STATE FORESTS

Research and Monitoring Program

PROGRAM SUMMARY

August 2006 – December 2007

OREGON DEPARTMENT OF FORESTRY

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Introduction

Four forest management plans guide operations. Operational activities on state forest lands are guided by four Forest Management Plans (Northwest Oregon, Southwest Oregon, Eastern Region, and Elliot State Forest). The Forest Management Plans (FMPs) describe Landscape Management Strategies (LMS) and Aquatic and Riparian Strategies (ARS) that are designed to supply a balance of economic, social and environmental benefits consistent with "the object of obtaining the greatest benefit for the people of this state, consistent with the conservation of this resource under sound techniques of land management."

Adaptive management measures progress toward objectives. The FMPs emphasize the need for adaptive approaches to management, in which the results of management actions are measured and compared to pre-determined objectives, and changes are made where necessary. This approach requires a commitment to long-term information gathering and the incorporation of that information into the decision-making process.

Research and monitoring meets information needs. The state forests research and monitoring program was developed to ensure that the levels of research, monitoring, and technology transfer are adequate to meet the information needs required by these long-range management plans. The State Forests Monitoring Program Strategic Plan (Strategic Plan - ODF 2002) was approved as part of the Implementation Plan "package" for the Northwest (NW) and Southwest (SW) Oregon Forest Management Plans. While this plan primarily focuses on research and monitoring related to the NW and SW FMPs, its general approach applies to Elliott State Forest (ESF) and Eastern Oregon Area (EOA) forest lands as well.

Validation of implementation and effectiveness. The Strategic Plan is designed to answer questions of implementation, effectiveness and validation of the "working hypotheses" and forest management strategies (LMS and ARS) described in the FMPs. It identifies high priority projects that will contribute to our understanding of FMP management strategies. It also identifies priority research and monitoring themes which will translate over the next several years into additional projects to contribute to the evaluation of the FMPs.

Funding set for research. A formal policy for State Forests Program research was adopted in 1995 (Appendix D, ODF 2002). The research policy states that approximately five percent of the State Forest Management Program annual budget can be invested in research, monitoring, and technology transfer. As a result of the funding structure, biennial and annual expenditures are somewhat variable in response to shifting revenue levels. The overall research budget to-date (both CSF and Board of Forestry funds) has ranged from about $350,000 to a high of over $1.5 million. For fiscal year 2007, investment in research and monitoring projects was approximately $1,300,000.

Doing what we said; making sure it's right. Two important objectives of the monitoring program are: 1) to determine whether FMP programs and strategies are implemented as stated; and 2) to determine whether FMP programs and strategies are effective at achieving stated objectives. The FMPs now serve as the basis for identification of specific information needs that should be addressed through new projects.

Seeking healthy forest ecosystems. New work will focus principally on the NW/SW FMP landscape management strategies because an important, largely untested, hypothesis of the management plans is that they will lead to the stand structures and habitat attributes necessary to support healthy and productive forest ecosystems. Because of their importance, the emphasis will be on implementation and effectiveness of landscape management, aquatic and riparian and forest health strategies. Although the emphasis of current initiatives is on the NW and SW FMPs, they will also inform the ESF and EOA FMPs due to the similarities in their overall approaches.

Using what's learned. Project results are incorporated into the adaptive management framework as new information becomes available. Research implications can inform a broad range of scales from site-level activities to FMP revisions. When project results indicate possible changes to the FMPs, those results will be incorporated into the Board of Forestry work plan and findings will be addressed as part of the Board's policy discussions.

Program staffing. Currently, the research and monitoring program includes two Monitoring Specialists (one NRS3 and one NRS2) under the Adaptive Management Unit Manager (PEMD). One NRS2 Monitoring Specialist position was lost in 2007 because a limited duration position was not made permanent.

Report summarizes accomplishments. This report summarizes State Forests Research and Monitoring Program accomplishments for August 2006 – December 2007. Highlights include:

- Stand Structure Development and Wildlife Relationships
- Implementation Monitoring
- Riparian Function and Stream Temperature (RipStream)
- Influence of Mineral Nutrition on Susceptibility and Recovery of Planted Seedlings to Animal Browse
- Trask River Intensively Monitored Watershed Study

Current Research and Monitoring Initiatives

Overarching themes guide research. As guidance in pursuing research projects and monitoring opportunities, several overarching research and monitoring themes have been identified that relate directly to the integrated forest management strategies and underlying assumptions:

- Silviculture and wildlife relationships;
- Hydrologic functions and aquatic and riparian habitat;
- Young stand development;
- Forest health; and,
- Socio-economic indicators

Broad area requires multiple approaches. These themes are meant to encompass a broad problem area that includes a number of more specific issues and questions, and, therefore, a number of potential research and monitoring approaches to meet the information needs.

Setting priorities. The following considerations were applied in setting initial priorities among effectiveness monitoring projects and will be used to help prioritize information needs within the research and monitoring themes:

- Is the activity central to answering critical implementation, effectiveness or validation questions relative to key FMP strategies?
- Will the activity provide information that will be critical to a scheduled periodic review?
- Does the package of activities result in a balanced program – i.e., it includes a variety of resources and disciplines, and includes both short term operational studies and longer term studies?
- Is there an activity or project currently underway that is a cooperative effort with other organizations and requires an on-going commitment for the project to be successful?

High-priority projects identified. Projects have been identified that will contribute to understanding the effectiveness of key management strategies, the underlying assumptions, and the working hypotheses related to the FMP. These projects are a high priority for ODF and include:

- Implementation monitoring procedures and reporting
- The interaction between Swiss needle cast and commercial thinning
- Assessment of young stand management strategies
- Stream temperature and riparian function
- Northern spotted owl and marbled murrelet surveys and site monitoring
- Stand structure development and wildlife relationships
- Socio-economic indicators
- Public acceptance assessment

Foundation for evaluating plans and making changes. This framework, including ODF projects to be initiated and in progress, ongoing cooperative work, and additional work related to the identified themes, will provide a strong foundation of monitoring and research information to help evaluate implementation and effectiveness of the FMPs. It will also play a key role in the adaptive management process by identifying and informing information needs and incorporating such information into the decision-making process. The following sections provide brief summaries of current and proposed research and monitoring, and completed projects.

Silviculture and Wildlife Relationships

Stand Structure

(ODF State Forests Program, Contractors)
(Relates to: Landscape Management Strategies; Structure and Habitat R&M Theme)

Rapidly emulate natural stands. Stand structure is defined as the physical and temporal distribution of trees and other plants in a stand. A major concept of the Northwest Oregon State Forests Management Plan (FMP – ODF, 2001) is to develop and maintain a range of forest stand structures through an approach known as structure-based management. By actively managing forest stands, structure-based management is designed to rapidly produce and emulate various natural stand development patterns and stand structures.

Test effectiveness of creating forest structure. The FMP defines five forest structural types that cover a range of structural attributes, from simple to complex. Forest managers plan harvesting and silvicultural activities to achieve a balance of these structure types across the landscape over time. When planning harvest activities, managers identify the intended "pathway" of the stand over time from the post-harvest structural type to the desired future condition structural type. While structure-based management is well-supported by silvicultural theory and practice, it remains largely untested. This project will test the effectiveness of active management to create forest structure as predicted by the FMP.

Looking at transition between structure types. Current stand structure types describe the condition of a stand at a particular point in time. This is limiting in that it does not describe the process of stand development between structure types or within a structure type. It is also limiting in that it does not identify either pre-existing or unknown indicator variables capable of describing whether a stand is on a particular pathway toward a defined desired future condition. A more detailed examination of stand structure conditions, attributes, and development over time will allow a better description of stand processes and indicators.

Study continues for decades. The first phase of this study, including post-harvest data collection, will be accomplished in 2007/2008. The study will continue as a long-term study for decades afterward in order to better describe the process of stand structure development. Information from this study will also be used as part of the Coarse Filter Monitoring project aimed at defining relationships between stand structure characteristics and native wildlife habitat.

See how management affects structure. The objective of the stand structure study is to examine how stand structure conditions are changing as a result of management prescriptions and to determine whether post-harvest stand structure conditions are developing as anticipated. The stand structure pathways we will be monitoring are stands in the Northwest Oregon Area districts projected to become Understory (UDS), Layered (LYR) and Older Forest Structure (OFS). Currently, only

stands in the 2002 to 2004 Annual Operations Plans will be measured. Each stand that will be measured must have a completed harvest. The resulting residual stand characteristics will be the baseline for future stand development monitoring.

Structure changing as anticipated. The second phase of the project will examine how stand structure conditions are changing as a result of management prescriptions and to determine whether post-harvest stand structure conditions are developing as anticipated.

Six questions. Six analytical questions will be addressed in this study.

1. Have post operation stand conditions developed as anticipated since harvest? within first 5 to 10 years? continuously beyond this period?
2. What parameters can be used as indicators to describe that the stand is developing toward a defined desired future condition?
3. Are pre-determined indicators effective in describing that the stand is developing toward a defined desired future condition?
4. What structural attributes are beginning to develop during this timeframe?
5. What variables influence the development of stand structure attributes and how quickly they develop?
6. Are the models used to define our stand structure types valid?

Seventy-eight sites in NW Oregon. Currently 78 sites have been selected for this study from the Northwest Oregon Districts. Data collection and plot installation began in the fall of 2007.

Coarse Filter Monitoring

(ODF State Forests Program)
(Relates to: Landscape Management Strategies; Structure and Habitat R&M theme.)

Broad range of habitat assumed. A key assumption of the FMP is that structure-based management will provide a broad range of quality wildlife habitat for native species. The FMP requires the monitoring of stand structures relative to wildlife habitat (ODF 2001a) but does not define how to achieve this goal.

Developing habitat monitoring approaches. ODF is in the process of developing a comprehensive wildlife habitat effectiveness monitoring program using various approaches depending on information needs and species characteristics.

Using habitat elements, not species. Generally, one can either monitor a species directly or use surrogates, including surrogate species (the presence of a species that is readily monitored is used to indicate the presence of a focal species that is difficult to monitor), guilds (groups of species with common behavioral traits or habitat needs) or habitat elements. Monitoring habitat elements as a surrogate for species presence, or habitat suitability, is known as coarse filter monitoring (CFM).

Several species can rely on habitat components. CFM represents an increase in efficiency over species monitoring because it tends to be much less expensive to monitor habitat elements than wildlife species. In addition, CFM can often make statements regarding several species that rely on a particular habitat component. This approach is only appropriate, however, when necessary habitat elements for a particular species are well-defined by empirical research. Therefore, it can only be used for well-studied species.

Determining whether right habitat is being developed and used. CFM will initially be developed using data from the Stand Structure project with a goal to expanding to all of state forests using Stand Level Inventory (SLI) data. Once finalized, CFM will help to answer the following questions: To what extent does the array of forest structure types incorporate habitat elements for native species?; How are forest structure types being utilized by native species?; How does the configuration of habitats support native species?; and, What structure types are currently limited? Are key wildlife structural elements or habitat elements (HE) are being provided across the landscape?

Eleven "specialist" species identified. The first stage of CFM was to define a list of species to monitor. An exhaustive literature review was used to identify species for which correlations between habitat elements and species presence was well-established and supported by empirical evidence (Weikel, 2004). This resulted in a list of 22 species with strong associations and another 41 that had potential but were lacking information regarding species-habitat relationships. This list was further refined in 2006 by identifying a group of species that represented the range of structural habitats and elements present on state forests. Habitat specialists were preferred over generalists because studies of these species' distributions do little to inform forest management. As a result of this refinement, the list now includes 11 species.

Three methods considered. The objective of the current phase of CFM is to identify, test and refine the most appropriate methodology. Several approaches to CFM were examined and three unique approaches were adopted for further development to determine their relative effectiveness and value to the agency. These approaches include the Wildlife Habitat Assessment Matrix (WHAM), Habitat Suitability Index Models (HSIM) and Bayesian Belief Networks (BBN). This comparison will be accomplished by applying these three approaches to all CFM species and contrasting the relative ease, functionality, precision and accuracy of each. Previous efforts by others, especially in HSIM and BBN model development will be heavily relied on in this phase.

WHAM uses broad to fine scale. WHAM is based on the Johnson and O'Neil Wildlife Relationships in Oregon and Washington Matrix (J&O Matrix - Johnson and O'Neil 2001). This matrix defines relationships between 743 wildlife species (excluding fish and invertebrates) known to occur in Oregon and Washington at three levels of habitat complexity. Their three predictive matrices vary from broad to fine spatial scales that are based on (in decreasing spatial scale) wildlife-habitats, forest structural conditions and habitat elements. The WHAM was created by identifying critical habitat elements for all 11 species as defined by both the J&O matrix and any other available empirical information. One to eight habitat elements were identified for each species and thresholds were defined to establish the outer bounds of habitat suitability for the species in question. A stand is considered suitable habitat for the species in question if it includes suitable levels of all habitat elements for that species. Thus, a stand is considered either suitable or not suitable for the species in question.

Stand-level reports link with inventory. A Microsoft Access-based program was created to compile data and create stand-level reports. This program has been incorporated into ODF's ROOTS (Reforestation Organization Operations Tracking System) program and can be used with any SLI data.

HSIM uses number values. HSIM incorporate habitat element values into a mathematical model that estimates an index of suitability for a particular species in a particular habitat. Index values range from zero (unsuitable) to one (ideal).

Offers range of suitable habitat. HSIMs are models that incorporate habitat elements (HE) that are expected to play a role in the likelihood of a species' presence. Like WHAM, HSIM are based on empirical data and expert opinion. Unlike WHAM, HE are combined in the model using some function, the most common of which are weighted addition without truncation, geometric or cube mean and minimum value (VanHorne and Weins, 1991). Thus, HSIM can present a range of suitability of one or more HE rather than a simple yes/no relationship as presented in WHAM. While HSIM could conceivably be based on one HE, they are typically much more complex (Juntti and Rumble, 2006).

