Blue River Landscape Study

Landscape Management and Watershed Restoration Strategy – Version 2

5/12/02

I. Introduction

A. Background

The Blue River Landscape Study (BRLS) was developed to meet guidance contained in the Northwest Forest Plan (NWFP, USDA and USDI 1994) for the Central Cascades Adaptive Management Area. Specific objectives for the Central Cascades Adaptive Management Area 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 USDOI 1994, p. D-12). Direction for the adaptive management area has been further refined through the Central Cascades Adaptive Management Area Strategic Guide (USDA and USDOI 1996).

Specific concepts and approaches to landscape management for the Blue River watershed were taken directly from experience in the Augusta Creek case study (Cissel et al. 1998). Augusta Creek was a collaborative project among scientists based at the nearby HJ Andrews Experimental Forest and managers on the Willamette National Forest undertaken to explore and develop ideas concerning the use of historical information about landscape dynamics and disturbance regimes to guide landscape management. Results from the Augusta Creek study demonstrated that it was operationally feasible to use historical fire regimes as a general template for future vegetation management, and that this approach may provide advantages as compared to the approach prescribed in the Northwest Forest Plan for Matrix lands, particularly for species associated with late-successional forests (Cissel et al. 1998).

A team of managers and scientists used the watershed analysis for the Blue River watershed (1996, unpublished report on file at the McKenzie River Ranger District) and numerous other sources of data to create a landscape management strategy for the Blue River watershed based on the concepts and processes developed for Augusta Creek (Blue River Landscape Project: Landscape management and monitoring strategy - Version #1, 1997, unpublished report, www.fsl.orst.edu/ccem/brls/brls.html). This report has been used to guide project-level implementation and monitoring efforts in the watershed since 1997.

The Blue River Landscape Team conducted an adaptive management process in 2000 and 2001 to evaluate new sources of information and operational experience gained to date, and to make recommendations for change to the 1997 landscape management strategy (2001, unpublished report, www.fsl.orst.edu/ccem/brls/brls.html). This document, known as “Blue River Landscape Study: Landscape management and watershed restoration strategy - Version 2”, incorporates these recommendations and makes other formatting and editing changes.

Other closely related documents include:

- Fire history studies in the watershed provided critical data and descriptions of general fire regimes in the Blue River watershed (Teensma 1987, Morrison and Swanson 1990, Weisberg 1996, 1998). Weisberg also documented his review of Version 1 of the landscape management strategy in an unpublished report on file at the McKenzie River Ranger District (1999), including recommendations for modifications to Version 1.

- *The Blue River Administrative Study Plan* (2001, unpublished report on file at the McKenzie River Ranger District, www.fsl.orst.edu/ccem/brls/brls.html) provides the objectives and methods for the monitoring components of the study.

- *Landscape management using historical fire regimes: Blue River, Oregon* (Cissel et al. 1999) compares the Blue River landscape plan to the NWFP in terms of landscape structure and identifies potential ecological and management implications.

B. Study Goals

1. Develop, demonstrate, and test an integrated landscape management and watershed restoration strategy to achieve ecological and social objectives based in part on historical disturbance regimes for the Blue River watershed (approximately 57,000 acres).

The primary goal is to sustain and restore native habitats, species, and ecological processes while providing a sustained flow of wood fiber for conversion to wood products. The general assumption is that the more future landscapes resemble historical landscapes, the higher the likelihood of retaining native habitats, species, and ecological functions. The focus of the strategy is on restoration and maintenance of ecosystem structure and ecological processes. An extensive monitoring and modeling component designed to evaluate the effectiveness of this approach is documented elsewhere (Blue River Administrative Study Plan, unpublished report on file at Blue River Ranger District 2001)

The goal of watershed restoration activities is to re-establish habitats, species, and processes where feasible so that aquatic ecosystems can function within a range of variability that approximates historical ecosystems in the watershed. The intent is that the spatial and temporal extents of management activities are coordinated as closely as feasible to meet overall landscape and watershed management objectives.

2. Develop and portray the Landscape Management and Watershed Restoration Strategy in sufficient temporal and spatial detail that planning for subsequent projects to implement the strategy can be focused on site-specific issues and conditions.

Future management actions will likely include prescribed fires, timber sales, stream and road restoration projects, reduction of exotic species, wildlife enhancement projects, and silvicultural activities such as reforestation and thinning.

3. Evaluate the effectiveness of this strategy for achieving the objectives of the Northwest Forest Plan.

The presence of the H. J. Andrews Experimental Forest within the watershed provides unique monitoring opportunities. Existing long-term datasets are available for the Andrews and surrounding lands to help evaluate trends within the watershed. In addition, the Andrews landscape itself provides a reference point for comparison with the rest of the watershed where management activities are planned. The 15,700 acre Andrews has had very little manipulation for the last 30 years (since 1970) and very little manipulation is anticipated in the future. Spotted owl demography, stream discharge, and amphibian populations have been monitored across the larger Blue River watershed. Comparison of future habitat patterns with nearby matrix lands, wilderness and large private industrial lands is also feasible. Vegetation and land-use data have been compiled using remote sensing for a much larger study area in the McKenzie and South Santiam watersheds since 1972.

4. Support and facilitate landscape-scale research opportunities.

The strategy described in this document is new and should present numerous opportunities for new research. The ongoing landscape pattern and process research based at the Andrews provides a sound basis for additional work. In addition, much hydrology and stream ecology research has been conducted in this watershed, and the implementation of this strategy should augment existing research opportunities.

C. Central Concept

The central concept of this project is that approximating key aspects of historical fire regimes through forest management practices can sustain native habitats and species, maintain ecological processes within historical ranges, and provide a sustained flow of timber. A premise of this approach is that native species are adapted to the range of habitat patterns resulting from historical disturbance events over the last 500 years, and the probability of survival of these species is reduced if their environment lies outside the range of historical conditions for a prolonged period of time (Swanson et al 1993). Similarly, ecological processes, such as those involved in nutrient and hydrologic cycles, have functioned historically within a range of conditions established by disturbance and successional patterns. Operating outside the range of past conditions may affect these processes in unforeseeable and perhaps undesirable ways. While this concept is largely untested, various projects are exploring this approach in a variety of settings across North America (e.g., Baker 1992, Hunter 1993, Mladenoff et al. 1993, Stuart-Smith and Hebert 1996, Landres et al. 1999).

Historical fire regimes in this portion of the central western Cascades vary over time and space (Teensma 1987, Morrison and Swanson 1990, Weisberg 1996, 1998). General fire regimes have been identified and mapped for the Blue River watershed based upon these studies. As a part of the Landscape Management and Watershed Restoration Strategy, timber harvest and prescribed fire regimes have been set to approximate key parameters of historical fire regimes (e.g., disturbance frequency, severity and spatial pattern) to the degree feasible while still meeting the underlying objectives of the Northwest Forest Plan. These management regime interpretations of past fire regimes reflect mean conditions and do not incorporate the extremes of past fire behavior. For example, very large and intense fires were a part of the historical fire regime, but are not incorporated into future management regimes. In addition, timber harvest frequencies were lowered in comparison with the corresponding fire frequency since unplanned and unsuppressed future fires will likely occur.

Several important qualifications to this approach should be understood. First, existing conditions are far different from historical conditions in many cases (e.g., the presence of roads, clearcuts, and a reservoir). Existing conditions require modification to historical disturbance regime based approaches in order to meet the objectives of the Northwest Forest Plan. And second, the combination of timber harvest and prescribed fire is different from the historical occurrence of fire in ways that can not be replicated in a timber harvest regime (e.g., much lower levels of residual dead wood). Large-scale habitat modifications resulting from past management actions in combination with societal expectations (e.g., that native species be maintained, timber produced, and fire suppressed) limit the degree to which historical patterns can be applied in future management regimes.

Testing these concepts requires ongoing monitoring, evaluation and adjustment programs. Traditional science-based hypothesis testing, using controls and replication, is not feasible for projects of this scale. The monitoring strategy focuses on comparing development of stand and landscape structure under this approach to stand and landscape structure resulting from natural disturbances, and on the consequences of this management approach on key taxa, ecological processes and human uses. Monitoring systems currently in place on and nearby the Andrews provide numerous opportunities to implement the monitoring strategy. Periodic interdisciplinary assessment of monitoring results and evaluation of the need to modify the landscape management strategy is planned.

D. Relationship to Forest Plan, Adaptive Management Area Guide, and NEPA

This document describes the landscape management strategy intended to guide management activities within the Blue River watershed. It is an implementation guide meant to provide consistency and focus to activities in the Blue River watershed that are directed to achieving Central Cascades Adaptive Management Area objectives. The Landscape Management and Watershed Restoration Strategy is based upon concepts developed at the watershed scale. It provides context and guidance to projects so that the underlying concepts are implemented over time. The effectiveness of larger scale monitoring and evaluation depends upon project implementation consistent with the landscape management strategy.

This document is consistent with the Northwest Forest Plan (USDA and USDI 1994). The Blue River watershed and surrounding lands were allocated to the Central Cascades Adaptive Management Area in the Northwest Forest Plan. The purpose of the Adaptive Management Area is to encourage development and evaluation of new approaches to integrate ecological and social objectives, with a specific emphasis on approaches for integrating forest and stream management objectives and on implications of natural disturbance regimes (USDA and USDI p. D-12, 1994).

This document is also consistent with the Central Cascades Adaptive Management Area Strategic Guide. The guide was developed to provide focus and coherence to Adaptive Management Area activities, and to meet Northwest Forest Plan requirements. The Adaptive Management Area guide identifies themes for Adaptive Management Area activities, and suggests potential projects to implement those themes. The Blue River Landscape Study is identified in the guide as a project to meet the landscape management theme, and is summarized in Appendix E of the guide.

This document does not make formal decisions resulting in activities affecting the environment. Decisions that commit resources to management actions will be made at the project-scale. Prior to commencement of any activity potentially affecting the environment a formal NEPA document will be prepared. Environmental analyses under NEPA for projects relying on guidance contained in this document will describe the relationship among the proposed project(s) and this strategy, and incorporate relevant material from this document into the project NEPA document. In particular, cumulative effects analyses for project assessments will incorporate information from this document.

E. Adaptive Management Model

The adaptive management model followed in this study consists of three phases. In the first phase new information is assessed to determine its potential relevance to the landscape management and watershed restoration strategy. These findings are evaluated in the second phase to determine their significance and potential implications, and recommendations for change are identified. Adjustments to the landscape management and watershed restoration 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 sources of new information are assessed in the first phase. 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. Field-based <u>monitoring</u> efforts are a second major mode of learning. 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</u> assessments 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. All of these sources of new information are assessed to determine their relevance, and issues or topics for further evaluation are identified.

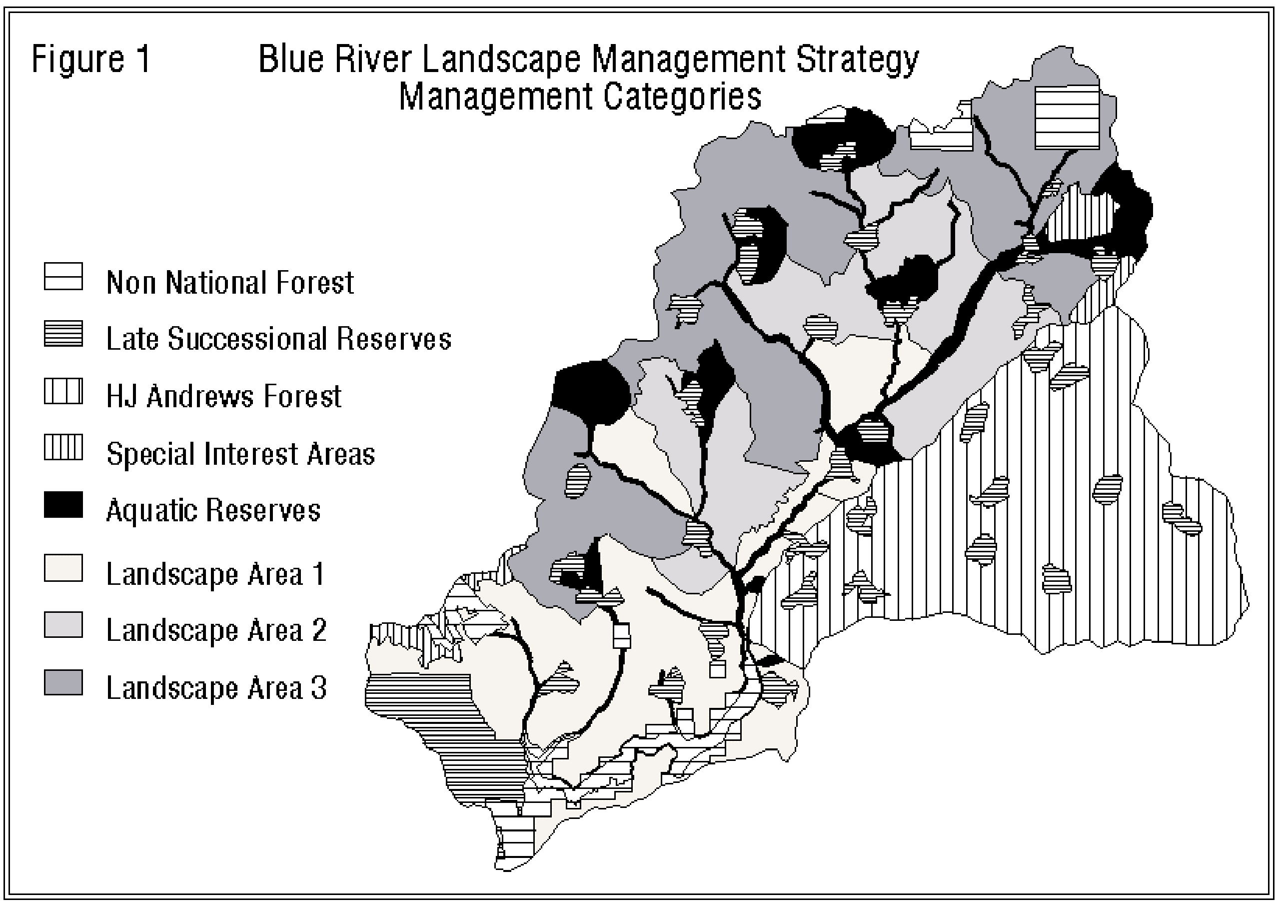
Topics and issues identified in phase one are then evaluated to determine if changes should be made to the landscape management and watershed restoration strategy, or to implementation and monitoring procedures. Small teams of specialists consider the implications of new information, develop options for responding to new information, and make recommendations for change. Options and recommendations are further evaluated through discussions with interested parties during workshops and field tours, and through feedback obtained directly from managers, policy-makers and interest groups through personal interaction. Evaluations and recommendations are posted on the study WWW site (www.fsl.orst.edu/ccem/brls/brls.html) for review. Responsible individuals and teams then document their evaluation and recommended changes.

