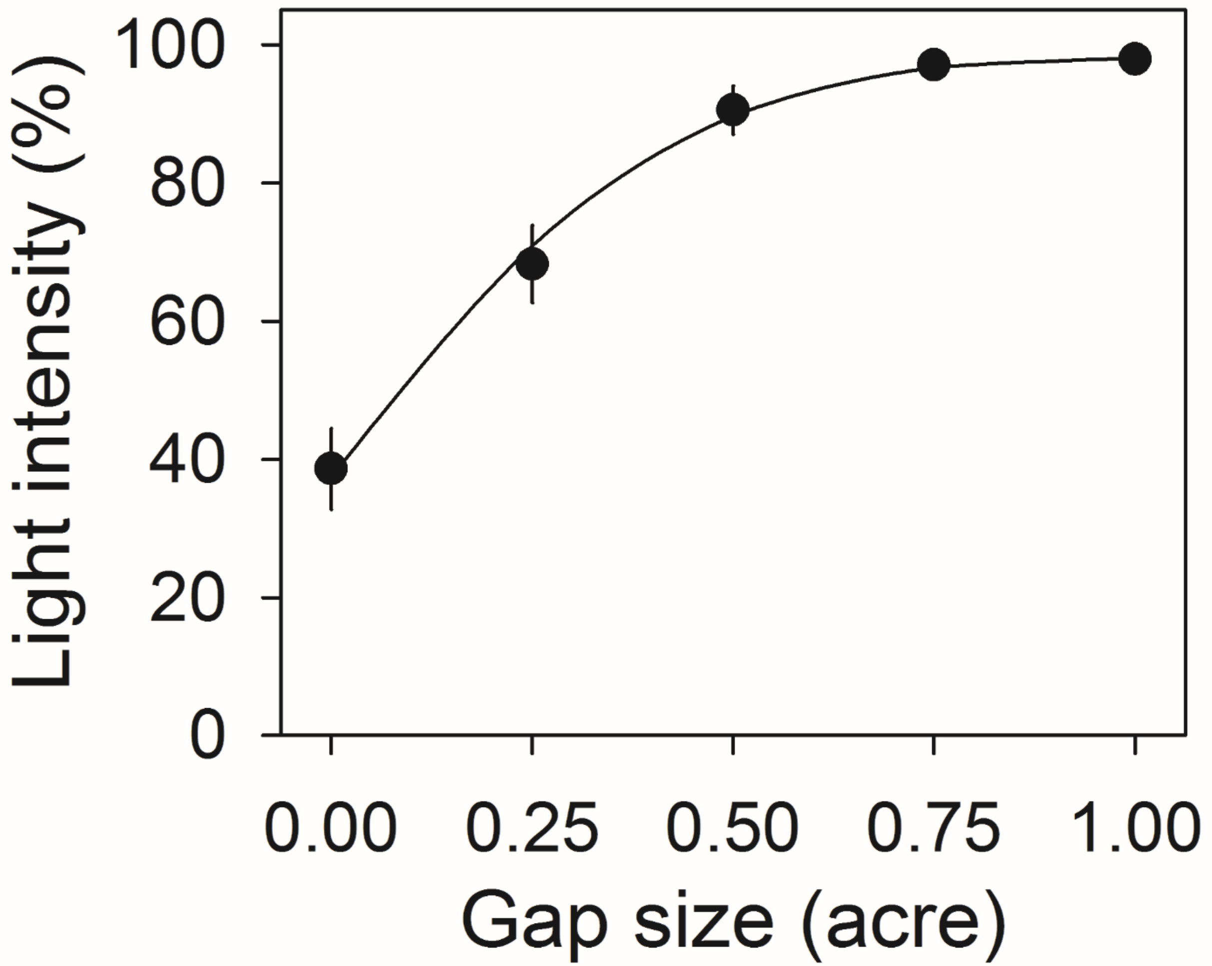
Planting grid (8’ spacing) near center of each gap