Ratio of observed to optimum habitat conditions. Simply put, the HSIM for a particular habitat will be the ratio of the observed habitat conditions to optimum habitat conditions. If actual conditions are identical to ideal conditions, HSI equals one.

Two similar adaptable projects. Sources for previously created HSIM were examined and two were found to be appropriate for use on state forests: CLAMS (Coastal Landscape Analysis and Modeling Study) and the Umpqua Land Exchange HSIM (Vesely et al, 2001). Both include models developed for use in western Oregon that could be relatively easily calibrated for use on state forests. From these two projects, models have been adapted for seven of the 11 species in the CFM project. These models have been incorporated into Microsoft Access databases and can use either Stand Structure Project or SLI data but they have not yet been incorporated into ROOTS.

BBN base probability on prior use of habitat. Bayesian belief networks (BBN) employ a different statistical paradigm than that used by traditional frequentist approaches. It is based on the Bayes theorem to form posterior distributions that can be used to make probability statements regarding future parameter values. This is done by combining prior distributions, which can be based on previously gathered data and / or subjective opinion, with sampling distributions from observed data. The ability to make probability statements is an important distinction from frequentist statistics, which cannot be properly used to make such statements.

Added precision in estimating suitable habitat. Like HSIM, BBN predict the suitability of a particular habitat for a particular species on a range from zero to one. BBN represent a potential improvement over HSIM because they provide an estimate of the level of confidence in the results. This is important in assessing the precision of habitat suitability estimates. Further, it can easily incorporate expert opinion separate from inputs based on empirical data and can relatively easily be updated with new information in a user-friendly computer interface (Netica – Norsys, 2007). ODF can potentially benefit from BBN developed for use in Oregon, but it will require the assistance of an expert on the development and use of BBN to further this aspect of the project.

Next Steps:

- Incorporate spatial information such as roads and streams into WHAM;
- Contract with a principal investigator to develop BBN;
- Apply all approaches to Stand Structure Project data to compare and contrast;
- Identify most appropriate CFM approach for ODF and implement; and,
- Develop a GIS interface so that results can be presented spatially.

Influence of Mineral Nutrition on Susceptibility and Recovery of Planted Seedlings to Animal Browse

(ODF State Forests Monitoring Program, ODF Districts, Purdue University)

(Relates to: Young Stand Management R&M Theme; Structure and Habitat R&M Theme)

Animal browsing reduces plantation success. The regeneration phase in forest management is critical to ensure that appropriate objectives related to species diversity, site productivity, and habitat conservation are met. Animal browse, mostly by elk and deer, has a severe impact on artificial reforestation success in the Oregon Coast Range, often resulting in reduced plantation establishment success.

Make trees grow faster to avoid browsing. A variety of silvicultural options exist to limit damage caused by animals during the regeneration phase. However, the expense associated with many of these options (e.g., fencing, vexar tubing) limits their practical application in operational reforestation. Chemical repellents applied to terminal buds are labor-intensive and produces varied, but often ineffective, results. An alternative means that may prove more cost effective, is to promote rapid seedling growth to free-to-grow status (i.e., above the browse line) as quickly as possible.

Four fertilizer applications; growth checked for 5 years. This study is assessing response of Douglas-fir, western hemlock, and western redcedar to manipulation of plant nutrient content via application of controlled-release fertilization at the time of outplanting on a continuum of four fertilizer application rates (0, 20, 40, and 60 grams). Seedlings will be consistently monitored over a five-year period for growth, foliar nutrient and monoterpene levels, and susceptibility and recovery from animal browse. Simultaneously, a simulated browsing study will be conducted to help verify animal browsing treatment responses observed in the primary field trials using the same fertilizer regime. Relationships between browse susceptibility, recovery, and fertilization treatments will be thoroughly quantified. Additionally, the effect of the fertilizer treatments and browsing intensity on production of plant monoterpenes will be examined. This information may be used to determine how variation in plant nutrition affects production of chemical plant herbivory defenses and will yield practical, useable scientific results regarding the efficacy of silvicultural treatments that may help reduce damage and costs associated with animal browsing during the reforestation process.

Looking at growth and recovery after browsing. The overall goal of this study is to determine the influence of variation in foliar mineral nutrition (resulting from fertilization at planting) on susceptibility of seedlings to animal browse, along with capacity for seedlings to recover following incurred browse damage.

Field Study Results – First Year

Little relationship seen between treatments and browsing. One year after planting, all three species experienced some level of browse across all sites and fertilizer treatments (Figures 1 and 2). Most of the browse originated from elk damage with additional damage occurring from mountain beaver. Currently, the fertilizer treatments are showing little in terms of a relationship between seedling nutrition and animal browse (Figure 2). Significant differences between fertilizer treatments are hypothesized during the recovery phase of all browsed seedlings.

Western redcedar browsed most. Western redcedar experienced the greatest level of browse evident from the high percent of seedlings browsed and the negative mean height growth (Figure 2 and 3) with a range of 46% to 49% and -0.24 cm to -1.00 cm across fertilizer treatments, respectively. No significant differences existed between any of the fertilizer treatments for any measured parameter suggesting uniform browsing pressure regardless of the fertilizer rate. Western redcedar seedlings under applied fertilization did reveal trends in greater mean diameter growth compared to the control, though not statistically significant (Figure 4).

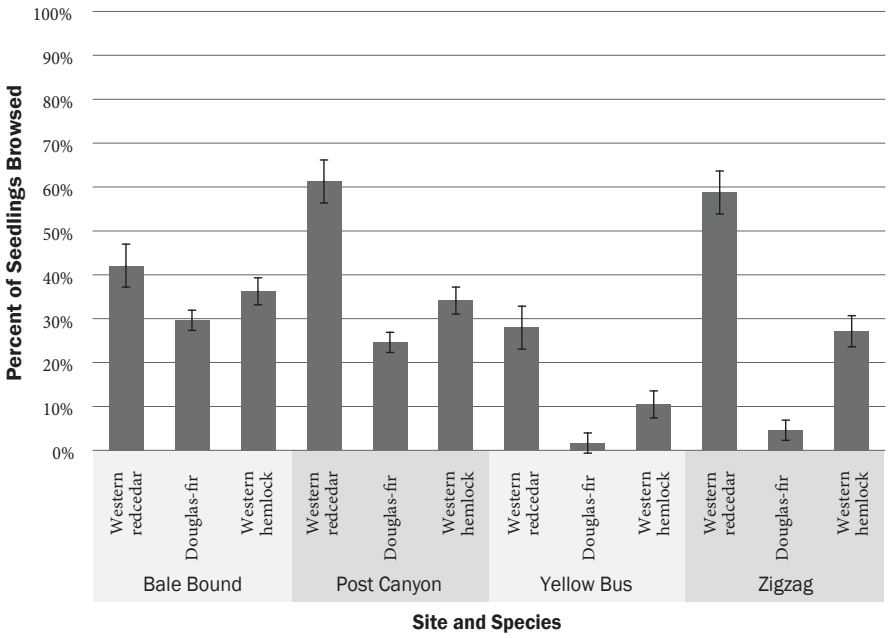

Figure 1: Percent of seedlings browsed based on site and species

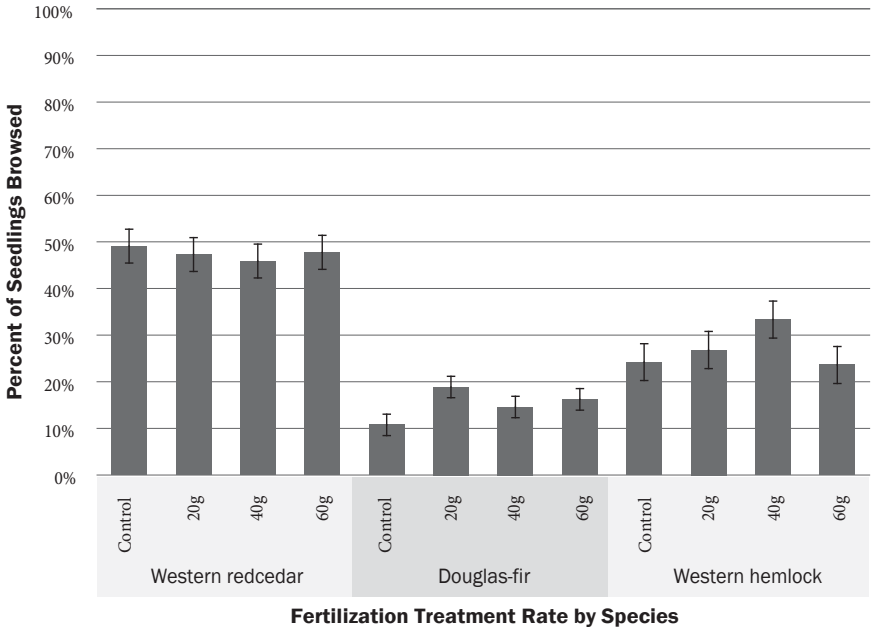

Figure 2: Percent of seedlings browsed based on fertilizer treatment and species

Hemlock growth maintained across treatments. The amount of hemlock seedlings browsed was relatively high with a range of 24% to 33% across fertilizer treatments. Though there was a high percentage of browse, hemlock seedlings maintained a positive mean height growth response across all fertilizer treatments (Figure 3). Both mean height and diameter growth showed significant gains under the applied fertilizer treatments compared to the control with the exception of mean height growth under the 40 gram treatment (Figure 3 and 4).

Douglas-fir sees low level of browsing. Browse intensity on Douglas-fir seedlings was extremely low relative to the other species (Figure 1 and 2) with a range of 11% to 19% across all fertilizer treatments. Mean height growth, though not significant, showed positive gains with increasing fertilizer rate (Figure 3); likewise, mean diameter growth was observed to have similar gains (Figure 4).

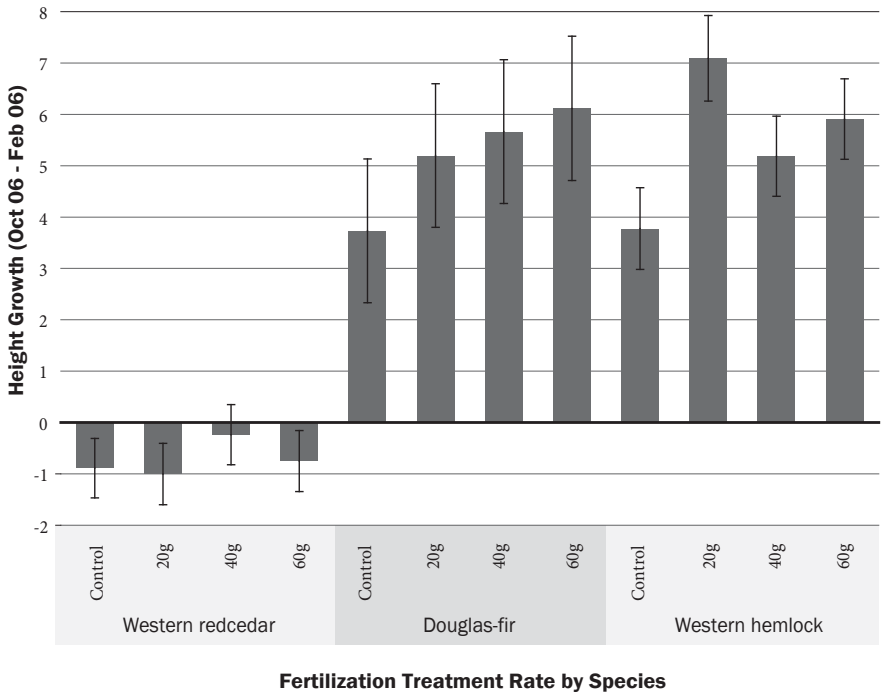

Figure 3: Mean height growth (March 2006 - October 2006) defined by fertilizer treatment and species

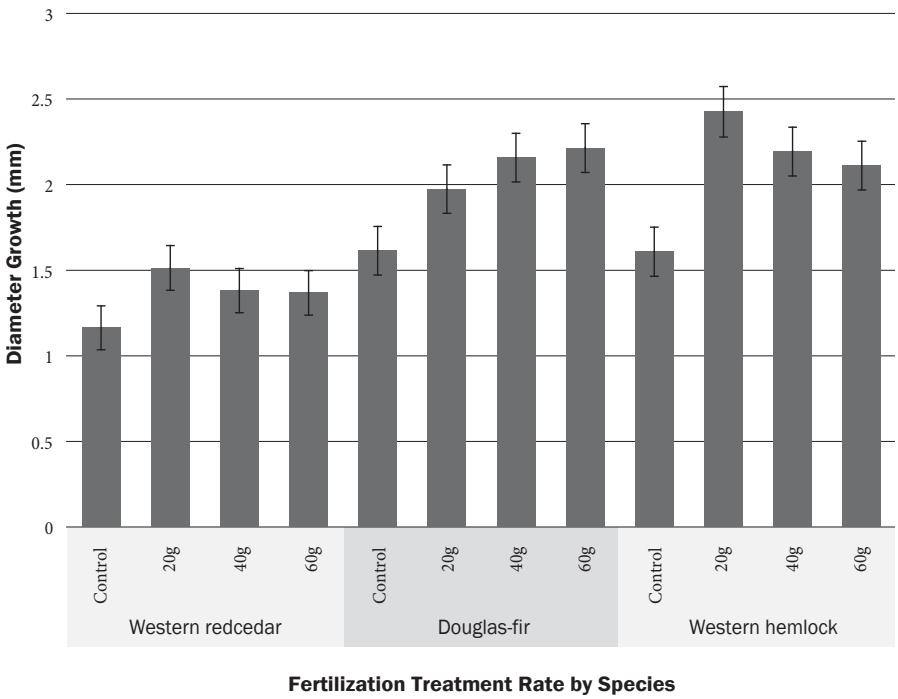

Figure 4: Mean diameter growth (March 2006 - October 2006) defined by fertilizer treatment and species

Simulated Browse Study

Site prep: aerial herbicide, slash removal, fencing, trapping. In the fall and early winter of 2006, the site chosen for the simulated browse study was prepared with an aerial herbicide application and intensive slash removal. Following these prescriptions, the site was fenced around its perimeter and trapped for mountain beaver. Western red-cedar, Douglas-fir, and western hemlock seedlings were planted in January 2007.

