Short- and Long-Term Growth Responses of Northern Rocky Mountain Conifers to Varying Thinning Intensities

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Overview:

- Dendrochronology (i.e., tree ring analysis) was used to examine diameter growth responses to different precommercial thinning intensities over 50 years after treatment in the moist mixed-conifer forests of northern Idaho. Data were paired with inventory data 11 and 50 years after thinning.
- All species showed immediate diameter growth releases, but releases for grand fir and western hemlock were weaker and shorter term than western redcedar and western larch. While growth slowed in the no thinning treatment for western larch and western redcedar as time proceeded, growth of both species remained significantly greater over a 30–40 year period in all thinning treatments compared to the no thinning treatment.
- This is the first study to follow an experimental precommercial thinning experiment in the moist mixed-conifer forests of northern Idaho 50 years after thinning. The species-specific responses provide guidance on species that should be selected as residual trees after thinning to maintain rapid tree growth and desirable species composition (i.e., western larch and western redcedar) to meet a variety of management objectives including timber, carbon sequestration, and restoration of early successional forest composition.

Summary:

Moist mixed-conifer forests of the northern Rocky Mountains often contain thousands of stems per acre following stand-replacing disturbance. Many of these trees are shade tolerant species such as grand fir and western hemlock, even though current management objectives aim to increase density of early seral species such as western larch. Managers are faced with questions on how best to manage these overstocked stands and thinning is often a proposed solution. Knowledge on changes in stand structure over long periods of time following thinning are limited in these forests. This study applied various thinning intensities to 27-year-old naturally regenerated stands on the Priest River Experimental Forest. The study was resurrected in 2017 when 50-year post-thinning measurements were collected. Results from

the tree core analysis showed species-specific responses to thinning (fig. 1). Western larch and western redcedar showed substantial increases in growth immediately after thinning that persisted multiple decades into the future. Comparatively, grand fir and western hemlock did increase in growth, but the increase was not as great and did not persist as many years into the future. The 50-year remeasurement of the inventory plots found that the density of large trees (≥ 5 in d.b.h.) and basal area remained lower in the thinned plots compared to the unthinned plots (table 1). Stand structure modified by the thinning remained 50 years after thinning with the unthinned plots containing a much greater density of trees in suppressed and intermediate crown classes, while trees in the thinning treatments were more concentrated in the codominant crown class (fig. 2).

Silvicultural Concepts:

- Thinning is a frequently applied silvicultural treatment that can be used to achieve various silvicultural objectives, including shifting species composition, increasing and maintaining growth of residual trees, and modifying stand structure. Thousands of acres across the moist forests of the Northern Rockies are in need of thinning and budget constraints often limit treatment to a single application. Long-term results from thinning studies in the region are helpful in providing justification for early thinning. Results from this study show growth responses of western larch and western redcedar were sustained 30–40 years after thinning. This is promising given these species are often considered desirable for contemporary management objectives across the National Forests in the Northern Rockies. Thinning also resulted in long-term shifts in stand structure towards stands dominated by codominant trees. The intensity of thinning had minimal impact on changes in tree growth or stand structure over time.
- Analysis of tree cores is a powerful tool for understanding changes in growth in response to silvicultural treatments without access to frequent inventory data that can be costly to collect. The method of tree ring analysis used in this study was able to detect sustained growth responses over a 40-year period following treatment when compared to trees in plots that were not thinned.

Management Applications:

- Thinning in naturally regenerated moist mixed-conifer forests of the Northern Rockies can shift trajectories in individual tree growth that vary by species and stand structure. Thinning from below can increase growth of residual trees in these forests. By favoring western larch and western redcedar as residual trees, growth will be sustained multiple decades after treatment. Since growth is related to vigor, thinning can result in sustained resistance to biotic attack.

- One-time application of thinning in young, naturally regenerated stands has the potential to result in stands where a majority of trees persist in the upper canopy and potentially minimize continual regeneration of shade tolerant western hemlock and grand fir.
- Results from this study suggest that the intensity of thinning did not matter after 50 years in terms of individual tree growth or stand development after 50 years. Instead, performing any type of thinning provides the opportunity to alter structure.

