Blue River Administrative Study Plan

Study title: Blue River Administrative Study

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Background

Approaches to the management of forest landscapes have evolved dramatically over the past 60 years, especially in the past decade on lands managed by the USDA Forest Service in the Pacific Northwest. For the first half of the 20th century the Forest Service focused on forest protection and little logging occurred on public lands while private-land owners exploited their abundant timber resources. World War II was followed by four decades of emphasis on sustained yield of timber and suppression of forest fires (Franklin and Forman 1987). A system of dispersed patch clearcutting was used to meet a variety of objectives, including creation of edge and early-seral wildlife habitat, development of a road network, and dispersal of hydrologic and sedimentation effects. By the late 1980's growing concern about fragmentation of old-growth forests (Harris 1984) and effects on key species, such as northern spotted owl (*Strix occidentalis*), led to brief consideration of aggregated patterns of forest cutting to minimize forest fragmentation in intensively managed landscapes (Franklin and Forman 1987, Swanson and Franklin 1992). Court-ordered injunctions against further harvest of spotted owl habitat and other events culminated in the Northwest Forest Plan (USDA & USDI 1994), the overriding plan for 9.7 million ha of federally-managed forest land. This plan, with its roots in the spotted owl issue, emphasizes static reserves and corridors, and standard matrix prescriptions.

At the same time concepts are emerging concerning use of information on historical disturbance regimes and recognition of the dynamic character of many forest landscapes (Baker 1992, Hunter 1993, Mladenoff et al. 1993, Morgan et al. 1994, Swanson et al. 1994, Bunnell 1995, Stuart-Smith and Hebert 1996, Cissel et al. 1998, Landres et al. 1999, Cissel et al. 1999). These approaches use information on historical and current landscape conditions, disturbance history, and social goals to set objectives for future landscape structures that provide desired habitat, watershed, timber supply, and other functions. The intent is not to mimic historical conditions, but rather to use them as a reference in developing and evaluating management alternatives to meet these goals.

Numerous studies in the Blue River watershed have characterized local disturbance regimes. Fire has been the predominant disturbance process controlling landscape structure in this part of the Cascade Range. Teensma (1987) characterized and mapped fire events that occurred in portions of the Blue River watershed over the last 800 years, and used that information to calculate historical fire frequency. Morrison and Swanson (1990) extended the area covered by fire history studies in the watershed, and examined two study areas in greater detail to discern general relationships among fire severity, spatial pattern and landscape features. Weisberg (1998) used more field data and more rigorous statistical techniques to extend the previous work over the entire Blue River watershed, develop and map general fire regimes, and analyze relations among fire regime and forest structure. Other disturbance processes have been studied in the watershed including floods (Jones and Grant1996), mass movements (Snyder 2000), land use (Swanson et al. 1998, Johnson and Jones 2000) and their effects on stream and riparian ecosystems (Wondzell and Swanson 1999, Johnson and Jones 2000, Johnson et al. 2000).

The Blue River Administrative Study extends research knowledge of historical conditions, habitats, and disturbance processes by incorporating that knowledge into a local landscape management regime. This alternative approach to landscape management contains fewer reserves and less intensive, less frequent timber harvest as compared to the reserve and matrix approach in the Northwest Forest Plan (Cissel et al. 1999), and is implemented in a manner consistent with historical forest conditions and disturbance patterns. Preliminary comparisons of these two management regimes are documented in Cissel et al. (1998) and Cissel et al. (1999), and indicate that an alternative approach rooted in historical disturbance regimes may provide greater capability to meet Northwest Forest Plan objectives. The Blue River Administrative Study will test these findings through field-based monitoring, and compare these results with computer modeling assessments, new research and current practices prescribed in the Northwest Forest Plan for most lands outside of reserves. An ongoing adaptive management process, including public discourse and interaction, will provide critical context and assessment of study findings.

Justification

The Blue River watershed and surrounding lands are in the Central Cascades Adaptive Management Area, an allocation in the Northwest Forest Plan that mandates development and evaluation of new approaches to integrating ecological and social objectives. Specific objectives for the Central Cascades Adaptive Management Area listed in the Record of Decision for the Northwest Forest Plan include: "intensive research on ecosystem and landscape processes and its application to forest management in experiments and demonstrations at the stand and watershed level; approaches for integrating forest and stream management objectives and on implications of natural disturbance regimes" (USDA and USDI 1994, p. D-12). Many long-term datasets collected because of the presence of the H.J. Andrews Experimental Forest within the Blue River watershed also support monitoring and analysis of alternative management approaches.

In addition, continuing changes in forest policy indicate a need to develop and test better methods of meeting social and economic objectives while maintaining ecological integrity. Incorporating information and understanding of historical disturbance regimes into management regimes is increasingly recognized as a potential method to help maintain ecological integrity. For example, new regulations for Forest Service policy and planning procedures require that the "range of historical variability" be used as a key reference point when assessing the ecological integrity of landscapes, and that new plans maintain conditions within this range unless documented rationale exists to the contrary. Developments in the ecological sciences mirror and support these changes in the policy arena. For example, applications of historical ecosystem dynamics to management problems are finding expression in both aquatic (e.g., managed floods in the Colorado River (Collier et al. 1997), and the maintenance of natural flow regimes (Poff et al. 1997)) and terrestrial ecosystems (see citations above).

Results from a recently concluded study in nearby Augusta Creek demonstrate that it is operationally feasible to use historical fire regimes as a general landscape management planning framework (Cissel et al. 1998). Methods developed in the Augusta Creek study have been used to develop an operational long-term landscape plan for the Blue River watershed (Cissel, editor 1997, unpublished report on file at the Blue River Ranger District). The present need is to further evaluate the feasibility and consequences of managing with a general historical disturbance regime template.

In sum, the formal management direction given to the Central Cascades Adaptive Management Area in the Northwest Forest Plan, the presence of the H.J. Andrews Experimental Forest in the watershed, ongoing changes in ecosystem science and forest policy, and past experience developing approaches using historical landscape dynamics all indicate that the Blue River watershed is an ideal place to further test these concepts in a real-world operational setting.

Relationship of the Blue River Administrative Study to the Blue River Landscape Study and H.J. Andrews Research

The Blue River Landscape Study is a multiple-component adaptive management project intended to implement, evaluate and refine a landscape management strategy based on natural disturbance regimes. Primary components include a landscape management plan used to guide on-the-ground activities in the Blue River watershed, the Blue River Administrative Study used to evaluate management activities through field-based effectiveness monitoring, computer modeling assessments to evaluate the landscape management plan and compare it to other landscape management approaches, and an open adaptive management process designed to periodically adjust the landscape management plan and related assessments. Ecosystem and social research conducted in the watershed through the H.J. Andrews Experimental Forest program and related studies also contributes directly to the Blue River Landscape Study.

