DRAFT

Proposal for follow-up treatments in the DMS

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Introduction and Objectives

The DMS demonstrates and evaluates different approaches to managing 40-70-year old forest stands on low elevation sites in western Oregon to produce and maintain late-successional characteristics. Scientific and management objectives include:

- Evaluate effects of alternative forest density management treatments on important stand and habitat attributes (large trees; standing and down dead wood; understory trees, shrubs, and herbs; vertical distribution of tree canopy; and spatial distribution of trees, shrubs, herbs, and dead wood)
- Determine treatment effects on selected plant and animal taxa (amphibians, arthropods, mollusks, nonvascular plants, and fungi)
- Assess the combined effects of density management and alternative riparian buffer widths on aquatic and riparian resources
- Use DMS sites to develop operational approaches to implementation of new prescriptions, and improve methods for effectiveness monitoring of plant and animal taxa
- Use DMS sites to share results of on-the-ground practices and findings with land managers, regulatory agencies, and policy-makers
- Use results from DMS to conduct a long-term adaptive management process where management implications and policy changes are regularly evaluated and changed as needed.

Desired Future Stand Conditions

The essential long-term goal is to accelerate the development of late-successional characteristics in these younger forests. When treated stands reach 120-150 years of age, the desired stand conditions are as follows:

1. Large green conifer trees

    10-30 TPA, diameter > 30 in.

    2-6 TPA, diameter > 50 in.

    1 TPA, diameter > 50 in. with a broken top

2. Enhanced species and structural diversity

    25-35 TPA, diameter 15-30 in., hardwoods and conifers

    100-200 TPA, diameter < 15 in., hardwoods and conifers

3. Snags

    8-12 snags/acre, 50% diameter 10-25 in., 50% diameter > 25 in.

    All decay classes present

4. Downed logs

    900 linear feet/acre of well-dispersed logs

    1/3 of logs > 24 in. diameter

    2/3 of logs 10-24 in. diameter

    All decay classes present

Rationale for follow-up treatments

Recent discussions among DMS site coordinators and scientists, and at the June 2004 DMS workshop and field tours, about follow-up treatments pointed out a need to define the experimental treatments in terms of management approaches to achieve late-successionl habitat rather than focusing solely on residual tree densities. Based on our current expectations of ecosystem development the treatments are now defined as a set of manipulations of the overstory and understory. Detailed information about our choices is provided later in this document. The treatment choices are not necessarily designed to implement the most likely future treatment, but to maximize our information gain to provide forest managers with guidance for the decision of appropriate treatment in different management conditions. Thus, the treatments should allow a quantification of tradeoffs when choosing the management intensity (choice of residual densities or speed of "conversion") from a low intensity approach with no treatment to an intensive approach that opens up the stand fairly quickly. This requires treatments that bracket possible management scenarios. This also ensures that the study setup provides an opportunity to investigate various ecosystem processes under a wide range of conditions. Note that a treatment (see definitions below) now consists of multiple manipulations or entries. All treatments will be viewed in terms of meeting the general objectives of the DMS which includes evaluation of both the upland treatments and associated riparian buffer treatments.

INITIAL THINNING SITES

1) Control treatments with no entry will document development of unmanaged forests and will provide information about the benefits and costs of treatments. Controls provide baseline information crucial for comparison of the treatments on the different study sites, especially since only one replication of each treatment is present on a site.
2) High density (HD) or three-step conversion: includes multiple treatments aimed at opening the overstory canopy very gradually. The first entry opened the canopy to 120 tpa, the second is proposed to occur 12 years later to 60 tpa, and the third at a time to be determined to 30 tpa.
3) Moderate density (MD) or two-step conversion: includes two intensive thinning treatments. It aims at opening the overstory in two steps with the first entry to 80 tpa and the second is proposed to occur 12 years later to 30 tpa. No further entries are planned with one exception described in the riparian buffer section.
4) Variable density (VD) treatment provides maximum heterogeneity within a stand. While likely not operational on an ownership scale, it provides a cornerstone of what can be achieved with intensive forest management. Thinning treatments for the 120 tpa and 80 tpa treatment components follow the same schedule as

described in treatment 2) and 3) above. The 40 tpa areas are proposed to be thinned to 20 tpa at the next entry, i.e., 12 years after the initial thinning.

Treatments 2, 3, and 4 also provide an opportunity to evaluate effects of leave islands and gaps in the context of a managed matrix. To ensure presence of snags, up to 5 snags will be created within 5 years after the second thinning, if they are not created naturally. Thus, for marking purposes the residual density after thinning will be higher, i.e., 65 tpa, 35 tpa, and 25 tpa.

