

U. S. Bureau of Land Management - Density Management Studies

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PART I - INTRODUCTION

Summary

This is a plan for an adaptive study of silvicultural systems that will be used under the new U.S. Bureau of Land Management (BLM) Resource Management Plans. These plans call for Density Management for some stands to achieve old-growth characteristics such as large trees and multiple understory layers as quickly as possible. Other stands are to be managed primarily for wood production, while still maintaining large conifers and hardwoods, in them in order to provide structure and habitat for a variety of wildlife species.

These silvicultural systems differ in two major respects from the evenage systems that are commonly used in western Oregon forests. They require: a) the regeneration of conifers and hardwood species beneath an overstory of conifers and/or hardwoods; b) the management of overstory density to grow large trees; provide snags and logs on the forest floor, and to regulate canopy density so that understory conifers will survive and grow. These silvicultural systems are new for western Oregon forests. There is, however, considerable information from research and implementation programs about thinning conifer stands and conifer regeneration that provide a basis for the work outlined here.

The purpose of this plan is to outline study objectives and protocols to test these new silvicultural systems. There are thousands of acres of stands 30 to 70 years old in the Salem and Eugene BLM Districts for which thinning and density management are appropriate. In addition, there are many more thousands of acres of plantations less than 30 years old in these Districts and in Roseburg and Coos Bay Districts as well. There is significant variation in forest species composition throughout the forests on these Districts. Therefore response to these systems will need to be monitored carefully throughout the forests on BLM lands in western Oregon. It will be necessary to insure silviculture systems being studied are appropriate given the ecosystem variables and specific management objectives for each District. Consequently, particular studies may be designed for each District but the overriding objective is to provide as much overlap and replication among Districts or Resource Areas as possible.

In order to understand how these systems will work in the management of forest lands, it is important to test them operationally. This means that treatments should be established as part of management programs, and that they be installed on large tracts of land, not uniform research plots.

Therefore, there is likely to be considerable variation among study sites and treatment replications. Nevertheless, an experimental approach and scientific rigor is needed to evaluate these systems across all BLM lands, if meaningful inferences are to be drawn from the results, and if the results are to provide a basis for adaptive management.

In this study, we will establish study sites on which the response of a range of taxa to stand density management can be evaluated. In this plan, we focus on the response of vascular plants to density management. Studies on other species will be established under separate study plans.

Past Research and New Information and Approaches Needed

There is considerable published information and practical experience on which to base these new silvicultural prescriptions. Much of the literature has been reviewed recently for the Final Recovery Plan for the Northern Spotted Owl (U.S.D.I., Tappeiner and others, 1992). The density management prescriptions called for in RMPs are similar to those suggested for managing stands to produce spotted owl habitat in the Final Draft Recovery Plan. Briefly, there has been considerable research on the effects of thinning on the growth and yield of Douglas-fir and hemlock stands (King 1986, Ruth and Harris 1979). This research includes response of very young stands (Reukema 1975), stands over 100 years of age (Williamson 1982), and a rather thorough study in stands from about 25 through 50 years of age (Curtis and Marshall 1986, Marshall et al 1992). These studies all show that Douglas-fir trees respond well to thinning and that they can be grown at a wide range of densities. For example, the levels of growing stock studies documents stand growth at stocking levels ranging from 50 to 400+ trees per acre. They also indicate that stands grown at these densities are not prone to windthrow, although assessing how thinning effects windthrow was not one of the objectives of the studies, and windthrow will likely vary from site to site. See the Final Recovery Plan for a more thorough review of research (U.S.D.I., Tappeiner and others, 1992).

Artificial regeneration methods for reforesting clearcuts with Douglas-fir have been well researched. There are successful procedures in place for nursery production of seedlings, site preparation, planting, shrub and herb control, and protection from wildlife damage (Cleary et al 1978, Hobbs et al 1992). This research and management experience strongly suggests that if healthy seedlings are properly planted, they will survive and grow. However, control of herbs and shrubs is often needed to insure satisfactory tree growth and plantation establishment. Control of competition is often of more concern on dry sites in southwestern Oregon than on moister sites to the north.