Hand clipping simulates elk browsing. The experimental design is a 4 by 2 factorial with fertilization and simulated browse as the main treatments. The fertilizer treatments are the same as the field study consisting of four different application rates (0, 20, 40, and 60 g per seedling). At the time of planting the emulated elk browse treatments were applied as follows: 1) no browse (control); 2) clip main stem with a 50% reduction; 3) clip main stem with 75% reduction.

Uses same protocol as field study. Survival, growth, and browse damage of seedlings within this experiment will be measured using the same protocol as the field study to examine both the impact of various levels of browse damage on seedling development and impact of fertilization treatments on recovery from damage. Additionally, seedlings will be randomly selected for destructive harvest to evaluate foliar levels of both nutrients and monoterpenes.

Marbled Murrelet Effectiveness Monitoring

(ODF State Forests Program)
(Relates to: Species of Concern Strategies)

Threatened seabird nests in older conifers. The marbled murrelet (Brachyramphus marmoratus) is a small seabird that forages in the ocean but nests in conifer forests with older forest structure up to 55 miles inland. Due to declining populations, it was federally listed as a threatened species in Washington, Oregon and California in 1992. Both known and potential nesting habitat occurs within state forests managed by ODF.

ODF surveys and uses take avoidance. ODF currently has no Habitat Conservation Plan (HCP) for lands in northwest Oregon and thus manages these lands under a take avoidance strategy. Management activities consistent with this strategy are described in the State Forest Program Marbled Murrelet Operational Policies (ODF, 2005) and Marbled Murrelet Guidance Document (ODF, 2004). These documents describe surveying requirements, the establishment of Marbled Murrelet Management Areas (MMMA) in areas in which murrelets have been detected, and allowable operational practices within MMMAs once established.

Thinning to expedite growth, habitat. Some MMMAs have potential murrelet nesting habitat within them that is not yet suitable because further growth of potential nest trees is necessary. ODF has undertaken selective thinning regimes to encourage this growth to occur more rapidly than would be expected if the stands remained unthinned.

Measuring how habitat maintained, improved. The effectiveness of strategies to maintain currently occupied habitat and improve unoccupied habitat have not definitively been measured. The goal of this project is to do so.

Occupied Habitat

Surveying occupied habitat is site specific. ODF procedures and guidance are designed to protect and maintain occupied nesting habitat in MMMAs. The intent is to maintain occupancy at known nesting sites. ODF is not required to conduct murrelet surveys at MMMAs, but often does on a site-by-site basis. This monitoring provides useful information at the site level but does not answer monitoring questions at a landscape scale. To do so requires a refinement of monitoring questions and approaches to determine the effectiveness of MMMA management.

Occupancy models look at landscape. The first phase will be to explore the use of occupancy models with previously collected presence/absence data. This technique allows for the variation in occupancy probabilities between sites to be modeled with covariates such as habitat condition or management actions. If feasible, this may allow ODF to explore influences on the probability that a MMMA remains occupied and make corrections if necessary.

Non-occupied Habitat

Nesting platforms on large limbs in dense old forests. Marbled murrelets nest on large or deformed limbs in conifer trees. They do not build nests but rather hollow out depressions on (typically) mossy limbs. Key components of marbled murrelet nesting habitat include trees with large limbs and foliage cover, high densities of large trees, numerous canopy layers and openings to facilitate take-offs and landing from nesting platforms.

Promoting quicker habitat development. Due to management history and natural causes, little of ODF's ownership is considered suitable as marbled murrelet nesting habitat. The highest quality habitat tends to be protected in MMMAs. Some stands have the potential to grow into suitable habitat, but the natural development rate of key structural components can be slow. However, some silvicultural treatments may accelerate this process. Recognizing this, ODF has taken efforts to implement silvicultural strategies to promote quicker development of nesting habitat in those stands judged to have potential.

Thinning around potential nest trees. These methods include identifying potential nest trees and selectively thinning around them to promote the rapid development of large limbs and provide canopy openings while maintaining suitable cover. To date, this approach has been implemented in three stands in the Tillamook and Astoria districts. Monitoring of these stands will provide measures of the rate of development of key nesting structures.

Treatments may attract predators. Stand manipulation, however, may also increase the habitat suitability for some murrelet predators, especially corvids (jays, crows and ravens), which tend to select more open stands than those with closed canopies. This could reduce the probabilities that a stand would be occupied by murrelets and that any nests in that stand would successfully fledge chicks. Monitoring of the relative abundance of corvids will help to determine if silvicultural treatments influence predator populations in these stands.

Long-term monitoring needed. An ideal measure of habitat suitability is reproductive success, but this is very difficult to measure in nature. A suitable proxy is occupancy, which can be reliably measured using an established protocol. Long-term monitoring of these stands for occupancy by murrelets will provide an excellent measure of the effectiveness of these silvicultural strategies.

Habitat assessment protocol completed. To date, two years of corvid monitoring have been completed, including both pre-harvest and post-harvest. A habitat assessment protocol has been completed and was implemented in 2007. A report on preliminary data results will be completed in late 2008.

Implementation Monitoring

(ODF State Forests Program)

(Relates to: Landscape Management Strategies; Implementation Monitoring, Structure and Habitat, and Aquatic and Riparian R&M Themes)

Balance of structure types sought. The Forest Management Plans (FMPs) adopted for the northwest and southwest Oregon areas in 2001 implemented a new paradigm for ODF, structure-based management, to develop a balance of forest structural types. This balance is sought through a series of Landscape Management Strategies (LMS) and Aquatic and Riparian Strategies (ARS).

Assessing success of forest management plans. Understanding the effectiveness of these strategies is critical to assessing the success of the FMPs, but concurrent monitoring of their implementation confirms whether they are being implemented as described in the FMPs. Implementation Monitoring (IM) seeks to answer the question "are we doing what we said we were going to do?"

Harvesting techniques, riparian areas studied. Four methodologies were developed to answer this question. They include three field-based sampling techniques that differ for clearcuts, partial cuts and Riparian Management Areas (RMAs) and one office-based document review. A pilot project was developed in 2005 to test these methodologies and to form a preliminary assessment of the implementation of FMP strategies.

Random operations picked for pilot. The pilot project defined a sample of 20 percent of all clearcuts and partial cuts, respectively, for each Annual Operation Plan (AOP). These operations are chosen randomly from each AOP. Where an operation has several areas, one area from each operation is sampled. The scope of the pilot project and currently planned implementation monitoring includes AOPs for all six Northwest and one Southwest districts over the years 2002 (the first year of FMP implementation) to 2004. Future information needs may require ongoing data collection and reporting.

Clearcut and partial cut from each district. The objective of the pilot project was to test the protocol on at least one clearcut and one partial cut (where available) for all seven NW and SW districts. Operations were sampled as they became available. Due to the length of time between planning and completion of harvest and silvicultural activities, it was not possible to sample an entire AOP for any one district in the first year. The data for the pilot project have been collected and analyzed and a final report is planned for early 2008. While the pilot project was designed to test methodologies, preliminary discussion of the results is informative.

Distinct methods developed to test implementation. IM was designed to test the FMP strategies that describe operational activities from planning to harvest. These include LMS 1 - 3 and ARS 2 and 5. Since strategies and sampling populations differ among clearcuts, partial cuts and RMAs, distinct methodologies were developed to test implementation in each as described below.

Contract Administration Review (CAR). CAR collects qualitative, office-based data on operational planning and contract administration at both the site and landscape-level on each district. Monitoring staff review Annual Operation Plans, pre-operational reports and contract documents and answer a series of questions with district staff. AOP-level questions include all operations within a given AOP while site-level questions focus on the randomly selected sites used for field sampling. These data are presented as the proportion of Yes, No and N/A responses for each question, respectively.

Clearcut Assessment (CC). CC Assessment collects mainly quantitative data on green tree, snag and downed wood retention following clearcut operations as well as some quantitative data such as the spatial distribution of green trees and snags. It is a plot-based methodology that includes a line intersect sample for downed wood and a variable area plot for green trees and snags.

Partial cut Assessment (PC). Stand Level Inventory (SLI) is an ODF-designed methodology for sampling forest structure attributes. It is most accurate when populations of green trees and snags are fairly high, such as in partial cuts. Since SLI collects all important information to capture implementation of FMP strategies in partial cuts, it was adopted as the methodology for these areas.

RMA Assessment. RMA Assessment is also a plot-based methodology that includes green tree, snag and downed wood data collection as well as qualitative data collection on operational activities within Riparian Management Areas.

Samples used to assess consistency. Data collected using each sampling regime are used to assess consistency with LMS and ARS that are specific to each operational type. Many strategies, however, are meant to be applied at the landscape-level. Data are thus averaged across sites using a stratified sampling approach to create landscape-level values. In the case of clearcuts, CC data is combined with RMA data to estimate site parameter averages; SLI site averages include both upland and RMA areas and do not need to be combined with RMA Assessment data.

Results so far broadly consistent. IM was initially designed to collect data on FY2002 – FY2004 operations, but it has been recognized that there is an ongoing need for data of this nature to inform program objectives, such as performance measures, and inform the districts on implications of operational approaches on an ongoing basis. The results of data collection will be reported annually. Data is stratified by district and by operational year, however it can often take several years before all sales within an operational year are completed. Interim reports will therefore also be written as data is completed for each district for each operational year. Results to date indicate that management of state forests is broadly consistent with FMP strategies but results are not presented here because the paper has not yet been reviewed.

Pilot recommends data collection improvements. The pilot study report will be completed and sent to the districts for review in early 2008. Several recommendations will be made regarding improvements to data collection procedures. Namely, the RMA sampling scheme requires revision to better estimate landscape-level retention of legacy structures and the clearcut downed wood plots can be reduced in size to increase efficiency in data collection.

Hydrologic Function and Aquatic and Riparian Habitat

Riparian Function and Stream Temperature (RipStream)

(ODF State Forests Monitoring Program, ODF Districts, Forest Industry)

(Relates to: Aquatic and Riparian Strategies; Aquatic and Riparian R&M Theme)

Measures stream protection rules. The RipStream project is a joint monitoring effort designed to measure the effectiveness of stream protection rules as prescribed for State Forests and private forestlands in the "Management Standards for Aquatic and Riparian Areas" and Oregon's Forest Practices Act, respectively.

Meeting water quality standards in Coast Range streams. Specifically, the project was intended to assess effectiveness in meeting Department of Environmental Quality (DEQ) water quality standards and the Desired Future Condition for Riparian Management Areas in the Forest Practices Act regarding large woody debris, shade, and vegetation. RipStream study sites are located throughout the Coast Range geographic region on small and medium sized fish-bearing streams. This project was initiated in 2002 and the final year of data collection is scheduled to be 2011.

Pre- and post-harvest data collection. The study design called for sites to have two years of pre-harvest data followed by five years of post-harvest data collection, though some sites have deviated from this framework due to delayed timber harvests. Currently, 31 sites have at least one year of post-harvest data (18 Private and 13 State). In addition to pre and post-harvest sampling on treatment reaches, all RipStream sites have untreated control reaches and in some cases an untreated downstream reach (18 sites). Preliminary analyses of collected data versus DEQ standards, stream shading, and changes in stream temperature are provided.

Temperature used to measure protection. Two DEQ temperature standards are used to measure effectiveness of stream protection rules: the Protecting Cold Water (PCW) standard (formerly the anti-degradation standard, OAR 340-041-0028 11(a)) and the Biologically Based Numeric Criteria standard (OAR 340-041-0028 4 (b) (c)). ODF personnel are working with DEQ on guidance and interpretation of both of these standards.

Both treated and control areas see increased temperature. There is no indication that the number of sites or frequency of days with temperatures exceeding DEQ's Numeric Criteria standard increased for treatment temperature probes relative to control temperature probes. After harvest, the number of sites exceeding the numeric criteria increased by a similar amount for all probes (+4 control, +4 treatment, +3 downstream). The same is true for the frequency of temperatures exceeding the Numeric Criteria after harvest (0.1% - 0.5% increase for all probe

categories). For this analysis, ODF staff assumed that one data point exceeding the Numeric Criteria meant the criteria had not been met. This should be a conservative assumption, but final guidance on interpretation of the Numeric Criteria standard may result in a different conclusion.

Guidance sought on applying cold water standard. ODF personnel are also working with DEQ on guidance and interpretation of the Protecting Cold Water (PCW) standard. This standard generally states that streams that currently meet the applicable Biological Numeric Criteria may not have their temperatures increased more than 0.3°C. According to draft guidance issued by DEQ, determining how the PCW standard is to be assessed requires the application of a complex decision matrix involving the presence/absence of salmon, steelhead, or bull trout within the water body, whether the water body is designated as critical habitat, and whether the Biologically Based Numeric Criteria are being exceeded.

Outcomes vary depending on what's exempt or applied. One of three different outcomes are possible from this decision matrix: 1) the water body is determined to be exempt from the cold water protection standard, 2) the 0.3°C temperature increase limitation is applied immediately downstream of a harvest unit, or 3) the 0.3°C temperature increase limitation is applied at a point farther downstream of the harvest unit.

Project not aligned with cumulative effects proposal. In its draft PCW guidance, DEQ has proposed a cumulative temperature effects analysis using aerial photos and assumed stream temperature gradients to take into account the impacts of multiple harvest units on downstream water temperatures to determine whether scenario 2 or 3 above applies. For these reasons, we do not yet have a full sense of how these three scenarios would be distributed across RipStream sites. The RipStream project was not designed to address cumulative effects other than the inferences possible through detectable temperature effects in downstream reaches. ODF personnel are working to determine the best means of addressing this issue.