Matrix area thinned to 30% of maximum SDI; 1-acre gap in background

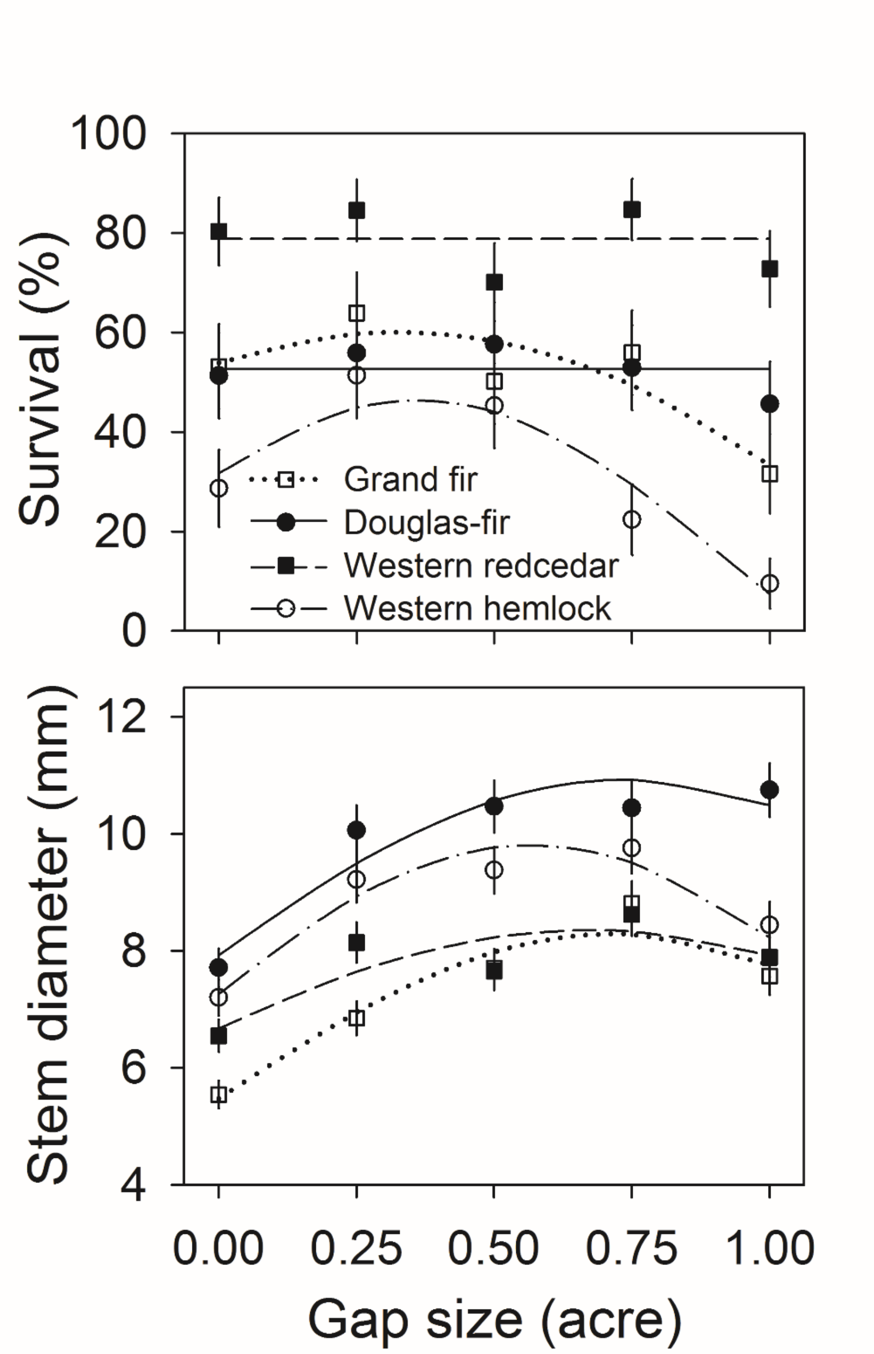
Gap size effects on light

- At gap sizes of 0.5 acre and greater, light intensity was 91 to 98% of full sun.
- Light intensity was 39 and 68% for forest matrix and 0.25-acre gaps, respectively.