What remains is to combine these two areas of information and experience into silviculture systems to produce or maintain structures that provide for wildlife habitat, and for other resources while producing wood. Thus, as mentioned above, stand density management or thinning has the objective of not only producing large trees, snags, and wood volume, but also enabling the establishment of multiple layers of trees, shrubs, and herbs in the understory. Reforestation practices must insure seedlings produced in nurseries or advanced natural regeneration will survive and grow beneath larger trees. These practices must take into account competition to seedlings from both understory species and overstory trees. Also, it is anticipated that seedlings in an understory may be more susceptible to animal damage than seedlings growing in clearcuts since they might be less vigorous and growing more slowly.

Other aspects of the studies outlined here are different from past thinning and regeneration studies. They should be done on fairly large tracts (30 to 50+ acres) so that wildlife use of the different stand management systems can be evaluated. Adequate tree response data can be obtained from small, well-monitored plots (0.2+ acres), but entire stands on a variety of sites are needed to evaluate response of multiple resources and to evaluate costs and implementation of these new systems.

Finally, these studies should provide a basis for monitoring and adaptive management. Scientists from the Biological Resources Division (BRD) of the U. S. Geological Survey will play the lead role in analyzing and interpreting initial results; they are based at the Forest and Rangeland Ecosystem Science Center (FRESC) in Corvallis, OR. Personnel from Districts, Resource Areas, the Pacific Northwest Research Station (PNW), Oregon State University (OSU), and other agencies should collaborate in these studies. Once these systems are begun, they should provide a basis for learning how to monitor new stand and landscape management systems and thus proceed with adaptive management. They should also provide the basis for studying a variety of ecosystems and management variables, such as site productivity, root disease effects, wildlife response, economics, etc.

Other Related Studies

There are other studies proposed or underway that are related to the work proposed here and will contribute to development of the silvicultural systems in the RMP. See Hunter (1995) for a recent summary of related studies. Following are examples of studies of active management of trees and understory vegetation.

1. Comparison of wildlife communities and tree response among three silvicultural systems in the east-central Coast Range, Oregon - OSU McDonald-Dunn Research Forest

An integrated study documenting the response of vegetation, wildlife and conifer regeneration in three different systems: a) clearcutting with 2 trees/acre retained; b) two-story stand development - 8 to 12 trees/acre left at a uniform spacing after harvest; natural regeneration and planted seedlings; c) "group selection or group shelterwood" - one-third of the stand is being regenerated in 1/2-acre openings; and d) no treatment. Study installed beginning in 1991 in 120-year-old Douglas-fir.

2. Young stand thinning and diversity study - Willamette National Forest

Documenting vegetation, wildlife and conifer regeneration response to: a) no treatment; b) spacing to 100-120 trees/acre; c) wide spacing of 50 trees/acre and underplanting; d) thinning to 100-120 trees/acre plus 1/2-acre openings planted with conifer seedlings. Study established in 30-40-year-old Douglas-fir plantations or naturally regenerated stands; bird and small mammal monitoring was completed prior to treatment. Logging is scheduled for 1993 and 1994. Each treatment to include 50+ acres.

3. Commercial thinning and understory regeneration in young western hemlock - Siuslaw National Forest-OSU

Stand densities or stocking levels of 30 year old hemlock range from about 30 trees per acre to an uncut control. Natural regeneration and planted seedlings will be monitored. Treatment units about 5 acres.

4. OSU and the Forest and Rangeland Ecosystem Science Center - Stand Reconstruction

Stands on BLM lands that have been thinned 10-30 years previously, unthinned stands, and old-growth stands will be inventoried to compare overstory stand structure, species composition, and growth rates. The species composition, density, and growth of understory trees, shrubs, and herbs will also be measured. Information from this work will help design future stand management systems and predict response of understory trees and shrubs and overstory trees in stands whose canopy has been regulated by commercial thinning. Work began in June 1993.

5. OSU and Forest and Rangeland Ecosystem Science Center - Understory Regeneration

A study to determine how to establish a conifer understory by planting. Douglas-fir, western hemlock, grand fir, and western redcedar will be planted under a range of overstory densities with and without vegetation control and protection from animal damage. Study to be conducted on east and west Coast Range sites. Overstory thinning done fall 1993, planting done spring 1994.

