

**STATE FORESTS RESEARCH AND MONITORING PROGRAM
PROGRAM SUMMARY
FISCAL YEAR 2011**

INTRODUCTION

The Forest Management Plans (FMPs) for State Forests 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.

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 (ODF 2002)¹ 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 the Elliott State Forest (ESF) and Eastern Oregon Area (EOA) forest lands as well.

The Strategic Plan is designed to answer questions of implementation, effectiveness, and validation of the “working hypotheses” and forest management strategies described in the FMPs. It identifies high priority projects that will contribute to our understanding of the FMP management strategies. A revision of the current Strategic Plan is planned for 2011. It will refocus and identify current and relevant research and monitoring themes to contribute to the continued evaluation and adaptation of the FMP strategies and will reflect our capabilities given ongoing budgetary limitations.

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.

Research and monitoring projects supported by the State Forests Research and Monitoring program have been described in a series of annual reports since 2002. During that time the budget for the program ranged from about \$350,000 to a high of over \$1.5 million. In fiscal year 2009 the SFRMP supported approximately 20 research and monitoring projects and forestry research cooperatives at a level of approximately \$1.2 million. For fiscal year 2010, which started July 1, 2009, support for research and monitoring projects was greatly reduced, due to the ongoing difficult budget situation.

In fiscal years 2010 and 2011, the program was able to continue to support research cooperatives, such as the Hardwood Silviculture Cooperative, Vegetation Management

¹ ODF, 2002. State Forests Monitoring Program Strategic Plan for the Northwest and Southwest Oregon State Forests Management Plans. Oregon Department of Forestry. 48pp.

Cooperative, etc. The program also continued to support important projects with direct ODF participation, such as the Trask Watershed Study, RipStream, Stand Structure Development, and Implementation Monitoring. Additionally, the program arranged for suitable study sites on ODF managed lands and technical support by district personnel to aid research conducted by Oregon State University scientists.

The following summarizes work conducted by the research cooperatives as well as projects with direct ODF participation and those with ODF technical support.

RESEARCH COOPERATIVES

Research cooperatives draw their membership from forest scientists and managers from private forest industry, state and federal forest management agencies, landowners, processors, and universities. Cooperatives create a pool of funding, scientific talent, and long-term continuity necessary to achieve their objectives. The state forests research and monitoring program was able to continue to support the following research cooperatives. Please check the cooperative's website for detailed information on specific research.

Hardwood Silviculture Cooperative (HSC)

Affiliation: Oregon State University, Corvallis, OR

Website: <http://www.cof.orst.edu/coops/hsc/>

The HSC is a multi-faceted research and education program focused on the silviculture of red alder (*Alnus rubra*) and mixes of red alder and Douglas-fir (*Pseudotsuga menziesii*) in the Pacific Northwest. The goal of the HSC is to improve the understanding, management, and production of red alder.

Research Highlights for 2010

- The HSC has established thirty-seven study installations spread from Coos Bay, Oregon to Vancouver Island, British Columbia. There are three study types:
 - 4 thinning studies in natural red alder stands
 - 7 replacement series studies of red alder/Douglas-fir mixtures
 - 26 variable density red alder plantations with thinning and pruning treatments
- Last year's data collection schedule was less than average. Six installations were measured including three Type 2 installations having their 17th year measurement. This brings the total number of installations with 17 year data to 14. Furthermore, of those 14 installations, 11 have had all the treatments completed.
- The data collected (combined with data from Weyerhaeuser Co.) are currently being used to develop a growth and yield model for red alder plantations (RAP-ORGANON), an essential tool for the management of red alder. This model will provide much needed information to

estimate site productivity, growth responses following thinning, and the extrapolation of stand volume, rotation ages, log sizes, etc.

So far, in the process of building RAP-ORGANON, all of the equations necessary for the control/non-treated stands have been developed. These are: plantation-grown red alder dominant height growth (site index), height-diameter, maximum crown width, largest crown width, crown profile, height to crown base, diameter growth, height growth, crown recession rate, mortality rate, and size density equations.

- Plans for 2011 include: continuation of HSC treatments, measurements, and data tasks; continue outreach and education efforts; and, continue ORGANON modeling efforts in the creation of both a plantation model and a natural-stand model.

Swiss Needle Cast Cooperative (SNCC)

Affiliation: Oregon State University, Corvallis, OR

Website: <http://sncc.forestry.oregonstate.edu/>

A major challenge to intensive management of Douglas-fir in Oregon and Washington is the current Swiss needle cast (SNC) epidemic. Efforts to understand the epidemiology, symptoms, and growth losses from SNC have highlighted gaps in our knowledge of basic Douglas-fir physiology, growth, and silviculture. The original mission of the Swiss Needle Cast Cooperative (SNCC), formed in 1997, was broadened in 2004 to include research aiming to ensure that Douglas-fir remains a productive component of the Coast Range forests. The SNCC supports research and monitoring 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.