The Blue River Administrative Study consists of a set of field-based monitoring activities designed to evaluate the implementation and effectiveness of the Blue River landscape management plan. Field-based effectiveness monitoring is designed to measure ecosystem response to the landscape management strategy, and compare responses to the reserve and matrix approach practiced elsewhere. Monitored attributes include upland vegetation, epiphytic lichens, riparian vegetation, stream-breeding amphibians, stream temperature, and stream channel morphology and wood accumulations. Data will be collected both prior to and following implementation of management activities according to a specific measurement schedule. While some observations and insight may be forthcoming in the short term (1-5 years), solid conclusions will likely require longer periods of time.

Modeling assessments are conducted as part of the Blue River Landscape Study due to the long periods of time it will take for ecosystem responses to be measurable, especially at the landscape scale. Models can provide estimates of effects that may not be evident in the field for several decades (e.g., evaluation of potential effects on spotted owl dispersal habitat), and compare results with alternative landscape management approaches (e.g., the reserve and matrix approach in the Northwest Forest Plan). Modeling assessments are currently underway or being planned to evaluate forest stand growth and development, late-successional habitat, epiphytic lichen response, timber volume production and economics, and spotted owl response.

Ecosystem research conducted in the Blue River watershed through the H.J. Andrews Experimental Forest Long-Term Ecological Research (LTER) program and related studies is aimed in part at understanding how landscapes are structured and function. Many of these studies are long-term, funded from research grants and allocations, and are designed to answer science questions. Because much of the local landscape is dominated by human activities, many science questions are cast in terms of management effects (e.g., what are the effects of timber harvest on peak streamflows). Data from these studies are used in a research context to portray and evaluate the implications of alternative landscape management concepts. Basic inventory data and information about management activities are often necessary for the conduct of science projects. Close coordination among managers and scientists working on the administrative study and on Andrews research studies benefits both; e.g., sharing data, results, interpretations and information exchange activities. Relevant information and results from administrative study activities and Andrews studies will be shared and interpreted jointly to evaluate the potential need to adjust the landscape management plan.

Adaptive management model

The adaptive management model followed in this study consists of three phases. The first phase, the investigative phase, employs multiple modes of learning to discover the potential effects of managing under this concept. These findings are evaluated in the second phase to determine their significance and implications. Adjustments to the landscape management strategy are made in the third phase based on the information produced from the preceding phases, and other sources of new concepts or information.

Four primary methods are used to investigate the effects of the landscape management plan. The plan is being implemented on the ground through normal Forest Service programs. Novel aspects of the plan challenge ranger district employees to think differently and try new approaches. Hence <u>operational experience</u> is a key mode of learning and a true testing ground. <u>Field-based monitoring</u> efforts are a second major mode of learning, including surveys of citizen attitudes towards the practices prescribed in the landscape management plan. Permanent plots are in place to measure the effects of plan implementation on a variety of species and ecological processes. However, it may take decades before many effects are observable and their significance known. Meanwhile a series of <u>modeling assessments</u> are being conducted to provide preliminary results. A fourth method of learning derives from the H.J. Andrews Experimental Forest <u>research</u> program. Applicable research projects conducted in the watershed are designed to help understand patterns and processes directly relevant to the landscape management approach in the study.

Findings are evaluated through information exchange with interested parties, and through analyses of the need for and benefits of revising the landscape management plan based on new information. Results from phase one are shared with a wide variety of audiences through field tours, informal and formal reports, web sites, presentations and open houses. Feedback obtained directly from managers, policy-makers and interest groups through personal interaction is an important means of evaluation. Results from phase one are also evaluated through analyses and written reports (e.g., Weisberg 1999), and through adaptive management workshops and field tours. The principle result from these efforts are recommendations for potential changes to the landscape plan or to assessment projects.

The landscape management plan will be periodically revised when these results indicate a potential benefit to doing so. Recommendations will be widely shared with involved individuals to gain further perspective on the desirability of making changes to the study. Forest Service managers and scientists responsible for conduct of the landscape study will make the final decisions concerning changes to the study.

Cooperators

The Blue River Landscape Study and Administrative Study are jointly administered by the Cascade Center for Ecosystem Management, a three-way ecosystem research and management partnership historically centered on the H.J. Andrews Experimental Forest. The three partner institutions cooperate in all phases of the project with each institution playing lead or supporting roles depending on the nature of the task. The Willamette National Forest is responsible for writing an administrative study plan, creating and maintaining the landscape management plan, implementing activities, and collecting monitoring data. The Pacific Northwest Research Station and Oregon State University are responsible for input and review of the study plan and landscape management plan, monitoring design, data storage, monitoring analysis, and the conduct of related research.

All parties are responsible for producing reports and other materials to share with others, and cooperating on information-sharing and adaptive management events. Responsibility for land management decisions reside with Willamette National Forest officials.

Representatives from all three institutions meet regularly in a variety of formats to ensure steady progress on the landscape study. Leaders from the three institutions meet quarterly to review progress and discuss needs and issues with this, and other, projects. Open session meetings are also held monthly where updates on the landscape studies are given. And once a year a Blue River Landscape Study "all-participants meeting" is held to update those involved in the study, review progress, and create a work plan for the following year.

Administrative study topics

Selection

This landscape management plan should be viewed as an untested approach to meeting the objectives of the Northwest Forest Plan, as is the matrix and riparian reserve approach applicable outside of the AMA. The Blue River landscape plan rests upon the assumption that habitat patterns and ecological processes that function within a range of variation historically expressed in the landscape have a high probability of maintaining productive ecosystems and native species. In particular, this strategy embodies an ecosystem dynamics view where disturbance processes have historically shaped landscape patterns, and future management practices emulate key aspects of those disturbance regimes (e.g., frequency, intensity and spatial pattern of historical disturbance processes) as closely as feasible. The Blue River watershed is uniquely positioned to evaluate the effectiveness of this approach to ecosystem management.

The landscape management plan has the potential to affect many ecological, economic and social indicators of interest. Since this approach to landscape management has not been previously implemented, estimates of potential responses have a high degree of uncertainty. A suite of indicators was selected for the administrative study to provide the information of greatest value with the limited resources available. Monitoring and assessment activities were selected based on the following criteria:

- directly related to Northwest Forest Plan objectives (i.e., late-successional habitat, aquatic ecosystem objectives, sustained timber production)
- primary response variables that are critical to derive other estimates (e.g., vegetation-> wildlife habitat-> wildlife population)
- related to issues that arise with this management strategy (e.g., effects on species expected to benefit by riparian reserves)
- complements other related work (e.g., stream temperature is being studied at several scales on nearby lands)
- responses can be measured or estimated with reasonable reliability
- people with the necessary skills are available and interested in participating

A brief summary of each component is provided below; study methods are given for each component in the appendices.

Upland vegetation (Appendix A)

Changes in vegetation through implementation of the landscape management plan have the potential to affect many habitats and ecological processes. Plant composition, establishment, abundance, growth, and mortality affect many vertebrate and invertebrate species, and influence streamflow, disturbance processes, nutrient cycling and other processes. The landscape management plan uses historical disturbance regimes as a general template for management regimes to achieve human use objectives. Stand-level practices to implement the landscape management plan are intended to guide stands along successional pathways that resemble successional pathways following fires, and to maintain adequate stand growth for commercially viable, long-term timber management.