6. A Demonstration of Ecosystem Management Options (DEMO) - Gifford Pinchot and Umpqua National Forests, Washington State Department of Natural Resources

This study will evaluate various silvicultural systems designed to sustain or develop late-successional forest attributes in managed forest ecosystems. To be implemented by the USFS and Washington DNR in conjunction with PNW and the Ecological Framework for Management Partners, which includes the USFS, OSU, the Ecosystem Research Group at the University of Washington, the Cascade Center for Ecosystem Management, and the Aerial Forest Management Foundation. Six treatments representing the full range of green-tree retention levels will be implemented. The biological and operational feasibility of the various green-tree retention designs will be evaluated, as will their economic and social acceptability.

7. Influence of commercial thinning intensity on stand structure and wildlife abundance. Two stand densities and a control on 60+ acre sites. In the Coast Range near Tillamook, OR - COPE and Oregon Department of Forestry.

8. Olympic habitat development study. Variable density treatments on small patches 0.1 to 0.5 acres to create variable stand structures. Installed on 6 sites on the Olympic Peninsula.

These studies will all provide information that will help with the design and implementation of the prescriptions called for in the RMPs. However, they alone will not provide sufficient information for the following reasons:

1. The sites studied do not adequately represent those managed by BLM, especially the numerous young stands. Therefore, they will not provide a basis for BLM monitoring and adaptive management.
2. They are not exactly compatible with prescriptions called for by the RMPs. For example, only treatment (2) in study one is similar to a GFMA prescription. But it includes only one leave tree number and pattern.
3. Plot or stand size is often not large enough to provide a basis for sampling wildlife populations.
4. They do not represent the planning analysis, prescriptions, and implementation skills of BLM personnel and are being implemented on research forests or on specially selected sites.

PART II - DENSITY MANAGEMENT STUDY PLAN

Objectives

1. General Scientific Objectives

- Test the working hypothesis that "regulation of stand density will enhance stand structural and species diversity."
- Evaluate several density management regimes to enhance species diversity as described in the proposed action. Test the null hypothesis that among the regimes there are no differences in structural characteristics and species diversity within 5, 10, or 15+ years following treatment.
- Provide a basis and experimental design for evaluating the response of various taxa to density management.

2. Management Objectives

- Begin to implement the density management program called for in the BLM's Resource Management Plans and the Record of Decision for the Northwest Forest Plan.
- Demonstrate the immediate and long-term effects of density management.
- Learn to integrate riparian and upland stand management prescriptions to achieve multiple species/stand structure objectives.
- Develop a basis for learning how to monitor populations of plants and animals.

Desired Future Condition at Age 120-150 Years

The following are the future stand goals that the treatments are intended to produce. They are taken from Spies and Franklin (1991), and represent a wide range of old-growth stand characteristics. Wherever possible, we will measure the characteristics of nearby old-growth stands and use them to guide stand development. The initial treatments will be similar for all stands, however.

1. Large green trees to be developed from the current stand

- 20 (range 10-30) trees/acre greater than 30" DBH
- 4 (range 2-6) trees per acre greater than 50" DBH
- 1 tree per acre greater than 50" DBH - with a broken top

2. Enhancement of species and structural diversity - this will be done through thinning the current stand, reserving the minor species that are already present, and by regenerating conifers and other plants in the understory.
 - 30 (range 25-35) trees/acre between 15 and 30" DBH. These trees would be a mixture of hardwoods, Douglas-fir, western redcedar, and western hemlock. They would include trees currently in the stand plus trees regenerated in the understory.
 - 150 (range 100-200) tree/acre less than 15" DBH. If natural regeneration is not present, one to three cohorts of a mixture of hemlock and cedar will be underplanted.
3. Snags
 - 10 (range 8-12) snags/acre with half greater than 25" DBH and half from 10 - 25" DBH. All decay classes would be represented.
4. Logs on the forest floor
 - 900 linear feet of well-dispersed down logs per acre
 - 1/3 of the logs would be 24" DBH or greater
 - 2/3 of the logs would be 10-24" DBH
 - All decay classes would be represented.