Gap size effects on conifer regeneration

- Stem diameter at planting: Douglas-fir (5 mm) > western redcedar (4 mm) > grand fir (3 mm) = western hemlock (3 mm).
- Year 3:
  - Survival of Douglas-fir and western redcedar did not vary with gap size, but survival of grand fir and western hemlock peaked at a 0.3-acre gap size.
  - Peak values of stem diameter occurred within a narrow range of gap sizes for all species (0.6-0.7 acre).
- Douglas-fir and western redcedar were the best performers (partly due to larger initial size).



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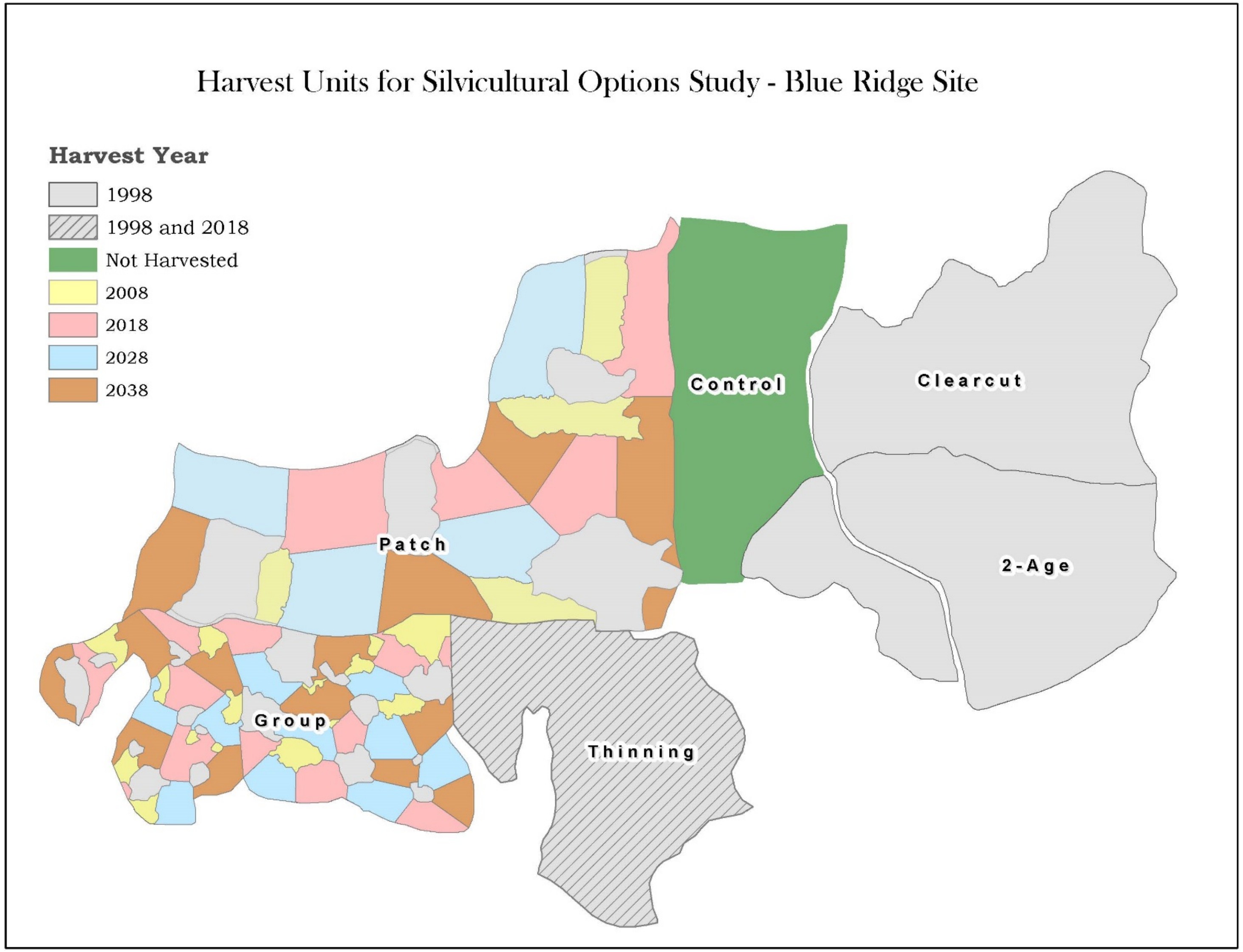
5. Comparing stand growth among various silvicultural systems

Reference: Curtis et al. 2004

Silvicultural options study

- Capitol State Forest, WA DNR; three sites: Blue Ridge (installed 1998), Copper Ridge (2002), and Rusty Ridge (2004).
- 50-year rotation.
- 10-year cutting cycle for patch and group treatments; 20% of area harvested at each entry.
- Second thinning in year 20; Curtis RD reduced to 40.
- Two-age treatment repeated in year 50.