Shade decreased 8 percent in treated areas. With regards to stream shade, a paired t-test comparing the average change in shade from pre- to post-harvest indicated that treatment reach shade levels decreased by 8% relative to control reaches ($p<0.004$). This test grouped all ownerships, stream classes, and treatments.

Changes in shade differ by stream size, ownership. In contrast, Figure 5 shows the average change in shade from pre- to post-harvest between control and treatment reaches further broken down by ownership and stream class. This figure suggests that changes in shade are not consistent for all stream classes and ownerships.

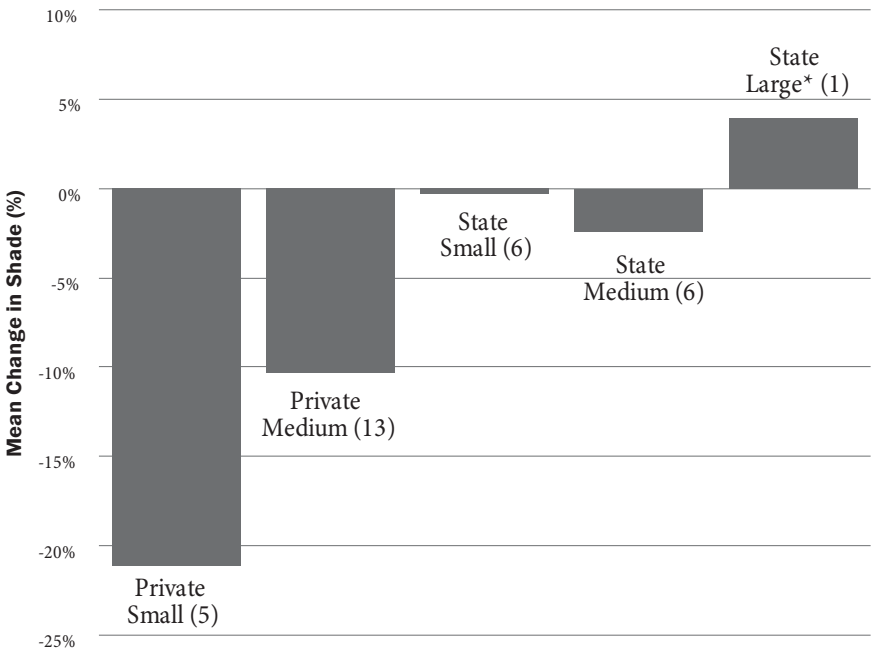

Figure 5: Mean percent change in shade between control and treatment reaches pre- to post-harvest (($\Delta_{\text{Pre-Post}}$ Control)-($\Delta_{\text{Pre-Post}}$ Treatment)) by ownership and stream class (sample size in parentheses). *Stream class transitioned from a Medium to a Large through the harvest unit. The applied riparian management prescription was categorized as a Large stream.

Stream temperature increases after harvest. In June 2006, preliminary RipStream results were presented to the Board of Forestry by Jennifer Fleuret, an Oregon State University graduate student, and her advisor, Dr. Stephen Schoenholtz. Fleuret's work showed a statistically significant average increase in stream temperature of about 0.6°C per 1000 feet of stream length after harvest relative to the control reach. This statistic was calculated from 22 sites that were harvested at the time of the study. Using Fleuret's same method on data from the 31 sites now available, the average increase in stream temperature for the first year post-harvest was found to be almost identical at 0.7°C per 1000 feet ($p<0.0002$).

Further analysis seeks breakdown by stream size, ownership, treatment. The statistical test that produced these results used only one year of pre-harvest data and lumped all stream classes, ownerships, and treatments. ODF personnel are currently working to identify an analysis method that will take advantage of the multiple years of pre-harvest data and examine changes in stream temperature by stream class, ownership, and treatment (one- or two-sided harvest, clearcuts versus thinnings, differing Riparian Management Area applications, etc.).

Temperature increase still safely below standard. It may seem counterintuitive that preliminary RipStream data indicate an average increase in stream temperatures after harvest but no evidence of an increase in the number or frequency of sites exceeding the Numeric Criteria. Most RipStream sites maintain stream temperatures far enough below the Numeric Criteria that an average increase of approximately 0.5°C did not push temperatures over the threshold. The PCW standard would be the criterion of concern in this case.

Next Steps:

- An article summarizing pre-harvest stream temperature patterns in RipStream sites was accepted with revisions by the Journal of the American Water Resources Association.
- Continued cooperation with DEQ staff on guidance and interpretation of the Numeric Criteria and PCW standards.
- Final analysis of the first-year post-harvest data.
- Continued analysis of all monitoring questions including: an exploration of stream channel, valley form, and riparian vegetation influences on shade and/or stream temperature; large wood recruitment to streams; and inputs of downed wood to the riparian areas.
- Examination of how ownership, stream class, and differing treatments are related to changes in stream shading and consequently changes in stream temperature. Characterizing harvest "treatment" is difficult because it includes harvest on one or both sides of the stream, clear-cuts and thins, differing riparian management area prescriptions, and differing harvest unit lengths (900 to 6000 feet).
- Future reporting on post-harvest year 3 and 5 milestones.

Final report in 2009. A final report from this project is expected in 2009.

Trask River Watershed Study

(ODF State Forests, OSU, USFS, BLM, USGS, Weyerhaeuser)
(Relates to: Aquatic and Riparian Strategies; Aquatic and Riparian R&M Theme)

Web site reference. Please see the following web site for more information on this project: *http://www.odf.state.or.us/trask/default.asp*

Summary of Accomplishments to date

Team formed. Formed Science and Operations Teams, which represent coordination among multiple research organizations, natural resource agencies, and landowners.

Joined cooperative. Joined Watershed Research Cooperative to collaborate with the two other watershed studies in Oregon.

Finalized design. Finalized the experimental design including the approach, locations, and timing of treatments for Weyerhaeuser, BLM, and ODF.

Installed collection stations. Installed hydrology and suspended sediment data collection stations and associated infrastructure (trails, sheds, log stringer bridge)

Started data collection. Two years of data collection on water quality, fish, periphyton, and macroinvertebrates. One year of amphibian data collection.

Summary of Objectives and Design

See how operations affect small streams and downstream. The Oregon Department of Forestry in partnership with Weyerhaeuser Company initiated a watershed-scale research study in the headwaters of the Trask River. The Trask River Watershed Study will examine the impacts of forest operations on small, headwater streams and the extent to which these impacts are transferred downstream.

Compare management practices. Our goals in the Trask Watershed Study are to understand how aquatic systems, particularly small streams, respond to forest harvest operations and to compare two management practices to determine the effectiveness of best management practices (BMPs) and the Northwest Oregon State Forest Management Plan (FMP). Our overall objectives are to determine:

- **Headwater effects.** The effects of forest harvest on the physical, chemical and biological characteristics of small streams;
- **Downstream fish-bearing effects.** The extent to which alterations in stream conditions caused by harvest along headwater channels influence the physical, chemical and biological characteristics of downstream fish-bearing streams.

Public and private ownership. Ownership of the upper basin is evenly split between the Oregon Department of Forestry (ODF) and Weyerhaeuser Company, with a small area managed by Bureau of Land Management.

Science teams leads research. The interdisciplinary science team, led by Dr. Sherri Johnson (Pacific Northwest Research Station) and Dr. Bob Bilby (Weyerhaeuser Company), was formed to design and lead the research. The team includes researchers from Oregon State University, US Forest Service Research, USGS Forest and Rangeland Ecosystem Science Center, and Weyerhaeuser Company. Frequent collaborations occur with personnel from Oregon agencies and local groups. Research in the Trask watershed is being coordinated with other watershed studies in Oregon through the Watersheds Research Cooperative.

Operations team designs forest operations. An operations team has been formed, including foresters and forest modelers from Weyerhaeuser, ODF, and BLM, to design forest operations that are compatible with research design needs and result in logical application of forest operations.

Study design looks at sediment, channel changes, water quality, bugs, amphibians, fish. Ten hypotheses have been developed addressing specific aspects of harvest-responses and conceptual models in hydrology, suspended sediment, channel morphology, water quality, macroinvertebrates, primary productivity, amphibians, and fish. Hypotheses are posed for on-site and downstream effects. The hypotheses and field methods for each are detailed in the full Trask River Watershed Study Plan and executive summary (Johnson et al. 2007)

Combines experiments, models, before-after-control impacts. In summary, methods are designed to integrate responses of each of the ecological components at the headwaters and downstream scales. Combinations of experimental, modeling, and before-after-control-impact designs are in place to allow the greatest flexibility, inference of responses, and integration across disciplines. By integrating multiple approaches to understand relationships between harvesting, habitat, and fish, we hope to overcome limitations of each approach, as well as take advantage of the strengths of each approach.

Nested and paired headwater catchments and sub-watersheds used. The overarching experimental design for the Trask River Watershed Study incorporates nested and paired headwater catchments and sub-watersheds. On-site responses are evaluated on small, non-fish bearing streams (headwater catchments). Effects of harvest on downstream reaches are examined on fish-bearing streams (sub-watersheds). Four headwater catchments have been clustered within four sub-watersheds. Three of these sub-watersheds will be treated and one will remain as a control. Within each treatment cluster, one headwater catchment will not be harvested serving as a within-cluster paired reference.

Treatments try different buffers. In the three treatment clusters, harvesting will occur around the non-fish bearing portion of the stream network. Harvest prescription will be blocked as follows:

- **No leave trees.** Clearcut with Forest Practices Act (FPA) restrictions and no leave-trees buffers
- **Variable with, without leave trees.** Mixed: A combination of thinning with variable buffers and Clearcut with FPA restrictions and no leave trees buffers
- **With leave trees.** Clearcut with FMP leave-tree buffers

Multi-year study. The study duration is 2007-2016. Synoptic data collection began in 2006 with more formal approaches implemented in 2007. Road construction will take place in 2011 and harvest in 2012. The last year of data collection will be 2016.

- 2007-2010: Pre-treatment
- 2011: Road Construction
- 2012: Harvest
- 2013-2016 Post-harvest data collection

ODF and Weyerhaeuser funding. ODF and Weyerhaeuser Company are providing long-term operational funding for this research, the results of which will be shared in peer reviewed publications, reports, online datasets and workshops. Additional funding is being sought through competitive grants.

Young Stand Development

Investigating Vegetation and Wildlife Response to Gaps in Young Plantations

(OSU, ODF Districts)

(Relates to: Landscape Management Strategies; Young Stand Management R&M Theme)

Examines gaps in young stands for wood volume and habitat. This study is examining the effects of maintaining and enhancing gaps in young Douglas-fir plantations on large spatial scales. Response measurements include productivity in terms of wood volume and quality, understory vegetation, and wildlife habitat, including usage of stands by songbirds, bats, and small mammals.

Gaps of different sizes compared. These responses will be assessed on individual gap and stand scales. Comparisons of development created gaps of different sizes will be investigated. These results should provide information to assist managers in integrating structure-based management options while following an operational schedule.

Results to provide options for management. The overall goal of this study is to investigate management options in young forest stands that allow management for wood production, older forest structure, and wildlife habitat. Specific objectives include determining the effects of different size and types of gaps in young plantations at both gap and standing scales on:

1. stand productivity (wood volume and quality)
2. understory vegetation (amount and diversity)
3. crown characteristics (size of crown and branches)
4. wildlife species (songbirds, bats, and small mammals)
5. wildlife habitat characteristics (e.g., foliage height diversity)

Involves three ODF districts. The study is installed on Oregon Department of Forestry land on three districts (Astoria, Forest Grove, and West Oregon).

Difficult to assess wildlife in 5- to 7-year-old stands. Young stands (5-7 years) are fairly homogenous and don't exhibit major differences in wildlife populations right after treatments. Also, annual variation in wildlife population is typically very high, making a documentation of temporal trends very difficult. Thus, wildlife populations will not be measured at this stage, but instead treatment differences in future measurements will be documented by comparing treated and untreated areas. However, development of various habitat structural components (e.g., foliage height distribution) will be documented, which will provide information about the development of habitat suitability over time.

Wildlife sampling planned in later years. Wildlife sampling is planned for years 5, 10, and 20 after treatment implementation. Sampling will be implemented on two scales: 1) usage of gaps by songbirds and bats and 2) populations of songbirds and small mammals at larger scales. Special emphasis will be placed on ground and shrub nesting birds and foliage gleaners.

Linkage sought between wildlife, gaps, stand characteristics. Data from vegetation measurements (especially vegetation measurement of wildlife habitat characteristics (see above)) will be taken at the same time, allowing linkage between wildlife use, populations, and gap and stand characteristics.

Condition of gaps, overall stands measured. This report contains summary information about post-treatment conditions with a special focus on tree information. Post-treatment measurements documented the baseline conditions for vegetation development. These measurements focused on two spatial scales: 1) conditions in (created) gaps, edges, and the stand matrix and 2) overall stand level conditions in stands with and without (created) gaps.

Creation of gaps started in 2005. Planted and naturally regenerated trees were killed in all areas selected for gap treatments in December 2005. Approximately half of the trees were cut down and the other half girdled. Girdled trees were assessed in October 2006 and trees that were not dead at the time were cut in October-November 2006.

Sampling done March to August 2006. Post-harvest sampling began in March 2006 and was completed in August 2006. Table 1 details the number of plots, subplots, etc. for each district.

Table 1: Summary of number of plots, subplots, transects, and photos

Number of	Astoria	Forest Grove	West Oregon
10m Gap plot	14	11	13
20m Gap plot	12	10	10
5m Gap tree plots	26	21	23
5m Edge tree plots	26	21	23
5m Matrix tree plots	36	36	36
1m Vegetation subplots	352	312	328
Foliage Height Diversity	62	57	59
100m Stand transects	54	51	53
Hemispherical photos	15	11	18

Initial tree measurements form baseline. Measures of stand and strata-based growth characteristics for conifers, hardwoods and shrubs were completed at these plots. These data will form a baseline against which future structural change can be compared in both controls and treatments.