Plots have been installed to monitor tree establishment, growth and mortality; dead wood amounts and inputs; and understory plant composition and abundance in each of the landscape areas. These plots will be remeasured following timber harvest and prescribed fire to determine the effects of these practices on vegetation. Patterns of stand development documented through analysis of these plots can be compared to permanent plots in established natural stands in the H.J. Andrews Experimental Forest, and to plots established in the Warner Creek fire area. The Warner plots were installed to assess the effect of fire severity and plant community type on stand structure and growth. The purpose of the vegetation monitoring is to determine if stand development following management activities adequately meets both ecological and stand growth objectives, and to refine those objectives over time as more information becomes available.

A specific area of interest for the vegetation monitoring is to assess soil suitability standards for forest regeneration under the timber management regimes prescribed in the landscape management plan. Current soil suitability standards for timber harvest were based on the probability of reforestation within five years following harvest assuming clearcutting on relatively short rotations (approximately 80-year rotations) as the standard harvest practice. However, timber harvest practices in the landscape management plan call for varying levels of overstory retention (15%-50% live overstory canopy cover) at the time of regeneration harvest and generally longer rotations (100-260 years). Overstory retention reduces evapotranspiration of seedlings, increases relative humidity at the soil surface, and provides more wood inputs to the soil over the long-term. There is a potential for some soils judged to be unsuitable because of difficulty in achieving regeneration to successfully reforest where higher amounts of overstory are left. However, high retention levels on some sites may hinder regeneration due to increased competition for soil moisture. Monitoring is designed to address the effectiveness of regeneration on marginal soils under these regimes.

Epiphytic lichens (Appendix B)

Epiphytic lichens are an essential component of biological diversity and perform important ecological functions; e.g., nutrient inputs and forage. Several species of epiphytic lichens have been identified as potentially benefiting from the interim riparian reserves prescribed for matrix lands in the Northwest Forest Plan. Allowing some timber harvest near nonfish-bearing perennial and intermittent streams under the landscape management plan could potentially affect these species. Also, creating and managing more complex stands with multiple canopy levels on upslope areas may enhance retention and dissemination of some lichen species.

Permanent plots for epiphytic lichens have been established across a range of stand structures in the Blue River watershed. Some of these plots are located in stands planned for future timber harvest; others are located in stands with stand structures similar to those expected to be created in the future under the landscape management plan. Plots cover a range of riparian and upland habitats within each of the three landscape areas and reserves. Lichen community structure and functional group biomass, stand structure, and basic environmental variables were measured.

Riparian vegetation (Appendix C)

The potential for changes in riparian plant communities to occur as a result of implementing the landscape management plan has arisen as an issue. Prescriptions in the landscape management plan will result in different densities of residual overstory trees near nonfish-bearing and intermittent streams after timber harvest. Elevated air temperatures, decreased relative humidity, increased wind penetration, and increased soil moisture may occur in the short-term as a result. Changes in microclimates could alter riparian communities.

A set of streams in each landscape area have been selected to monitor riparian vegetation; pre-treatment plots have been installed. Post-treatment monitoring will help determine what changes occur in riparian plant communities, the duration of any observed changes, and how the density of residual overstory trees affects the magnitude of observed increases. Sites within harvested landscape blocks will be compared with upstream and downstream locations, unharvested stream reaches, and to streams with different management regimes.

Stream temperature (Appendix D)

The potential for increases in stream temperature to occur as a result of implementing the landscape management plan has arisen as an issue. Prescriptions in the landscape management plan will result in different densities of residual overstory trees near nonfish-bearing and intermittent streams after timber harvest. Elevated stream temperatures may occur in the short-term as a result. Elevated stream temperatures pose risks to aquatic ecosystems, and to the ability to meet state water quality standards.

A set of streams in each landscape area has been selected to monitor stream temperature. Temperature sensors have been placed in each stream (10 streams total) to gather pre-treatment data on background summer temperature patterns. Post-treatment monitoring should determine to what extent elevated temperatures occur, the duration of any observed increase, and how the density of residual overstory trees affects the magnitude of observed increases. Sites within harvested landscape blocks will be compared with upstream and downstream locations, unharvested stream reaches, and to streams with different management regimes. Ongoing stream temperature research in the H.J. Andrews Experimental Forest and other nearby areas will help place these observations in a larger basin context.

Stream-breeding amphibians (Appendix E)

Stream-breeding amphibians are an important component of biological diversity, and sustaining aquatic species is central to the Aquatic Conservation Strategy Objectives in the Northwest Forest Plan. Prescriptions in the landscape management plan will result in different densities of residual overstory trees near nonfish-bearing and intermittent streams after timber harvest, potentially affecting stream habitat. A two-year, watershed-scale assessment was undertaken to describe pre-treatment distribution of stream-dependent amphibians in the Blue River watershed (Hunter 1998). These data provided a context for the monitoring design employed at the stream reach scale.

A set of streams in each landscape area has been selected to monitor stream-breeding amphibians. Pre-treatment sampling has occurred in each stream (10 streams total) to gather data on background amphibian distribution. Post-treatment monitoring should determine to what extent changes in amphibian abundance occur, the duration of any observed change, and how the density of residual overstory trees affects observed changes. Sites within harvested landscape blocks will be compared with upstream and downstream locations, unharvested stream reaches, and to streams with different management regimes.

Stream channel morphology and large wood (Appendix F)

Prescriptions for the three landscape areas in the landscape management plan will each result in different densities of residual overstory trees near nonfish-bearing and intermittent streams when timber harvest occurs. Falling and removing trees within a tree height of streams could reduce wood input to streams, or otherwise cause changes in stream channel morphology. Changes to stream channels could affect aquatic ecosystems, and has been identified as an issue.

A set of streams in each landscape area has been selected to monitor stream channel morphology and wood inputs. Inventories of existing conditions in each stream (10 streams total) have been conducted to gather pre-treatment data. Post-treatment monitoring should determine to what extent changes in stream channel morphology and wood have occurred following timber harvest. Sites within harvested landscape blocks will be compared with upstream and downstream locations, unharvested stream reaches, and to streams with different management regimes.

Expected products and schedule

Blue River Administrative Study effectiveness monitoring activities are scheduled to occur both prior to and following timber harvest, reforestation, and prescribed fires. Post-treatment measurements are generally scheduled in years 1, 3, 5 and 10 following completion of the activity. Data management will follow protocols established by and data will reside in the Forest Science Data Bank, a cooperative endeavor of the Pacific Northwest Research Station and Oregon State University. Copies of all relevant data will also be provided to the Willamette National Forest. Reports suitable for a management audience will be generated in both electronic and hard copy format in the winter and spring following each measurement period. Formal publications will be produced when the results merit broad dissemination.

A WWW site for the Blue River Landscape Study (www.fsl.orst.edu/ccem/brls/brls.html) is being actively managed as a medium for information sharing. The objective is to document plans, results, and the adaptive management process so participants and others can follow progress of the study, or find information that will help implement similar projects elsewhere. A list of publications and reports is maintained on the site with links to electronic documents, or with instructions for how to obtain the report.