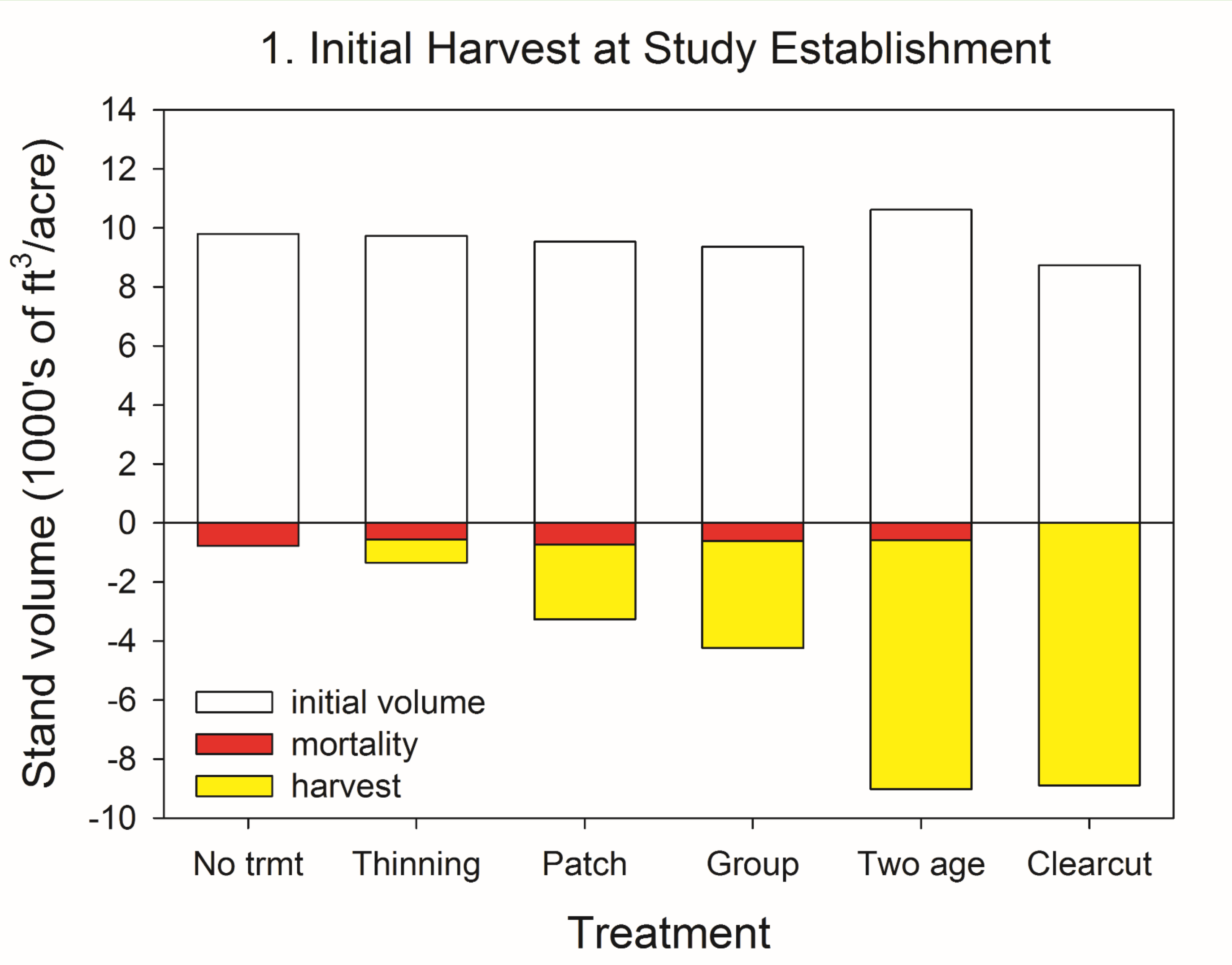
Silviculture Options Study

2009 Photographs from Blue Ridge

Aerial photographs by James Dollins, PNW Research Station

