Characterizing understory vegetation response to variable density thinnings in young Douglas-fir forests of western Oregon

Shanti D. Berryman, Robert T. Fahey and Klaus J. Puettmann

Oregon State University, Corvallis, OR 97331

OBJECTIVES

To investigate whether variable density thinning (with leave islands and gap openings) can accelerate development of late-successional characteristics in young, managed Douglas-fir forests while producing wood for the regional economy.

Vegetation study objective:

Investigate the response of overstory and understory vegetation to thinning treatments through time.

Preliminary results of understory vegetation response 5 years post-thinning are presented here.

METHODS

Study sites:

- Seven initial thinning study sites (~80 ha in size) located on BLM lands in the Coast Range and Cascade Foothills of western Oregon.
- Results for three sites are presented here (Table 1, Figure 1).
- Sites are pre-dominantly Douglas-fir forests and were thinned in 1997.

Table 1. Initial thinning site characteristics.

Site	Location	Range: Elevation (m)	Range: Slope (%)	Average: Age (yrs)	Average: Size (ha)
Keel Mountain	Cascade Foothills	604 – 763	0 – 35	45	90
Bottomline	Coast Range	238 – 366	8 – 22	55	100
OM Hubbard	Coast Range	427 – 763	3 – 74	39	89

Figure 1. Locations (red stars) of three study sites.

Treatments:

Four treatments implemented at each site:

Control (CON)
- unthinned

High Density (HD)
- 300 TPH
- 10% leave islands

Variable Density (VD)
- 25-30% thinned to 300 TPH
- 25-30% thinned to 200 TPH
- 10% thinned to 100 TPH
- 10% leave islands
- 10% gap openings

Moderate Density (MD)
- 200 TPH
- 10% leave islands
- 10% gap openings

- Leave islands and gap openings were 0.1, 0.2 and 0.4 ha in size.

Statistical analyses:

- Treatment averages were computed using plot totals.
- Treatment comparisons were performed using complete randomized block ANOVA with Tukey-Kramer adjustments for multiple comparisons.
- Non-metric multi-dimensional scaling (NMS) ordination evaluated gradients in understory vegetation composition.
- Multiple-Response Blocked Procedure (MRBP) tested differences in understory community compositions among treatments.
- Indicator Species Analysis (ISA) determined indicator species.

Vegetation sampling:

- 0.1 ha, circular plots randomly located within each treatment.
- 77 plots at each site (14 plots in control and 21 plots in each thinned treatment).
- All overstory trees and snags >5 cm were measured in 0.1 ha plots.
- Understory vegetation was measured in four 0.002 ha subplots within each 0.1 ha plot, including: shrubs, ferns, herbs and grasses/sedges/rushes.

RESULTS - Understory vegetation (Figure 2)

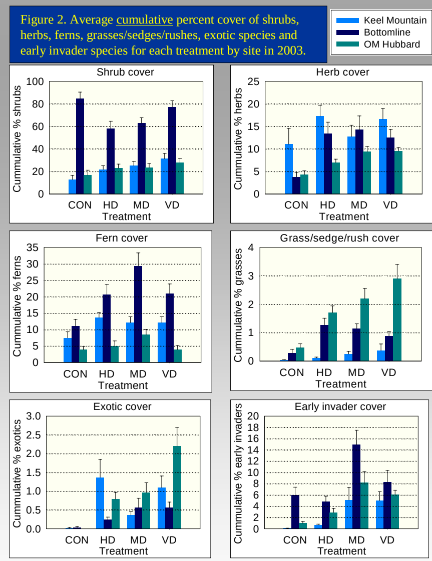
Shrub cover
- Varied more among sites than among treatments
- Greatest at Bottomline due to abundant *Gaultheria shallon* in nearly every plot

Herb cover
- Lowest in unthinned controls and greatest in the variable density treatment
- Greater in thinned areas

Fern cover
- Varied among sites and was greatest in the moderate density treatment (predominantly *Polystichum munitum*)

Grass, sedge and rush cover
- Lowest in unthinned controls and greatest in variable density treatments
- Generally in low abundance at Keel Mountain

Figure 2. Average cumulative percent cover of shrubs, herbs, ferns, grasses/sedges/rushes, exotic species and early invader species for each treatment by site in 2003.

