Vegetation measurements and analysis of the

DENSITY MANAGEMENT STUDY

Submitted to the

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Background

The BLM Density Management Study (DMS) was set up on BLM land to investigate whether thinnings can accelerate development of late-successional characteristics in managed forests. It consists of a thinning (7 sites) and re-thinning (5 sites) component. An overview of ecological issues related to management of young Douglas-fir forests is provided by Muir et al. (2002).

The DMS is a response to the lack of information required to implement the Recovery Plan for the Northern Spotted Owl, the Northwest Forest Plan, and the BLM's Resource Management Plans. The DMS has attracted a number of collaborators, including the USDA Forest Service Pacific Northwest Research Station (PNW), Oregon State University (OSU), and the Pacific Northwest Mycology Service. To further enhance collaboration, the proposed work will done in cooperation with the Cooperative Forest Ecosystem Research Program (CFER).

<u>Thinning study:</u>

Sites were selected to represent common conditions in 40 to 50-year old stands on BLM land in western Oregon. Treatment plots were large (40 to 70 acres), which allowed thinning treatments to be operational, i.e., part of management programs. Treatments included

- an unharvested control,
- high density retention (120 tpa),
- moderate density retention (80 tpa), and
- variable density retention (120, 80, and 40 tpa).

All treatments (with the exception of the unharvested control) included three sizes of leave islands and canopy gaps (1/4 acre, ½ acre, and 1 acre) and were thinned to the target densities in the matrices. The first sites were thinned in 1997 and the last site was thinned in 2000 (see Table 1 for details) and portions of the sites were underplanted using four conifer species. For more detailed information about original study objectives, site descriptions, treatment implementations, measurement protocols, etc., see Thompson and Larsen (2003).

Rationale

The original DMS protocol called for 30 to 60 vegetation plots to be placed in areas thinned to target densities (tpa +/- 20%). While the original sampling scheme provides information about ecosystem response in areas with the prescribed densities, it does not provide information about average treatment responses and variation within the treatment areas, especially variation due to leave islands and canopy gaps. Therefore, as the objectives of the studies have been modified, the proposed work includes an altered vegetation measurement protocol.

The proposed work has three objectives:

Objective 1: Document vegetation dynamics and average conditions in matrices, where target densities were achieved.

This analysis utilizes the existing plot network and provides information about average conditions and variation of the vegetation after homogenous thinning treatments. The analysis is limited to areas in the matrix, where post-thinning densities (tpa) were within +- 20% of target densities. It provides no information about influences of canopy gaps and leave islands. Also, areas where residual densities deviated from targets (e.g., near skids trails) are not covered. In areas, where target densities were achieved, the vegetation conditions were documented on most sites within one year after thinning. Remeasuring these plots will provide information about vegetation dynamics by quantifying changes between year 1 and year 6 after thinning. While the direct interpretation of these changes is limited to homogenous thinning conditions, it will provide help with interpretation of all vegetation data.

Objective 2: Document average treatment responses.

This analysis will provide information about average conditions and the variation within subtreatments (canopy gaps, leave islands, and different matrix densities) and for the whole treatment area (i.e., the composite of the various subtreatments). This will allow predicting vegetation responses if the treatments (using similar proportions of canopy gaps and leave islands) are implemented in comparable stands. The calculation of average conditions for whole treatments has to account for the fact that the subtreatments were not applied to the same acreage within whole treatment areas. This requires a stratification scheme to quantify the respective areas in each subtreatments (For stratification purposes the matrices will be separated into areas with < 80% of target tpa, areas >=80% and <=120% of target tpa, and areas > 120 % of target tpa). The stratification also provides information about the ability to implement complex treatments and we will quantify the difference between planned targets and actual proportion of various subtreatments (e.g., actual acreage in canopy gaps, leave islands, various densities of matrix conditions).

Objective 3: Response gradients.