Tests validated comparison of stands. To test the assumptions that the study stands were comparable and that treatment assignment did not result in a bias, we compared planted conifer basal area in matrix plots in both control and treatment stands statistically. We used a mixed model (PROC MIXED) that included treatment as a main effect term (fixed factor) and district, district*treatment, stand (district) as random factors. The response variable was assessed for agreement with statistical assumptions (i.e., normality and homoscedasticity of residuals) and basal area was log transformed. We found no difference in basal area between matrix plots in control stands and matrix plots in treatment stands ($F=0.02$; $df=1$; $p=0.9030$), supporting the above stated assumption.

Measured variables show no difference. We compared planted conifer variables such as DBH, height, height to base of live crown (BC), lowest live branch length (BL), height (BH), diameter (BD), and crown diameter in matrix and edge plots in treatment stands. We used a mixed model (PROC MIXED) that included strata (matrix, edge) as a main effect term and district, district*strata, strata*stand (district) as random factors. Means for the planted conifer variables were computed at the plot level prior to analysis. Response variables were assessed for agreement with statistical assumptions (i.e. normality and homoscedasticity of residuals). We found no difference between stratums (matrix, edge) in the treatment stands for any of the variables (data not shown).

Line intercept used for stand composition. The line intercept method was used to obtain information on overall stand composition. We measured the length of sections by condition class along 50 m transects. Condition classes were characterized as stand matrix (fully stocked), natural opening, gap created by treatment, or road. Natural openings and gap created by treatment areas were defined as having no conifer and/or hardwood trees along segment lengths equal to or greater than 6 m (20 ft) and extending 1 m on each side of the transect. Segment lengths in open areas included shrub species. On average, 19% of stands were occupied by natural openings in West Oregon, 23% in Forest Grove, and 14% in Astoria (Table 2).

Table 2: Percent of stand in classes: matrix, natural opening, treatment opening, and road measured by the line intercept method

	Matrix (%)	Natural opening (%)	Treatment opening (%)	Road (%)
West Oregon				
203 (control)	88	12	0	0
204 (treatment)	65	23	11	1
206 (control)	51	49	0	0
208 (treatment)	74	12	13	1
209 (treatment)	88	2	8	2
210 (control)	83	17	0	0
Forest Grove				
301 (treatment)	69	13	17	1
302 (control)	99	1	0	0
303 (treatment)	72	11	17	0
304 (control)	86	14	0	0
305 (treatment)	33	67	0	0
306 (control)	67	32	0	1

	Matrix (%)	Natural opening (%)	Treatment opening (%)	Road (%)
Astoria				
400 (control)	89	11	0	0
401 (treatment)	84	4	12	0
402 (control)	95	5	0	0
403 (treatment)	82	12	7	0
405 (treatment)	59	28	14	0
406 (control)	76	22	3	0

Downed wood measured at stand level. Large coarse downed wood (CDW) was measured at the stand level along 50 m transects (log volume) and in treated stands at the plot level in the 10 and 20 m radius fixed plots (snag and stump volume). In control stands, CDW was measured only along transects (N/A=not applicable). The total volume for control stands includes log volume summarized from transect data while the total volume for treatment stands includes snag and stump volume and log volume. Volume estimates for fixed plots were slightly underestimated (<2%) because we did not account for stump taper (Sexton, pers. comm.; see calculation in Harmon et al. 1996). CDW volume was also summarized by species decay class. Decay class assignment was based on M. Harmon and J. Sexton's decay class definitions.

Summary

One-year baseline conditions established. Tree measurements, stand transects, and coarse downed wood measurements contribute to documentation of baseline conditions for vegetation development 1-year post-treatment. Additional measurements 5-years post-harvest (2010) are necessary to evaluate how wildlife interpret structure.

Swiss Needle Cast and Commercial Thinning

(OSU, ODF Districts)

(Relates to: Landscape Management and Forest Health Strategies; Forest Health R&M Theme)

Seeing how 30-year-old infected stands respond to thinning. Prior to this study, observations and limited data led to the assumption that thinning stands with severe Swiss needle cast (SNC) may increase symptom development and exacerbate thinning shock. The growth and development following thinning of older stands (30+ years old) with varying degrees of SNC damage was largely unknown. This research was developed to study these uncertainties. Specifically, the project addresses 1) growth trends following thinning of older stands with varying levels of SNC damage, 2) interactive effects of SNC with intensity of thinning, and 3) possible interactions between thinning, disease severity, and seed source (where data are available).

Measure severity of diseased stands, intensity of thinning. The purpose of the project is to determine the interaction between thinning of older stands (30+ years old) and disease severity and intensity of thinning. The approach includes a combination of a retrospective study of stand growth since thinning with permanent monitoring plots to track future growth.

Positive growth response seen after thinning. Results from the retrospective study indicated a positive response to thinning in many stands. These results were incorporated into a revision of the ODF SNC Strategic Plan (September 2003). In summary, study results to date indicate that thinning does not increase SNC severity and that the average stand showed a positive basal area growth response to thinning regardless on SNC severity. These results are from the retrospective portion of the study, and are reinforced by initial information from 2 years of data from the permanent plot portion of the study. The study will continue, with additional plot measurements and analysis scheduled for 2008.

Tillamook looks to alter plans for infected stands. These results are significantly influential to the Tillamook district, where district plans are governed by decisions on SNC management. West Oregon and Astoria districts were less affected by the research results. In response to the research findings, actions have already begun or are under consideration to adjust the Annual Operations Plans (AOPs) and the Implementation Plan (IP) for the Tillamook District.

At the Annual Operational Plan level:

- **Assess stands.** Develop and apply SNC stand assessment tool (Currently being tested by OSU and ODF; see descriptions under "Stand Growth Assessment Tool")
- **Adjust thinning.** Adjust thinning prescriptions to reflect recent research and to meet various objectives.

At the Implementation Plan level, and via Harvest and Habitat model:

- **Use research in modeling.** Incorporate recent SNC information into the H&H model. Document SNC model inputs and assumptions.
- **Initially harvested in 20 years.** In initial modeling runs, harvest "severe" SNC stands over 20 years.
- **Look at different options.** In future modeling, develop some SNC "scenarios".
- **Thinning more viable than previously thought..** Reflect recent SNC findings in a revised Tillamook Implementation Plan. In the IP, for the purposes of SNC management, more stands should be identified as potential candidates for commercial thinning, and fewer stands identified as regeneration harvest candidates.
- **Remain flexible.** IPs should remain sufficiently flexible to take advantage of new information or a status change in SNC.

No change to overarching forest management plan. No changes at this time were recommended at the Forest Management Plan (FMP) level.

Stand Growth Assessment Tool

(OSU, ODF State Forests Program and Districts)
(Relates to: Landscape Management and Forest Health Strategies; Forest Health R&M Theme)

Some infected stands grow well, others not. Douglas-fir stands infected with Swiss needle cast (SNC) have shown conflicting growth responses in which some stands grow extremely well while others put on little volume. This has important implications for forest managers who must decide how to manage infected stands.

Needle retention fails to consider growth. The current convention directs foresters to clearcut stands if they have needle retention levels below a minimum threshold. However, using SNC severity alone, as estimated by needle retention, to prioritize harvest plans does not consider growth as a factor. As a result, there is a need for a method to determine treatment priorities that is based on expected stand growth results.

Tool compares infected stand's performance to non-SNC expectations. In response to this need, Doug Mainwaring from OSU and Doug Robin and Owen Burney from ODF developed the Stand Growth Assessment Tool program "which allows the user to examine how a particular stand is growing in relation to growth model estimates of how it would be growing in the absence of Swiss needle cast. By doing so, stands may be ranked by their current performance relative to expectations, allowing informed decisions on the value of holding, thinning, or clearcutting them." (Doug Mainwaring, unpublished information). The Stand Growth Assessment Tool is a derivative of the original Swiss Needle Cast Stand Evaluation Software (SNCSES) program developed by Doug Mainwaring and Nate Coleman.

Will allow forest managers to make better decisions. The primary function of this assessment tool is to assist forest managers in making definitive decisions on harvest prescriptions for a stand using a combination of real and modeled quantitative growth values. The program was deployed in the spring of 2006 to the Tillamook District for operational trials. These data have been collected and a report is expected in 2008.

Kamela Tract Laminated Root Rot Research Area

(ODF)

(Relates to: Forest Health Strategies; Forest Health R&M Theme)

Reducing damage from root rot. The objective of this project is to demonstrate and quantify reduction in damage from laminated root rot by: 1) mechanical removal of stumps and roots, and; 2) planting conifer species resistant or tolerant to the disease.

Stumps, roots removed from half of two sites. In 1977-78 two five-acre parcels of mixed conifer timberland infested with Phellinus weirii were selected. All trees on each parcel were mapped by species, diameter and condition (live or dead, infected or uninfected with P. weirii) during 1978-80 and stumps and roots were removed from half the area in each parcel.

Multi-species planted and thinned. In 1980-81 seedlings were planted with 4' x 4' spacing in randomly located 0.1-acre plots. Tree species planted were Douglas-fir, Englemann spruce, grand fir, western larch, and ponderosa pine. The plots were thinned in 1998.

Untreated areas show greater mortality. Recent results show that laminated root rot mortality was greater in the untreated areas that in areas where stumps were removed. Mortality from laminated root rot was least in ponderosa pine and western larch. Western larch has exhibited the greatest height growth, Englemann spruce the poorest.

Another disease crops up in treated areas. In contrast, however, Armillaria root disease has killed trees more frequently in the areas with stumps removed than in the undisturbed areas. Sampling will continue in the fall of 2008.

Integrated Programs

Cooperative Forest Ecosystem Research (CFER)

(Cooperative research program supported by OSU, Bureau of Land Management (BLM), US Geological Survey (USGS), and ODF.)
(Relates to: Landscape Management and Aquatic and Riparian Strategies; Structure and Habitat, Aquatic and Riparian R&M Themes)

Addresses complex information needs. The initial cooperative agreement with BLM, USGS, and OSU was signed in 1995. ODF became a cooperator in 1998. The CFER program is designed to be integrated at various levels to produce a body of knowledge that will address complex scientific and management information needs that span multiple disciplined, spatial scales, and geographic regions in western Oregon.

Funding shortfalls end program in 2007. This program has made significant contributions of information on how to tailor forest management to achieve the objectives of the long-range Forest Management Plans (CFER 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006). However, due to funding shortfalls, 2007 will be the last year as a formal program.

Research under way will continue. Current research commitments will be maintained until completion of the projects, but no new projects will be started under the CFER umbrella. A summary symposium, "Recent Trends: Linking Research to Management – CFER and Beyond" was held on November 6-7, 2007.

Development of a Decision Tool for Evaluating State Forest Program Performance Measures

(ODF State Forests, Contractor)
(Relates to: Silviculture and wildlife relationships; Hydrologic functions and aquatic and riparian habitat; Forest health; and, Socio-economic indicators)

Performance measures used to evaluate management strategies. The State Forest Program committed to using performance measures (PM) as an indication of the success of the FMP and its associated strategies to provide the greatest permanent value for the citizens of Oregon. The performance measures are seen as a decision-aiding tool for the Board of Forestry (BOF) to evaluate implications of management strategies.

Interrelationships of nine performance measures explored. Nine performance measures were approved by BOF in 2007 and preliminary data have been presented to the Board. It was determined that a further refinement of the performance measures could clarify the decision-making process by helping to understand their interrelationships. This will help to understand how improving the results on one PM may or may not affect others. To further this goal, a project

began in 2007 to develop a tool and evaluation process that integrates and displays relationships among the nine performance measures to help evaluate a wide variety of information in the adaptive management process.

First, develop methods and models. Phase I of this project will develop evaluation methods and models that combine the related indicators into a summary of measure performance for each of the nine PM. This may entail developing simple models for each PM that determine the degree to which conditions provide for various levels of that measure.

Determine level of performance measure. This will be achieved by specifying the states for each of the indicator (input) variables and the degree to which the outcome is met. Phase I thus will result in a set of models or calculations that explicitly express the level of each PM, given the values of their indicators.

Second, look at trade-offs and interactions. In Phase II, the nine PM will be linked in a model or tool that displays their trade-offs and interactions. This model or tool may be categorical, qualitative or quantitative as needed for policy evaluation. The aim is to develop a model or tool that is complex enough to denote interactions among the PM at a specified level of precision and accuracy, but simple and general enough to be readily understandable and usable.

Linking probability to risk analysis. The outcome may express interactions between the PM in terms of probabilities of each measure achieving various states or levels. Such a probability-based tool would lend well to risk-analysis and risk management.

Many models, approaches to consider. Several modeling approaches and tools might be considered in this phase, including the use of Bayesian networks, decision trees and others. The model or tool will be developed in consultation with ODF experts and managers.

Third, embed tools into multi-attribute decision process. Phase III consists of embedding the tools developed in the first two phases in a structured multi-attribute decision-aiding process. This process will help ODF explore trade-offs and interactions among the nine PM, express their risk attitudes and determine the degree to which policy objectives may be met given existing or potential conditions of the various indicators affecting each PM.

Lead to structured, understandable decisions. The purpose of providing a structured decision-aiding process is to help ODF make decisions that are defensible. In general, the best-structured decisions are those that are repeatable, that disclose assumptions and criteria, that weight the quality of information, and that disclose and weight information gaps and areas of uncertainty. Further, the tools developed in Phases I and II will constitute "value-neutral" means of conducting risk analyses whereas Phase III entails taking those tools a step further into risk management where by acceptable levels of risk are identified by ODF policy-makers and managers.

Methods depend on decision required, data availability. Various formal methods exist and can be explored for Phase III. These include the use of methods in multi-attribute utility theory, goal hierarchy, analytic hierarchy process, multiple criteria decision making and others. The determination of the appropriate approach will be made in consultation with ODF and would be a function of the type of decision required, availability of data and information required and other factors.