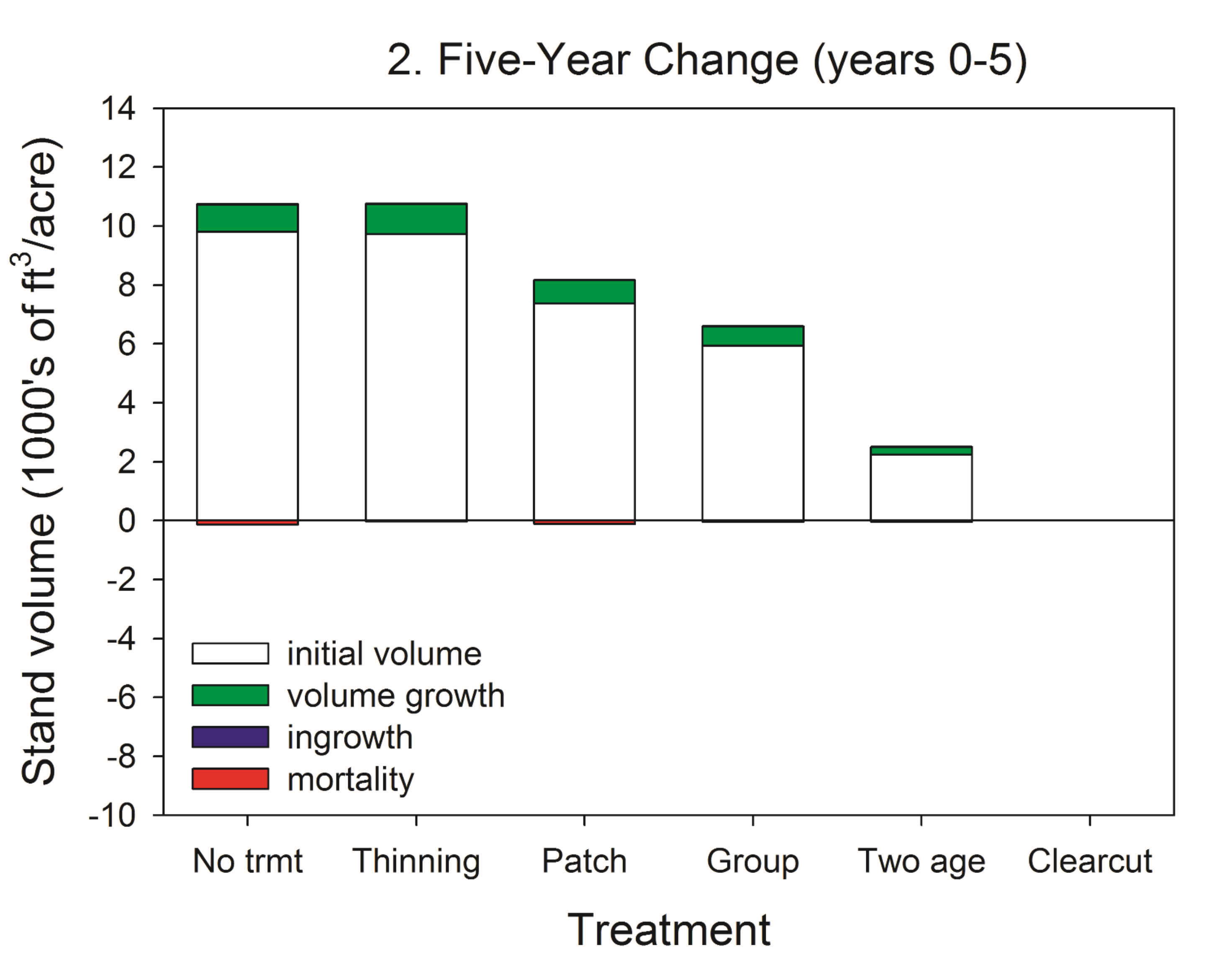
Initial conditions

- Initial volume differed little among treatments at the beginning of the study.
- Harvesting intensity varied with treatment.