Other management considerations, such as long-term snag creation, downed wood, treatment of understory vegetation and regeneration, are applied consistently across all treatments and described below.

Following is a detailed discussion of new or altered treatments:

HD Treatment

High density or three-step conversion: Thin High Density (120 tpa) treatment to 60 tpa (65 tpa including snag allowance) at the next entry (12 years after initial thinning). Future plans include a third thinning lowering the density to 30 tpa (after accounting for snags).

This treatment is aimed at converting an even-aged, single-story stand structure to more complex late successional habitat by employing multiple, low intensity thinnings. Our preliminary assessments indicate that the overstory and understory development in the HD treatment are not very different from control stands. Consequently, we view the initial treatment as quite conservative and repeated thinnings are necessary to ensure stands develop towards a diverse stand structure characteristic of late-successionla forests. On the other hand, this treatment provides a high amount of protection for plants and animals that require overstory cover.

The initial treatment was originally designed to reflect "traditional" management strategies. Current practices include thinning to lower densities (than 120 tpa) even in stands managed for timber production. However, a slow, three step treatment provides information for strategies where protection of interior stand conditions is important during the process of converting even-aged stands into late-successional habitat. From an experimental point of view this treatment provides a "conservative" conversion option.

Since the initial treatment included leave islands and thus created spatial diversity, we plan to thin to an evenly spaced 60 tpa. The next entry will allow crown and taper condition to recover and improve tree stability for the third thinning, which will open the stand to 30 tpa (35 tpa) and provide "open" growing conditions for the residual trees.

In summary, this treatment will provide information about a conservative management approach aimed at converting homogenous stands to diverse stand structure. The information will apply to stands that have been thinned conservatively in the past. The low-intensity repeated thinnings will allow trees to adjust to more open conditions fairly slowly. This treatment provides information directly usable in stands with fairly easy access, where risk of windthrow is high, continuous protection by overstory trees is desirable, and where multiple entries are economical.

MD Treatment

Two-step conversion: Thin Moderate Density (80 tpa) treatment areas to 30 tpa, (after accounting for creation of 5 large snags/acre)

The treatment choice was driven by our desire to maximize the scientific value of the DMS. Preliminary results of the vegetation and other analyses indicated that the initial DMS treatment selection was fairly conservative. In hindsight it is clear that a wider range of treatments may be desirable to bracket the possible range of conditions. Traditionally, the choice of thinning intensities was influenced by growth-growing stock relationships and stand stability considerations. The proposed thinning to 30 tpa goes below “traditional” density levels. The site will not likely be fully occupied by overstory trees and we expect this treatment will result in lower growth (per acre) of the overstory. Thinning to levels below full site occupation provides a scientific baseline for conditions where lack of a closed canopy changes microclimatic conditions and a large amount of site resources are available for other (than overstory) stand components, such as understory vegetation or regeneration.

This proposal represents an attempt to accelerate the development of late successional habitat in two thinning entries. Even though not originally envisioned as such, the first entry can be viewed as similar to a “preparation cut”. The stands grew at a fairly high density and trees had low crown ratios and taper. Concerns about tree stability after exposing trees in a high intensity thinning treatments were addressed by opening up the stand to 80 tpa and allowing the residual tree crowns to recover and taper to increase, thus increasing stand stability. At the same time, our measurements and observations indicate that the understory vegetation did not respond in a major way to the initial thinning. With 12 years to adjust the tree architecture to more open conditions, rethinning to 30 tpa in one thinning entry may be more likely to succeed. At the same time, we expect the understory vegetation, which has developed rather slowly during the first 12 years, to quickly respond to the increased resources after the second thinning and start providing components of late-successional habitat fairly quickly.

From this treatment we expect to gain information useful for management of a wider range of stand conditions. For example, in younger or low density stands with higher stability (i.e., fairly high live crown ratios and lower taper) the initial entry may not be necessary to improve tree stability. While we won’t be able to do a direct comparison, the responses to our proposed treatment may provide useful information for conditions, when dense stands are opened up with a single, very intensive thinning. The conversion of the two-tree height riparian buffer to a variable width buffer (see below) will provide further complementary information for these conditions.

A third reason for this treatment is the location of the riparian treatments adjacent to the MD treatment areas. Initial analysis of microclimate and amphibian habitat indicated that all riparian buffer treatments seemed to be able to buffer impacts of thinning the upland area to 80 tpa. Thus, the study setup did not provide the best opportunity to compare the different riparian treatments. Lowering the upland density fairly drastically to 30 tpa will result in a higher contrast between upland areas and buffers. We expect that differences between the riparian treatments will be more obvious under these conditions and a more powerful evaluation of the relative strengths and weaknesses of each treatment will be possible.