Research Highlights for 2010

- **Aerial Survey:** Aerial surveys to detect and map the distribution of Swiss needle cast damage have been flown annually since 1996. Although the fungus that causes Swiss needle cast, *Phaeocryptopus gaeumannii*, occurs throughout the range of Douglas-fir, damage is most severe in the forests on the west slopes of the Coast Range. The 2010 survey mapped 393,923 acres of Douglas-fir forest with obvious Swiss needle cast symptoms; this was the largest area with damage since the survey began. Although most damage occurred within 18 miles of the coast, it extended up to 28 miles inland in some areas. SNC damage continues at very high levels despite a shift by many landowners to forest management practices aimed at ameliorating disease effects.
- **Foliage Retention and Growth:** In 1998, twenty-three sets of plots were installed in 5-16 yr old operational Douglas-fir plantations in the northern Oregon Coast Range to test the effects of pre-commercial thinning in Swiss needle cast-diseased stands. Previously identified trends of increasing foliage retention in the lower crowns of trees in thinned stands were determined to depend on initial foliage retention. Increases in foliage retention following thinning were most apparent in lower crowns of healthy trees. In the first six years after thinning, there was

no evidence that foliage retention increased within any part of the crown of residual trees in the most heavily infected thinned stands (initial foliage retention < 2 yrs). Volume periodic annual increment in thinned stands was *most responsive in the most heavily infected stands, because the stands were thinned from below and* residual trees were probably the most tolerant of Swiss needle cast. The improvement in performance following thinning in infected stands is probably the result of numerous factors. Needle loss associated with SNC disease and exposure to wind and weather is greatest in the upper crown, while lower portions of the crown still retain significant foliage. Exposure of this foliage following thinning improves light interception and tree growth. In addition, stands of this age in this region have grown in the presence of SNC since they were established, which indicates that their size distribution at time of thinning reflects their level of SNC-tolerance. These stands were pre-commercially thinned from below; therefore, stocking was reserved for the trees that demonstrated the ability to grow best in the presence of SNC.

- **Nutrient Amendments:** Management of forest nutrition in Douglas-fir plantations has predominantly addressed nitrogen limitations, yet growth of Douglas-fir is often unresponsive to nitrogen fertilization. High soil nitrogen availability and harvesting of second and third generation stands has raised the potential for other nutrient limitations, and nutrient imbalances have been hypothesized to predispose young Douglas-fir to Swiss needle cast. Six fertilizer treatments were tested for their ability to improve the growth of dominant and co-dominant trees within young Douglas-fir plantations in western Oregon and Washington. Treatments included a control and applications of urea, lime, calcium chloride, or mono-sodium phosphate on 16 experimental installations. Two additional site-specific blends (Fenn and Kinsey) were applied at 12 of the 16 the installations. Stem volume growth responded positively to urea, lime, and phosphorus treatments. There was no evidence of regional differences in the effect of the blended fertilizers, although marginal regional effects were observed at two of the 12 sites. Volume growth response to nitrogen was negatively correlated with site index and positively correlated with the ratio of soil calcium to soil nitrogen. Growth response to lime was negatively correlated with both initial foliar calcium concentration and soil pH, and growth response to phosphorus was negatively correlated with initial foliar phosphorus concentration and positively with soil pH. Three years into this study, these fertilization treatments do not appear to have improved the growth of SNC-diseased trees. Likewise, it is possible that SNC disease and associated foliage loss prevents trees from responding positively to nutrients that might otherwise limit growth. Results from this study suggest that Douglas-fir does not generally respond to these fertilizers where soils are high in nitrogen or low in calcium or pH, all common characteristics of the soils where SNC is especially a problem. Whether such soil conditions are themselves an exacerbating factor of SNC is unknown. Refinements in managing nutrition of Douglas-fir plantations can boost or maintain production, but the viability of specific fertilization regimes will depend on economic and environmental performance.

Vegetation Management Research Cooperative (VMRC)

Affiliation: Oregon State University, Corvallis, OR

Website: <http://www.cof.orst.edu/coops/vmrc/>

Formed in 1993, the Vegetation Management Research Cooperative (VMRC) sets out to conduct applied reforestation research of young plantations from seedling establishment through crown closure with an emphasis on operational vegetation management. The VMRC also promotes reforestation success such that survival, wood-crop biomass, and growth are maximized while protecting public resources.

With the creation of the VMRC was the creation of a revised prospectus to carry out vegetation management that is consistent with the needs of its cooperators. New Reforestation regulations were enacted from British Columbia to Northern California. These regulations generally have in common an emphasis on restricting the use of traditional modes of vegetation management, primarily greater restrictions on the use herbicides and burning. The VMRC is well placed to carry out research that can aid in reducing the overall use of herbicides in a manner consistent with the law, while still promoting increases in forest regeneration success.