This analysis provides information necessary to design thinning treatments tailored to specific ownership objectives. To develop this information base, we quantify the extent and impacts of subtreatments within their contexts. While approaches 1 and 2 (see above) assume subtreatments (i.e., canopy gaps, leave islands, and matrix) have distinct boundaries, it is documented that ecological conditions change gradually along borders (Thompson et al. 2001). Thus, this third objective implies quantification of gradients from one subtreatment into another. We will establish the relative importance of subtreatments along this gradient. For example, open conditions due to patch cutting will likely be the dominant influence in the center of canopy gaps, but their influence will diminish towards the edges and into the matrix. On the other hand, the matrix may have no or little impact on conditions in centers of canopy gaps, but its influence increases towards the edges and it eventually becomes a dominant influence in the matrix. We will document how this “edge effect” differs in gap and leave islands of different sizes and with different matrix densities.

The gradient analysis (Objective 3) will be initially limited to a subset of sites and treatments. Based on preliminary results we plan to pursue funding opportunities to sample more sites in more detail. We view the DMS study as a very unique opportunity to investigate these important aspects. Specifically, we would like to expand the combinations of subtreatments beyond those listed in Table 3. Also, we envision expanding the gradients into other cardinal directions. In combination with other aspects of spatial analysis (e.g., calculation of total length of edges in a stand) we see a potential to provide unique guidance for development of variable density treatments that can be tailored to specific management objectives.

Sampling scheme:

<u>Stratification</u>

The treatment areas will be stratified into classes listed in Table 2. Class boundaries will be determined from maps, airphotos, notes, and field visits. Target densities are those described in the original study setup (40, 80, and 120 tpa). Control areas will not be stratified. This information will be used for two purposes. First, it will provide information about the difference between planned and actually implemented treatments. Second, areas in stratification classes will be used to develop expansion factors for calculation of treatments means.

<u>Plot layout</u>

Plot layout and sampling scheme will generally follow the established protocol (Thompson and Larson 2003). Quarter-acre, circular plots will be used for measurement of overstory tree characteristics and large woody debris. Within each overstory plot, we will install four 0.005 acre subplots to monitor the understory vegetation, tree seedling and sapling presence, and shrub and herb species, height, and percent cover. Specific sampling criteria (e.g., minimum size for overstory measurements) will follow the protocol used for year 1 measurements (J. Cissel, personnel communication).

To achieve objective 1, we will remeasure all existing measurement plots. Analysis of these data will determine whether the sampling intensity can be reduced in future years.

For objective 2, we will randomly locate 21 measurements plots in each treatment area. The stratification class for each plot will be noted. If plot areas fall into more than one stratification class, measurements will be separated for each stratification class and the area in each class will be noted. Calculation of an overall treatment mean is accomplished by calculating means for each subtreatment and subsequently calculating weighted averages. For this calculation, weights are proportional to areas in the different stratification classes.

To achieve objective 3, we will select a subset of subtreatment combinations (Table 3). We will select five canopy gaps and five leave islands (for each treatment combination) and establish transects from the matrix on the north side of a gap or leave islands through the center into the matrix on the south side. The exact site for selection of gaps and leave islands will be determined after preliminary field visits. Transects will be broken into segments (for example see Figure 1) and measurement plots will be established in each segment. Segments may vary in length to ensure higher intensity sampling near the edges and ensure that segment borders coincide with canopy gaps and leave island borders, regardless of gap and leave island size. (Borders of ¼, ½, and 1 acre circles are at 59 feet, 83 feet, and 118 feet, respectively). We will modify the distances to accommodate the actual field layout. Overstory information will be measured in rectangular plots (25 by 15 feet) placed in the centers of segments. A circular 0.005 acre vegetation plot (8.3 feet radius) will be placed in the center of each overstory plot.

Data Management and Analysis:

Data will be stored in the Oregon State University Forest Science Data Bank and will be made available to NBII for development of a website.

To achieve objective 1, we will calculate the differences between year 1 and year 6 measurements. These differences will be regressed against variables, such as slope, aspects, and distances from stream or ridge. Initial conditions (i.e., overstory and understory conditions) will be used as covariates. This will provide information about vegetation dynamics after thinning. Also, based on the results of this analysis we will assess the impact of less intensive sampling schemes.

For objective 2, we will calculate expansion factors based on the plot area in each stratification class and area in each stratification class as a proportion of the overall treatment area. Plot values will be weighted based on this expansion factor to calculate overall treatment means. Means and variation within treatments will be compared between treatment using ANOVA and multiple comparison tests.