In the third phase, revisions to the landscape management and watershed restoration strategy, or to monitoring and implementation procedures, are considered if recommendations from phase two indicate a potential benefit to doing so. Forest Service managers and scientists responsible for conduct of the landscape study make the final decisions concerning changes to the study. Changes are documented in an update to the landscape management plan, such as this document, or in monitoring and research plans.

II. Landscape management - vegetation

A. Management categories

The watershed is subdivided into three categories to facilitate landscape management and watershed restoration: special area reserves, landscape areas, and aquatic reserves (Figure 1, Table 1).



Objectives associated with other allocations in the 1990 Willamette National Forest Plan (e.g., visual management and special wildlife habitat areas) will be met or exceeded through the guidelines applicable to each of these categories as described below.

Management Category	**Area (acres)**
Non national forest	3,687
Late-successional reserves	5,299
HJ Andrews Experimental Forest	14,520
Special interest areas	1,191
Aquatic reserves	5,090
Landscape Area 1	10,084
Landscape Area 2	7,573
Landscape Area 3	11,634
Total	**59,078**

NOTE: Categories are listed in order of precedence for acreage reporting purposes; e.g., the area within late-successional reserves in the HJ Andrews Experimental Forest is tabulated under late-successional reserves.

Table 1. Area by management category

1. Special area reserves

Several unique areas allocated to reserves in the 1990 Willamette National Forest Plan, as amended by the Northwest Forest Plan, were kept in a reserve status in this strategy. Reserve boundaries and general management prescriptions in the Willamette National Forest Plan apply for these areas:

- Thirty-five core area reserves associated with pairs of northern spotted owls (100 acres each)
- Hagan Late-Successional Reserve
- H. J. Andrews Experimental Forest
- Carpenter Mountain Special Interest Area
- Wolf Rock Special Interest Area
- Gold Hill Special Interest Area.

2. Landscape areas

Landscape areas are non-contiguous zones of similar ecological conditions and disturbance regimes, based in large part on fire frequency regimes (Weisberg 1998). Vegetation management prescriptions were developed for each zone based on an interpreted range of historical conditions. Landscape areas are expected to provide some level of timber harvest while meeting a variety of ecological and social objectives (e.g., scenic views, functional riparian areas, and unique habitats).

Three landscape areas are mapped, each representing different portions of a complex gradient of ecological conditions and disturbance regimes. The fire frequency map in Weisberg's study (Weisberg 1998) is a primary basis for these delineations. The plant series map, road map, stream map, and topographic maps provided additional information that was integrated with the fire frequency map to form landscape areas. Boundaries are drawn so they can be readily located on the ground.

General prescriptions for each landscape area were drawn from an examination of the fire history (Weisberg 1998) and other analyses documented in the Blue River watershed analysis report, and in the BRLS Adaptive Management – 2000 report (www.fsl.orst.edu/ccem/ccem/brls). Parameters of timber harvest regimes were derived from corresponding parameters of fire regimes. Timber harvest rotation ages (cutting frequency) approximated the frequency of stand- or partial stand-replacing fires for each landscape area. Rotations were lengthened by 20-40 years relative to the corresponding fire-return interval in recognition of the likelihood of an occasional escaped fire. The amount of forest cover retained at the time of regeneration harvest was matched with the interpreted severity of stand- or partial stand-replacing fires in each area. Spatial pattern objectives for each landscape area were developed from analysis of individual fire event sizes, and from the pattern of patch sizes resulting from recurring fires over time within each area (Morrison and Swanson 1990).

The correlation between the desired characteristics of future human-initiated disturbances with past disturbance regimes was general. The intent was to reflect the variability and central tendency of historical fire frequency, severity, and spatial pattern in future management regimes. Variability across the landscape in implementation is encouraged.

Hydrologic analyses were used to evaluate and adjust landscape prescriptions to ensure that the Aquatic Conservation Strategy Objectives will be met. Prescriptions set for areas of potential high susceptibility to rain-on-snow flood events or high contribution to late-summer baseflow were adjusted if necessary to minimize effects to hydrologic processes by management activities. Guidelines for placement of retention trees, location and scheduling of future timber harvests, and the size of future timber harvest blocks were developed considering the sensitivity of the landscape to altered hydrologic functions (see Aquatic Habitat Source Areas).

General objectives were also established for the occurrence of fire. Moderate to high severity fires were replaced in this management approach by the use of prescribed fire following timber harvest activities, and by the anticipated occasional escaped fire. Objectives were also established for low-severity fire in unharvested mature forest through either natural or human ignitions.

General landscape area prescriptions

Vegetation management within each of the three landscape areas is intended to approximate key elements of an interpreted historical fire regime associated with that area. Each landscape area has a general disturbance regime associated with it:

Landscape Area 1: approximate key elements of a relatively frequent, moderate severity (40-60% overstory mortality) stand-regeneration fire regime; dead wood levels are lowest in this area.

Landscape Area 2: approximate key elements of a moderate frequency, moderate-to-high severity (60-80% overstory mortality) stand-regeneration fire regime; dead wood levels are intermediate.

Landscape Area 3: approximate key elements of an infrequent, high severity (>80% overstory mortality) stand-regeneration fire regime, including large inputs of dead wood at the time of stand regeneration.

Key elements of the landscape area prescriptions are displayed in Table 2. Areas termed *landscape blocks* were mapped within each landscape area (Figure 2) in order to link landscape area prescriptions to project-level implementation. Objectives for landscape block size were taken from the objectives for mortality patch size for each landscape area (Table 2).

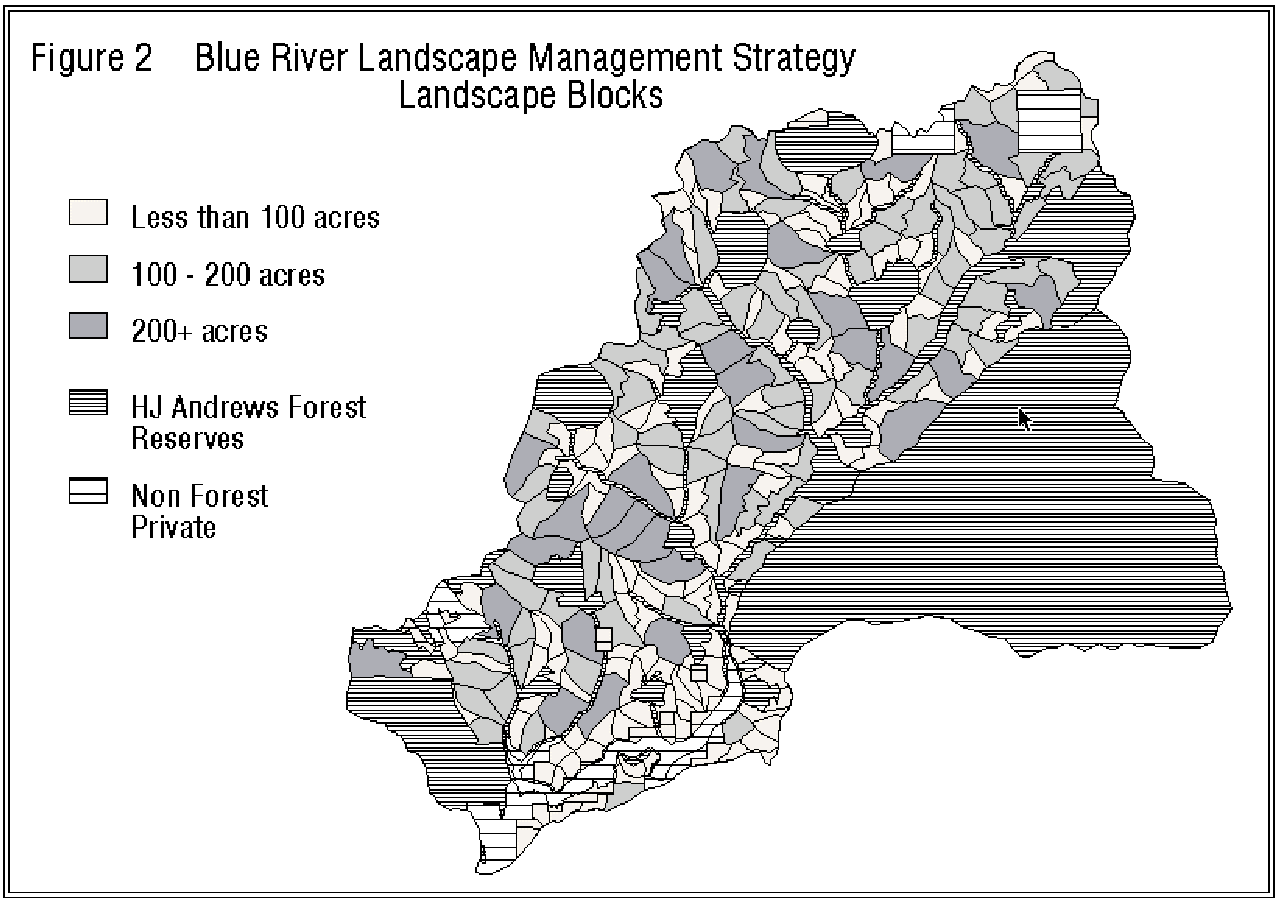


Figure 2 Blue River Landscape Management Strategy Landscape Blocks

Prescription Elements	Landscape Area 1	Landscape Area 2	Landscape Area 3
Rotation age	100 years	180 years	260 years
Area regeneration harvested annually	1.0%	.56%	.38%
Landscape block size (% of area) < 100 acres 100-200 acres 200-400 acres	 60% 20% 20%	 40% 40% 20%	 20% 40% 40%
Retention level (overstory crown closure after harvest)	50%, except 70% within 75' of a Class III stream	30%, except 50% within 75' of a Class III stream	15%, except 30% within 75' of a Class III stream
Post-harvest snag level (proportion of trees >18" DBH in pre-harvest stand)	5%	15%	30%
Post-harvest prescribed fire mortality objective (proportion of trees >18" DBH)	5% (2-10%)	10% (5-20%)	30% (10-50%)
Reforestation density (planted trees per acre)	140	200	400
Reforestation species composition	Shade intolerant species	Shade intolerant species	75% shade intolerant 25% shade tolerant
First thinning (trees per acre - age)	200 tpa - 12-15 yrs.	200 tpa - 12-15 yrs.	200 tpa - 12-15 yrs.
Second thinning (trees per acre - age)	100 tpa - 35-40 yrs.	110 tpa - 40 yrs.	110 tpa - 40 yrs.
Third thinning (trees per acre - age)	60 tpa - 65 yrs.	40 tpa - 60 yrs.	40 tpa - 60 yrs.
Fourth thinning (trees per acre - age)	Not planned	Optional - 80 yrs.	Optional - 80 yrs.
Prescribed underburn frequency	Not planned	Once between year 100 and year 180	Twice between year 100 and year 260

Table 2. Key elements of the landscape area prescriptions

Limitations of approach

Continuation of a general fire suppression policy and goals for economically viable, long-term timber production limit the ability of managers to replicate the historical role of fire. The vegetation management regimes described in this section focus primarily on the role of fire in controlling forest and landscape structure, and secondarily on the process effects of fire itself (e.g., soil heating or nitrogen release). Vegetation management regimes described in Table 2, and the anticipated occasional fire that escapes initial suppression efforts, are intended to develop forest and landscape structure similar to historical landscapes. Variation in the frequency, severity, and spatial distribution of timber harvest is designed into the regimes themselves, and escaped fires will add still greater variability. The process roles of fire are simulated to a degree by the use of controlled fires after timber harvests and after forest stands mature (Table 2), and by anticipated escaped fires. The actual effects of these fires may vary substantially from historical fires. These fires will be less frequent, of lower severity, and smaller in size than those that occurred historically.

A timber management and prescribed fire regime are clearly different than the historical role of fire. These differences are largely unavoidable, but should be considered in the implementation of this strategy. Major differences include:

- Variability - historical fire frequency, severity, size, and spatial pattern were all more spatially and temporally variable than the landscape management strategy.

- Intense fire - the effects of an intense fire are substantially different than the effects of an intense timber cutting followed by prescribed fire (e.g., effects on soil litter).

- Harvest logistics - the use of timber harvest machinery and roads imposes limitations on the resulting opening size, configuration and remaining forest structure.

- Economics - the need to ensure that proposed silvicultural activities are economically viable precludes some forms of low intensity vegetation management.

- Dead trees - a major difference with a timber harvest strategy is that only a small percentage of dead trees remains on the site in comparison with a similar severity fire.

- Frequency of low-severity fires - low severity fires will be significantly less frequent in this vegetation management strategy than they were historically in some areas of the landscape.

- Large patches - the very large patches (thousands to tens of thousands of acres in size) that sometimes occurred historically will not be generated with this vegetation management approach.

Response to Unplanned Disturbances

Changes in future conditions will undoubtedly occur through unplanned disturbances. Small-scale disturbances (e.g., small pockets of windthrow, insect-induced mortality, or small fires) create additional variability and are biologically desirable. Changes in the overall schedule of activities would not generally be necessary, and salvage logging of these small patches of mortality should generally be avoided. Large-scale disturbances should trigger reevaluation of landscape objectives and projected management activities. While the long-term landscape and watershed objectives would likely still be applicable, changes in short-term plans may be appropriate.

For example, a large, severe fire may produce early seral conditions over a significant proportion of the planning area. An appropriate response might be to reschedule timber cutting to delay further regeneration harvests of live forest until the post-fire stands have closed their canopies. Salvage logging of a volume of timber approximately equal to that scheduled to be removed over that time period may be appropriate to maintain projected timber flows. The condition of adjacent areas, both within and adjacent to the Adaptive Management Area, provides important context for this evaluation.

The recommended management response to disturbance would depend upon current conditions and knowledge, and should include consideration of these factors:

- Location of disturbance in the area: For example, if reserves were burned, the landscape blocks may need to be reconfigured to provide new reserves; or it may be desirable to redraw blocks to better align block boundaries with new, post-disturbance edges, if fire occurs in landscape areas where timber harvest is planned.