The VMRC has made great strides in initiating research and publishing findings since its creation. As of January 2011, the VMRC has published 14 peer-reviewed journal articles, 6 conference proceedings, 1 PhD dissertation and 5 Masters theses. In addition, VMRC staff regularly present research results at regional and international conferences.

Research Highlights for 2010

- Combining weed control intensity and seedling stock size to maximize Douglas-fir productivity and economic return
- Fourth-year results evaluating the effectiveness of commonly used herbaceous weed control regimes in a PNW Douglas-fir plantation
- Delayed planting of Douglas-fir to improve chemical site preparation efficacy
- Comparative growth relations of four weedy plant species in a regenerating Pacific Northwest Douglas-fir plantation

Center for Intensive Planted Forest Silviculture (CIPS)

Affiliation: Oregon State University, Corvallis, OR

Website: <http://www.fsl.orst.edu/cips/>

The mission of the CIPS is to understand the interactive effects of genetics, silviculture, protection (from insects, disease, and animal damage), competition, nutrition, and soils on the productivity, health, and sustainability of intensively-managed, planted forests. CIPS achieves this goal by coordinating, facilitating, conducting and synthesizing collaborative research between existing cooperatives, institutions, and researchers in a manner that addresses long-term and interactive effects of all possible treatments constituting a silvicultural regime.

Research Highlights for 2010

- Simulation of tree and stand development on VMRC controlled experiments using the SMC variant of the CONIFERS young stand growth model

- Incorporating the influence of competing vegetation control on young Douglas-fir (*Pseudotsuga menziesii*) dominant height growth through dynamic age-shift models
- Diameter and height growth equations for Douglas-fir growing in intensively managed plantations in the Pacific Northwest
- Mortality equations for intensively managed Douglas-fir plantations in the Pacific Northwest
- A model for assigning dbh to young Douglas-fir trees established and growing under varying levels of competing vegetation
- A model describing the effects of crown closure on the dynamics of competing vegetation in young Douglas-fir plantations
- Models for simulating competing vegetation dynamics under varying control regimes implemented by the Vegetation Management Research Cooperative

Stand Management Cooperative (SMC)

Affiliation: University of Washington, Seattle, WA

Website: <http://www.cfr.washington.edu/research.smc/>

The mission of the SMC is to provide a continuing source of high-quality information on the long-term effects of silvicultural treatments and treatment regime on stand and tree growth and development and on wood and product quality. SMC membership includes forest industry; federal, provincial, state, and local agencies; suppliers; research institutions and universities who contribute resources and expertise in carrying out the mission. Scientists from member organizations meet in Silviculture, Nutrition, Wood Quality and Modeling Technical Advisory Committees (TAC's) to develop research plans and the experimental design of field installations, define field measurement protocols, and review progress and results.

At the end of the 10/11 field season, the database contained data from 527 installations which contain 7,742 plots which have been measured 33,531 times. This translates into 289,284 trees which have been measured a total of 1,670,086 times. Presently there are 147 active installations of Types I through V². These installations hold 3,485 plots, which in aggregate have been measured 8,386 times. These plots contain 110,293 trees which have in total been measured 566,902 times. The remaining data are either inactive installations of the old Regional Forest Nutrition Research Program (RFNRP) or active/inactive special contract installations with SMC members.

Research Highlights for 2010

- **Modeling:** A collaboration to integrate ORGANON into the FVS interface is just getting underway. It will include SMC-ORGANON and the new red alder model with the expectation that testing will commence in late summer 2011. ORGANON 9.0 which includes

² Type I: Established 1986-1994 in juvenile DF and WH plantations before onset of substantial inter-tree competition; Type II: Established 1986-1991 in DF plantations approaching commercial thinning stage; Type III: Planted 1985-2001 at 100, 200, 300, 440, 680, and 1210 tpa; Type IV: A DF genetic gain and spacing trial planted 2005-2006; Type V: Paired-tree study with 0 and 224 kg N/ha to study effects on growth and yield, carbon and wood quality.

the alder model has been released and was presented at the Growth Model User's Group meeting. ORGANON 9.1, with new taper equations, is now available.