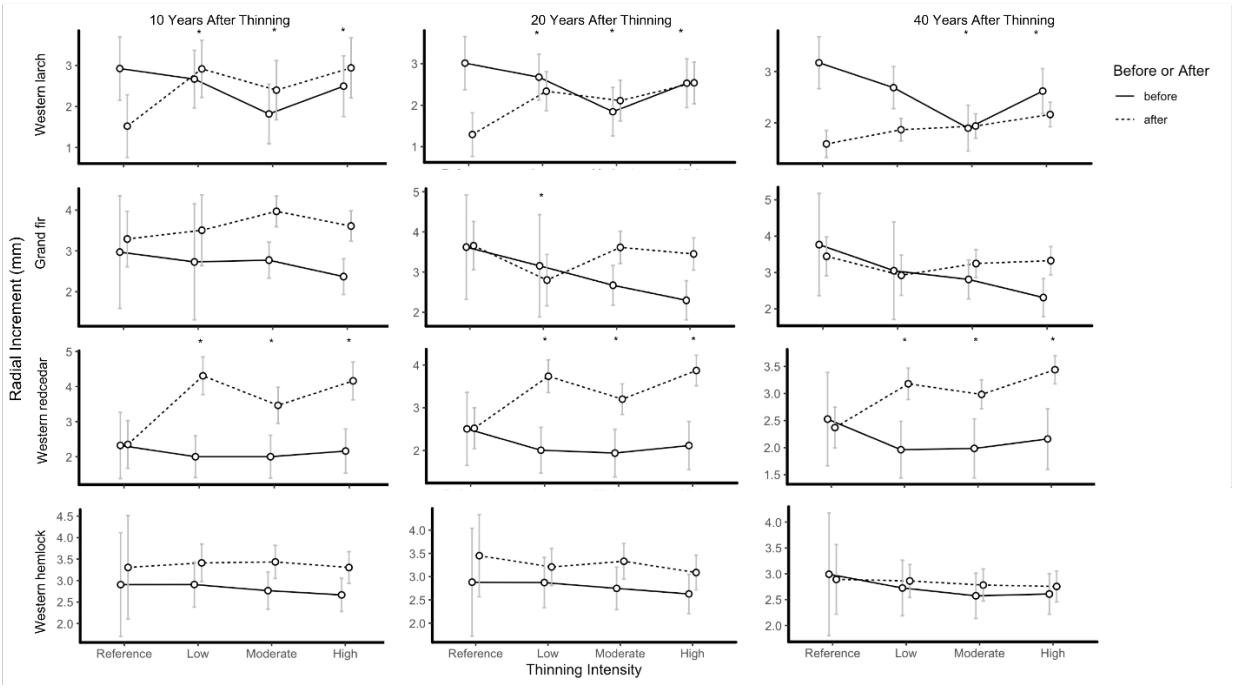

Figure 1—Radial tree stem increment from tree cores showing the increment before treatment (solid line) and after treatment (dotted line) at different time periods after thinning to different intensities. Also shown are before and after growth in untreated reference plot. Asterisks above data points indicate significantly different growth before and after for a given treatment at $p \leq 0.05$.