The Blue River Ranger District will also host an information-sharing event on an annual or bi-annual basis to share the progress and results of the Blue River Landscape Study and Administrative Study. The format will include both field trips and workshops. Individual presentations on the Blue River Landscape Study are regularly given to classes, symposia, workshops, and on field trips.

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Appendices

Appendix A - Upland vegetation
Appendix B - Epiphytic lichens
Appendix C - Riparian vegetation
Appendix D - Stream temperature
Appendix E - Stream-breeding amphibians
Appendix F - Stream channel morphology and large wood

Appendix A - Upland vegetation

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I. Objectives

The overall objective of this monitoring effort is to document changes of upland vegetation following timber harvest designed to approximate natural disturbance regimes in the Blue River watershed. A variety of vegetation attributes are of interest, either for their contributions to biological diversity or for their commodity values. Attributes of the vegetation to be measured include tree regeneration, growth and mortality of residual trees, log and snag amounts and persistence, vascular plant dominance and diversity, and plant biomass and production.

It is important to note that timber harvest prescriptions in the Blue River watershed will reflect the reconstructed pattern of natural disturbance regimes which vary across the watershed. Variation across the watershed in potential productivity and natural vegetation (i.e., plant associations) is correlated with variation in natural disturbance regime (e.g., both vary with elevation). Thus it will not be possible to observe all the conceivable combinations of plant association and harvest prescription. In addition, stands to be harvested vary in age and structure, including mature stands, old-growth stands, and stands which are difficult to classify as either due to salvage logging or other factors. It is unlikely that all types of stands will be well represented even within a particular combination of plant association and harvest prescription.

Thus we plan to concentrate on those combinations of harvest prescription, plant association, and stand type which are common in any particular set of timber sales. It is critical to replicate observations to have any confidence in conclusions about the various treatments. Thus we intend to monitor at least three separate patches per combination of harvest prescription, plant association, and stand type. For the most part, mature stands will be harvested. Initial harvest units are located in the western hemlock zone; most of the upland area appears to fall into the Oregon grape or salal plant association, or the corresponding rhododendron plant associations. It does not appear practical to distinguish between these plant associations for this effort.

II. Questions

1. What are the growth and mortality rates of residual trees, and how do they vary by residual tree density?
2. How does residual tree density affect tree regeneration composition, growth and mortality?
3. What are the growth rates of understory trees, and how do they vary over time by residual tree density?
4. How does residual tree density affect understory plant composition and biomass?
5. How does the amount, size, and decay class of logs and snags vary by residual tree density?

III. Methods

Plot selection

The basic unit of observation will be the patch, a contiguous area within a harvest unit. Upland vegetation within patches will be measured using fixed-radius plots of 0.1 ha area (slope-corrected). Plots will be placed so that perimeters are at least 50 m from the nearest road or boundary with a stand of different age, structure, or prescription. The centers of plots will be separated by at least 100 m. Plots will not be located within obvious riparian-influenced areas. Within these constraints, the selection of plot centers will incorporate some element of randomization. Given the 50 m buffer width, 100 m between plot centers, and slope-corrected plot radius of approximately 18 m, the minimum size of patch to accommodate 3 plots is about 5-6 ha. For patches that are larger than 5-6 ha, proportionately more plots may be established. On the other hand, patches smaller than 5-6 ha may be included if the patch represents a common combination of prescription, plant association, and stand type that lacks an adequate number of larger patches. In this case, fewer than 3 plots per patch will be established.

Monumenting/documenting plot locations

The centers of plots will be marked with rebar, pounded into the ground so that only a few inches remain exposed, with a brightly painted pvc pipe over the rebar. The PVC will be labeled with the plot identifier and the date. Coordinates of each plot center will be recorded with GPS equipment. In addition, the three trees marked for retention that are nearest to the plot center will be used as witness trees. These trees will be tagged at breast height (see "Plot measurements" below), and tag number, diameter at breast height, and species will be recorded. The bearing, distance, and slope to the center of the plot from the point on each of these trees facing the center of the plot will be recorded.

Plot layout

As mentioned above, fixed-radius plots of 0.1 ha area will be used. The radius of a 0.1 ha plot is 17.84 m. Plot boundaries will be slope-corrected so that plots will be 0.1 ha in horizontal area. To achieve this, plot radii will be corrected for the effects of slope (i.e., 17.84 m horizontal distance corresponds to a longer distance along steep slopes).

Plot measurements

Plot measurements will encompass vascular plants (trees, saplings, seedlings, shrubs, and herbs), coarse woody debris (snags and downed logs), and some site characteristics.

<u>Canopy closure:</u>

The first measurement will be of canopy closure. Twelve readings per plot will be taken with a moosehorn densiometer. Readings will be taken at 5.0, 10.0, and 15.0 m (slope-corrected) away from the center of the plot on the 4 cardinal directions.

<u>Tree inventory:</u>

Within the entire 0.1 ha plot, for all trees >= 5 cm diameter at breast height (DBH), species, DBH, canopy class, overall vigor, and crown ratio will be recorded. Trees that are marked for retention will be tagged at breast height with aluminum tags and nails. All trees between 5 and 18 cm DBH should be tagged, since 18 cm DBH is the lower size limit for trees to harvest. Tags will be placed facing the center of the plot.

Breast height will be defined as 137 cm, measured along the bole, from the uphill location. The possible values for canopy class are:

D = dominant — Crown emerges from the general canopy layer, and so receives light from the top and the sides

C = co-dominant — Crown extends to the top of the general canopy layer, and so receives light from the top, but not much from the sides

I = intermediate — Crown extends into the lower portion of the general canopy layer, and so receives mostly filtered light from the top and the sides

S = suppressed — Crown completely beneath the general canopy layer

Overall vigor is one of the following:

1 = good vigor — No apparent signs of distress (e.g. discolored foliage, paucity of leaves)
2 = fair vigor — Some signs of distress apparent
3 = poor vigor — Extreme distress apparent (i.e. death imminent)

Crown ratio is defined as the proportion of a tree's total length for which at least 1/3 of the bole's circumference is covered by live crown. Widely scattered branches are not included. Crown ratio will be estimated to the nearest 5 percent. If epicormic branches are present, (short branches arising directly from the bole), these should be noted in a comment.

<u>Intensive tree measurements:</u>

A subsample of trees will be selected for height measurement, increment coring, and measurement of crown width. To determine which trees to include in the subsample, first tally the number of trees by species from the tree inventory (excluding those with broken or dead tops, or other obvious, serious damage or disease). For species with fewer than 5 individuals, no intensive measurements will be taken. For species with 5 to 10 individuals, all trees will be measured. For species with more than 10 individuals, determine the range of diameters by subtracting the smallest diameter from the largest diameter. Then divide the trees into three groups, each group including 1/3 of the range of diameters. The first group will include all trees from the smallest to those with diameter equal to the minimum diameter plus 1/3 of the range. The second group will include all trees with diameters between the minimum plus 1/3 of the range and the maximum minus 1/3 of the range. The third group will include all trees larger than the maximum diameter minus 1/3 of the range. Use a random number generator on a pocket calculator, or other randomization device, to pick 3 trees from the 1st group, 4 trees from the 2nd group, and 3 trees from the 3rd group. If any group lacks the specified number of individuals, randomly choose additional trees from the other groups.