Study Design and Analysis of Results

The study will be replicated in blocks consisting of a control and three density management treatments. To the extent possible, each block will have a uniform forest cover of about 200 acres, and treatments will be assigned randomly to 50-acre parcels. Large treatment units are necessary in order to study the response of some wildlife populations to density management, and to evaluate the effects of operational treatments on stand structure. Within a block, the treatment units because of their size will generally not be homogenous or similar. For example, some will include streams and riparian buffers; others will include large trees from the previous stand; and understory vegetation will vary among and within treatment units. Nevertheless, our experience with stand reconstruction work in thinned, unthinned, and old-growth stands suggests the treatment effects on overstory trees and understory vegetation can be analyzed using regression to relate understory development to overstory density, and using analysis of variance with a block design to compare differences among treatments.

Analysis of the response of individual plant species such as native shrubs and herbs as well as lichens and bryophytes may be more difficult to assess, and less amenable to rigorous statistical analysis. These species are not likely to be uniformly distributed throughout blocks, among blocks, or within stands. Therefore, we will have to do analyses on a site-by-site basis using appropriate techniques among treatments and blocks. In some cases, this may mean simply reporting the presence or absence, relative abundance, or means and standard errors. In other cases, testing for significant treatment effects may be possible.

The experience gained by monitoring these density management studies can be directly applied to the monitoring and adaptive management called for in the Northwest Forest Plan. By replicating density management studies across many sites and systematically monitoring for "survey and manage" species, riparian zone characteristics, and stand growth and structure development, we expect to be able to document the responses of a range of taxa to density management.

Treatments to Achieve Desired Future Conditions

1. Stand Treatments

See Figure 1 and Table 1 in the appendix for the projected effects of these treatments on the size of overstory trees.

High density - vertical structural development only

- About 70-75% of the stand will be thinned to a density of 120 TPA to provide a moderate rate of understory development and growth in tree diameter.

Moderate density (with openings) - vertical structure and some horizontal structure

- About 60-65% of the stand will be thinned to a density of 80 TPA.
- About 10% of the stand will consist of well-dispersed circular patch cuts ranging from .25 - 1.0 acre in size (see below)

Variable density - rapid, "maximum" development of vertical and horizontal structure

- A highly variable (light to heavy) opening of the canopy that will provide an opportunity for the most rapid development of species and structural diversity.
- each thinning will be implemented in three or more areas of about the same size:
 - 10% of the stand will be thinned to a density of 40 TPA
 - 25 - 30% of the stand will receive the high density treatment (120 TPA left)
 - 25 - 30% of the stand will receive the moderate density treatment (80 TPA left)
- in 10% of the stand there will be well-dispersed circular openings ranging from .25 - 1.0 acre in size (see below)

The complement of patch cuts to be implemented in the moderate and variable density treatments is as follows:

3 or more .25-acre patches (59-ft radius) = .75 acre

3 or more .5-acre patches (83-ft radius) = 1.5 acres

3 or more 1-acre patches (118-ft radius) = 3 acres

For example, 5.25 acres or 10.5% of a 50-acre unit would be in patch cuts. They should be located in spots conducive to the growth of planted seedlings.

Control

- The control unit will provide a means of comparing stand development and species response in treated versus untreated stands. Stand development will occur slowly through such natural processes as self-thinning, root disease, and wind. See Figure 1 to see how the projected diameter distributions in the control at stand age 120 compare with those in the treated stands.

2. Riparian Zones

Streamside treatment unit boundaries will be adjusted from the one- and two- site-potential tree height buffers set forth in the ROD, as appropriate pending the results of watershed analysis and environmental assessment development. Riparian ecologists from the Aquatic-Lands Interaction Group of the PNW Research Station in Corvallis, OR have described two additional buffer widths that they are examining with the Riparian Buffer Component of the Density Management Study. These are:

Variable-width: varies with ecological breaks of vegetation (composition, age) and slope character (stability, gradient). Minimum width is 50 feet, measured as slope distance from the edges of the active channel, to ensure shading and wood/litter input to the stream.