- Timing of disturbance relative to the block schedule: For example, if a fire occurred relatively close in time to when a block is scheduled to be harvested for timber, the block could be salvaged as a substitute for its scheduled cutting. If timber harvest is not scheduled for many decades, though, it may be appropriate to leave the block unsalvaged to provide patches of dead wood habitat.

- Extent of disturbance: For example, small areas of blowdown may be considered a biological bonus adding diversity to the landscape. Large areas of blowdown may trigger a reevaluation of block configuration and scheduling.

- Condition of surrounding watersheds: For example, burned patches may serve particularly important ecological roles if they are the only patches of high snag densities in the entire watershed.

Ecological functions of burned patches need to be considered if salvage for timber values is contemplated. Relative to natural conditions, managed landscapes are generally characterized by low levels of snags, and especially by the lack of high-density snag patches. Leaving fire-killed patches unsalvaged and maintaining the overall block harvesting schedule may be the most appropriate response to unplanned disturbance in many cases. Unplanned disturbances should also be viewed as opportunities to refine understanding of disturbance processes and patterns, and post-disturbance recovery trajectories.

3. Aquatic reserves

Aquatic reserves (Figure 1) were established to ensure that aquatic habitats and processes are protected, and that management for aquatic features is integrated with upslope management. In particular, the aquatic reserves are meant to ensure that the Aquatic Conservation Strategy Objectives in the Northwest Forest Plan (USDA and USDI 1994) will be met. Aquatic reserves were considered after the general landscape management strategy was established so that the need for additional reserves could be considered in light of likely future management actions. The pattern of aquatic reserves was based in part upon the likely frequency, severity, and spatial pattern of future timber harvests, the context of the surrounding watershed, and the degree to which the landscape has been altered by past, intensive human use (e.g., dams, roads, timber cutting). Stream type (fish-bearing, perennial or intermittent) and geomorphic setting (gradient, constrained or unconstrained valley segment type) set the context for reserve decisions.

Small-basin reserves were established to meet aquatic conservation objectives and to provide contiguous blocks of undisturbed habitat. Reserves were dispersed throughout the watershed and across elevation zones in locations of highest aquatic habitat diversity. In particular, reserves were placed in headwater locations thought to benefit the Cascade torrent salamander (a species thought to be limited in distribution and particularly sensitive to management activities), around important stream junctions, and in locations with a high potential to contribute wood and other materials to streams through mass soil movements. In addition, reserves encompass and adjoin Late-Successional Reserves associated with pairs of spotted owls with the highest reproductive rates, and those located in areas with the highest concentration of late-successional habitat.

Aquatic reserves also took the form of riparian corridors along both sides of all fish-bearing streams. The corridor reserves were essentially linear, and occupy the entire valley bottom and adjacent toe-slopes. These corridors connect aquatic and riparian areas throughout the basin and link with the small-watershed reserves. Along Blue River a streamside reserve was delineated to run from Road #15 on the northwest to two tree-heights on the southeast side of the river. One tree-height reserves along constrained channels (most of the fish-bearing streams), and two tree-height reserves along unconstrained segments were designated for all other fish-bearing streams.

Management objectives for aquatic reserves are to maintain or establish late-successional forest conditions. These reserves are intended to serve as intermediate-scale refugia in a landscape where timber harvest is occurring. Management guidelines for aquatic reserves should be similar to those in the Northwest Forest Plan. Small-basin reserves are meant to be managed similar to Late-Successional Reserves, while corridor-reserves should be managed similar to Riparian Reserves in the Northwest Forest Plan.

Reserves are generally intended to provide late-successional habitat. Low-severity fire (0-30% mortality) may be prescribed in reserves where operationally feasible, and where there are no unacceptable risks to other values. The primary goal is to reduce fuel loadings and lower the probability of high-severity fires in the future. Low-severity fire (1-10% mortality) in aquatic reserves may also be appropriate on sites where fire has substantially influenced plant communities in the past (higher fire frequencies) and there is no significant risk to ecological processes or existing communities. Fire may also be appropriate in aquatic reserves to better integrate upslope and riparian habitats, and to induce a range of seral conditions more closely resembling historical conditions. Prescribed fire is a higher priority in reserves with high-frequency fire regimes where fuel loads can be reduced with low risk of accidental escalation of fire severity. Lack of road access may substantially increase costs of treatment and reduce options for fire ignition, holding, and mop-up tactics in some reserves.

B. Aquatic habitat source areas

Streams within the watershed were further evaluated to identify reaches with high aquatic habitat value or potential value. The majority of the streams in the Blue River watershed have high channel gradients and flow through narrow restricted valleys with little floodplain area. These streams possess a great deal of power and regularly transport large wood and coarse sediment downstream. Most of these streams have little opportunity to store these materials, or to use them to develop complex channels.

Areas with the highest potential to store large wood and coarse sediment were identified by evaluation of valley shape. Stream segments that flow through terrain with valley gradients approximately 3 percent or less were identified by evaluation of valley gradient on topographic maps. This process identified stream reaches that had both unconstrained valley forms and relatively gentle valley gradients, where reduced stream power increases the ability of the stream to store and use large wood and coarse sediment.

After high-value stream reaches were identified and mapped, the surrounding landscape was evaluated and source areas for coarse sediment, large wood, nutrients, and abundant cool stream flows were identified.

Criteria used to identify landscape blocks that contribute coarse sediment and large wood included blocks that had substantial areas prone to land sliding, or blocks with areas situated on earth-flow terrain. Landslide potential was based on steepness of terrain and the presence of shallow soils. The rationale was that slope failure is a natural process for the recruitment of large wood and coarse substrates into these systems. Consequently, management to retain large wood on areas susceptible to failure will insure that large wood will be input to the system along with sediment.

Groupings of blocks with the characteristics needed to provide coarse substrate material and large wood that are located upstream of the low gradient reaches were identified as substrate source areas, and management prescription elements were developed. These source areas were mapped in relation to the locations of the low-gradient stream reaches, and those areas that could be linked to downstream low gradient reaches were identified. Prescriptions were developed for these areas to maintain and restore their ability to produce the materials needed downstream to facilitate the development and retention of desired habitat features in the low-gradient reaches.

Criteria used to identify landscape blocks that provide nutrient inputs to the system focused on blocks with substantial wetland habitats. Most wetlands in the Blue River landscape are hardwood dominated, and provide substantial amounts of leaf litter to these streams. Blocks that met this criterion were identified visually by comparing a block map with a GIS overlay of wetland areas in the watershed.

Criteria used to identify landscape blocks that provide substantial quantities of cool water included those blocks that have a relatively high contribution to base flows during the summer period. These blocks were identified by examining a GIS generated map of the watershed that rated the landscape into high, medium, and low potential, based on characteristics of aspect, elevation, precipitation, and soil depth. The presence of wetlands also indicates an ability to provide substantial flows of cool water, so blocks that possessed either or both of these traits were selected as candidate source areas for cool water.

Groupings of blocks with the characteristics needed to provide nutrients and abundant cool water that are located upstream of the low-gradient reaches were identified as water quality source areas, and management prescription elements were developed. These source areas were mapped in relation to the locations of the low-gradient stream reaches, and those areas that could be linked to downstream low-gradient reaches were identified. Prescriptions were developed for these areas to maintain and restore their ability to produce the materials needed downstream to facilitate the development and retention of desired habitat features in the low-gradient reaches.

C. Landscape Blocks

Landscape blocks were delineated in the three landscape areas where future timber harvest is prescribed. These blocks are the units used for prescribed fire and timber sale planning and implementation, and as scheduling units to project future landscape conditions.

Landscape blocks are management units representing the spatial locations of future stands created through timber harvest and subsequent forest regeneration. The same general age-class structure will prevail within a block after timber harvest, but the spatial patterning and composition may be quite variable. Objectives for individual landscape areas provided specific guidance for the range of landscape block sizes, and for the spatial distribution of the blocks. Landscape blocks range in size from tens to hundreds of acres, and may be further subdivided into operational units, such as cutting units, to implement management activities. Existing stand conditions may be quite variable within a block, ranging from very young plantations to old growth.

Landscape blocks (Figure 2) were mapped according to the landscape area objectives for block sizes and spatial distribution, and the following mapping criteria:

- Use existing large patches of a similar structural stage wherever possible. Rationale: large patches with interior forest habitat are the most critical, since they are hardest to establish and maintain.

- Use ridges and streams for boundaries whenever feasible. Rationale: they are definable on the ground and are relevant to ecosystem processes and operational realities.

- Delineate blocks stream to stream, rather than ridge to ridge, where applicable. Rationale: spreads management effects over more than one drainage area, and increases stability of riparian areas by having a mature forest bordering riparian zones on at least one side.

- Use roads as boundaries where feasible, if ridges and streams were not feasible. Rationale: roads are definable on the ground and influence habitat conditions through edge effects.

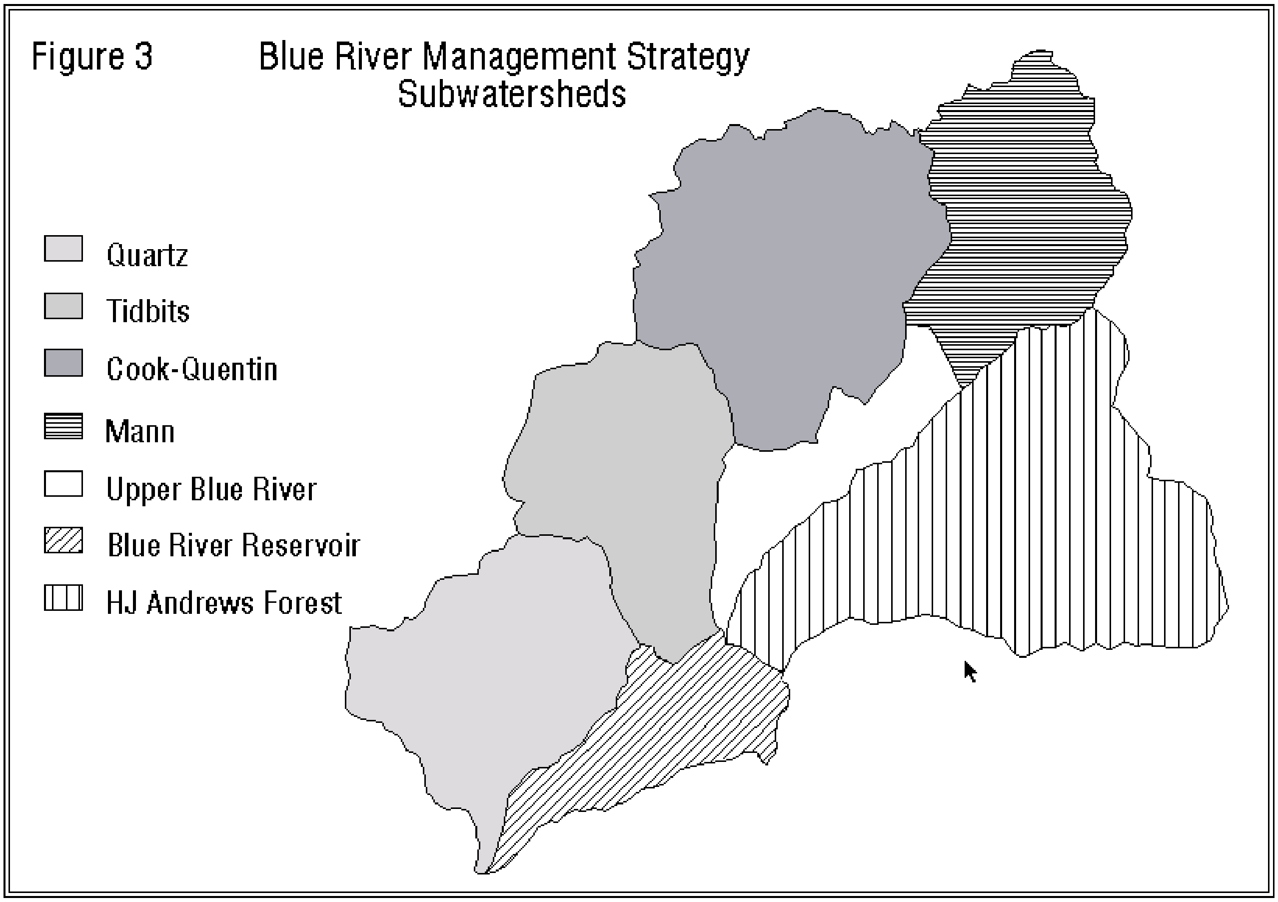
- Delineate blocks to include similar landforms where feasible. Rationale: landforms substantially influence disturbance processes and environmental conditions.

- In Landscape Area 3 (where retention levels are relatively low) include no more than 30% of the boundary of a Late-Successional Reserve as a landscape block boundary. Rationale: will minimize edge impacts to a given Late-Successional Reserve during any given period of time.

- Place smaller blocks in more visually sensitive areas around Blue River Reservoir. Rationale: degree of perceived change in the landscape is less with smaller blocks.

D. Timber Harvest Scheduling

Timber harvest scheduling will be controlled at two scales: landscape blocks and subwatersheds. Landscape blocks are the basic scheduling units. These blocks roughly correspond in size with the size of individual mortality patches from past fires. Subwatersheds are large areas roughly corresponding in size with the outer perimeter of many past fire events. Six subwatersheds or subwatershed aggregates are defined for scheduling purposes: Quartz, Tidbits, Cook-Quentin, Mann, Upper Blue River, and Blue River Reservoir (Figure 3, Table 3).



Subwatershed	Area (acres)
Quartz	8,492
Tidbits	7,643
Cook-Quentin	11,685
Mann	7,373
Upper Blue River	3,758
Blue River Reservoir	4,388
Lookout Creek	15,739
Total	59,078

Table 3. Area by subwatershed

At the watershed scale, the general approach is to group harvest blocks within one or two subwatersheds in a given time period (40 years) over most of the upper watershed, and disperse harvest blocks over time within the Quartz, Blue River Reservoir, and upper Blue River subwatersheds. Harvest blocks should be scheduled in Mann and Tidbits subwatersheds in the first 40 years, then in Cook-Quentin subwatersheds for the next 40 years, and then continue alternating in a 40-year pattern. This approach produces a pattern of disturbance and habitat more similar to the temporally variable pulse pattern of natural ecosystems while postponing significant disturbance in subwatersheds that are contributing the best aquatic and late-successional habitat currently. Grouping harvests within one or two subwatersheds in a given time period roughly approximates the scale of many past fire events.