VD Treatment

Variable density thinning. This treatment was designed to provide a baseline of introducing the "maximum" amount of diversity within a stand. Clearly the implementation of this treatment is quite labor intensive and its operational application will be limited. From an experimental point it provides another cornerstone of information as it establishes a response to the attempt at maximum diversity at a stand level. It will be used to in the investigation of the relative importance of the various treatment components (matrix, gaps, leave islands). It provides a reference stand for evaluation of spatial scale relationships found in the other treatments. Thus, future treatments should be comparable to thinning treatments 2 and 3. We propose to duplicate the prescriptions listed in treatments 2 and 3 for the variable density treatments in areas with 120 tpa and 80 tpa, respectively. In addition, we propose to thin the area currently in 40 tpa to 20 tpa (25 tpa including the snag allowance). Thus, we maintain small-scale diversity and differences within this treatment should be enhanced over time.

For all thinning treatments:

Riparian buffers

The riparian buffer areas themselves will not be altered (with one exception, see below), However, the riparian buffers have to be viewed in the context of the upland management. Effectively, the thinning treatments in upland areas will redefine the riparian buffers treatments and we will gain additional information about the importance and impacts of leaving unthinned areas near the streams (see also discussion about riparian treatments under treatment 3).

Based on preliminary analysis of microclimate and vegetation trends, we feel that the two-tree height riparian buffers don't seem to provide any additional information (compared to smaller buffers, especially the one-tree height buffer) in terms of protecting the stream from the impact of upland thinnings. Two-tree height buffers were hard to layout in a segmented landscape and in fact they only could be implemented on ? sites. We propose to reduce the two-tree height buffer in the moderate density (MD or treatment 2) treatments to a variable width buffer. The variable width buffer (minimum of 50 feet, averaging 70+ feet) is of special interest as its width is determined by local ecological conditions. It has been shown to protect microclimate and amphibian habitat conditions in the stream under the current thinning treatment. The drastic opening of the portion of the two-tree height buffer that is outside the variable width buffer will provide an opportunity to document a case study how trees and buffers perform when only a single entry is used to convert dense stands to open conditions favorable for development of late successional habitat.

Understory vegetation

No understory treatments will be implemented at this stage. Development of the tree regeneration will be monitored and the need for future PCT treatments will be assessed periodically.

Development of diverse and well established understory vegetation is one of the main goals of the overstory treatments and as such viewed as desirable. At the same time understory vegetation can impede development of tree regeneration, which may be of special concern in planted areas on the DMS sites. At this stage, the main need for weed control would be in gaps (especially on some sites with alder regeneration) which were planted and where the understory vegetation is more developed. For assessment of the need for understory treatments (i.e., weed control) following points have to be considered. The objective of gap treatments was to increase stand structural diversity. As part of this intention conifers were planted to create more diverse conditions in the stands. In this case the creation of diverse conditions conflicts with the desire to provide "optimal" growing conditions for the tree regeneration and develop a secondary conifer layer as soon as possible. After considering these "conflicting" objectives we feel that the original objective is worthwhile pursuing. The study setup was not designed to efficiently provide information about tree seedling optimal performance under various overstory densities. Other studies (some already published) provide good information about this topic. Understory weed control treatments would counteract the objective to document response of understory vegetation in gaps by reducing or eliminating desirable stand components that contribute to structural diversity, e.g., hardwoods (see desired future stand conditions).

As a practical consideration it is already too late to assess optimal performance of tree regeneration in many gaps. Based on information about tree performance in clearcuts, weed control should have been down a few years ago to ensure optimal tree seedling growth. In addition, underplantings in control treatments show high mortality.

Regeneration

At this stage no treatment of the understory regeneration is planned. We will monitor development of advanced regeneration and assess the need for future treatments including PCT (see discussion of RE-THINNING sites below) and commercial thinnings over time.