Streamside Retention: maintains trees directly contributing to streambank stability and overhead shading. A streamside tree is reserved if a branch crosses a plane extending vertically from an edge of the active channel. Generally, trees within 20-30 feet of the stream are considered for retention.

At some sites, these same PNW riparian ecologists will install studies to evaluate the effects of thinning within Riparian Reserves on the populations and habitats of aquatic-dependent species such as fish and amphibians. PNW personnel will work directly with the Resource Area as riparian treatment boundaries are located on the ground during sale layout. For study sites or treatment units where PNW activity is absent, the local Interdisciplinary Team will employ either the variable-width or streamside retention concept when adjusting the buffer widths, consistent with the outcome of the watershed analysis.

3. Marking Guidelines

Marking criteria will be developed for each study block. Following are general criteria that may be modified for a given block:

- thinning will generally be "from below." Leaving the largest trees will result in a somewhat clumpy distribution of overstory trees.
- retain all hardwoods.
- retain conifers that are minor species for that stand.
- retain all understory conifers less than 5.0 inches in diameter.
- retain all residual overstory trees from the previous old-growth stand.
- retain all existing large down logs and snags from trees in the previous stand.
- retain limby/wolf trees from all canopy levels.
- select larger trees on the margins of root disease centers to thin around for coarse woody debris recruitment.
- maintain or enhance species diversity. Vary spacing or marking guidelines as needed to retain desired species or even to retain a single tree.

4. Reserve Areas

There will be aggregated green tree retention or "leave islands" in each of the thinning treatments. They help increase horizontal structural diversity and provide suitable microclimates for many organisms. They may be located around known populations of certain plant species, and can be used with adjacent thinned areas to determine how species respond to the direct effects of overstory thinning.

- About 20-30% of the area will be left untreated, with riparian reserve acres contributing to this component. Generally, circular leave islands will be left as follows:
 - 3 or more .25-acre areas (59-ft radius) = .75 acre
 - 3 or more .5-acre areas (83-ft radius) = 1.5 acres
 - 3 or more 1-acre areas (118-ft radius) = 3 acres

In treatment units with low amounts of riparian reserve acres, we will use 2.5-acre leave islands (186-ft radius) to arrive at the desired percentage.

5. Regeneration

Both outplanting and natural regeneration will contribute to the development of additional canopy levels. As stated on Page 7, the stand development goal is to have about 150 trees per acre less than 15" dbh in the understory at stand age 120-150.

Areas to be planted:

- all patch openings
- underplant all areas of 40 tpa in the variable density unit
- underplant 3 1-acre areas (circles, squares, or rectangles) in the moderate and high density treatments, and the control

The planting scheme outlined below should be used in all areas to be planted:

- planting at a 15 X 15 spacing will result in about 200 tpa. Spacing may vary by 20%, i.e. from 12-18 feet.
- The planting rows may be oriented in any direction, although planting at right angles to the contour seems to make the rows easier to re-locate. One species should be planted per row, with no two adjacent rows containing the same species. To make the planting outcome somewhat random, we would use the following process when there are four species. Randomly assign a species to Row # 1. Then randomly assign any of the remaining three species to be in Row # 2. Then randomly assign either of the remaining two species to Row # 3, leaving only one species choice to be in Row # 4. At this point, the only species we don't want in Row # 5 is whatever species was in Row # 4 (so that no two rows of the same species are adjacent). Row # 5 would then be assigned any one of the species that were in Rows # 1, 2, or 3; etc. In like fashion, Row # 9 would be assigned any of the species that didn't end up in Row # 8. The planters should adhere as well as they can to the established transects and spacing, regardless of existing regeneration or overstory trees.

Species to be planted in the patch openings and underplanted in 40 tpa: western hemlock, western redcedar, and Douglas-fir.

- a fourth conifer or hardwood species appropriate for a given site could be planted at the Resource Area's option.

Species to be underplanted in 80 tpa, 120 tpa, and the control: western hemlock and western redcedar.

- a third conifer or hardwood species appropriate for a given site could be planted at the Resource Area's option.
- these areas should be placed where the seedlings are likely to succeed, and it is preferred that they be at least 50-100 feet from roads.