Phase I (2008), II (2008), III (2009). Phase I is projected to be completed in early 2008, Phase II in late 2008 and Phase III in 2009.

Research Cooperatives

Stand Management Cooperative

(University of Washington)

(Relates to: Landscape Management Strategies; Young Stand Development R&M Theme)

Information on structure-based management. The mission of the cooperative is to provide a continuing source of high-quality information on the long-term effects of silvicultural treatments and treatment regimes on stand and tree growth and development and on wood and product quality. Work of the cooperative has been restricted to managed plantations of Douglas-fir, and to a limited extent, western hemlock. Thus, this coop provides background information for structure-based management.

Growth equations re-estimated with 20 years of data. The SMC Modeling TAC sponsored the update of equations in SMC ORGANON, a widely-used forest growth model, using data from the SMC Type I, II, and III installations. At the time SMC ORGANON was developed, very little data was available from the SMC trials. Dave Hann, Dave Marshal, and Mark Hanus incorporated data from SMC installations gathered over the last 20 years to complete the re-estimation of the equations used in the model. The "Phase 2" version of SMC ORGANON was reviewed and tested, and is now ready for release.

Contributed to young stand growth model. The Cooperative also contributed to the update of CONIFERS young stand growth model. Dave Marshall and Martin Richie are the Principal Investigators.

Genetic-gain trials established, seedlings doing well. Six Genetic Gain Trial, Type IV installations have been established. The seedlings have been planted on 132 plots with excellent survival.

Growth and yield tested for fertilization, other species. Other research being conducted by the SMC such as fertilization, hardwood, and mixed species will yield good information for growth and yield modeling. Although much research has been done over the years in the federal arena, the SMC is the best source of new growth and yield data today. The Coop is responsive to its members' needs for projects.

Hardwood Silviculture Cooperative

(OSU)

(Relates to: Landscape Management Strategies; Young Stand Development R&M Theme)

Looking at red alder growth with different prescriptions. The objective of this research cooperative is to develop an understanding of red alder plantation growth and development under a range of possible silvicultural practices. If ODF decides to intensively manage a significant acreage of red alder plantations, this research will provide the necessary information to develop operational prescriptions for site location, planting, pruning, pre-commercial and commercial thinning and timing of final harvest.

Research leads to red alder growth models. The HSC partnered with the USFS PNW Research Station to develop taper equations for red alder plantations. Presently volume and taper equations for red alder do not include intensively managed stands. Red alder growth models are being developed based on HSC growth data. Fieldwork was completed on 6 installations.

Pacific Northwest Tree Improvement Research Cooperative (PNWTIRC)

(OSU)

(Relates to: Landscape Management Strategies, Young Stand Development R&M theme)

Genetic tree improvement for reforestation. This cooperative supports a variety of applied research projects oriented toward tree improvement and seed orchard programs. Information from the coop supports ODF's investment in genetic tree improvement and enhances the quality of the reforestation program. Research in the coop develops methods to improve management of the Schroeder seed orchard.

Swiss Needle Cast Cooperative (SNCC)

(OSU)

(Relates to: Forest Health R&M Theme)

Seeks better understanding of disease affecting tree growth. Swiss needle cast (SNC) causes significant impacts in the Douglas-fir forests in western Oregon. The disease causes growth loss and alters stand structural development, affecting many aspects of forest management. The Coop supports research across a broad range of disciplines to understand the disease and causal or contributing factors. Major areas of research include impacts on tree growth, pathogen biology/ecology, host physiological response, silvicultural treatments, host tree genetics/resistance, direct control, and tree nutrition.

The SNCC manages several ongoing projects. Highlights of recent research include:

- **Increase in impacted acres, still below 2002.** Aerial surveys for SNC were conducted for the 11th consecutive year. Of approximately 2.95 million acres of forest, 324,584 acres of Douglas-fir forest had obvious symptoms of SNC. This represents a marked increase in the area with SNC symptoms compared to the previous three years (~268,000, 177,000 and 207,000 acres from 2003 – 2005, respectively) but is below the peak measured in 2002 (~387,000 acres). The majority of impacted areas were within 18 miles of the coast.

- **No impact in Cascade foothills.** No impact of SNC on the growth of Douglas-fir trees was found over five years in 59 stands in the Cascade foothills.
- **Diameter growth modifier developed.** A diameter growth modifier was developed to be incorporated into ORGANON, an individual tree growth model developed for use in western Oregon. This modifier estimates and incorporates the effects of SNC on individual tree growth in the model.
- **Sulfur does not help SNC stands.** The growth of stands treated with aerial applications of sulfur showed no difference in growth over the first two years after application (2002 – 2003) but substantial improvement in the second two-year interval (2004 – 2005). The difference was attributed to changes in growing season precipitation and not the effect of the sulfur application.
- **Nutrition-added tests begin.** A study to test the impact of nutritional amendments on SNC growth effects was initiated. This study will take six years to complete, with final results expected in approximately 2012.
- **Sulfur and lime increase branch size.** Sulfur + lime treatments increased branch diameter and branch total foliage but applications of sulfur only had no measurable effect.
- **Little volume increase from sulfur and nutrients.** Sulfur + nutrient application improved tree taper values but not total height, diameter, crown ratio, crown width or sapwood area. However, this did not lead to a significant increase in tree volume.
- **Seasonal, annual weather patterns affect SNC.** SNC distribution and severity can likely be explained by seasonal and annual weather patterns. Observed patterns of distribution if SNC in western Oregon are a result of longer term historical climate trends and likely will be influenced by future climate trends. Ongoing research will help to improve disease distribution predictions.
- **SNC effect on fungi levels difficult to assess.** Levels of ectomycorrhiza fungi may be affected by the presence of SNC but it was not possible to differentiate this effect from the effects of previous harvest or post-harvest silvicultural practices.

Surveys

Threatened &Endangered Species Surveys

(ODF Contractors)
(Relates to: Species of Concern Strategies)

Timber sales surveyed to avoid take of T&E species. ODF policy states that we will take measures to avoid take of listed species. Timber sales are surveyed according to established protocols to determine presence or occupancy of threatened and endangered (T&E) species (currently northern spotted owl and marbled murrelet) to help ODF avoid take of the species and to ensure that our timber harvesting activities will remain in compliance with the federal and state endangered species regulations. In addition to sale related surveys, known T&E sites are monitored on an annual basis to determine occupancy and productivity.

Tillamook Burn Northern Spotted Owl Surveys

(ODF, ODF Contractors)
(Relates to: Species of Concern Strategies)

Burn area seen as unsuitable habitat for northern spotted owls. ODF manages a large portion (approximately 286,282 acres) of the historic Tillamook Burn. Within this area, approximately 157,000 acres were burned in multiple fires and have been determined by ODF to constitute a very large expanse of unsuitable and marginal quality habitat for northern spotted owls.

Fifteen sampling units in Burn surveyed over time. ODF has been conducting surveys for northern spotted owls in order to determine if any resident spotted owl activity centers exist within this area. ODF has partitioned this landscape into 15 discrete sampling units that will be surveyed in a random order over the next 10 years. Three units will be surveyed for 2 years each, until all 15 of the units have been surveyed. The first year of surveys for the project was 2003.

No northern spotted owls found in Burn. To date, there have been no observations of northern spotted owls in the study area.

Table 3: Barred owl detections in Tillamook burn area from 2003-2006 including both Tillamook burn surveys and operational surveys on adjacent land.

Year	# individuals	# pairs	Total
2003	2	0	2
2004	5	1	7
2005	2	2	6
2006	11	2	15

Barred owls in Burn grows in 2006. Table 3 shows numbers of barred owls detected in the Tillamook burn area from both Tillamook burn surveys and any adjacent operational surveys.

Provide social, economic, environmental benefits. The goal for management of state forest lands is to "secure the greatest permanent value of such lands to the state" (OAR 629-035-0000 - 0110). Just as the landscape management strategies will provide habitats and conditions necessary to support and protect numerous species of plants and wildlife and to maintain good forest health, they also ensure management of forests to provide "healthy, productive, and sustainable forest ecosystems that over time and across the landscape provide a full range of social, economic, and environmental benefits to the people of Oregon"

Socio-Economic Indicators

Socio-Economic Report Update

(ODF State Forests Program, ODF Resources Planning Program)
(Relates to: Socio-Economic Strategies and R&M Theme)

Report in 1996 eyed potential impacts of forest management plan. In 1996, ODF's Resources Planning Program produced a lengthy report on potential social and economic impacts of the NW FMP (Angle et al. 1996).

Study includes economic analysis, forest ownership, population trends. The report covers background; economic analysis approach; Oregon forest ownership patterns, ages, and sizes; Oregon and local population trends; and Oregon economic performance and outlook. It describes local economies and non-timber resource uses, including recreation and special forest products.

Updated report planned in 2009-10. The report summarized the NWFMP management strategies (as of 1996) and the potential economic impacts of the strategies in the short- and long-term. We intend to update this study in the 2009-2010 timeframe. We have been working with the Resources Planning Program to determine the information to constantly improve updated reports.

Proposed Research

Long-term Response of Birds to Thinning Young Douglas-fir Forests

(OSU, ODF State Forests)

(Relates to: Landscape Management Strategies, Species of Concern Strategies)

Thinning to accelerate development of older forest habitat. In 1994, a study was initiated on the Tillamook State Forest to examine the potential effects of thinning on wildlife in young forest stands. Of particular interest to ODF was the hypothesis that thinning will accelerate the development of characteristics typical of older forests. This study was sponsored by ODF and conducted through the Coastal Oregon Productivity Enhancement (COPE) Program, and became known as the COPE thinning study.

The study was designed to be scientifically rigorous, and had the following characteristics:

1. **A manipulative, randomized experimental design.** Four replicated forested areas were chosen for study; each originally consisted of young, 35-45 year old unthinned forest. Replicates were selected that minimized differences among sites within a replicate and one of three treatments was randomly assigned to each stand in a replicate: no thinning, moderate thinning (RD 35) or heavy thinning (RD 20).
2. **Pre-treatment/post-treatment comparison.** Stands were initially sampled prior to treatment in 1994. Treatments were performed between 1994 and 1995. Subsequent sampling was conducted up to 6 years post-treatment, depending on the subject of the study.
3. **Long-term study design.** The study was designed to provide data over the course of multiple years to minimize influences of conditions in any one year. The structure is in place for a long-term research effort, should funding availability and interest make this possible.
4. **Appropriate size study plots.** All treatments in this study are at least 65 acres in size. This relatively large size allows influences on a wider array of wildlife species than many studies which are constrained by small stand sizes.
5. **A multi-disciplinary approach.** Rather than focus on only one species or group of species, this study took a multi-disciplinary approach and examined the responses of a variety of resources, including: stand structure and vegetation dynamics, abundance of breeding birds, flying squirrels, chipmunks, small mammals, amphibians, and ungulates.

Looks at how thinning of young stands affects wildlife habitat. The results of this study are of particular relevance to ODF in the implementation of the NW Forest Management Plan (FMP), adopted in 2001. A key strategy of the FMP is that stand density will be actively managed to accelerate stand development

through periodic thinning and partial cutting. A key assumption is that this active management will produce both revenue and wildlife habitat. The COPE thinning study addressed the question of how thinning young stands affects habitat for a number of different wildlife species.

After 12 years, a chance for a snapshot. It has been 12 years since the initial thinnings took place in the COPE thinning study. Because the study stands are still intact, there is an opportunity to take another snapshot of vegetation and wildlife response at this further point in time. There are very few, if any, studies, that have examined wildlife response at this time interval; therefore, this is a unique opportunity that would provide valuable information to forest managers regarding wildlife response to young stand thinning.

Some stands ready for second thinning. In addition, from a silvicultural standpoint, some of the moderately thinned stands are approaching a state where a second thinning would be appropriate to continue on the stand structure development trajectory. There is an additional opportunity to continue the study by furthering examining wildlife responses to a typical management scenario of a second thinning.

Treatments included heavy, moderate thinnings and control group. COPE used a manipulative, blocked study design with four replicates and three treatments. Each replicate included a control, a moderately thinned stand (RD35), and a heavily thinned stand (RD20). Stands were thinned in 1994-95. Survey schedules for the following surveys varied but typically included two years of pre-harvest surveys and five years of post-harvest surveys.

The following studies were conducted within these replicates:

- **Structure.** Stand structure/Vegetation
- **Regeneration.** Natural regeneration and cone production
- **Birds.** Breeding bird abundance
- **Small mammals.** Abundance of forest floor vertebrates (small mammals and amphibians) and reproduction of small mammals
- **Tree mammals.** Flying squirrels and chipmunks
- **Large mammals.** Elk and deer
- **Damaged stands.** Laminated root rot/blowdown

Some stands altered. Since the original study, one of the replicates has been harvested (Simpson Timber Company). Swiss needle cast has infected the Tillamook stands, but not to the extent that it masks any thinning response.

Medium-term report could influence future thinning. COPE II is designed to determine changes in stand structure and wildlife populations at 15 years post-harvest and after further operations in the study area. This will help ODF understand how management affects wildlife populations in the medium-term and has implications for the way in which partial cuts are planned in an effort to create complex structure.

Budget limitation narrows study. Due to budgetary limitations, fewer taxa will be examined in COPE II than COPE. This will likely include stand structure/ vegetation and breeding bird abundance. Other taxa may be added if researchers are able to obtain external funding.

Surveys in 2008. Surveys are expected to begin in 2008 with operational activities occurring in 2010.