Gaps

All proposed treatments include no direct manipulations of gaps. We discussed the notion of enlarging gaps or "feathering the edges" by thinning more intensive around gaps. Preliminary analysis and discussions with various groups indicated that especially the small gap size was not viewed as very effective in providing refugia or other benefits of dense forest cover. At this point in time we decided against these options for several reasons. First, any gap manipulation will be confounded with the thinning treatments. Second, we do not have a strong rationale that larger gaps are more common ("natural" or "desirable") in late successional stands and the current gap sizes provide a range of responses. Thus, while the small gaps may not provide enough openings for significant establishment of tree regeneration and understory vegetation, they may have other impacts, such as altering crown architecture of neighboring trees. Third, the implementation of gap manipulations is quite labor intensive and thus not likely to be applied on large portion of the landscape. Fourth, thinning the matrix will provide more "open" conditions inside the gaps. Fifth, other studies provide information about survival of tree regeneration under various light conditions. This information can be used in conjunction with our light measurements in the gaps to make some prediction about the impact of larger gaps on tree regeneration.

Leave islands

A similar rationale as outlined for the gaps also applies to leave islands. Initial analysis (especially from S. Wessel) indicated that small leave islands may not provide refugia for amphibians etc. We propose to maintain the leave islands for various other reasons. Their value will likely increase over time as the matrix is opened up through repeated thinning. In addition due to the high density leave islands will likely have future mortality and thus provide an important source of snags.

We view the gap creation and leave island designation as part of initial setup that will be maintained through future treatments. The spatial analysis (e.g., R. Fahey) will provide information about the specific benefit of these components within different matrix conditions. This will allow predictions about the benefits of creating gaps or leaving unthinned areas and considerations of size and spatial arrangement.

Snags: The low residual overstory density limits the potential for future recruitment of snags. The goal of the treatment is to ensure a minimum of 5 large snags and additional smaller snags. These will be provided from a combination of residual overstory trees (large snags) and leave islands. Thus, the thinning prescription will call for leaving 5 additional trees (for a total of 35 or 65 tpa). We will monitor whether mortality in the residual overstory due to harvesting damage, sudden exposure, etc. will create these snags. If "natural" processes fail to do so within the next measurement interval (5 years), we will create the snags at that time.

The leave islands will remain unmodified and are expected to provide a second source of snags. Because leave islands contain a range of tree sizes at fairly high (control) densities, we expect mortality mainly in the smaller size classes. Consequently, these snags will likely be smaller and spatially concentrated.

The residual density of 30 tpa also provides a potential pool of future snags. We expect that the likelihood that these trees will be harvested commercially is fairly low (especially in LSRs). Thus, we view their main future purpose as habitat structure sources of regeneration (live trees), and future snags. Thus, we suggest an analysis of the amount of snags and downed wood to be repeated at every re-measurement. The creation of additional snags or downed wood should be considered and implemented as needed to achieve the Desired Future Stand Conditions (see above).

Downed wood

We are not planning an investigation of the benefit of various levels of downed wood. This goes beyond the scope of the DMS study. Instead, downed wood is seen generally lacking in intensively managed landscape and a crucial part of late successional habitat. The management goal of our treatments include accelerating development of this feature by ensuring a minimum of 200 cubic feet per acre in decay classes 1, 2, and 3 after the next proposed thinning entry (12-years after initial thinning) and 300 cubic feet per acre after the second proposed thinning entry (likely 24 years after the initial thinning). We expect further additions as residual trees and snags fall down. If this is not occurring naturally the downed wood pool may be supplemented through cutting to an eventual level of 600 cubic feet per acre in all decay classes. This schedule accommodates a continuous buildup of downed wood. The slow buildup also ensures a supply of larger downed wood pieces over time, as trees had an opportunity to respond to the thinning treatment.

We deviated from the using length and diameter of downed wood for our treatment schedule, since that information is not easily available. Instead, the measurement of total volume of downed wood is conducted as part of the standard vegetation measurement. Thus, the 11-year re-measurement will provide updated information and after assessing the amount of downed wood, the thinning contract will be modified to ensure that all treatments reach the target goal. As larger trees become available as sources of downed wood, selecting of trees to be supplemented to the downed wood will take the size objectives (as listed in the Desired Future Stand Conditions) into account.

Timing

Implementing follow up treatments on the DMS sites changes the experimental setup, by changing the definition of treatments. Ecosystem responses cannot be attributed to a single manipulation anymore. Instead, they are the result of a set of manipulations that together make up the treatments. To minimize problems due to confounding manipulations, we plan to document the response to the initial manipulations 11-years after they were implemented. These measurements provide information about the response of the initial treatments. They also will be used as pre-manipulation conditions and, in conjunctions with post-manipulation surveys, will be used to document the extent and intensity of the second manipulation. This will result in implementation of the second set of manipulations in year 12 after implementation of the initial manipulations.

Species choice

To ensure maximum tree species diversity, thinning will avoid cutting species other than Douglas-fir. Overstory trees of other species, including hardwoods, will be counted towards target tree density.