- **Performance of SMC Type III Installations Workshop:** The Type III installations are designed planting density trials at 100, 200, 300, 440, 680, and 1210 stems per acre to study the effects of no further management and the use of thinning and pruning. They were planted between 1985 and 2001 with the regeneration practices typical of that time. Plantings were in blocks of at least 3 acres per spacing. In each spacing block a control measurement sample plot was established that would receive no further treatment. In the three dense spacings an additional plot for a thinning regime based on relative spacing was established. In the three widest spacings an additional plot for a pruning regime was established. The purpose of the workshop was to present a summary of the performance of the Type III installations at their present stage of development to answer the questions “*What is the growth, yield, and quality of Douglas-fir stands planted at different spacings and what is the effect of thinning and pruning?*”.
- **Nutrition Project:** The major SMC-related work on nutrition completed in 2010 includes: continued establishment (to 73 total) of Type V Paired-Tree fertilization studies, and initiation of an NSF-funded study of the fate of N-15 fertilizer applications at the site; and, additional work on the Fall River/Matlock/Molalla research studies including producing a synthesis paper comparing 5-year biomass at each site, nitrogen leaching at Fall River and Matlock, and characterizing current biomass at Fall River.
- **Silviculture Project:** Data collection was completed for the research sites scheduled for measurement. In particular, measurements made at the Type IV installations yielded 7-year from seed information on the first three plantations in that trial. The complete 7-year data will be available after the 2011 growing season. Overstory/understory vegetation relationship modeling was completed in 2010.
- **Wood Quality Project:** Work continued on several projects: Determining the effect of thinning, site quality and stand density on wood quality using non-destructive testing to develop predictive models; Non-destructive evaluation of wood quality in standing Douglas-fir trees and logs; and, Modeling biomass growth patterns in four SMC Type II Douglas-fir installations as affected by treatment, soil and local climate.

Pacific Northwest Tree Improvement Research Cooperative (PNWTIRC)

Affiliation: Oregon State University, Corvallis, OR

Website: <http://www.fsl.orst.edu/pnwtirc/>

The PNWTIRC was formed in 1983 to conduct research in support of operational tree improvement in the Pacific Northwest. Goals of the cooperative are to:

- Create a knowledge base concerning genetic improvement and breeding of Pacific Northwest tree species.
- Develop reliable, simple, and cost-effective genetic improvement methods and apply these methods to solve tree-breeding problems.
- Promote effective collaboration and communication among public agencies and private industries engaged in tree improvement in the region.

Research Highlights for 2010

- **Effects of Site and Genetics on Douglas-fir Growth, Stem Quality, and Adaptability:** The ability to project the value of Douglas-fir plantations is limited by: how stand growth, stem quality, and adaptability are influenced by site characteristics; the effects of seed source and genotype transfer among sites; and, the effects of climate change. This study seeks to increase understanding of how plantation site characteristics affect growth and adaptability, how parental site characteristics are related to the performance of their progeny, the extent to which seed sources and families can be successfully moved among sites, and the near-term effects of climate change. Precise location and elevation information have been obtained for 237 progeny test sites and 3390 parent trees. Because adequate data were obtained from existing sources, visiting field sites was no longer required for this project. Methods were developed for mapping current seed zones in future climates using climate models and GIS. These latter procedures have been incorporated into a web-based climate mapping program called the Seedlot Selection Tool (SST). Data analyses conducted include univariate correlations, multiple regression analyses, and Random Forest analyses to understand the relationships between site productivity and site characteristics for 37 progeny test programs.
- **Early Genetic Selection for Wood Stiffness in Douglas-fir and Western Hemlock:** Previous research on Douglas-fir indicates that log-based acoustic tools can be used to measure and select for improved bending stiffness of 25-year-old Douglas-fir trees. Although the effectiveness of a standing-tree acoustic tool (ST300) was noticeably lower, joint research by the PNWTIRC and other research cooperatives is already being used to clarify the relative effectiveness of standing-tree versus log tools on older trees (e.g. 15-25 years old). There is also a strong interest in measuring and selecting for wood stiffness at younger ages (e.g. 6-12), but we do not know which approaches are best, or what results to expect. Furthermore, genetic improvement of wood stiffness in western hemlock has not been studied. This study will provide estimates of genetic parameters and genetic gains for juvenile wood stiffness of Douglas-fir and western hemlock and determine optimal approaches for measuring and selecting for juvenile wood stiffness at young ages.

In addition, molecular markers developed for Douglas-fir are being used by seed orchard managers for increasing genetic gains, artificial freeze tests are being used to select adapted genotypes, early flower stimulation treatments are being used to speed genetic gains from seed orchards, and genetic information on growth, wood stiffness, stem form, cold hardiness, and drought hardiness is being used to design optimal breeding programs.

PROJECTS WITH DIRECT ODF PARTICIPATION

During fiscal years 2010 and 2011, the research and monitoring program was able to continue to support important projects with significant direct participation of ODF personnel. These were:

- Stand Structure Development project to determine how stands are changing over time as a result of management
- Implementation Monitoring to determine if operations were conducted according to the prescriptions in annual plans

- Trask Watershed Study to examine the effects of contemporary forest practices on aquatic ecosystems at multiple scales
- Riparian Function and Stream Temperature (RipStream) to measure the effectiveness of stream protection rules on state- and privately-owned lands.

Stand Structure Development

Principal Investigator: Oregon Department of Forestry, State Forest Division

Background

The two objectives of this 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 being monitored are stands in the Northwest Oregon Area districts projected to become Understory (UDS), Layered (LYR) and Older Forest Structures (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 all future stand development that we will be monitoring.