Both total height and height to the base of the live crown will be measured. Two relatively short cores will be obtained from each of these trees at breast height, with the cores separated by at least 90 degrees. For trees < 18 cm DBH, only 1 core will be taken. For each core, bark thickness, sapwood thickness, and 5- and 10-year radial growth will be recorded. Information from the cores will allow us to estimate leaf area index and recent bole production. We will also measure four perpendicular radii of the crowns of the trees selected for height measurement and coring. From the base of tree, walk due north to edge of crown. Use a clinometer to check that the edge of the crown is directly overhead. Record slope distance to nearest point on tree, and the slope along which the radius was measured. Repeat the process walking due east, due south, and due west.

Understory measurements: herbs, shrubs, and tree regeneration:

Quantitative measurements of saplings, seedlings, shrubs, and herbs will be structured around two parallel line transects. The endpoints of these transects will be located 10.00 m, slope-corrected, from the center of the plot, on the subcardinal compass bearings (i.e., NW or 315 degrees, NE or 45 degrees, SE or 135 degrees, SW or 225 degrees). It is important that a standard declination setting is used throughout. This value will be 19.5 degrees east. These four points will also be marked with rebar, which will be brightly painted. The two line transects will run in a clockwise fashion from adjacent points: line 1 will run from the NW point to the NE point; line 2 will run from the SE point to the SW point.

These line transects will be used for line-intercept measurements of cover of shrubs and tree regeneration, and for location of 1 x 1 m quadrats for other measurements. The perimeters of the 1 x 1 m quadrats will be slope-corrected. In the quadrats, estimated cover of herbs by species will be recorded. In addition, tree regeneration will be tallied by species and size class. Seedlings will be defined as trees < breast height and will be recorded in four height classes: 1 (0 to 10 cm tall); 2 (10 to 25 cm tall); 3 (25 to 75 cm tall); and 4 (75 to 136 cm tall). Saplings will be defined as trees >= 137 cm tall and < 5.0 cm DBH. Saplings will be recorded in 1-cm DBH classes from 0 (i.e., up to 0.9 cm DBH) to 4 (i.e., 4.0 to 4.9 cm DBH). Also in the 1 x 1 m quadrats, basal diameter of upright shrub species will be recorded. Upright shrubs include species such as rhododendron and vine maple, but not salal or dwarf Oregon grape. Finally, litter depth and degree of soil disturbance will be recorded in or near the 1 x 1 m quadrats (see below for details).

Three 1 x 1 m quadrats will be measured along each of the 2 lines, with the upper left-hand corner of the quadrats (if looking from the center of the plot) on the lines at 1.00, 6.00, and 11.00 m. Quadrats will be placed on the inside of the line transects as viewed from the center of the plot.

After the quantitative measurements of live vegetation have been taken, a complete list of vascular plant species on the plot will be recorded. The entire 0.1 ha plot will be inspected briefly to identify any species not included in the quantitative measurements. The entire species list will be recorded on a separate data sheet.

Coarse woody debris: snags and logs:

All snags and logs within the 0.1 ha plot will be measured. The minimum size for coarse woody debris is 10 cm (DBH for snags, diameter of the larger end for logs). Snags marked for retention (or between 10 and 18 cm DBH) will be tagged. For snags with intact tops DBH will be measured. For broken snags, DBH and total height will be measured, and top diameter will be estimated. For downed logs, the portion within the plot will be measured. The length and the two end diameters of all pieces will be recorded (note that the diameter of the smaller end can be less than 10 cm). Only the segments of logs within plots will be measured, so that if one or both ends of a log lie outside of a plot, the diameter(s) where the log crosses the perimeter of the plot would be recorded. For all snags and logs the decay class (from 1 to 5) will also be recorded.

Environmental variables:

Environmental variables recorded will include slope, aspect, topographic position, degree of soil disturbance, and litter depth. Slope, aspect, and topographic position will be recorded from the center of plot. Slope in degrees will be recorded both up the slope and down the slope. Topographic position will be recorded as either top 1/3 of slope, middle 1/3 of slope, bottom 1/3 of slope, or flat. Soil disturbance and litter depth will be recorded for each of the 1 x 1 m quadrats within which cover of herb species, numbers of tree saplings and seedlings, and basal diameters of upright shrubs were recorded. Soil disturbance will be recorded using the four categories developed for Watersheds 1 and 3 on the Andrews Experimental Forest:

1) undisturbed (soil surface similar in appearance to areas not logged and burned, with minimal mixing of soil and litter and no evidence of fire);
2) disturbed-unburned (disturbance from logging evident; litter removed or mixed with mineral soil but minimal evidence of fire);
3) lightly burned (surface litter charred by fire but not completely removed);
4) heavily burned (surface litter completely removed by intense fire).

Litter depth will be measured approximately 1 m farther along the line transect from the lower right-hand corner of each quadrat (e.g. for quadrat 1 at 3.0 m along the line and 1.0 m off the line towards the center of the plot). Litter depth will be measured by making a small, temporary cut into the forest floor with a trowel.

<u>Frequency of measurements:</u>

Measurements will be made prior to harvest and in the first year after harvest, slash treatment and reforestation. Subsequent measurements will be made in years three and five post-treatment, and every 5 years thereafter.

Data management and quality control

After initial training, there should be periodic contact with field crews by either Willamette National Forest or Pacific Northwest Research Station personnel supervising the monitoring. This contact should include opportunities to answer any questions about field measurements, and inspection of data sheets by the supervisory personnel.

Following the field season, data will be checked for completeness by Pacific Northwest Research Station personnel and any resolvable problems will be attended to. Data will be archived in the Forest Science Data Bank at Oregon State University using standard protocols. Duplicate copies of the data will be provided to the Willamette National Forest.

Analysis

Data summaries will be prepared by Oregon State University or Pacific Northwest Research Station personnel following each field season. Pacific Northwest Research Station, Oregon State University and Willamette National Forest personnel supervising the monitoring will collaborate on preparation of internal reports and manuscripts for peer-reviewed journals.

Appendix B - Epiphytic lichens

Dr. Bruce McCune, Oregon State University, plant ecologist
Shanti Berryman, Oregon State University, plant ecologist
John Cissel, Willamette National Forest, ecologist

I. Objectives

1. Monitor survival of *Pseudocyphellaria rainierensis* after cutting. This is a strategy 1 and 3 species in the Northwest Forest Plan. The results of this study will help to establish appropriate buffer widths for this species.

2. Monitor lichen community structure and biomass in permanent plots. These plots were established in 1998 and 1999, prior to any cutting. Monitoring will provide a basis for evaluating the effect of the various silvicultural treatments in the landscape management plan on the lichens. A key component of the lichen resource is *Lobaria oregana* and forage lichens (*Alectoria* and *Bryoria*). In managing for these, it is not sufficient to know that they are present. Instead it is desirable to estimate their biomass, since their contributions to nitrogen fixation, forage, and other ecosystem roles are probably proportional to their biomass.