To achieve objective 3 we quantify the position on the gradient for each plot in absolute terms (distance of plot center to the center of the gap or leave island and distance of plot center to edge) and relative terms (fixed gap or leave island center and edges, see Figure 1). Regression analysis will be used to quantify this relationship and compare them for canopy gaps or leave islands of different sizes and matrix densities. A theoretical example of these relationships is presented in Figure 2. Analysis of variance will be used to compare whether the relationships are consistent for the different gap or leave island sizes and matrix densities. Also, the difference between the north and south edge will be quantified using analysis of variance.

Re-thinning study

The re-thinning study was installed in 60- to 70-year old stands that were commercially thinned previously. Treatments included a control (not re-thinned) and re-thinning to 30 to 60 TPA, allowing for clumpy distribution). Typical treatment areas ranged from 15 to 50 acres.

We will document average treatment responses by remeasuring existing plots (approximately 20 per site) to document changes in overstory and understory conditions. In addition, this will provide information about the variation in re-thinned stands.
To allow a comparison, we will be using the same measurement protocol (plot sizes, etc.) as used in the initial measurements. Analysis will accomplished by paired t-tests.

Time line:

Below is the time line for the initial stage of the project. Follow-up agreements will cover future measurements (see Table 2), data analyses, and write-ups.

	2003				2004	
	Spring	Summer	Fall	Winter	Spring	Summer
Stratification	XXX					
Plot installation		XXXXXXX				
Vegetation measurements		XXXX				
Overstory measurements			XXX			
Data summary and analysis				XXXXXXXXXX		
Write up of results					XXXXXXX	
Stratification						XXX

Budget Justification:

The budget includes salary for a post-doctoral research associate who will oversee the day-to-day activities of the projects. The PI will provide overall guidance and direction. A field crew (6 people) will be measuring research sites summer of 2003. Travel expenses (overnight, per diem) for the field crew are included. Vehicle expenses are not included as vehicles will be provided by the BLM. Field supplies and equipment include range finders, GPS units, flagging, paint, etc. necessary to find and document plots and measure vegetation. OSU's match is the reduced overhead rate of 15% (instead of 41.5%), and 0.08 FTE of the PI, resulting in a total contribution $ 55,294. The budget for future measurements (for schedule see Table 2) is subject to follow-up agreements.

Budget: (Budget is for initial phase only. Costs for future measurements, analysis and write-up will be subject to follow-up agreements).

Year	**2002/3**	**2003/4**	**2004/5**	**2005/6**	**Overall**
PI	1470	1528.8	0	0	$2,999
OPE (PI)	632.1	687.96	0	0	$1,320
Post-doc Res. Asst.	$ 7,000	$36,400	$0	$0	$43,400
OPE (FRA)	$ 3,990	$21,476	$0	$0	$25,466
Research Assistantship	$0	$0	$0	$0	$0
OPE (RA)	$0	$0	$0	$0	$0
Tuition (RA)	$0	$0	$0	$0	$0
Retention Fee (RA)	$0	$0	$0	$0	$0
1040 H employee	$8,960	$31,200	$0	$0	$40,160
OPE (1040 H)	$896	$3,120	$0	$0	$4,016
Field supplies (Flagging, paint, etc.)	$500	$400	$0	$0	$900
Travel - in state	$3,150	$12,600	$0	$0	$15,750
Travel - out of state	$0	$0	$0	$0	$0
Phone, mail, misc.	$400	$800	$0	$0	$1,200
Photo copies	$350	$400	$0	$0	$750
Publication	$0	$0	$0	$0	$0
Software (network support)	$1,425	$1,482	$0	$0	$2,907
Equipment	$0	$0	$0	$0	$0
Service and Supplies (Equipment)	$4,500	$100	$0	$0	$4,600
Total direct	$33,273	$110,195	$0	$0	$143,468
Indirect cost/Overhead	$4,991	$16,529	$0	$0	$21,520
Total	**$38,264**	**$126,724**	**$0**	**$0**	**$164,988**

Schedule of Deliverables:

Two reports will summarize the results of sampling efforts and data analysis.
A report, submitted before December30, 2003, will

- summarize the accomplishments during the field season,
- provide an initial summary of the data,
- provide an initial overview of year 1 data (status of organization and clean up), and
- provide an overview of sampling and analysis methodology.