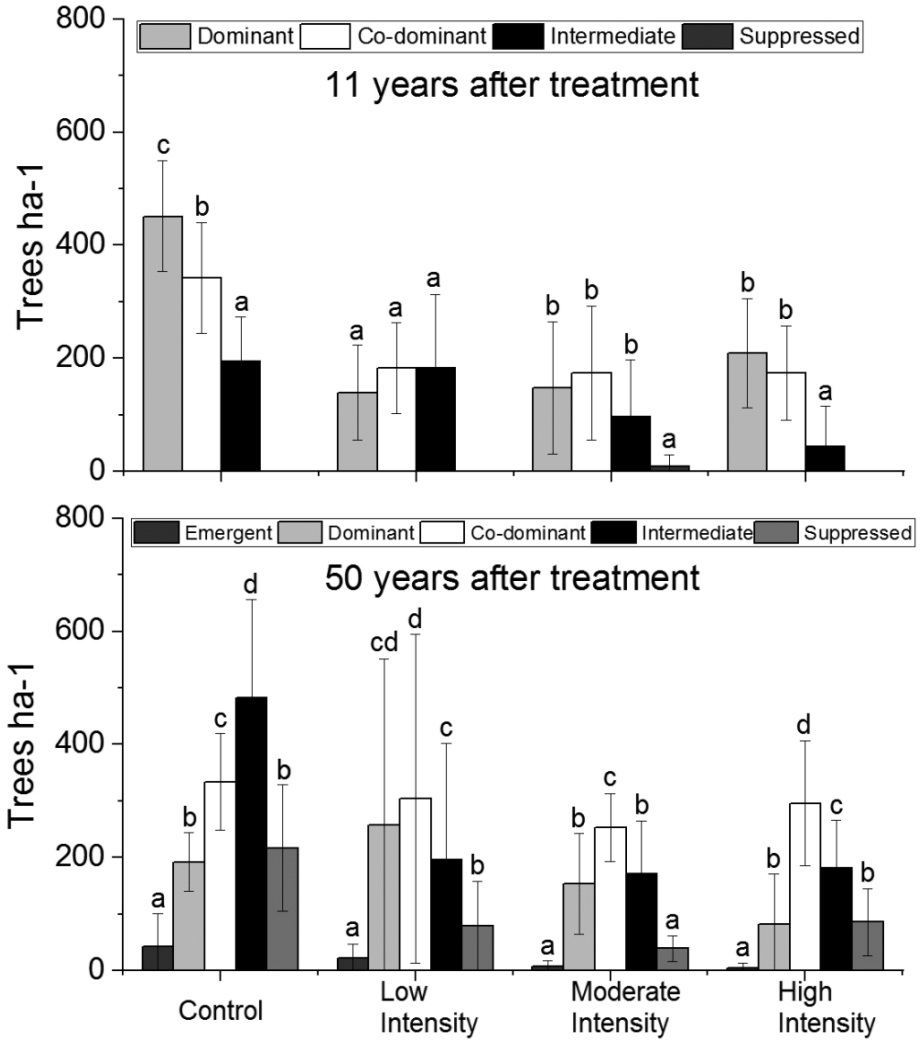

Figure 2—Trees per hectare by stand crown classes for trees only ≥ 11.5 cm (5 in) d.b.h. Data are shown for 11 and 50 years after thinning. For each group, different letters indicate significant differences at $p \leq 0.05$.

Table 1—Total basal area and stem density (trees ac^{-1}) for overstory trees (≥ 5 in d.b.h.), saplings (greater than 1 in d.b.h., but less than 5 in d.b.h.), and seedlings (≤ 1 in d.b.h. and taller than 6 in). Shown are means ± standard errors. Letters indicate significant differences between treatments within a year for each metric.

Treatment in trees per acre	**Total basal area (ft^2 ac^{-1})**	**Overstory density (trees ac^{-1} ≥ 5 in d.b.h.)**	**Sapling density (trees ac^{-1})**	**Seedling density (trees ac^{-1})**
11 years post-treatment				
Control	135.5 ± 6.0 b	400 ± 19 b	833 ± 49 b	1600 ± 170 a
Low (800)	61.9 ± 10.5 a	204 ± 24 a	200 ± 35 a	2406 ± 152 b
Moderate (400)	67.1 ± 14.8 a	172 ± 16 a	135 ± 19 a	2399 ± 148 b
High (200)	49.2 ± 0.4 a	172 ± 14 a	107 ± 31 a	2485 ± 121 b
50 years post-treatment				
Control	301.4 ± 32.2 b	513 ± 55 c	391 ± 117 b	27 ± 18 a
Low (800)	244.2 ± 17.9 a	347 ± 34 b	400 ± 122 b	256 ± 47 b
Moderate (400)	210.0 ± 8.7 a	253 ± 17 a	255 ± 81 a	283 ± 68 b
High (200)	194.2 ± 13.5 a	263 ± 30 a	463 ± 107 c	253 ± 95 b