II. Questions

1. What is the relationship between *Pseudocyphellaria rainierensis* populations (births, deaths, and growth rates) and degree of reduction in canopy density?

2. How do epiphytic lichen communities respond to reduction in canopy density? There are two parts to this question: what is the initial effect of removing the trees and what is the subsequent response by the lichens.

III. Methods

Field methods

<u>Pseudocyphellaria populations</u>

Existing populations of *Pseudocyphellaria rainierensis* will be sought by climbing trees where litterfall of *Pseudocyphellaria* is found in cutting units. Established individuals (ca. 300) will be marked, measured, mapped, and their position relative to the crown recorded. These individuals will be selected across the full range of microhabitats in the tree. Measure birth rates by annual census of marked areas of 100, 50-cm branch lengths. Measure growth rates by measuring the areas of repeated tracings on acetate of 100 of the marked individuals. Measure mortality by annual census of marked individuals.

<u>Lichen Community Sampling</u>

One hundred seventeen stands were sampled in 1998-1999. Permanent lichen plots were established in harvest units prior to any cutting activities. The plots should not be revisited until several years after cutting, to allow time for the lichens to equilibrate to the new conditions. The following schedule can be used for each unit:

Pre-harvest measurements	1998-1999	(Completed)
Harvest year	0 years after harvest	
Initial effect	3 years after harvest	
Short-term response	5-10 years after harvest	
Long-term response	40 years after harvest	

Each unit was sampled with one permanent FHM plot (see below). Biomass is sampled with litter plots (below). Future monitoring of the permanent plots will allow an evaluation of predictions based on ongoing work by Berryman, McCune, and Cissel.

Forest Health Monitoring (FHM) Plots

The FHM lichen community method will be used for the field plots. It has been used for over 1000 plots in the Forest Health Monitoring program nationwide. It is also used by the PNW Forest Service air quality program for about a thousand plots in western Oregon and Washington.

The FHM method determines the presence and abundance of macrolichen species on all standing woody plants in each FHM plot. The field crew collects samples for mailing to lichen specialists. The field methods are described in detail elsewhere (http://www.fs.fed.us/r6/aq/lichen/) and the method has been closely scrutinized and documented for repeatability.

The method has two parts that are performed simultaneously: (1) In each plot the field crew collects specimens for identification by a specialist, the collection representing the species diversity of macrolichens in the plot as fully as possible. If possible, the specialist will be a crew member performing the field work, with assistance from McCune and Geiser. The population being sampled consists of all macrolichens occurring on woody plants, excluding the 0.5 m basal portions of trees and shrubs. Lichens on fallen branches and other lichen litter are included. Given the large plot area, fallen branches provide a sample of the canopy lichens; and (2) The field crew estimates the abundance of each species using a four-step scale: 1 = rare (< 3 individuals in plot); 2 = uncommon (4-10 individuals in plot); 3 = common (> 10 but < 40 individuals in plot, 4 = very common (> 40 individuals in the plot but less than half of the boles and branches have that species present); and 5 = abundant (more than half of boles and branches in the plot have the subject species present).

Plots will be marked by a 0.5 m section of 1 cm rebar driven nearly flush with the ground (to allow relocating with a metal detector after fire or logging), along with an 0.5 m section of 2 cm white PVC pipe as a more visible center stake.

Litter Plots

Collecting lichen litterfall in late summer is a viable method of estimating biomass of lichens in the canopy. In general there is a 100:1 ratio of canopy biomass to late-summer lichen litter.

Fifteen biomass subplots are placed on transects through each macroplot. At each biomass subplot, the oven-dry mass of the lichen functional groups (cyanolichens, forage lichens, and matrix lichens) is estimated visually to the nearest order of magnitude, or more accurately if possible. Reference samples of each functional group (1/10, 1, 5, 10 grams) are used for assistance in the field. Visual estimates are calibrated against the litter-pickup method by performing both methods in a sample of the biomass sub-plots. Visual estimates are also calibrated against individual litter specimens collected daily. The specimens are dried and weighed. The estimated weights and actual weights are compared to calibrate the two sampling methods.

All macrolichen litter is picked up and sorted by functional group in 10-15, 2-m radius plots per stand. This typically yields a standard error of 10-20% of the mean. The material is oven dried, weighed, then the results expressed in kg/ha.

Analysis methods

1. Evaluate population demographics of *Pseudocyphellaria rainierensis* (births, deaths, growth) in relationship to degree of and distance to canopy opening. Recommend suitable buffer width based on this information.

2. Describe changes in lichen community composition and biomass over time.

Appendix C - Riparian vegetation

Dr. Andy Gray, Pacific Northwest Research Station, Forest Ecologist
Jim Mayo, Willamette National Forest, Silviculturist
Dr. Steve Acker, Oregon State University, Forest Ecologist

I. Objectives

The objective of the riparian vegetation monitoring is to determine if the timber harvest prescriptions in the Blue River Landscape Study alter the composition or abundance of riparian-associated herbs, shrubs or trees. Extensive and intensive plots established in the upland vegetation monitoring component will answer general questions about the effect of the prescriptions in the landscape management plan on vegetation. The riparian vegetation monitoring is specifically focused on addressing the potential effects of management activities on riparian-associated vegetation. Concerns about potential effects on riparian vegetation have arisen because the standard riparian reserve approach is not being applied in the Blue River landscape management plan.

II. Questions

1. Is the composition or abundance of riparian-associated herbs, shrubs or trees changed by implementation of the landscape management plan prescriptions?
2. Are changes in the composition or abundance of riparian-associated herbs, shrubs or trees related to residual tree density?
3. What is the rate of recovery by riparian-associated herbs, shrubs or trees?

III. Methods

Locate transects just below the permanently marked amphibian plots, using a set of two transects, 5 meters apart and ten meters to each side of the stream center. This will be a sufficient distance to include all riparian vegetation for this size stream.

Each transect consists of a line intercept where shrubs, substrate (wood, rock, etc.) and surface characteristics (terrace, toe slope, etc.) are measured. The two transects should provide adequate data to quantify the amount of coarse wood in the stream.

In addition to the line intercept, a belt transect, one meter wide and divided into one meter lengths, is marked out. Each one meter square plot is coded as to active channel, riparian or upland condition. These plots are used to record presence of herbs, seedlings and saplings, and disturbed soil by percent ground cover.

Canopy closure is measured at the center of the stream, and at the 5 meter and 10 meter points along the transects, using a moosehorn densiometer.

A photo point is established at the center of the stream on the upper transect with photos taken upstream, downstream, and both sides of the transect.

A large 10th hectare plot centered on the stream at the upper transect, provides basic data about overstory trees (number per acre, basal area, avg. dbh, etc.), for comparison to upslope conditions as well as before and after comparisons. These trees are not tagged or cored for growth data.

A total of 54 transects will be needed to cover the three landscape areas. There are 2 transects per amphibian plot, 3 amphibian plots per stream, 3 streams per treatment (control, buffer, and no buffer), for each of the 3 landscape areas.

Frequency of measurements

Measurements will be made prior to harvest and in the first year after harvest, slash treatment and reforestation. Subsequent measurements will be made in years three and five post-treatment, and every 5 years thereafter.