Analytical Questions

- How have post operation stand conditions developed since harvest? Within first 5 to 10 years? Continuously beyond this period?
- What structural attributes are beginning to develop during this timeframe?
- Are the pre-determined indicators the models/algorithms use to define our stand structure types valid?
- What variables influence the development of stand structure attributes and how quickly they develop? i.e., additional harvest or snag creation.

Progress

78 stands were sampled by contractors in 2007. Over half of these stands have been revisited to perform maintenance on plot centers and tree markings along with acquiring GPS coordinates.

Future Work

Additional maintenance of plots is planned for the summer of 2012 to preserve plot markings for re-measurement which is estimated to occur in 5 years. This study will continue as a long-term study in order to better describe the process of stand structure development.

Implementation Monitoring

Principal Investigator: Oregon Department of Forestry, State Forests Division

Background

Implementation monitoring broadly seeks to determine if management and conservation strategies specified in the Oregon Department of Forestry's Forest Management Plans (FMP) are being properly implemented. It also helps establish baseline conditions from which to measure effectiveness of the strategies. This type of monitoring measures on-the-ground indicator variables to assess how management practices are put into practice and is an accounting of what we did. Further, it seeks to determine to what degree post-operation conditions reflect original management intent defined in pre-operational prescriptions. Lastly, Implementation Monitoring helps assess the feasibility and achievability of strategies and targets.

This study addressed the metrics and strategies established by the Landscape Strategies and the Aquatic & Riparian Strategies in the FMP, as well as the strategies for management of Salmon Anchor Habitat areas. A total of 55 stands across seven operational districts were sampled from Annual Operation Plan years 2002-2006.

Progress

The Implementation Monitoring Report was completed in 2010 and a workgroup was established to finalize recommendations from the report and put those recommendations into action. The full report is available at:

http://www.oregon.gov/ODF/STATE_FORESTS/docs/IMReportandRecommendations.pdf

Overall Summary

- Department staff indicated understanding and intent to implement the strategies in the FMPs.
- Broad compliance with FMP strategies in the upland and riparian management areas, with a few areas of over or under achievement of strategies.
- A number of areas where the FMP targets or goals are unlikely to ever be achieved without significant investment (e.g. converting hardwood riparian areas to conifer)

Riparian Sampling Results: Fish and Medium Type N streams (30 streams total)

- Mature forest conditions have not yet developed in the Inner zone of any of the sampled streams.
- Outer zone conifer retention was met on 22 of the 30 sampled streams. Those with deficits were hardwood dominated areas with low numbers of existing conifers. It is not known if management actions contributed to this deficit or if the deficit exists solely from pre-existing hardwood conditions. Further guidance on Appendix J standards may be needed.
- As the FMP strategies require, there were no trees harvested from the stream bank or inner gorges of Type F streams.
- Ground disturbance strategies were implemented; in all cases ground disturbance was less than 3% and in some zones, less than 0.3%.
- Snags and down wood were not being created in riparian areas.
- Describing a definition of Mature Forest Condition (MFC) in RMAs with the same stand descriptions used for upland stands (e.g. older forest structure, layered) may better meet functional goals for riparian areas and would create consistency with the rest of the FMP.

- Need to provide a standardized approach on how to manage hardwood dominated and mixed conifer/hardwood riparian stands (see MFC), including consideration of alternate vegetation treatment plans.
- Meeting RMA targets on Fish and Medium Type N streams can only be assured with an RMA inventory prior to operations. Such an inventory could describe the frequency and size classes of conifers per zone and stream length.

Riparian Sampling Results: Small Perennial Type N streams (83 streams total)

- 8 of the 10 streams sampled that were connected to a Fish stream had 80% of canopy cover post harvest. Without pre-harvest measurements the effect on canopy cover of the harvest could not be determined.
- The minimum requirement of 15 trees & snags/acre in the Inner zone was met. Clearcuts average 30 TPA and partial cuts were at 61 TPA.

Riparian Sampling Results: Small Seasonal Type N streams (107 streams total)

- The minimum requirement of 10 trees & snags/acre in the Inner zone was met across all stands and prescription types.

Other Findings

- 50% of the streams identified in the GIS stream layers (which were used to create maps and define the sample) did not exist on the ground.
- Five green tree retention patches were omitted from the sample. These areas were outside of the posted sale boundaries and were not shown on the sampling maps. Future communication with unit managers will help bring attention to these areas before future sampling occurs.

In addition to the results identified above, the monitoring effort raises some questions about the targets and how to apply them in mixed hardwood conifer stands, where desired targets for mature forest condition cannot be met with or without active management (with the exception of rehabilitation)

Future Work

Implementation monitoring will occur in the future as personnel and funding are available to perform field projects.