A report, submitted before June, 30 2004, will provide

- a detailed summary of the 2003 data,
- an assessment of the time trends between year 1 and year 6 (depth of assessment may be influenced by need to clean up and organize year 1 data),
- an assessment of the tradeoffs when sampling intensity of established plots (Objective 1) is reduced,
- information about treatment means and differences between treatments and sites,
- information about the vegetation response along gradients between subtreatments,
- a literature review, and
- a discussion of management implications.

Also, by June 2004 we will have set the stage (i.e., stratification schemes, etc.) for the 2004 field season.

Results of the DMS study will be presented at regional and national meetings and workshops as opportunities become available. Technical manuscripts will be prepared for publication in peer-reviewed journals as information is considered adequate for manuscript preparation.

Literature cited:

Thompson, C., Olson, D., Chan, S., Mass-Hebner, K., and J. Tappeiner. 2001. The density management and riparian buffer studies of Western Oregon. Poster presentation, Sept. 2001.

Thompson, C. and L. Larsen. 2002. Density Management Studies Status Report. Oregon/Washington Bureau of Land Management, Internal document. Dec. 2, 2002. 53p.

Muir, P. S., Mattingly R. L., Tappeiner J.C. II, Bailey J.D., Elliott W.E., Hagar J.C., Miller J.C., Petersen E.B., Starkey E E. 2002. Managing for biodiversity in young Douglas-fir forests of western Oregon. U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Biological Science Report, USGS/BRD/BSR-2002-0006.

Table 1: Harvesting and measurement schedule. Note that the remeasurement schedule has been constructed to standardize measurements on the same year of post-treatment development so that measurements are on a comparable basis across the study. Basic measurement schedule is year 1, 6, 11, 16, 21 etc.

I. Initial Thinning Sites

Site name	Majority harvest completed	Initial measurement (date/growing seasons post harvest)	Stand development (growing seasons post harvest, March 2003)	Reinstall plots (year/growing seasons post harvest, fall 2003)	Remeasure plots (year/growing seasons post harvest)
Bottomline	11-97	9-98/1	5	2003/6	2008/11
OM Hubbard	11-97	9-00/3	5	2003/6	2008/11
Keel Mtn	12-97	9-99/2	5	2003/6	2008/11
North Soup	8-98	9-00/2	4	2004/6	2009/11
Green Peak	1-00	4-02/2	3	2005/6	2010/11
Ten High	1-00	4-02/2	3	2005/6	2010/11
Delph Creek	4-00	3-03/3	3	2005/6	2010/11

II. Rethinning Sites

Sand Creek	11-97	9-98/1	5	2003/6	2008/11
Little Wolf	9-98	7-00/2	4	2004/6	2009/11
Blue Retro	3-99	8-99/1	4	2004/6	2009/11
Perkins Creek	3-00	10-00/1	3	2005/6	2010/11
Keel Flats	12-02		0	2003/1	2008/6; 2013/11
Ward Creek					

Table 2: Stratification scheme for treatment areas (excluding control).

Canopy gaps	**Leave Island**	**Matrix**
¼ acre	¼ acre	Tpa < 80% of target
½ acre	½ acre	Tpa >= 80% and <=120% of target
1 acre	1 acre	Tpa > 120% of target

Table 3: Treatment combination selected for initial gradient analysis.

¼ acre canopy gaps	80 tpa matrix
1 acre canopy gaps	80 tpa matrix
1/4 acre leave island	80 tpa matrix
1 acre leave island	80 tpa matrix
1 acre leave island	40 tpa matrix*
1 acre canopy gaps	40 tpa matrix*

*Selections may be modified based on actual site layout.

Figure 1: Example transect across a ¼ acre gap or leave island with section layout. Note, that for all gap and leave island sizes, one section break will be right at the edge.

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Figure 2: Theoretical relationship between percent vegetation cover and relative distance from the edge of a gap. Matrix densities were held constant. **{** SHAPE * MERGEFORMAT **}**

Segments (distance from center in feet)
0 - 20
20 – 40
40 – 59
59 – 83
83 – 100
100 – 118
118 – 140
140 – 160
160 – 180