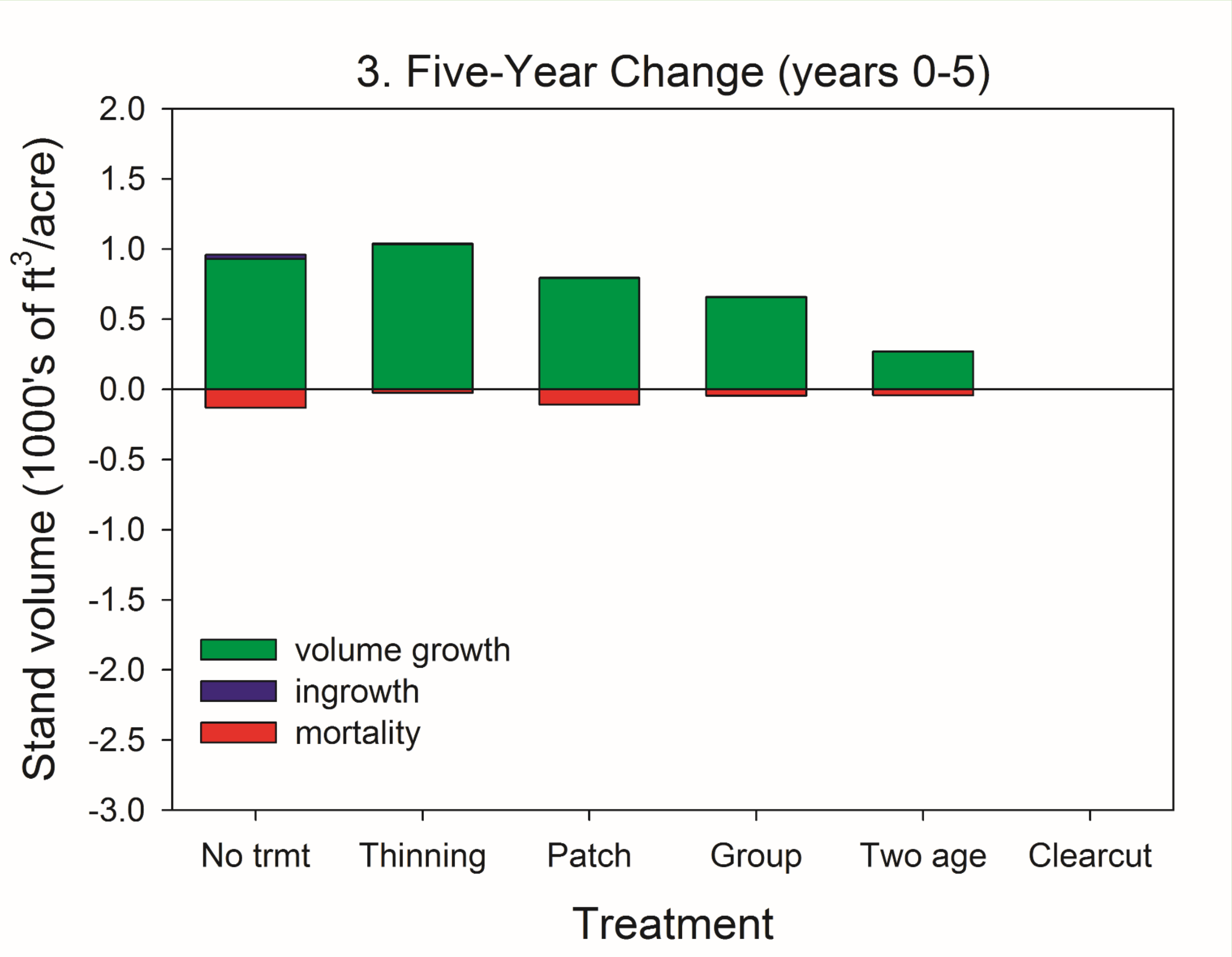
First five years…

- Volume growth increased with the level of growing stock.