Within a subwatershed where timber harvest occurs, blocks selected for harvest will match the desired size of landscape blocks given in the landscape prescriptions and be dispersed within the subwatershed. Individual landscape blocks where harvest will occur roughly simulates the size of past fire-induced mortality patches. In addition to approximating aspects of past fires, this approach concentrates disturbance and habitat loss on relatively few spotted owl pairs at any one time, provides meso-scale refugia by not scheduling harvests in broad areas for an extended period of time, and creates opportunities for large-area road closure strategies in conjunction with extended post-harvest recovery periods (see section IV. Road restoration).

Within the Quartz, Blue River Reservoir, and upper Blue River subwatersheds, harvest of landscape blocks will be regularly dispersed through time and space. The intent of this strategy is to disperse the visual effects of timber harvest throughout the area seen from the heavily-used areas around Blue River, the Blue River Reservoir, and Road #15.

The following additional criteria are meant to guide specific scheduling choices:

- No more than one block adjacent to a given Late-Successional Reserve should be cut in a given time period (20 years). Rationale: avoids rapid changes in habitat and edge conditions in close proximity to spotted owl nest sites.

- No more than 25% of the area in the "high" rain-on-snow susceptibility zone (Figure 4) should be cut in a given time period in Ore, Cook and Quentin landscape subwatersheds. Rationale: avoids concentration of timber cutting in areas potentially susceptible to harvest-induced increases in peak stream flows.

- Schedule initial cuttings in blocks that are currently the most fragmented. Rationale: retains existing large blocks for the maximum potential time, and establishes the desired landscape pattern most quickly by creating larger blocks where fragmented conditions currently exist.

- Delay cutting of a landscape block that is adjacent to blocks containing large openings. Rationale: since spatial pattern objectives are designed directly into the landscape block pattern itself, cutting a block next to existing openings would create an opening larger than that described in the landscape objectives.

- Schedule block harvests so that the mix of block sizes cut in any 20-year time period is roughly proportional to the prescribed mix of block sizes within that landscape area. Rationale: ensures that the desired range of block sizes is present at all times.

E. Prescribed fire

Low-severity fire (0-30 % mortality of overstory trees) is included in landscape prescriptions to help maintain ecosystem processes and historical plant and animal habitats. Fire exclusion is inconsistent with one of the stated goals of this project - to sustain ecological processes - since fire itself is an ecological process that has historically played a significant role in this landscape. The absence of fire may be affecting ecosystems in both known and unknown ways. Effects of fire exclusion may become more obvious as the length of time fire suppression has been in force approaches or exceeds historical fire return intervals. Since fire suppression is expected to continue as a basic policy governing response to unplanned fires, prescribed fire provides opportunities to restore fire to the landscape. Habitats and ecological processes are expected to more closely resemble historical conditions where fire is restored. While many direct effects of high-severity fire are well-known, knowledge of the influence of fire on habitats and other ecological processes is incomplete, especially for low- and moderate-severity fires. Effectiveness monitoring is necessary to evaluate prescribed fire effects. Goals for prescribed fire are to:

- Kill a proportion of overstory trees to create snags and future down wood.
- Reduce fuel loading and fuel ladders lowering the probability of future high-severity fire.
- Stimulate herb and shrub growth by increased light levels, an initial flush of nutrients, and seed germination.
- Provide horizontal heterogeneity to understory habitats.
- Provide a mix of fine-scale habitats similar to historical conditions following low-severity fires.
- Provide research and monitoring opportunities to study the effects of low-severity fire on plants and animals under a variety of stand structures.

The degree to which each of these objectives is applicable depends upon the overall management category the site lies within, the timing and spatial extent of projected management activities on and nearby the site, and site-specific conditions (e.g., stand structure, fuel loading, levels of snags).

Timber management and harvest is expected to occur in each landscape area. Prescribed fire should be scheduled and planned to complement timber management activities and minimize avoidable conflicts where feasible. Low-severity fire is prescribed both in conjunction with scheduled regeneration timber harvests, and later in the rotation when trees are more resistant to potential fire damage. Prior to an age of approximately one hundred years old fires may cause high levels of mortality to overstory dominants, and interfere with early stand silvicultural activities (e.g., precommercial and commercial thinnings).

As a part of the long-term prescriptions, low-severity fires were prescribed to occur one or two times between age one hundred and the timber harvest rotation age (180-260 years depending upon landscape area). Where blocks are not scheduled for cutting for several decades, fire should be planned in Landscape Areas 2 & 3. Natural post-fire recovery processes can then occur for several decades prior to timber harvest. The goal is to create 10% mortality of overstory trees, within an acceptable range of 5-15% mortality.

III. Landscape block management

This section provides guidelines for management at the scale of individual landscape blocks where prescriptions are developed.

A. Spatial pattern of retention trees

These guidelines are intended to help translate spatial objectives for retention of live overstory trees at the time of timber harvest from the landscape level to the stand level, and to provide a basis for evaluation of the landscape plan. The intent is to create a variable pattern of retention trees within landscape blocks. Final placement of retention trees should integrate these criteria and fit on-the-ground conditions assessed at the time of timber sale planning. To the degree allowed by the need to protect ecological values, spatial patterns of retention trees should use site-specific disturbance patterns as a general template.

Designation of retention trees along edges of cutting blocks should be designed to 1) minimize edge contrast, 2) avoid sharp boundaries with high wind throw potential or abrupt microclimate shifts, 3) emulate common post-fire patterns, and 4) maintain nutrient uptake capacity across the hillslope down to the riparian zone. Hardwood trees should generally be left standing where feasible, but are not considered part of the retention tree component of these prescriptions.

Overall guidelines:

1. Retention trees should be both clumped and scattered individuals. Retention trees should be left out of some areas to create gaps.
2. Clumps should range in size from _ acre to 5 acres.
3. Rock outcrops, wet areas or other special or unique habitats can be used to locate retention clumps.
4. Larger blocks should have larger clumps.
5. Scattered individual trees can range from 40% to 70% of the total number of retention trees (see Appendix for examples).
6. Retention trees should include the largest, oldest live trees, decadent or leaning trees, wolf trees, and hard snags.
7. Retention tree species mix should meet the goals outlined in the Appendix.
8. Spatial patterns of retention trees should consider the structure and timing of future cutting in adjacent blocks, and minimize edge contrast where feasible.
9. There should be gaps in each landscape block based on the goals for each landscape area. Landscape Area 1 should have twice as much area in clumps as gaps. Landscape Area 2 should have the same area in clumps and gaps. Landscape Area 3 should have twice as many gaps as clumps.

10. Minimum size of gaps is one tree height by one tree height. This will allow for removal of trees and for understory regeneration.
11. Small landscape blocks should have relatively smaller gaps and large landscape blocks should have larger gaps.
12. When unsuited or unavailable lands occupy a significant portion of the landscape within a block it may be appropriate to reduce the general target green-tree retention guidelines (see section titled ”Land Unsuited or Unavailable for Timber Management”).
13. When a significant portion of the landscape block is currently in a clear-cut, or young conifer plantation that will not be harvested in the first entry, it may be appropriate to increase the overall green-tree retention level for the remainder of the block.

Riparian guidelines:

1. No trees should be cut on any floodplain or streambank, nor should trees directly contributing to streambank stability be cut.
2. Higher levels of retention should generally be located near streams and lower slope positions. Lower levels of retention should generally be located on upper slope areas.
3. Fish-bearing streams are mapped as reserved areas. The distance of the reserve depends on whether the channel is constrained or unconstrained. The trees left within this distance do not count towards the prescription retention levels.
4. Non-fishbearing perennial streams are not mapped as reserve areas but have an additional retention requirement within a half tree height of the stream, as follows:

Landscape Area 1	70% canopy retention
Landscape Area 2	50% canopy retention
Landscape Area 3	30% canopy retention

   These retention levels are prescribed to meet the Aquatic Conservation Strategy objectives, and do not count toward overall prescription retention levels.

   In areas identified as water quality source areas, 70% canopy closure will be retained on all perennial streams with substantial flow within one site potential tree height (172 feet) buffer. On streams flowing east-west, the entire buffer will be situated on the south side of the stream. On streams flowing north-south, the buffer will extend for one half site potential tree height on each side of the stream. These additional trees do not count toward overall prescription retention levels.

   On streams within earthflow terrain, or within areas of glacial deposits on potentially unstable earthflow terrain retain a one-site tree no-harvest buffer. This will maintain a supply of large wood while maintaining stability and retention of fine sediments. These additional trees do not count toward overall prescription retention levels.

5. A portion of the overall retention trees should be placed near intermittent streams. 50% canopy closure should be retained along these streams in Landscape Area 1, 30% canopy closure in Landscape Area 2 and 15% canopy closure in Landscape Area 3.

Where intermittent streams flow through earthflow areas, a _ to full site tree no-harvest buffer is prescribed. This will maintain a supply of large wood while maintaining stability and retention of fine sediments. These additional trees do not count toward overall prescription retention levels.

A portion of the clumps prescribed for Landscape Area 3 should be retained adjacent to intermittent streams. For every 1000 feet of stream reach approximately _ acre of 100% canopy closure would be retained to provide for riparian and terrestrial processes. The extra trees provided will count toward overall retention levels.

6. Retention trees and clumps should be placed on sites of potentially unstable ground, and on localized areas adjacent to streams prone to streamside slides, to the degree needed to minimize mass movement risks.

7. If on-the-ground conditions indicate that higher levels of retention trees are needed to meet ecological objectives, prescriptions should be modified accordingly. Similarly, reductions in retention levels may be appropriate in some instances to improve operational feasibility, as long as ecological objectives are met.

B. Dead wood

Provision for standing and down dead trees should be included in prescriptions to ensure habitats and ecological functions associated with dead wood (e.g., storage of carbon and water, nitrogen fixation). Levels of dead trees to be left or created at the time of regeneration harvests are in addition to the green tree retention levels; long-term replacement dead trees can be obtained from the green tree retention levels. Levels of dead trees are intended to vary across landscape areas reflecting variable disturbance frequencies.

Detailed, integrated prescriptions for snag and down log management should be prepared as part of the prescription process during project planning, and revised after stands have been monitored for the first few years following logging.

Regeneration harvests

Snags

The intent is to create patterns of snag habitat in a managed landscape that represent patterns created through historical and natural landscape dynamics as closely as feasible given other management objectives. Fire suppression and timber harvest greatly complicate efforts to achieve this goal. The objective for snag management is to provide pulses of snags in proportion to the severity of the disturbance when regeneration harvests occur. The frequency and severity of regeneration harvests vary by landscape area, as prescribed elsewhere. All existing snags >20” in diameter must be retained where safety allows. In addition, the following amount of live trees should be left from the pre-harvest stand for short and long-term snag habitat:

Landscape Area 1 (moderate frequency/low severity)	**5%**
Landscape Area 2 (low frequency/moderate severity)	**15%**
Landscape Area 3 (very low frequency/high severity)	**30%**

Trees to be left for snag habitat should be calculated, prescribed and designated in three diameter classes (18-24", 24-30", and 30"+) and four species groups (Douglas-fir, western hemlock, western redcedar, and noble fir/Pacific silver fir) in proportion to their representation in the pre-harvest stand where feasible. Data limitations and other site-specific factors may preclude use of all size classes or species groups.

If snags are not present in the prescribed amounts following logging and prescribed fire, green trees will be killed to provide future snags. Only decomposition class one and two snags are to be counted towards the prescribed totals.

A variety of methods should be used to create snags, including prescribed fire, girdling, topping and inoculation to ensure snags will be created through time, and through natural processes when feasible. Prescribed fire is to be the primary method for snag creation where feasible (see prescribed fire section). Additional snag creation activities should be delayed for a few years post-harvest to allow time for initial mortality from the harvest and prescribed fire.

Down wood

High densities of standing trees left either as green trees or as snags will result from treatments in all three landscape areas, leading to significant and variable levels of down logs across the watershed and across time. All existing down wood of decay class III or greater will be retained in place. To ensure an immediate input of sound down wood, **at least three sound trees per acre** will be placed on the forest floor by five years following harvest activities. Placement can occur through blowdown or other natural process, or by management activity.

Attainment of this objective should be evaluated three-four years after timber harvest to allow time for down wood resulting from initial blowdown or prescribed fire to occur. Results from monitoring activities should be consulted to help determine likely rates of tree fall from retention trees (Adler, Busby in press). Additional activities to create down wood necessary to meet this goal should be planned and implemented following this evaluation.

Sound trees felled to create down wood should come from the largest size class of trees left on site by tree species group in proportion to the stand composition post-harvest.

Prescribed fire

Fire is prescribed following regeneration harvests to meet a number of objectives, including creating mortality for snag and down wood habitat. Objectives for mortality created through prescribed fire are expressed as the percent of live trees 18" dbh and greater remaining after harvest. Variability in mortality patterns is expected and desired. Objectives are as follows:

	Target	*Acceptable Range*
Landscape Area 1	**5%**	**2-10%**
Landscape Area 2	**10%**	**5-20%**
Landscape Area 3	**30%**	**10-50%**

Safety considerations may require that fire not be used in a given unit.

Intermediate harvests

Snags

Commercial thinning may be planned one or more times between the ages of 40-100 years in all three landscape areas. Thinnings occur in a stage of stand development when high levels of competition-induced mortality are common. Snags may be abundant in smaller size classes, although snag mass may be relatively low. Thinnings complicate the natural development and maintenance of snags by removing snags considered safety hazards to the logging operation, removing trees likely to die in the future, and by mechanical damage to snags and residual trees. In addition, one of the goals of thinning is to promote development of bigger trees for future snag habitat.

The intent of snag management with these intermediate harvests is to provide snag habitat during this stage of stand development using the larger trees (>14” dbh, if available) in the cohort prescribed for thinning. Objectives for large snag density are relatively low at this stage of stand development to minimize loss of the very trees that will provide live and dead big tree habitat in the future. The goal is to provide **at least two snags per acre** from the largest trees in the thinned cohort for each thinning up to the last commercial thinning. If it is anticipated that no future thinning will be prescribed then the goal is to provide **at least four snags per acre** from the largest trees in the thinned cohort. Snags in older age classes left from the previous stand do not contribute to this goal.

Post-thinning monitoring will be conducted three to four years after thinning and used to establish the amounts and types of snag creation needed to meet these goals. Trees to be treated for future snags should be taken from the largest size class (>14” dbh, if available) in the thinned cohort, and distributed within that size class in proportion to the diameter distribution post-thinning. Use of a variety of snag creation methods is desired, including some that result in delayed mortality.