Trask Watershed Study

Principal Investigators: Oregon Department of Forestry, State Forests Division; Weyerhaeuser; U.S. Geological Survey; U.S. Forest Service

Background

The goal of the Trask Watershed Study is to quantify effects of forest harvest on the physical, chemical and biological characteristics of small non-fish headwater streams and the extent to which harvest on these small streams influences downstream fish reaches. This goal will be achieved through long-term, cooperative, multi-disciplinary research involving researchers from Weyerhaeuser Company, U.S. Geological Survey, U.S. Forest Service PNW Research Station, and ODF. The study will link effects of forestry to aquatic responses locally and downstream. It will provide a basis for future regulatory actions to be based on technically sound information and it will foster relationships with many diverse groups. The study is funded primarily by ODF and Weyerhaeuser with additional grants.

Study Design

The study uses a nested design, incorporating local and downstream sites for both reference and treatment watersheds. Three harvest treatments will be applied on small non-fish streams. These are: clearcut with buffer; clearcut with no buffer; thinning with buffer. Treatment type depends on ownership. The study duration is 2007 – 2016. Road construction will start in 2011, allowing four years of pre-treatment data collection. Harvest will occur in 2012 and the study will end in 2016 after four years of post-harvest data collection. Study parameters include fish, amphibians, macroinvertebrates, birds, hydrology, stream temperature, nutrients, sediment, etc.

Initial Results

Low Flow Hydrology

Approach: Measure stage and discharge during low flow in all 15 watersheds using wells and tracer dilution. Couple stage and flow measurements with temperature.

Initial Results: The small watersheds with more earthflow terrain were less responsive to rainfall and in some cases had less drop in summer flow. The degree of diurnal stage fluctuation is apparently related to maximum stream temperature with wells showing less fluctuation having cooler temperatures.

Stream Chemistry

Approach: Use sondes to measure nutrients during spring and summer.

Initial Results: Most sites are phosphorus limited. The Pothole Watershed cluster is nitrogen limited. Some sites are highly variable over time, while others are more consistent.

Macroinvertebrates

Approach: Examine benthic and emergent macroinvertebrate patterns in headwater and downstream reaches over time.

Initial Results: Benthic communities are similar between catchments and years, but differ by headwater vs. downstream and by season. Biomass is lower in August. Data from emergence and terrestrial traps show differences by year with a tendency toward higher numbers in July. Terrestrial insects are much more abundant than aquatics. Availability of both aquatic and terrestrial insects is lower in upland areas.

Fish Dynamics

Approach: Intensive monitoring during low flow

Initial Results: Coastal cutthroat trout survival was greatest for fish approximately 100mm in size (consistent with findings from the Hinkle Creek paired watershed study). Growth of fish was fastest for smaller (<100mm) salmon and trout and minimal (not measurable) for larger (>100mm) coastal cutthroat trout. Movement during the monitoring period was very restricted for coastal cutthroat trout.

Amphibian Abundance and Survival

Approach: Compare local harvest effects with downstream effects; isolate effects on aquatic stages from effects on terrestrial/adult stages; relate variation over space and time to environmental conditions.

Initial Results: Tailed frog larvae move downstream more than Pacific Giant Salamanders. Tailed frog abundance increases in a downstream direction with higher abundance just below the lower boundary of planned treatment (harvest) areas. Low abundance is likely a function of lower habitat quality. Downstream sites are better than headwater sites for maintaining mass during advanced development stages.

Outreach and Technology Transfer

- Tours for public, research, regulatory and environmental groups
- Website and brochures available
- Educational outreach to watershed councils
- Numerous posters and presentations
- Contextual Analysis
- Three fisheries MS degrees and one PhD degree are in various stages of completion
- One MS degree on bird use of riparian areas and one MS degree on riparian conditions
- One microclimate and three riparian measurement manuscripts (Forest Science, Western J. of Applied Forestry, Can. J. of Forest Research, Forest Ecology and Management)
- Fish and amphibian manuscripts are in progress for individual pre-treatment components.

The Trask Watershed Study will allow greater understanding of aquatic ecosystem response to forest management and the degree to which local responses influence downstream aquatic communities. Already during the pre-treatment period valuable insights into the patterns and processes in forested watersheds have been gained.

Riparian Function and Stream Temperature (RipStream)

Principal Investigators: Oregon Department of Forestry, State and Private Forests Divisions; Oregon State University, Corvallis, OR; Oregon Dept. of Environmental Quality

Background

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 (FPA), respectively. Thirty-three RipStream study sites are located throughout the Coast Range geographic region on small and medium sized fish-bearing streams.

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 schedule due to delayed timber harvests. In addition to pre- and post-harvest sampling on treatment reaches, all RipStream sites have untreated control reaches upstream and, in some cases, an untreated control reach downstream. At each site, plots were established for measurement of riparian buffer zone variables and in-stream channel measurements were taken at regular intervals. Channel and vegetation measurements include: stream temperature, stream flow, in-channel downed wood, shade, overstory and understory vegetation, riparian downed wood, and blowdown.