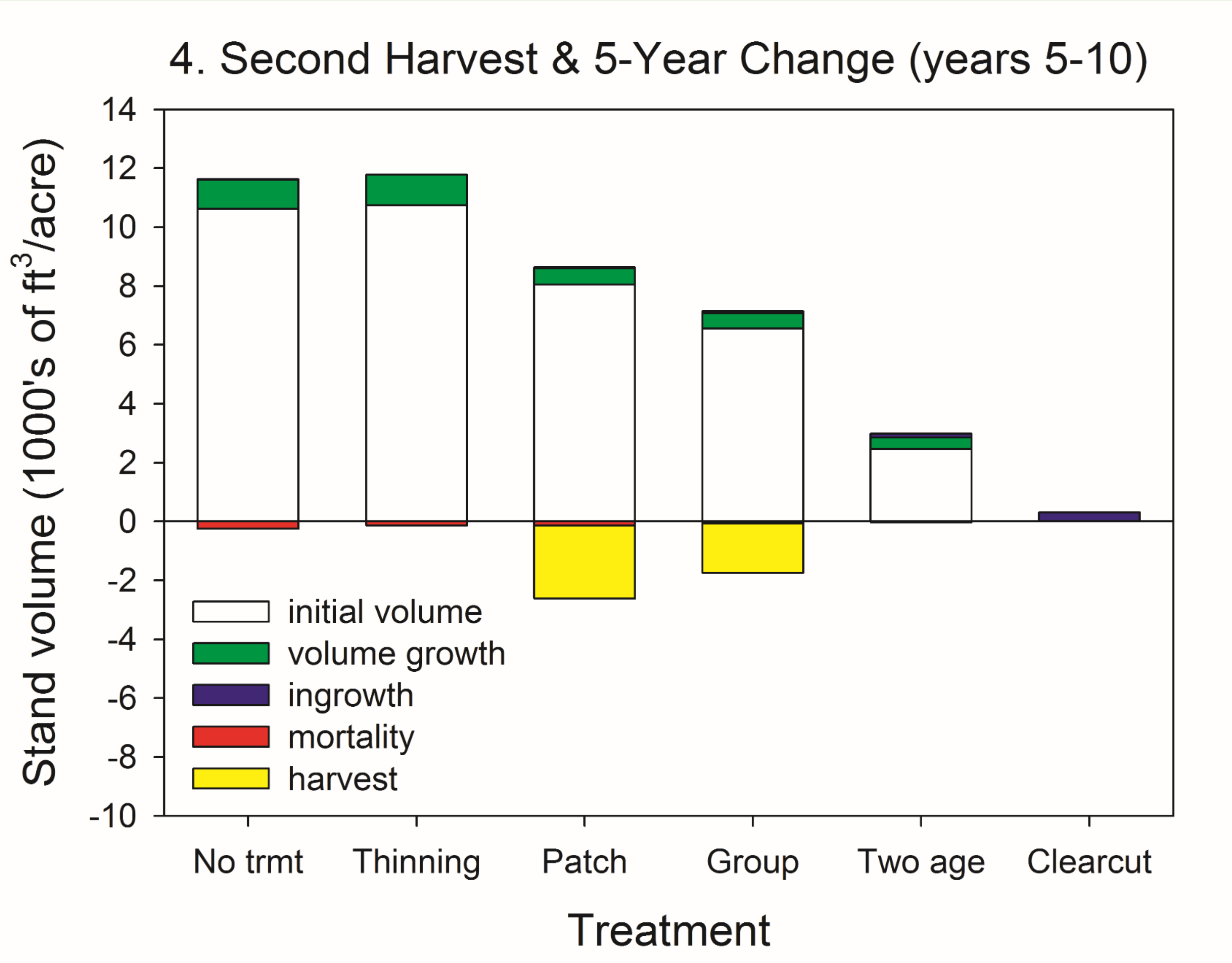
First five years…

- Mortality volume in the clearcut treatment was less than in each of the other treatments.
- Very little in-growth (1.6” dbh).