RETHINNING SITES

The rethinning study has a simpler design and needs to be viewed in conjunction with the initial thinning study. It provides information about responses to multiple thinning entries and thus facilitates longer term predictions based on information from initial thinning stands.

We propose to drop the Keel Mountain rethinning site. The site not only is very limited in size, it also did not receive a well defined commercial thinning. It was salvaged logged (repeatedly?) and does not have a true control (treatment 1). For the remaining 4 rethinning sites the proposed treatments include:

1) Control (Once thinned). Once-thinned control with a single commercial thinning that reduced overstory density to 100+ tpa. Preliminary assessment indicated that the development of over-and understory towards late successional habitat does not seems to be accelerated appreciatively at this stage. However, this treatment provides baseline data. We feel that this baseline information is necessary as it allows us to link the different study sites in the statistical analysis. This is especially important since the study was replicated across sites, i.e., each site has only one replication of the treatments.
2) Fast conversion. This treatment included the “original” thinning to 100+ tpa; a second thinning reduced the density to a clumpy distribution of 30 to 60 tpa. We propose a third thinning to reduce the overstory to 20 to 30 tpa, with creation of 5 snags, if not naturally provided within 5 years. This treatment will be paired with treatment 3 on the Initial Thinning Sites. Aim of the treatment is to maintain and

encourage the development of structural diversity, especially in the understory layers. The two thinnings initiated understory regeneration of various species, including Douglas-fir and western hemlock. To maintain the growth of the advanced regeneration and avoid unstable conditions, i.e., unfavorable height/diameter ratios of the seedlings, requires more growing space. The treatments are aimed at opening the canopy to a level that seedlings can maintain strong growth and vigor. In many spots the advanced regeneration is clumpy and dense. Repeated thinning will damage seedlings, especially seedlings of larger size classes. However, with careful logging we expect that advanced regeneration will still be sufficient to provide a significant component of future stand structure. The PCT prescription (see below) will take the harvesting damage into account.

Understory vegetation

The understory vegetation will not be treated at this time. It has not prevented advanced regeneration to become established in many portions of the stands (especially in re-thinned stands) and provides an important component of late successional habitat.

Tree regeneration:

PCT patches of dense advanced tree regeneration to approximately 100 tpa of all tree species. PCT should maintain species mix were present.

The natural regeneration on the rethinning sites is extremely variable, from very dense in some spots to lack of regeneration. With the same rationale as described above for initial thinning sites, we are trying to define the treatments as a set of manipulations aiming to achieve a desired goal. On the rethinning sites the goal is to provide information for development of management systems to facilitate quicker development of late successional habitat. The goal is not to document understory response to single and multiple thinning operations. Thus, all stand components need to be assessed in terms of their impact on the potential to achieve this goal. Thus, the same rationale that was applied to the overstory (perceived assumption that high density would not facilitate quick development of structural diversity) also should apply to the understory. Especially dense hemlock regeneration will likely impact other desirable structural components, such as a deciduous shrub layer

Goal of the rethinning study is to provide a context for predicting future response of the initial thinning sites. Thus, matching the treatments is very important. While a direct comparison is not possible (e.g., the rethinning sites don't have gaps and leave islands) the rethinning sites provide information about long-term development of various stand structural components. For example, the continuous "recovery" of live crown ratios or stand tapers can be assessed on the rethinning sites and is helpful in putting the initial thinning treatments in perspective. Thus, we will use the response on the rethinning sites as a reference point or validation when we predict development of the initial thinning sites or use growth models to simulate overstory development of alternative treatments. Also, while a number of studies investigate development of young seedlings under various overstory densities, this information cannot be directly used to predict long-term future development. Seedlings are expected to become more light demanding as they get older and few study investigate the growing conditions of saplings and their transitions to the overstory canopy. Thus, the re-thinning sites are also very helpful in predicting future development of advanced regeneration and understory vegetation.

PCT prescriptions have been limited to clearcut conditions and experience of PCT in understory settings is very limited. The density of the advanced regeneration is quite a bit lower than in clearcut conditions (100 tpa at the most, in many areas the regeneration density will be less). This accounts for the resources taking up by overstory trees, for the objective to provide a diverse stand structure rather than ensuring full site occupation by the regenerating cohorts, and it provides opportunities for other understory vegetation, e.g., hardwood regeneration, to develop.

<u>Snag</u> and <u>Downed wood</u> will be provided as described for the INITIAL THINNING sites above.

Timing

Treatments will be applied 12 years after the rethinning treatments (see discussion of timing on INITIAL THINNING sites above for rationale).