Data management and quality control

After initial training, there should be periodic contact with field crews by either Willamette National Forest, Pacific Northwest Research Station or Oregon State University personnel supervising the monitoring. This contact should include opportunities to answer any questions about field measurements, and inspection of data sheets by the supervisory personnel.

Following the field season, data will be checked for completeness by Pacific Northwest Research Station or Oregon State University personnel and any resolvable problems will be attended to. Data will be archived in the Forest Science Data Bank at Oregon State University using standard protocols. Duplicate copies of the data will be provided to the Willamette National Forest.

Analysis

Data summaries will be prepared at by Pacific Northwest Research Station or Oregon State University personnel following each field season. Pacific Northwest Research Station, Oregon State University and Willamette National Forest personnel supervising the monitoring will collaborate on preparation of internal reports and manuscripts for peer-reviewed journals.

Appendix D - Stream temperature

Dave Kretzing, Willamette National Forest, hydrologist
Matt Hunter, private consultant, wildlife ecologist

I. Objectives

The objective of this monitoring component is to generate information necessary to determine the effectiveness of this landscape management approach in meeting Northwest Forest Plan Aquatic Conservation Strategy (ACS) objectives and State Water Quality Standards for stream temperature, and to test key assumptions regarding the response of stream temperature to prescribed streamside treatments. The most relevant objectives from the Aquatic Conservation Strategy are: **#4** “Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival growth, reproduction, and migration of individuals composing aquatic and riparian communities,” and **#8** “Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability."

As with many of the ACS objectives, these are non-quantitative and the extent and resolution undefined, therefore some interpretation was necessary to develop a monitoring approach that would allow evaluation of this objective. We take these objectives to apply at nearly any scale, but many of the management practices that might affect these processes, as well as the processes themselves, occur at the scale of individual stream reaches or segments. Therefore, we will examine temperature changes in streams at the scale of reaches and segments in the Blue River watershed.
The State Water Quality Standard for the Blue River watershed, above the Blue River dam, is that any 7-day average of daily maxima should not exceed 17.6 C (64 F). This quantitative objective will be straightforward to assess.

A key assumption of the Blue River Landscape Study is that prescribed harvest activities may temporarily increase local stream temperatures, but that these temperatures are expected to recover as the surrounding vegetation re-establishes (Cissel 1997, p 47-49). Because of the relatively low rate of timber harvest associated with the long rotations and relatively high levels of green-tree retention prescribed in the Blue River Landscape Study, these effects are not expected to be significant. Our investigation will attempt to quantify the effects of harvest prescriptions in the Blue River Landscape Study to stream temperatures over time in 1^{st}-order streams within and near harvest units.

II. Questions

1. Will the timber harvest prescriptions in the Blue River landscape management plan result in elevated stream temperatures in and near the harvest unit?
2. If so, what is the magnitude and duration of any observed increases?
3. If so, are changes in stream temperature related to residual canopy density, or appear to be controlled by other factors (e.g., soil depth)?
4. If so, do these changes persist downstream?

III. Methods

Materials and calibration

Optic StowAway® temperature loggers by Onset Computer Corporation were used to record stream temperatures. Associated software was used to initiate temperature loggers and download data. Data loggers were set to collect temperatures at 1-hr intervals. A PVC casing was constructed to house the temperature loggers while in the stream. One-meter lengths of 0.5-in PVC piping were used as stakes in stream banks to mark data logger locations in the field. A National Institute of Standards and Time (NIST) thermometer was used to calibrate sensors.

Monitoring design

The management practice in the Blue River Landscape Study of most interest in regard to stream ecosystems is the harvest or partial harvest of streamside forests near Class IV (intermittent) and Class III (perennial without fish) streams. Therefore, streams of this type within harvest units are a priority to monitor. However, due to the low number of these stream types in Blue River Landscape Study harvest units, and the value of comparing alternative treatments over the same time period, we have initiated monitoring in sets of 3 streams each in three timber sales in the watershed. This approach is patterned after an experimental block design in which several treatments are replicated in multiple blocks. The blocks in this case are the timber sales and the treatments are “buffered”, “unbuffered”, and “control” streams. The buffer treatment is a 15- to 20-m no-harvest buffer around the entire length of stream within the harvest unit. The no-buffer treatment does not have a no-harvest buffer, but will have increased canopy retention near the stream, compared to upslope, and no streambank trees will be cut. The “control” units are nearby streams of similar size and character where no harvest is expected to occur.

Site selection

Two levels of site selection were involved: choosing timber sales (blocks) and choosing specific stream units within each timber sale. In each timber sale there were two units that contained the headwaters of small streams, one with a buffer and one without a buffer. Other streams passed through the unit and had large buffers, or had only a very short length within the harvest unit, offering little in terms of sample area for monitoring. Therefore, the very limited sample of units with small streams was chosen for monitoring. Nearby streams of similar size were chosen as “control” streams. All streams were Class IV or very small Class III streams with spatially intermittent surface water in late summer.

Sensor placement

In each of the units, 3 sensors were placed within the unit: one near the headward extent of perennial surface water, one near the lower boundary of the harvest unit, and one between the two previous sensors. In the North Fork Quartz timber sale, an additional sensor was placed downstream from the harvest unit, just before the tributary entered the main stem of North Fork Quartz Creek. In each case the stream went subsurface prior to entering North Fork Quartz Creek. Therefore sensors were placed in the last available perennial surface water on the tributary.

Sensors were placed in streams in June and July 1998 and 1999. For each timber sale, sensors were placed in this order: unbuffered unit, buffered unit, control. Pink or orange flagging over or adjacent to the stream was used to mark sensor locations. Locations were later marked by placing a PVC stake on the stream bank near each sensor location. Because all monitored streams were expected to have spatially intermittent surface flow in late summer, sensors were placed in the deepest locations available, typically in small pools 10-30 cm deep. A rock (or waterlogged piece of wood in rockless reaches) was placed over the sensors to stabilize the sensor in the stream.

Data collection and management

The data loggers collected temperatures at 1-hr intervals. Data from this project are stored in the Forest Science Data Bank, Oregon State University. Metadata are viewable on the web at: http://sequoia.fsl.orst.edu/lter/data/studies/we025/we025fmt.htm.

Analysis

Temperature regimes may be described in a wide variety of ways depending on the specific parameters and temporal resolutions of interest. For this study, we will examine these temperature regime parameters: seasonal maximum, seasonal minimum, seasonal range, average daily range, minimum daily range, maximum daily range, and seasonal peak of 7-day average of daily maxima. We will also display 7-day averages of daily maxima for the entire season in chart form.

Appendix E - Stream-breeding amphibians

Ruby Seitz, Willamette National Forest, wildlife ecologist
Matt Hunter, private consultant, wildlife ecologist

I. Objectives

The objective of this monitoring effort is to generate information necessary to determine the effectiveness of this landscape management plan in meeting Aquatic Conservation Strategy objectives, and to test key assumptions in the Blue River Landscape Study regarding the response of stream amphibians to prescribed streamside treatments. The most relevant objective from the Northwest Forest Plan Aquatic Conservation Strategy is objective #9: "Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species."