Down wood

Trees should be felled to create down wood during all commercial thinning entries at a rate of **three per acre**. Felled trees should come from the largest size class (>14” dbh, if available) in the thinned cohort in proportion to the species and diameter distribution that exist post-thinning.

Underburns

Underburns are prescribed forty to one hundred years following the last commercial thinning in Landscape Areas two and three. One of the goals of the underburns is to create mortality for snag and future down wood habitat. Objectives for mortality created through underburns are expressed as the percent of live trees 18" dbh and greater on site prior to the fire. Variability in mortality patterns is expected and desired. Objectives are as follows:

	Target	***Acceptable Range***
Landscape Area 2	**10%**	**5-15%**
Landscape Area 3	**10%**	**5-15%**

Safety considerations may require that fire not be used in a given unit.

C. Commercial thinning

Harvest areas

A moderate first thinning entry provides a balance between volume, time to late-successional habitat, and risk of blowdown. The stand is opened up enough to promote development of crowns, diameters and root systems. This will reduce the risk of blowdown when the stand is opened up to promote development of the second cohort at age 60.

In areas with a low risk of blowdown, a heavy first thin would be an option that accelerates development of late-successional habitat, but at a significant cost to overall volume production.

Deferred harvest areas

The main concern in these areas is limiting the number of entries over the 40 year deferred harvest period. The option of skipping one or two thinning entries in dynamic young stands involves some tradeoffs. Not thinning at age 40 and/or 60 can produce good overall volumes, including the maximum. However, the stand becomes very dense, with small crowns and small diameters. After delaying entry, the first thin can have a high risk of blowdown, and care must be taken during the planning process so as not to exacerbate the risk. These prescriptions should be used in combination with other choices to produce relatively long periods (ten years or more) of quiet within the refugia. This means that some stands will have a thinning at age forty, and some will be thinned at ages older or younger, so that periods of disturbance are minimized (perhaps three entries over the 40 year interval). These changes will affect volume production, risk of blowdown, and the time it takes to reach late-successional habitat, but the impact should be relatively minor.

Another consideration for stands in deferred harvest areas, is whether they originated as a result of natural disturbance or management activities.

Managed stands: These stands have been impacted by past harvest, burning of slash, reforestation, precommercial thinning, etc. Unnatural conditions resulted from planting heavily to insure regeneration within five years as required by law. A commercial thinning entry is a relatively small disturbance compared to what the site has been through.

Natural stands: These stands most commonly originated after a stand replacement fire, and regeneration took place over a longer time period and with a significant brush component. Stocking levels were generally much lower, and stands may not have gone through a stem exclusion seral stage. These stands should be evaluated on a case by case basis to see if a commercial thin is desired. Stand characteristics like stocking level, structure, species diversity of the overstory and understory, and canopy height diversity should be considered. Other factors include the existing road network, stream conditions, and how long until the scheduled regeneration harvest for the block. The main reason for commercial thinning is to accelerate the development of late-successional habitat, and maintaining it for a significant period of time.

D. Regeneration harvests

Retention species mix

The species mix of retention trees should reflect a range of conditions that approximates a range that might be expected following a fire of similar severity. In the absence of better information, the species mix of retention trees can approximate the current mix of dominant and codominant trees in the overstory of the stand that is being harvested.

Reforestation species mix

The main concern is for maintaining Douglas-fir and introducing rust-resistant western white pine in these stands. Western white pine is also more shade tolerant that Douglas-fir, and should do well in Landscape Area 1 and 2. Western hemlock and western redcedar are expected to seed in naturally over time and grow well under the relatively heavy overstory. Planting is not required and the genetic program is not as advanced as for Douglas-fir and white pine. The guideline is to plant Douglas-fir and white pine to ensure their presence in Landscape Areas 1 and 2. Planting will take place in the gaps and matrix only. Total trees to be planted will average 140 per acre in Landscape Area 1 and 200 per acre in Landscape Area 2 (75% DF and 25% WP), and will be somewhat variable with more being planted in gaps and less in the matrix. Spacing will range from 12 feet in the gaps to 20 feet in areas with 30-40% crown closure.

Configuration of gaps and clumps

The ratio of clumps to gaps will generally be 2:1 in Landscape Area 1. This will allow the overall block to average 50% canopy closure, while the matrix will average 40% or less. This is based on modeling with Organon that showed Douglas-fir could survive and grow relatively well at 40% crown closure, but tended to drop out of the stand at 50% or more. Western white pine, being a little more shade tolerant, should also do well.

E. Prescribed fire

Low-severity fire (0-30 % mortality of overstory trees) is included in landscape prescriptions to help maintain ecosystem processes, and plant and animal habitats. The degree to which these objectives are applicable depends upon the overall management category the site lies within, the timing and spatial extent of projected management activities on and nearby the site, and site-specific conditions (e.g., stand structure, fuel loading, levels of snags).

Site-specific analysis will be needed to determine locations where fire can be prudently used. Stand conditions, fire history, wind patterns, potential fuel breaks, slope position, aspect, and elevation all need to be considered. Some areas will not be suitable for prescribed fire due to operational and safety reasons. In areas where timber management is prescribed, landscape blocks are intended as operational units and should provide a basis for site-specific planning for prescribed fire. Where feasible, the upper boundaries of a block were placed along ridgelines or roads to help establish safe fire lines. Scheduling of areas selected for burning can create firebreaks and increase fire suppression effectiveness. Consider scheduling prescribed fire events to obtain varying sizes of burns distributed across the landscape.

Prescribed fire should be planned at the scale of the individual landscape block when regeneration timber harvests are planned for that block. Fires should be prescribed to reduce activity created slash where needed as well as meet the above goals. Age of existing stands should be 100 years or greater to assure limited overstory mortality. Blocks should be scheduled for the next vegetation management activity should be at least 40 years out. Burn activity can be scheduled to coincide with the last thinning activity. Prescribed fire may also be scheduled to occur simultaneously on sites that will not be harvested within these blocks (e.g., on soils unsuitable for timber harvest, see subsection F. Land unsuited or unavailable for timber management). In neither case are prescribed fires intended to significantly reduce the soil litter layer. Monitoring of fire effects from burning may indicate seasonal response differences in flora and fauna and modify timing and intensity prescriptions for underburns. Site-specific analysis should ensure that unique or rare plant and animal communities are not adversely affected. Existing plantations should be protected from prescribed fire.

F. Land unsuited or unavailable for timber management

Land not appropriate for long-term timber management occurs in some landscape blocks where timber harvest is scheduled. These areas could include soils deemed unsuitable for timber management based upon regeneration or slope stability criteria, areas not intended for long-term timber management based upon specific plant or wildlife habitat objectives (e.g., the Willamette National Forest Special Habitat objectives or for Threatened or Endangered species), or other site-specific reserves needed to meet the Aquatic Conservation Strategy Objectives. Inclusions of land not intended for long-term timber management should be identified and mapped during site-specific timber sale planning. Identification of inclusions should consider the size and spatial extent of inclusions within the landscape block as well as the prescription for the corresponding landscape area. For example, the frequency and intensity of timber harvest or prescribed fire intended for that landscape area may help determine whether long-term timber management is appropriate.

Managed disturbances may be appropriate in some inclusions in conjunction with timber harvest or prescribed fire scheduled in the remainder of the landscape block. In many cases fires historically burned through these areas in a similar fashion as in adjacent forests and have been an important factor shaping plant community dynamics. Absence of disturbance has resulted in development of closed-canopy forests in some areas where more open conditions were common in the past. Trees may be felled and fire prescribed within these inclusions to provide more open conditions, create more natural environmental gradients, or for other reasons, but not for the purpose of providing timber products. The decision to leave or remove felled trees in these areas should be made at the project level within the context of the overall prescription for the landscape block. The overall intent is to create conditions more typical of historical disturbance regimes, and to integrate these areas with surrounding lands.

Inclusions are separate from green-tree retention areas. Green tree retention objectives are meant to apply to the remainder of the landscape block where timber harvest is prescribed. Green tree retention marking guidelines should leave densities of retention trees near these inclusions that create a gradient of environmental conditions from the inclusion into the landscape block where feasible. Densities of retention trees near the inclusion may be lower or higher depending upon the prescription planned for the inclusion.

Where these inclusions occupy a significant portion of the landscape block it may be appropriate to reduce the general target green-tree retention level over the remainder of the block. The conditions of the landscape block and the general prescription for the landscape area provide context to help determine if adjustment of the retention tree level objective is appropriate. For example, it may be more appropriate to adjust retention tree levels downward where the overall retention objective is relatively high, or where there are few streams or unique habitats. Similarly, where a significant portion of the landscape block is currently in a clearcut, or young conifer plantation, it may be appropriate to increase the overall target green-tree retention level over the remainder of the block for the first timber harvests in the block under this strategy. The objective in either case is to create a disturbance pattern that approximates past general fire mortality patterns according to the goals for the landscape area.

G. Aquatic habitat source area management

Prescription elements to be applied in substrate source areas include:

- Fifty percent retention of evenly spaced mature or older trees within blocks designated as substrate source areas.

- Leave tree retention density along streams within substrate source areas will be those designated for that landscape area.

- Retention trees should not be allocated from elsewhere in the block, but in addition to the green tree retention a described for that landscape area.

- Active earth flows are identified and dropped from the timber base.

- Within landscape blocks where Quaternary earthflow terrain or glacial deposits occur adjacent to perennial and intermittent streams there will be a one-site tree height, no-harvest buffer.

- Depending on the feasibility of harvesting operations and topographic characteristics, no-harvest buffers may vary in width. Where possible the entire toe of the earth flow should be deferred from harvest in order to maintain the source of large wood.

- Use of prescribed fire is consistent with the objectives of the substrate source areas, as it will not eliminate large wood, and may introduce some variability in the decay status of the retained trees.

Prescription elements to be applied in water quality source areas include:

- No road construction, ground skidding, or other activity with the potential to affect surface and subsurface water flow should be permitted within two site-potential tree heights of wetlands, unless site specific analysis indicates that surface and subsurface flows will not be affected.

- All non-fishbearing perennial streams with substantial flows will have a one site-potential tree height buffer where at least 70% canopy cover will be retained. On streams flowing east to west, the entire buffer will be situated on the south side of the stream. On streams flowing north to south, the buffer will extend for one half site-potential tree height on each side of the stream.

- Silvicultural treatments, such as pre-commercial thinning, fertilization, and commercial thinning, should be evaluated and utilized to accelerate development of large wood, shade, and late successional stand structure in existing managed stands adjacent to perennial streams with substantial flows.

- Use of ground-based yarding equipment and road construction should not be permitted within one site potential tree height of wetlands, and use of this equipment or construction of new roads within an additional site potential tree height should only occur if site specific evaluation indicates that alteration of subsurface water patterns will not occur.

- Use of prescribed fire is consistent with the objectives of the water quality source areas, as it will not eliminate large wood, and may introduce some variability in the decay status of the retained trees. It may also spur growth of riparian shrub species, leading to a more diverse and abundant nutrient pool available to the streams within these areas.

H. Wetlands

Wetland habitats should be evaluated at the project level to develop appropriate prescriptions that maximize the likelihood that these habitats are sustained over time. Project evaluations should consider ecological processes that create and maintain wetlands, including the temporal dynamics and disturbance processes that may be important to these habitats. Existing conditions and the effects of potential management activities should be considered.

IV. Watershed restoration – road strategy

Studies have shown significantly higher rates of landslides associated with roads, and a linkage of roads to increased peak stream flows during flood events (Swanson and Dyrness 1975, Jones and Grant 1996, Jones et al. 1996, Wemple et al. 1996, Snyder 2000, Wemple et. al. 2001). In addition, roads occupy riparian areas, contribute to chronically higher sediment loads in some streams, obstruct movement of organisms, and impede delivery of organic and inorganic material to streams. Because of these adverse effects to aquatic ecosystems substantial restoration effort focuses on roads. Potential restoration projects in the Blue River watershed include road obliteration or decommissioning, road storage, road cut stabilization, side-cast stabilization, slide re-vegetation, culvert excavation or replacement, and obliteration and revegetation of landings and spur roads. The road analysis and restoration strategy summarized below provides guidance and priorities for road restoration activities in the Blue River watershed.

Road analysis process

Steep declines in road maintenance funding and risks to aquatic ecosystems and watershed processes from existing road conditions were identified in the Blue River watershed analysis (unpublished report on file at the McKenzie River Ranger District) as primary factors that should determine road restoration priorities and decisions. Thus the analysis process was focused on assessing risks to aquatic ecosystems, and to determine the relative needs for each road to support human uses of the watershed.

Each road was ranked by a set of aquatic risk indicators, assembled from a field inventory of roads and from GIS analyses (e.g., stream/road crossing density, sideslope steepness). Aquatic risk indicators were summed by the risk of initiation, risk of transport, and the magnitude of the potential effects on aquatic ecosystems for each of three major watershed processes (mass movement risk, fine sediment risk, hydrologic interaction risk). Ratings were summed by major watershed process, and then again for all processes to give a total rating for risks to aquatic ecosystems for each road.

Risks to aquatic ecosystems from roads were also assessed at the subdrainage scale to more completely deal with watershed processes operating at scales larger than individual roads or hillslopes, and to link with the long-term scheduling of timber harvest in the watershed. Long-term patterns of timber harvest were designed, in part, to provide long periods of time with relatively low needs for road access. Each of ten subdrainages within the watershed were ranked based on several criteria analyzed through GIS analyses (e.g., rain-on-snow susceptibility, road density). Subdrainages were then grouped into three broad classes: low, moderate, and relatively high risk to aquatic ecosystems.

A composite aquatic ecosystem risk rating for each road was assigned based on the individual road ranking and the subdrainage ranking (Table 4).

Subdrainage Risks	**Road Risks**		
	Low	***Moderate***	***High***
Low	Low	Low	Moderate
Moderate	Low	Moderate	High
High	Moderate	High	High

Table 4. Composite rating of risks to aquatic ecosystems from roads.

Future needs for human uses of roads were also assessed. Each road was rated for cultural, fire management, mining and minerals, private land access, recreation, research and monitoring, silvicultural, and timber product uses. Ratings were summed to give a total human use score for each road.

Further details of the analysis process are documented on the road portion of the Blue River Landscape Study website (www.fsl.orst.edu/ccem/brls/brls.html). Analysis results are stored in spreadsheets and GIS maps on file at the McKenzie River Ranger District.