Competitive Interactions and Resource Partitioning Between Northern Spotted Owls and Barred Owls in Western Oregon

(OSU, ODF State Forests, USGS, USFWS, NPS, and USFS)
(Relates to: Species of Concern Strategies)

Northern spotted owl populations declining. The northern spotted owl (Strix occidentalis caurina) inhabits coniferous forests in western Washington, Oregon, and northwestern California. It was listed federally as a threatened species in 1990 and has been the focus of much research over the last three decades. A recent analysis of spotted owl demographics at 14 sites from 1985 to 2003 showed that survival rates and populations of northern spotted owls on three study areas in Oregon had declined 20–50% (Anthony et al. 2006).

Barred owl populations increasing. Barred owls (Strix varia) are similar to northern spotted owls both morphologically and ecologically. They have been increasing their geographic range southward and are becoming more abundant in Washington, Oregon and northern California (Kelly et al. 2003).

Competition between owl species may explain spotted owl decline. There is evidence for competitive interactions between the two species (Herter and Hicks 2000, Kelly et al. 2003, Person and Livezey 2003) and barred owls may have a negative effect on survival of spotted owls (Anthony et al. 2004). There is considerable overlap between the species in habitat use, but relatively little overlap in home range areas (Hamer et al. in review). This suggests that, in addition to competing with spotted owls for food, barred owls may exclude spotted owls from their home range areas.

Definitive evidence could influence forest management. Most of the research on spotted owls and barred owls provides circumstantial but not definitive evidence that there is competition going on between the species. Understanding competition between barred owl and northern spotted owls is critical to shaping management actions that may affect populations of this threatened species. ODF has partnered with OSU and four federal agencies to implement a study that will help to shape this understanding.

Better understanding of competition sought. The purpose of this research project is to develop a better understanding of the competitive relationships between northern spotted owls and barred owls, including exploitation of common resources and behavioral interactions. Specific objectives:

1. **Home range overlap.** Describe size and spatial overlap of home ranges in areas where the species co-occur.
2. **Diets.** Compare diets and habitat associations of the two species with respect to:
    a) differences among seasons,
    b) assessment of prey preference, and
    c) computation of habitat selection.
3. **Resource partitioning.** Investigate resource partitioning based on indices of overlap in use of space, habitats, and food resources.
4. **Behavioral interactions.** Investigate behavioral interactions between the two species to determine dominance-subordinance relations.
5. **Survival rates.** Estimate survival rates of the two species.

Central Coast Range on mostly federal forests. The study will be conducted in the central Coast Range of Oregon on mostly federal lands, but fieldwork on some adjacent private lands will be unavoidable, because radio-marked owls do not respect property boundaries.

Two-year study. The study will be conducted for two full years in the field in order to investigate the movements, habitat use, and diets of the two species. Nest sites of both species will also be monitored to document occupancy of nesting areas and fecundity of territorial females.

Spotted Owl Distribution and Barred Owl Resource Selection

(ODF State Forests, National Council for Air & Stream Improvement (NCASI), BLM, USFS)
(Relates to: Species of Concern Strategies)

Barred owl seen as primary threat to spotted owl. Recent reviews of northern spotted owl (NSO - Strix occidentalis caurina) demography identified competition with barred owls (BAOW - Strix varia) as a primary threat to sustainable populations (Courtney et al. 2004; Anthony et al. 2004).

Determine whether forest management can influence interaction of owl species. These evaluations emphasize a critical need to understand how alternative silvicultural practices (e.g., variable-density thinning, partial harvesting, forest restoration activities) might influence interactions between the two species. Specifically, there is an urgent need to determine how habitat changes from anticipated extensive thinning programs will affect northern spotted owls directly and indirectly via influencing interactions with barred owls.

I. Density and Distributions of BAOW and NSO

"Blanket" surveys to determine numbers and trends. The primary goal of this NCASI- and privately funded study is to compare the current abundance (crude density, i.e., numbers/area surveyed) and distributions of NSO and BAOW with data collected in the same area from 1990-2005. Because only previously occupied or "known" sites are continually monitored, the occupancy status of historic NSO sites and current locations of leg-banded individuals that have not been located for several years are not known. Intensive "blanket" surveys, will help to resolve these issues and document trends in populations of each species. The study also will determine if banded NSO have moved to new nest sites in an apparent avoidance response to BAOW.

Specific objectives include the following:

1. **Survey 250,000 acres for 2 years.** Intensively survey and monitor NSO and BAOW on approximately 250,000 acres, including up to 60 previously occupied NSO nesting sites and an estimated 20 BAOW nesting sites for two years (2007-2008).
2. **Use northern spotted owl protocol.** Use accepted survey protocol to broadcast NSO calls by voice and recordings. Barred Owl calls would not be used in general surveys or monitoring NSO. Barred Owl calls may be used to determine BAOW nesting status and to capture individuals if such

actions are deemed to not interfere with local spotted owl behavior. We recognize that this protocol may underestimate BAOW densities, because their responses would be incidental to seeking NSO responses. However, this provides an assessment of BAOW population trend.

3. **Identify banded birds.** For both NSO and BAOW, identify previously banded birds, and capture and attach color bands and uniquely numbered USFWS metal bands to unbanded individuals to the extent possible (BAOW are more difficult to capture than NSO).
4. **Take blood samples from barred owls.** Extract and store blood-droplet samples from brachial veins from all captured BAOW for future DNA fingerprinting and for identifying blood parasites and presence of West Nile Virus (as funding allows).
5. **Do follow-up visits to confirm occupancy.** Conduct standardized follow-up site visits to confirm occupancy, pair, nesting, and reproductive status for all NSO found. Geo-reference all nest trees and measure habitat conditions at nest sites for all NSO and attempt to locate BAOW nest sites for the BAOW's that are radio-tagged.
6. **Use regurgitated pellets to compare diets.** Provide regurgitated pellets to a cooperating investigator for comparison of diets of both species, emphasizing BAOW at sites where BAOW are radio-tagged (diet analysis was previously conducted for NSO).

Calling begins March 2006 in McKenzie area. Beginning in March 2006 NCASI personnel started blanket calling all habitat 40 years and older throughout the McKenzie resource area east of I-5 and Eugene, Oregon on lands predominantly owned by Weyerhaeuser Co. and the Eugene, BLM.

Fifty-three pairs of barred owls, 14 pairs of spotted owls verified. By the end of the field season, 53 pairs of barred owls and 14 pairs of spotted owls had been verified. There were 22 other barred owl responses throughout the project area that have not yet been verified and hopefully many of these audio locations will be reconciled to determine if they are valid sites, floaters or unknowns.

Backpack radios attached to barred owls. Since the beginning of the 2007 season, NCASI personnel are again blanket calling the entire study area and have attached backpack radios to barred owls at 10 sites with prior telemetry locations on spotted owls.

II. Barred Owl Nighttime Resource Selection

Find out preferred habitat of barred owls. The goal for this telemetry study is to quantify responses by BAOWs to variation in forest stand density, tree species composition, abundance of coarse woody debris, understory vegetation, and tree size-class distribution in a young and intermediate-aged forest landscape. Specifically, we will estimate a resource selection function (RSF) using data from detailed forest inventories and from nocturnal locations of radio-tagged BAOWs. RSFs (Manly et al. 2002) provide an optimal means of linking BAOW foraging behavior with their habitat and environmental conditions because RSFs combine multiple and interacting influences.

Night activity of barred owls tracked. Barred owls will be radio-tracked at night when they hunt most extensively. Foraging choices and other nocturnal behaviors such as territory maintenance should influence lifetime reproductive performance

and survival (Newton 1979). Therefore, the combinations of vegetative and physical environmental factors that comprise BAOW foraging habitat will be retrospectively identified.

Could promote thinning practices to support spotted owls. The primary goal involves estimating a RSF that will: a) include forest stand details so as to forecast short-term consequences of applications of commercial thinning; b) can be linked with forest-growth and other models to forecast long-term effects as forests grow. Results might also promote development of silvicultural prescriptions that may support conservation of NSOs. This study will also add to the growing database on BAOW food items.

Specific objectives include:

1. **Radio-tagging barred owls.** Capture and radio-tag 8-10 pairs of barred owls, emphasizing locations in close proximity to those where NSOs were radio-tracked from 1998-2003.
2. **Measuring barred owl home ranges.** Measure detailed habitat conditions in BAOW home ranges, using variable-radius plots.
3. **Determining what barred owls look for in habitat.** Using data from Objectives 1 and 2, develop a discrete-choice resource selection function for BAOWs and compare model variables and their coefficients with a similar RSF to be developed in 2007 for NSOs in the same area.
4. **Comparing capable habitat maps for both species.** Prepare a habitat capability map for BAOW and compare it to a similar map for NSOs in the same area.
5. **Looking at spotted owl home range size near barred owls.** Compare fixed-kernel home range sizes of NSOs and BAOWs occupying the same area.

Same 4,183 habitat plots to be used again in 2009. The 4,183 habitat plots were finished in March 2007 and were presented in the winter of 2007 for the final analysis for the Adaptive Management Study. These same plots will be used in 2009 for the habitat use analysis work concerning the barred owls. Radio-tagged barred owls will be tracked until the spring of 2009 at which time the radio collars will be removed.

Mature Forest Study

(OSU, ODF State Forests, BLM)
(Relates to: Landscape Management Strategies)

Continues study that combines mature habitat with wood production. This project continues and advances a study of intensively-managed forests that evaluates many combinations of management choices applied toward long-term goals of mature forest habitat combined with high yields of high-quality forest products.

Conducted on two OSU sites resembling ODF forests. The study has been in place for 14 years at one installation (OSU's McDonald Forest, 150 ac of plots) and 11 years at another (Blodgett Tract). The more recent installation, OSU's Blodgett Tract, consists of about 110 acres of plots adjacent to ODF's Clatsop State Forest, and exhibits most of the same features, including site quality and plant communities, ratios of hemlock/Douglas-fir and age-class distribution, and other characteristics including history.

Findings being prepared for publication. Data have been synthesized and prepared for publications describing the first ten years of the McDonald Forest installation, close to Corvallis, and for seven years at the Blodgett Tract. Data collection for year 10 at the Blodgett Tract has been completed but not analyzed for both understory and overstory components.

The long-term objectives include the following:

- **Understory development.** To characterize understory development toward mid-story structure; develop a basis for efficient conifer regeneration in the understory of 40- to 70-year-old Douglas-fir stands, using modifications of current technology in planting and competition management to enhance late-successional features in productive forests.
- **Uniform vs. gap in overstory.** To determine overstory cover and basal area growth as a function of overstory treatment, including differences between uniform and gappy distribution.
- **Shrub response to thinning.** To quantify responses of shrubs and herbaceous plants to thinning and site preparation, and their subsequent long-term effect on conifer regeneration.
- **Underplanting after thinning.** To determine whether distribution of trees after thinning influences underplanted regeneration.
- **Tree spacing that leads to mature forests.** To create demonstration sites for late successional management; establish variable spacing and density studies in Douglas-fir stands that can be used to display long-term, structure-based management options for Douglas-fir and mixed conifer forests in long rotations, leading to late-successional stand characteristics.
- **Compare natural and planted understory.** Evaluate comparative contribution of natural and planted seedlings to understory structure in the two forest types.
- **Stands susceptible to wind damage.** Attempt to evaluate net effect of salvage following wind events, and what factors influence susceptibility of stands to damage, as pertains to future objectives.
- **Vertical structure documented over time.** Re-measurement will occur each year of one or two of the three major elements basic to the study, a) overstory periodic growth, b) understory regeneration growth, and c) understory community cover and composition. This cycle will allow details of understory and overstory development after 15 years (winter 2008-9) to be published, with emphasis on changes in vertical structure. In addition, a comparative analysis of natural vs. planted regeneration will be completed and submitted as a manuscript in fall/winter 2007/8. An analysis of effect of salvage logging on structures that have developed in the forest will also be completed. Part of the mission of the project will be to translate developmental changes into language that can be readily used by field personnel designing and implementing silvicultural systems.

Results can be used by ODF foresters. Silvicultural techniques used in this project broadly reflect those used by ODF in their approach to structure-based management and contributes to ODF's understanding of the issues and effects of this management paradigm. Results will directly inform decision-making process for forest managers.

Evaluation of ODF stand type classification based on Stand Level Inventory data

(OSU, ODF State Forests)

(Relates to: Landscape Management Strategies)

Looks at forest management plan assumptions. The proposed research will investigate basic assumptions underlying the Northwest Oregon State Forest Management Plan. It will take advantage of the large database collected as part of the ODF Stand Level Inventory (SLI).

Stand type classification system evaluated. First, we will evaluate the current stand type classification system, which is solely based on information about overstory tree conditions. We will further investigate which measures besides trees are indicative of current stand types, e.g., understory vegetation and wildlife habitat structures.

Alternative stand typing developed. Second, we will develop alternative classification systems that utilize the full suite of vegetation, including shrubs, herbs, and grasses.

Determine how thinning moves stands to next stage. Third, we will investigate whether management activities influence the transition from one stand type to another, specifically whether thinning accelerates the transition from CSC to Layered forest.

Assess current classification system, inventory protocol. Examination of these questions will help to evaluate the strengths and weaknesses of the current stand type classification system. At the same time, the assessment of the usefulness of the current SLI collection protocol will provide guidance for changes to the SLI to be more useful in quantifying stand structure.

Tree growth, understory measured after 5 years. Additionally, five-year post treatment measurements are proposed for the manipulative study plots in three ODF districts. Specifically, tree growth and understory vegetation will be measured following the original sampling scheme documented in the Final Report. Data will be analyzed and a report about the impact of actively maintaining gaps will be provided. Also, throughout the project period maintenance of other ongoing studies will be provided as needed.

Completed Research

Integrative Young Stand Management Strategies for Productivity and Structural Diversity on State Forests

(OSU, ODF Districts)

(Relates to: Landscape Management Strategies; Young Stand Management R&M Theme)

Connecting early stand management to later mature forests. This project is designed to determine whether early stand management has foreclosed options for older stands to develop all desired structural components.