RipStream focuses on effectiveness in protecting stream temperature and promoting riparian structure that provides necessary functions for the protection of fish and wildlife. Specific monitoring questions include:

- Are the riparian rules and strategies effective in meeting DEQ water quality standards for protecting cold water and maintaining temperatures below thresholds for specific life stages of salmonids?
- Are the riparian rules and strategies effective in maintaining large wood recruitment to streams, downed wood in riparian areas, and shade?
- What are the trends in riparian area regeneration
- What are the trends in overstory and understory riparian characteristics and how do these trends, coupled with channel and valley characteristics, relate to stream temperature and shade?

Currently, all 33 sites have two years of pre-harvest and at least three years of post-harvest data. Minor gaps exist in post-harvest Year 4 and Year 5 for stream temperature, shade and channel measurements. The most significant gap remains in post-harvest Year 5 vegetation and riparian and in-channel downed wood data collection.

Results

Two journal publications have resulted from RipStream work to date, and a third has been accepted. The first publication laid the foundation for subsequent analyses by describing the importance of pre-harvest stream temperature variability and patterns at a reach scale³.

The second analysis focused on a strict regulatory perspective of stream temperature. This analysis indicated that applying the minimum FPA riparian buffers for small and medium fish-bearing streams resulted in a 40% probability of not attaining the DEQ Protecting Cold Water Standard (PCW) in the first two years post-harvest. Harvest to state FMP riparian standards did not exhibit exceedance rates that differed from pre-harvest, control, or downstream rates (5%)⁴.

³ Dent, L.; Vick, D.; Abraham, K.; Shoenholtz, S.; Johnson, S. 2008. Summer temperature patterns in headwater streams of the Oregon Coast Range. *Journal of the American Water Resources Association* 44:803-813

⁴ Groom, J.D.; Dent, L.; Madsen, L.J. 2011. Stream temperature change detection for state and private forests in the Oregon Coast Range. *Water Resour. Res.* 47, W01501, doi: 10.1029/2009WR009061

The third analysis left the regulatory perspective behind and addressed functional questions what site or other environmental variables specifically influence stream temperature and the magnitude of temperature changes. Overall no change in maximum temperatures for State Forests was found while Private sites increased pre-harvest to post-harvest on average by 0.7°C with minimum and maximum observed changes of -0.9° to 2.5° C⁵. The observed increases are less than changes observed with historic management practices. The observed changes in stream temperature were most strongly correlated with shade levels measured before and after harvest. Treatment reach length, stream gradient, and changes in the upstream reach stream temperature were additionally useful in explaining treatment reach temperature change. Shade was best predicted by riparian basal area and tree height. Findings suggest that riparian protection measures that maintain higher shade such as the State Forest's were more likely to maintain stream temperatures at control conditions. Streams with longer treatment reaches and low gradient may be more susceptible to changes in stream temperature.

Technology Transfer

Several manuscripts have been submitted or accepted by peer-reviewed journals and a further series of papers or reports is planned.

PROJECTS WITH ODF TECHNICAL SUPPORT

Although unable to continue to fund external research, research and monitoring program and district staff have worked with principal investigators to provide land for study sites, technical assistance in plot establishment, and maintenance of study areas over time.

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

Principal Investigator: Matthew Betts, Oregon State University

Background

Previous land management or natural disturbances (e.g., fire) created relatively even-aged second growth forests across much of the Pacific Northwest of the United States. Managing even-aged stands with silvicultural treatments like thinning may promote establishment of late-seral stand attributes and development of structural diversity by reducing competition for resources and maintaining ecosystem function and species diversity. As structural and vegetative diversity have been shown to influence the diversity of niches available to birds and other species, altering the overstory structure may improve habitat for some vertebrate species.

Oregon Department of Forestry, in conjunction with Oregon State University, conducted a manipulative study to investigate the short-term (1-6 years) and intermediate-term (13-14 years)

⁵ Groom, J.D.; Dent, L.; Madsen, L.J. 2011. Response of western Oregon stream temperatures to contemporary forest management. *Forest Ecology and Management*, In Press.

effects of thinning forests on species of birds. We selected three replicate areas for study and randomly assigned stands to one of three treatments: no thinning (control, 410-700 trees/ha), moderate thinning (240-320 trees/ha), or heavy thinning (180-220 trees/ha) ($n = 9$). We conducted pre-treatment (1994), initial post-treatment (1995-2000) and intermediate post-treatment (2007-2008) surveys of birds in all stands.

Objectives

Our objectives were to measure trends in bird abundance in relation to thinning Douglas-fir forests and determine if bird response varies as a function of thinning intensity over time.

Results

Hayes et al. (2003)⁶ reported the initial results of the study (1994-2000). During this short-term period, canopy foragers and closed-canopy specialists tended to decrease (e.g., Brown Creeper), ground foragers (e.g., Dark-eyed Junco) and aerial hawkers (e.g., Hammond's Flycatcher) tended to increase, and no response was detected for generalists (e.g., Chestnut-backed Chickadee).