Road restoration strategy

Road rankings were further assessed to determine the status of each road. Human use ratings were used to determine whether a road should remain on the forest road system or be removed from the road system, and for system roads were used to determine whether they should remain open or be closed for future use. Most roads were identified as candidates to remove from the forest road system. Roads slated to remain open as system roads were then further screened by their aquatic risk ratings. Roads determined to be a high risk to aquatic ecosystems were changed to a closed status. The aquatic risk ratings were also used to determine the priority for removing roads from the forest road system, to convert roads that remain on the forest system to closed status while ensuring self-maintenance, and to establish maintenance priorities for open roads. Thus each road was assigned to one of three categories: remove from forest road system, forest road system-closed, or forest road system-open. And each road was assigned a relative priority for actions needed to convert from the existing condition to the assigned status.

Specific treatments for road restoration are to be determined through road-specific project-level planning. Road restoration treatments are to be designed in a way that facilitates effectiveness monitoring of restoration treatments, and, where feasible, supports further research on the effects of roads.

V. Watershed restoration – other activities

Vegetation management regimes in this strategy are intended to restore landscape patterns and structure over time within the context of the goals of the Northwest Forest Plan. The intent is that the management of the overall landscape will enhance the ability to manage for more natural fire regimes without undue risk of resource loss or jeopardizing public and firefighter safety. Additional restoration of watershed functions and habitats is needed where past management actions have substantially altered stream flows, coarse wood input and storage, riparian and aquatic habitats, composition or abundance of aquatic taxa, sediment or temperature regimes, aquatic nutrient cycles, and migration or movement routes of aquatic organisms. Upslope disturbances prescribed in this strategy through timber harvest and prescribed fire are planned so that their frequency, severity and spatial pattern approximate historical patterns. An aquatic ecosystem able to function within a range of historical variability is also essential to maintain ecological functions and habitats and retain a capacity to recover from these disturbances. In some cases restoration actions will need to be sustained over time to ensure long-term recovery.

Restoration actions should be planned in the context of the larger landscape recognizing the connections among upslope and riparian forests, engineered structures, riparian and stream habitats, and stream ecology. For example, upland forest conditions affect stream habitat through modification of stream flow regimes, temperature, or in-stream structure. Similarly, roads affect riparian habitat, sediment and stream flow regimes, and movement routes of aquatic organisms. Blue River Reservoir and road-related barriers block fish migration affecting species composition and nutrient cycles.

Prescriptions for restoration projects should be identified based upon specific objectives for future conditions. For example, objectives for input rates of organic and inorganic material to streams, or for riparian vegetation should be developed prior to project design. Historical conditions for aquatic ecosystems provide important reference points for restoration objectives. Studies conducted on the H. J. Andrews Experimental Forest provide data to help estimate reference conditions. The FEMAT report (USDA and USDI 1993, Table V-J-1) identifies a wide variety of restoration measures that may be appropriate.

A. Locations of restoration activities

Three general approaches will be used in the restoration of Blue River watershed. One will focus on restoring the quality of aquatic and terrestrial habitat in drainages that are deferred from timber harvest. Another will focus on areas that are being entered for timber extraction. The last approach will be restoration methods utilized throughout the watershed, wherever the need occurs.

1. Reserves and deferred harvest areas

Watersheds and patches of varying size are anticipated to provide undisturbed late-successional habitat for extended periods of time so that organisms can repopulate areas negatively impacted by natural (e.g., wildfire or landslides) or human-initiated (e.g., timber harvest or prescribed fire) disturbances. These areas are distributed throughout the watershed where Special Area Reserves and Aquatic Reserves are designated. In addition, timber harvest is planned to concentrate in certain subwatersheds so that timber harvest can be delayed in other subwatersheds that currently function as high quality late-successional habitat. These habitats should generally receive first priority for restoration actions, with a particular emphasis on Cook and Quentin Creek subwatersheds where habitat for native cutthroat and rainbow trout exists. Potential restoration activities include addition of large wood to streams and the river, closure of roads (including the pulling of drainage structures), and riparian silviculture (including thinning, planting, release). Untreated stream reaches within these habitats can be considered as control sites for comparison with actively restored stream reaches, and with stream reaches in areas where timber harvest occurs, to evaluate the effectiveness of management activities.

2. Timber harvest areas

Timber harvest frequently occurs in locations that could benefit from watershed restoration activities, and can contribute restoration funding for the nearby area. Timber harvests are likely to occur in accessible areas where past road construction, clearcutting, and stream channel clearing may have adversely affected aquatic habitats and processes. In addition restoration or mitigation activities may need to occur in conjunction with future timber harvest or prescribed fire. Restoration activities can sometimes take advantage of heavy machinery that may be in the location due to logging operations. Timber harvest also creates funding opportunities for restoration through road reconstruction and maintenance funds, and through K-V fund deposits. Potential restoration projects include decreasing the impact of FS Road 15, obliteration of roads and skid trails, riparian silviculture activities, and increasing culvert capacities to accommodate 100-year flood events.

3. Other locations

A variety of additional restoration activities that could occur in the watershed without regard to timber harvest locations should be evaluated. These activities include:

- Work with ODF&W to strengthen wild trout in Blue River.
- Replace culverts at Ore Creek and Road 2620.126 to restore upstream fish passage.
- Restore the nutrients that spawned-out chinook salmon historically provided to Blue River. Work with ODF&W to dispose of spawned out chinook carcasses from the hatchery in historical Blue River chinook spawning areas.
- Develop a shoreline restoration plan for Blue River reservoir and implement high priority activities
- Develop and implement an eagle management plan for Blue River reservoir
- Determine the extent of the pollution left from the mining activities on Gold Hill, including the potential mercury in North Fork Quartz Creek. Develop a clean-up plan and implement and monitor as needed.

B. Watershed analysis

Watershed analysis conducted under guidance from the Northwest Forest Plan provides additional context for undertaking restoration activities. The Blue River watershed analysis (1996) assessed historical, existing, and potential future conditions, trends and uses. Recommendations from the watershed analysis have been incorporated throughout the Landscape Management and Watershed Restoration Strategy, including the basic concepts regarding the use of information on natural disturbance regimes.

C. Restoration types

In-stream structures

Placement of in-stream structures is an inherently short-term measure to restore channel and habitat complexity where existing conditions are degraded. The range of historical conditions in comparable streams should be used as an approximate guide for the amounts of large woods or other structures desired in streams. Trees located near streams can be placed back in streams or adjacent riparian areas. The highest benefits of installed in-stream structures may be in basins with low landslide frequencies, because basins with more frequent landsliding may have relatively rapid natural recovery. In-stream structures are also more likely to survive peak stream flows when installed in stream reaches of relatively low gradient (<4%). Subwatersheds where timber harvest is deferred should be emphasized for in-stream restoration activities.

Riparian vegetation

Silvicultural activities in riparian areas may be useful in restoring longer-term ecological functions. Planting, releasing or thinning to promote rapid establishment and growth of large conifers may accelerate the time where large wood can be input to streams channels at historical rates. Unstable areas, such as stream-side slides, may also benefit from revegetation. Subwatersheds where timber harvest is deferred should be emphasized for in-stream restoration activities.

Terrestrial habitats

A variety of additional activities to restore terrestrial habitats will likely be implemented. Potential projects include meadow burning, tree habitat enhancement (e.g., creation of bat roost sites), control of exotic plant species, and snag creation. Site-specific proposals for these activities will be evaluated for consistency with the Landscape Management and Watershed Restoration Strategy.

VI. Literature Cited

Adler, Peter B. 1994. "New forestry" in practice: a survey of mortality in green tree retention harvest units, western Cascades, Oregon. Cambridge, MA: Harvard College. 46 p. B.A. thesis.

Baker, W.L. 1992. The landscape ecology of large disturbances in the design and management of nature reserves. Landscape Ecology vol. 7:181-194.

Busby P., T.L. Warren, F.J. Swanson. 2001. A survey of the fates of residual trees in green tree retention units, western Cascades, Oregon. Report on file on Andrews LTER webpage. 24 p.

Cissel, John H., Swanson, Frederick J., Weisberg, Peter J. 1999. Landscape management using historical fire regimes: Blue River, Oregon. Ecological Applications 9(4): 1217-1231.

Cissel, John H., Swanson, Frederick J., Grant, Gordon, Olson, Dede, Gregory, Stanley, Garman, Steve, Ashkenas, Linda, Hunter, Matthew G., Kertis, Jane, Mayo, James, McSwain, Michelle, Swetland, Sam G., Swindle, Keith A., Wallin, David O. 1998. A disturbance-based landscape plan for a managed forest ecosystem: the Augusta Creek study. PNW GTR-422. USDA-Forest Service, Portland, OR. 82 p.

Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. US Gov. Print. Off., Washington D.C.

Hunter Jr., Malcom L. 1993. Natural fire regimes as spatial models for managing boreal forests. Biological Conservation 65:115-120.

Jones, J. A., G. E. Grant. 1996. Cumulative effects of forest harvest on peak streamflow in the western Cascades of Oregon. Water Resources Research 32(4): 959-974.

Jones, J.A., F.J. Swanson, B.C. Wemple, and K.U. Snyder. 2001. Road effects on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14:76-85.

Landres, Peter B., P. Morgan, F.J. Swanson. 1999. Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications 9(4): 1179-1188.

McGarigal, K., and B. J. Marks. 1995. FRAGSTATS: Spatial pattern analysis program for quantifying landscape structure. Gen. Tech. Rep. PNW-GTR-351. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 122 p.

Miller, G. S., S. DeStefano, K. A. Swindle, E. C. Meslow. 1996. Demography of northern spotted owls on the H. J. Andrews study area in the central Cascade mountains, Oregon. Studies in Avian Biology No. 17: 37-46.

Mladenoff, David J., Mark A. White, John Pastor, and Thomas R. Crow. 1993. Comparing spatial pattern in unaltered old-growth and disturbed forest landscapes. Ecological Applications 3(2): 294-306.

Morrison, P.; Swanson, F.J. 1990. Fire history and pattern in a Cascade Range landscape. Gen. Tech. Rep. PNW-GTR-254. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Snyder, K.U. 2000. Debris flows and flood disturbance in small, mountain streams. MS thesis. Oregon State University. 53p.

Stuart-Smith, K., D. Hebert. 1996. Putting sustainable forestry into practice at Alberta-Pacific. Canadian Forest Industries, April-May: 57-60.

Swanson, F. J. and C.T. Dyrness. 1975. Impact of clearcutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology, vol.3, p. 393-396.

Swanson, F. J. and M.E. James. 1975. Geology and geomorphology of the H. J. Andrews Experimental Forest, western Cascades, Oregon. Res. Pap. PNW-188. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14P.

Swanson, F. J., J. A. Jones, D. O. Wallin, and J. H. Cissel. 1993. Natural Variability - Implications for Ecosystem Management. In: Jensen, M. E. and P.S. Bourgeron eds. Eastside Forest Ecosystem Health Assessment - Volume II: Ecosystem management: principles and applications. Portland, OR: USDA Forest Service, Pacific Northwest Research Station: 89-103.

Teensma, P. D. A. 1987. Fire history and fire regimes of the central western Cascades of Oregon. Ph.D. Dissertation, Univ. of Oregon. Eugene, OR.

USDA Forest Service. 1990. Land and resource management plan, Willamette National Forest. Willamette National Forest, Eugene, OR.

USDA Forest Service and USDI Bureau of Land Management. 1994. Record of decision for amendments for Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. USDA For. Serv. and USDI Bur. Land Manage. 74 p.

USDA Forest Service, Willamette National Forest. 1996. Blue River Watershed Analysis. Informal report on file at the Blue River Ranger District office.

Weisberg. Peter. 1996. Blue River Fire Regime Analysis and Description. Informal report on file at the Blue River Ranger District office.

Weisberg. Peter J. 1998. Fire history, fire regimes, and development of forest structure in the central western Oregon Cascades. Ph.D. Dissertation. Oregon State University, Corvallis, OR. 256 p.

Wemple, B. C.; Jones, J. A.; Grant, G. E. 1996. Channel network extension by logging roads in two basins, western Cascades, Oregon. Water Resources Bulletin Vol. 32(6): 1195 -1207.

Wemple, B.C., F.J. Swanson , and J.A. Jones. 2001. Forest roads and geomorphic process interactions, Cascade Range, Oregon. Earth Surface Processes and Landforms. 26:191-204.

Appendix A – Implementation methods and examples for designation of retention trees

Placement of Retention Trees
Seven Steps To Follow

1- Determine if block is in a Sediment/Large Wood Source Area or a Water Quality Source Area. Apply each prescription element as described.

Course Sediment/Large Wood Source Areas

Apply a 50% Canopy Retention evenly spaced if any of the following conditions occur:

- Blocks are dominated by very steep slopes over 70% with shallow soils.
- Block have a high drainage density.
- Blocks are adjacent to or immediately above response stream reaches with high aquatic values and populations of spring chinook or cutthroat trout.

Fine Sediment/Large Wood Source Areas

Apply a 100% Canopy Retention along Class III and IV streams within identified earthflow or glacial deposits according to the following chart. Trees left will be considered extra to the retention trees for the block.

Stream Class	Side of Stream for Buffer	Width of Buffer	Percent Canopy Cover
Class III	Each Side	1 site tree	100%
Class IV	Each Side	_ to 1 site tree	100%

Water Quality Source Area Table

Perennial Stream Orientation	Side of Stream for Buffer	Width of Buffer	Percent Canopy Cover
East-West	South Side	1 site tree	70%
North-South	Each Side	_ site tree	70%

2 - Determine if there are any Class III perennial streams. Use table to determine the retention level along the streams. Trees left will be considered extra to the retention trees for the block.

Landscape Area	Side of Stream for Buffer	Width of Buffer	Percent Canopy Cover
LA – 1	Each Side	_ site tree	70%
LA – 2	Each Side	_ site tree	50%
LA – 3	Each Side	_ site tree	30%

3 - Determine if there are any Class IV intermittent streams. Use table to determine the retention level along the streams.

Landscape Area	Side of Stream for Buffer	Width of Buffer	Percent Canopy Cover
LA – 1	Each Side	_ site tree	50%
LA – 2	Each Side	_ site tree	30%
LA – 3	Each Side	_ site tree	15%

4 - Determine 100% Canopy Closure (CC) areas.

a) Using the Spatial Pattern of Retention Trees (Appendix A), determine the Proportion of harvested area in 100% Canopy Closure.

b) Determine the locations of 100% CC areas along Class III and IV streams in Landscape Area 3.