Site preparation, manual planting spot preparation, protective action such as vexar tubing, and follow-up stocking maintenance would occur at the Resource Area's option as needed for growth and survival. To date the western redcedar have been tubed.

Since advanced natural regeneration has generally been retained in these study sites, there may be clumps of these trees that will need thinning in the future.

Any formal monitoring of seedling growth and survival after planting will be the responsibility of the BRD Unit in Corvallis.

6. Future Treatments

We are examining the process of stand development towards achieving old growth structure and species diversity under varying stand densities. Each treatment or overstory density represents a different way to achieve old forest characteristics.

Residual stand density in the high retention treatment will likely develop a level of competition that reduces vigor and causes suppression mortality to occur within 10-20 years. Such a degree of competition for growing space will inhibit growth and slow progress towards the desired future condition. A similar stand development scenario will occur in the moderate retention treatment, but at a later time. Additional intermediate harvests are planned to maintain growth and vigor by reducing stocking in order to achieve structural objectives. For example, old-growth stands commonly have only 10-60 large trees per acre. The only density management prescription which will reduce stocking to this level, e.g. 40 trees per acre, is on about 10% of the study area in the variable density treatment. Part of the variable treatment may also be thinned in the future.

Future thinnings and the number of trees per acre to be left are outlined in Table 1. Potential results of these treatments on tree size are shown in Figure 1. For example, the high density treatment (2) may be considered for additional density management in 10-20 years. The monitoring of overstory and understory development will indicate when to treat. In addition, planting or releasing established understory trees may be done to increase vertical or horizontal diversity along with these future thinnings.

Rethinning

Many stands on BLM and Forest Service lands have been thinned when they were 30 to 60+ years of age. Recent work by the BRD research staff at Corvallis suggests that these thinnings often stimulate initiation of conifer and shrub seedlings in the understory and development of trees with full crowns and large branches - all of which could lead to the development of old-growth characteristics. After these initial commercial thinnings the stand is often stocked with 80 to 100+ trees per acre at regular spacing. Old-growth stands often have a variable stocking of approximately 10 to 60 large trees per acre at irregular spacing. Thus it appears that rethinning may help promote old forest characteristics by further reducing overstory density while creating an irregular distribution of overstory trees. It will also promote continued development of 1), a second layer of conifers or hardwoods; 2), a shrub and herb understory; and 3), fuller crowns, larger branches, and furrowed bark on overstory trees.

Rethinning may be done in stands that have been commercially thinned. It is also part of the studies on density management in young stands described above (Table 1). As with the younger stands the goal is the same: development of old-growth characteristics while producing yields of commercial wood.

Treatments - will be done to enable large trees to continue their growth, and to promote the establishment of a multi-storied stand. Thinning will be "from below," generally resulting in a clumpy distribution of the 30 to 60 trees per acre to be left. Thinning will be heavier around clumps of understory conifers and hardwoods, thus promoting their release. Site-specific marking guidelines to be developed for each project area may vary from those found on P. 10. For example, we intend to reserve from thinning all stems contributing to additional canopy

layers; so for each site we will need to set a diameter limit, below which all trees left undamaged by logging are reserved from thinning. This could be as much as 8-10 inches dbh.

Installation - where possible, it is desirable to rethin 50+ acres, while retaining at least 15 acres as a once-thinned control. These acreages will vary among sites, but at each study site there will be a block of a rethinned stand with a once-thinned control. In some cases, the unthinned control area from the Stand Reconstruction study can be retained as well. These controls need to be left intact for about 15 years after the rethinning to allow us to get enough of a data set for vegetation analysis purposes.

Regeneration - one of the criteria for selecting these six study sites was that a significant amount of advanced regeneration resulted from the previous thinning. We do not propose to do any planting in these areas, however a management unit may decide to plant an unstocked area or introduce a species lacking in the stand. In some cases, it may be necessary to perform stocking control on the understory to maintain the growth and development of this canopy layer.

Vegetation Variables

The primary variable to be studied on all sites is the response of vegetation to density management. Studies of other species will be initiated on a case-by-case basis. Following are general outlines of the variables that should be quantified on each District, or set of studies.