Our initial analysis of the intermediate-term data indicates that species of birds are continuing to respond to the thinning treatments and demonstrate a variety of responses to thinning forests. Responses include an initial decline in numbers after thinning followed by a rebound (e.g., Swainson's Thrush), delayed response (>6 years) to thinning (e.g., Wilson's Warbler), and continuation of initial trend (e.g., Chestnut-backed Chickadee).

We are currently working on complete analysis that incorporates the intermediate post-treatment data. The analysis will be submitted to a peer-reviewed journal for publication.

Role of ODF

ODF established and maintained the original study sites from the COPE project and helped re-establish plots for the intermediate-term data collection.

Quantifying Trade-offs Between Biodiversity Conservation and Timber Production in Intensively Managed Forests

Principal Investigator: Matthew Betts, Oregon State University

Background

Intensive forest management (IFM) can maximize timber production, but results in a simplified floristic composition and structure. As IFM becomes more prevalent, unmanaged early-seral forest is becoming increasingly scarce, but the consequences of this for biodiversity are poorly understood. In the Pacific Northwest and elsewhere this is hypothesized to have contributed to the rapid declines in songbird populations.

⁶ Hayes, J.P.; Weikel, J.M.; Huso, M.M.P. 2003. Response of birds to thinning young Douglas-fir forests. *Ecological Applications* 13:1222-1232.

On a tour of recent harvest blocks in Forest Grove District, it was clear that though there have been big advances in creating treatments that provide greater vegetation diversity, the implications of these treatments for biodiversity are unknown. In order to manage early seral stands on Oregon lands, managers need some scientific guidance on the biodiversity contribution of such treatments.

Objectives

The goal of our research is to develop and disseminate information on managing forested landscapes for biodiversity conservation while sustaining high-levels of timber production. NCASI, Oregon State University and various landowners (Weyerhaeuser, Forest Capital Partners, Hancock Resource Management, Plum Creek Timber, and Oregon Department of Forestry) will address this goal via a manipulative study that tests for effects of Intensive forest management (IFM) on songbird and arthropod abundance and diversity, as well as songbird populations. This study represents the first globally to investigate response from multiple measures of diversity and populations to IFM as well as the influence of IFM on arthropods. This is a critical knowledge gap because: a) Arthropod species are important for ecosystem functioning and services; b) Some insect species serve roles as pollinators and as regulators of pest populations; and c) a leading hypothesis for declines in songbirds is that IFM reduces the abundance of arthropod prey. Birds and arthropods will be measured along an experimentally manipulated gradient of forest management intensity. This will allow investigators to determine the need or potential for ‘softening’ the effects of IFM on biodiversity while maintaining timber production.

Study Design

In cooperation with private and state landowners we have established 32 study plots, approximately 30 acres each, in the northern Oregon Coast Range. These sites have undergone clear-cutting operations during fall 2009 or spring 2010 and will be planted with Douglas-fir during spring 2011. This study follows a randomized complete block design, where four study plots will be located within each of the seven blocks, with each plot randomly assigned to one of four treatments spanning a gradient of management intensity, from a control (no chemicals applied) stand, to an intensively managed stand with >5 yrs of herbicide broadleaf and shrub control. Two intermediate treatments (reflecting typical stand management) have been determined with the participation of operational foresters from the participating agencies and organizations. Repeated sampling will document how invertebrate abundance and diversity are influenced by the herbicide treatments, and in turn how that may influence avian nesting success. We expect to monitor the effects of herbicide treatments on birds and arthropods until canopy closure occurs to document the full range of conditions present in early seral industrial forests.

Progress

The project was initiated in 2009 and is expected run at least through 2016. Work beyond 2016 will require additional funding.

- All 32 sites have been established on industrial and ODF ground. This constitutes 8 blocks with 4 treatments ranging from an no-herbicide control through high intensity management (complete vegetation control). To date, all sites have been clearcut and planted. The two most intensive treatments have received fall site-prep spray and spring herbaceous release. The low-intensity treatment and the control have not received any herbicide at this point.
- Bird point counts in the first year following site prep were conducted. This resulted in 90 points within the 32 sites being censused for birds (3 visits/ season). Fifty-one species were detected out of a total of >5000 individual bird detections. Preliminary results show higher species richness in lower intensity treatments.
- 120 nest boxes for bluebirds and house wrens were established across the 32 sites. Boxes had an occupancy rate of 80% (mostly house wrens) which will enable us to calculate nest survival.
- 32 ungulate exclosures (one at each site) were established. These were erected to test for the interacting effect of ungulates and herbicide on forest succession, Douglas-fir survival and songbird habitat.

Role of ODF

ODF established and maintains study plots on Forest Grove and Tillamook districts. District staff have also helped with herbicide application.