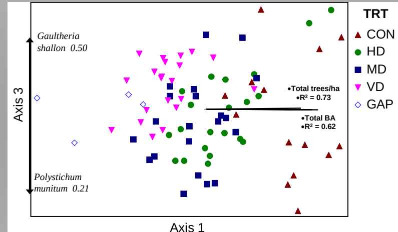


Exotic species cover
- Low cover across all treatments, greatest in thinned treatments

Early invader species (as classified based on Halpern 1989*)
- More abundance in thinned stands, especially the areas with heaviest thinning

RESULTS - Understory community composition

- Understory vegetation communities differed significantly by site.
- Community composition differed among thinning treatments, after accounting for site-to-site variation (MRBP; p-value = 0.003, A-statistic = 0.1).
- Strongest patterns in understory vegetation communities were highly correlated with stand density, suggesting a treatment effect (results from ordination analyses performed separately by site; see Figure 3 for ordination for OM Hubbard site). See Table 2 for overstory densities by site.
- Understory vegetation in gap plots and in the variable density treatments were most different from other stands, containing abundant early successional species that tend to invade disturbed/open sites (see indicator species for all sites, Table 3)
- Indicator species for thinning treatments varied by sites due to strong site differences in plant communities among sites.



Open sites → Shaded forest

Early Invaders		**Forest Understory**	
Elymus glaucus	0.31	*Rhododendron macrophyllum*	0.31
Hypochaeris radicata	0.55	*Trillium ovatum*	0.16
Rubus leucodermis	0.23		
Rubus ursinus	0.35		
Vicia americana	0.21		
Whipplea modesta	0.60		

Figure 3. NMS ordination of OM Hubbard site, plots in species space (83% variation explained, 50% variation on Axis 1, 15% on Axis 2). Plots are coded by treatment. Bolded species are exotic/invasive.

Table 2. Average overstory densities. TPH=trees per hectare, BA=basal area (m^2/ha), Con=conifers, Hdwd=hardwoods.

	TPH	Total BA	Con BA	Hdwd BA
Keel Mountain				
Control	575	73.6	73.2	0.4
High density	351	45.7	45.3	0.4
Moderate density	306	34.8	33.7	1.2
Variable density	221	36.7	36.2	0.6
Bottomline				
Control	388	39.0	38.8	0.2
High density	260	46.2	44.8	1.4
Moderate density	187	36.0	35.3	0.7
Variable density	212	36.6	36.2	0.5
OM Hubbard				
Control	905	48.0	46.3	1.7
High density	357	29.2	26.9	2.3
Moderate density	344	25.7	22.6	3.1
Variable density	250	19.8	18.7	1.1

Table 3. Indicator species across all sites (derived from vegetation data averaged to treatment level). IV = indicator value.

Indicator species	TRT	IV	p-value	Habitat
Rubus leucodermis	MD	65.9	0.02	early invader
Agrostis exarata	VD	100.0	0.02	early invader
Iris tenax	VD	47.9	0.04	open areas
Juncus sp.	VD	65.8	0.04	early invader
Rubus ursinus	VD	39.3	0.02	early invader

CONCLUSIONS

- Shrub and fern cover was not clearly related to treatments, but varied among sites.
- Herbs and grasses/sedges/rushes were more abundant in thinned stands than in controls. This may indicate a release response to thinning treatments.
- Understory plant communities differed among sites and differences between thinned and unthinned stands were apparent.
- Plant composition in variable density treatments and gaps was most different from that in other thinned treatments, due to abundant herbs, grasses, sedges and rushes and a general abundance of early invader species.
- Pre-harvest stand conditions and harvesting damage confound understory vegetation response to the thinning treatments.

AKNOWLEDGEMENTS

Special thanks to John Cissel, John Tappeiner, Charley Thompson, Larry Larsen, Floyd Freeman, Hugh Snook, Peter O'Toole, Craig Kintop, and Frank Price for their continual involvement, cooperation and assistance. We also thank the OSU field crews for assistance with data collection. Statistical support was provided by Manuela Huso, Liane Beggs, and NaDene Sorensen. This project is funded by the Bureau of Land Management.

* Halpern, C. 1989. Early successional patterns of forest species: interactions of life history traits and disturbance. Ecology 70(3): 704-720.