1. Overstory tree response to density management (See Part III)
 - subsequent growth rates of trees and stands
 - cause of mortality (wind, insects, diseases, etc.)
 - snag recruitment rates
2. Response of shrubs and herbs (and lichens, bryophytes, and fungi if possible) to overstory density, and to treatments controlling competition to conifer seedlings (See Part III)
 - species composition
 - cover and height
3. Effects of trees, shrubs, and herbs on conifer regeneration (planted; new and advanced natural regeneration)
 - survival
 - growth
 - competition management
4. How well can these prescriptions be implemented using BLM procedures?
 - success of prescription implementation evaluated by achieving designated tree and snag retention, stand density, low levels of damage to trees, regeneration survival and growth
 - cost of implementation
5. Procedures for monitoring
 - data collection procedures for objectives 1-4 will be used to develop District-wide monitoring methods
 - data summary, analysis, and review for objectives 1-4 will be used to evaluate the need for adaptive management
6. Other objectives will become apparent as this plan is reviewed and other information needs surface. These study sites will create opportunities for wildlife ecologists to evaluate the response of some wildlife species (such as amphibians, small mammals, and some birds) to several density management regimes which will have been replicated at least twelve times on a representative set of young forests on four BLM Districts. Particular studies and variables to measure will be decided study by study. For example, underburning is being considered as a part of stand management by some Districts or Resource Areas. Evaluation of underburning could be incorporated in these studies.

Monitoring Plot Installation and Measurement

We propose to install about 60 of the quarter-acre plots described below at each of the density management study sites. Rethinning study sites will likely need closer to 20 plots. The total number of plots for a given site will depend on the number of strata, with probably 3-6 plots per strata. Strata may derive from different Land Use Allocations, different thinning densities, and different riparian buffer widths. Four sites have been measured, and Kathleen Maas-Hebner of OSU Forest Science is doing statistical analysis of this data now, with results due 4/1/00.

These plots should be established and measured within two years following harvest, and subsequent measurements should occur at roughly five-year intervals. This data on vegetation response and stand development is essential for determining how well density management prescriptions such as these can create the desired stand structural characteristics, and will facilitate the use of these sites by other researchers.

The FRESC Unit in Corvallis has an ongoing commitment to assist and guide the BLM in analyzing this monitoring plot data. The FRESC Unit cannot commit to any significant amount of the data gathering effort, so individual Districts and Resource Areas will need to install and remeasure these plots if the monitoring component of the study is to be fully implemented. Some amount of State Office guidance and oversight is expected to continue into the foreseeable future.

Overview of Plot Design

.25-acre fixed-radius (58.9') plot

- record and number all live trees that are ≥ 2.0 inches dbh
- record and number all dead trees that are ≥ 10.0 inches dbh and are ≥ 1 foot high. This definition of a dead tree will allow the tracking of old-growth stumps.
- record presence for all vascular plant species identified as late-successional/old-growth associates, e.g. those listed in the FEMAT report (1993).
- in thinned areas, record diameter (2-inch classes) and species of stumps in order to estimate basal area & number of trees per acre removed in thinning.

Four 8.33 ft. (.005 acres) fixed-radius subplots

- 4 satellites located 50 feet from plot center at the four cardinal directions.
- seedling count: for each tree species (conifers and hardwoods), tally the total number of stems that are 6 inches to 4.5 feet in height.
- sapling count: for each conifer tree species, tally the total number of stems that are ≥ 4.5 feet in height and < 2.0 inches in diameter.
- record average height and absolute per cent cover for all vascular plant species. Height is recorded to the nearest foot for shrubs, and to the nearest 0.1 foot for herbs.

Coarse woody debris sampling

- 100% sample of the .25-acre plots for pieces that are ≥ 10.0 inches in diameter at the large end, when the large end of the piece is within the perimeter of the plot. To observe this tally rule, we will often need to determine which end is the large end. Record length, species, condition class, and large- and small-end diameters.
- 100% sample of the .005-acre plots for pieces that are 3.0 - 9.9 inches in diameter at the large end and when the large end of the piece is within the perimeter of the plot.