Alternative approaches seek optimum conditions. The first two decades are a very dynamic period in Douglas-fir plantations when components considered critical habitat for several species, such as crown structure and understory vegetation, are changing quickly and are very responsive to manipulations. This study explores alternative management approaches in young plantations to minimize negative aspects of the stem exclusion phase. Specifically, an Observational study quantified how various stand structural components are influenced by stand density over time in young Douglas-fir plantations. As a follow-up, a Manipulative study was setup to determine whether density management can slow down or reverse undesirable trends in young plantations.

Stands 6-20 years old used with varying densities. Using a chronosequence approach, stands for the Observational study were selected in winter 2003 along an age continuum between 6-20 years old in three ODF districts (Astoria, Forest Grove, and West Oregon). Plots were placed along transects to ensure coverage of low, medium, and high densities (gap, transition, matrix).

Preliminary results shared in multiple forums. Tree characteristics and understory vegetation were measured in spring and summer. Data analysis began in late fall and preliminary results were summarized for presentation at the Young Stand Management Workshop (November 25, 2003). The Workshop was organized to gain insight from individuals in different agencies on the issue of managing young Douglas-fir stands for structure. Preliminary data were also presented at the State Forests Conference (March 10-12, 2004) by Klaus Puettmann (Principal Investigator).

Growth trends develop earlier than assumed. Data from the retrospective analysis indicate that some trends in stand development develop earlier than commonly assumed. Tree growth in young stands was positively related to stand density, but this trend reversed fairly early.

Low stand density, thinning improve live crowns. Crown characteristics were influenced very early by stand density, indicating that maintaining a long live crown in typical plantations can only be accomplished by lowering stand density through pre-commercial thinning.

Early invasive species later gave way to natives. Understory herb cover was reduced over time, while shrub cover increased. Species compositions were quite complex, with an initial strong presence of invasive species and later dominance of species usually associated with mature forests. However, there were many exceptions and early successional species were still present after 20 years. These results of the retrospective analysis show that this early stage is very complex and the dynamics vary for different characteristics.

Gaps encourage diverse stand composition. The retrospective study showed that any gaps or openings in young plantations may provide for a diversity of within-stand conditions that may affect the role and impact of the stem exclusion phase on development of stand composition and ecosystem functions. Even if gaps are created over time due to various mortality agents, it appears that stand modifications of standard management operations are necessary to ensure gaps that have fully developed shrub, herb, and hardwood vegetation layers.

Gaps enhance biodiversity in Douglas-fir plantations. The results of the observational study, findings from other recent studies and discussions with ODF personnel determined that gaps (low density areas) can provide opportunities to maintain or enhance biodiversity in Douglas-fir plantations.

Natural vs. managed gaps compared. The specific objective of the manipulative study was to document the development of natural gaps and compare them with managed gaps, i.e., gaps treated to maintain or enlarge their size. In keeping with the goal to avoid, rather than reverse undesirable trends (e.g., crown recession) in stand development, 10 to 13-year old stands studied in the observational study were used in the manipulative study. Thus, we followed individual gaps and documented approximately 24 gaps within a stand (one stand per ODF district) in each of the three districts (described above). Plot installation occurred in winter 2004 and tree characteristics and understory vegetation were measured in spring and summer, 2004-2005. Periodic (2 to 4 year interval) remeasurements are planned through 2014.

Standard plantation management studied for gaps. In addition, questions were raised regarding whether standard plantation management practices provide for gaps or whether additional management to create gaps was needed. As a follow up, we initiated a gap inventory study with the objective to provide baseline information about diversity of conditions (i.e., area in gaps versus fully stocked areas) created by standard management operations in plantations on ODF land.

Gaps make up minor proportion of Douglas-fir plantation. The investigation indicated that gaps make up a minor proportion of Douglas-fir plantations on ODF land. Even if gaps are created over time due to various mortality agents, it appears that stand modifications of standard management operations are necessary to ensure gaps that have fully developed shrub, herb, and hardwood vegetation layers.

Later creation of gaps results in reduced understory vegetation. In comparison, gaps that appear or are enlarged in later developmental stages would have reduced understory vegetation, as a consequence of early stand development, as new invasion would be required to provide desirable stand structural components. In any case, concerns about the total plantation area not growing crop trees would need to be assessed before management actions occur.

First Biennial Survey of Public Knowledge and Opinions toward Management of Oregon State Forests

(ODF State Forests Program)
(Relates to: All Strategies, R&M Themes and Socio-Economic Strategies)

Public opinion analyzed to gauge support for forest management. One of the underlying assumptions guiding management of Oregon state forests is that the citizens of Oregon will support integrated and active management of forest lands to provide multiple benefits. To test this assumption, we contracted with a human dimensions research company with extensive experience in natural resources to gather and analyze public opinion information about the management of state forests in Oregon.

Focus groups used to formulate questions for telephone survey. In early 2006, focus groups were conducted in Portland and Coos Bay to collect qualitative information on attitudes, opinions and perceptions of state forests. Information from the focus groups was used to formulate a questionnaire for use in a telephone survey conducted later that year.

Opinion sought on importance and expectations of forests. The focus groups and the telephone survey focus on four main areas: The importance of forests to Oregonians; knowledge of the Oregon Department of Forestry; expectations of forest management; and understanding adaptive approaches to forest management.

Forest management trails top concerns. The survey found a majority of Oregonians (57 percent) say they are concerned about forest management. But it trailed other top concerns - public education (75 percent), health care (71 percent), the environment (65 percent), and the economy (60 percent).

ODF seen as wise forest manager. Seven out of 10 Oregonians said they believed the Oregon Department of Forestry (ODF) does a good job managing state forests. Nearly half (47 percent) said ODF is a world leader in wise forest management.

Top benefits found to be water and wildlife, fish habitat. In terms of important benefits coming from state-managed forests, the survey found clean water (87 percent) on top, followed by wildlife habitat (82 percent), fish habitat (78 percent), hiking and wildlife viewing (71 percent), recreation areas (65 percent), timber (63 percent) and campgrounds (62 percent).

Need for thinning accepted. Nine out of 10 Oregonians accept and understand the need for thinning. They saw thinning as moderating the risk of severe wildfires and improving forest health.

Some saw no need for snags, decaying logs. Although about two-thirds said a healthy forest should have some snags and decaying logs, a third said a healthy forest shouldn't have those characteristics.

Clearcutting elicits sharp division. Clearcutting is a divisive issue; with 51 percent saying it should never be allowed on state-managed forests, and 42 percent believing it should be allowed.

ODF viewed in high regard, but often confused with Forest Service. The survey noted that Oregonians have a high regard for ODF, viewing the agency as credible and trustworthy – as a world leader in wise and sustainable forest management. They also often confuse ODF with the Forest Service.

More information welcomed, "balance" wanted for forest management. Oregonians say they would like to be better informed about state forests. They also say they want "balanced" forest management.

Follow-up efforts to measure public opinion planned. Follow-up surveys will be conducted in 2008 and 2010.

Second-Party Assessment of NW and SW Forest Management Plans

(ODF State Forests Program)
(Relates to: All Strategies and R&M Themes)

Independent review of plans' implementation sought. While ODF has a robust monitoring program in place, a need was identified in early 2006 to provide an independent, objective review of the implementation and effectiveness of the NW and SW FMPs. To this end, Strategic Resource Systems (SRS) was commissioned to conduct a 2nd Party Assessment

Assessment sought weaknesses and how to fix them. A 2nd Party Assessment differs from an external audit in that the contractor has an invested interest in identifying potential weaknesses or oversights and provides recommendations to fix such inconsistencies. By comparison, a 3rd Party Assessment (equivalent to an external audit) identifies problems but does not make any recommendations regarding how to fix them.

Designed for oversight and monitoring. To support the Oregon Board of Forestry in their ongoing oversight function of the NW and SW FMPs and ODF in its continuing review and revision of its management and monitoring practices, the assessment was designed to provide:

- **Objectivity.** Offer an independent, objective review,
- **Solutions.** Help ODF find solutions to any problems identified in the review,
- **Baseline.** Supply a baseline for future re-assessments or forest management, certifications, and
- **Systems.** Assist ODF in developing its own implementation and performance monitoring systems based on its own existing initiatives.

Specifically, SRS was commissioned to assess:

- **Clarity of multiple goals.** The clarity of the plans' goals addressing a range of environmental, social, and economic issues,
- **Adequacy of strategies.** The adequacy of the plans' strategies and ODF's procedures for achieving the plan's goals,
- **Implementation.** ODF's implementation of these strategies and procedures, and
- **Necessary changes.** Whether any plan or implementation changes are warranted.

Plans' resource goals used as criteria. To focus on a tractable set of criteria, the 2006 assessment team used the Resource Management Goals (RMGs) in the respective FMPs. These goals are of a scope and number comparable to the audit criteria embodied in forest certification standards, but are tailored specifically to the mission and conditions of ODF State Forests. To provide an understanding of ODF's forest management processes for achieving these goals, other provisions of the FMPs (notably, their strategies) and other ODF plans and procedures were evaluated by the assessment team prior to their visit to Oregon to conduct the field assessment.

Site visits showed if management met goals. An opening meeting was held in each district office to review the assessment process and to interview staff on their forest management procedures (and SW District staff was interviewed briefly by phone). After the opening meetings (and, at Forest Grove, a full team meeting with ODF staff at one field site), the assessment team split up to visit field sites with ODF staff who explained the management of each site. At each field site, management issues relevant to the RMGs were reviewed with ODF land managers to determine how the site was being managed to meet the RMGs.

Findings reviewed prior to final report. The assessment team completed the field assessment by orally reviewing its findings in a two-hour meeting on Friday, March 10, with 34 ODF staff from both Salem and the field. This review provided staff with an early indication of the results of the assessment and resulted in further feedback on the assessment findings. The assessment report was presented to the Board of Forestry on April 27, 2006.

The report is posted on the ODF Web site at:
http://oregon.gov/ODF/STATE_FORESTS/docs/Second_Party_Assessment_3-06_FINAL_REPORT.pdf

Moving toward mixed habitats. Among the findings, the study found that by using structure-based management, ODF is moving the primarily "middle-aged" forests toward a mixture of habitats, including complex forest stands that are similar to old-growth.

Off-highway vehicles use causing erosion, sedimentation. In the area of recreation, according to the study, some off-highway vehicle use near streams is causing erosion and sedimentation problems. It suggested that ODF seek "more cooperation with recreational users to construct and maintain facilities and control problematic users."

Some roads need upgrades and some introduce sediment to streams. The study said the access system to the forests is good and being improved, but a few roads still need major upgrades. Some roads and stream crossings are introducing sediment to streams, and the study warned that wet-weather log hauling can harm even good roads.

Fish and wildlife habitat being protected and diversified. The study noted that by following its forest management plans, ODF is doing a good job of protecting and diversifying fish and wildlife habitats. It said the habitat needs of northern spotted owls and marbled murrelets – two threatened species under the federal and state endangered species acts – are being addressed through surveys, habitat management and protection, and by restricting activities.

Harvest levels appear sustainable. In terms of timber, the study said the harvest levels appear to be sustainable. It did offer some suggestions for improving timber production.

More browsing monitoring, slash burning suggested for regenerated stands. Wildlife browsing on regeneration stands (replanted after clearcuts) should be more formally monitored, the report said, and more complete slash burning could reduce habitats for over-abundant rodents. It also suggested lower-density plantings that could reduce the need for precommercial (a non-timber sale activity) thinnings.

Better stand-level record-keeping recommended. The study said better stand-level record-keeping would help to determine the effectiveness of past treatments, such as thinnings. It said additional marketing opportunities might exist for both smaller and large diameter wood.

Desired mix of values and outputs being provided. "Stable and sustainable timber harvest levels and other management programs appear to be providing a mix of values and outputs desired by the citizens of the state," the report stated. It also said that in addition to seeking objective information through a public opinion survey, ODF could provide more opportunities for regular, direct and local interaction with the public.

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Appendix A

Table A1: Selected current projects showing relationships to research and monitoring themes and Forest Management Plan strategies

Project	Research & Monitoring Themes						NW/SW Forest Management Plan Strategies						
	Implementation Monitoring	Structure and Habitat	Aquatic and Riparian	Young Stand Management	Forest Health	Socio-Economic Indicators	Landscape Management 1	Landscape Management 2	Landscape Management 3	Aquatic and Riparian	Forest Health	Specie of Concern	Socio-Economic Indicators
Implementation Monitoring Project	✓	✓	✓				✓	✓	✓	✓			
Stand Structure & Wildlife Habitat		✓					✓		✓				✓
Mature Forest Study		✓		✓			✓		✓				
Young Stand Management Studies				✓			✓		✓				
Intensively Monitored Watershed Study (Trask)			✓				✓			✓			
Stream Temperature & Riparian Function			✓						✓	✓			
Coastal Oregon Productivity Enhancement Program (COPE II)		✓	✓				✓	✓	✓	✓			
Swiss Needle Cast - Commercial Thinning					✓		✓				✓		

Project	Research & Monitoring Themes						NW/SW Forest Management Plan Strategies						
	Implementation Monitoring	Structure and Habitat	Aquatic and Riparian	Young Stand Management	Forest Health	Socio-Economic Indicators	Landscape Management 1	Landscape Management 2	Landscape Management 3	Aquatic and Riparian	Forest Health	Specie of Concern	Socio-Economic Indicators
Swiss Needle Cast Cooperative					✓		✓				✓		
Stand Management Cooperatives		✓		✓			✓		✓				
Tree Improvement Cooperatives				✓	✓	✓					✓		✓
Threatened & Endangered Species Surveys												✓	
Spotted Owl Surveys - Tillamook Burn												✓	
NCASI Spotted Owl Monitoring		✓					✓		✓			✓	✓
Barred Owl Ecology		✓							✓			✓	
Asset and Revenue Reporting						✓	✓		✓				✓
Recreation						✓	✓						✓
Performance Measures		✓	✓		✓	✓			✓	✓	✓		✓
Public Acceptance Surveys		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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