This objective is non-quantitative and the extent and resolution undefined, therefore some interpretation was necessary to develop a monitoring approach that would allow evaluation of this objective. We take this objective to apply at the extent of the Blue River watershed, and at a resolution of 1st- to 3rd-order basins. A key assumption of the Blue River Landscape Study is that prescribed harvest activities may temporarily reduce local populations of stream amphibians, but that these populations are expected to recover as the surrounding forest re-establishes (Cissel 1997, p 60-63). Furthermore, some temporary decrease in local populations is acceptable as long as the overall watershed population remains relatively stable. Therefore, our investigation will attempt to quantify the temporal effects of harvest prescriptions in the Blue River Landscape Study to aquatic amphibians in 1st-order streams within and near harvest units.

II. Questions

1. Will the timber harvest prescriptions in the Blue River landscape management plan result in changed abundance of stream-breeding amphibians in the samples streams?
2. If so, what is the magnitude and duration of any observed changes?
3. If so, are changes in abundance related to residual canopy density, or appear to be controlled by other factors (e.g., stream gradient)?

III. Methods

Monitoring design

The management practice in the Blue River Landscape Study of most interest in regard to stream ecosystems is the harvest or partial harvest of streamside forests near Class IV (intermittent) and Class III (perennial without fish) streams. Therefore, streams of this type within harvest units are priority to monitor. However, due to the low number of these stream types in harvest units thus far in the Blue River Landscape Study, and the value of comparing alternative treatments over the same time period, we have initiated monitoring in sets of 3 streams each in the two timber sales so far sold in the watershed, and will continue with this approach in one additional area. This approach is patterned after an experimental block design in which several treatments are replicated in multiple blocks. The blocks in this case are the timber sales and the treatments are "buffered", "unbuffered", and "control" streams. The buffer treatment is a 15- to 20-m no-harvest buffer around the entire length of stream within the harvest unit. The no-buffer treatment does not have a no-harvest buffer, but will have increased canopy retention near the stream, compared to upslope, and no streambank trees will be cut. The "control" units are nearby streams of similar size and character where no harvest is expected to occur.

Site selection

Two levels of site selection were involved: choosing timber sales (blocks) and choosing specific stream units within each timber sale. In each timber sale there were two units that contained the headwaters of small streams, one with a buffer and one without a buffer. Other streams passed through the unit and had large buffers, or had only a very short length within the harvest unit, offering little in terms of sample area for monitoring. Therefore, the very limited sample of units with small streams was chosen for monitoring. Nearby streams of similar size were chosen as "control" streams. All streams were Class IV or very small Class III streams with spatially intermittent surface water in late summer.

Sampling within a treatment

At each harvest unit and "control," 10 2-m amphibian search areas were placed along study streams. Five were within the harvest unit, and five were downstream of the harvest unit. Search areas were placed approximately 30-50 m apart, depending on the length of stream available within the harvest unit or below it, and were randomly located as possible by the extent of perennial flow.

Detection

A "light-touch" method was used to search for amphibians in these streams, in order to maintain stream integrity for future years. All potential cover particles that were not key to maintenance of the water level in the channel unit being searched were temporarily moved or removed. Therefore, small steps or debris jams were not disassembled, and small pools located above these structures were not drained. Instead, sticks and twigs were used to probe into all potentially inhabited interstitial space.

Data collection and management

A variety of environmental data were collected at each amphibian sample point, including average stream width, gradient, substrate composition, canopy cover, and water temperature. Each captured amphibian was identified to species, age and sex (when possible), and measured (snout-to-vent length [SVL], and total length [TL]). Data from this project are stored in the Forest Science Data Bank, Oregon State University. Metadata are viewable on the web at http://sequoia.fsl.orst.edu/lter/data/studies/we022/we022fmt.htm.

Analysis

Parameters that will be followed over time include total numbers, frequency of occurrence at sample locations within each stream, and average density in streams. Additional analysis may take place in an attempt to associate changes in habitat variables with amphibian response. This would most likely involve regression analysis associating changes in habitat variables to changes in amphibian numbers.

Appendix F - Stream channel morphology and large wood

Dave Kretzing, Willamette National Forest, hydrologist
Matt Hunter, private consultant, wildlife ecologist

I. Objectives

The channel structure and wood function components of this monitoring effort were initiated to provide information that could potentially assist in interpretation of stream amphibian and water temperature monitoring results. Bedrock streambeds in headwater stream channels are typically areas of non-habitat for stream amphibians and amplified warming for stream water (especially when combined with direct solar exposure). Therefore, a measure of bedrock exposure in the stream channel may help explain future trends in amphibian populations and stream temperatures. Similarly, but in an opposite fashion to amount of bedrock, wood in headwater stream channels often creates complex morphologies and hyporheic flow (especially via step structures), which increase amphibian habitat and potential for cooling of stream water. Step structures, often created by wood and accumulated bed material in the active channel, may be especially important refugia for stream amphibians. Therefore, amount of wood and a specific measure of step morphology are additional measures that may help interpret future trends in amphibian populations and water temperature.

II. Questions

1. Will the timber harvest prescriptions in the Blue River landscape management plan change the amount of bedrock exposure or the amount of wood in sampled streams?
2. If so, what is the magnitude and duration of any observed increases?
3. If so, are changes in bedrock exposure or the amount of wood in the channels related to residual canopy density, or appear to be controlled by other factors (e.g., disturbances)?

III. Methods

Establishment of transect locations

Transects were established over nearly the entire stream length within each harvest unit (or a comparable length on nearby control streams). Each transect began at the 5th amphibian search area down from the top of the stream, and extended up to include at least the lower end of the uppermost amphibian search area. For control streams, the 1st and 5th uppermost amphibian search areas were used as endpoints for channel monitoring transects.

Measurements of channel structure and wood function were taken in 5-m intervals along the transect. Two wooden staffs connected with a relatively non-elastic 5-m chord were used to designate consecutive 5-m measurement areas, from downstream to upstream. Each 5-m measurement area was not marked in the field. In all cases, each of 5 amphibian search areas (identified by a PVC stake) was noted when the PVC marker fell within a 5-m measurement area, to allow comparisons of transect interval locations among years.

Measurements

Three sets of data were collected: channel structure, wood tallies, and step structures. Channel structure measurements included active channel width, active channel depth, gradient, azimuth, and percent of the active channel composed of bedrock. Wood tallies involved tallying 10-cm diameter classes of all wood pieces 2 cm diameter in two location categories: vertically over the active channel and within the active channel. Step structures =30 cm in height were classified based on the key piece(s) forming the step (rock, wood, or both), the height measured in 10-cm classes, and if a wood piece was judged as a key piece forming the step, the diameter class of the piece of wood was recorded.

Analysis

Initial years will simply involve summary statistics of results. In 3-5 years, analyses will include a visual display of percent bedrock over years, displays of wood amounts, size of steps, and comparisons of contributions of wood versus rock particles in creating steps in small streams. It will also be possible to map changes in bedrock and log configurations in channels within each transect over time.