Data Recording and Storage

The Polycorder 2000 is intended to hold all the field data, to be downloaded to a PC for storage and editing. Data sheets have been developed in the event that field data should need to be recorded by hand. A spreadsheet application of the DataPlus software has been developed for this project for use on the Polycorders. Once downloaded, the data can be manipulated by software such as Lotus or Excel.

Salem District is hosting a training in March 2000 on the DataPlus Professional software, which will be used to develop a better handheld data recorder application for this year's field measurements.

This section is included as info only, as to the data elements to be collected. Forest Survey procedures were “junked” with the decision to use the above-mentioned “DataPlus” application. Reports from raw data, e.g. BA/acre, to be developed by Kathleen Maas-Hebner of OSU. The field procedures are much closer to those used in the Current Vegetation Survey plot procedure, as opposed to Forest Survey plot procedures.

Forest Survey Handbook - Data Elements

MASTER SCREEN			
	Yes	No	Remarks
Project Name	X		
Stand Model Type	X		SPS or Willamette Valley ORGANON
Date of Survey	X		
RMA	X		
Township	X		
Range	X		
Section	X		
Unit	X		
OI Key Number	X		
Examiners	X		
Min. CWD Intersect Diameter		X	To be tallied, a piece must be 10 inches in diameter at the large end. Logs will be marked with paint.
Min. CWD Length	X		6 feet.
Stand/Strata Acres	X		
Stand Attributes	X		
Basal Area Factor		X	
Transect Segment Length		X	100% sample on the .25-acre plots.
Fixed Plot Size	X		F1=.25 (R1=58.9'), F2=.005 (R2=8.33'), & F3=.00025 (R2=1.9')

STAND EXAM DETAIL SCREEN			
	Yes	No	Remarks
Tree Number		X	Record azimuth & slope distance for all tally trees.
Plot Factor	X		
Strata & Tree Type	X		
Plot Number	X		Numbered consecutively per study site.
Tree Species	X		
Diameter Breast Height	X		Record for all tally trees; trees will have dbh nails as per CFI procedures; measured on uphill side of tree.
Form Factor		X	
Total Height	X		For each species, measure heights on 2-3 trees per 4-inch diameter class. If using SPS, use these figures to calculate a mean value to enter for non-measured heights. 4" classes are: 2-6, 6-10, 10-14, 14-18, etc.
Crown Ratio	X		Record only for trees where total height was measured.
Crown Class	X		Record for all tally trees.
Tree Rank		X	
Plot Crown Closure		X	Plant canopy analyzer (LICOR) measurements will provide % available light & leaf area index
Dead Trees	X		Minimum tally standards: 10.0 inches dbh & 6 feet tall.
Damage Type/Severity	X		Logging damage recorded only if there is a cambial break.
Defect Deduction		X	
Site Tree	X		
Breast Height Age	X		
Radial Growth		X	

VEGETATION DETAIL SCREEN			
	Yes	No	Remarks
Plot Number	X		
Plot Size	X		
Strata	X		
Layer	X		
Vegetation Species	X		
Average Height	X		6 inches is the minimum tally height for seedlings.
Cover Percent	X		"absolute" % so total for all could exceed 100%
Special Forest Products Quality		X	
Physiographic Class	X		

- Shrub and herb plot data should be gathered between May 1-September 1. Actual time of data collection will depend primarily on the recommendation of local botanists.
- Need aerial photograph punched showing plot locations and reference points.

APPENDICES

- I. Density Management Study - Wildlife Habitat Section
Joe Lint - Oregon State Office, BLM

- II. Density Management Study - Riparian Buffer Components
 - 1) Aquatic Habitats and Vertebrate Diversity: Dede Olson, Bruce Hansen, Loretta Ellenburg, & Jim Sedell - PNW Research Station, Corvallis

 - 2) Microhabitat and Microclimate of Riparian and Upland Areas: Samuel Chan, Dan Mikowski, Howard Weatherly, & Valerie Banner - PNW Research Station, Corvallis

- III. Density Management Study - Enhancing Diversity of Lichens and Bryophytes in Managed Stands: Influence of Legacy Attributes and Response to Density Management - Pat Muir & Bruce McCune - Oregon State University

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