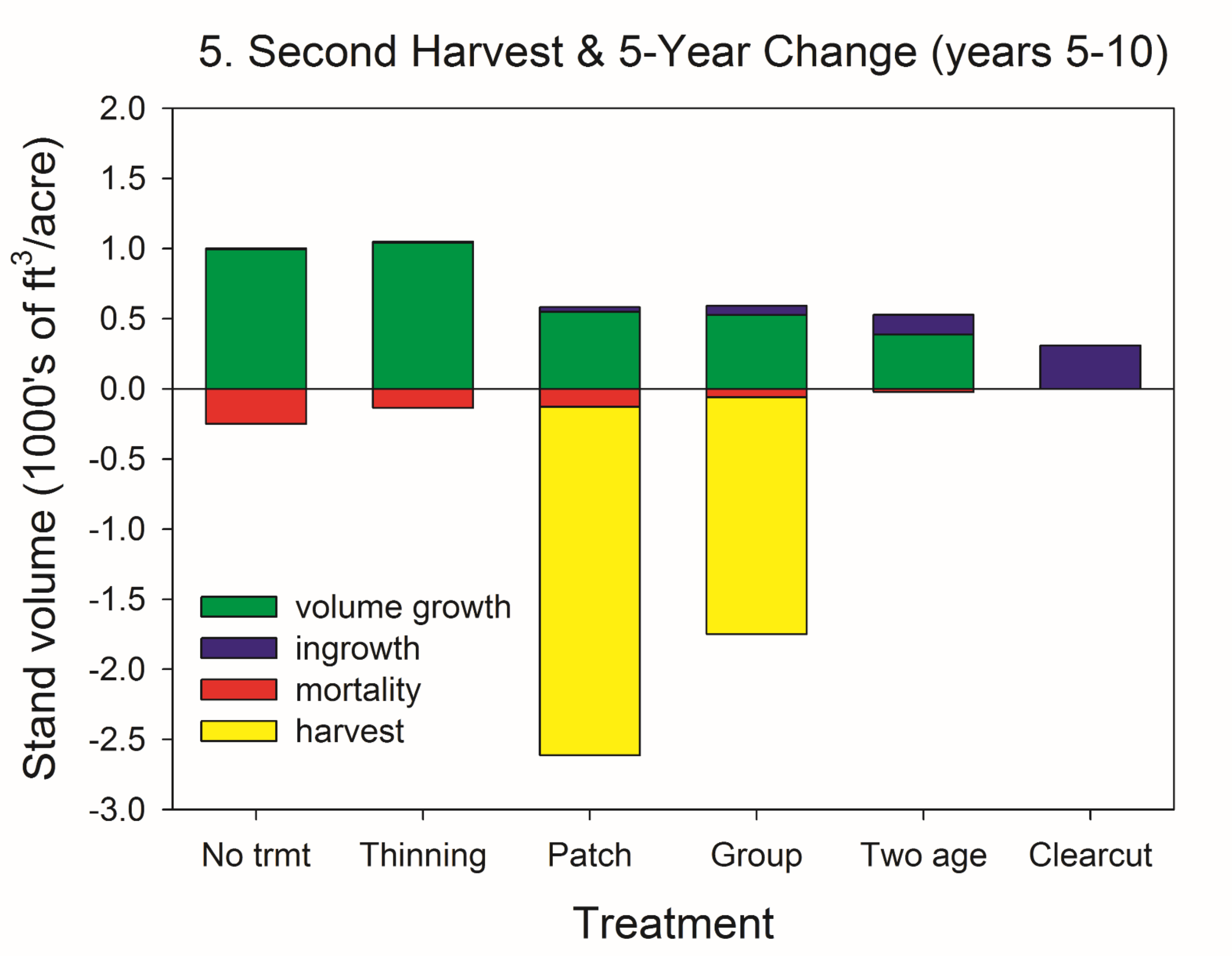
Second five years…

- Second harvest for patch and group treatments.



Second five years…

- Again, mortality volume less in the clearcut.
- Volume growth increased with the level of growing stock.
- Considerable in-growth in the clearcut and two-age treatments.



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References (most available at: https://www.fs.usda.gov/pnw-beta)

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