Landscape Area	Side of Stream for Buffer	Width of Buffer Per 1000 ft. of reach	Percent Canopy Cover
LA – 1	N/A	N/A	N/A
LA - 2	N/A	N/A	N/A
LA – 3	Each Side	_ acre	100%

c) Calculate the area to receive 100% CC. Place these 100% CC areas using the Rules of Retention.

5 - Determine 0% Canopy Closure (CC) areas.

a) Determine area and size in 0% CC using the following rules of thumb:
   1) Landscape Area 1 should have twice as many 100% areas as 0% areas.
   2) Landscape Area 2 should have the same ratio of 100% areas as 0% areas.
   3) Landscape Area 3 should have twice as many 0% areas as 100% areas.

b) Determine placement of 0% CC areas using Rules of Retention.

6 - Determine number of trees to scatter using the Spatial Pattern of Retention Trees (Appendix A) and corresponding Canopy Cover percentage. Decide on the location of trees to scatter. Use the average canopy cover percentage of the average tree, determine the number of trees that will need to be scattered. Place these trees in locations according to the Rules of Retention.

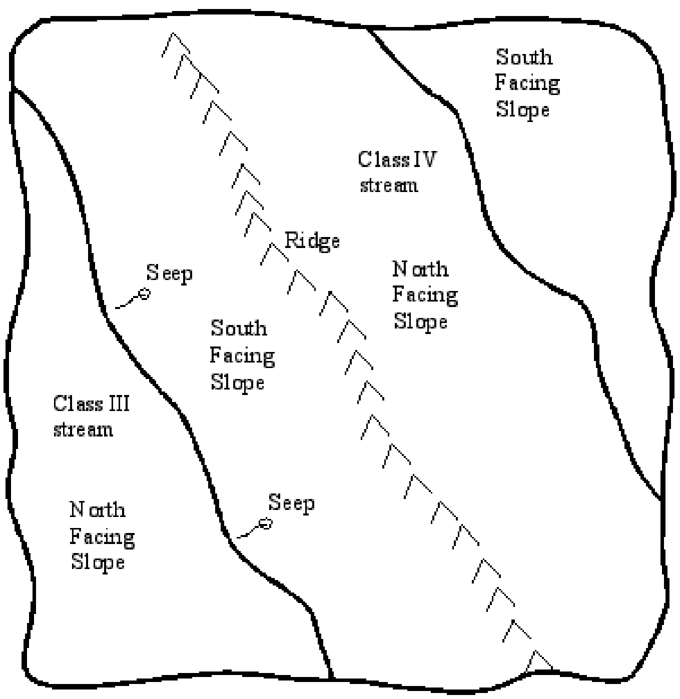
7- Place wildlife trees and down wood trees using the following table. Apply the percentage to the original stand trees per acre >18" DBH.

Snag and Down Wood Percentages

Landscape Area	Percentage of Trees >18"DBH in Original Stand to Leave for Snags	Amount to Leave for Down Wood
LA –1	5%	3 TPA
LA –2	15%	3 TPA
LA –3	30%	3 TPA

Scenario 1
Landscape Area 3
Perennial (Class III) and Intermittent (Class IV) Streams

Given:
Landscape Area 3
100 acre Landscape Block
3000 ft Class III perennial stream, 10 acres within a half site tree either side of stream
2000 ft Class IV intermittent stream, 7 acres within a half site tree either side of stream
30 acres in north facing slopes
42 acres in south facing slopes

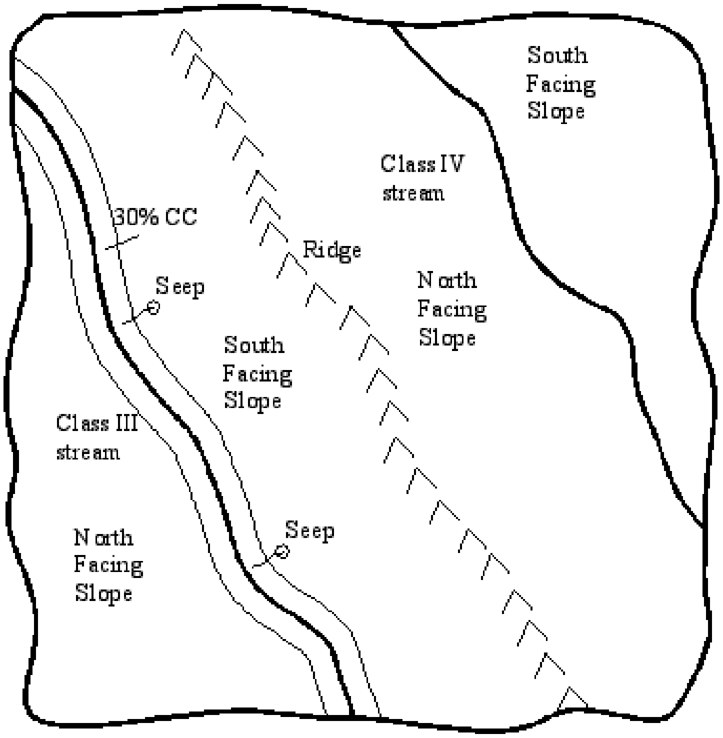


Step 1.

1 - Block does not contain a Sediment/Large Wood Source Area or Water Quality Source Area.

2 - Determine the retention level along the Class III streams:

Leave 30% retention within _ site tree (75 feet) both sides of creek in Landscape Area 3. These trees are considered <u>extra</u> to the retention trees.

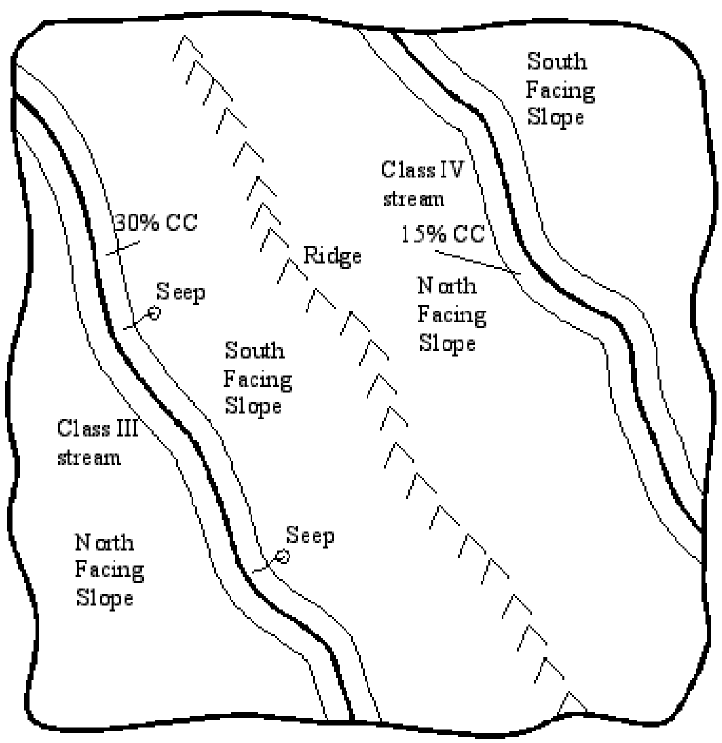


3 - Determine the retention level along the Class IV streams:

Leave 15% retention within _ site tree (75 feet) both sides of creek in Landscape Area 3. Calculate the trees needed and subtract from retention trees.

Average Tree is 20 inches, which has a 1% canopy per acre.

15% x 7 acres x 1% per avg tree = 105 trees needed.



4 - Determine 100% Canopy Closure (CC) areas.

a) IDT chooses 4% of the area to be in 100% CC from Appendix A.

4 % of 100 acres is 4 acres.

b) Both the Class III and Class IV streams will need 100% CC areas along the streams.

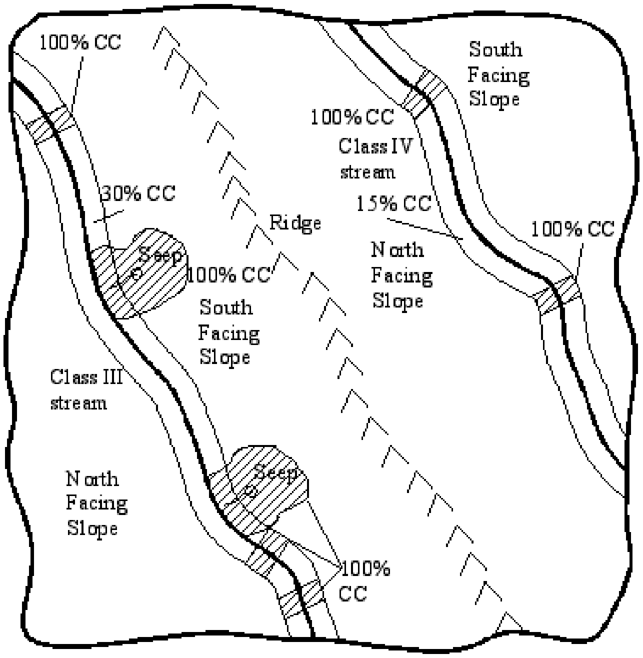
Class III and IV streams need one _ acre 100% CC area for every 1000 reach.

5000 feet of stream/ 1000 feet = 5 _ acre 100% CC areas needed.

5 x _ acre = 1.25 acres in 100% CC along streams.

c) There are 2.75 acres remaining of 100% CC that need to be placed in the block.
4 acres 100%CC – 1.25 acres along stream = 2.75 acres

The IDT has determined that the 2.75 acres will be placed around seeps.



5 - Determine 0% Canopy Closure (CC) areas.

a) Create one 0% CC area that is twice as large as the 100% CC area.

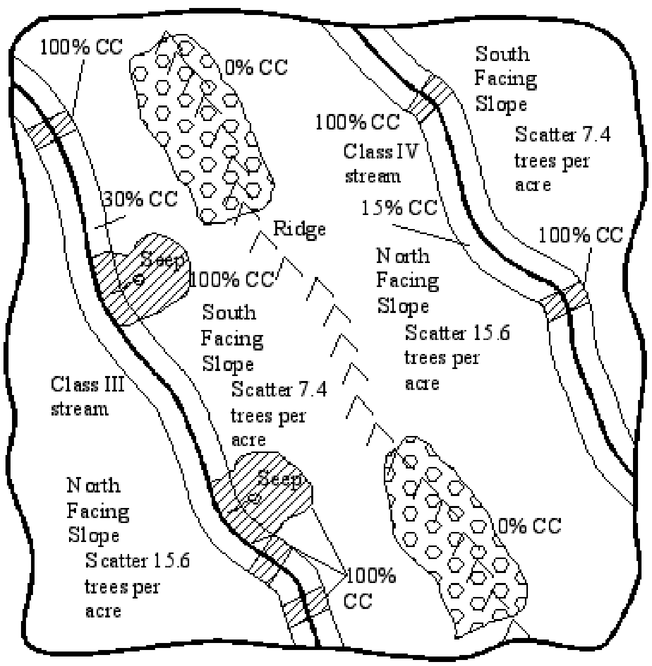
2 times 4 acres = 8 acres

b) IDT places the 0% CC area on ridge top in two separate areas.

Determine number of trees to scatter.

100	acres
- 10	acres along Class III stream
- 4	acres of 100% CC area
- 7	acres along Class IV stream
- 8	acres of 0% area
71	acres to scatter trees across

4% of area in 100%CC results in 70% of the retention trees scattered. This results in an 11% CC of the scattered trees.



Since the average tree size is 20 inches, and a 20 inch tree equals 1% canopy per acre, there will need to be on the average, 11 trees per acre.
11 trees per acre x 71 acres = 781 trees total to scatter.

6 - Decide location of trees to scatter.

a) Place 60% of the scattered trees on the north facing slopes.

781 trees x 60% = 469 trees to scatter over 30 acres (15.6 trees per acre)

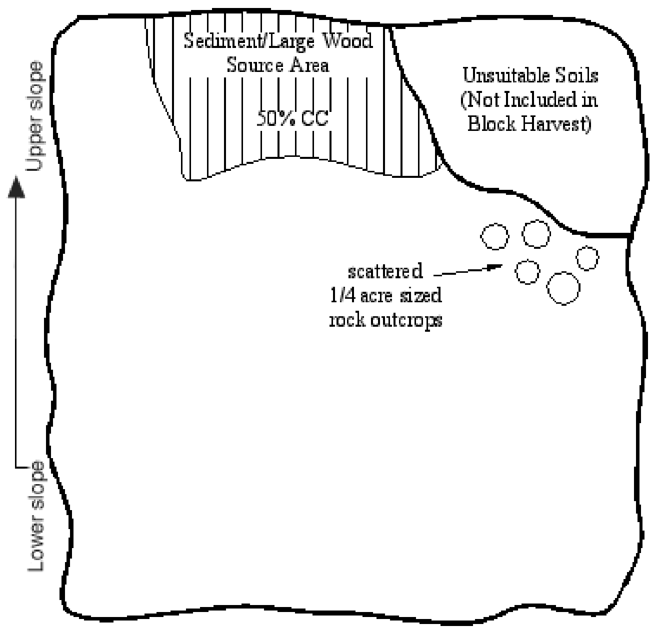
b) Place 40% of the scattered trees in the south facing slopes.

781 trees x 40% = 312 trees to scatter over 42.2 acres (7.4 trees per acre)

7 - Scatter 15% of the original stand of the trees for wildlife and down wood trees.

Scenario 2
Landscape Area 2

Given:
100 acre Landscape Block
20 acres unsuitable soil
11 acres in Sediment/Large Wood Source Area



Step 1 - Determine if block is in a Sediment/Large Wood Source Area or a Water Quality Source Area.

Block contains a Sediment/Large Wood Source Area of approximately 11acres. Leave a canopy closure of 50% evenly scattered across the Sediment/Large Wood Source Area. The trees being scattered will not count against the retention trees for the block.

Average Tree is 20 inches, which has a 1% canopy per acre. 50% x 11 acres x 1% CC avg per tree = 550 trees needed.

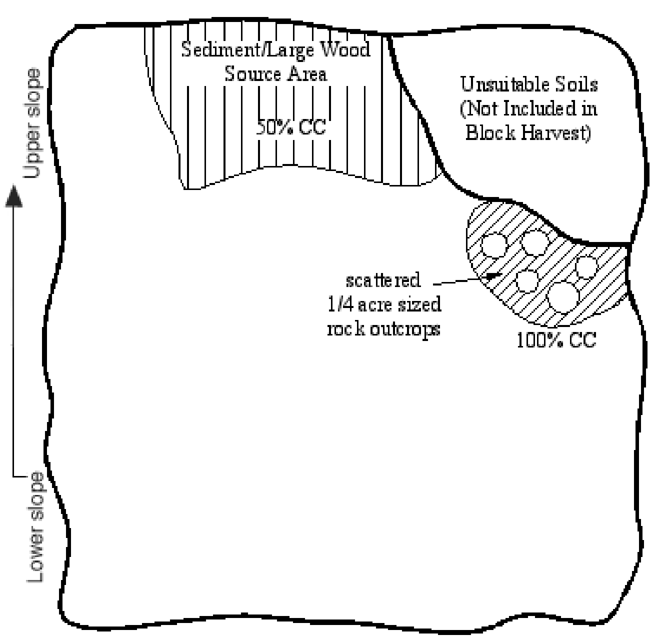
Block is not in a Water Quality Source Area.

Step 2 - Determine if there are any Class III perennial streams.

There are no Class III streams.

Step 3 - Determine if there are any Class IV intermittent streams.

There are no Class IV streams.



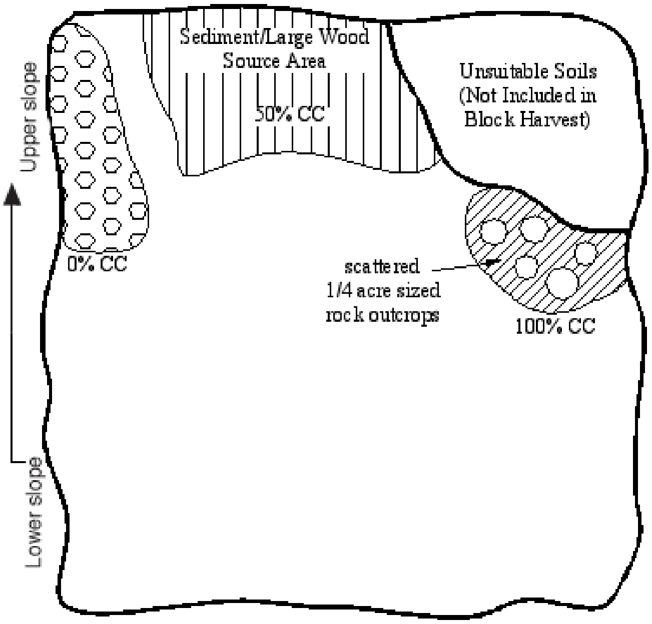
Step 4 – Determine 100% Canopy Closure (CC) areas.

a) IDT chooses 9% of the area to be in 100% CC from Appendix A.

100 acres - 20 acres unsuitable not counted in block acres = 80 acres
9 % of 80 acres is 8 acres.

b) There are no streams, which will need any 100% CC areas.

c) IDT determines that all of the 8 acres of 100% CC should be placed in area of scattered unmappable unsuitable areas and that it should tie in with the larger unsuitable area.

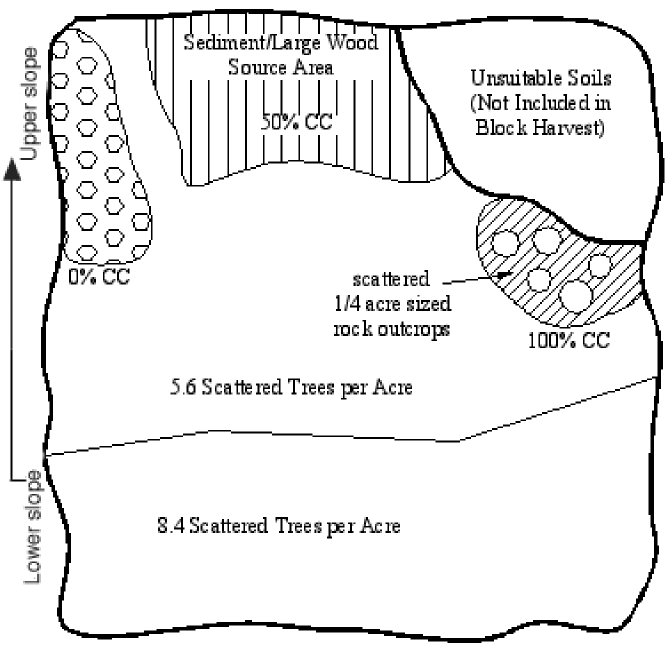


Step 5 - Determine 0% Canopy Closure (CC) areas.

a) Create one 0% CC area that is approximately the same size as the 100% CC area.

2 times 8 acres = 16 acres

b) Place 0% CC area on upper slopes.



Step 6 - Determine number of trees to scatter.

80 acres – (8 acres of 100% and 16 acres of 0%) = 56 acres
9% of area in 100% results in 40% of the retention trees scattered. This results in a 7% CC of the scattered trees.

Since the average tree size is 22 inches, and a 22 inch tree equals 1% canopy per acre, there will need to be on the average, 7 trees per acre.
7 trees per acre x 56 acres = 392 trees total to scatter.

Decide on location of trees to scatter.

a) Place 60% of the scattered trees in the lower half of the slope.

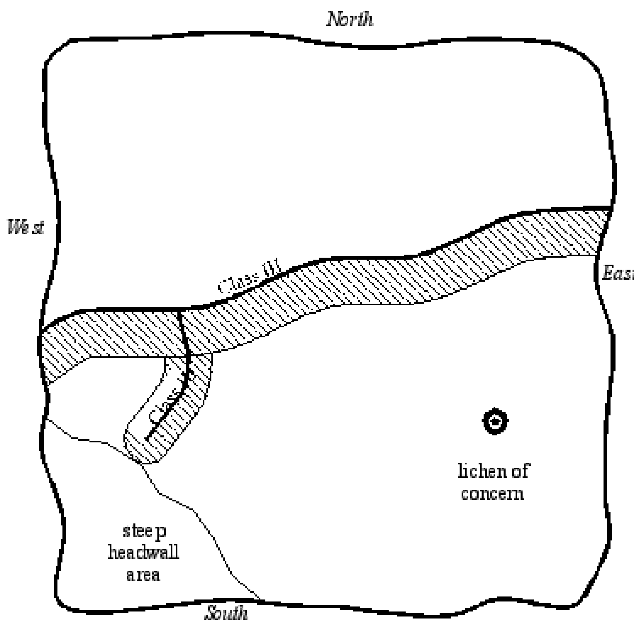
392 trees x 60% = 235 trees to scatter over 28 acres (8.4 trees per acre)

b) Place 40% of the scattered trees in the lower half of the slope.

392 trees x 40% = 157 trees to scatter over 28 acres (5.6 trees per acre)

Step 7 – Determine number and location of wildlife and down wood trees.
Scatter 10% of the original stand of the trees for wildlife and down wood trees.

Scenario 3
Landscape Area 1
Perennial (Class III) and Intermittent (Class IV) Streams in LA1



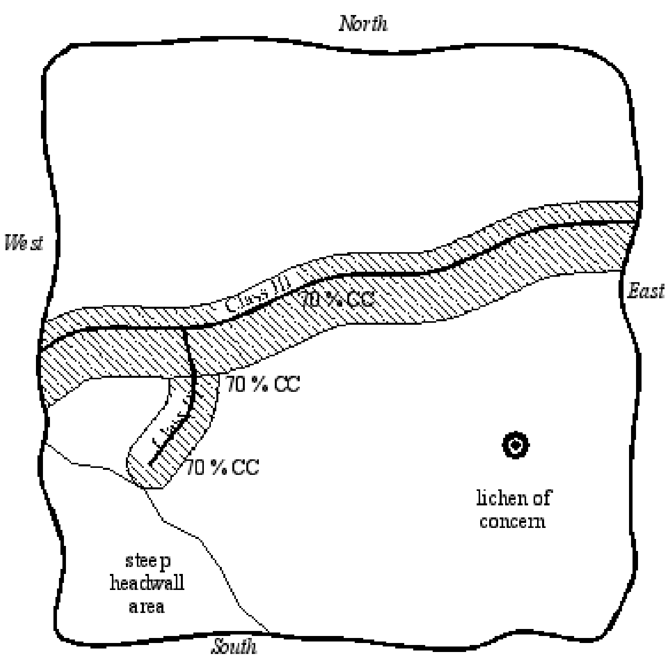
Given:
Landscape Area 1
100 acre Landscape Block
4000 ft Class III perennial stream, 20 acres in reserves within either side of stream
30 acres in north facing slopes
20 acres in south facing slopes

1 - Block does not contains a Sediment/Large Wood Source Area.

Block is in a Water Quality Source Area.

Leave 70% CC on the south side of the east-west running stream for a distance of 1 site tree. Leave no buffer on the north side of the same stream. Leave 70% CC on both sides of the north-south running stream for a distance of _ half site tree on each side. The trees being placed for 100% CC will not count against the retention trees for the block.

2 - Determine the retention level along the Class III streams.

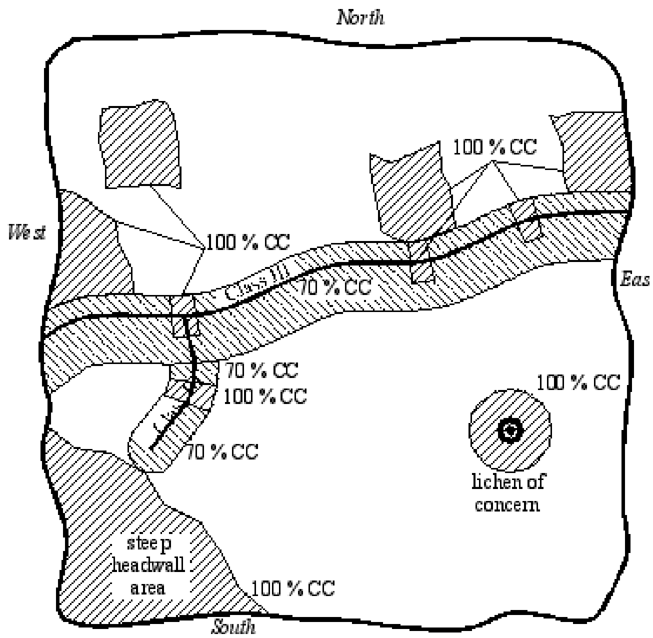


Since the south side of the east-west facing stream is being buffered due to the stream being in a Water Quality Source Area, then only the north side will need the standard Class III stream treatment of 70% CC retention a distance of _ site tree.

The north-south stream is also buffered because of the Water Quality Source Area. The buffer distance and canopy matches that of what is required with the standard Class III treatment.

These trees are considered extra to the retention trees.

3 - There are no Class IV streams.



4 - Determine 100% Canopy Closure (CC) areas.

a) IDT chooses 20% of the area to be in 100% CC using Appendix A.

20 % of 100 acres is 20 acres.

b) Both Class III streams will need the required 100% CC areas.
(see matrix on stream retention).

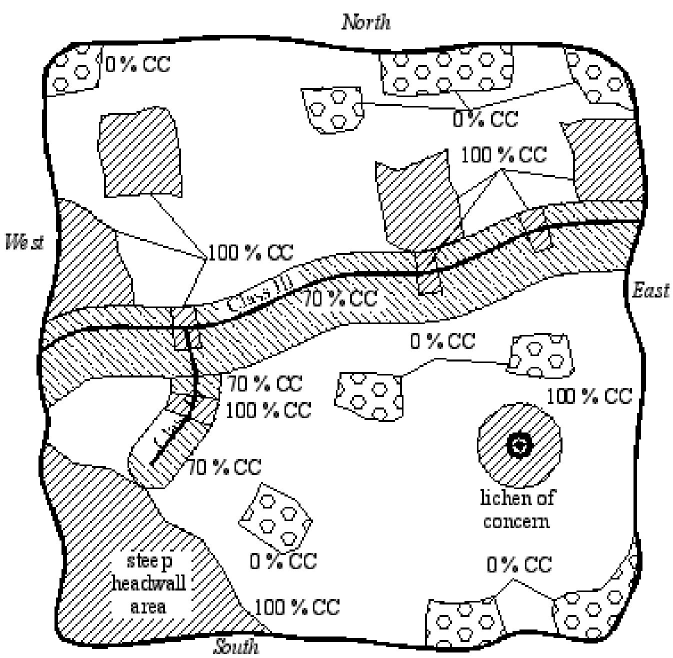
c) Class III streams need a _ acre 100% CC area for every 1000 feet of reach.

4000 feet of stream/ 1000 feet = 4 _ acre 100% CC areas needed.

4 x _ acre = 1 acre in 100% CC along streams.

d) There are 19 acres remaining of 100% CC that need to be placed in block.
20 acres 100%CC - 1 acres along stream = 18 acres

IDT determines that the 18 acres of 100%CC will be placed around the lichen of concern, the steep headwall area, and scattered in the block in four clumps.



5 - Determine 0% Canopy Closure (CC) areas.

a) Create 0% CC areas that total about half the area as the 100% CC areas.

Half of the 20 acres in 100%CC = 10 acres in 0%CC.

b) IDT determines size of 0%CC to be large enough to facilitate the regeneration of Douglas-fir (approximately 1 tree height in size) which results in a _ acre size gap. The IDT decides to scatter the 0% CC gaps across the block in 9 to 10 clumps.

6 - Determine number of trees to scatter.

100	acres
- 20	acres along Class III streams
- 20	acres of 100%CC area
- 10	acres of 0% area
50	acres to scatter trees across

20% of area in 100%CC results in 61% of the retention trees scattered. This results in a 37% CC of the scattered trees.

Since the average tree size is 20 inches, and a 20 inch tree equals 1% canopy per acre, there will need to be on the average, 37 trees per acre.
37 trees per acre x 50 acres = 1850 trees total to scatter.

Determine amount and area of trees to scatter.

a) The IDT decided that the north facing slopes should have a Canopy Closure of 40%. To accomplish this, 40 trees per acre will need to be left.

40 trees per acre = 1200 trees to scattered over 30 acres

b) The balance of the scattered trees should be placed on the south facing slopes.

1850 trees – 1200 trees = 650 trees/ 20 acres = 33 trees per acre (33% CC)

Step 7 – Determine number and location of wildlife and down wood trees.
Scatter 5% of the original stand of the trees for wildlife and down wood trees.